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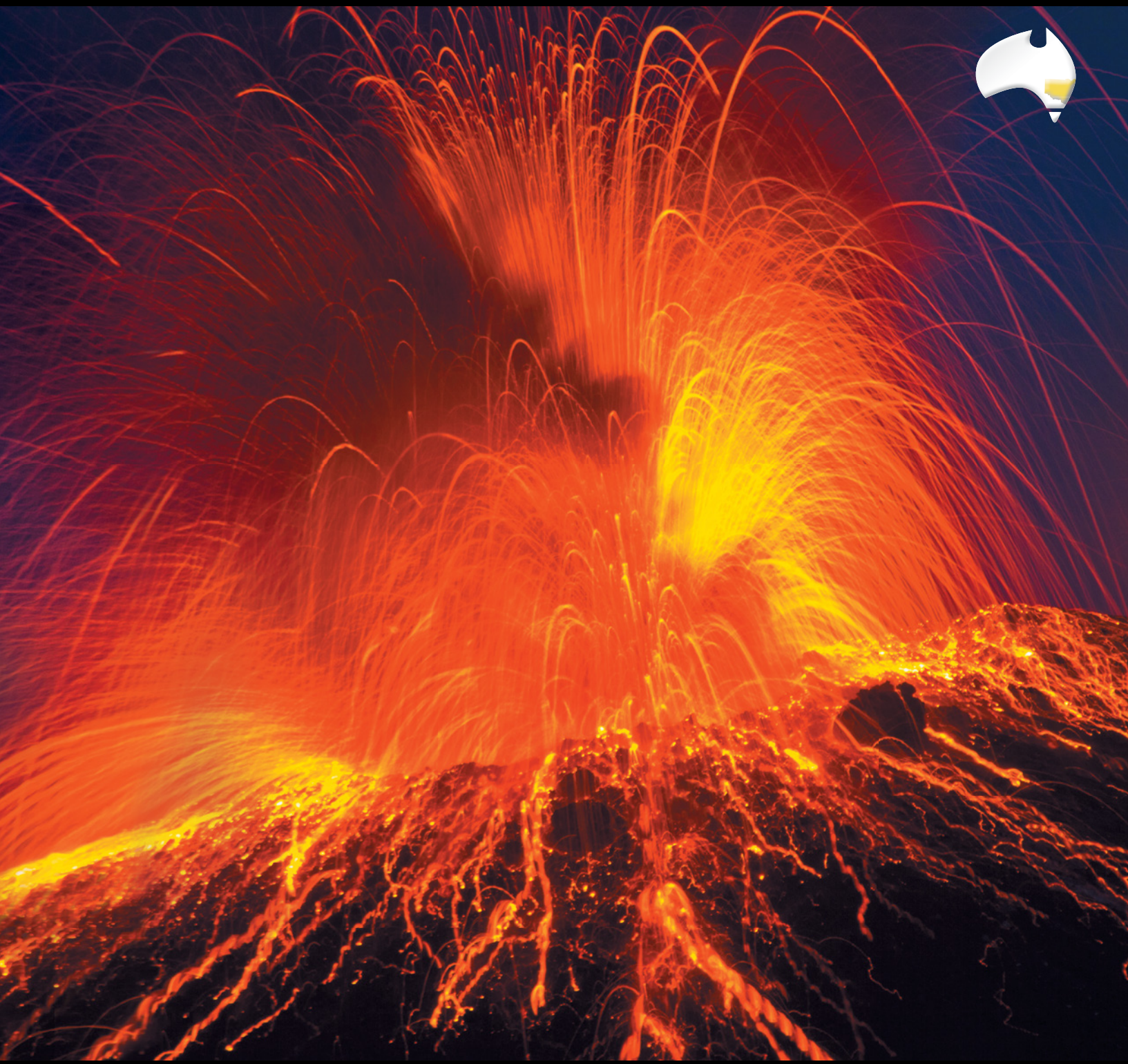
NSW AUSTRALIAN CURRICULUM **GEOGRAPHY STAGE 4** FOURTH EDITION



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NSW AUSTRALIAN CURRICULUM GEOGRAPHY STAGE 4 FOURTH EDITION

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It is recommended that teachers should first preview resources on Indigenous topics in relation to their suitability for the class level or situation. It is also suggested that Indigenous parents or community members be invited to help assess the resources to be shown to Indigenous children. At all times the guidelines laid down by the relevant educational authorities should be followed.

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HOW TO USE THIS RESOURCE

Jacaranda Geoactive 1 NSW Australian Curriculum Geography Stage 4, 4th Edition, consists of your textbook as well as a wealth of online resources. The structure and features of the textbook and eBookPLUS are described here.

Easily identifiable visual material is referenced in the text and in activities.

myWorld Atlas links extend and deepen your understanding.

'Geographical concepts' is a valuable reference section that covers each of the seven concepts.

Each concept is clearly defined.

A variety of visual resources support the explanations.

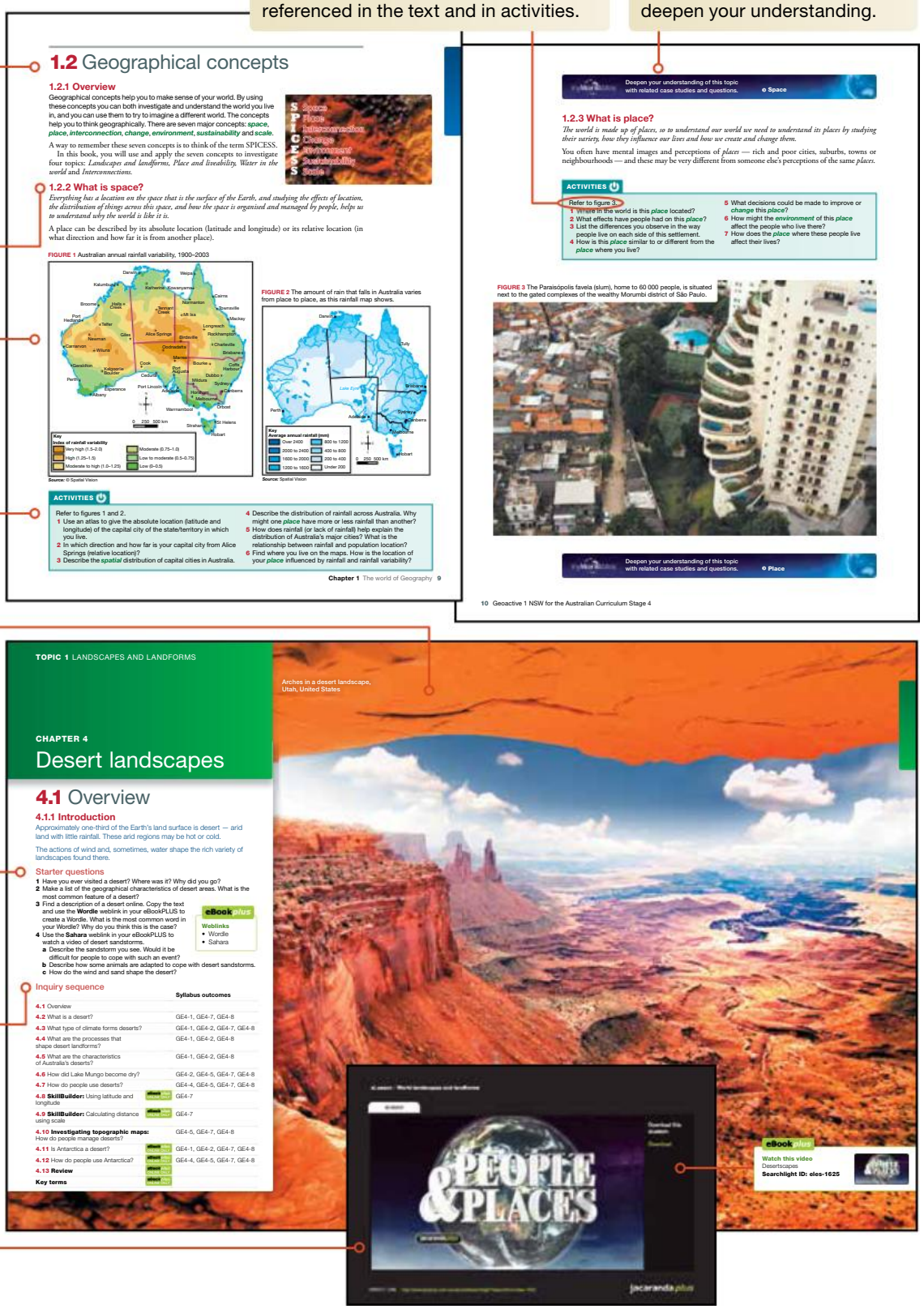
A series of activities to build and develop your understanding of each concept is provided.

Evocative and informative images stimulate interest and discussion.

Starter questions raise issues, link the chapter to your life, and prompt you to think about what you already know and feel about the topic being investigated.

A sequence for your inquiry is provided.

A specially commissioned *People and places* video clip provides an overview of each chapter.



Each section begins with a clearly identifiable spread number and inquiry question.

Integrated digital resources reinforce and expand understanding.

Key terms are explained.

Engaging and informative visuals promote understanding.

Scaffolding is provided to assist you to write extended written pieces and develop literacy skills.

Graded activities address the NSW syllabus for the Australian curriculum.

References to online material to go to next are provided.

This section includes a range of different activities useful for reviewing the chapter, especially prior to a test.

Italicised key concepts are applied to the content in the spread.

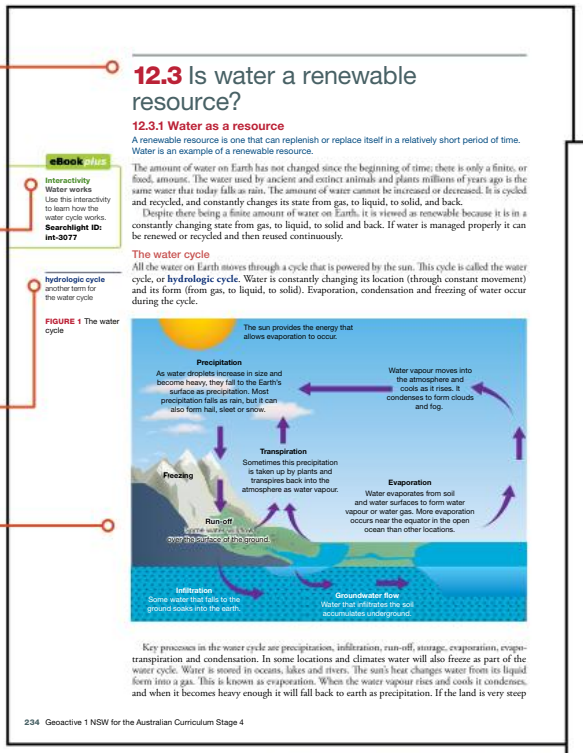
Develop your map interpretation skills in the context of the topic you are investigating.

Introductory text, maps and images provide background information.

Succinct summaries of geographical tools are provided.

Graded activities guide analysis of each topographic map extract.

Clear and custom-designed topographic maps enable development of map interpretation skills.



12.3 Is water a renewable resource?

12.3.1 Water as a resource

A renewable resource is one that can replenish or replace itself in a relatively short period of time. Water is an example of a renewable resource.

eBook plus
Interactivity
Water works
Use this interactivity to learn how the water cycle works.
Searchlight ID: int-3077

The amount of water on Earth has not changed since the beginning of time; there is only a finite, or fixed, amount. The water used by ancient and extinct animals and plants millions of years ago is the same water that today falls as rain. The amount of water cannot be increased or decreased. It is cycled and recycled, and constantly changes its state from gas, to liquid, to solid, and back.

Despite there being a finite amount of water on Earth, it is viewed as renewable because it is in a constantly changing state from gas, to liquid, to solid and back. If water is managed properly it can be renewed or recycled and then reused continuously.

The water cycle

All the water on Earth moves through a cycle that is powered by the sun. This cycle is called the water cycle, or **hydrologic cycle**. Water is constantly changing its location (through constant movement) and its form (from gas, to liquid, to solid). Evaporation, condensation and freezing of water occur during the cycle.

hydrologic cycle
another term for the water cycle

FIGURE 1 The water cycle

Key processes in the water cycle are precipitation, infiltration, run-off, storage, evaporation, evapotranspiration and condensation. In some locations and climates water will also freeze as part of the water cycle. Water is stored in oceans, lakes and rivers. The sun's heat changes water from its liquid form into a gas. This is known as evaporation. When the water vapour rises and cools it condenses, and when it becomes heavy enough it will fall back to earth as precipitation. If the land is very steep

FIGURE 4 Australia's aid is more focused on the Asia-Pacific and Indian Ocean regions.

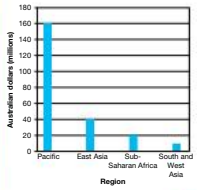


FIGURE 5 Emergency supplies of food and water assist communities severely affected by natural hazards.

FIGURE 6 Australian aid in the Pacific region

FIGURE 7 Bulk quantities of aid are delivered by the Australian defence force.

ACTIVITIES

IDENTIFY
1 What forms of foreign aid are donated by countries?
2 What regions of the world receive most of Australia's aid funding and why do you think this is so?

EXPLAIN
3 What reasons can you put forward to explain why Australia's foreign aid programs are worthwhile in terms of Australia's *interconnections* with its neighbours?
4 Is there a case that could be argued for cutting aid budgets? Explain your reasons.

INVESTIGATE
5 Conduct internet research to find out how the Sustainable Development Goals guide Australia's foreign aid program.
6 a Why is the Pacific region such an important *place* for the distribution of Australian aid?
b Why does South and West Asia receive little foreign aid from Australia?

APPLY
7 If Australia were to stop donations of aid, what *changes* do you think this would have on Australia's reputation in the international community?
8 What elements of Australia's aid do you think will have the greatest impact on the lives of people in the Pacific region? Give reasons for your selection.
9 Can you suggest a better way of distributing the budget dollars of the Australia's aid program in order to improve the lives of people in the Asia-Pacific region?
10 If Australia's economic prosperity were to decline in the next 50 years, what elements of Australia's aid program do you believe would not be *sustainable*?

eBook plus ONLINE ONLY

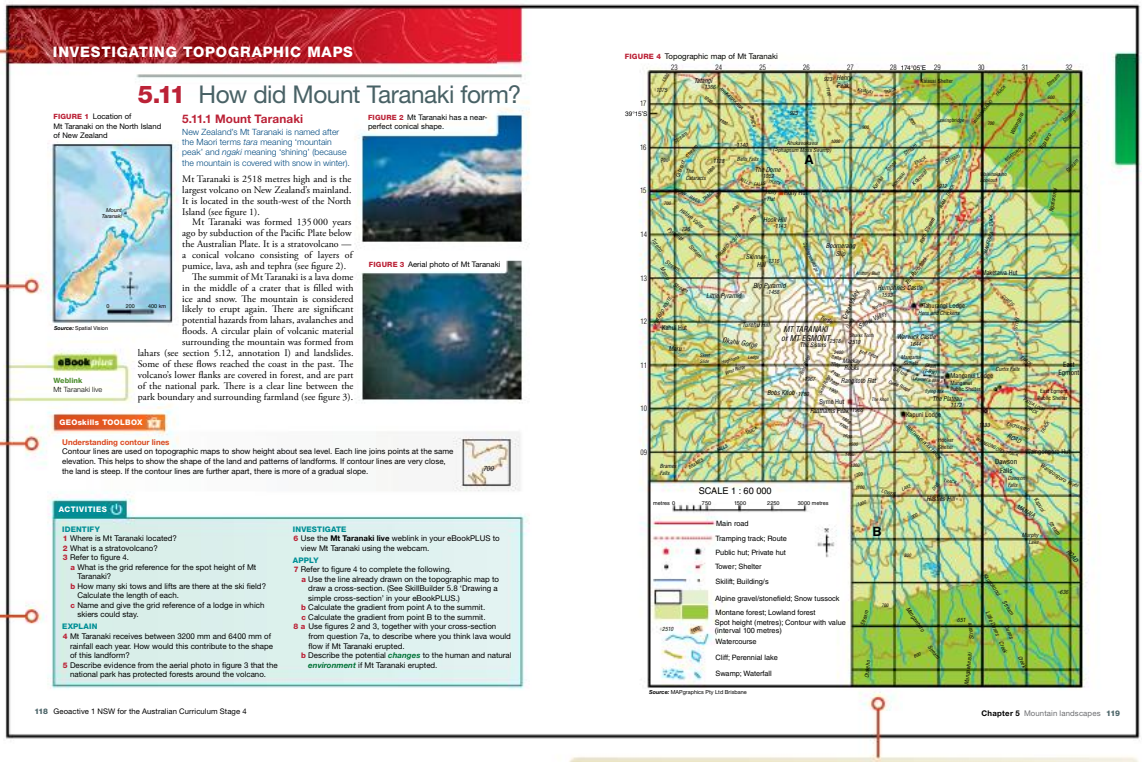
19.13 Why is the illegal wildlife trade a cause for concern?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBook plus ONLINE ONLY

19.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.



INVESTIGATING TOPOGRAPHIC MAPS

5.11 How did Mount Taranaki form?

FIGURE 1 Location of Mt Taranaki on the North Island of New Zealand

Source: Spatial Vision

5.11.1 Mount Taranaki

New Zealand's Mt Taranaki is named after the Maori terms *tara* meaning 'mountain peak' and *ngaki* meaning 'shining' (because the mountain is covered with snow in winter).

Mt Taranaki is 2518 metres high and is the largest volcano on New Zealand's mainland. It is located in the south-west of the North Island (see figure 1).

Mt Taranaki was formed 135 000 years ago by subduction of the Pacific Plate below the Australian Plate. It is a stratovolcano — a conical volcano consisting of layers of pumice, lava, ash and tephra (see figure 2).

The summit of Mt Taranaki is a lava dome in the middle of a crater that is filled with ice and snow. The mountain is considered likely to erupt again. There are significant potential hazards from lahars, avalanches and floods. A circular plain of volcanic material surrounding the mountain was formed from lahars (see section 5.12, annotation I) and landslides. Some of these flows reached the coast in the past. The volcano's lower flanks are covered in forest, and are part of the national park. There is a clear line between the park boundary and surrounding farmland (see figure 3).

FIGURE 2 Mt Taranaki has a near-perfect conical shape.

FIGURE 3 Aerial photo of Mt Taranaki

eBook plus
Weblink
Mt Taranaki live

GEOskills TOOLBOX

Understanding contour lines

Contour lines are used on topographic maps to show height about sea level. Each line joins points at the same elevation. This helps to show the shape of the land and patterns of landforms. If contour lines are very close, the land is steep. If the contour lines are further apart, there is more of a gradual slope.

ACTIVITIES

IDENTIFY
1 Where is Mt Taranaki located?
2 What is a stratovolcano?
3 Refer to figure 4.
a What is the grid reference for the spot height of Mt Taranaki?
b How many ski tows and lifts are there at the ski field? Calculate the length of each.
c Name and give the grid reference of a lodge in which skiers could stay.

EXPLAIN
4 Mt Taranaki receives between 3200 mm and 6400 mm of rainfall each year. How would this contribute to the shape of this landform?
5 Describe evidence from the aerial photo in figure 3 that the national park has protected forests around the volcano.

INVESTIGATE
6 Use the **Mt Taranaki live** weblink in your eBookPLUS to view Mt Taranaki using the webcam.

APPLY
7 Refer to figure 4 to complete the following.
a Use the line already drawn on the topographic map to draw a cross-section. (See SkillBuilder 5.8 'Drawing a simple cross-section' in your eBookPLUS.)
b Calculate the gradient from point A to the summit.
c Calculate the gradient from point B to the summit.
8 a Use figures 2 and 3, together with your cross-section from question 7a, to describe where you think lava would flow if Mt Taranaki erupted.
b Describe the potential *changes* to the human and natural *environment* if Mt Taranaki erupted.

FIGURE 4 Topographic map of Mt Taranaki

Source: MAPgraphics Pty Ltd Brisbane

Integrated digital resources reinforce and expand understanding.

Two SkillBuilder links for each chapter develop and model key geographical skills in context.

Ideas, information and tips help you collect, process and communicate fieldwork data.

The Fieldwork Inquiry and Geographical Inquiry ProjectsPLUS provide you with an opportunity to develop your inquiry skills in the field and through research.

You are guided through creative online projects using ProjectsPLUS. These are designed to engage students and provide quality assessment support for teachers, with an innovative management system featuring multimedia and project templates.

New worksheets have been designed to consolidate learning for students with learning support needs (including Life Skills students). Each worksheet is mapped to a life skill outcome.

About SkillBuilders

SkillBuilder: Cardinal points: wind rose

Tell me

What are wind roses?

A wind rose is a diagram that shows the main direction of wind. It shows wind direction, speed and frequency. Wind directions can be divided into eight or sixteen compass directions.

Before you can understand a wind rose, you must know your cardinal points. Let's quickly revisit these first.

Cardinal points

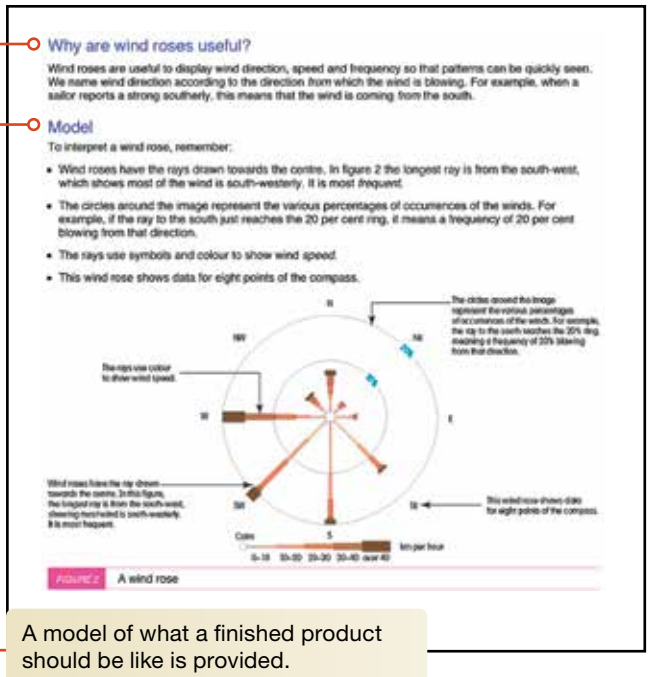
A compass has four main (or cardinal) points: north, east, south and west. These four cardinal points are used to describe direction. For example, if you are facing north, then south is behind you, east is to your right and west is to your left.

To give more accurate directions, the four cardinal points can be divided again into inter-cardinal points: north-east, south-east, south-west and north-west. For even finer definition, points that divide each inter-cardinal point are shown in figure 1. Cardinal and inter-cardinal points are used in wind roses.

Each skill is clearly defined.

eLessons visually explain, and model, the steps in the process for each skill.

The importance of the skill for you as a Geography student is explained.


Why are wind roses useful?

Wind roses are useful to display wind direction, speed and frequency so that patterns can be quickly seen. We name wind direction according to the direction from which the wind is blowing. For example, when a sailor reports a strong southerly, this means that the wind is coming from the south.

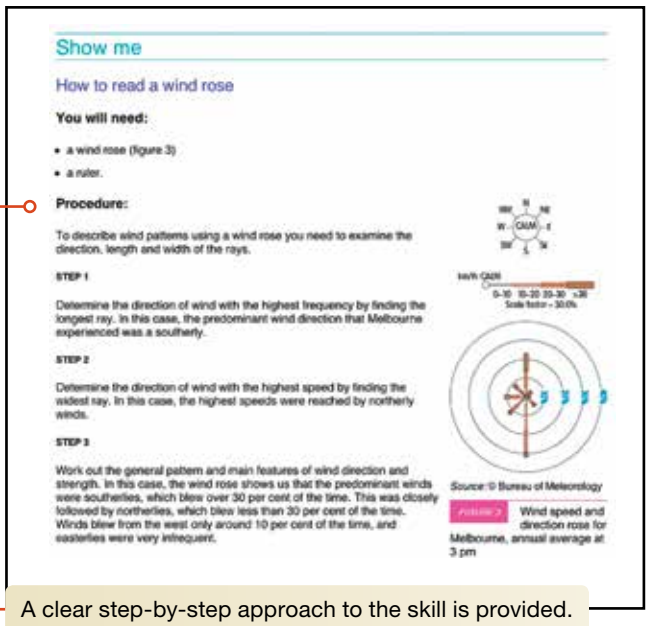
Model

To interpret a wind rose, remember:

- Wind roses have the rays drawn towards the centre. In figure 2 the longest ray is from the south-west, which shows most of the wind is south-westerly. It is most frequent.
- The circles around the image represent the various percentages of occurrences of the winds. For example, if the ray to the south just reaches the 20 per cent ring, it means a frequency of 20 per cent blowing from that direction.
- The rays use symbols and colour to show wind speed.
- This wind rose shows data for eight points of the compass.

A wind rose

A model of what a finished product should be like is provided.


Show me

How to read a wind rose

You will need:

- a wind rose (figure 3)
- a ruler.

Procedure:

To describe wind patterns using a wind rose you need to examine the direction, length and width of the rays.

STEP 1

Determine the direction of wind with the highest frequency by finding the longest ray. In this case, the predominant wind direction that Melbourne experienced was a southerly.

STEP 2

Determine the direction of wind with the highest speed by finding the widest ray. In this case, the highest speeds were reached by northerly winds.

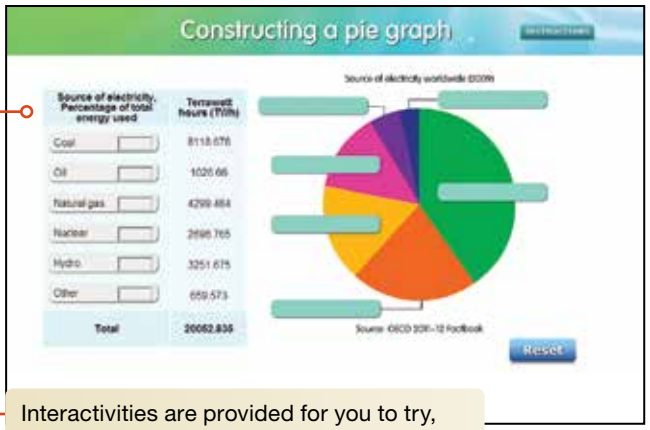
STEP 3

Work out the general pattern and main features of wind direction and strength. In this case, the wind rose shows us that the predominant winds were southerlies, which blew over 30 per cent of the time. This was closely followed by northerlies, which blew less than 30 per cent of the time. Winds blew from the west only around 10 per cent of the time, and easterlies were very infrequent.

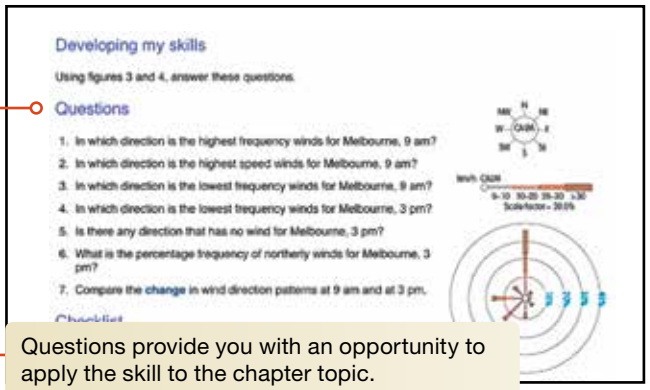
Source: © Bureau of Meteorology

Wind speed and direction rose for Melbourne, annual average at 3 pm

A clear step-by-step approach to the skill is provided.



Interactivities are provided for you to try, focusing on key aspects of each skill.


Developing my skills

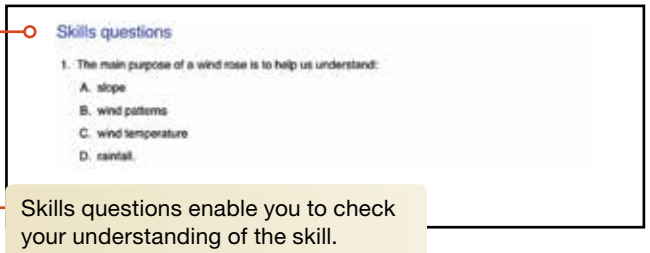
Using figures 3 and 4, answer these questions.

Questions

1. In which direction is the highest frequency winds for Melbourne, 9 am?
2. In which direction is the highest speed winds for Melbourne, 9 am?
3. In which direction is the lowest frequency winds for Melbourne, 9 am?
4. In which direction is the lowest frequency winds for Melbourne, 3 pm?
5. Is there any direction that has no wind for Melbourne, 3 pm?
6. What is the percentage frequency of northerly winds for Melbourne, 3 pm?
7. Compare the change in wind direction patterns at 9 am and at 3 pm.

Checklist

Questions provide you with an opportunity to apply the skill to the chapter topic.


Skills questions

1. The main purpose of a wind rose is to help us understand:
   A. slope
   B. wind patterns
   C. wind temperature
   D. rainfall.

Skills questions enable you to check your understanding of the skill.

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Text

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1.1 Overview

1.1.1 What is a geographical inquiry?

The world around us is made up of interesting places, people, cultures and environments. Geography is the subject that you study at school to learn about different places, and how relationships between environments and people shape these places. Geographers question how environments functions and why the world is the way it is. They explore geographic issues and challenges facing us today, predict outcomes and come up with possible solutions for the future. Geographers are active and responsible citizens, who are informed about our world and are capable of shaping the future.

FIGURE 1 Our planet is made up of a large variety of fascinating places, peoples, cultures and environments.

Have you ever visited or gone on holidays to a place other than where you live? If so you have probably noticed that some of the features and characteristics of the people and places are similar and some are different. Studying Geography at school provides you with the skills, the knowledge

and the tools to learn about and understand the relationships between the world's people, places and environments.

As a geographer you get to ask questions and then seek to answer them. Geographers use what is called an inquiry approach to help them learn about and understand the world around them. This could involve you working individually, or as part of a group, to discover the answer to a geographical question, using a variety of geographical skills, tools and concepts.

Geographers also look at many interesting issues which face the world today; for example, different people have different viewpoints, or perspectives, about what we should do about climate change. The answer to this question might vary for an individual, a local area, a country, or even on a world scale.

1.1.2 What are inquiry skills?

Have you ever noticed that young children ask many questions as they begin to learn because they are curious about the world around them? Below are some examples of questions which we can call *geographical* questions:

- Why are there many different types of landscapes around the world and how are they formed?
- Where is the best place to live?
- How can we look after our water resources so we have enough for the future?
- What are the effects of tourism in different places?

Geographical inquiry skills develop your ability to collect, process and communicate information.

Acquiring geographical information

Acquiring or collecting geographical information needs to be focused and well planned. Begin a geographical inquiry by developing a problem or issue to investigate. This will be the general theme of your inquiry. Develop a few geographical questions that will help you study your issue or problem. Ensure that your questions are not so broad that they will be difficult to investigate, for example water management in Australia, or so specific that you won't be able to find enough information to support your inquiry.

Think about how you will collect information about your inquiry. You should include both primary geographical data and information from secondary sources. Primary data is information that you have collected yourself using fieldwork. Secondary sources are data that has been collected and processed by someone else, or written by someone else. Secondary sources include websites, books and brochures. Once you have decided on the information you need, plan your investigation and carry out your fieldwork and collate information from secondary sources.

Processing geographical information

Before you begin processing the information you have collected, you should evaluate the sources and techniques you have used to determine whether they are reliable and free from bias. Can you trust the sources of information? Did you carry out your fieldwork techniques thoroughly and with care? Present your information in a range of different forms. This might include graphs, tables, diagrams, sketch maps and annotated photographs. You might also write paragraphs explaining your results. Look at the information you have collected and reflect on your research questions. At this stage you can start to interpret the information. Did you answer your research questions? What are the answers to your research questions? Analyse the findings of your research and draw conclusions.

Communicating geographical information

You can choose to communicate your research findings in a range of ways. Consider who you will be presenting your findings to. Choose methods to communicate your information that are appropriate to your audience. Explain how you undertook your investigation and your findings. Propose actions that you think should be taken to address your problem or issue, and explain why you think this is the right course of action. If possible, take action yourself to address the geographical issue you have chosen.

1.1.3 What are geographical tools?

Geographers use a range of tools to help them collect information during a geographical inquiry. Geographical tools include:

- maps
- fieldwork
- graphs and statistics
- spatial technologies
- visual representations.

Maps

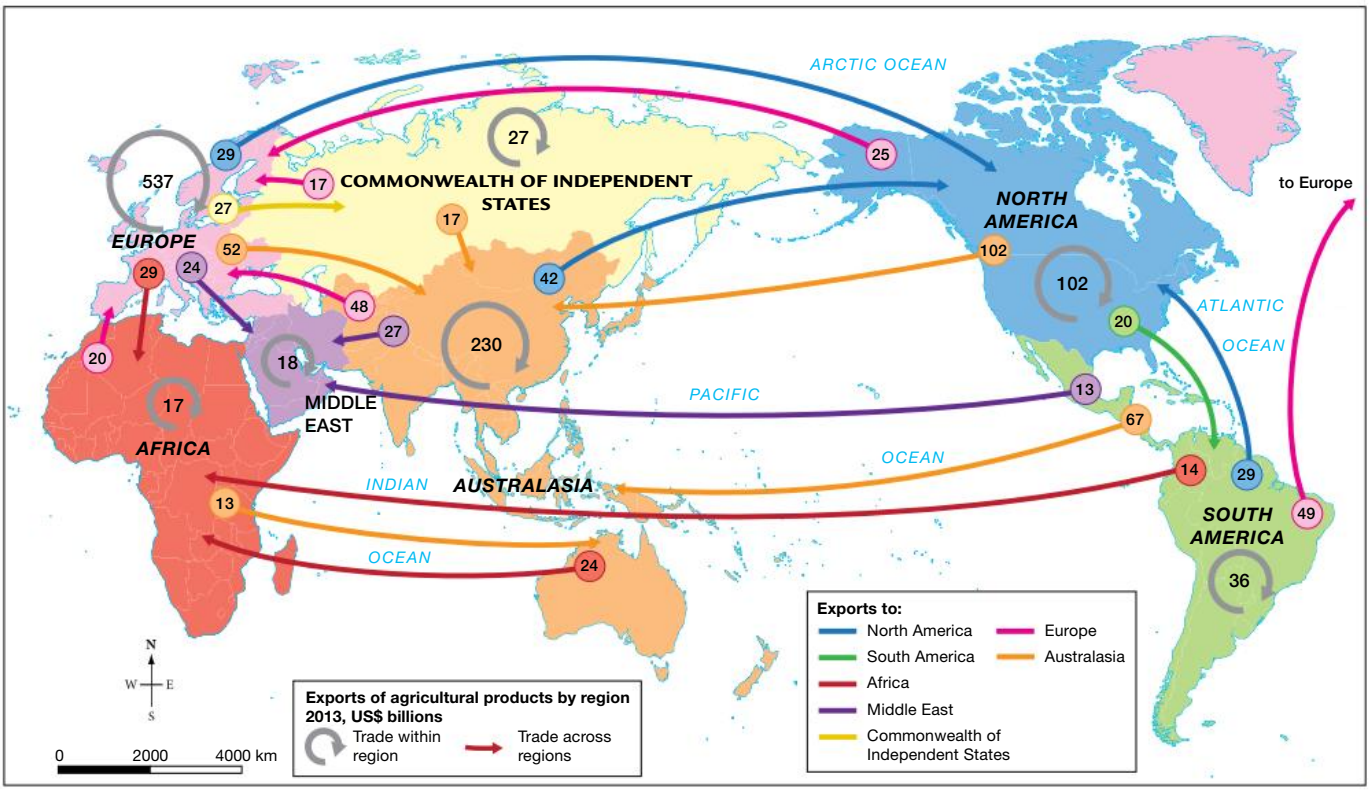
Maps are the most basic tool of the geographer as they are possibly the most effective way to locate, represent, display and record spatial information. These days, geographers are able to use, and create, both digital and non-digital maps.

Political maps are common; they show the boundaries of countries, states and regions, and usually show major cities and bodies of water. Topographic maps and relief maps show the shape of the land on a map. Sketch maps are hand drawn maps which show only the most basic details. Maps can be used to show information about particular themes, such as choropleth maps or flowline maps. Precis maps show a basic summary of information found on a topographic map.

FIGURE 2 A political map of Africa showing the boundaries of countries

ATLANTIC OCEAN
MEDITERRANEAN SEA
RED SEA
ARABIAN SEA
INDIAN OCEAN
ATLANTIC OCEAN
ALGERIA
LIBYA
EGYPT
MAURITANIA
MALI
NIGER
CHAD
SUDAN
SOUTH SUDAN
ERITREA
YEMEN
ETHIOPIA
SOMALIA
DJIBOUTI
KENYA
UGANDA
TANZANIA
RWANDA
BURUNDI
DEMOCRATIC REPUBLIC OF THE CONGO
CONGO
GABON
CAMEROON
NIGERIA
BENIN
TOGO
GHANA
BURKINA FASO
GUINEA
SENEGAL
GAMBIA
GUINEA-BISSAU
SIERRA LEONE
LIBERIA
COTE D'IVOIRE
EQUATORIAL GUINEA
SAO TOME AND PRINCIPE
CENTRAL AFRICAN REPUBLIC
ANGOLA
ZAMBIA
MALAWI
MOZAMBIQUE
ZIMBABWE
NAMIBIA
BOTSWANA
SOUTH AFRICA
LESOTHO
SWAZILAND
MADAGASCAR
COMOROS
SEYCHELLES
MAURITIUS
Reunion (France)
Mayotte (France)
Ascension (UK)
Saint Helena (UK)
Tropic of Cancer
Tropic of Capricorn
Equator
Western Sahara
Boundary claimed by Western Sahara
Boundary claimed by Sudan
Boundary claimed by South Sudan
Algiers
Tunis
Tripoli
Cairo
Khartoum
Addis Ababa
Nairobi
Kampala
Dar es Salaam
Kinshasa
Brazzaville
Luanda
Lusaka
Harare
Pretoria
Maputo
Cape Town
Windhoek
Gaborone
Lilongwe
Antananarivo
Port Louis
Victoria
Mogadishu
Djibouti
Asmara
Juba
Bangui
N'Djamena
Niamey
Bamako
Nouakchott
Dakar
Praia
Banjul
Bissau
Conakry
Freetown
Monrovia
Abidjan
Yamoussoukro
Accra
Lome
Porto-Novo
Abuja
Lagos
Malabo
Libreville
Sao Tome
Yaounde
Kigali
Bujumbura
Dodoma
Moroni
Victoria
Port Louis
Ouagadougou
Tripoli
Rabat
Melilla (Spain)
Ceuta (Spain)
Madeira (Portugal)
Canary Islands (Spain)
SPAIN
ITALY
GREECE
TURKEY
CYPRUS
SYRIA
LEBANON
ISRAEL
IRAQ
IRAN
AFGHANISTAN
PAKISTAN
JORDAN
KUWAIT
BAHRAIN
QATAR
UNITED ARAB EMIRATES
SAUDI ARABIA
OMAN
Socotra
MOROCCO
TUNISIA
MALTA
Namibe
Windhoek
Gaborone
Pretoria
Maputo
Bloemfontein
Maseru
Durban
Harare
Lusaka
Lilongwe
Antananarivo
Moroni
Mayotte (France)
Reunion (France)
Port Louis
Victoria
Mogadishu
Djibouti
Asmara
Juba
Bangui
N'Djamena
Niamey
Bamako
Nouakchott
Dakar
Praia
Banjul
Bissau
Conakry
Freetown
Monrovia
Abidjan
Yamoussoukro
Accra
Lome
Porto-Novo
Abuja
Lagos
Malabo
Libreville
Sao Tome
Yaounde
Kigali
Bujumbura
Dodoma
Nairobi
Kampala
Dar es Salaam
Kinshasa
Brazzaville
Luanda
Lusaka
Harare
Pretoria
Maputo
Cape Town
Windhoek
Gaborone
Lilongwe
Antananarivo

FIGURE 3 A flow line map shows the movement of oil trade around the world.



Source: Spatial Vision

It is important for geographers to develop skills in map reading to be able to use all the information found. Mapping skills include being able to determine direction and use the scale of the map to determine distance between different places. Geographers use lines drawn on maps to determine and communicate the location of different places. On topographic maps, grids are used to determine the area and grid reference of different places. On some maps lines of latitude and longitude are shown to help us locate places.

Fieldwork

There is nothing better than going into an environment, or to visit a place, that you are studying. Seeing something first-hand provides a better understanding than reading about it or looking at it in photographs. That is why fieldwork is such an important, and compulsory, part of your studies.

Fieldwork involves observing, measuring, collecting and recording information and data outside the classroom.

FIGURE 4 Conducting a survey in the field

FIGURE 5 Collecting your own data and information

Fieldwork can be undertaken within the school grounds, around the local neighbouring area or at more distant locations. We can use tools such as weather instruments, identification charts, photographs and measuring devices to collect information about our environment.

Sometimes it may be necessary to use information and communication technology to undertake virtual fieldwork.

Graphs and statistics

Often geographers collect information as numbers. Examples include traffic counts and surveys. These numbers are called statistics. On a field trip you might count the number of pedestrians on a footpath in a given period of time. Statistics which are collected and not processed or analysed yet are called primary data. Statistics which have been processed or analysed by someone are called secondary data.

A simple and effective way geographers present statistics or data is through the use of graphs. There are many different types of graphs that can be used. The most common types of graphs you will use in this resource are column graphs, pie graphs, climate graphs, population profiles and data tables.

Graphs and statistics allow us to easily identify trends and patterns and to make comparisons.

Using statistics helps us to find patterns in the information we have collected. This will help us to draw conclusions about the themes we have investigated.

FIGURE 6 Australia's leading exports of goods and services in A$ million

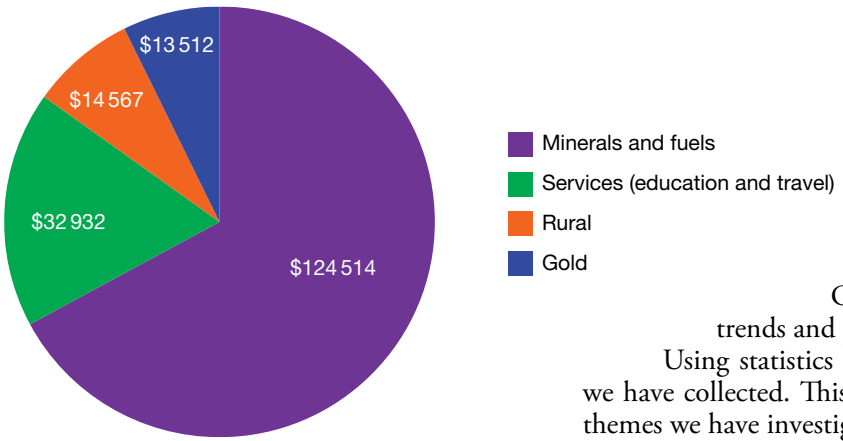
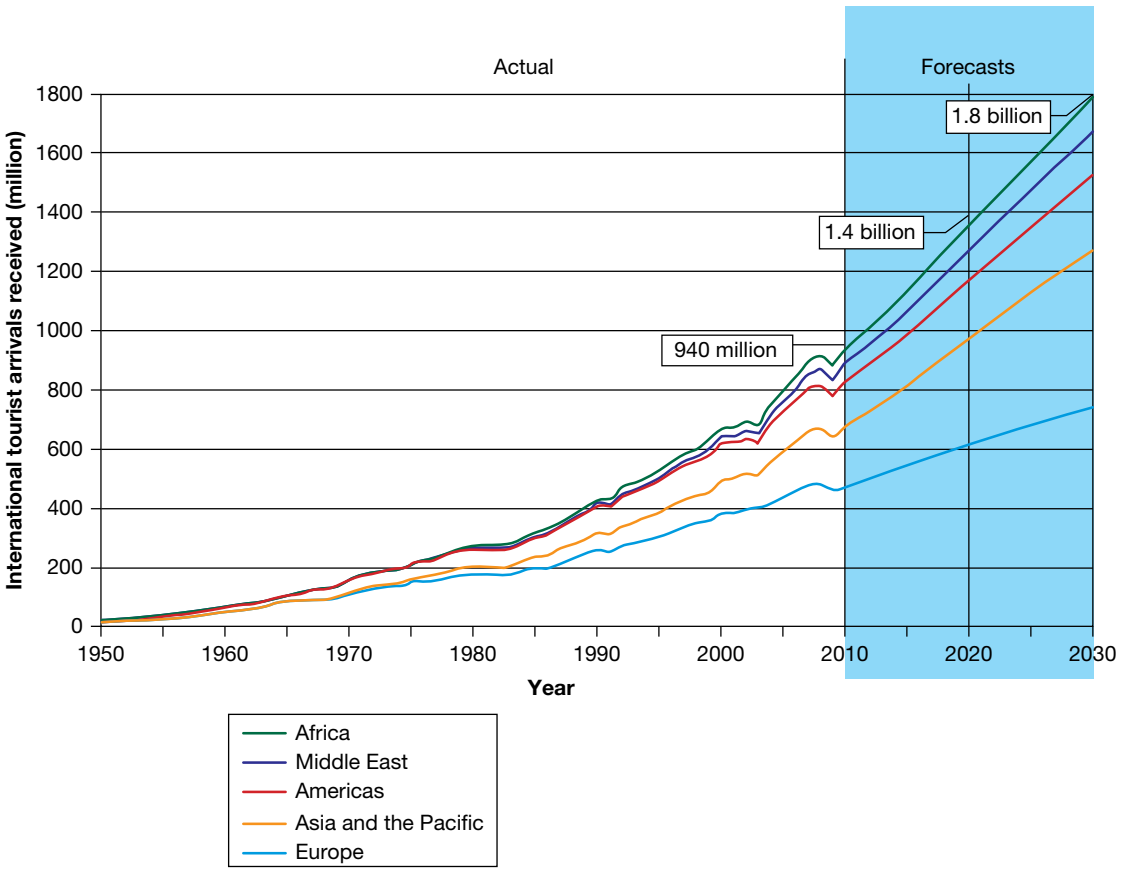


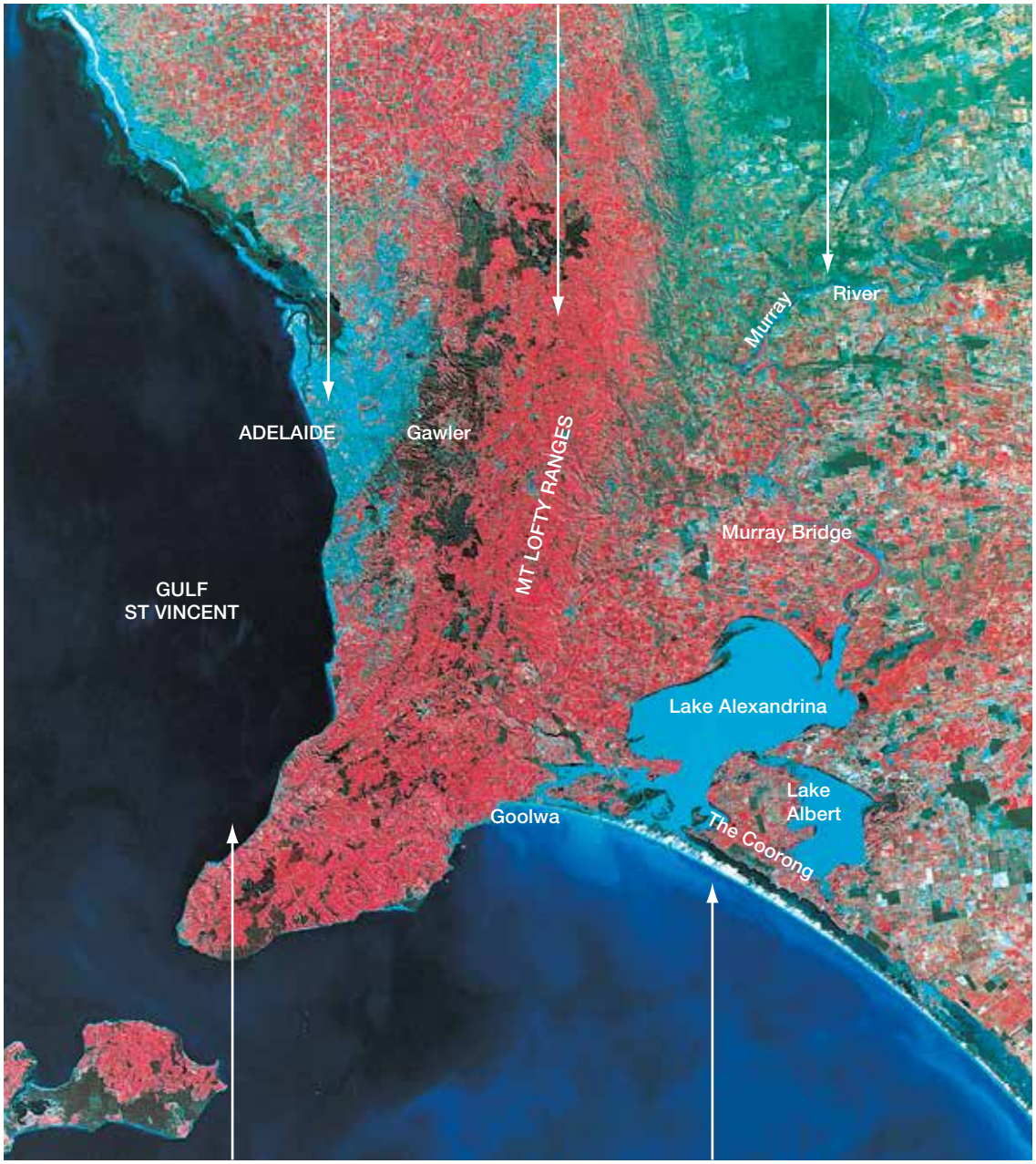
FIGURE 7 Trends and forecasts in tourist arrivals



Spatial technologies

Spatial technologies involve using satellite information and virtual maps to explore and record information. When you use Global Positioning System (GPS) or Google Earth you are using a form of spatial technology. Spatial technologies are any software or hardware that interact with real-world locations. Geographic information systems (GIS) are another commonly used spatial technologies. They help us analyse, display and record spatial data.

FIGURE 8 A false-colour satellite image of the Mt Lofty Ranges



Source: © Commonwealth of Australia. Geoscience Australia 1982.

FIGURE 9 Satellite image of Canberra, by GeoEye, 26 September 2011. Satellite images show a realistic view like a photograph, providing a birds-eye view of a place.

Source: © GeoEye

Visual representations

A visual representation is an effective way of showing complex information using pictures, symbols and diagrams. Examples of visual representations include photographs, field sketches, cartoons and infographics. They are used to display, analyse and communicate geographical data and information.

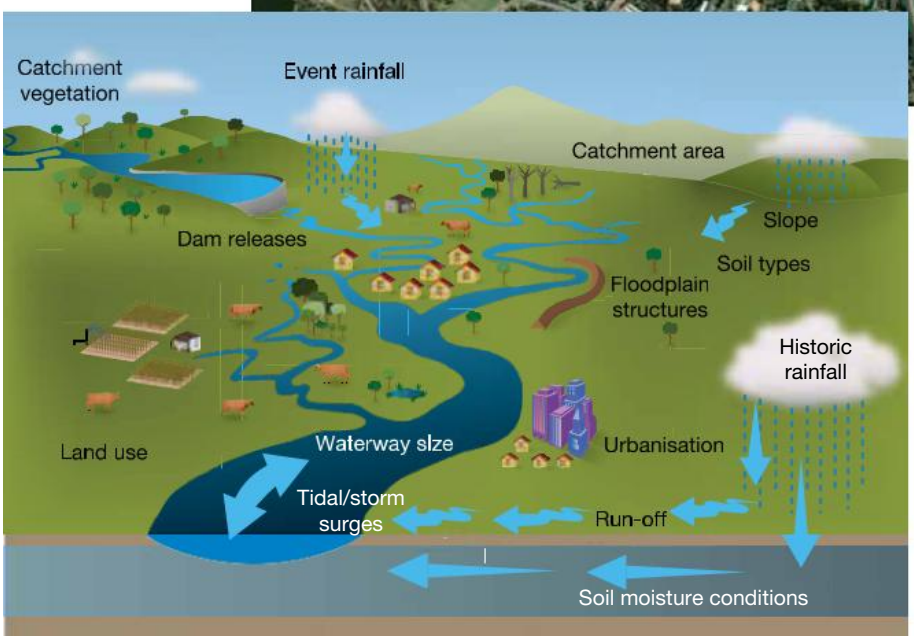


FIGURE 10 This visual representation of the water cycle and factors that affect flooding includes information and images to help you understand geographical processes.

1.2 Geographical concepts

1.2.1 Overview

Geographical concepts help you to make sense of your world. By using these concepts you can both investigate and understand the world you live in, and you can use them to try to imagine a different world. The concepts help you to think geographically. There are seven major concepts: ***space***, ***place***, ***interconnection***, ***change***, ***environment***, ***sustainability*** and ***scale***.

A way to remember these seven concepts is to think of the term SPICESS.

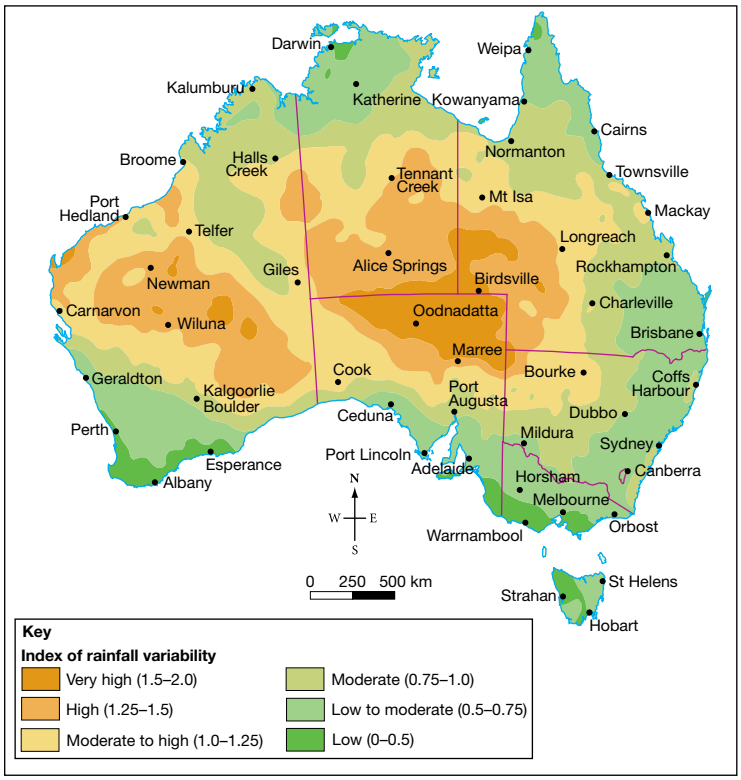
In this book, you will use and apply the seven concepts to investigate four topics: *Landscapes and landforms, Place and liveability, Water in the world* and *Interconnections.*

1.2.2 What is space?

Everything has a location on the space that is the surface of the Earth, and studying the effects of location, the distribution of things across this space, and how the space is organised and managed by people, helps us to understand why the world is like it is.

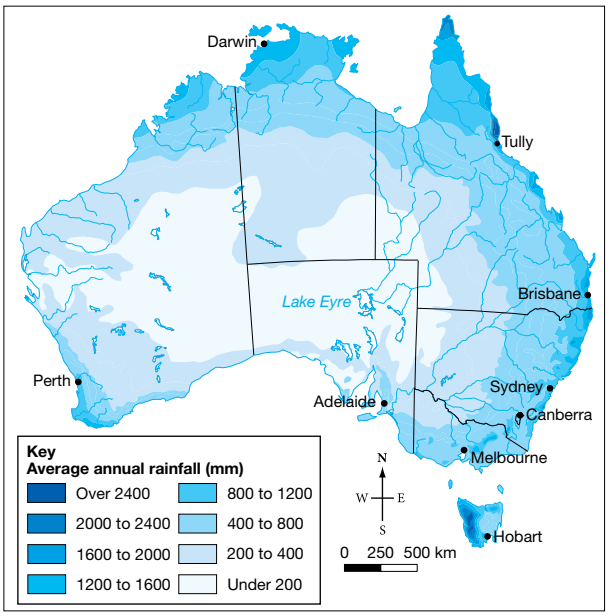
A place can be described by its absolute location (latitude and longitude) or its relative location (in what direction and how far it is from another place).

FIGURE 1 Australian annual rainfall variability, 1900–2003



Source: © Spatial Vision

FIGURE 2 The amount of rain that falls in Australia varies from place to place, as this rainfall map shows.



Source: Spatial Vision

ACTIVITIES

Refer to figures 1 and 2.

1. Use an atlas to give the absolute location (latitude and longitude) of the capital city of the state/territory in which you live.
2. In which direction and how far is your capital city from Alice Springs (relative location)?
3. Describe the ***spatial*** distribution of capital cities in Australia.
4. Describe the distribution of rainfall across Australia. Why might one ***place*** have more or less rainfall than another?
5. How does rainfall (or lack of rainfall) help explain the distribution of Australia's major cities? What is the relationship between rainfall and population location?
6. Find where you live on the maps. How is the location of your ***place*** influenced by rainfall and rainfall variability?

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Space

1.2.3 What is place?

The world is made up of places, so to understand our world we need to understand its places by studying their variety, how they influence our lives and how we create and change them.

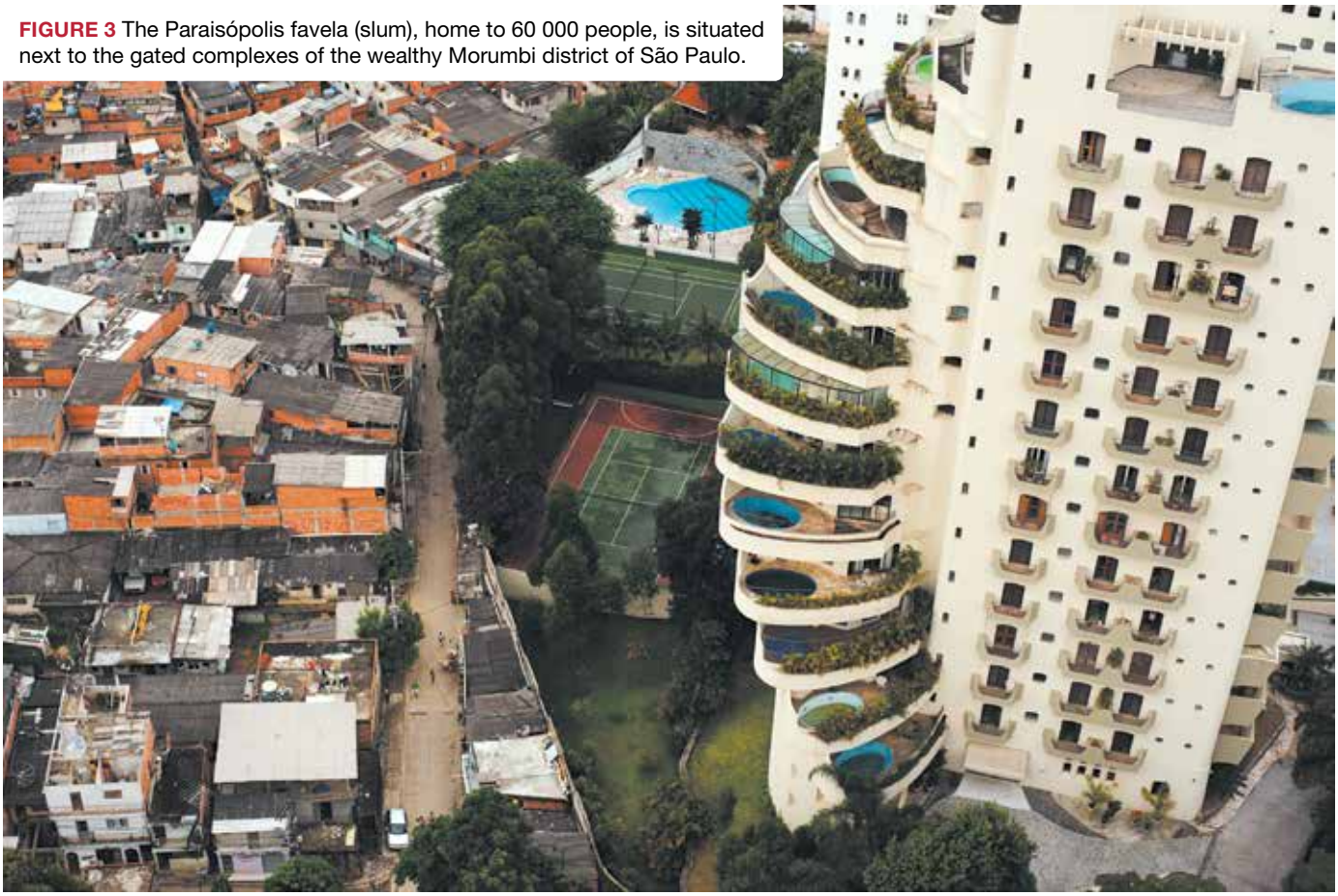
You often have mental images and perceptions of *places* — rich and poor cities, suburbs, towns or neighbourhoods — and these may be very different from someone else's perceptions of the same *places*.

ACTIVITIES

Refer to figure 3.

1. Where in the world is this ***place*** located?
2. What effects have people had on this ***place***?
3. List the differences you observe in the way people live on each side of this settlement.
4. How is this ***place*** similar to or different from the ***place*** where you live?
5. What decisions could be made to improve or ***change*** this ***place***?
6. How might the ***environment*** of this ***place*** affect the people who live there?
7. How does the ***place*** where these people live affect their lives?

FIGURE 3 The Paraisópolis favela (slum), home to 60 000 people, is situated next to the gated complexes of the wealthy Morumbi district of São Paulo.



myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Place

1.2.4 What is interconnection?

People and things are connected to other people and things in their own and other places, and understanding these connections helps us to understand how and why places are changing.

Individual geographical features can be interconnected — for example, the climate within a place or biome, such as a tropical rainforest, can influence natural vegetation, while removal of this vegetation can affect climate. People can be interconnected to other people and other places via employment, communications, sporting events or culturally. The manufacturing of a product may create interconnections between suppliers, manufacturers, retailers and consumers.

Source: Spatial Vision

FIGURE 4 Many countries have strict laws dealing with e-waste disposal. It is often easier to export the material to countries in South-East Asia, where there are fewer laws and the wastes can be broken down, recycled or sold. It is extremely hazardous.

ACTIVITIES

Refer to figure 4.

1. Describe the distribution of the main ports dealing with e-waste trade.
2. What is the ***interconnection*** between the main recycling countries and the main ports that receive and dispatch e-waste?
3. Describe the ***interconnection*** between North America and Asia in relation to e-waste trade.
4. Create a diagram to show the ***interconnections*** that could occur for the growing, manufacturing, sales and consumption of a can of pineapple slices.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Interconnection

1.2.5 What is change?

The concept of change is about using time to better understand a place, an environment, a spatial pattern or a geographical problem.

The concept of change involves both time and space — change can take place over a period of time, or over an area. The time period for change can be very short (for example, the impact of a flash flood) or over thousands or millions of years (for example, the development of fossil fuel resources).

Environmental change can occur over short or long periods of time. The use of technology can result in rapid change — think of the explosions at a mining site that reveal mineral seams.

The degree of change occurring can be used to predict, or plan for, actual or preferred futures.

FIGURE 5 Port Douglas, 60 kilometres north of Cairns, was a busy port in the 1870s, with a population over 10 000. The mining that had attracted people to this hot, wet area did not last. By the 1960s, the population was only 100. In the 1980s, road and air access to the town improved and tourist numbers to the area grew. The permanent population is now about 1300. During the peak holiday season (May to November), this number increases by four times.

(a) 1971

(b) 2009

ACTIVITIES

Refer to figure 5.

1. How and why has the population of Port Douglas ***changed*** over time?
2. Which economies have declined and grown in the Port Douglas area?
3. How has technology (transport links) been important in the development of this ***place***?
4. How do you think the ***changes*** have affected the ***environment***, businesses and economy in the area?
5. List five ***changes*** you can observe in the two photographs of Port Douglas.
6. Use evidence from the photographs to decide if the natural ***environment*** has changed faster than the human ***environment***.
7. What is your preferred future for this ***place***? What ***changes*** need to occur for your preferred future to come about?

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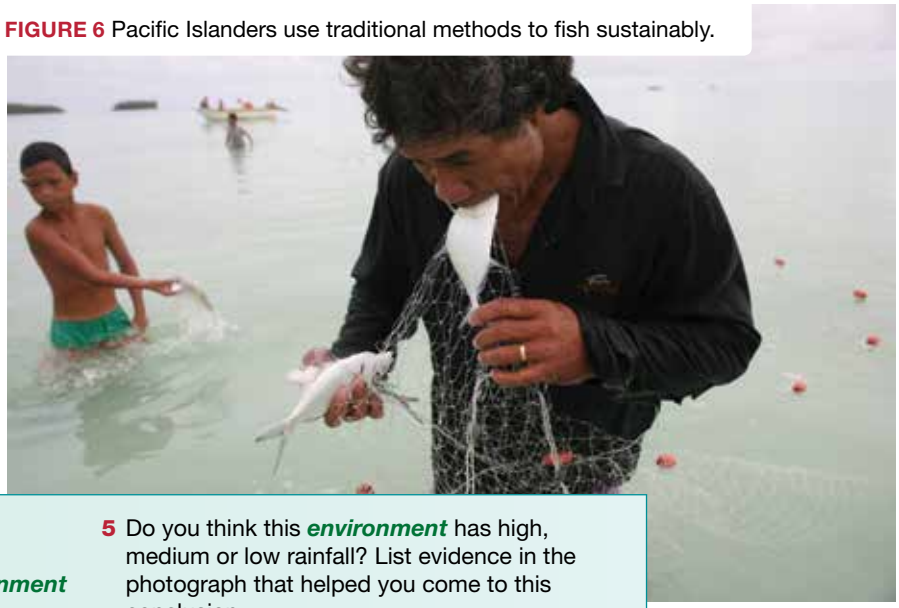
1.2.6 What is environment?

People live in and depend on the environment, so it has an important influence on our lives.

The environment, defined as the physical and biological world around us, supports and enriches human and other life by providing raw materials and food, absorbing and recycling wastes, and being a source of enjoyment and inspiration to people.

FIGURE 6 Pacific Islanders use traditional methods to fish sustainably.



ACTIVITIES

Refer to figure 6.

1. Do you think the photograph of Pacific Islanders fishing depicts a natural ***environment*** or a human ***environment***? Explain.
2. Does this ***environment*** appeal to you? Would you like to visit this ***place***? Why? Why not?
3. Which resource/s do you think people would obtain from this ***environment***?
4. Describe how these people are fishing. Why might this be ***sustainable***?
5. Do you think this ***environment*** has high, medium or low rainfall? List evidence in the photograph that helped you come to this conclusion.
6. List the impacts on this ***environment*** if a factory was built on the edge of the water.
7. How have people changed this ***environment*** (for better or worse)? What are the positive and the negative aspects of this?
8. How might technology ***change*** this ***environment*** to make it less ***sustainable***?

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1.2.7 What is sustainability?

Sustainability is about maintaining the capacity of the environment to support our lives and those of other living creatures.

Sustainability involves maintaining and managing our resources and environments for future generations. It is important to understand the causes of unsustainable situations to be able to make informed decisions on the best way to manage our natural world.

FIGURE 7 The unsustainable nature of fishing

ACTIVITIES

Refer to figure 7.

1 What does this cartoon tell us about the ***sustainable*** nature of fishing?
2 How has modern technology contributed to a decline in world fish populations?
3 Suggest reasons that fishing can be considered an ***unsustainable*** practice.
4 Give reasons that some fish species are over-exploited while others are not.
5 What difficulties would arise with managing an ocean-based resource compared to a land-based resource?

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Sustainability

1.2.8 What is scale?

When we examine geographical questions at different spatial levels we are using the concept of scale to find more complete answers.

Scale can be applied at personal and local levels to regional, national or global levels. Looking at things at a range of scales allows a deeper understanding of geographical issues.

Different factors can be involved in explaining phenomena at different scales. Local events can have global outcomes; for example, removing areas of forest at a local scale can have an impact on climate at a global scale. A policy at a national scale, such as forest protection, can have an impact at a local scale, such as the protection of an endangered species.

ACTIVITIES

Refer to figures 8 and 9.

1 If you were to zoom in on the areas on these maps, would you see more or less detail?
2 List the extra information and detail you see on Annette's map compared to Jayden's map. Which gives more information?
3 Refer to the railway map. What might be the relationship between the location of settlements and the location of the railway?
4 The railway map is of a regional ***scale***. Which region of Australia is it showing?
5 Use the scale to measure the longest straight stretch of railway shown on the map. How long is it? Why is it significant?
6 What is the main information each map is trying to show?

FIGURE 8 Mental map of Jayden's local place (a) by Jayden and (b) by Annette, Jayden's mother

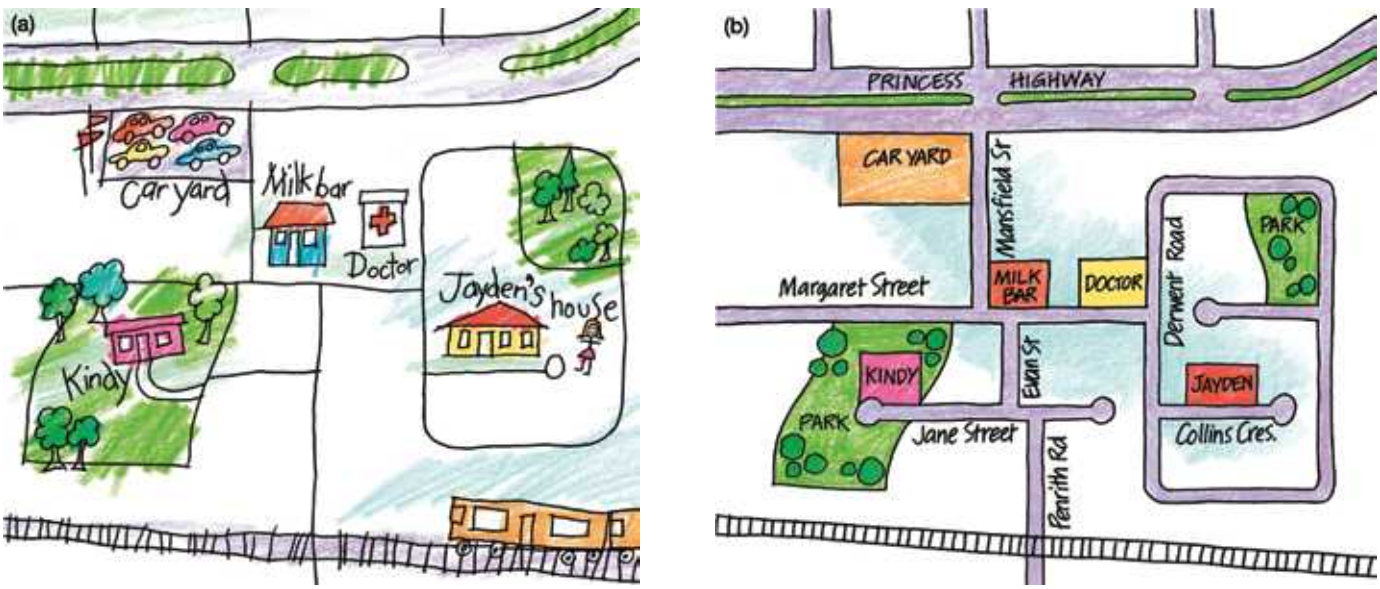


FIGURE 9 Railway route and main settlements between Sydney and Perth

Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Scale

1.3 Work and careers in Geography

1.3.1 Connecting Geography to school and work

As a student of Geography, you are starting to build the knowledge and skills that will be needed by you, your community; now and into the future. The concepts and skills that you will use will not only help you in Geography, but can also be applied to everyday situations such as finding your way from one place to another. Studying Geography may even help you in a future career here in Australia or overseas.

Throughout the year you will be studying topics that will give you a better understanding of the world around you – both the local and global environment. You will be investigating issues that need to be addressed, and investigate options for the future.

Explore: Skills you need for a job

Many questions come up during a typical Geography class, such as the ones below in table 1. These questions need to be answered in the real world by people in a wide variety of occupations that have links with Geography.

TABLE 1

Question	Occupations/organisations who try to answer these questions
• How high is Mount Everest? How do we know?	Surveyor; Cartographer
• How can we protect our parks and wildlife?	Park ranger; Planner; Environmental manager
• Where should we establish a new suburb for our future population?	Urban planner; Demographer
• How can we prepare for future droughts and floods?	Civil engineer
• Does our town really have enough water? • Where should we build a new dam? *Should* we build a new dam?	Coastal engineer; Hydrologist; Cartographer

(*Continued*)

TABLE 1 (*Continued*)

Question	Occupations/organisations who try to answer these questions
• Should a boat marina be built at location X or at location Y?	Oceanographer
• Do we have good quality drinking water?	Chemist; Hydrologist
• How do countries such as India and China deal with air pollution problems?	Environmental scientist/manager
• How do we provide aid to other countries?	Air Force, Navy, Army officer; Red Cross, World Vision and other aid agencies
• How do we build sustainable housing?	Architect; Landscape architect; Civil engineer/ Construction manager; Town planner; Real estate salespeople

Think: Consider who you are and what your position in the world is …

Do you know much about these occupations? Are any of interest to you?

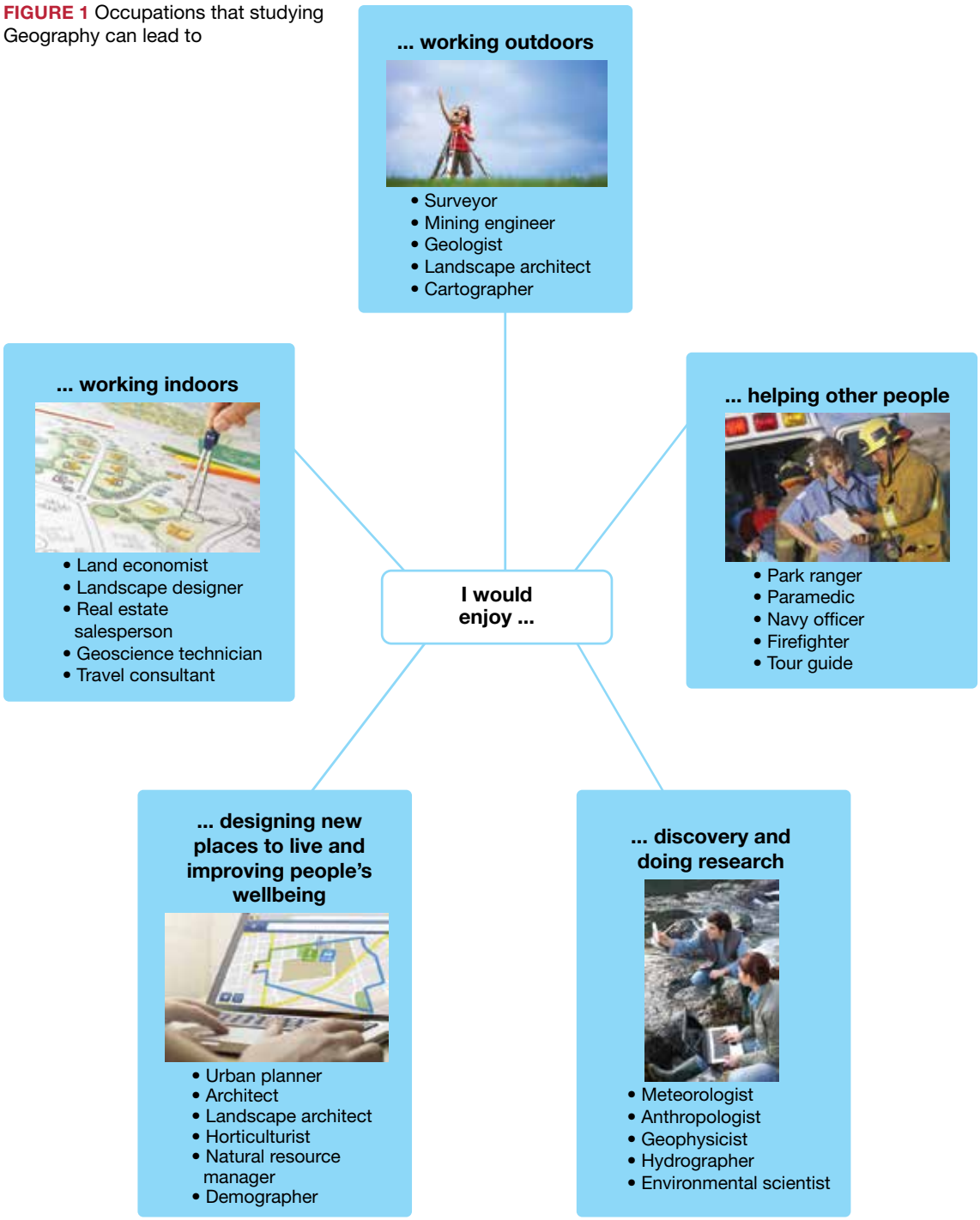
The first step in thinking about your future is to consider questions such as:

- Who am I?
- What are my interests?
- What do I enjoy doing?
- What am I good at?
- What would I like to do when I leave school?

1.3.2 Geography careers on the move

A great part of studying Geography is being able to explore the many occupations and areas that it opens up. Figure 1 shows some occupations that you may not have thought studying Geography could lead you into.

FIGURE 1 Occupations that studying Geography can lead to



1.3.3 Finding my way as a local and global citizen

A wide range of exciting new jobs are developing in the spatial sciences, which use geographical tools such as GPS, GIS, satellite imaging and surveying. These tools help people make important decisions about managing and planning places and resources. Whether it be how to manage water somewhere in the Middle East or how best to design a new housing estate here in Australia, these skills and occupations will be an important part of working as a global citizen.

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Weblink
Geocareers

ACTIVITIES

PREDICT

1 Consider spatial technologies and work and enterprise careers of the future. Which geographical tools do you predict will be used by:
- a meteorologist
- a naval officer
- an airline pilot
- a farmer?

DISCOVER

2 We can develop a better understanding of work and enterprise by exploring what others have to say about their careers. Use the **Geocareers** weblink in your eBookPLUS to help you locate one male and one female geographer working as local or global citizens.
- What career path did they follow?
- How did they include their passion for geography into their career journey?
- What advice did they share about their career journey?

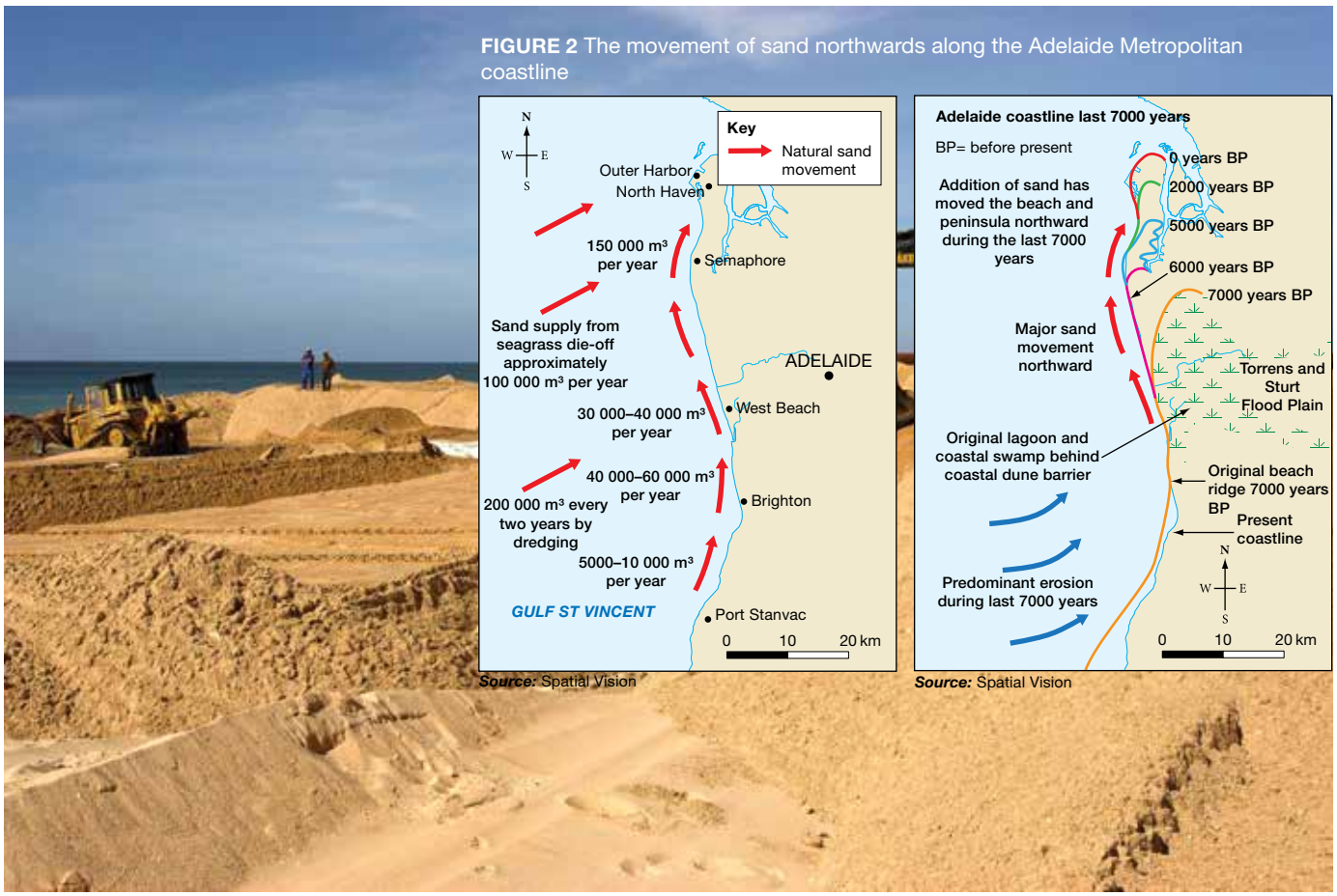
1.4 Review

1.4.1 Applying the concepts

For the past 7000 years, the sandy beaches close to Adelaide in South Australia have been eroding and the sand has been moved northwards by the prevailing winds from the south-west. This has resulted in the growth of a peninsula and large dune system at North Haven.

As many people have now settled along this coastline, the sand movement is being managed to stop erosion by trapping the sand or trucking and piping it back to the south. The cost of this action can be very high.

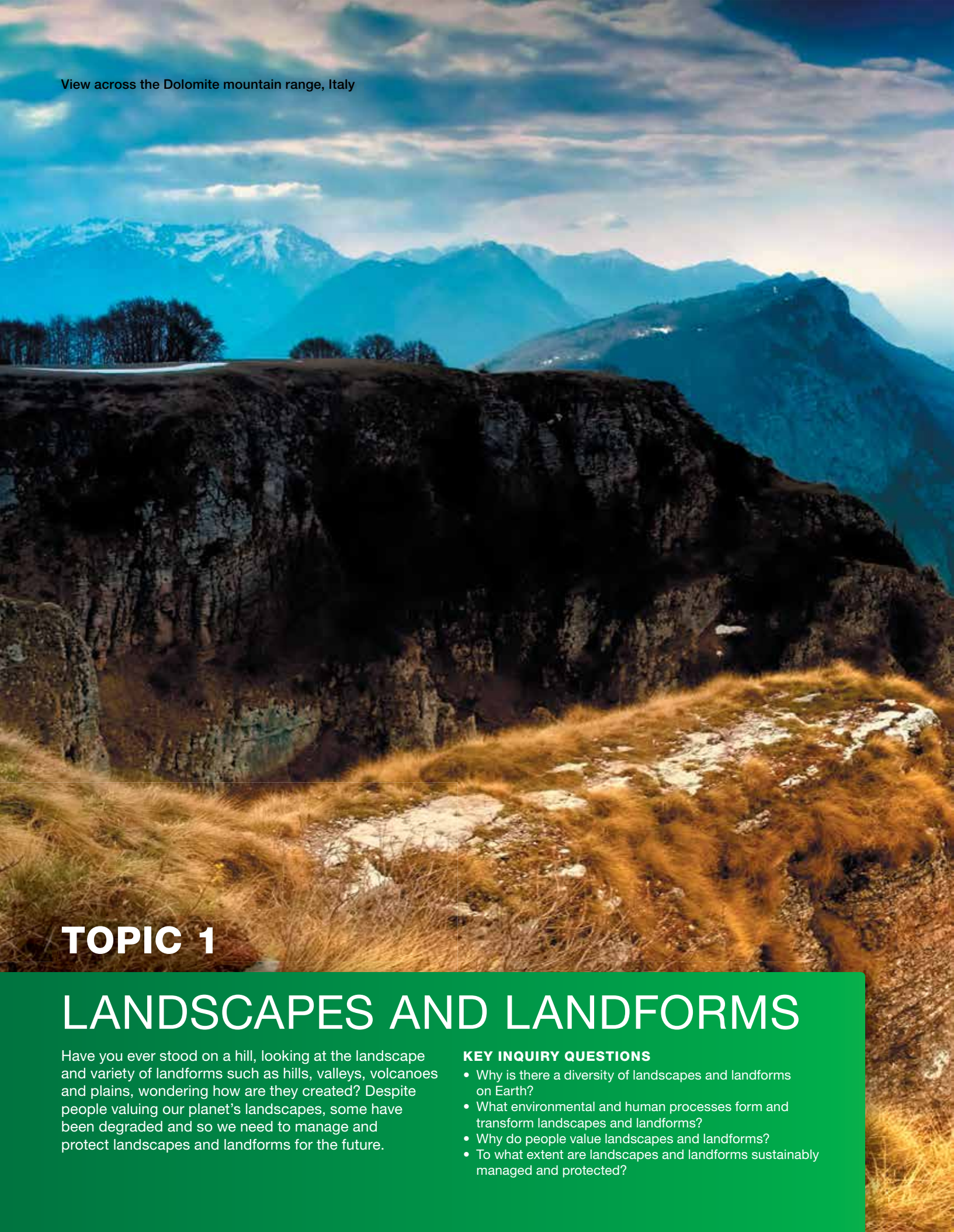
FIGURE 1 Sand is being transported from north to south along Adelaide's beaches



ACTIVITIES

Note: The terms in brackets are intended to help students identify which concept the question is related to.

1. Use an atlas to describe the location of Adelaide relative to where you live. What is its absolute location? (***space***)
2. Is the Adelaide coast a ***place*** where you would like to live? Why or why not?
3. How would the perception of coastal erosion differ between people who live in coastal settlements and those living five or more kilometres inland? (***place***)
4. What are the human natural characteristics of this ***place***? Do you think this coastal ***environment*** is natural or human? Justify your answer.
5. What is the length of the coastline shown on the map? (***scale***)
6. Describe how this ***environment*** may have looked 7000 years ago. How has it ***changed*** over time?
7. How have people ***changed*** this ***environment***?
8. What is the relationship (***interconnection***) between:
   a. prevailing wind and sand movement (the prevailing wind along this coastline comes from the south-west)
   b. sand movement and formation of coastal features?
9. Which local management ***scale*** is shown in the photograph?
10. How has technology helped manage this coastline? (***change***)
11. What ***changes*** might occur if the sand movement was not managed?
12. Is the movement of sand to stop beach erosion a ***sustainable*** activity — that is, is it worth stopping the movement of sand? Explain your answer.



View across the Dolomite mountain range, Italy

TOPIC 1

LANDSCAPES AND LANDFORMS

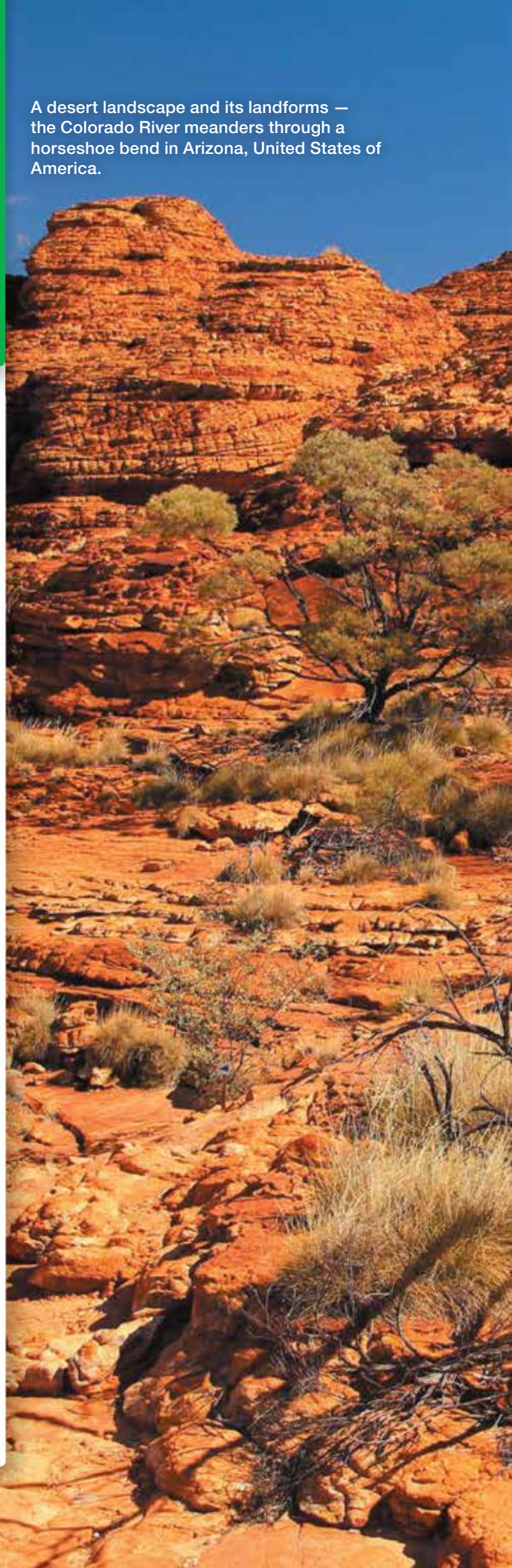
Have you ever stood on a hill, looking at the landscape and variety of landforms such as hills, valleys, volcanoes and plains, wondering how are they created? Despite people valuing our planet's landscapes, some have been degraded and so we need to manage and protect landscapes and landforms for the future.

KEY INQUIRY QUESTIONS

- Why is there a diversity of landscapes and landforms on Earth?
- What environmental and human processes form and transform landscapes and landforms?
- Why do people value landscapes and landforms?
- To what extent are landscapes and landforms sustainably managed and protected?

CHAPTER 2

The diversity and formation of landscapes and landforms



A desert landscape and its landforms — the Colorado River meanders through a horseshoe bend in Arizona, United States of America.

2.1 Overview

2.1.1 Introduction

Landscapes are the visible features occurring across an area of land. They are created by a combination of environmental processes and human activities. Examples include coastal, desert and agricultural landscapes.

Landforms are distinctive, natural features occurring on the surface of the Earth. They are identifiable by their shape. Examples of landforms include: plateaus, canyons, valleys, hills and dunes.

Landscapes often include a variety of landforms.

Starter questions

1. Identify key features of the landscape shown in the image at right.
2. Watch the video and identify the landforms shown.
3. Identify and locate different landscapes around the world. Describe your favourite landscape and provide a reason why it is your favourite.
4. Brainstorm as a class different landscapes around the world. Describe your favourite landscape and explain why it appeals to you.

Inquiry sequence

		Syllabus outcomes
2.1 Overview		
2.2 What are different types of landscapes?		GE4-1, GE4-2
2.3 What types of landscapes and landforms are there in Australia?		GE4-1, GE4-2
2.4 SkillBuilder: Recognising land features	eBook plus ONLINE ONLY	GE4-7, GE4-8
2.5 What types of landscapes are found in the Pacific region?	eBook plus ONLINE ONLY	GE4-1, GE4-2
2.6 What processes transform landscapes?		GE4-2, GE4-8
2.7 Which landscapes are created by water?		GE4-2, GE4-8
2.8 How are landscapes created underground?		GE4-2, GE4-8
2.9 How are river landscapes created?	eBook plus ONLINE ONLY	GE4-2, GE4-8
2.10 How are coastal landscapes shaped by erosion?	eBook plus ONLINE ONLY	GE4-2, GE4-8
2.11 How are coastal landscapes shaped by deposition?	eBook plus ONLINE ONLY	GE4-2, GE4-8
2.12 How do I undertake coastal fieldwork?		GE4-1, GE4-2, GE4-7, GE4-8
2.13 SkillBuilder: Constructing a field sketch	eBook plus ONLINE ONLY	GE4-7, GE4-8
2.14 SkillBuilder: How to read a map	eBook plus ONLINE ONLY	GE4-7, GE4-8
2.15 Investigating topographic maps: What are topographic maps?		GE4-1, GE4-7, GE4-8
2.16 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	

eBook*plus*

Watch this video
World landscapes and landforms
Searchlight ID: eles-1623

2.2 What are different types of landscapes?

plateau an extensive area of flat land that is higher than the land around it. Plateaus are sometimes referred to as tablelands.

2.2.1 Global landscapes

There are many different landscapes across the Earth, and similarities can be observed within regions. Variations in landscapes are influenced by factors such as climate; geographical features, including mountains and rivers; latitude; the impact of humans; and where the landscapes are located.

FIGURE 1 Selected world landscapes

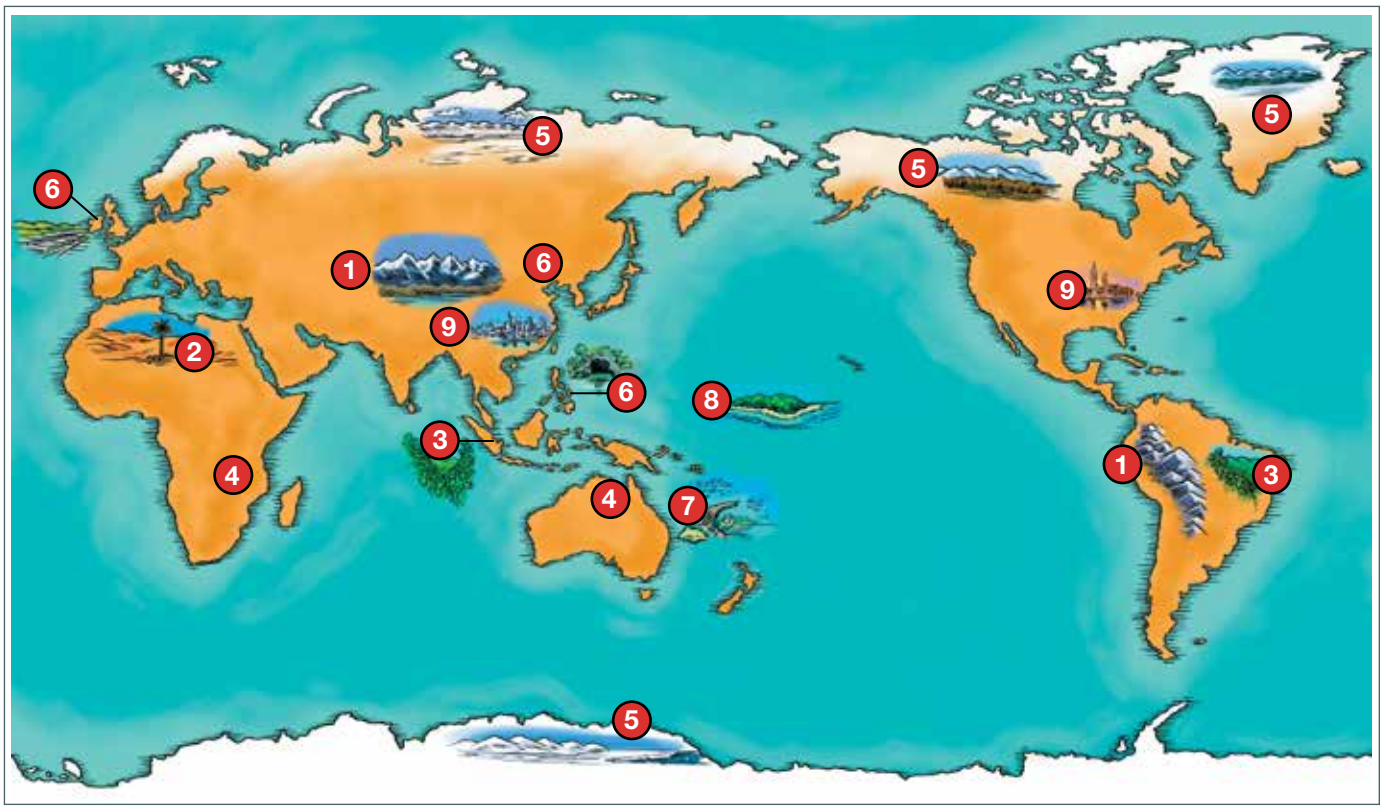


FIGURE 2 At 8848 metres, Mount Everest in the Himalayas is the highest mountain on Earth.

2.2.2 Mountain landscapes 1

Mountains rise above the surrounding land. They often have steep sides and high peaks and are the result of processes operating deep inside the Earth. Some reach high into the atmosphere where it is so cold that snow is found on their peaks.

2.2.3 Desert landscapes 2

Deserts are areas of low rainfall; they are an arid or dry environment. They can experience temperature extremes: hot by day and freezing at night. However, not all deserts are hot. Antarctica is the world's largest desert, and the Gobi Desert, located on a high **plateau** in Asia, is also a cold desert.

2.2.4 Rainforest landscapes 3

Rainforests are the most diverse landscapes on Earth. They are found in a variety of climates, ranging from the hot wet tropics to the cooler temperate areas.

The lush vegetation found in these regions depends on a high level of rainfall. Over 50 per cent of all known plant and animal species are found within them. In addition, many of our foods and medicines come from rainforests.

2.2.5 Grassland landscapes 4

Grasslands, or savanna, are sometimes seen as a transitional landscape found between forests and deserts. They contain grasses of varying heights and coarseness, and small or widely spaced trees. They are often inhabited by grazing animals.

2.2.6 Polar landscapes 5

Polar regions and tundra can be found in polar and alpine regions. Characterised by **permafrost**, they are too cold for trees to grow. Vegetation such as dwarf shrubs, grasses and lichens have adapted to the extreme cold and short growing season. **Glaciers** often carve spectacular landscape features.

permafrost a layer beneath the surface of the soil where the ground is permanently frozen

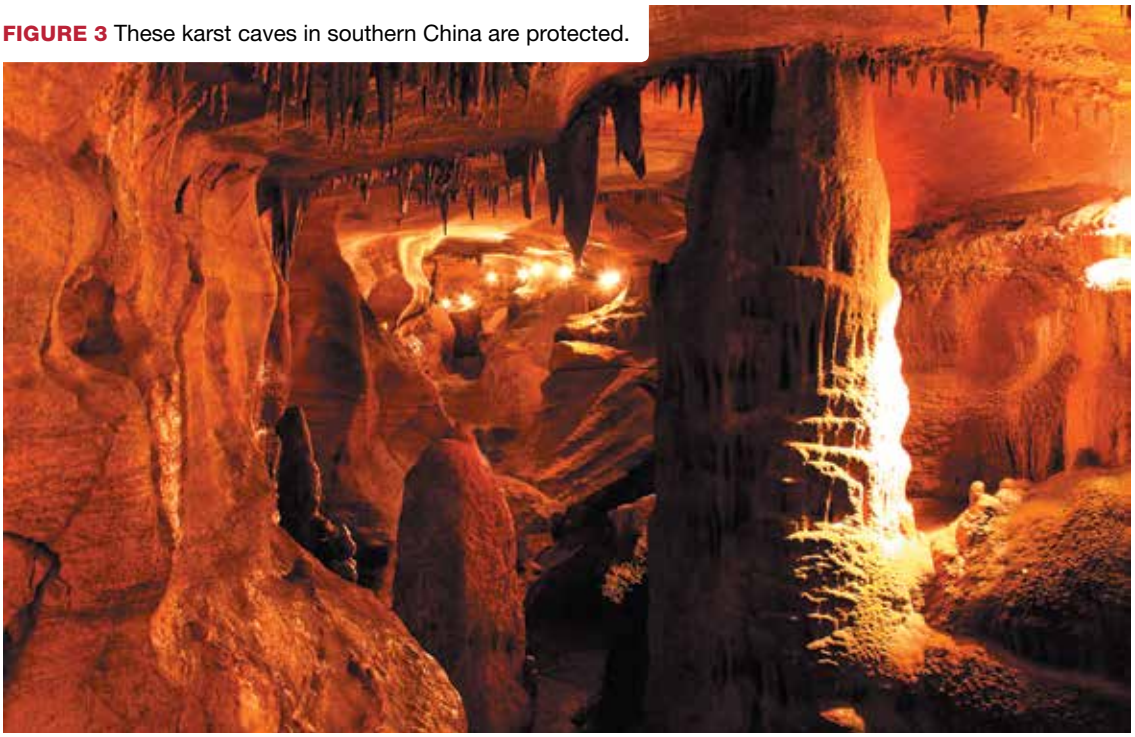
glacier a large body of ice, formed by an accumulation of snow, which flows downhill under the pressure of its own weight

2.2.7 Karst landscapes 6

Karst landscapes form when mildly acidic water flows over soluble rock such as limestone. Small fractures form, which increase in size over time and lead to underground drainage systems developing. Common landforms include limestone pavements, disappearing rivers, reappearing springs, sinkholes, caves and karst mountains. Around 25 per cent of the world's population obtains water from karst **aquifers**.

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater

FIGURE 3 These karst caves in southern China are protected.



2.2.8 Aquatic landscapes 7

Aquatic landscapes cover around three-quarters of the Earth and can be classified as freshwater or marine. Marine landscapes are the saltwater regions of the world, and include oceans and coral reefs. Freshwater landscapes are found on land, and include lakes, rivers and wetlands.

2.2.9 Island landscapes 8

Islands are areas of land that are completely surrounded by water. They can be continental or oceanic. Continental islands lie on a continental shelf — an extension of a continent that is submerged beneath the sea. Oceanic islands rise from the ocean floor and are generally volcanic in origin. A group or chain of islands is known as an archipelago.

2.2.10 Built landscapes 9

Human or built landscapes are those that have been altered or created by humans.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Grasslands

ACTIVITIES

IDENTIFY

1 List the factors that make landscapes different.

EXPLAIN

2 Why do you think people ***change*** landscapes?

3 The map in figure 1 shows the wide variety of landscapes found on the surface of the Earth. However, it does not show all locations for each landscape type. Investigate one of the featured landscapes and find out other ***places*** in which it is found. Show this information on a map. Annotate your map with characteristics of your landscape.

INVESTIGATE

4 Copy the following table into your workbook.

a Select one of the landscape types described in this section and complete the table.

Landscape characteristics	How people use it	Positive effects	Negative effects

b Which list is larger — the positive impacts or negative impacts?

c Review the column of negative impacts. Select three of these impacts and suggest a way in which the ***environment*** could be used in a more ***sustainable*** way.

5 Describe how the ***scale*** of the following landscapes might differ around the world: deserts, polar regions, aquatic landscapes and islands.

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Interactivity
Landscapes galore
Use this interactivity to learn about the variety of landscapes that are around us.
Searchlight ID: int-3102

2.3 What types of landscapes and landforms are there in Australia?

2.3.1 What processes have shaped Australia's landscapes and landforms?

The tectonic forces of folding, faulting and volcanic activity have created many of Australia's major landforms. Other forces that work on the surface of Australia, and give our landforms their present appearance, are **weathering**, mass movement, **erosion** and **deposition**. These forces are examples of geomorphic processes.

Australia is an ancient landmass. The Earth is about 4600 million years old, and parts of the Australian continent are about 4300 million years old.

weathering the breaking down of rock through the action of wind and water and the effects of climate, mainly by water freezing and cooling as a result of temperature change

erosion the wearing away and removal of soil and rock by natural elements, such as wind, waves, rivers or ice, and by human activity

deposition the laying down of material carried by rivers, wind, ice and ocean currents or waves

FIGURE 1 Many of Queensland's mountain peaks were formed by volcanic activity around 20 million years ago. The Glasshouse Mountains, north of Brisbane, are volcanic plugs. They are composed of volcanic rock that hardened in the vent of a volcano. Over millions of years, weathering and erosion have worn away the softer rock that surrounded the vent, leaving only the plugs.

Over millions of years, Australia has undergone many changes. Mountain ranges and seas have come and gone. As mountain ranges eroded, sediments many kilometres thick were laid down over vast areas. These sedimentary rocks were then subjected to folding, faulting and uplifting. This means that the rocks that make up the Earth's crust have buckled and folded along areas of weakness, known as faults. Sometimes, fractures or breaks occur, and forces deep within the Earth cause sections to be raised, or uplifted. Over time the forces of weathering and erosion have worn these down again. Erosion acts more quickly on softer rocks, forming valleys and bays. Harder rocks remain as mountains, hills and coastal headlands.

Because it is located in the centre of a **tectonic plate**, rather than at the edge of one, Australia currently has no active volcanoes on its mainland, and has very little tectonic lift from below. This means its raised landforms such as mountains have been exposed to weathering forces for longer than mountains on other continents and are therefore more worn down.

About 33 million years ago, when Australia was drifting northwards after splitting from Antarctica, the continent passed over a large **hotspot**. Over the next 27 million years, about 30 volcanoes erupted while they were over the hotspot. The oldest eruption was 35 million years ago at Cape Hillsborough, in Queensland, and the most recent was at Macedon in Victoria around six million years ago. Over millions of years, these eruptions formed a chain of volcanoes in eastern and south-eastern Australia, that are known today as the Great Dividing Range. At present, the hotspot that caused the earlier eruptions is probably beneath Bass Strait (see figure 2).

FIGURE 2 Relief map of Australia's east coast. The Great Dividing Range stretches from north of Cairns in Queensland to Mount Dandenong near Melbourne in the south.

Source: Spatial Vision

tectonic plate one of the slow-moving plates that make up the Earth's crust. Volcanoes and earthquakes often occur at the edges of plates.

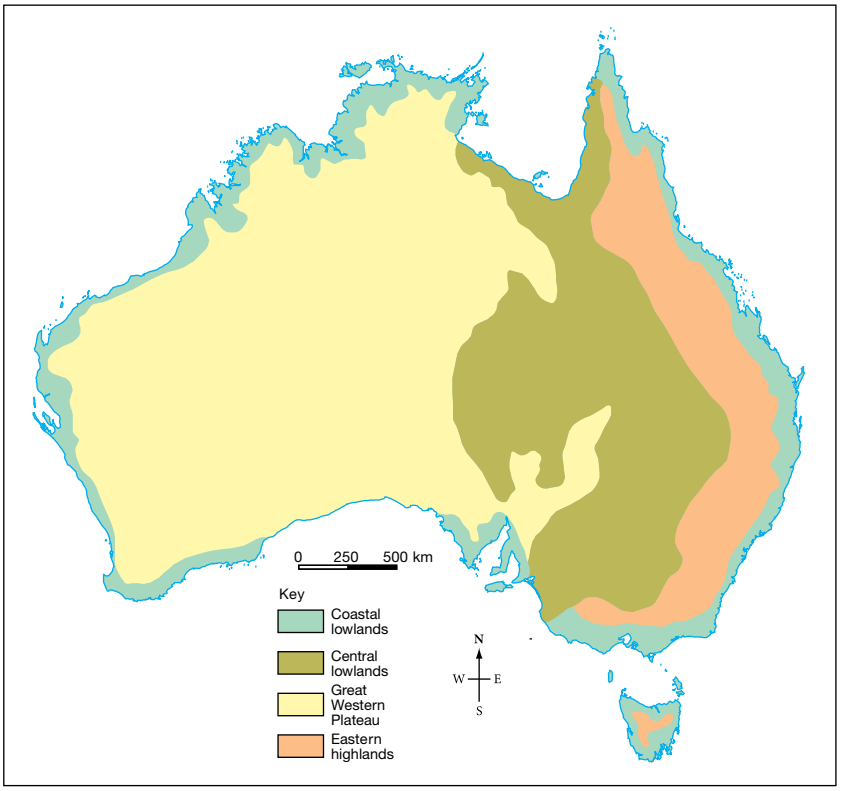
hotspot an area on the Earth's surface where the crust is quite thin, and volcanic activity can sometimes occur, even though it is not at a plate margin

The present topography of much of Australia results from erosion caused by ice. For example, about 290 million years ago a huge icecap covered parts of Australia. After the ice melted, parts of the continent subsided and were covered by sediment, forming sedimentary basins (a low area where sediments accumulate) such as the Great Artesian Basin. On a smaller scale, parts of the Australian Alps and Tasmania have also been eroded by glaciers during the last ice age.

Rivers and streams are another cause of erosion, having carved many of the valleys in Australia's higher regions.

When streams, glaciers and winds slow down, they deposit or drop the material they have been carrying. This is called deposition. Many broad coastal and low-lying inland valleys have been created by stream deposition. These areas are called floodplains.

FIGURE 3 Australia's four major landform regions



Source: MAPgraphics Pty Ltd Brisbane

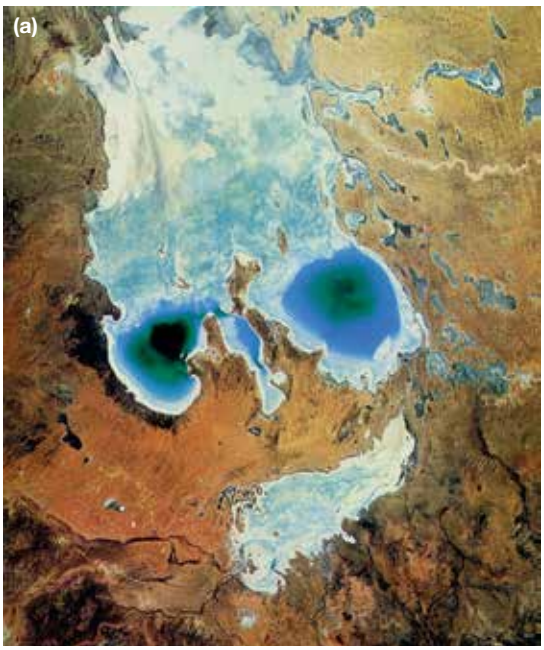
What are Australia's landform regions?

The topography of Australia can be divided into four major regions (see figure 3).

- The coastal lowlands around Australia's edge are narrow and fragmented. The plains often take the form of river valleys, such as the Hunter River Valley near Newcastle.
- The eastern highlands region (which includes the Great Dividing Range) is mainly a series of tablelands and plateaus. Most of the area is very rugged, because rivers have cut deep valleys. It is the source of most of Australia's largest rivers, including the Fitzroy, Darling and Murray. The highest part is in the south-east, where a small alpine area is snow-covered for more than half the year.
- The central lowlands are a vast area of very flat, low-lying land that contains three large **drainage basins**: the Carpentaria Lowlands in the north, the Lake Eyre Basin in the centre (see figure 4) and the Murray–Darling Basin in the south.
- The Great Western Plateau is a huge area of tablelands, most of which are about 500 metres above sea level. It includes areas of gibber (or stony) desert and sandy desert. There are several rugged upland areas, including the Kimberley and the McDonnell Ranges.

drainage basin the entire area of land that contributes water to a river and its tributaries

FIGURE 4 Lake Eyre, the lowest point on the Australian mainland, is part of the Great Artesian Basin. It is 15 metres below sea level. Once a freshwater lake, the region is now the world's largest salt pan. The evaporated salt crust shows white in the satellite image (a) below left. The lake fills with water only three or four times each century, transforming it into a haven for wildlife. Deep water is shown as black in image (b) below right.



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CASE STUDY

The Murray–Darling Basin

The Murray–Darling River covers about one million square kilometres, and more than 20 major rivers flow into it. It has a wide variety of landscapes, ranging from alpine areas in the south-east to plains in the west. The basin produces 43 per cent of Australia's food and over 40 per cent of Australia's total agricultural income.

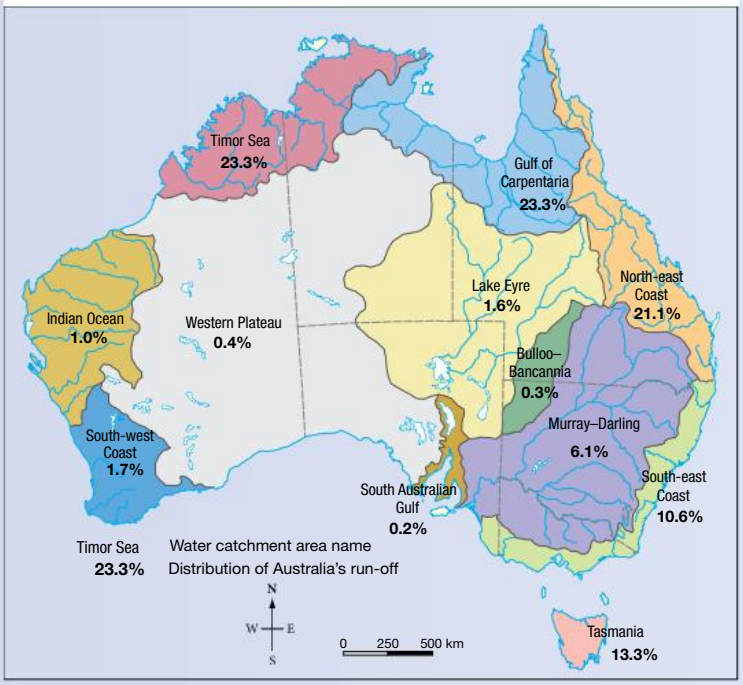
The Murray–Darling Basin is the largest and most important drainage basin in Australia, covering one-seventh of the continent. However, the amount of water flowing through it in one year is about the same as the *daily* flow of the Amazon River. The basin is facing severe problems.

- Only about 20 per cent of the water flowing through the basin ever reaches the sea. The rest is diverted for agriculture, industry and domestic use.

FIGURE 5 Aerial view of the Murray River, where it enters the Coorong and Lake Alexandrina in South Australia

- The Murray supplies about 40 per cent of Adelaide's drinking water. The quality of the water continues to decline, mainly because of salinity levels.
- Approximately 50 to 80 per cent of the wetlands in the basin have been severely damaged or destroyed, and more than a third of the native fish species are threatened with extinction.
- In 2008, inflows into the river system were at their lowest levels since records began 117 years earlier.
- An estimate of weather trends shows that the flow to the Murray River mouth may be reduced by a further 25 per cent by 2030. However, with the added problem of climate change, it is predicted that precipitation in the Murray–Darling catchment will decrease, so that the reduction in flow to the mouth could be as high as 70 per cent.

FIGURE 6 Australia's drainage basins



Source: MAPgraphics Pty Ltd Brisbane

FIGURE 7 Lake Eyre and surrounding drainage systems

Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Murray–Darling Basin

How does water flow across the land?

Permanent rivers and streams flow in only a small proportion of the Australian continent. Australia is in fact the driest of all the world's inhabited continents. It has:

- the least amount of run-off
- the lowest percentage of rainfall as run-off
- the least amount of water in rivers
- the smallest area of permanent wetlands
- the most variable rainfall and stream flow.

Australia has many lakes, but they hold little water compared with those found on other continents. The largest lakes are Lake Eyre (see figure 4) and Lake Torrens in South Australia. During the dry seasons, these become beds of salt and mud. Yet an inland sea did once exist in this area. It covered about 100 000 square kilometres around present-day Lake Eyre and Lake Frome. South Australia is Australia's driest state, and has very few permanent rivers and streams.

GEOskills TOOLBOX

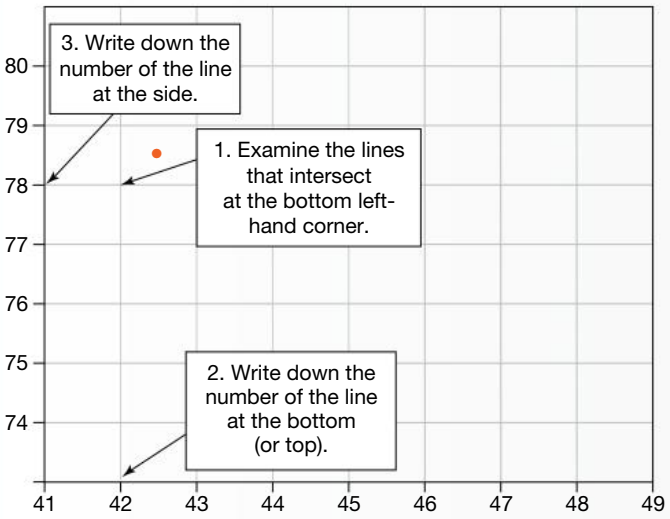
Area and grid references

Topographic maps usually have grids with numerical references. The lines that are horizontal are called northings. The lines that are vertical are called eastings.

- Area references have 4 digits, for example AR4278.
- Grid references have 6 digits, for example GR425786.

To work out area references, go to the bottom left-hand corner of the square. Examine the lines which are intersecting. Write down the number of the line at the bottom (or top) first and then write down the number of the line at the side.

FIGURE 8 Steps to determine the area reference of a location



To work out a grid reference you need to imagine that the square has been divided into tenths along both the northing and the easting.

- The area reference of this square is AR4276.
- The grid reference of this point is GR424766.

1 Determine the area references for points 1–10.
2 Determine the grid references for points 1–10.

FIGURE 9 Steps to determine the grid reference of a location

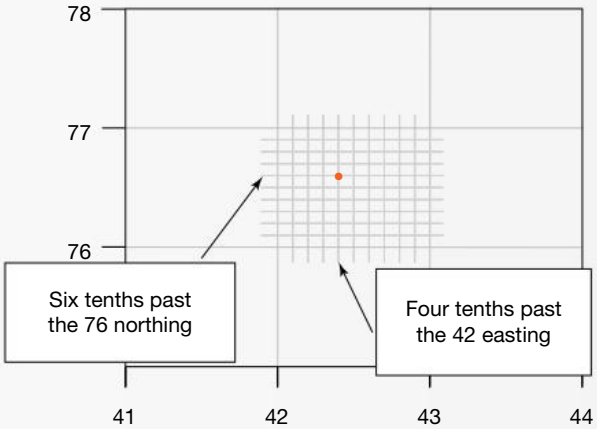
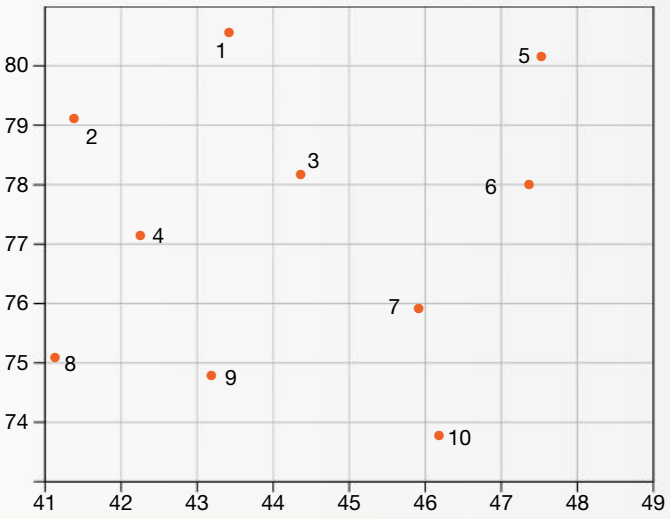


FIGURE 10 A basic grid is an important feature of a topographic map.



ACTIVITIES

IDENTIFY

1 In your own words, explain what is meant by the terms *folding*, *faulting* and *uplift*.
2 Describe some of the physical ***changes*** Australia's landmass has undergone.
3 Describe the major characteristics of Australia's four main landform regions.

EXPLAIN

4 Explain why Australia is so low in altitude compared with other continents.

INVESTIGATE

5 Use an atlas to complete the table below, listing the highest mountains in each Australian state and territory. Describe the location of each.

State/ Territory	Highest mountain	Elevation (metres)	Absolute location	Relative location
New South Wales				
Victoria				
Queensland				
Tasmania				
Western Australia				
South Australia				
Northern Territory				
Australian Capital Territory				

6 Use Google Earth to view any part of the Murray–Darling Basin. Describe the landscape.
7 Divide your class into four groups. Assign each group one of Australia's landform regions to investigate. Collectively compile a list of landforms that are found in each region. Then have each member of the group investigate a different landform and prepare a series of PowerPoint slides that show the following:
   a the landform
   b where it is located
   c how it was formed
   d whether people might want to visit this landform, including the reasons why it is or is not a popular landform.

   Put the individual presentations together for viewing by the rest of the class.
   Refer to the information on page 28 to complete this question.
8 Use your atlas to find the Cape Hillsborough and Macedon volcanoes, or refer to figure 2.
   a Calculate the distance between them.
   b Use the information in this section to work out the rate at which the Australian landmass is moving.
   c How far has Australia moved over the Bass Strait hotspot? Now calculate where under Bass Strait this hotspot might now lie.
   d Use the information in this section to explain why this hotspot has ***changed*** its location over time.
9 It is said that the amount of water that flows down the Amazon River in a day is more than flows down the Murray in a year.
   a What does that tell you about how dry Australia's climate is?
   b How might this affect the way the ***environment*** around the Murray River is affected?

APPLY

10 Australia is an ancient landmass and has undergone many ***changes*** over millions of years. In groups, brainstorm and compile lists under the following headings.
   - Physical ***changes*** that have taken place on the Australian landmass
   - Tectonic processes that have contributed to these ***changes***
   - ***Changes*** caused by processes such as weathering and erosion
   - Within your group, write a series of paragraphs that explain the ***interconnection*** between these factors.

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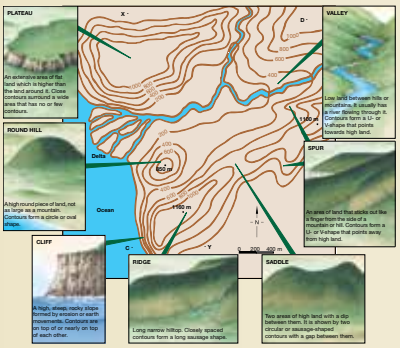
2.4 SkillBuilder: Recognising land features

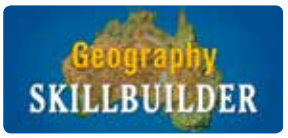
What are land features?

Land features are landforms with distinct shapes, such as hills, valleys and mountains. You can recognise these as you look around your natural environment. On topographic maps you can recognise land features from the patterns formed by the contour lines.



eLesson

Watch this video to learn how to recognise land features.



Searchlight ID: eles-1648

Interactivity

Try this interactivity to learn how to recognise land features.

Searchlight ID: int-3144

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2.5 What types of landscapes are found in the Pacific region?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

2.6 What processes transform landscapes?

2.6.1 Are all processes natural?

There are processes at work that continuously sculpt and change the landscape. In the future, the Earth's surface will look very different from the way it looks today.

There are a variety of natural processes that shape and reshape not only the surface of the Earth, but also what lies beneath it. Natural processes, also called geomorphological processes, include uplift, such as that caused by tectonic activity, erosion, deposition and weathering. People change the landscape when they clear land for agriculture or build cities and road networks; these are known as human processes. Sometimes they alter the course of a river or trap its flow behind the walls of a dam.

What role do tectonic forces play?

The Earth's surface, or crust, is split into a number of plates, which fit together like a giant jigsaw puzzle. These plates sit on a layer of semi-molten material in the Earth's **mantle** — the layer of the Earth between the crust and the core. Heat from the Earth's core creates convection currents within the mantle, causing the plates to move. Most of the Earth's great mountain regions were formed as a result of this movement.

mantle the layer of the Earth between the crust and the core

FIGURE 1 Over millions of years, the Colorado River has cut deep channels to form the Grand Canyon.

When two plates collide, one plate often slides under the other, in a process known as subduction, and it becomes part of the mantle. Other rocks are forced upwards and bent or folded. Large mountain ranges that were formed in this way include the Himalayas in Asia and the Rocky Mountains in North America.

transportation the movement of eroded materials to a new location by elements such as wind and water

How is the landscape worn away?

Erosion is the wearing away of the Earth's surface by natural elements such as wind, water, ice and human activity. The landscape is further eroded when agents such as wind, water and ice **transport** these materials to new locations. Eventually, transported material is deposited in a new location. Over time, this material can build up and new landforms result. The Grand Canyon in Colorado in the United States (figure 1) is an example of these elements at work. These processes work more quickly on softer rocks.

Human activity also contributes to erosion. Deforestation, agriculture, urban sprawl, logging and road construction all alter the natural balance and increase erosion by as much as 40 per cent in some areas. Vegetation not only provides valuable habitat for native animals but also is vital for binding the soil together. Once vegetation is removed, it is more easily broken down and removed by wind and water. When topsoil is removed, plants are unable to obtain the nutrients they need for growth. Sometimes wide, deep channels, known as gullies, form (figure 2).

FIGURE 2 Deep gullies caused by human activity

FIGURE 3 After tectonic forces cause a section of the Earth to be raised (uplifted), other processes take over and re-sculpt the landscape.

1 Weathering is the breakdown of rocks due to the action of rainwater, temperature change and biological action. The material is not transported (removed).

It can be physical, chemical or biological.

2 Erosion is the process whereby soil and rocks are worn away and moved to a new location by agents such as wind, water or ice.

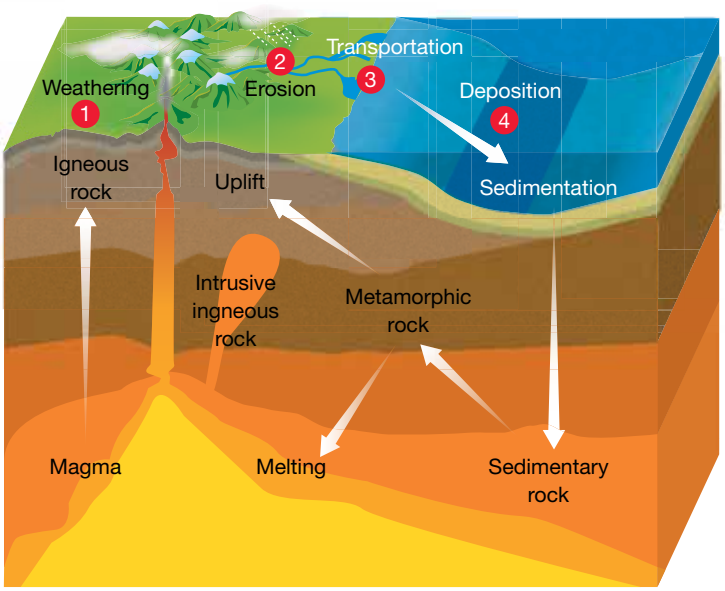
3 Transportation is the process that moves eroded material to a new location — examples include soil carried by the wind, and sediment or pebbles in a stream.

4 Deposition — materials moved by wind and water eventually come to a halt. Over time new landforms are built. Sand dunes and beaches are common landforms associated with deposition.

Physical — occurs where water is continually freezing and thawing. The water penetrates cracks and holes in the rocks. As water freezes it expands, making the cracks larger. Over time the rock breaks apart.

Chemical — some rocks, such as limestone, contain chemicals that react with water causing the limestone to dissolve.

Biological — living organisms such as algae produce chemicals that break down rocks. They can also be forced apart by plant roots.



ACTIVITIES

IDENTIFY

1 In your own words, define the natural processes at work shaping the Earth.

EXPLAIN

2 Explain how and why human activity might contribute to weathering and erosion.

3 Using terms such as *uplift*, *erosion*, *deposition*, *weathering* and *transportation*, explain the ***interconnection*** between landscapes and physical processes.

4 Choose a landscape to investigate using the internet.

- **a** Copy and paste an image of this landform into a Word document
- **b** Annotate the image with information about its location, formation and change over time.
- **c** Develop a sketch to show how this landform might have looked in the past and how it might look in the future.
- **d** Ensure that you show the source of the image.

PREDICT

5 Study the ***environment*** around your home or school and find a ***place*** where there is evidence of erosion. Make a sketch and label the features of the landscape. Highlight areas where erosion is evident and add annotations to explain what you think might have caused this ***change***, and in particular, the ***scale*** of this ***change***. Estimate the proportion of this ***environment*** that has been affected. What proportion do you think is the result of human activity? Compare your estimate with the figure given in this section.

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Interactivity
Break down!
Use this interactivity to learn how weathering, erosion and deposition shape our landscapes.
Searchlight ID: int-3101

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. **› Active Earth**

2.7 Which landscapes are created by water?

2.7.1 How does water change landscape features?

A torrent of gushing water can shift rocks, remove topsoil or shape river valleys. Gentle rain can change the chemical structure of any surface material, making it more likely that soil will be transported by the next heavy shower. In cold climates, frozen water in glaciers works like a slow-moving bulldozer to erode land and create unique landscape features. Once fresh water has made its way to the ocean, the power of waves creates coastal landscape features.

Landscapes are predominantly changed or created by two processes: erosion and deposition (see sections 2.10 and 2.11). Water is one of the most powerful agents, causing erosion and deposition, and thereby breaking up, moving and repositioning material across the Earth's surface. In figure 2 you can see the power of water as it rushes over a rockface and carves pools in its hard surface. You may have seen pools of a similar shape carved by waves in rocky coastal landforms.

FIGURE 1 The Twelve Apostles in Port Campbell National Park, Victoria. How might the potential for erosion change along this coast if the waves were larger and it was high tide?

As water makes contact with landscapes, it can change the shape and size of its features or landforms (figures 2 and 3). The coastal landscape that you see today is not the same as it was hundreds or thousands of years ago. Figure 1 is a photo of the Twelve Apostles, located on the coast of south-western Victoria. The name suggests that there may once have been twelve pillars of rock, or stacks, visible along this stretch of coastline. In the foreground you can see the remnants of two quite recently collapsed stacks. Even these stacks were once joined to the cliffs as part of the mainland. This highly erodible coastline has been constantly altered by many years of rainfall and wave action on the soft limestone cliffs. The resulting coastline has seen much creation and destruction of stacks over time.

FIGURE 2 How is the flow of water changing this landscape?

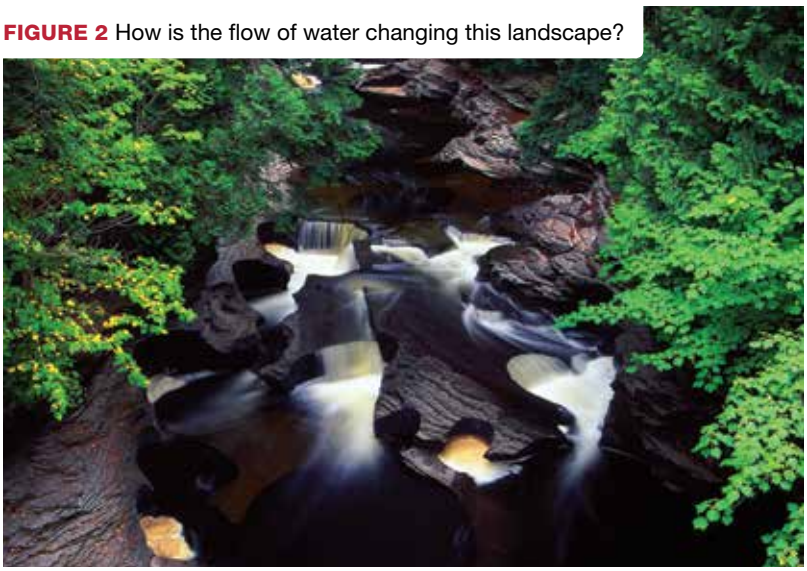
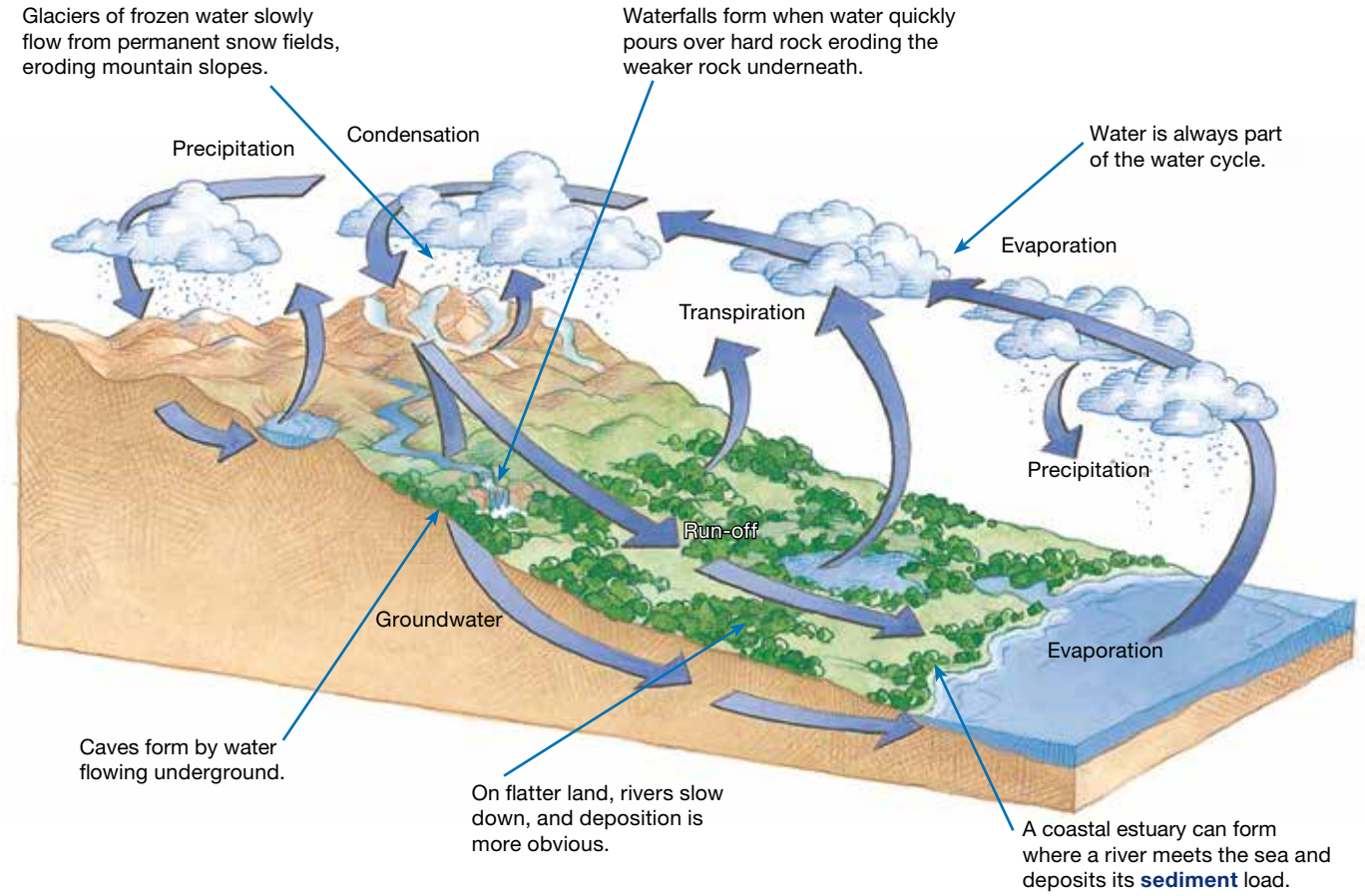


FIGURE 3 Water constantly moves over and through the Earth and through the air.



sediment material carried by water

ACTIVITIES

IDENTIFY

1 Landscapes are in a state of continual ***change***.
- **a** Which two natural processes powered by water are most responsible for continually ***changing*** landscapes?
- **b** How are these two processes linked?

EXPLAIN

2 Where would figures 1 and 2 be ***placed*** on the landscape depicted in figure 3? Explain.

3 Explain how the water cycle and the formation of landscapes are ***interconnected***.

INVESTIGATE

4 Using an atlas, Google Earth and other sources where appropriate, label on a world map each of the following:
- **a** the largest glacier
- **b** the longest river
- **c** the highest waterfall
- **d** the widest river
- **e** the largest ocean
- **f** the deepest point in an ocean
- **g** one other world water fact of your choice.

PREDICT

5 Many landscapes change rapidly; for example, the Twelve Apostles. With a partner or group, discuss another example of a landscape that has been shaped by the power of water. Do you think the ***changes*** to the landscape have been positive or negative? To what extent should people try to stop the ***changes*** caused by water?

6 Water can be considered one of the most important architects of desert landscape features. After looking at the images in this section, try to explain how you think water can ***change*** the landscapes of arid or desert ***environments***.

7 Identify three possible ways that people can ***change*** the flow of water, either across the surface of the Earth or along the coast. Predict how you believe this may alter landscape features. Examples may include the use of river water for irrigation or the construction of a marina.

2.8 How are landscapes created underground?

2.8.1 What is karst?

Apart from rivers and streams that flow across the surface of the Earth, vast networks of rivers also exist under the ground. The result is a network of caves and channels that carve a very different landscape, known as karst.

Karst is a landscape formed by water dissolving bedrock (solid rock beneath soil) over hundreds of thousands of years (see figure 1). On the surface of the Earth, sinkholes (holes in the Earth's surface), vertical shafts (tunnels), and fissures (cracks) will be evident. Rivers and streams may seem to simply disappear, but underground there are intricate drainage networks, complete with caves, rivers, **stalactites** and **stalagmites** (see figure 2).

Karst topography makes up about 10 per cent of the Earth's surface; however, a quarter of the world's population depends on karst environments to meet its water needs.

stalactite a feature made of minerals, which forms from the ceiling of limestone caves, like an icicle. They are formed when water containing dissolved limestone drips from the roof of a cave, leaving a small amount of calcium carbonate behind.

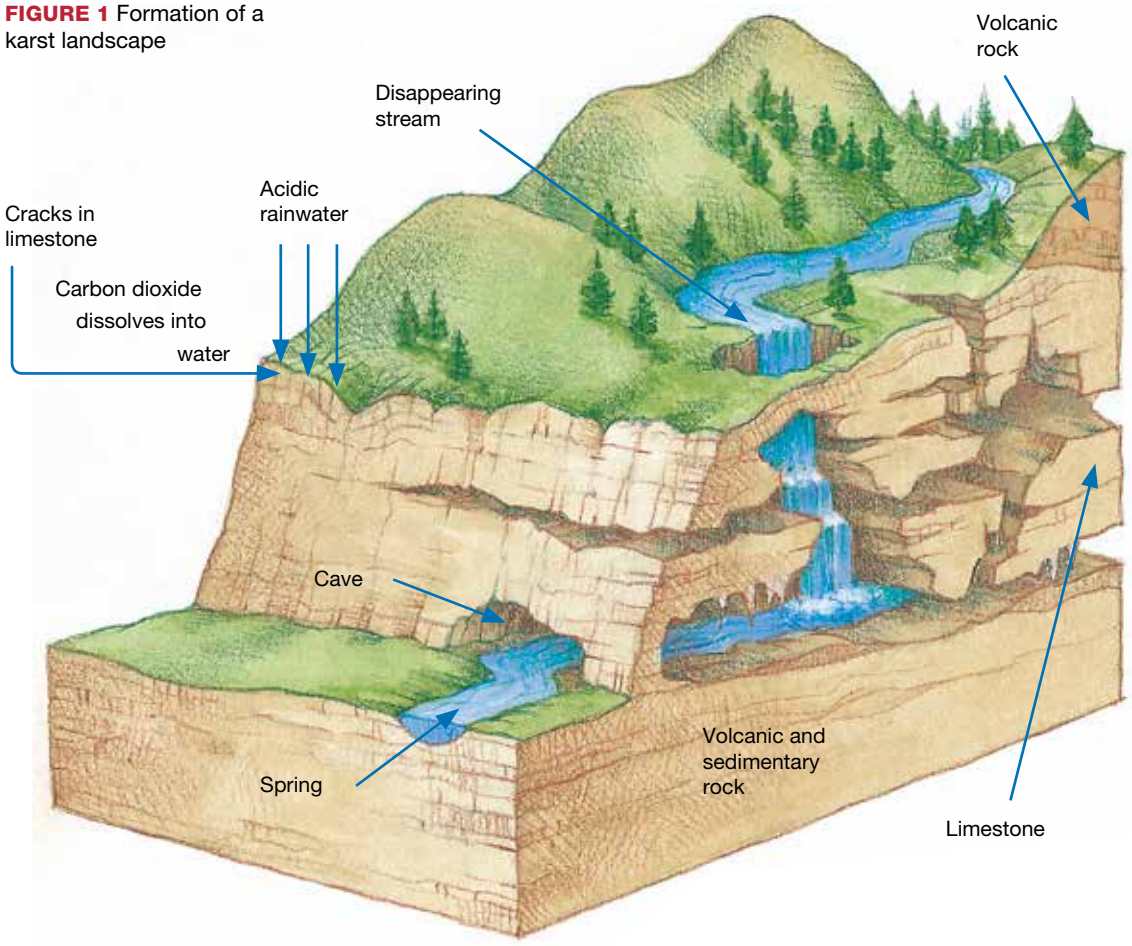
stalagmite a feature made of minerals found on the floor of limestone caves. They are formed when water containing dissolved limestone deposits on the cave floor and builds up.

soluble able to be dissolved in water

2.8.2 How are karst landscapes formed?

Water becomes slightly acidic when it comes into contact with carbon dioxide in the atmosphere (as it does when raindrops form) or when it filters through organic matter in the soil and percolates into the ground. Acidic water is able to dissolve **soluble** bedrock, such as limestone and dolomite. This creates cracks or fissures, allowing more water to penetrate the rocks. When the water reaches a layer of non-dissolving rocks, it begins to erode sideways, forming an underground river or stream. As the process

FIGURE 1 Formation of a karst landscape



continues, the water creates hollows, eventually creating a cave. Some karst landscapes contain aquifers that are capable of providing large amounts of water.

FIGURE 2 Caves in Guilin, Guangxi Province, southern China

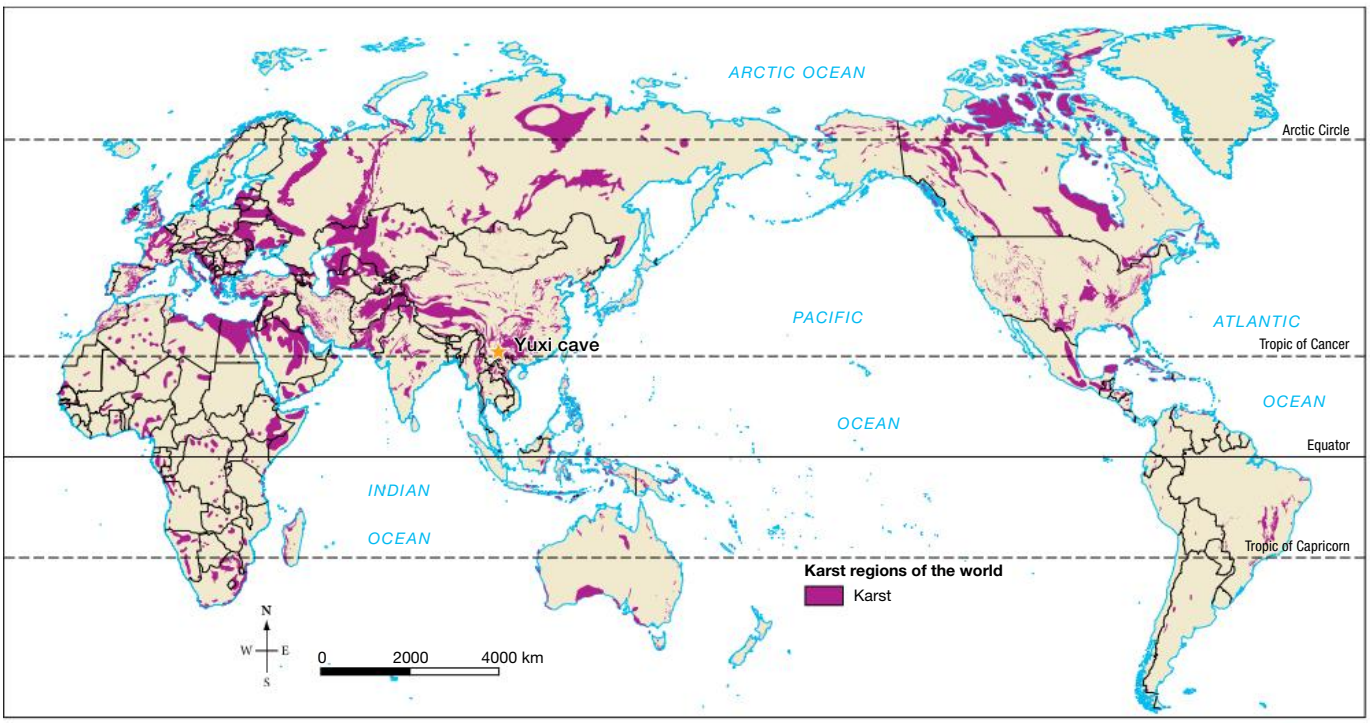
2.8.3 Where are karst landscapes located?

Karst landscapes are found all over the world, as shown in figure 3, in locations where mildly acidic water is able to dissolve soluble bedrock such as limestone and dolomite.

In tropical regions, where rainfall is very high, karst mountains sometimes develop. This is because the high rainfall levels wear away the soluble rock much faster than rock is worn away in karst areas with lower rainfall. Examples of tropical karst mountains include the peaks of Ha Long Bay in Vietnam and the Guilin Mountains in China.

The Earth's largest arid limestone karst cave system is located on Australia's Nullarbor Plain, covering 270 000 square kilometres. It extends 2000 kilometres from the Eyre Peninsula in South Australia to Norseman in the Goldfields–Esperance region of Western Australia, and from the Bunda Cliffs on the Great Australian Bight in the south to the Victoria Desert in the north. The extensive cave system provides a unique habitat for a variety of native flora and fauna. Within the caves are fossils that can reveal much about our distant past, along with important Aboriginal heritage sites.

FIGURE 3 Karst regions of the world



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 In your own words, explain how a karst landscape is formed.

EXPLAIN

2 Describe the global distribution of karst landscapes.

3 Do you think we should preserve karst landscapes? Give reasons for your answer.

INVESTIGATE

4 Examples of karst landscapes in Australia include the Buchan, Naracoorte, Jenolan, Labertouche, Princess Margaret Rose, Judbarra and Abercrombie caves. Working with a partner, investigate one of these karst landscapes and prepare an annotated visual display. On a map, show its absolute and relative location. Include information about its landforms, land use, concerns or threats to this environment, and what is being done to ensure sustainable management of the landscape. Share your findings with the rest of the class.

5 The largest limestone arid karst system is found on the Nullarbor Plain, Australia.

- **a** The Nullarbor Plain is an example of a desert landscape; suggest how an ***environment*** formed by water can occur in this location.
- **b** This cave ***environment*** is a popular destination for caving groups. Use the internet to investigate this ***environment*** and why people are attracted to it. Compare this ***environment*** to the one you studied in question 4. Pay particular attention to the *scale* and *change* that has occurred in each ***place***. Is one more fragile than the other? Explain. Suggest strategies for the ***sustainable*** management of karst in the Nullarbor.
- **c** Describe how you think this landscape would be different if it were located in Australia's tropical north.

eBookplus

Interactivity
Underground wonders
Use this interactivity to find out more about how karst landscapes form.
Searchlight ID: int-3103

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2.9 How are river landscapes created?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

2.10 How are coastal landscapes shaped by erosion?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

2.11 How are coastal landscapes shaped by deposition?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

2.12 How do I undertake coastal fieldwork?

2.12.1 Your fieldwork task

A fieldwork activity will allow you to put the knowledge you have gained in the classroom into practice.

Any coastal landscape would be suitable to investigate. Once a fieldwork site has been identified, there is quite a lot of planning that you should do before you get there.

What is your fieldwork task?

Your task is to identify the landforms and dynamic nature of a coastal landscape and to recognise and assess the influence of people on it.

In class

1. Prepare a base map of the fieldwork site or sites. On this base map, mark in the location of the coastal landscape's natural features (such as beach, rock, dunes, water, vegetation) and **human features** (such as seawall, groyne, steps, lawn, shelter, jetty). Using Google Maps or a topographic map is an excellent way of identifying the specific details of the coastal landscape.
2. Looking at the aerial shot on Google Maps will also allow you to see the pattern of the waves as they move to the shore. Does it look as if longshore drift is occurring on the day this image was taken?

human features structures built by people

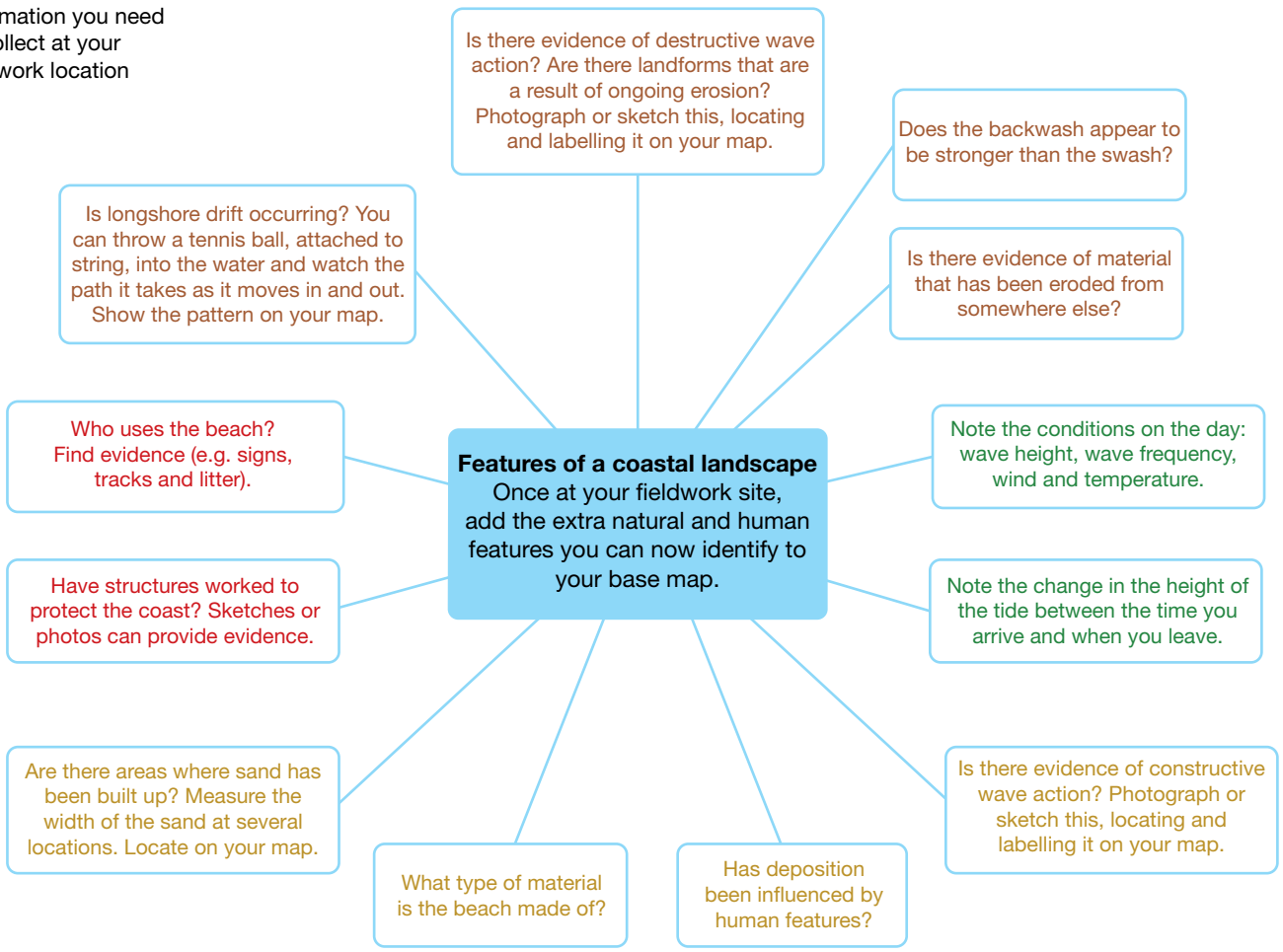


FIGURE 1 The information you need to collect at your fieldwork location

On your field trip

What do you need to do at the coast to collect your information?

It is good to work in groups to collect your data in the field. It is then possible for some students to take measurements and some to record. Sharing tasks means that there will be others with whom to discuss what you have recorded. On returning to class you can pool your observations. You will need recording sheets, pencils, a digital or phone camera, tape measure, compass and maybe a clinometer. You could also collect information using data logging equipment, a GPS locator, weather recording equipment and notepads. Your group should decide what equipment is the most practical and relevant for collecting the data you need.

You may not be able to return to your fieldwork site, which means your data needs to be very detailed.

- Always record the location of the information on your map.
- Take photos of the coastal landscape, including the landforms and human structures.
- Measure distances and heights.
- Draw **field sketches** to remind you of details. Even when you have photographed something, a field sketch allows you to annotate the diagram so that you can remember important characteristics about how it was formed or the direction of longshore drift. Do not worry if you are not a gifted artist, as there are apps that allow you to convert your photos to sketches when you get back to class.

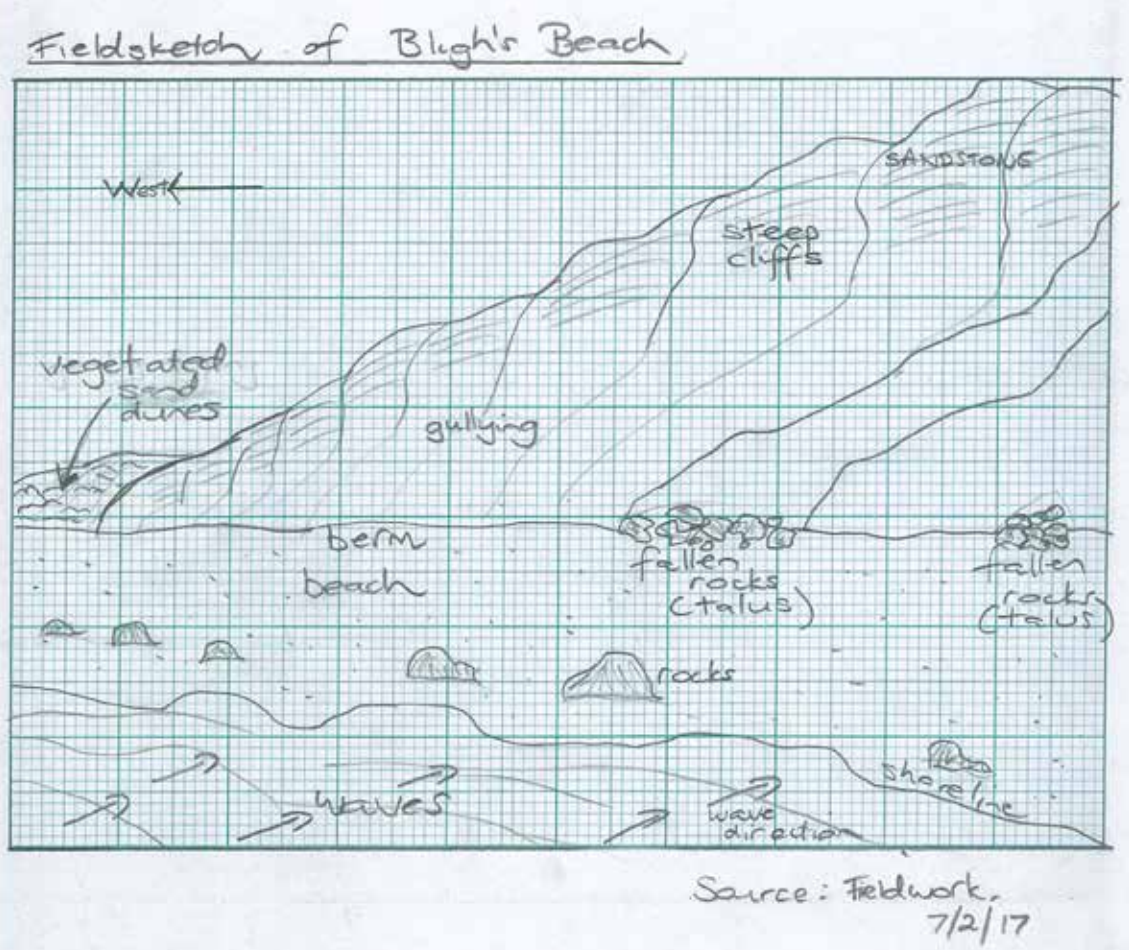
field sketch
a diagram with geographical features labelled or annotated

FIGURE 2 Investigating the rocky shores of a coastal landscape

Back in class

Now that you have collected your information in the field, you need to present your findings about the coastal landscape you visited.

FIGURE 3 A completed fieldwork sketch



There are many ways that you could present this information. Your fieldwork report could be presented as a poster, website, PowerPoint presentation, booklet, blog, movie, news report or podcast. Consider using Google Maps and uploading images of the sites you visited. You will need to present the data you collected and describe your findings.

FIGURE 4 Students on a fieldwork trip, measuring the slope of a sandy beach

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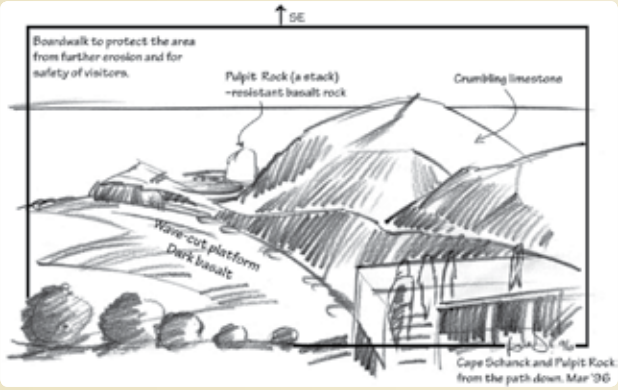
2.13 SkillBuilder: Constructing a field sketch

What are field sketches?

Field sketches are drawings completed during fieldwork — geography outside the classroom. Field sketches allow a geographer to capture the main aspects of landscapes in order to edit the view, focusing on the important features and omitting the unnecessary information.



eLesson
Watch this video to learn how to construct a field sketch.

Searchlight ID: eles-1650

Interactivity
Try this interactivity to learn how to construct a field sketch.

Searchlight ID: int-3146

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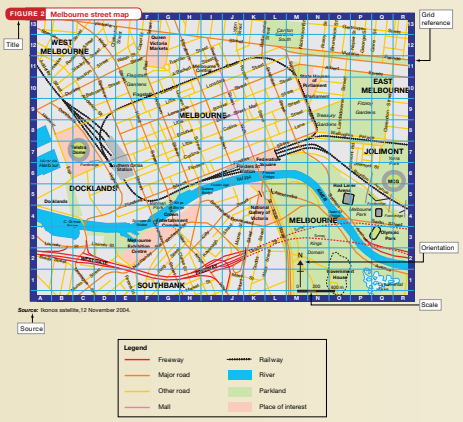
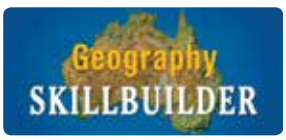
2.14 SkillBuilder: How to read a map

What is a map and why are they useful?

Maps represent parts of the world as if you were looking down from above. Maps are useful to show features so that we have a deeper understanding of places. When travelling, maps are essential to navigate unfamiliar places. All maps should have what we call BOLTSS.



eLesson
Watch this video to learn how to read a map.



Searchlight ID: eles-1634

Interactivity
Try this interactivity to learn how to read a map.

Searchlight ID: int-3130

2.15 What are topographic maps?

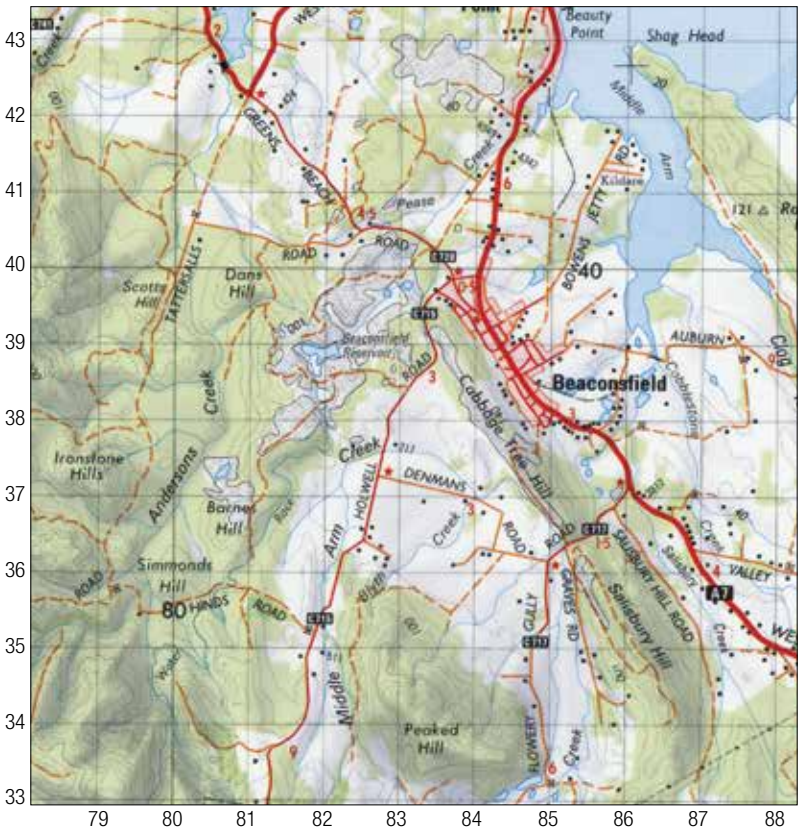
2.15.1 What is a topographic map?

A topographic map is a representation of the Earth which shows the features of a landscape. The map is overlaid with a coordinate grid.

2.15.2 What is shown on a topographic map?

- **Cultural features:** urban developments, buildings, borders and boundaries, and transportation infrastructure such as roads, bridges, airports and railways
- **Vegetation:** different types of vegetation such as grasslands, heathlands, peatlands, forests and woodlands
- **Water sources:** physical features related to water such as rivers, oceans, lakes and swamps
- **Relief:** the height of the land and different landforms such as mountains, slopes and depressions

FIGURE 1 Topographic map extract, Tamar Valley, Tasmania



2.15.3 How do you interpret a topographic map?

The basic features that help you read a topographic map are the border, orientation, legend, title, scale and source. This can be remembered with the acronym BOLTSS.

B	Border
O	Orientation
L	Legend
T	Title
S	Scale
S	Source

Border

The border defines the boundaries of the map face. Around the edges of the border you will find grid coordinates and possibly latitude and longitude references. The border outlines all the key features of the map.

Built-up area, National route marker
Principal road and highway; Cutting
Secondary road; Embankment
Road under construction
Minor road
Vehicular track
Bridge, road; Bridge, railway; Tunnel, railway
Gate; Cattle grid

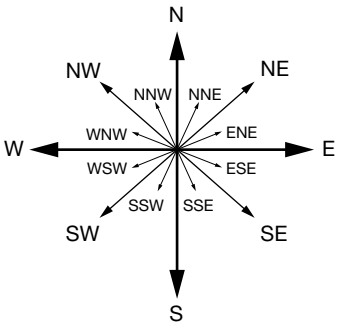
Railway, multiple track; Station; Siding
Railway, single track; Station with siding
Light railway or tramway
Power transmission line (cross-country)
Fence; Levee or bank
Mine; Windmill; Quarry
Building; Church; Ruins; Yard
Trig station; Bench mark; Spot elevation
Contour with value; Auxiliary contour

Forest, dense; medium; scattered
Orchard or vineyard; Mangrove
Swamp, perennial; intermittent
Land subject to inundation; Ricefield
Lake, perennial; Stream, perennial
Lake, intermittent; Stream, intermittent
Lake, mainly dry; Stream, mainly dry
Bore or well; Spring; Tank or small dam
Irrigation channel

Orientation

Direction is used to tell us the location of one place in relation to another. The four cardinal points are:

- North
- South
- East
- West.



Legend

The features shown on a topographic map are explained in a key or legend (see below). The key provides symbols with explanations.

Title

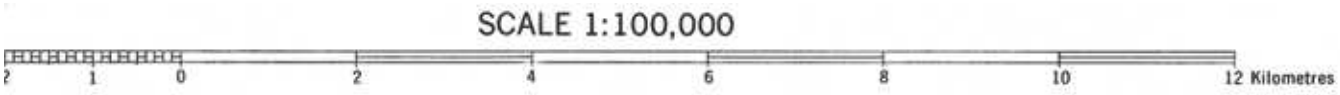
The title tells you the location of the map.

Scale

Scale describes the relationship between the size of an object in real-life compared to the size of an object on a map. Scale helps us to determine the distance of one location from another.

Scale can be shown in three ways.

Linear scale



Scale statement

A scale statement expresses the map scale in words. For example:

- One centimetre represents half a kilometre.

Scale as a ratio

A map scale may be expressed as the ratio of the distance on the map to the corresponding distance on the ground. For example:

- 1 : 50 000

The most common scale is 1 : 100 000. This means that 1 centimetre represents 100 000 centimetres, or 1000 metres or 1 kilometre; so, if you measure 4 centimetres on the map it will represent 4 kilometres on the ground.

Source

For Australian locations, many topographic maps are created by the state and federal governments of Australia. Others can be made by private companies. It is always important to examine the source of a map to ensure it is from a trusted source.

Map supplied by MAPLAND, Environmental and Geographic Information, Department for Environment and Heritage, South Australia.

contour line a line joining places of equal height above sea level

spot height a point on the map which shows the exact height above sea level at that place

2.15.4 Contour lines

Topographic maps enable us to understand the shape of the land even though they are shown in two dimensions (on a flat piece of paper).

Contour lines and **spot heights** help us to determine the altitude of different places on the map.

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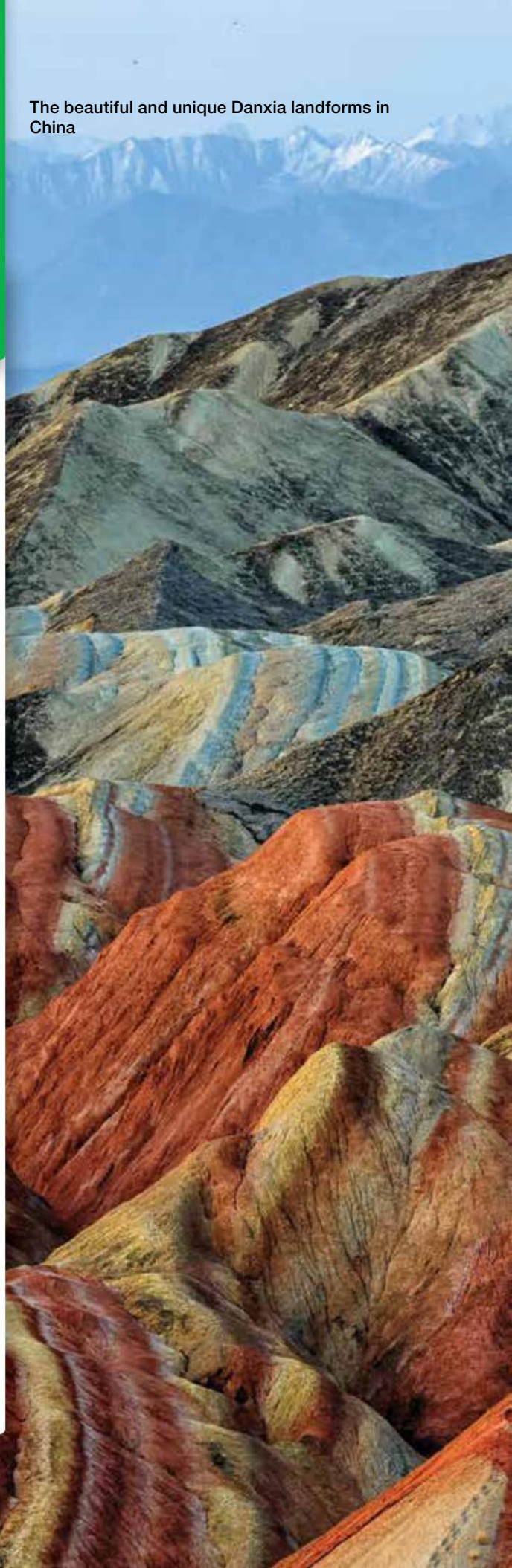
2.16 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

CHAPTER 3

Valuing, managing and protecting landscapes and landforms



The beautiful and unique Danxia landforms in China

3.1 Overview

3.1.1 Introduction

There are a variety of reasons why people value landscapes and landforms. They are central to many indigenous cultures' identity, they inspire because of their natural beauty and play a role in the economic activities of humans. Whatever the reason, landscapes and landforms are important to us as humans and we are obliged to manage and protect them sustainably for current and future generations to use and appreciate.

Starter questions

1 Use the **Iguazu Falls** weblink in your eBookPLUS to watch a video of the Iguazu Falls.
   a List as many adjectives as you can to describe this landscape.
   b As a class, use an online word cloud generator to create a word cloud using all the adjectives used by your class to describe the landscape. In turn, ask each person to call out their adjectives to be entered into the word cloud generator; include repeated words.

2 Identify and describe two ways in which Iguazu Falls has the potential to make money for the local community.

eBookplus
Weblink
Iguazu Falls

Inquiry sequence

		Syllabus outcomes
3.1 Overview		
3.2 Why do people value landscapes and landforms?		GE4-4
3.3 How do landscapes and landforms have cultural and spiritual value?		GE4-4
3.4 What are the economic values of landscapes and landforms?		GE4-4
3.5 SkillBuilder: Using positional language	eBookplus ONLINE ONLY	GE4-3, GE4-7
3.6 How are landscapes protected and managed?		GE4-5
3.7 Kakadu—Australia's first World Heritage Area	eBookplus ONLINE ONLY	GE4-4, GE4-5
3.8 Why is Uluru an iconic Australian landform?		GE4-4, GE4-5
3.9 How is Uluru protected and managed?		GE4-5
3.10 How have humans changed and degraded landscapes?		GE4-2
3.11 What are geomorphic hazards?		GE4-2
3.12 SkillBuilder: Using topographic maps	eBookplus ONLINE ONLY	GE4-3, GE4-7
3.13 Investigating topographic maps: What is the value of Gunnedah Shire?		
3.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	

eBook*plus*

Watch this video
Landscapes sculpted by water
Searchlight ID: eles-1624

3.2 Why do people value landscapes and landforms?

3.2.1 What are the aesthetic values of landscapes and landforms?

Landscapes and landforms are valuable as they play an important part in the way the physical environment functions. However, humans have always been interconnected with landscapes and believe they are important for their aesthetic, economic, cultural and spiritual values.

aesthetic relating to something beautiful and pleasing to look at

Many landscapes and landforms are valuable to humans because of their natural beauty. This is also known as **aesthetic** value. There is a variety of landscapes that inspire people, from the vibrant and colourful coral reef aquatic ecosystems to the beautiful vista of a mountain landscape. Many recreational activities are taken up because of the aesthetic value of landscapes and landforms (figure 1). People participate in outdoor recreations such as scuba diving, bushwalking, rock sports and photography. Artists, poets and musicians have also been inspired by the aesthetics of landscapes, and have created some of the most famous pieces of poetry, art and songs about them (see case study below).

FIGURE 1 Outdoor recreational activities take advantage of the natural beauty of landscapes and landforms.

FIGURE 2 The beach and lifesavers are recognised as part of Australia's cultural identity.

3.2.2 The beach — Australian cultural identity

The aesthetic value of the beach landform plays an important part in Australia's national identity. Globally, Australia is well known for its beautiful beaches and its leisure lifestyle based around the beach (figure 2). Many international tourists will visit one or more of Australia's famous beaches such as Bondi Beach in Sydney, Broadbeach on the Gold Coast or Bells Beach in Victoria. This is due to Australia being a large island continent with 10 685 beaches, and most of its population living within 50 kilometres of the coastline, making access to the beach relatively easy.

CASE STUDY

'My Country'

Dorothea Mackellar was an Australian poet who wrote 'My Country', one of the most famous poems about the Australian landscape. She grew up in the city, but her family had property in the Hunter Valley of New South Wales, and near Gunnedah to the north. She visited these places frequently and was heavily influenced by the landscapes she saw.

I love a sunburnt country,
A land of sweeping plains,
Of ragged mountain ranges,
Of droughts and flooding rains.
I love her far horizons,
I love her jewel-sea,
Her beauty and her terror –
The wide brown land for me!

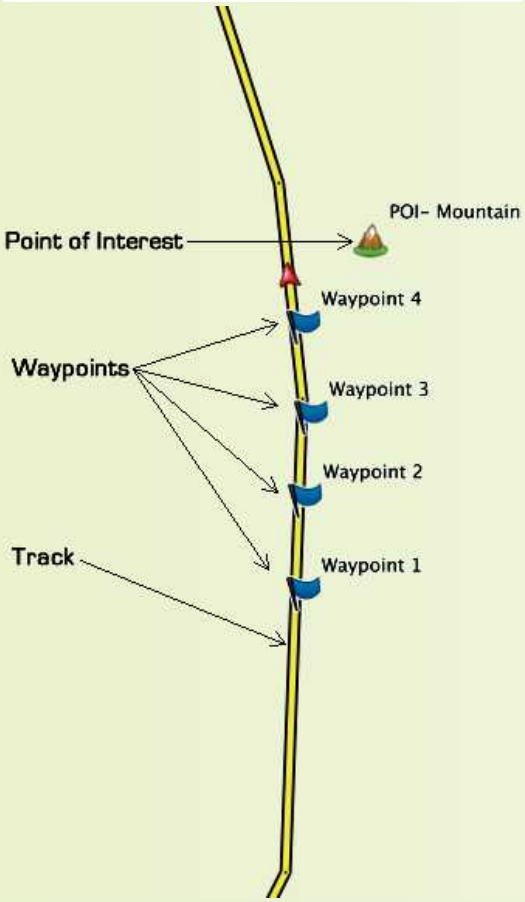
FOCUS ON FIELDWORK

Using a GPS in the field

A popular instrument that bushwalkers use, which is a valuable fieldwork tool for Geographers, is a hand-held Global Positioning System (GPS) device. These can be a specialty device or an application on a smartphone (figure 3). A GPS accurately locates a person on the surface of the Earth by connecting to **geostationary satellites** that are in orbit around our planet. GPS devices record locations by logging in your latitude and longitude at a particular spot. These are called **Waypoints**. If you walk along a path, a GPS unit can record your **Track**. Another feature on a GPS is that a person can log in **Points of Interest** (POI) to help locate places they have found interesting and want to visit again. All this data can be transferred to mapping software such as GIS or Google Earth so it can be accurately viewed on a map (figure 4). Also, the GPS can be used to navigate back to Waypoints and POIs and/or to follow a track that has been recorded (a route).

FIGURE 3 A smartphone with a GPS application installed

FIGURE 4 Waypoints, Tracks, Routes and POI as recorded by a GPS and put on a map



geostationary satellites satellites that orbit with the Earth's rotation and appear to be stationary in the sky making locating features on the Earth's surface more accurate with GPS

ACTIVITIES

IDENTIFY

1 Define the word *aesthetic*.

2 Name and describe some recreational activities you can do in landscapes.

EXPLAIN

3 Explain why the beach is considered part of Australia's cultural identity.

INVESTIGATE

4 There have been numerous songs and artists that have been inspired by landscapes. Research either a song or an artwork that is well known. Outline how the artist or songwriter described or portrayed the beauty of the landscape.

APPLY

5 Think of a landscape or landform you have visited. Write a poem or a song using as many adjectives as you can to describe what the landscape/landform looks like and how it made you feel.

6 a Conduct a survey in your class to count how many people visit the beach. Create a table that will tally your results like this:

Visit beach daily	Visit beach weekly	Visit beach monthly	Visit beach yearly	Rarely or never

b Based on your class results, do you think the beach is an important part of your culture? What are the location reasons that would explain your results?

3.3 How do landscapes and landforms have cultural and spiritual value?

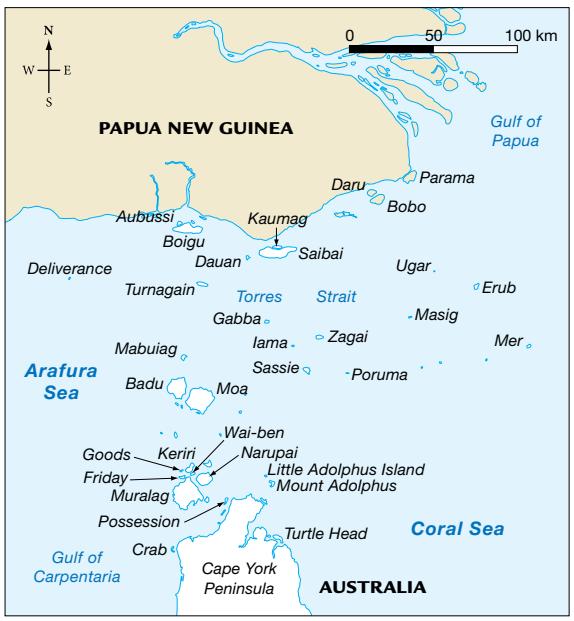
Dreaming in Aboriginal culture, the time when the Earth took on its present form, and cycles of life and nature began, also known as the Dreamtime. Dreaming Stories pass on important knowledge laws and beliefs.

3.3.1 The Australian experience

Humans have always been interconnected with the physical environment, and landscapes and landforms have helped shape our beliefs and way of life. Many of the world's indigenous people continue to have a special relationship with their physical surroundings, and these landscapes continue to be an important part of their culture and spirituality.

Australian Aboriginal and Torres Strait Islander people inhabited Australia for thousands of years before European settlement. Their culture and spirituality are linked to the landscapes that they live in. Both the Aboriginal and Torres Strait Islander people recount how their ancestors created the landforms as they travelled across the landscape during a time that is commonly referred to as The **Dreaming**.

FIGURE 1 Location map of Torres Strait islands



Source: Geoscience Australia

The Dreaming and Tagai

The Dreaming has different meanings to the various Indigenous peoples around Australia. Generally, Dreaming Stories tell of a time when the Aboriginal ancestors travelled across the country and created the variety of landscapes, landforms, plants and animals by either carving them out or becoming the landforms themselves (see case study below). This makes all elements of the physical environment related to Aboriginal people. All aspects of Aboriginal culture from art, dance and stories are centred around The Dreaming, and the landscapes and landforms are their sacred spaces.

The Torres Strait Islander people are the Indigenous people living on the tip of Cape York and the 17 islands in the Torres Strait between Australia and Papua New Guinea (figure 1). They are culturally different to mainland Aboriginal people and their stories are set around the Tagai, a warrior who is visible in the stars. These helped them navigate the islands in their canoes and explain the close connection with the landscapes and oceans around them. Both Aboriginal and Torres Strait Islander people are dependent on their surroundings, and the landscapes and landforms are crucial to their culture and spirituality.

CASE STUDY

Ngiyaampaa Dreaming

The following Dreaming Story is told by Aunty Beryl Carmichael, from the Ngiyaampaa people of western New South Wales. It tells the story of Ngiyaampaa country and how the Darling River was created (figure 2).

Now long, long time ago of course, in the beginning, when there was no people, no trees, no plants whatever on this land, 'Guthi-guthi', the spirit of our ancestral being, he lived up in the sky. So he came down and he wanted to create the special land for people and animals and birds to live in. So Guthi-guthi came down and he went on creating the land for the people — after he'd set the borders in place and the sacred sites, the birthing places of all the Dreamings, where all our Dreamings were to come out of.

Guthi-guthi put one foot on Gunderbooka Mountain and another one at Mt Grenfell. And he looked out over the land and he could see that the land was bare. There was no water in sight, there was nothing growing. So Guthi-guthi knew that trapped in a mountain — Mt Minara — the water serpent, Weowie, he was trapped in the mountain. So Guthi-guthi called out to him, 'Weowie, Weowie', but because Weowie was trapped right in the middle of the mountain, he

couldn't hear him. Guthi-guthi went back up into the sky and he called out once more, 'Weowie', but once again Weowie didn't respond. So Guthi-guthi came down with a roar like thunder and banged on the mountain and the mountain split open. Weowie the water serpent came out. And where the water serpent travelled he made waterholes and streams and depressions in the land. So once all that was finished, of course, Weowie went back into the mountain to live and that's where Weowie lives now, in Mount Minara. Old Pundu, the cod, it was his duty to drag and create the river known as the Darling River today. So what I'm telling you — the stories that were handed down to me — all come from within this country.

FIGURE 2 The meandering landscape of the Darling River in Menindee, NSW, where Ngiyaampaa people tell of Weowie the water serpent who travelled and made the water holes and depressions.

ACTIVITIES

IDENTIFY

1 What is The Dreaming?
2 Describe where the Torres Strait Islander people are located.

EXPLAIN

3 Read the Dreaming Story as told by Aunty Beryl Carmichael. What landscapes and landforms are being created?
4 Why do Aboriginal and Torres Strait Islander people believe they are related to the land?
5 What is a sacred site?
6 Explain why landforms and landscapes are an important place to Aboriginal and Torres Strait Islander people.

INVESTIGATE

7 Research and identify the name/s of your local Aboriginal nation.
8 Research a local Aboriginal sacred site in your area or region. Describe its landscape or landforms. Locate the site using an online mapping engine such as Google Maps, Bing Maps or OpenStreetMap.
9 Organise with your class for an Aboriginal elder from your local area to share a Dreaming Story that you are allowed to hear that describes the creation of a local landscape or landform.

3.4 What are the economic values of landscapes and landforms?

3.4.1 Tourism

'Economic' is a word we use to describe how we, as humans, make money and spend money. Humans have used landscapes and landforms to dig out natural resources, but they can also be a valuable source of money in their natural state. As outlined in 3.1, landscapes and landforms hold aesthetic values and people are willing to spend money to enjoy them.

Tourism is when people travel to other places from where they live for recreation, pleasure, relaxation or education. Many landscapes and landforms are excellent tourist destinations and are important for local communities because of the money and jobs created for the local economy. For example, the Great Barrier Reef is the largest coral reef landform in the world and tourism was responsible for 91 per cent of the economic activity in the region. In 2012 over $6.4 billion was spent by tourists and tourism was responsible for creating over 64 000 full-time jobs.

Adventure tourism

A type of tourism that attracts people to landscapes and landforms is adventure tourism. This is a trip that has at least two of the following:

- a physical activity
- occurs in the natural environment
- cultural immersion.

Many landscapes and landforms are a great place for people to enjoy adventure tourism by participating in activities such as rock climbing, mountain biking and hiking (figure 1). Adventure tourism activities are classified as 'soft' as most people can participate and 'hard' where significant skills and equipment are needed (see table 1). Economically, adventure tourism makes money at a local scale by directly benefiting local communities through the money spent on accommodation, eating out or guides. Adventure tourism often requires specialised equipment, such as skis, bikes or ropes, so, at a larger scale, it contributes to the national and global economy. For example, the hard adventure activity of climbing the landform of Mount Everest, the world's highest mountain, cost on average US$48 000 per person. The permit to climb is US$11 000 and there is the additional cost of buying training, specialised equipment, airfare and tour guides.

FIGURE 1 Mountain biking is a popular form of adventure tourism that enjoys the aesthetics of landscapes and landforms and helps local economies.

TABLE 1 Types of adventure tourism activities

Activity	Category Hard: significant skill and effort Soft: some skill and effort
Backpacking	Soft
Bird watching	Soft
Camping	Soft
Canoeing	Soft
Caving	Hard
Climbing (mountain/rock/ice)	Hard
Hiking	Soft
Horse riding	Soft
Hunting	Soft
Kayaking/sea/whitewater	Hard
Mountain biking	Hard
Safaris	Soft
Scuba diving	Soft
Skiing/snowboarding	Soft
Surfing	Soft
Trekking	Soft
Walking tours	Soft

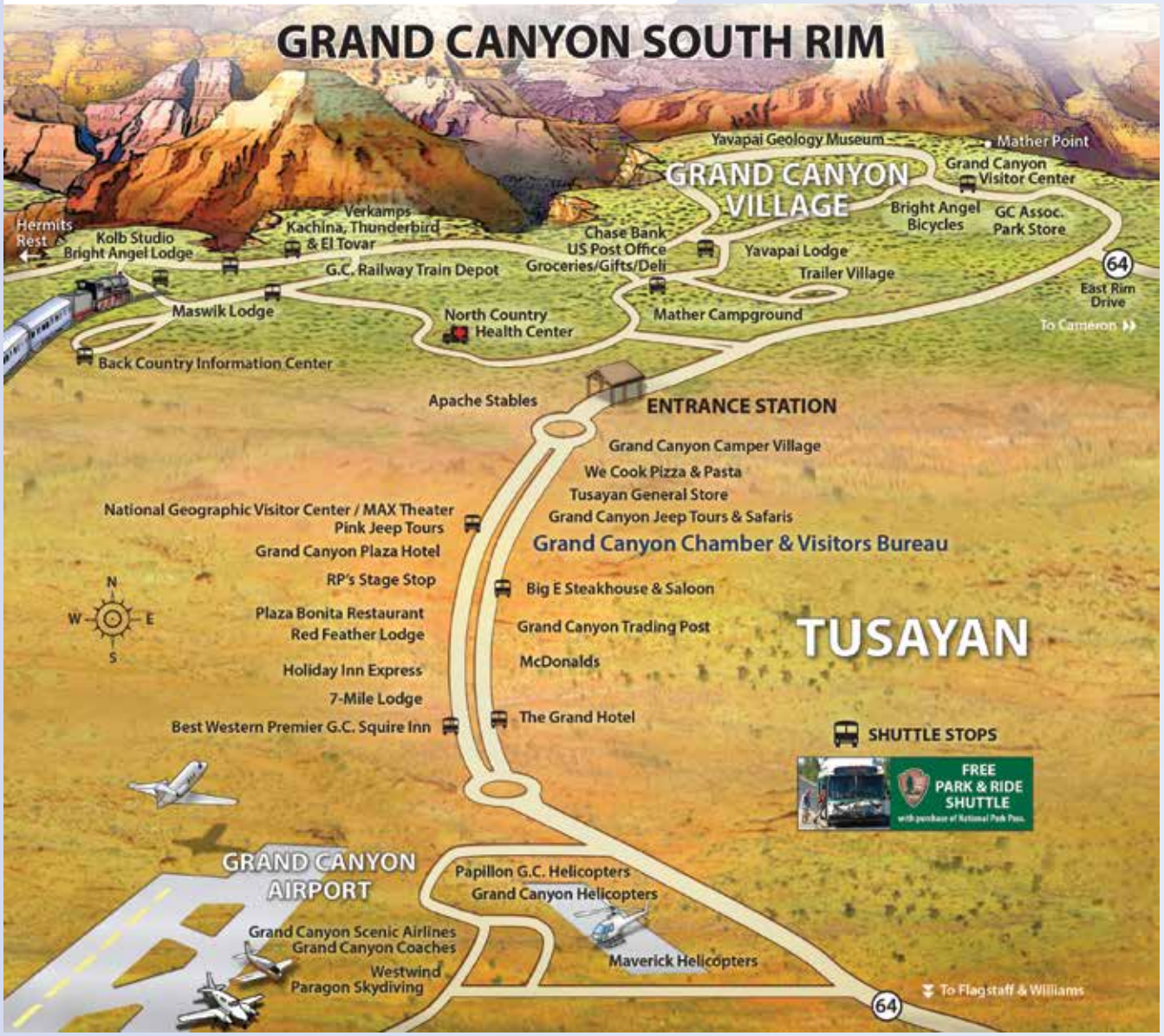
Source: World Tourism Organization (2014), AM Reports, Volume nine — Global Report on Adventure Tourism, UNWTO, Madrid.

CASE STUDY

Grand Canyon National Park, United States

The Grand Canyon is a famous, steep-sided canyon in the Unites States that was created by the processes of weathering and erosion caused by the Colorado River. It is a distinctive landform that is 446 kilometres long and in some parts 18 kilometres wide. This landform has a large economic impact on the local communities. In 2011, $4.7 billion was spent by the 4.3 million visitors to the Grand Canyon National Park. Over 7361 jobs were created either directly or indirectly because of the tourist trade (figure 2).

FIGURE 2 Pictorial map showing tourist activities in the Grand Canyon



pictorial map a map using illustrations to represent information

Most park visitor spending within the park is for accommodation, followed by food and beverages, fuel, admissions and fees, and souvenirs. Local communities up to 100 kilometres away also benefit from tourist spending as tourists travel to the Grand Canyon National Park and purchase food and other provisions. Apart from guided tours, visitors participate in a variety of activities including hiking and walking tours, river rafting, helicopter tours and tandem skydiving which provides employment opportunities for local people.

ACTIVITIES

IDENTIFY

1 What is tourism?

2 Using statistics in the text and case study, copy and complete a table like the one below that compares the economic benefits of tourism in the Great Barrier Reef and the Grand Canyon.

	The Great Barrier Reef	The Grand Canyon
Continent and country		
Visitors		
Money spent by visitors		
Jobs created		
Activities		

EXPLAIN

3 Explain why adventure tourism relies on landscapes and landforms.

4 How does adventure tourism make money directly and indirectly for the economy?

INVESTIGATE

5 Using an atlas and the internet, locate and name some popular places around the world where the following activities can be conducted.
- a Scuba diving
- b Rock climbing
- c Mountain photography
- d Aboriginal rock art tour

APPLY

6 a Locate Kings Canyon in the Northern Territory on a map.
- b Create a list of what you would need to purchase and the services you would need to pay for if you were to go on an adventure in Kings Canyon in the Northern Territory.
- c List some activities you could do in this landscape.

7 Refer to figure 2. List as many activities as you can that provide jobs and places where tourists can spend money.

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- Grand Canyon
- Himalayas video

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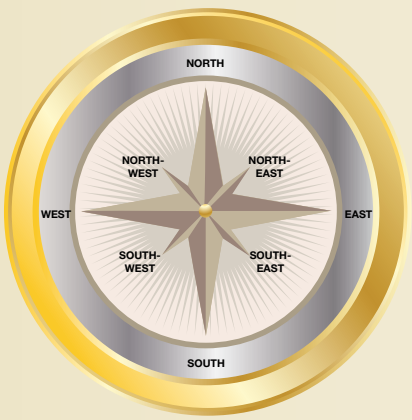
3.5 SkillBuilder: Using positional language

What is positional language?

Positional language is the use of compass points to locate places and provide directions between places. North, north-east, east, south-east, south, south-west, west, and north-west are shown on an 8-point compass. We can use positional language to describe the location of one feature in relation to another.



eLesson

Watch this video to learn how to use positional language.

Searchlight ID: eles-1649

Interactivity

Try this interactivity to learn how to use positional language.

Searchlight ID: int-3145

3.6 How are landscapes protected and managed?

3.6.1 The World Heritage Convention

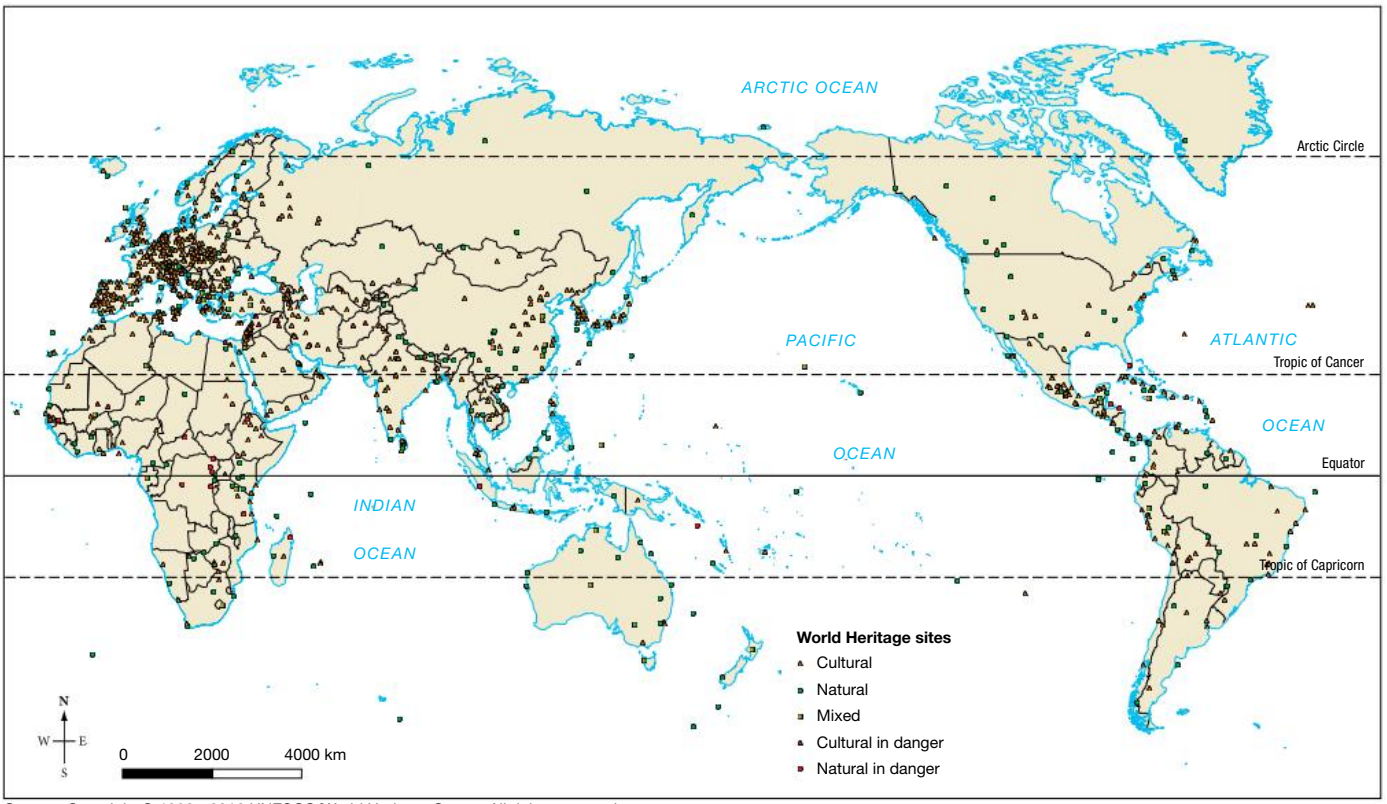
People have realised the value of landscapes and landforms, and the need to protect and manage them more effectively. This is so that they can ensure the landscapes and landforms continue to function in their natural state, as they are habitats for a variety of plants and animals, and so that future generations are able to enjoy them too. There are international agreements in place at the global scale to help protect these places and, at a local scale, governments have created areas that can be managed and protected by special laws that ensure the **sustainable** use of landscapes and landforms.

The World Heritage Convention is an international agreement that has been signed by 190 countries since 1972. This was recognition at a global scale that there are important parts of the physical and human environments that needed to be protected. The convention is overseen by UNESCO (United Nations Educational, Scientific and Cultural Organization). The process begins by a country nominating a place inside its territories as a World Heritage site, then the World Heritage Committee assess if it matches at least one of the 10 set criteria (see table 1). If it adequately addresses the criteria, it is inscribed on to the **World Heritage List** and it will be become a World Heritage site (figure 1). It is expected that the country the site is located in will take all precaution to protect and manage it. In some countries, once a place is put on the World Heritage List, their national and local laws protect it.

sustainable to use the environment now in such a way that it continues to support our lives and the lives of other living creatures into the future

World Heritage List a list of human and natural sites that have been approved by UNESCO as meeting the criteria of being a World Heritage site

FIGURE 1 The World Heritage List includes 1031 sites of significance.



Source: Copyright © 1992 - 2016 UNESCO/World Heritage Centre. All rights reserved

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › World Heritage sites

TABLE 1 The UNESCO Criteria for World Heritage sites

The 10 criteria for the selection of outstanding and/or unique World Heritage sites are summarised below. They should show:

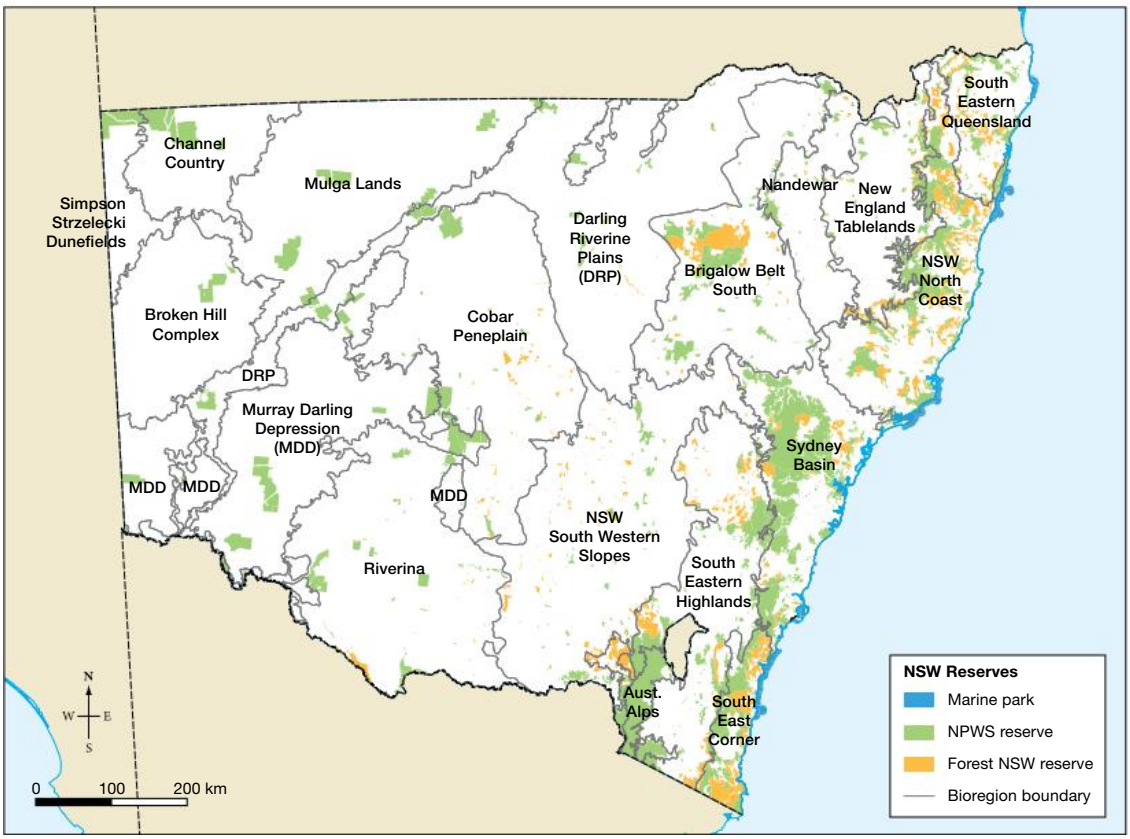
Cultural sites
i. human creative genius
ii. exchange of human values, over time or within a culture
iii. culture or civilisation that is living or has disappeared
iv. building or landscape that illustrates significant stage(s) in human history
v. human settlement representing human interaction with the environment, especially if vulnerable to extinction
vi. events, traditions, ideas or beliefs
Natural sites
vii. exceptional natural beauty and importance
viii. major stages of the earth's natural processes such as landforms
ix. ongoing processes in the evolution of living things and developing ecosystems
x. important natural habitats for conservation of biodiversity

Source: UNESCO

National parks and reserves

At a national and state level, governments have created special places called national parks and reserves. These are places that are protected by law and have special rules on how they can be accessed and used. In NSW, Australia, the National Parks and Wildlife Service (NPWS) manages 850 national parks and reserves that cover over 7 million hectares of land (figure 2). This includes four World Heritage sites, a number of Australian National Heritage sites and 17 Ramsar wetlands (these are wetlands that have been ratified by the International Convention on Wetlands). There are different types of parks with different purposes that are managed by National Parks and Wildlife. These range from areas that are completely protected, with minimum human interference, to areas that allow many human activities. As each different landscape requires different levels of management, each national park has its own managers and strategies that best suit its needs.

FIGURE 2 Location of the 850 national parks and reserves in NSW, Australia



Source: Commonwealth Dept. of Environment, CAPAD 2014 (terrestrial and marine), IBRA7, NSW Forestry Corporation

FOCUS ON FIELDWORK

Using a compass

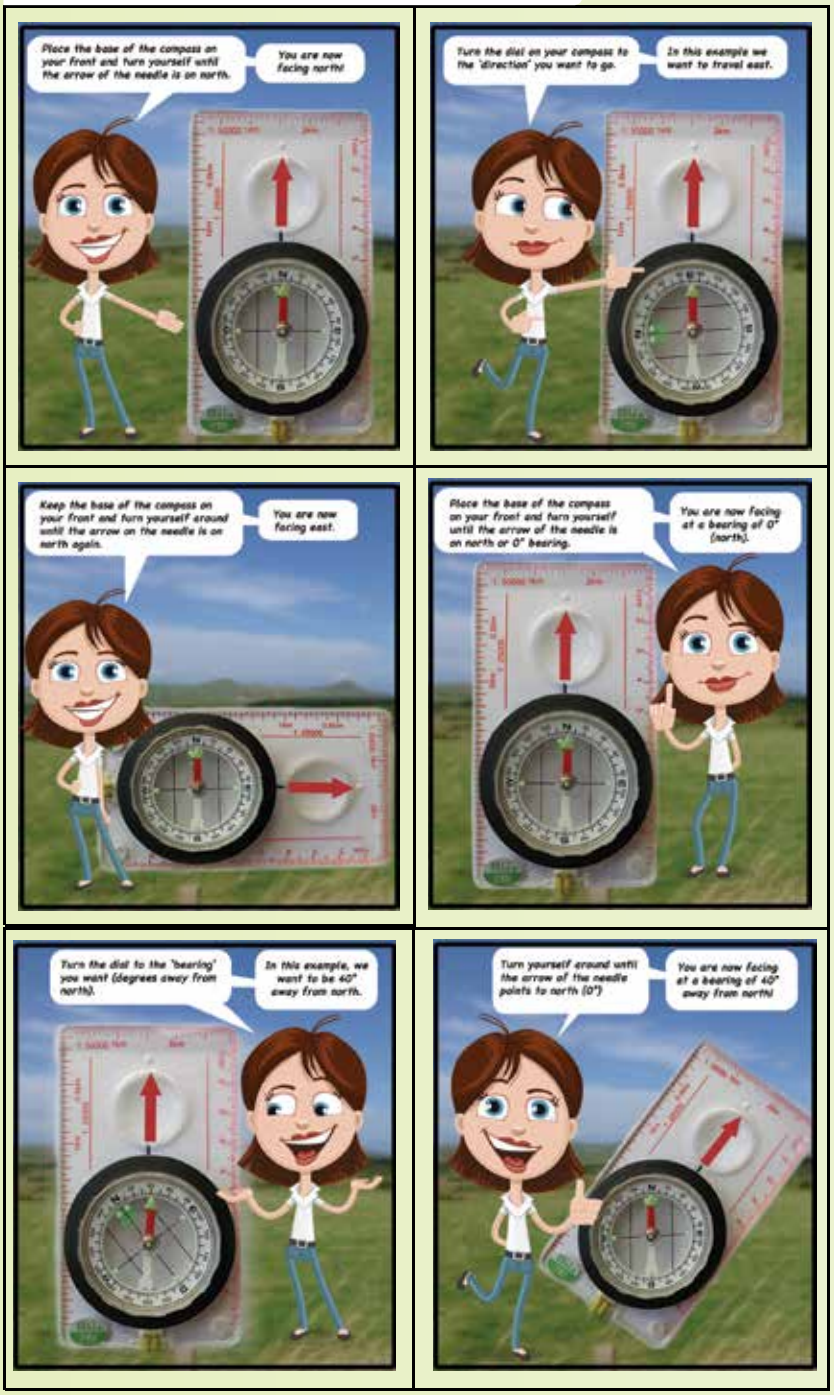
1 Use a compass to complete the following activities:
   - **a** In what direction is the whiteboard from where you are sitting in the classroom?
   - **b** In what direction is the canteen from your geography classroom?
   - **c** In what direction is your home from the school?
   - **d** Name four suburbs or towns that surround your school. In what direction are they from your school?

2 Write down the directions you would give for someone to navigate, using the cardinal and ordinal points of a compass, from the front gate of your school to your geography classroom.

3 Write down the directions you would give for someone to navigate, using bearings, from the front gate of your school to your geography classroom.

4 Which method of giving directions with a compass is more accurate?

FIGURE 3 Using a compass — direction and bearing



ACTIVITIES

IDENTIFY

1 Why have people realised that landscapes and landforms need be protected and managed?

2 Give an example of a global ***scale*** strategy and an example of local ***scale*** strategy to protect and manage landscapes and landforms.

EXPLAIN

3 Create a flow diagram that shows how a site becomes a World Heritage Area.

4 Why do the different national parks and reserves have their own managers and management strategies?

INVESTIGATE

5 Using the internet, research NSW national parks. Create a table with the column headings shown and research the different types of parks within the National Parks and Wildlife Service of NSW.

Type of park	Description	Examples	Example nearest to my home

6 Research a landscape or landform that is on the World Heritage List and write an explanation of what criteria were used to put it on the list.

APPLY

7 Choose a landscape or landform that is not on the World Heritage List and that you think should be included. Prepare a proposal to the World Heritage Committee, either through a report, slide presentation or multimedia presentation, trying to persuade them, by using the appropriate criteria, to place your chosen site on the World Heritage List.

inselberg an isolated hill, knob, ridge, outcrop or small mountain that rises abruptly from the surrounding landscape

plateau an extensive area of flat land that is higher than the land around it. Plateaus are sometimes referred to as tablelands.

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3.7 Kakadu – Australia's first World Heritage Area

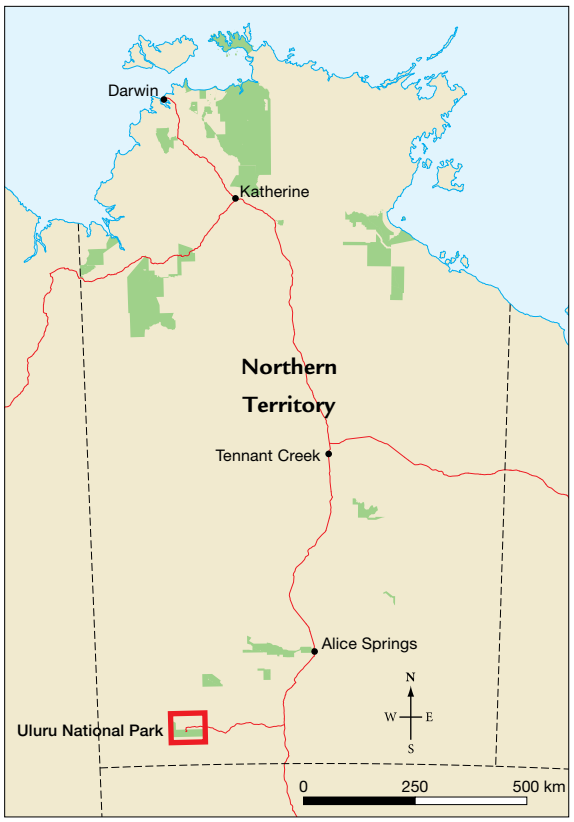
To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au.**

3.8 Why is Uluru an iconic Australian landform?

3.8.1 Aesthetic value

Uluru is one of Australia's most famous and recognisable landforms. It is located very close to the centre of Australia in the south-west corner of the Northern Territory (figure 1). It is a large sandstone **inselberg**, a word that literally means 'island mountain'. It is 3.6 kilometres long, 1.9 kilometres wide and 348 metres high from ground level but it is 860 metres above the sea level as it is located on a **plateau**. Its perimeter measures roughly 9.4 kilometres.

FIGURE 1 Location of Uluru



Source: Spatial Vision

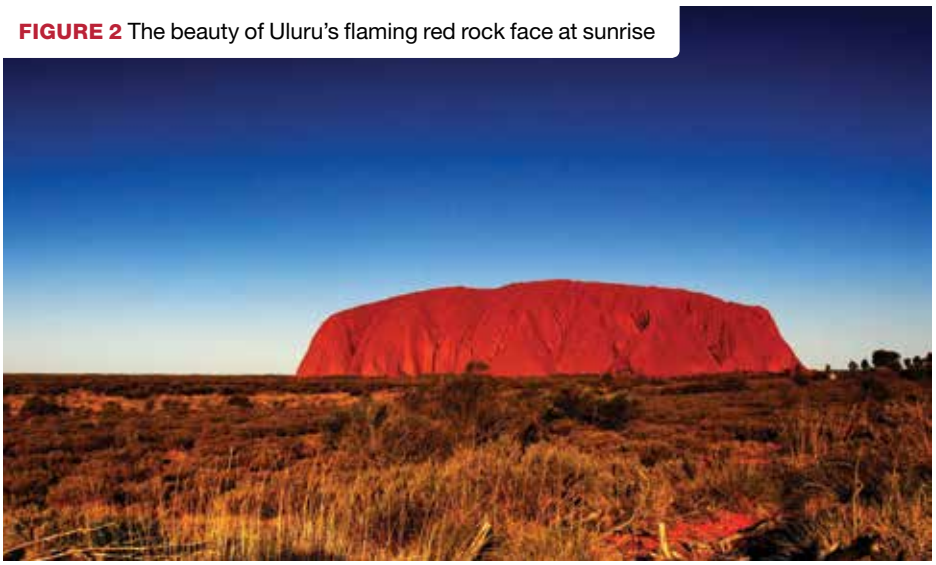
The colour of Uluru's rock face dramatically changes throughout the day. At sunrise, a popular time for tourists, it is flaming red (figure 2) then during the day it turns a red sandstone colour and at sunset it turns blue or violet. Its sheer size, shape and different colours have made this landform an inspiration and 'must see' place for its majestic beauty, awe and wonder.

3.8.2 Cultural and spiritual value

Uluru is a sacred place to the local traditional owners, the Anangu Aboriginal people. It has special meaning to them as they recount

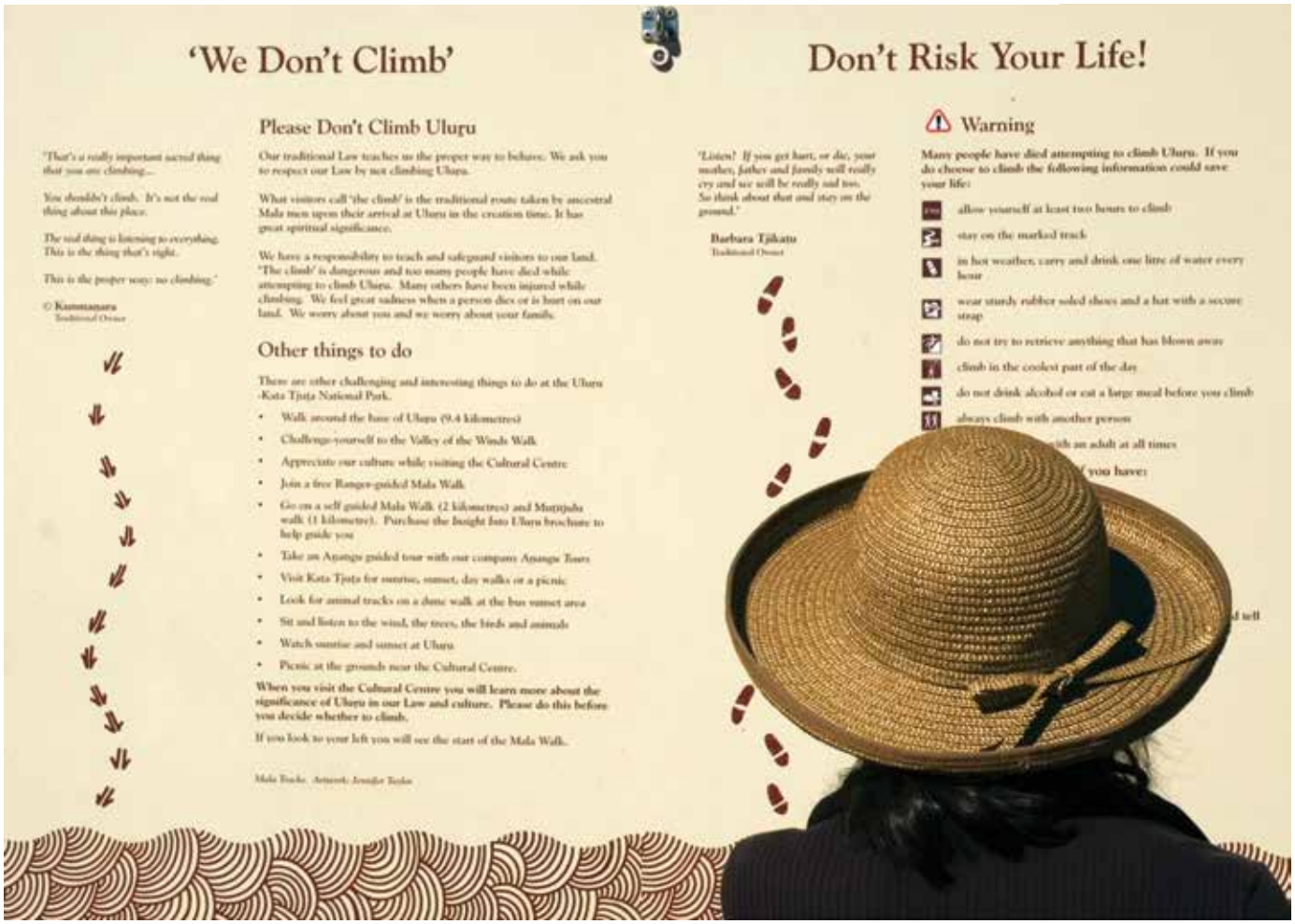
that their ancestors left behind the rock's many **fissures** and caves when it was created during the *Tjukurpa*, a name they give to their creation time. It is a site important to their spiritual beliefs with many ancient rock paintings of their ancestors inside the caves, and sacred rituals and ceremonies continue to be performed around the site. As it is a sacred place for Anangu, 'No Photography' signs are put up as a reminder to visitors to respect the Anangu's beliefs. Europeans have been visiting the site since the 1800s, and have enjoyed climbing the large rock for adventure and to appreciate the inselberg close up. However, as seen in figure 3, the Anangu have asked that they do not do this and many discussions over the years have focused on whether they should stop people climbing because of the cultural and spiritual importance of the site.

FIGURE 2 The beauty of Uluru's flaming red rock face at sunrise



fissure a long, narrow crack or opening in the face of a rock

FIGURE 3 Uluru is a sacred site and the Anangu request people do not climb this cultural and spiritual site.



'We Don't Climb'

'That's a really important sacred thing that you are climbing...

You shouldn't climb. It's not the real thing about this place.

The real thing is listening to everything. This is the thing that's right.

This is the proper way: no climbing.'

© Kunmanara
Traditional Owner

Please Don't Climb Uluru

Our traditional Law teaches us the proper way to behave. We ask you to respect our Law by not climbing Uluru.

What visitors call 'the climb' is the traditional route taken by ancestral Mala men upon their arrival at Uluru in the creation time. It has great spiritual significance.

We have a responsibility to teach and safeguard visitors to our land. "The climb' is dangerous and too many people have died while attempting to climb Uluru. Many others have been injured while climbing. We feel great sadness when a person dies or is hurt on our land. We worry about you and we worry about your family.

Other things to do

There are other challenging and interesting things to do at the Uluru -Kata Tjuta National Park.

- Walk around the base of Uluru (9.4 kilometres)
- Challenge yourself to the Valley of the Winds Walk
- Appreciate our culture while visiting the Cultural Centre
- Join a free Ranger-guided Mala Walk
- Go on a self guided Mala Walk (2 kilometres) and Mutitjulu walk (1 kilometre). Purchase the Insight Into Uluru brochure to help guide you
- Take an Anangu guided tour with our company Anangu Tours
- Visit Kata Tjuta for sunrise, sunset, day walks or a picnic
- Look for animal tracks on a dune walk at the bus sunset area
- Sit and listen to the wind, the trees, the birds and animals
- Watch sunrise and sunset at Uluru
- Picnic at the grounds near the Cultural Centre.

When you visit the Cultural Centre you will learn more about the significance of Uluru in our Law and culture. Please do this before you decide whether to climb.

If you look to your left you will see the start of the Mala Walk.

Mala Tracks. Artwork: Jennifer Tjalas

Don't Risk Your Life!

'Listen! If you get hurt, or die, your mother, father and family will really cry and we will be really sad too. So think about that and stay on the ground.'

Barbara Tjikatu
Traditional Owner

Warning

Many people have died attempting to climb Uluru. If you do choose to climb the following information could save your life:

- allow yourself at least two hours to climb
- stay on the marked track
- in hot weather, carry and drink one litre of water every hour
- wear sturdy rubber soled shoes and a hat with a secure strap
- do not try to retrieve anything that has blown away
- climb in the coolest part of the day
- do not drink alcohol or eat a large meal before you climb
- always climb with another person

3.8.3 Economic value

Regardless of its remote location, Uluru's uniqueness and beauty have made it a popular tourist destination making it an important source of money for the small community that live in the area. Over 257 000 people visited the region in 2014, and international guests made up 53 per cent of those who came. It is an isolated place, so tourists would stay an average of three nights and were spending $2506 per trip. This contributed $322 million to the economy as money was spent on accommodation, tour guides, airfares, eating out and paying to experience many cultural activities. Tourism also helps Indigenous people to earn an income whilst maintaining their link to the land. These cultural activities included guided tours of sites that are open to non-initiated people, viewing performances of songs and dance, campfire tours that demonstrate traditional hunting and gathering techniques, and the purchasing of the unique Aboriginal art.

FIGURE 4 Respecting sacred places

ACTIVITIES

IDENTIFY

1. What type of landform is Uluru?
2. What is the name of the creation time of the Anangu?

EXPLAIN

3. Why is Uluru important for the Anangu?
4. Refer to figure 2. Explain how we know this photo was taken at sunrise.
5. Uluru is important to the economy. Give reasons to support this statement.

APPLY

6. Looking at figure 4, what do you think this cartoon is trying to highlight about Uluru as a sacred space?
7. You are a travel agent, and you are responsible for creating a tour for your class to travel to Uluru. Create a travel itinerary including costs of airfare, tours, accommodation and eating out. Present it as a travel brochure.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Uluru

3.9 How is Uluru protected and managed?

3.9.1 Aboriginal management over generations

The area around Uluru has been home to the Anangu for hundreds of generations. They have been the guardians of the land long before the arrival of Europeans, and continue to play a role in managing the area today.

While the Anangu did not 'manage' the land in the modern sense, their way of life and spiritual connection to the landscape kept the country healthy. There is an obligation to look after one's country because of interconnection to the land, so the Anangu focused on using resources sustainably. Through detailed knowledge of the land, its habitats, their small population size and **nomadic lifestyle**, the Anangu made sure they did not place stress on the landscape and kept it pristine. By limiting access to the site to only sacred rituals, erosion on Uluru was lessened.

nomadic lifestyle describes a lifestyle in which people do not live in one fixed spot but move according to the seasons from place to place in search of food, water and grazing land

3.9.2 National park and joint management

Uluru has been managed as a national park since 1950. Ayers Rock (Uluru) and Mt Olga (Kata Tjuta) became the Ayers Rock/Mt Olga National Park in 1958, which saw it become a tourist and wildlife reserve. In 1975, the park was given more protection under a new federal government law. In particular, the law provided protection from tourism. In 1985 the Australian government returned the land back to the Anangu people who then leased it back to the government to help manage it. In 1992, the park's name was changed to Uluru–Kata Tjuta National Park to reflect the Aboriginal heritage of the land (figure 1). The Uluru–Kata Tjuta National Park has a joint management approach. This means that the Anangu and Parks Australia Rangers work together to help protect the landscape and unique landforms by using both scientific and Aboriginal knowledge to make decisions on how best to look after the area (figure 2).

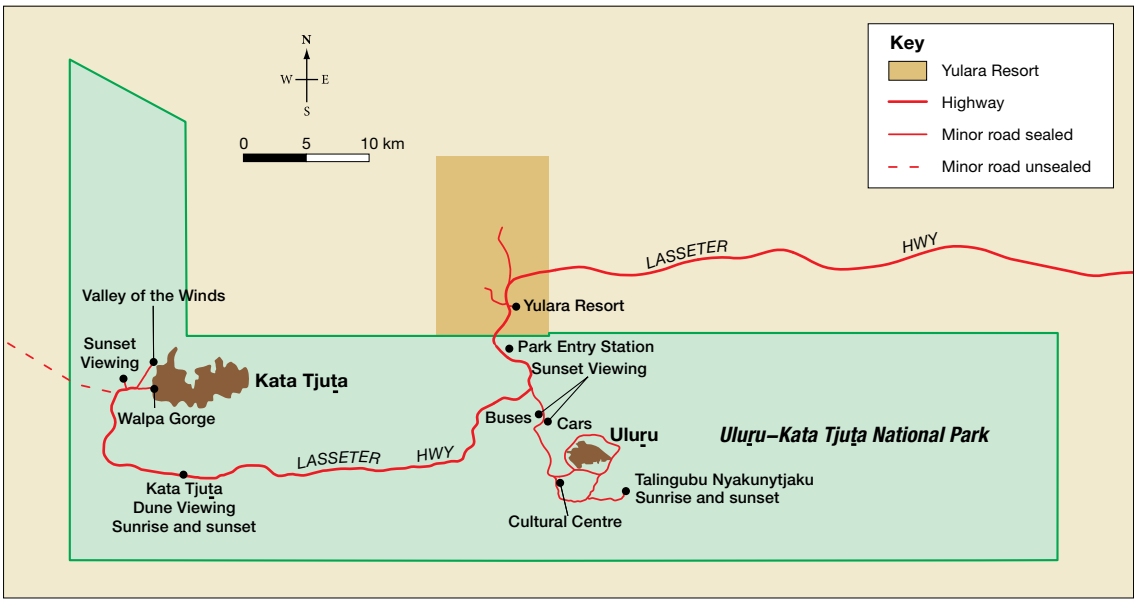
FIGURE 1 The Uluru–Kata Tjuta National Park emblem

FIGURE 2 The Anangu and Parks Australia Rangers combine their knowledge to manage the park.

3.9.3 World Heritage listing

Uluru is a unique landform that is globally recognised. The Uluru–Kata Tjuta National Park was recognised as a World Heritage site with natural significance by UNESCO in 1987. In 1994, it became the second World Heritage site to be recognised by the World Heritage Committee as both a natural and cultural World Heritage site. The World Heritage listing puts more responsibility on the managers to preserve and protect the landscape not only for the local people, but also as a place of international importance. The World Heritage Area is the same as the whole National Park (figure 3). The Anangu and the Park Rangers work together to protect this World Heritage site for current and future generations to enjoy.

FIGURE 3 The Uluru–Kata Tjuta National Park and World Heritage site



Source: http://whc.unesco.org/document/119879

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Weblink
Climbing Uluru

ACTIVITIES

IDENTIFY
1 Describe how the Anangu managed the area around Uluru before Europeans arrived.
2 What was the national park's main purpose after 1950?
3 What significant event in 1985 changed the way the national park was managed?

EXPLAIN
4 What were the three different names the national park has been known by and what is its current name?
5 Explain how joint management works.
6 Refer to the **Climbing Uluru** link in your eBookPLUS. Watch this video and list the reasons the managers give for not climbing Uluru.

INVESTIGATE
7 Research some management techniques that the Anangu and Park Rangers in Uluru–Kata Tjuta National Park use and create a fact file that identifies and describes the techniques.

APPLY
8 Refer to figure 1. Why do you think the national park's emblem reflects joint management?
9 Create an annotated timeline showing the significant events in Uluru's management.

PREDICT
10 Think–pair–share. With a partner, list what you think would have happened if Uluru was not managed and protected as a National Park and World Heritage site. What changes would have occurred? Share your findings with the class.

ice age a geological period during which the Earth is colder, glaciers and ice sheets expand and sea levels fall. The last ice age was approximately 13 000 years ago.

Anthropocene a period of time to describe the time when humans made significant changes to the Earth's environments

degradation a decline in quality caused by time or improper use

domesticate to tame a wild animal or plant so it can live with or be looked after by people

3.10 How have humans changed and degraded landscapes?

3.10.1 What human activities have degraded landscapes?

Humans depended on landscapes for their survival for thousands of years by living harmoniously within them. Since the end of the last **ice age**, humans began to settle in one place and made changes to the landscapes that surrounded them. Some scientists have named this period of time the **Anthropocene**. People built farms and settlements, such as towns and cities, and they used spaces for other industrial purposes such as mines. As a consequence, the built environments humans created have often resulted in the **degradation** of landscapes.

Farming

Humans moved from being nomadic to settling in one place. This happened because people discovered that they could grow crops and **domesticate** animals like cattle, sheep, goats and pigs. Since

humans no longer needed to migrate during different seasons to hunt and look for food, they changed the environment around them to farm more effectively. Farms need areas of clear flat land with good soil and access to water. Clear land often did not occur naturally, so humans removed many trees and other vegetation. Landscapes that often look natural now were altered by humans thousands of years ago (figure 1). The roots of trees help hold soil together and the falling organic material from plants and animals replaced the **nutrients** in the soil. However, removing the vegetation increased **erosion** and reduced the nutrients being replaced into the soil. Ploughing and irrigation also sped up **leaching** the nutrients out of the soil.

FIGURE 1 Once covered in vegetation, this Irish landscape in County Kerry was changed by the removal of trees for farming thousands of years ago.

Settlements

Since farming allowed humans to stay in one place they started to build large **settlements** to create communities with other people. Settlements began as small villages and some eventually turned into large towns or cities. To make way for housing, streets and other utilities landscapes needed to be cleared of vegetation and the ground excavated (figure 2). Cities and towns were very compact for many centuries, as most people had to walk around them. Since the invention of transport technologies, such as trains and motor vehicles, cities have expanded outwards to create suburbs (figure 3). Where once landscapes were dominated by natural elements, settlements have created large areas of built features that changed the landscape and reduced the size of habitats of many plant and animal species.

FIGURE 2 Impacts of spreading settlements

1. A new treeline is created after trees have been removed to clear land.
2. New surfaces change the pattern of water run-off and absorption.
3. Earth is excavated and the landscape reshaped.
4. New suburban houses are built.

FIGURE 3 Cities have expanded outwards to create suburbs. These have modified landscapes.

nutrient an essential element that feeds living things to help them function and grow

erosion the picking up, transport and depositing of weathered material

leaching a process that occurs where water runs through the soil, dissolving minerals and carrying them into the subsoil

settlement place where humans live together, e.g. houses, villages, towns and cities

CASE STUDY

Open cut mining

Mining for minerals, such as iron ore and coal, has been an activity humans have been involved in for thousands of years, and has provided many economic benefits and resources to communities. Open cut mining is an activity where humans excavate large holes in the earth to access the minerals they are seeking (figure 4). To access the minerals, miners remove the top layers of soil and dirt (overburden) and pile them up (figure 5). The mineral being mined is removed, but it is often mixed in with other substances that are not valuable so the waste is separated (tailings) and stored in large ponds that are engineered to keep the contaminated water away from the local environment. Previously, miners pumped tailings straight into local waterways, causing significant contamination and environmental degradation. Once all the valuable minerals have been removed from the mine a large pit is left called a final void. Unfortunately, in many parts of the world final voids are left and not backfilled as it is a costly exercise. Final voids that are not dealt with properly experience high rates of erosion, and there are concerns that they degrade water tables. Also, many believe the modern, large-scale open cut mining has degraded the aesthetics of the landscapes that were dug up by significantly changing the topography of the area.

FIGURE 4 Mt Tom Price Mine is a huge iron ore open cut mine in the Pilbara region in Western Australia.

FIGURE 5 Overburden piled up from an open cut mine

ACTIVITIES

IDENTIFY

1 Describe what the term degradation means?
2 State the name of the major climate event which occurred before humans started to make large impacts on landscapes?

EXPLAIN

3 Explain why humans were able to stop being nomadic.
4 Explain how farming has degraded soil.
5 Explain how settlements change landscapes.

INVESTIGATE

6 Research the Anthropocene and write a paragraph to explain what this period of time is.
7 Using the internet, research open cut mining and draw an annotated diagram that identifies and describes the basic features of an open cut mine.

lithosphere the Earth's crust, including landforms, rocks and soil

natural hazard an extreme event that is the result of natural processes and has the potential to cause serious material damage and loss of life

geomorphic describes a process that occurs in the lithosphere

mass movements large areas of earth that move

3.11 What are geomorphic hazards?

3.11.1 What is a landslide?

Geographers who study geomorphology examine the processes that shape and create the natural features of the Earth's crust. The layer of the Earth's crust they are interested in is called the **lithosphere**. **Natural hazards** are often events that happen in the natural environment that pose a threat to humans. A **geomorphic** hazard is any natural hazard that occurs in the lithosphere such as **mass movements**, glacial hazards, and soil erosion.

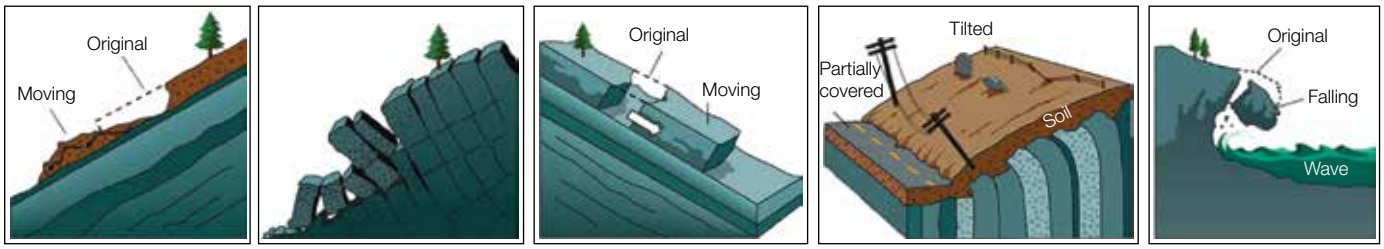
Landslides are a geomorphic hazard where loose rock, debris or earth moves down a steep slope. Landslides happen when the materials that make up the slope give way and move down because of gravity (figure 1). Landslides are known also as landslips, slumps or slope failure.

FIGURE 1 Travellers look at a landslide-affected road in Manali, India. Landslides are a regular hazard in this region.

What are the different types of landslides?

There are five categories of landslides (figure 2). The most dangerous type of landslide is a *flow*. They are called a flow because the rock and debris moves like water down the slope very quickly. A *fall* is where rock or debris free-falls before it rolls or slides down a slope. A *topple* is when rock tilts and does not collapse; often caused by the fissure pattern in a rock, similar to dominos toppling. A *slide* is a type landslide where large intact pieces of earth slip down another layer of a slope and often move slowly. *Spread* is when large areas of land creep slowly sideways over very gentle or flat terrain.

FIGURE 2 The different types of landslides



FLOW TOPPLE SLIDE SPREAD FALL

3.11.2 What are the causes of landslides?

Landslides can either occur naturally, be caused by humans or be caused and made worse by a combination of the two factors.

What are the natural causes of landslides?

Landslides that are caused naturally have three main triggers: (i) water, (ii) earthquakes and (iii) volcanic activity. Each of these triggers can occur independently or can work in combination with each other to cause a landslide.

Water

Slopes becoming saturated with water are one of the main causes of landslides. This can happen after lots of rain, as snow melts, or as a result of changes to water levels. Flooding and landslides are often related; as floodwater saturates the ground, loosening the earth, it creates the trigger for a landslide to happen.

Earthquakes

Areas that experience earthquakes often have landslide events. When the ground starts shaking it often loosens the material on steep slopes, causing a landslide or making the soil less compact, meaning water can saturate the ground quickly. Also, some materials when they shake can turn almost liquid, a process called liquefaction, and then they flow down a slope rapidly.

Volcanoes

When volcanoes erupt the lava can melt snow that then causes debris, such as ash, rock, soil and water, to flow down the slope. Volcanic debris is called *lahar*, an Indonesian word, and it flows very

rapidly, often leaving a trail of destruction. Also, the large volcanic explosion can cause earthquakes that then loosen the rock and create landslides.

Human causes

When humans move into an area they modify the landscape significantly. The roots of grass, plants and trees on slopes hold the soil together, but when removed, the earth is loosened creating conditions for a landslide. Digging out the bottom of a slope (undercutting) can change how steep a slope is and it also makes it top heavy. Human's use of water also contributes to landslides as the ground can be saturated by watering from farming (irrigation), drain pipes that leak and changing the way water flows when hard surfaces, such as roads, are created. All these factors, if not properly addressed by good engineering, can cause landslides.

3.11.3 What are the impacts of landslides?

Landslides can happen anywhere in the world with most countries experiencing them. Many landslides occur with minimal damage and no loss of life, but some of them have had disastrous impacts. In Australia, there have been 100 disastrous landslides recorded since 1842. These have killed 105 people and injured 129, and were mainly caused by human action (figure 3). One such disaster was the Thredbo Landslide on 30 July 1997. It killed 18 people, injured one person, and cost the government $40 million in compensation. This disastrous landslide occurred on a steep slope in the Thredbo village in the Kosciuszko National Park in NSW. Poor drainage was a contributing factor when the road was created above the village (figure 4).

Overseas, many poor communities are built on the side of steep hills due to the land being of poor quality and, therefore, the only place they can afford to live. They are at risk of being in a landslide, especially when heavy rains occur (see case study, page 68) having built housing on steep slopes.

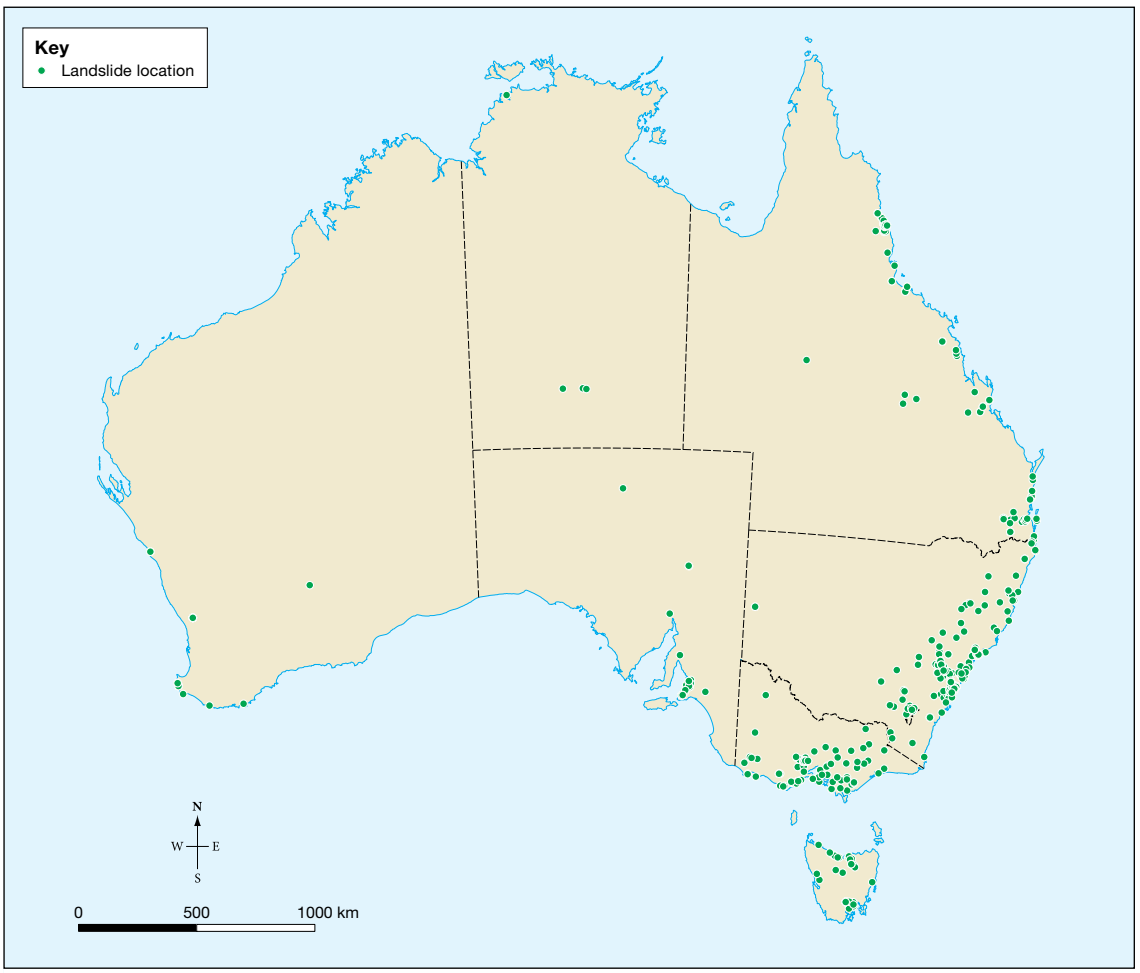


FIGURE 3 Locations of major landslides in Australia

Source: Geoscience Australia

FIGURE 4 The destructive path of the Thredbo Landslide

FIGURE 5 Signage used to warn people that landslides are a natural hazard in the area

3.11.4 Responding to landslides

After landslides occur, emergency services attend to assist with rescue and recovery. However, a preferred option is to try to minimise the impacts of landslides. Ideally, houses should not be built on land that is prone to landslides. If an area is prone to landslides, meshing can be used on the side to catch falling rocks, retaining walls are built where a hill has been undercut and signage is used to warn people of the dangers of landslides (figure 5).

CASE STUDY

Brazil landslides, April 2010

Between 6 April and 8 April in 2010, Rio de Janeiro experienced a high amount of rain due to a severe storm that saturated the ground that was already waterlogged. *Favela* is the name given to the slum-style housing that poorer people live in, and many favelas were built on steep slopes on the outskirts of the city. The saturated ground, the stresses put on the slope by removing the vegetation, and undercutting when building the houses caused massive flow landslides where it was heavily populated (figure 6). These landslides killed over 279 people, injured many more and left countless already poor people homeless.

FIGURE 6 A flow landslide on a steep slope on the outskirts of Rio de Janeiro

ACTIVITIES

IDENTIFY

1 Define the term geomorphology.
2 Describe what is a natural hazard.
3 Outline what is a geomorphic hazard.

EXPLAIN

4 Explain why a landslide is a geomorphic hazard.
5 Outline what changes to landscapes cause landslides?
6 Why is a flow landslide considered the most dangerous?
7 What caused the landslides in Brazil?
8 Create a table in your workbook and identify the different types of landslides and their causes. Then sketch a diagram showing how they occur.

APPLY

9 Refer to figure 3 and an atlas showing the physical characteristics of Australia. Using *positional language*, describe where most of Australia's landslides occur. What reasons can you give as to why landslides are occurring in these places?

PREDICT

10 Refer to figure 1. Using evidence from the photo, explain why this part of India has many landslides.
11 Using an online map, such as Google Maps or Google Earth, locate a site where landslides could occur in your area. Give reasons for your answer.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Thredbo Landslide

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3.12 SkillBuilder: Using topographic maps

What are topographic maps?

Topographic maps are a type of map that provides detailed and accurate information of features that appear on the Earth's surface. They show features of the natural environment, such as forests and lakes, and features of human environments, such as roads and settlements. Relief is often shown using contour lines.

eLesson
Watch this video to learn how to use topographic maps.

Searchlight ID: eles-1641

Interactivity
Try this interactivity to learn how to use topographic maps.

Searchlight ID: int-3137

3.13 What is the value of Gunnedah Shire?

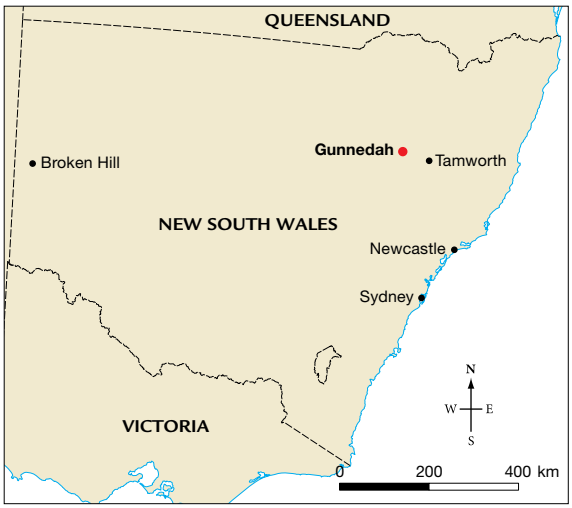


FIGURE 1 Location of Gunnedah

Source: Spatial Vision

3.13.1 Gunnedah Shire

Gunnedah Shire is located in NSW in the Namoi Valley, and is approximately 450 kilometres north-west of Sydney. It covers an area of 5092 square kilometres with the town of Gunnedah being the main regional centre.

Gunnedah was inhabited by the *Gunn-e-dar* people of the Kamilaroi nation and its name means 'place of white stones'. The area is situated on the Liverpool Plains so it is very flat. The plains are 264 metres above sea level and the highest hills are only 200 metres above the flat plains. As the area is flat, Gunnedah's main industry is agriculture with approximately 403 000 hectares of land used to grow crops such as wheat, sorghum, barley, cotton, sunflowers, soya beans and vegetables. Gunnedah also has a strong coal mining industry with 10 million tonnes of coal exported every year.

FIGURE 2 The Namoi Valley in the flat Liverpool Plains is good agricultural land

FIGURE 3 Aerial view of the Namoi Valley

ACTIVITIES

IDENTIFY

1 Refer to figure 4. Using your topographic map reading skills:
- **a** State the contour interval of this map.
- **b** State the ratio scale of the map.
- **c** Name the road in AR5671 and identify the type of road it is in the key.
- **d** How many buildings are located in AR5069?
- **e** What is the grid reference of the cemetery?
- **f** What is the height of the highest point on this map?
- **g** Name the main river evident on this map.
- **h** Name the major road evident on this map.

EXPLAIN

2 Refer to the text, figures 2, 3 and 4, and explain why farming is the main activity which occurs in this landscape.

INVESTIGATE

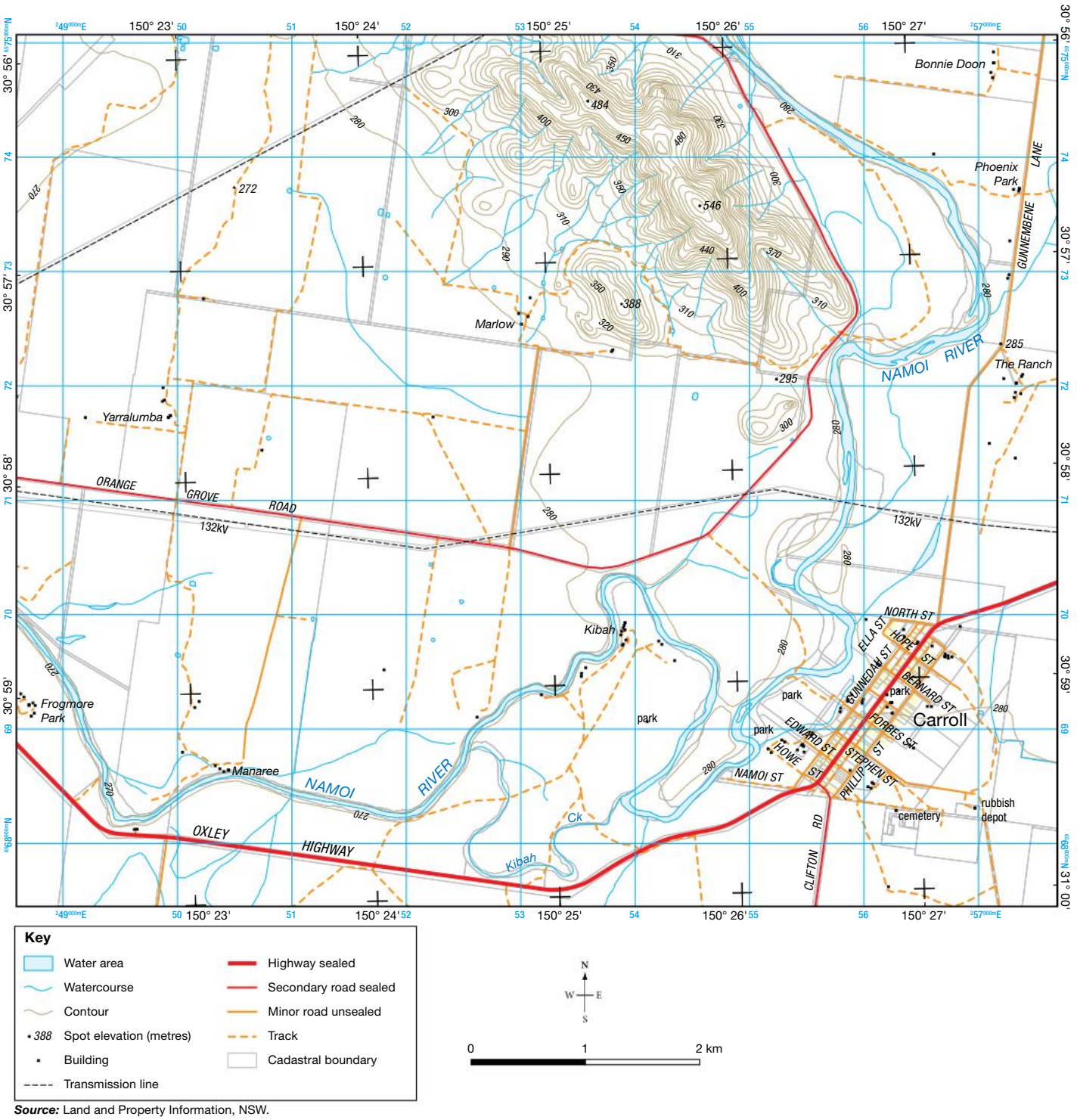
3 Use an online map, such as Open Street Map or Google Maps, and find the name of the town located in the south-east quadrant of this topographic map.

4 Why do you think the town was built in this space? What natural hazard would the town be under threat from?

APPLY

5 Choose an area on this map where you would establish a farm. Give the area reference and outline three reasons why you would locate a farm there.

FIGURE 4 Topographic map of Gunnedah Shire



Source: Land and Property Information, NSW.

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3.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

Arches in a desert landscape, Utah, United States

CHAPTER 4

Desert landscapes

4.1 Overview

4.1.1 Introduction

Approximately one-third of the Earth's land surface is desert — arid land with little rainfall. These arid regions may be hot or cold.

The actions of wind and, sometimes, water shape the rich variety of landscapes found there.

Starter questions

1 Have you ever visited a desert? Where was it? Why did you go?
2 Make a list of the geographical characteristics of desert areas. What is the most common feature of a desert?
3 Find a description of a desert online. Copy the text and use the **Wordle** weblink in your eBookPLUS to create a Wordle. What is the most common word in your Wordle? Why do you think this is the case?
4 Use the **Sahara** weblink in your eBookPLUS to watch a video of desert sandstorms.
  a Describe the sandstorm you see. Would it be difficult for people to cope with such an event?
  b Describe how some animals are adapted to cope with desert sandstorms.
  c How do the wind and sand shape the desert?

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Weblinks
- Wordle
- Sahara

Inquiry sequence

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4.1 Overview		
4.2 What is a desert?		GE4-1, GE4-7, GE4-8
4.3 What type of climate forms deserts?		GE4-1, GE4-2, GE4-7, GE4-8
4.4 What are the processes that shape desert landforms?		GE4-1, GE4-2, GE4-8
4.5 What are the characteristics of Australia's deserts?		GE4-1, GE4-2, GE4-8
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Key terms	eBookplus ONLINE ONLY	

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Watch this video
Desertscapes
Searchlight ID: eles-1625

4.2 What is a desert?

4.2.1 Defining a desert

A desert is a hot or cold region with little or no rainfall. Around one-third of the Earth's surface is desert and is home to about 300 million people.

Although they receive little rainfall, most deserts receive some form of precipitation. When it does rain, it is usually during a few heavy storms that last a short time.

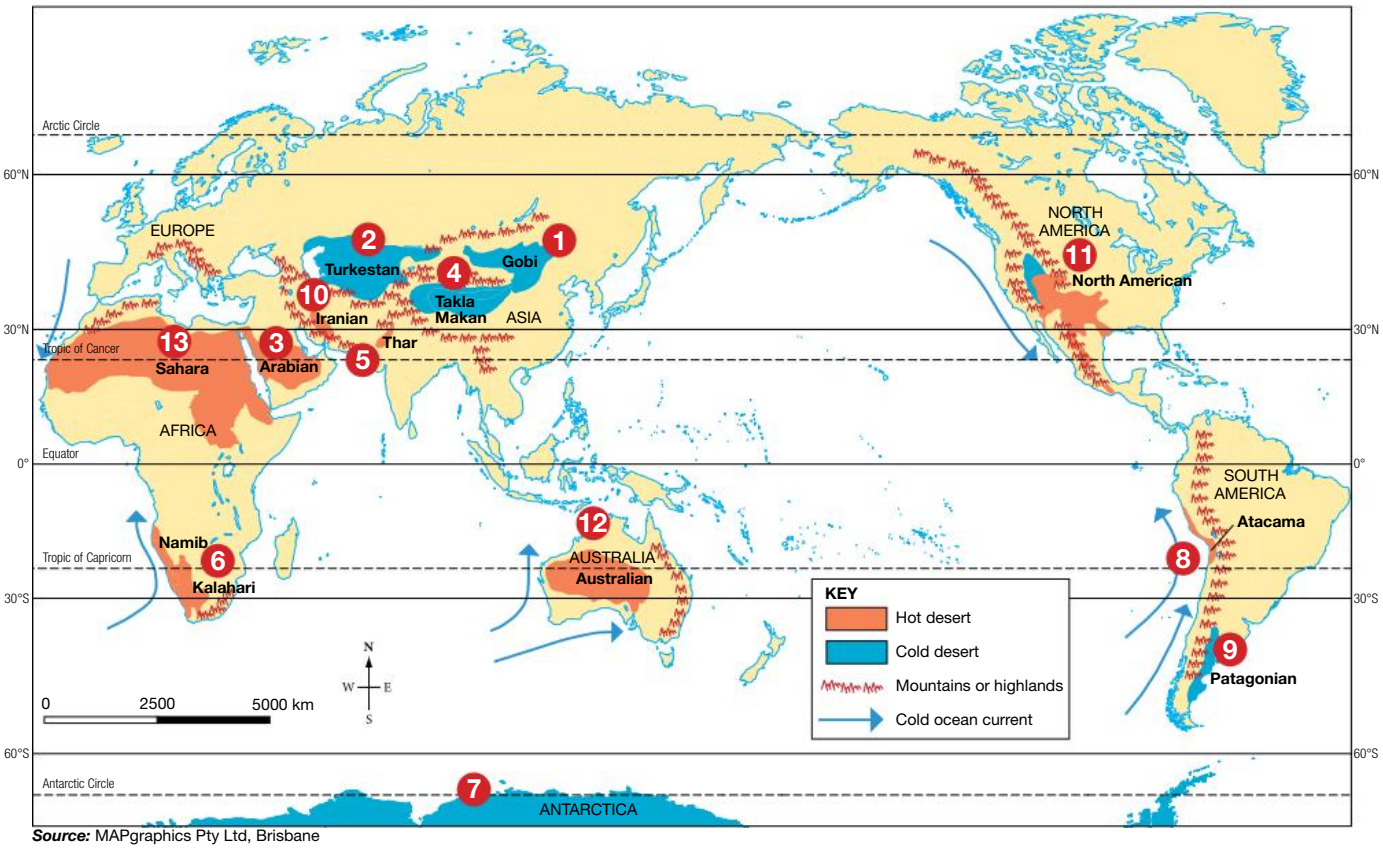
TABLE 1 Types of deserts

Rainfall (mm/year)	Type of desert	Examples
<25	Hyper-arid	Namib; Arabian
25–200	Arid	Mojave
200–500	Semi-arid	Parts of Sonoran Desert

Hot deserts

Most of the world's hot deserts are located between the Tropic of Cancer and the Tropic of Capricorn (see figure 1). They have very hot summers and warm winters. Temperature extremes are common, because cloud cover is rare and humidity is very low; this means there is nothing to block the heat of the sun during the day, or prevent its loss at night. Temperatures can range between around 45 °C and –15 °C in a 24-hour period.

FIGURE 1 The distribution of the world's deserts



Source: MAPgraphics Pty Ltd, Brisbane

Cold deserts

Cold deserts lie on high ground generally north of the Tropic of Cancer and south of the Tropic of Capricorn (see figure 1). They include the polar deserts. Any precipitation falls as snow. Winters are very cold and often windy; summers are dry and cool to mild.

4.2.2 Deserts of the world

1 Gobi Desert

Asia's biggest desert, the Gobi, is a cold desert. It sits some 900 metres above sea level and covers an area of some 1.2 million square kilometres. Its winters can be freezing.

FIGURE 2 The Gobi, an example of a cold desert

2 Turkestan Desert

The cold Turkestan Desert covers parts of south-western Russia and the Middle East.

3 Arabian Desert

This hot desert is as big as the deserts of Australia. Towards its south is a place called Rub al-Khali (meaning 'empty quarter'), which has the largest area of unbroken sand dunes, or erg, in the world.

4 Takla Makan Desert

The Takla Makan Desert is a cold desert in western China. Its name means 'place of no return'. The explorer Marco Polo crossed it some 800 years ago.

5 Thar Desert

The Thar Desert is a hot desert covering north-western parts of India and Pakistan. Small villages of around 20 houses dot the landscape.

6 Namib and Kalahari deserts

The Namib Desert extends for 1200 kilometres down the coast of Angola, Namibia and South Africa. It seldom rains there, but an early-morning fog often streams across the desert from the ocean. The dew it leaves behind provides moisture for plants and animals. It joins the Kalahari Desert, which is about 1200 metres above sea level.

7 Antarctic Desert

The world's biggest and driest desert, the continent of Antarctica, is another cold desert. Only snow falls there, equal to about 50 millimetres of rain per year.

8 Atacama Desert

The Atacama Desert is the driest hot desert in the world. Its annual average rainfall is a tiny 0.1 millimetre.

9 Patagonian Desert

The summer temperature of this cold desert rarely rises above 12 °C. In winter, it is likely to be well below zero, with freezing winds and snowfalls.

10 Iranian Desert

Two large deserts extend over much of central Iran. The Dasht-i-Lut is covered with sand and rock, and the Dasht-i-Kavir, mainly in salt. Both have virtually no human populations.

11 North American deserts

The desert region in North America is made up of the Mojave, Sonoran and Chihuahuan deserts (all hot deserts) and the Great Basin (a cold desert). The Great Basin's deepest depression, Death Valley, is the lowest point in North America.

FIGURE 3 The Sahara, an example of a hot desert

12 Australian deserts

After Antarctica, Australia is the driest continent in the world. Its deserts are generally flat lands, often vibrant in colour.

13 Sahara Desert

The largest hot desert in the world, the Sahara stretches some nine million square kilometres across northern Africa over 12 countries. Only a small part is sandy. It is the sunniest place in the world (see figure 3).

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Interactivity
Great deserts of the world
Use this interactivity to check your knowledge of some of the main hot and cold deserts of the world
Searchlight ID: int-3106

ACTIVITIES

IDENTIFY
1 What climate conditions are needed for hot and cold deserts to form?
2 Where is the sunniest ***place*** in the world?
3 Name three deserts in the Asia–Pacific region.

EXPLAIN
4 Describe key differences between hot and cold deserts.

INVESTIGATE
5 Look carefully at the map in figure 1, and the text.
- a Which continent has the largest area of hot desert?
- b Which continent has the largest area of cold desert?
- c What is the largest hot desert in the world?
- d What is the largest hot desert in the Asia–Pacific region?
- e Which is the driest continent in the world?
- f Which continent contains the driest hot desert?
- g Which North American desert contains the lowest land on the continent?

APPLY
6 Use the information in this section to design a quiz of 10 questions entitled 'Deserts of the world'. Test your friends and family.
7 Draw up and complete a table like the one below to show your understanding of the locations and features of desert ***environments***. Look for photos on the internet.

Name of desert	Mountain range	Continent	Ocean current	Photos

4.3 What type of climate forms deserts?

4.3.1 The subtropics

Deserts form in many different parts of the globe: the subtropics; continental interior areas at middle latitudes; on the leeward side of mountain ranges; along coastal areas; and in the polar regions. The only common factor is their low rainfall — but why do these areas experience low rainfall?

Most of the world's greatest deserts are found in the subtropics near the Tropics of Cancer and Capricorn.

Because of the way the Earth rotates around the sun, areas around the equator receive more direct sunlight than anywhere else on Earth. This means the air there is always very hot. Hot air can hold much more moisture than cold air, so the **humidity** in these areas is always very high. Hot air also rises. As the air heads upwards into the atmosphere above the equator, it drifts away, heading north and south.

humidity the amount of water vapour in the atmosphere

The higher the air gets, the cooler it becomes. Cool air can't hold as much moisture, so it releases it as rain. Areas around the equator and to the immediate north and south of it (the tropics) receive frequent heavy downpours (see figure 1).

With its moisture gone, the cool, dry air continues moving north and south away from the equator until it meets zones of high air pressure around the tropics. Here, it is forced downwards. The more the dry air descends, the warmer it gets. This means it can hold more moisture and it is likely to absorb any moisture that already exists in this environment. It is like using a sponge to wipe up some water on the kitchen bench; a dry sponge will absorb more of the spill than a wet sponge. This is how the subtropical deserts form.

FIGURE 1 The formation of subtropical deserts in Africa

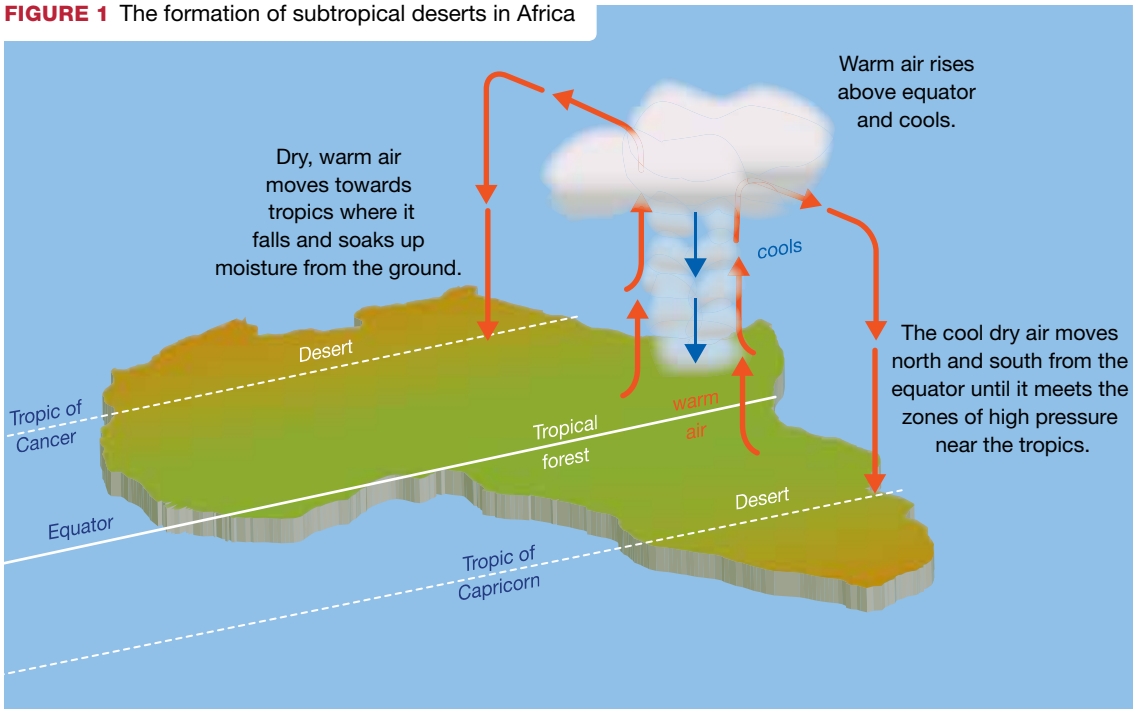


FIGURE 2 The Sahara Desert of northern Africa is the world's largest and can experience temperatures as high as 57 °C.

Temperatures in these deserts are usually high all year round. In summer the heat is extreme, with daytime temperatures often going above 38 °C and sometimes as high as 49 °C. At night — with no clouds to provide insulation — temperatures drop quickly to an average of 21 °C in summer and sometimes below freezing during winter.

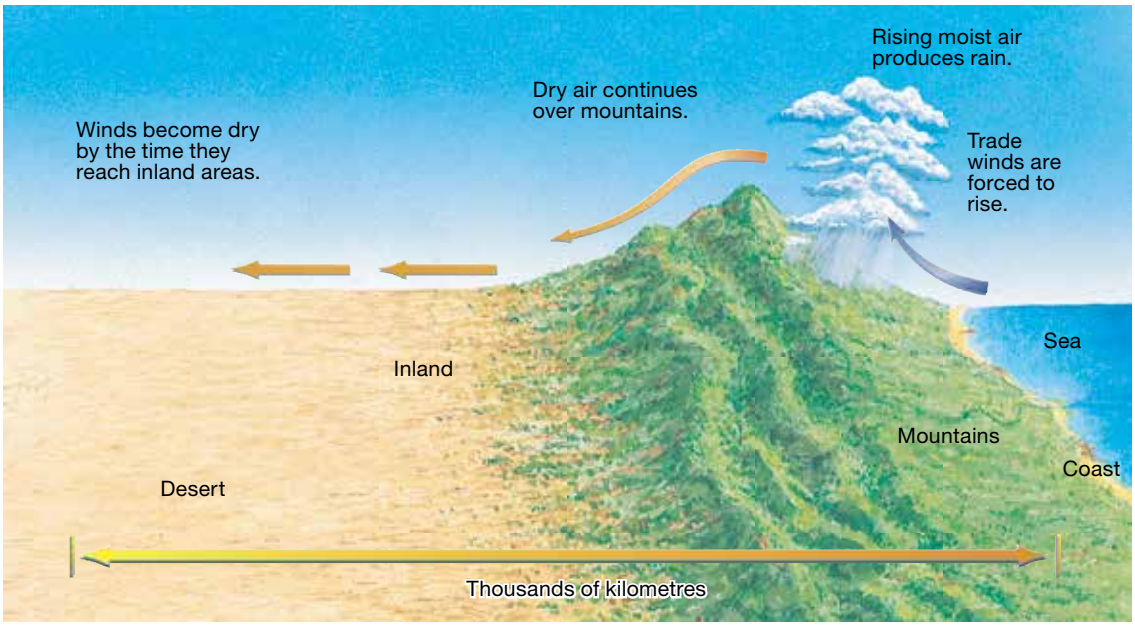
4.3.2 Rain-shadow deserts

Rain shadows form on the leeward side of a mountain range (opposite the windward side that faces rainbearing winds). Deserts commonly form in rain shadows.

rain shadow the drier side of a mountain range, cut off from rain-bearing winds

- Moist air blowing in from the ocean is forced to rise up when it hits a range of mountains. This cools the air. As cool air cannot hold as much moisture, it releases it as precipitation falling on the windward side of the mountain (see figure 3).
- By the time the air moves over the top of the range and down the other side, it is likely to have lost most, if not all, of its moisture. It will therefore be fairly dry.
- The more the air descends on the other side of the range, the more it warms up. Hence, it can hold more moisture. So, as well as not bringing any rain to the land, the air absorbs what little moisture the land contains.
- In time, as this pattern continues, the country in the rain shadow of the mountain range is likely to become arid (see figure 3).

FIGURE 3 The formation of rain-shadow deserts

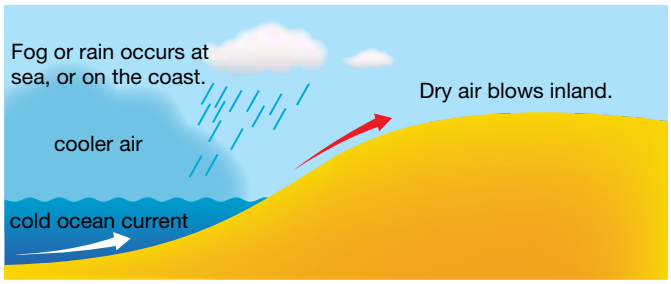


An example of this effect is the Great Dividing Range in Australia; cool moist air produces rainfall on the eastern side of these mountains and desert to the west. The Mojave Desert in the south-western United States is located on the leeward side of the Sierra Nevada mountain range.

4.3.3 Coastal deserts

Currents in the oceans are both warm and cold, and are always moving. Cold currents begin in polar and temperate waters (with moderate temperatures), and drift towards the equator. They flow in a clockwise pattern in the northern hemisphere, and in an anticlockwise pattern in the southern hemisphere. As they move, they cool the air above them (see figure 4).

FIGURE 4 The formation of coastal deserts



If cold currents flow close to a coast, they can contribute to the creation of a desert. This occurs because cold ocean currents cause the air over the coast to become stable, which stops cloud formation. If the cool air the currents create blows in over warm land, the air warms up; it can then hold more moisture (see figure 4). It is therefore not likely to release any moisture it contains unless it is forced up by a mountain range. Large coastal deserts, including the Atacama Desert in Chile and the Namib Desert in Namibia, are formed in this way (see figure 5).

FIGURE 5 The coastal Namib Desert

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Interactivity
How to make a desert
Use this interactivity to check your understanding of the ways deserts are created.
Searchlight ID: int-3107

4.3.4 Inland deserts

Some deserts form because they are so far inland that they are beyond the range of any rainfall. By the time winds reach these dry centres, they have dumped any rain they were carrying or have become so warm they cannot release any moisture they still hold. The air that enters such areas is usually extremely dry and the skies are cloudless for most of the year. Summer daytime temperatures can rise as high as those of subtropical deserts. In winter, however, temperatures are much lower. Average daily temperatures below freezing are common during winter.

Examples of inland deserts are the central deserts of Australia (see figure 6), the Thar Desert in north-west India and the vast Gobi and Taklimakan deserts of Central Asia.

FIGURE 6 The Simpson Desert in central Australia

4.3.5 Polar deserts

Polar deserts are areas with a precipitation rate of less than 250 millimetres per year and an average temperature lower than 10 °C during the warmest month of the year. Polar deserts cover almost five million square kilometres of our planet and consist mostly of rock or gravel plains. Snow dunes may be present in areas where precipitation occurs. Temperatures in polar deserts often alternate between freezing and thawing, a process that can create patterned textures on the ground as much as five metres across.

FIGURE 7 Although covered in frozen water, Antarctica receives little rain and is therefore classified as a desert.

FOCUS ON FIELDWORK

Investigating your local climate: Using weather instruments

Setting up a weather station around your school is a great way to get an accurate record of your local climate. Set up a rain gauge and a thermometer in an unobstructed area around the school. Check the measurements once or twice a day to keep a record throughout the month, term or even the year. Use this information to create a climate graph of your school.

1. How does the school's temperatures and rainfall compare to local weather reports?
2. Could anything be influencing the temperature or rainfall around the weather station?
3. How does the temperature and rainfall influence the plants around the school?

FIGURE 8 A weather station

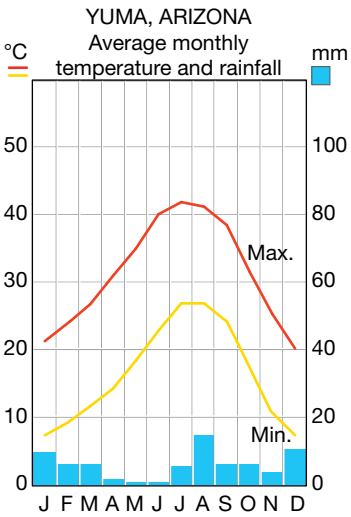
4.3.6 Desert climate

Temperature

One geographical characteristic of many deserts is the high temperature, which quickly evaporates any water that might be around. The Earth's highest recorded temperature — 58 °C — occurred at El Azizi in the Libyan Desert of northern Africa on 13 September 1922.

During the summer of 1923–24, the semi-arid town of Marble Bar in Western Australia (average rainfall 361 mm per year) experienced temperatures of more than 37.8 °C for 160 days in a row, from 31 October 1923 to 7 April 1924. This set an Australian temperature record, and possibly a world record. During that summer the temperature at Marble Bar peaked at 47.5 °C on 18 January 1924.

FIGURE 9 Temperature and rainfall data can be displayed clearly in a climograph, such as this one for Yuma, Arizona.



Rainfall

Although low rainfall is a characteristic of deserts, rain does fall and violent storms can sometimes occur. A record 44 millimetres of rain once fell within three hours in the Sahara. Large Saharan storms may deliver up to one millimetre of rain per minute. Normally dry stream channels, called arroyos or wadis, can quickly fill after heavy rains, and flash floods make these channels dangerous.

Monthly data for rainfall and temperature can be used to create climographs such as figure 9. Data for other desert locations such as Khormaksar in Yemen and Alice Springs in Australia (see table 1) can be used to construct climographs.

TABLE 1 Climate data for (a) Khormaksar, Yemen, and (b) Alice Springs, Australia

(a) Khormaksar, Yemen

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average temperature (°C)	25.0	25.5	27.0	28.5	30.5	33.0	32.0	32.0	32.0	28.5	26.5	25.5	
Average rainfall (mm)	5.0	0.0	5.0	0.0	0.0	0.0	5.0	3.0	0.0	0.0	0.0	5.0	23.0

(b) Alice Springs, Australia

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec	Total
Average temperature (°C)	28.5	27.7	24.8	20.0	15.4	12.4	11.5	14.3	18.3	22.8	25.8	27.7	
Average rainfall (mm)	40.5	41.5	34.7	16.6	17.0	16.7	12.1	10.0	9.0	20.0	25.3	37.2	281.2

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Interactivity
Climate graph: Timbuktu
Use this interactivity to build a climate graph for Timbuktu, in the Sahara Desert.
Searchlight ID: int-0780

Weblink
Desert rain

ACTIVITIES

IDENTIFY

1 Decide whether the following statements are true or false. Rewrite the false statements to make them true.
- **a** The cooler the air, the more moisture it can hold.
- **b** Rain shadows often contain dry areas of land.
- **c** Cold ocean currents cool the air above them.
- **d** Deserts do not form along coastlines.

EXPLAIN

2 Use figure 1 to explain why deserts form around areas near the tropics but not at the equator. Alternatively, form small groups and create a short drama performance to explain the process.

3 Use figure 3 and any other information in this section to write a paragraph explaining why deserts tend to form in rain shadows. Alternatively, form small groups and create a short drama performance to explain the process.

4 Why do temperatures in deserts drop so much at night after being so high during the day?

INVESTIGATE

5 Use the **Desert rain** weblink in your eBookPLUS to watch a video about desert rain, and then answer the following questions.
- **a** What is a flash flood?
- **b** What happens to water as it flows over sand? Think of what happens to water at the beach.
- **c** How do animals and plants respond to these rare water events?
- **d** Describe how the landscape quickly ***changes*** once there is water in the desert.

APPLY

6 Draw a diagram to explain how cold ocean currents influence the formation of a desert ***environment*** along the south-west African coastline.

7 Complete the **Climate graph: Timbuktu** interactivity in your eBookPLUS, and then use tables 1a and 1b to draw climate graphs for Khormaksar, Yemen, and Alice Springs, Australia.

4.4 What are the processes that shape desert landforms?

4.4.1 Shaping the desert

Although most people imagine a sea of sand when they think of deserts, sand covers only about 20 per cent of the world's deserts. Sand is the end product of millions of years of **erosion** of other landforms such as rock and plateaus that, over time, are worn away by extremes of temperature, wind and water.

erosion the wearing away and removal of soil and rock by natural elements, such as wind, waves, rivers or ice, and by human activity

The landforms and patterns of a desert are created by a number of natural processes. The unprotected land surfaces are prone to erosion. After heavy rain, often a long distance from the desert flood plains, erosion of ancient river channels can be major. Extreme temperatures, along with strong winds and the rushing water that can follow a desert rainstorm, cause rocks to crack and break down into smaller fragments. This process is called **weathering**.

weathering the breaking down of rocks through the action of wind and water and the effects of climate

Erosional landforms

The process of erosion removes material such as weathered rock. Most erosion in deserts is caused by wind and, at times, running water. During heavy rainfall, water carves channels in the ground. Fast-flowing water can carry rocks and sand, which help to scour the sides of the channel. As vegetation is usually sparse or non-existent, there are few roots to hold the soil together. Eventually, deep gullies called wadis can form.

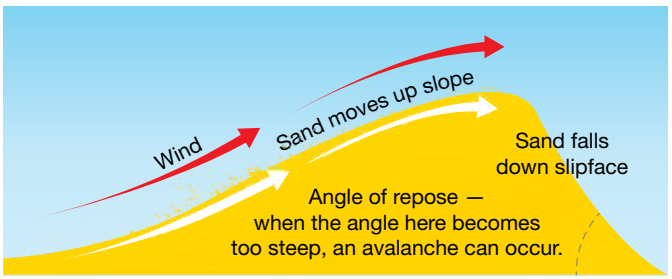
Erosion can also result from the action of wind and from chemical reactions. Some rock types, such as limestone, contain compounds that react with rainwater and then dissolve in it. Wind is a very important agent of transport and deposition, and can change the shape of land by abrasion — the wearing down of surfaces by the grinding and sandblasting action of windborne particles. Erosional landforms in deserts include buttes, mesas and inselbergs (see figure 7).

Depositional landforms

Materials carried along by rushing water and wind must eventually be put down. Over time these materials build up, forming different shapes and patterns in the desert. This process is called deposition.

Depositional landforms in deserts include alluvial fans, playas, saltpans and various types of sand dunes (see figure 7).

FIGURE 1 The transport and deposition of sand creates and moves dunes.



4.4.2 Sand dunes

Different dune shapes are created by the action of the wind. These include crescent, linear, star, dome and parabolic. The most common are the crescent-shaped dunes that are formed when the wind blows in one direction. They are usually wider than they are long and can move very quickly across desert landscapes (see figure 2).

FIGURE 2 A series of crescent dunes in Egypt

Linear dunes are a series of dunes running parallel to each other. They can vary in length from a few metres to over 100 kilometres. It appears that winds blowing in opposite directions help create these dunes. The Simpson Desert in central Australia has linear dunes (see figure 3).

FIGURE 3 Linear sand dunes in the Simpson Desert, Australia

Star dunes have 'arms' that radiate from a high central pyramid-shaped mound. They form in regions that have winds blowing in many different directions and can become very tall rather than wide — some are up to 500 metres high (see figure 4).

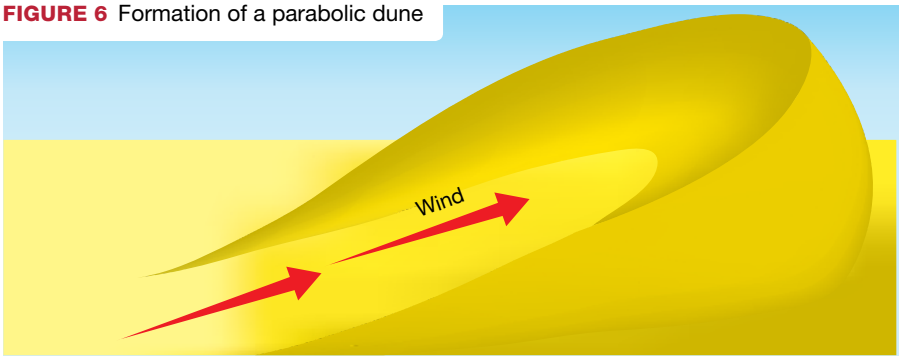
FIGURE 4 Star dunes are found in many deserts including the Namib, the Grand Erg Oriental of the Sahara, and the southeast Badain Jaran Desert of China.

Dome dunes are made up of fine sand without a steep side. These rounded structures tend to be only one or two metres high and are very rare (see figure 5).

FIGURE 5 A dome dune in the Chihuahuan Desert, North America

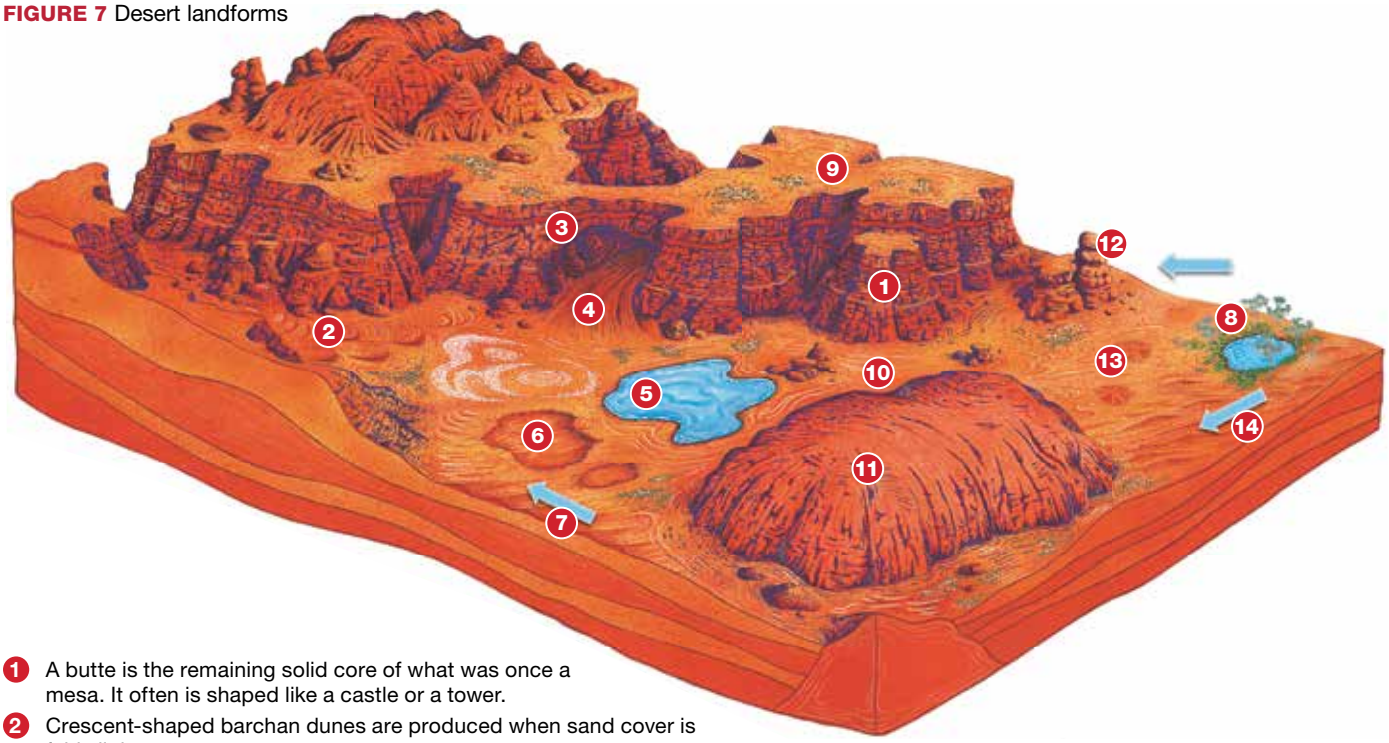
Parabolic dunes have a U shape and do not get very high. They often occur in coastal deserts. The longer section follows the 'head' of the dune (the opposite process to the formation of crescent dunes) because vegetation has anchored them in place. The arms can be long — in one case, measured at 12 kilometres (see figure 6).

FIGURE 6 Formation of a parabolic dune



4.4.3 Desert landforms

FIGURE 7 Desert landforms



1. A butte is the remaining solid core of what was once a mesa. It often is shaped like a castle or a tower.
2. Crescent-shaped barchan dunes are produced when sand cover is fairly light.
3. An arch, or window, is an opening in a rocky wall that has been carved out over millions of years by erosion.
4. An alluvial fan is the semicircular build-up of material that collects at the base of slopes and at the end of wadis after being deposited there by water and wind.
5. A playa lake may cover a wide area, but it is never deep. Most water in it evaporates, leaving a layer of salt on the surface. These salt-covered stretches are called saltpans.
6. Clay pans are low-lying sections of ground that may remain wet and muddy for some time.
7. The rippled surface on transverse dunes is the result of a gentle breeze blowing in the one direction.
8. An oasis is a fertile spot in a desert. It receives water from underground supplies.
9. A mesa is a plateau-like section of higher land with a flat top and steep sides. The flat surface was once the ground level, before weathering and erosion took their toll.
10. Sand dunes often start as small mounds of sand that collect around an object such as a rock. As they grow larger, they are moved and shaped by wind.
11. An inselberg is a solid rock formation that was once below ground level. As the softer land around it erodes, it becomes more and more prominent. Uluru is an inselberg.
12. A chimney rock is the pillar-like remains of a butte.
13. Star dunes are produced by wind gusts that swirl in from all directions.
14. Strong winds blowing in one direction form longitudinal dunes.

Playas and pans

A desert basin may fill with water after heavy rains to form a shallow lake, but for the majority of the time the often salt-encrusted surface is hard and dry. Such expanses of land are known as playas, saltpans or hardpans. The flat terrains of pans and playas make them excellent race tracks

and natural runways for aeroplanes and spacecraft. Ground-vehicle speed records are commonly established on Bonneville Speedway, a race track on the Great Salt Lake hardpan. Space shuttles land on Rogers Lake Playa at Edwards Air Force Base, California.

FIGURE 8 A driver lying in a streamlined racing car, Bonneville Salt Flats, Utah, USA

ACTIVITIES

IDENTIFY

1 List the agents of erosion and weathering in a desert.
2 Name two erosional and two depositional landforms in a desert.
3 Name the most common dune shapes that are formed in deserts.

EXPLAIN

4 Explain the difference between a mesa and a butte.
5 How does vegetation help to prevent erosion in a desert?
6 What wind conditions are needed to create a:
  a star dune
  b longitudinal dune
  c parallel dune?
7 Why do you think oases are such fertile places?
8 What do chimney rocks and arches have in common?
9 What do playa lakes and saltpans have in common?
10 Draw up and complete a table like the one below for the three landforms listed. Continue to add the landforms shown in figure 7 to your table. Add examples of other desert landforms that you have found when researching this topic.

INVESTIGATE

11 Locate all the desert ***places*** named in this section. Use Google Maps to create your own world map of these locations, adding interesting facts and some images of each location. Email a link to your completed map to your teacher.

PREDICT

12 Study the landforms labelled 1, 3 and 9 in figure 7. Sketch what each of these may look like in the future as erosion and weathering continue to occur.

APPLY

13 Work in small groups to create a model of a desert (using plasticine or playdoh, for example) that contains a number of desert forms and patterns. Use figure 7 as a guide. Show your completed model to the other groups, providing and responding to constructive feedback.

Name of landform	Picture of landform	Location	Type of erosion (wind or water)	Type of deposition (wind or water)
Butte				
Mesa				
Inselberg				

4.5 What are the characteristics of Australia's deserts?

4.5.1 The location of Australia's deserts

Australia is the world's driest inhabited continent. Over 70 per cent of the country receives between 100 and 350 millimetres of rainfall annually, which makes most of Australia arid or semi-arid.

Australia's deserts are sub-tropical and are located mainly in central and western Australia, making up about 18 per cent of the country (see figure 1). They are hot deserts, which mean that they are areas of little rainfall and extreme temperatures — rainfall can be less than 250 millimetres per year, and temperatures can rise to over 50 °C. The average humidity (moisture in the air) is between 10 and 20 per cent. The desert terrain is very diverse and can range from red sand dunes to the polished stones of the gibber plains — the term *gibber* comes from an Aboriginal word for stone.

Great Victoria Desert

The Great Victoria Desert, Australia's largest, covers 424 400 square kilometres. It is not a desert of dunes, but has some desert-adapted plants including marble gums, mulga and spinifex grass. Part of this desert has been named a Biosphere Reserve by UNESCO and is one of the largest arid zone biospheres in the world.

The Great Sandy Desert

The Great Sandy Desert makes up 3.5 per cent of Australia. The red sands of this desert reach almost to the Western Australia coast, where they join with the white sand of Eighty Mile Beach south of Broome.

Simpson Desert

The Simpson Desert is in one of the driest areas of Australia, with rainfall of less than 125 millimetres per year. It is located near the geographical centre of Australia. Dunes (see figure 2) make up nearly three-quarters of the desert. Long parallel dunes (see figure 3 in section 3.3) form in a north–north-west/south–south-east direction; some can be straight and unbroken for up to 300 kilometres and can be 40 metres high. The space between the dunes can vary from 100 metres to 1000 metres.

Strzelecki Desert

This desert is located within three states — far northern South Australia, south-west Queensland and western New South Wales. The dunes support vegetation such as sandhill wattle, needlebush and hard spinifex.

Tanami Desert

Located to the east of the Great Sandy Desert, this desert is mostly characterised by red sand plains with hills and ranges.

Little Sandy Desert

The Little Sandy Desert is located in Western Australia and borders three other deserts. Its landforms are similar to those in the Great Sandy Desert. It includes a vast salt lake called Lake Disappointment.

FIGURE 1 The location and distribution of Australia's deserts

Source: Spatial Vision

FIGURE 2 Sand dunes and vegetation in the Simpson Desert

FIGURE 3 Gibber landscape in the Sturt Stony Desert in South Australia

FIGURE 4 Desert between Oodnadatta and William Creek, South Australia

Sturt Stony Desert

The Sturt Stony Desert, located in north-eastern South Australia, is a harsh gibber desert covered in closely spaced glazed stones. These are left behind when the wind blows away the loose sand between the dense covering of pebbles. The desert also contains some dunes and hills that are resistant to weathering.

Tirari Desert

This small desert covers almost 1600 square kilometres and is located in far northern South Australia, east of Lake Eyre. It contains many linear (parallel) dunes and salt lakes. Cooper Creek runs through the centre of the desert, as do many other **intermittent creeks**. Where there is enough water — usually in waterholes — river red gums and coolabah gums will grow. Tall, open shrubland also occurs in some areas.

Gibson Desert

The fifth largest in Australia, the Gibson Desert is located in Western Australia and borders three other deserts. It consists of sand plains and dunes plus some low, rocky ridges. Some small salt-water lakes are also present in the south-western part of the desert.

Pedirka Desert

The Pedirka Desert in South Australia is Australia's smallest desert, located north-east of Oodnadatta (see figure 4). The lines of parallel red dunes run north-east to south-west, and the space between the dunes can be up to one kilometre. Hamilton Creek is located in this desert and its banks are home to river red gums, coolabah, mulga, prickly wattle and dead finish.

intermittent creeks
a creek that flows for only part of the year following rainfall

FOCUS ON FIELDWORK

Investigating the diversity of vegetation in the school grounds

The extent of vegetation varies depending on temperatures and rainfall. In desert areas, vegetation is often limited due to harsh climatic conditions. Collect data on the vegetation diversity around your school grounds to compare them to a desert area. Complete the following activities to help collect data. Use SkillBuilders in your eBookPLUS to help you.

- Construct a sketch map of areas of vegetation around the school.
- Annotate the sketch maps to describe and identify the vegetation found.
- Photograph the vegetation areas around the school at different times of the year.

1. How does the temperature and rainfall data that you collected earlier help to explain the diversity and type of vegetation around the school?
2. Is there any vegetation present that can thrive in desert-like conditions?
3. What would happen to the vegetation in your school area if less rainfall and extreme temperatures were experienced?

FIGURE 5 Examining information and recording data in the field

ACTIVITIES

IDENTIFY

1 Name the deserts bordered by:
   a the Gibson Desert
   b the Little Sandy Desert.
2 What is a gibber desert?
3 What percentage of Australia is arid or semi-arid?

EXPLAIN

4 Look at figure 1 showing the distribution of Australia's deserts. Describe their location in terms of the tropics.

INVESTIGATE

5 Several plants are listed in the descriptions in this section of Australia's deserts. Choose two different plant types (for example a grass and a tree) and conduct research to find out how they are adapted to desert conditions.
6 Conduct some research to find out the characteristics of the Biosphere Reserve declared by UNESCO located in the Great Victorian Desert.
7 Use an atlas to find the locations of Brisbane, Geraldton and Exmouth. These are located at the same latitude as many of Australia's deserts. Use the **BOM** weblink in your eBookPLUS to find the average temperature, rainfall and humidity of these places.
   a How do these characteristics compare with the temperature, rainfall and humidity in Australia's deserts?
   b How can you account for the differences?

eBookplus

Weblink
BOM

4.6 How did Lake Mungo become dry?

4.6.1 Where are Lake Mungo and the Willandra Lakes located?

Lake Mungo, in Mungo National Park, is just one of 13 ancient dry lake beds in a section of the Willandra Lakes Region World Heritage area in semi-arid New South Wales. There is no water there now, yet the lakes were once full of water and teeming with life, supporting Aboriginal people for more than 47 000 years — archaeological records show this continuous human presence. What happened to change this environment into the semi-arid landscape it is today?

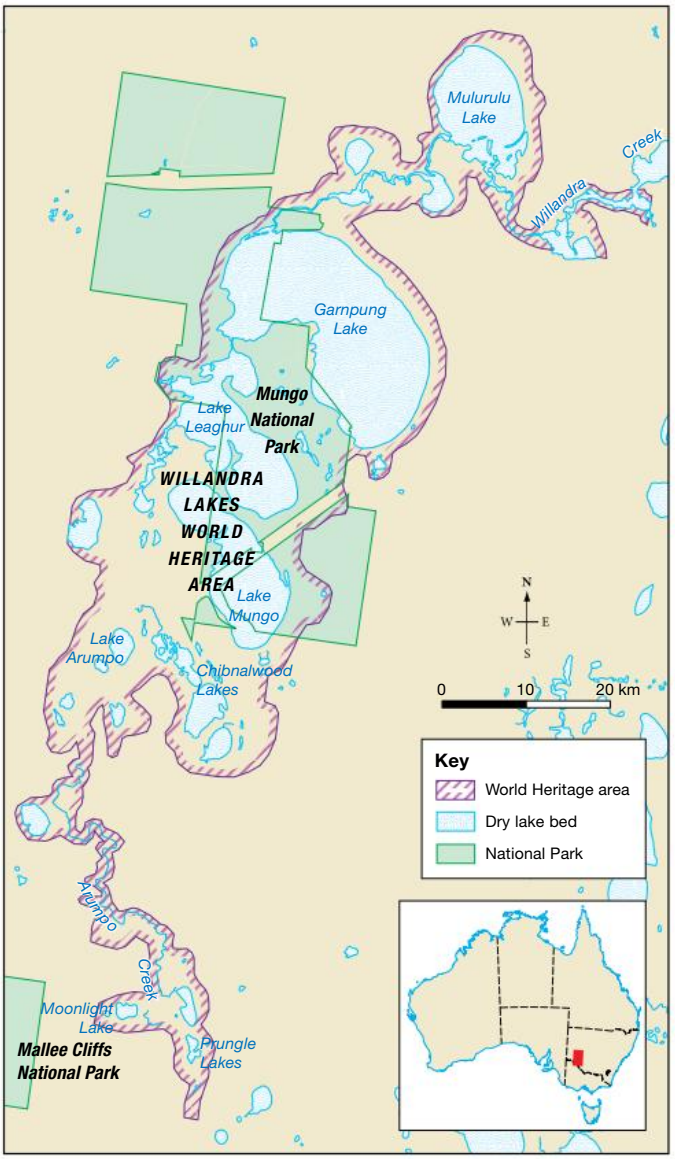
The Willandra Lakes are located in far south-western New South Wales and the region is part of the Murray–Darling River Basin. Lake Mungo is 110 kilometres north-east of Mildura, Victoria. The lakes were originally fed by water from Willandra Creek (see figure 1), which was a branch of the Lachlan River. The average rainfall in this area is 325 millimetres per year, making it a semi-arid desert region.

How has Mungo changed over time?

40 000 years ago

During the last ice age, huge amounts of water filled the shallow lake. At its fullest, Lake Mungo was 6–8 metres deep and covered 130 square kilometres (more than twice the area of Sydney Harbour). The lakes were rich with life, including water birds, freshwater mussels, yabbies, and fish such as golden perch and Murray Cod. Giant kangaroos, giant wombats, large emus and the buffalo-sized Zygomaturus — all now extinct — grazed around the water's edge. Remains of more than 55 species have been found in the area and identified — 40 of these are no longer found in the region, and 11 are extinct.

FIGURE 1 Location of the Willandra Lakes, including Lake Mungo



Source: Spatial Vision

Aboriginal people lived here in large numbers — evidence for this has been found in more than 150 human fossils, including 'Mungo Lady' discovered in 1968 and 'Mungo Man' in 1974, both believed to be over 40 000 years old. The youngest fossil is 150 years old.

30 000–19 000 years ago

A west wind blows across this landscape. During low-water years, red dust and clay was blown across the plains to the eastern side of the lake and mixed with sand dunes on the edge of the lake (formed when the lake was full; see figure 3). This began the formation of lunettes (crescent-shaped dunes) on the east side — called 'the Walls of China' in Lake Mungo. Vegetation covered the dunes, protecting them.

FIGURE 2 Traditional owners clean fossilised footprints at Lake Mungo.

19 000 years ago

The lakes were full of deep, relatively fresh water for a period of 30 000 years — with cycles of wet and dry occurring — which came to an end 19 000 years ago when the climate became drier and warmer. Eventually, the water stopped flowing into the lake system and it dried out (see figure 4).

FIGURE 3 The process of erosion while Lake Mungo was full

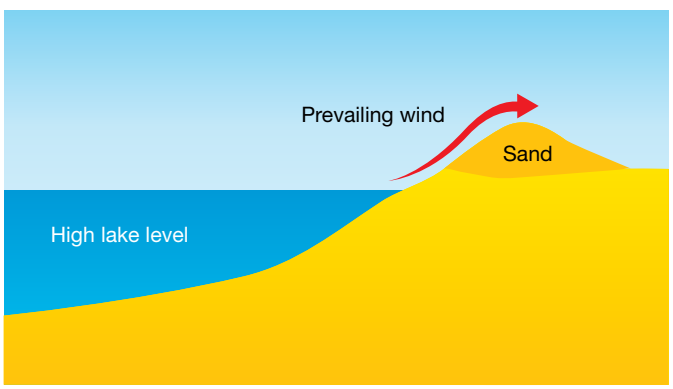
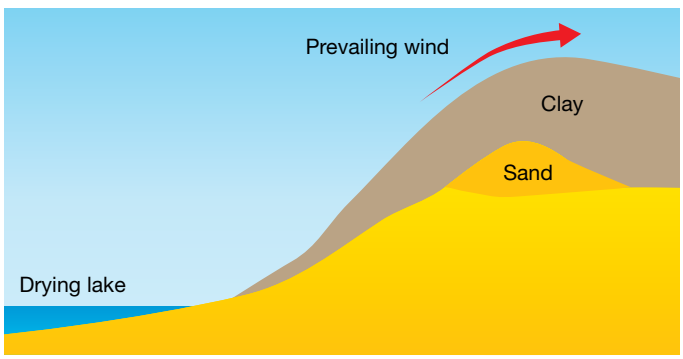


FIGURE 4 The process of erosion while Lake Mungo was drying out



Present day

Today, the lake beds are flat plains covered by low saltbush and bluebush as well as grasses. Grazing cattle and sheep (now no longer allowed in the national park) and rabbits have caused erosion of the lunettes and sand dunes, exposing the human and animal fossils that have since been discovered (see figure 5).

FIGURE 5 The 'Walls of China' at Lake Mungo. The dry lake bed is covered by low bushes and grasses.

4.6.2 World Heritage listing

The Willandra Lakes Region, which includes Lake Mungo, is listed as a World Heritage Area. This region is important because of its archaeology and geomorphology. Human skeletons, tools, shell middens and animal bones found here make up the oldest evidence of burial places in the world. The ancient and undisturbed landforms and sediments provide rich information about the geomorphological processes that created this environment.

eBookplus

Interactivity
Evolving Lake Mungo
Use this interactivity to examine how Lake Mungo has changed over time.
Searchlight ID: int-3108

ACTIVITIES

IDENTIFY

1 What makes Lake Mungo and the Willandra Lakes region a semi-desert?
2 When did Lake Mungo dry up?
3 What is a lunette?

EXPLAIN

4 Describe how the lunettes formed over time.
5 Outline the evidence that shows that many Aboriginal people lived in this area.
6 What human activity caused the lunettes to erode? What did the erosion unearth?
7 Find out what World Heritage listing means in terms of protecting this ***place***. Why is it important?

INVESTIGATE

8 Work in small groups to create an identification brochure with pictures and facts about these three extinct animals that once lived at Lake Mungo.
- *Genyornis newtoni* (giant emu)
- *Protemnodon goliah* (giant short-faced kangaroo)
- *Zygomaturus trilobus* (Zygomaturus)

9 Use the **Timetoast** weblink in your eBookPLUS, the information in this subtopic and images you find through online research to create your own colourful electronic timeline of the changes that occurred at Lake Mungo.

eBookplus

Weblink
Timetoast

4.7 How do people use deserts?

4.7.1 Traditional livelihoods

Although not many people live in deserts, these environments have been important to traditional communities for many years. People either adapt to living in deserts or transform deserts to suit their needs. People are also attracted to desert regions to mine resources.

There are many traditional communities who live in deserts including the Australian Aborigines; the Bedouin of the Middle East and Sahara; the Tuareg of the Sahara in North Africa; the Topnaar in the Namib Desert and the Bushmen of the Kalahari in southern Africa (see figure 1); the Timbisha Shoshone of the Mohave Desert in the USA; and the communities from the Atacama Desert in South America.

FIGURE 1 Bushmen of the Kalahari

nomadic describes a group or tribes that move from place to place depending on the food supply

Many of these communities are **nomadic** and live traditional lives, moving with the seasons and obtaining all their needs from the land or herding animals and trading with people in settlements. It is important to understand that not all desert people are traditional desert-dwellers. For example, many Australian Aboriginal groups do not live in deserts and do not practise traditional ways.

In some deserts the traditional ways have changed as greater contact has been made with settlements, with many previously nomadic groups now choosing to live in settlements.

4.7.2 Desert resources

Many of the changes in deserts have been brought about by developments in technology. These changes have resulted in water being extracted and used to grow crops, and minerals being mined and used in many ways.

Water in the desert

Drilling equipment and pumps have allowed deep bores to tap into groundwater in aquifers deep below the desert surface. This has transformed some deserts in northern Africa and the Middle East into a series of circular irrigation fields — some of these can be up to three kilometres in diameter. In Australia, groundwater from the Great Artesian Basin has enabled desert communities to exist and grazing to take place. Unfortunately, the groundwater in many areas is being pumped out far more quickly than it is being replaced and may be in danger of running out.

Desalination plants have also provided water to desert communities in many areas, especially the Middle East, including large cities such as Dubai.

FIGURE 2 (a) Satellite image of circular irrigation fields in Saudi Arabia; (b) aerial photograph of a circular irrigation field

Mining in deserts

Many deserts contain valuable mineral deposits that were formed in the arid environment or have been exposed by erosion. Desert mining has created a lot of wealth for some people and companies, but usually not for the traditional desert people.

Examples of mining resources include:

- iron and lead-zinc ore — mined in Australian deserts
- phosphorus (used to make fertilisers) — mined in the Sahara region
- borates (used to manufacture glass, ceramics, enamels and agricultural chemicals) mined in the deserts of California, United States
- copper, iron ore and nitrates — mined in Chile's Atacama Desert
- precious metals such as gold, silver and platinum — mined in the deserts of Australia, America and central Asia
- uranium — mined in Australia and the United States
- diamonds — mined in the Kalahari and Namib deserts of south-western Africa
- oil — more than 65 per cent of the world's oil is found in the desert regions of the Middle East, mainly in Kuwait, Iraq, Iran and Saudi Arabia.

FIGURE 3 A uranium mine next to the Colorado River in the United States

ACTIVITIES

IDENTIFY

1 List the sources of water in a desert that can be used to grow crops and provide water for people.

2 How has technology enabled water to be used in deserts?

EXPLAIN

3 Explain how most desert people adapt to live in the desert ***environment***, or adapt the ***environment*** to live in the desert? Give two examples to support your reasoning.

4 Why is it important to use groundwater ***sustainably***?

5 Mining companies generally receive the wealth from mining. Why do you think that the traditional desert communities miss out? Should they receive some of the benefits of mining? How could the profits be distributed more evenly?

INVESTIGATE

6 Investigate one of the desert communities mentioned in this section. Conduct research to identify where these communities generally live, and find examples of their traditional ways of life including living conditions and shelter. Present your information in an interesting way, such as a Prezi, Keynote or PowerPoint presentation, and use images and maps where possible.

PREDICT

7 Make a sketch of figure 3. Label your sketch to include the river, the mine site and the buildings. How has mining ***changed*** this ***environment***? What issues could arise due to the location of this mine? Predict what might happen to this area when mining stops.

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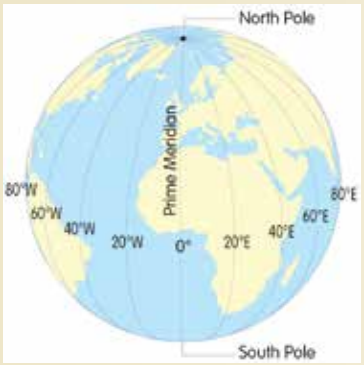
4.8 SkillBuilder: Using latitude and longitude

What are latitude and longitude?

Latitude and longitude are imaginary grid lines encircling the Earth. The lines that run parallel to the equator are called parallels of latitude and are measured in degrees. Lines of longitude run from north to south from the North Pole to the South Pole. These are called meridians of longitude and are also measured in degrees. Lines of latitude and longitude are drawn on maps to help us locate places.



eLesson
Watch the video to learn how to use latitude and longitude.

Searchlight ID: eles-1652

Interactivity
Try this interactivity to learn how to use latitude and longitude.

Searchlight ID: int-3148

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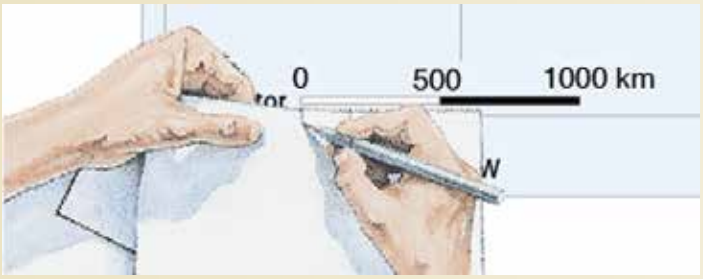
4.9 SkillBuilder: Calculating distance using scale

What does it mean to calculate distance using scale?

Calculating distance using scale involves working out the actual distance from one place to another using a map. The scale on a map allows you to convert distance on a map or photograph to distance in the real world. A linear scale is the easiest to use.



eLesson
Watch this video to learn how to calculate distance using scale.

Searchlight ID: eles-1653

Interactivity
Try this interactivity to learn how to calculate distance using scale.

Searchlight ID: int-3149

4.10 How do people manage deserts?

4.10.1 Sahara: a desert on the move

Many people around the world use deserts to live in, to mine for resources or to use for agricultural purposes. All of these things have an impact on desert areas and they need to be managed.

FIGURE 1 Sand taking over in Nouakchott

Nouakchott, the capital city of Mauritania in West Africa, is slowly being engulfed by the Sahara Desert. Years of continuous drought, deforestation and poor farming methods have all contributed to the **desertification** being experienced. The Mauritanian government has planted vegetation to act as a barrier to the encroaching sand; however, not all of these **greenbelts** have worked due to poor management. Current projects include expanding the greenbelts with a variety of different plant species and to manage the population growth of Nouakchott to avoid moving into the desert areas.

desertification the process by which an area becomes a desert

greenbelts plantations of trees for the purpose of conservation

GEOskills TOOLBOX

Using scale to measure distance on a map

We can use the scale on a map to measure the distance between two points. If the distance is in a straight line, we can use a ruler. If you need to measure something that is not in a straight line, such as a river or a coastline, you can use a piece of string and then measure that length of string on a ruler.

ACTIVITIES

IDENTIFY

1 Explain how desertification is affecting Nouakchott.
2 Refer to the topographic map of Nouakchott to answer the following.
   a What landform features are shown on the map?
   b What is the area reference of the city of Nouakchott?
   c Using the scale, how far away is Nouakchott from the coastline?
   d How close are the sand and the dunes to the built-up areas?

PREDICT

3 What impact could the sand dunes have on the wells?
4 What impact could the sand have on the roads?

APPLY

5 Describe how the map confirms that desertification is a problem in Nouakchott.
6 Write a proposal to the Mauritanian government suggesting where greenbelts should be placed. Include the area reference of where your greenbelts will go and what they will help to protect. Refer to the writing task in your eBookPLUS for information on how to respond to this question.

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4.11 Is Antarctica a desert?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au.**

eBookplus ONLINE ONLY

4.12 How do people use Antarctica?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au.**

FIGURE 2 Topographic map of Nouakchott, Mauritania

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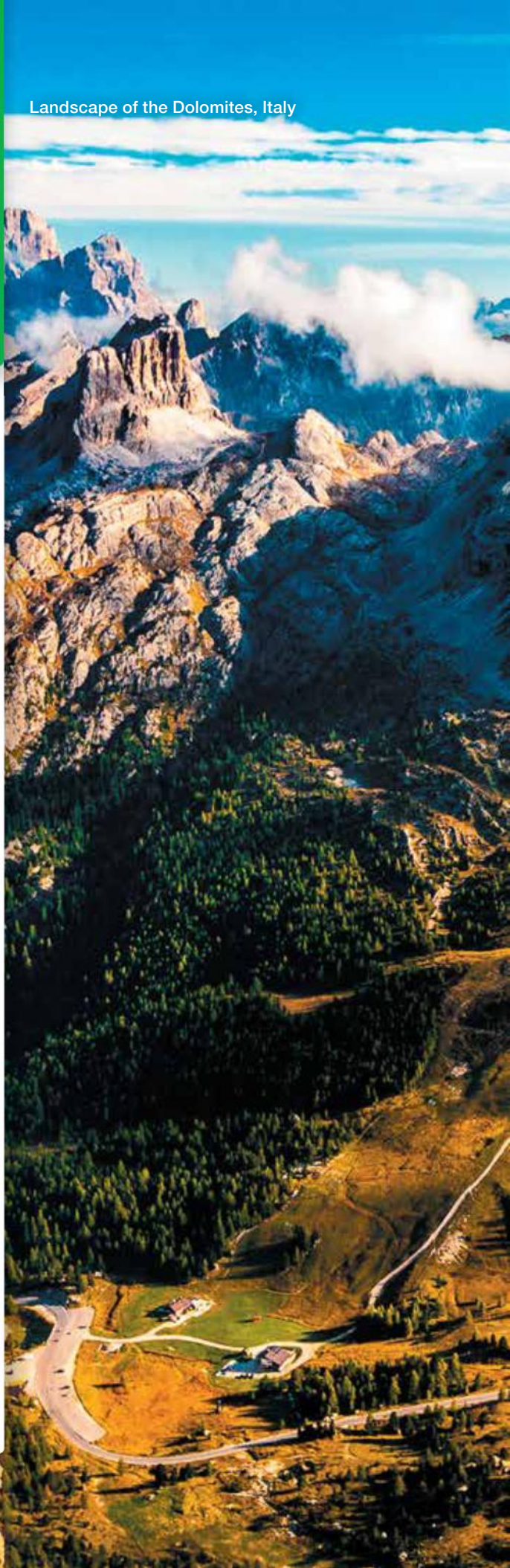
4.13 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au.**



Landscape of the Dolomites, Italy

CHAPTER 5

Mountain landscapes

5.1 Overview

5.1.1 Introduction

Mountains occupy 24 per cent of the Earth's landscape, and are characterised by many different landforms. The forces that form and shape mountains come from deep within the Earth, and have been shaping landscapes for millions of years. The Earth is a very active planet — every day, many volcanoes are erupting somewhere on the planet, and even more tremors are occurring.

Starter questions

1. What is the highest mountain you have visited? What did you do there?
2. Have you ever seen a volcano? Where was it?
3. Is there a mountain or mountain range you would like to visit? Why?
4. Have you ever felt an earthquake or earth tremor? Where were you when it happened? How did you react?
5. Watch the video to describe how movements in the Earth can transform and destroy the landscape.
6. How do mountains change where we live?

Inquiry sequence

		Syllabus outcomes
5.1 Overview		
5.2 Where are the world's mountains?		GE4-1, GE4-3, GE4-4
5.3 How do people use mountains?		GE4-1, GE4-3, GE4-4
5.4 What are the forces that form mountains?		GE4-2, GE4-5, GE4-7, GE4-8
5.5 How do different types of mountains form?		GE4-2, GE4-5, GE4-7, GE4-8
5.6 How do earthquakes and tsunamis occur?		GE4-2, GE4-5, GE4-7, GE4-8
5.7 What are the impacts of earthquakes and tsunamis?		GE4-4, GE4-5, GE4-7, GE4-8
5.8 SkillBuilder: Drawing a simple cross-section	eBook plus ONLINE ONLY	GE4-2, GE4-5, GE4-7, GE4-8
5.9 SkillBuilder: Interpreting an aerial photo	eBook plus ONLINE ONLY	GE4-2, GE4-5, GE4-7, GE4-8
5.10 How are volcanic mountains formed?	eBook plus ONLINE ONLY	GE4-2, GE4-5, GE4-7, GE4-8
5.11 Investigating topographic maps: How did Mount Taranaki form?		GE4-2, GE4-5, GE4-7, GE4-8
5.12 What is the anatomy of a volcano?		GE4-2, GE4-5, GE4-7, GE4-8
5.13 How do volcanoes affect people?		GE4-4, GE4-5, GE4-7, GE4-8
5.14 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	

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Watch this video
Majestic mountains
Searchlight ID: eles-1626

5.2 Where are the world's mountains?

5.2.1 The world's mountains and ranges

A mountain is a landform that rises high above the surrounding land. Most mountains have certain characteristics in common, although not all mountains have all these features. Many have steep sides and form a peak at the top, called a summit. Some mountains located close together have steep valleys between them known as gorges.

Mountains make up a quarter of the world's landscape. They are found on every continent and in three-quarters of all the world's countries. Only 46 countries have no mountains or high plateaus, and most of these are small island nations.

Some of the highest mountains are found beneath the sea. Some islands are actually mountain peaks emerging out of the water. Even though the world's highest peak (from sea level) is Mount Everest in the Himalayas (8850 metres high), Mauna Loa in Hawaii is actually higher when measured from its base on the ocean floor (9170 metres high). Long chains or groups of mountains located close together are called a mountain range.

1 The Himalayas

Located in Asia, the Himalayas are the highest mountain range in the world. They extend from Bhutan and southern China in the east, through northern India, Nepal and Pakistan, and to Afghanistan in the west.

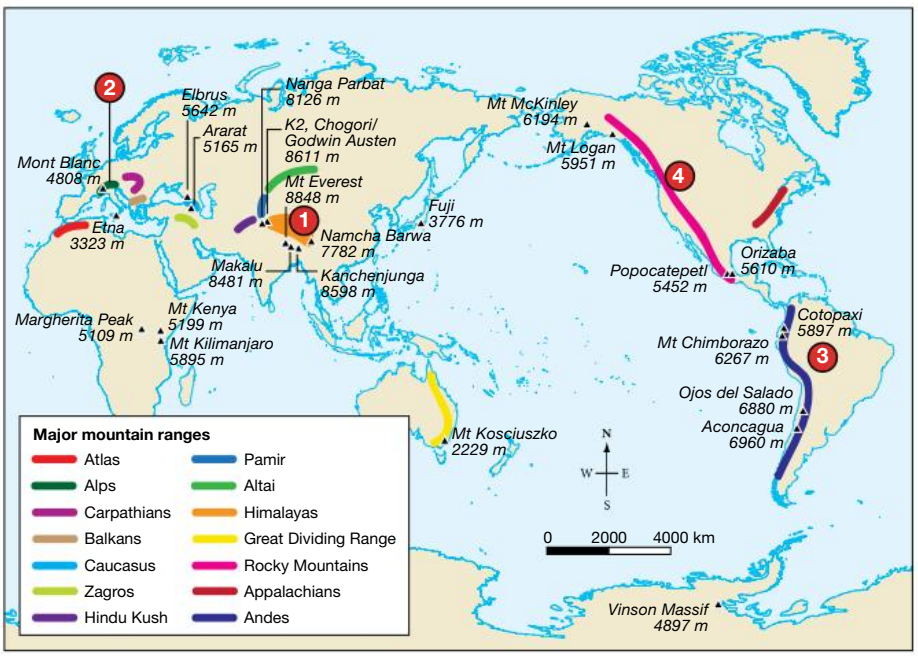
2 The Alps

The Alps, located in south central Europe, extend 1200 kilometres from Austria and Slovenia in the east, through Italy, Switzerland, Liechtenstein and Germany, to France in the west. The highest mountain in the Alps is Mont Blanc in France, which is 4808 metres high.

3 The Andes Mountains

The Andes Mountains are located in South America, extending north to south along the western coast of the continent. The Andes has many mountains over 6000 metres and, at 7200 kilometres long, it is the longest mountain range in the world.

FIGURE 1 The world's main mountains and mountain ranges



Source: Spatial Vision

4 The Rocky Mountains

The Rocky Mountains in western North America extend north–south from Canada to New Mexico, a distance of around 4800 kilometres. The other large mountain range in North America is the Appalachian Mountains, which extends 2400 kilometres from Alabama in the south to Canada in the north.

5.2.2 Mountain climate and weather

It is usually colder at the top of a mountain than at the bottom, because air gets colder with **altitude**. Air becomes thinner and is less able to hold heat. For every 1000 metres you climb, the temperature drops by 6 °C. The effect of this on vegetation is shown in figure 2.

altitude height above sea level

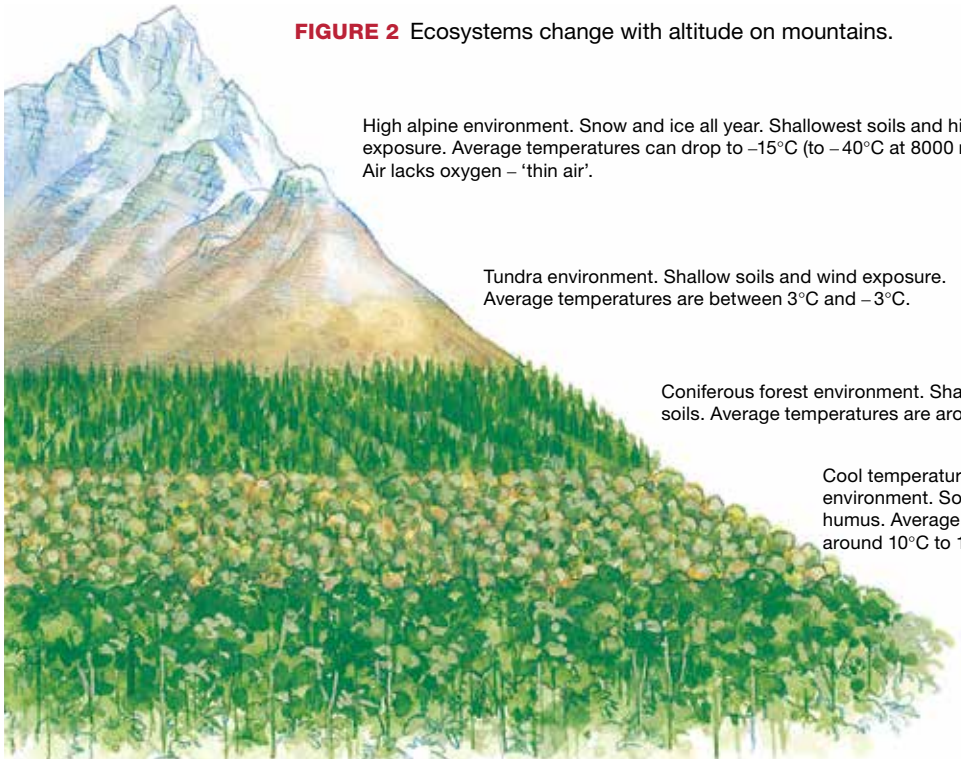


FIGURE 2 Ecosystems change with altitude on mountains.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
- **Himalayas**
- **Mountain environments**

FOCUS ON FIELDWORK

Vegetation identification

Using a vegetation identification chart to classify ecosystems

Vegetation identification charts provide us with information on plants to help identify them when undertaking fieldwork. They are a useful tool as they allow us not only to classify ecosystems but also to examine changes that occur within an environment. With the accessibility of technology, we no longer have to rely on paper identification charts. There are many different applications available on devices to help identify plants and animals. Draw a sketch to indicate the location of vegetation along a slope that has been selected on a field excursion.

ACTIVITIES

IDENTIFY

1 What percentage of the Earth's surface is covered by mountains?

EXPLAIN

2 Refer to figure 2. How does vegetation ***change*** on a mountain?

3 Refer to figure 1. Describe how the ***scale*** of the world's mountains varies across the continents.

APPLY

4 Locate and name the highest mountain closest to where you live in your state or territory.

5 Name a mountain located close to where you live. Name two other mountains in your state or territory. Where are they located in relation to your school or home?

6 Use the internet to find a photograph of a mountain environment. Sketch the photograph and identify the human and physical features of the environment.

INVESTIGATE

7 Work in groups of 4 to 6 to investigate some of the following mountain ranges.

- Antarctica — Antarctic Peninsula, Transantarctic Mountains
- Africa — Atlas Mountains, Eastern African Highlands, Ethiopian Highlands
- Asia — Hindu Kush, Himalayas, Taurus, Elburz, Japanese Mountains
- Australia — MacDonnell Ranges, Great Dividing Range
- Europe — Pyrenees, Alps, Carpathians, Apennines, Urals, Balkan Mountains
- North America — Appalachians, Sierra Nevada, Rocky Mountains, Laurentians
- South America — Andes, Brazilian Highlands

Each student should choose a different range, and complete the following.

a Map the location of the range in its region.

b Describe the climate experienced throughout the range.

c Name and provide images of a selection of plants and animals found in the range.

Present your information in Google maps.

5.3 How do people use mountains?

5.3.1 Mountain people and cultures

People have moved through and lived in mountain areas for centuries. But few people live in the world's highest mountain ranges, where it can be very cold and difficult to grow food and make a living. Thousands of people visit mountains, often in remote areas, for recreation and to see the spectacular scenery, plants and animals, historic and spiritual sites, and different cultures. Mountains are also vital for global water supply.

Around 12 per cent of the world's people live in mountain regions. About half of those live in the Andes, the Himalayas, and the various African mountains.

Usually, population density is very low in these areas. One reason for this is that mountains are very difficult to cross, as they are often rugged and covered with forests and wild animals. They can also be hard to climb and may have ice, snow or glaciers that make travel dangerous.

As a result of these difficulties, mountains have long provided a safe place for **indigenous peoples** and **ethnic minorities**. People live as nomads, hunters, foragers, traders, small farmers, herders, loggers and miners.

indigenous peoples the descendants of those who inhabited a country or region before people of different cultures or ethnic origins arrived

ethnic minority a group that has different national or cultural traditions from the main population

Mountain landscapes in the Dreaming

There are many examples of Aboriginal and Torres Strait Islander Dreaming stories that are linked to mountain landscapes. These legends help explain the formation and importance of each landscape and landform.

Australia's Indigenous people were guided by elders who knew the local Dreaming stories and customs. Dreaming stories were passed on through the generations and explained the origin of the world around them.

CASE STUDY 1

The Three Sisters legend in the Blue Mountains

There is a story, thought to be an Aboriginal legend, about the formation of the Three Sisters in the Blue Mountains in New South Wales (see figure 1). It tells of three sisters, Meehni, Wimlah and Gunnedoo, who lived in the Jamison Valley as members of the Gundungurra tribe. These young women had fallen in love with three brothers from the Dharruk tribe, yet tribal law forbade them to marry. The brothers were not happy with this law and so decided to use force to capture the three sisters, which caused a major tribal battle.

As the lives of the three sisters were seriously in danger, a clever man from the Katoomba tribe took it upon himself to turn the three sisters into stone to protect them from any harm. He intended to reverse the spell when the battle was over, but the clever man himself was killed. As only he could reverse the spell and bring the sisters back to life, they remain in their rock formation.

FIGURE 1 The Three Sisters in the Blue Mountains

CASE STUDY 2

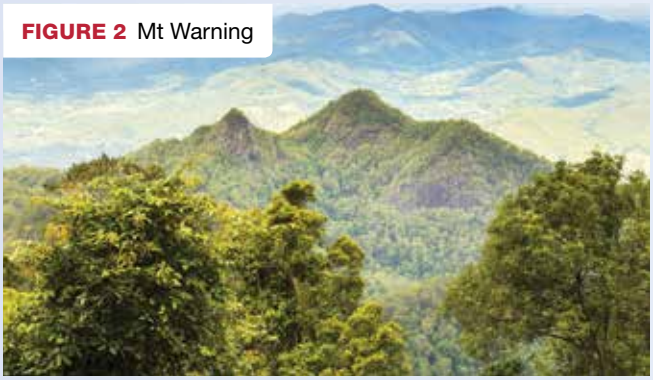
Wollumbin on the New South Wales north coast

Wollumbin, also known as Mount Warning, is a site of cultural significance to the Bundjalung people. As the first place in Australia to see the sun each morning, Wollumbin represents a source of energy and life, making it a place of clan lore, initiation and spiritual learning. The ancient rainforests also provided food, medicines and shelter to several generations of the Bundjalung people. The walking track to reach the summit of Wollumbin is popular, but it is climbed against the wishes of the traditional owners.

The 1156-metre high peak is the central plug of a huge shield volcano that once dominated the landscape more than twenty million years ago. The caldera that is visible today was formed after a major explosion that caused the walls of the volcano to collapse. This site was recognised for its geological significance when it became protected as a World Heritage Area in 1986.

Captain James Cook gave Wollumbin the name Mount Warning in the eighteenth century as he wanted to warn others after his ship almost ran aground on nearby reefs.

FIGURE 2 Mt Warning



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Sacred and special places

Mountain landscapes often have special meaning to certain groups of people. This might be because the location includes sacred sites or religious symbols; it might also be because people want to be close to nature or to feel spiritually inspired or renewed.

Mountaineers who take great risks, climbing alone or in small groups, often find a special meaning in mountain environments. These areas may hold deep spiritual, **cultural** and aesthetic (relating to beauty) values and ideas, and these will often inspire people to care for and protect mountain environments.

The following list gives examples of beliefs that are connected to mountains.

- Hindus and Buddhists have beliefs about Mount Kallas in the Himalayas.
- Hindus in Bali, Indonesia, have a special connection with Mount Gunung Agung.

cultural relating to the ideas, customs, and social behaviour of a society

FIGURE 3 Mount Everest

FIGURE 4 Mount Fuji

- Tibetan Buddhists revere Chomolungma (Mount Everest).
- The landscape of Demojong in the Himalayas is sacred to Buddhist Tibetans.
- Nanda Devi in the Himalayas is a sacred site for both Sikh and Hindu communities, and is a UNESCO World Heritage site.
- Mt Fuji is a place of spiritual and cultural symbolism to Japanese people.
- St Katherine Protectorate in South Sinai, Egypt, is in an area holy to Jews, Christians and Muslims.
- Jabal La'lam is a mountain that is sacred to the people of northern Morocco.

5.3.2 Skills to survive

It can be hard to make a living in mountain regions. People living in small, isolated mountain communities have learned to use the land and resources sustainably. Many practise shifting cultivation, migrate with grazing herds, and have terraced fields.

Some of the world's oldest rice terraces (see figure 5) are over 2000 years old. Rice and vegetables could be grown quite densely on the terraces. This enabled people to survive in a region with very steep slopes and high altitude.

FIGURE 5 The Longsheng rice terraces in China show how a mountainside can be changed to grow food.

FIGURE 6 Animals grazing in the Himalayas

On very high ranges, below the snowline is a treeless zone of alpine pastures that can be used in summer to graze animals (see figure 6). Elsewhere, in the valleys and foothills, agriculture often occurs, with fruit orchards and even vineyards on some sunny slopes. Not every human modification to mountain slopes, however, has been sustainable. Areas such as the Australian Alps were once used for cattle grazing, which resulted in erosion, soil structure damage and damage to alpine vegetation such as mosses.

Mountains supply 60 to 80 per cent of the world's fresh water. This is due to orographic rainfall (caused by warm, moist air rising and cooling when passing over high ground, such as a mountain; as the air cools, the water vapour condenses and falls as rain). Where precipitation falls as snow, water is stored in snowfields and glaciers. When these melt, they provide water to people when they need it most.

FOCUS ON FIELDWORK

Using clinometers to measure slopes

Clinometers measure the angle of a slope, indicating how steep the incline or decline is. Measuring slopes is a useful fieldwork tool to help work out the gradient of the various slopes around us. Clinometers can come in many forms and are easily made or used through an app on a phone or other device. Additionally, clinometers can give us the height of tall objects by using simple trigonometry calculations.

Measure and record the slopes around your school area or peaks in your local landscape.

Consider these questions:

- Was there any evidence of erosion on the slopes around your area?
- Was there more or less erosion on different slopes?
- What was the vegetation like on these slopes?

FIGURE 7 A handmade clinometer

FIGURE 8 A student using a clinometer

ACTIVITIES

IDENTIFY

1 List the geographical characteristics of mountains that limit the number of people who live there.

2 What type of work and recreation can people undertake in mountain regions? Present this information in words or in a diagram.

EXPLAIN

3 Think of a mountain you have visited or seen. Do you feel inspired by mountain environments? How can spiritual or religious beliefs linked to mountain landscapes help in protecting them?

4 How has the natural mountain ***environment*** in figure 1 been ***changed*** by people? Sketch the photo and make notes to show the ***changes***. You may wish to review the *Constructing a field sketch* SkillBuilder in your eBookPLUS.

5 Imagine you work as a park ranger in the Blue Mountains or Wollumbin. How can the Dreamtime legends of the region help other people understand this ***environment***?

6 Describe how different groups of people value mountainous ***places***.

APPLY

7 Use the internet to find photographs of Nepal in the Himalayas. Use these photographs to examine the ways that the Nepalese people use the mountain environment. Complete further research on the traditional Sherpa lifestyle and describe their connection with the land.

PREDICT

8 Draw and annotate a picture to show how and why mountains are important for water supply. Now add information to your picture in the form of annotations or additional drawings about what might happen if this was reduced for some reason; for example, through climate ***change***.

INVESTIGATE

9 Use the internet to locate the Jamison Valley in the Blue Mountains. Describe its location.

10 From this section, choose one of the Hindu or Buddhist beliefs linked to mountains. Use the internet to find out details of this connection. Present your information as a print or electronic brochure.

11 Research where your water supply comes from. How do mountains determine your water supply and availability?

5.4 What are the forces that form mountains?

5.4.1 Continental plates

Mountains and mountain ranges have formed over billions of years from tectonic activity; that is, movement in the Earth's crust. The Earth's surface is always changing — sometimes very slowly and sometimes dramatically.

The Earth's crust is cracked, and is made up of many individual moving pieces called continental plates, which fit together like a jigsaw puzzle (see figure 1). These plates float on the semi-molten rocks, or magma, of the Earth's mantle. Enormous heat from the Earth's core, combined with the cooler surface temperature, creates **convection currents** in the magma. These currents can move the plates by up to 15 centimetres per year. Plates beneath the oceans move more quickly than plates beneath the continents.

convection current a current created when a fluid is heated, making it less dense, and causing it to rise through surrounding fluid and to sink if it is cooled. A steady source of heat can start a continuous current flow.

converging plate a tectonic boundary where two plates are moving towards each other

Continental drift

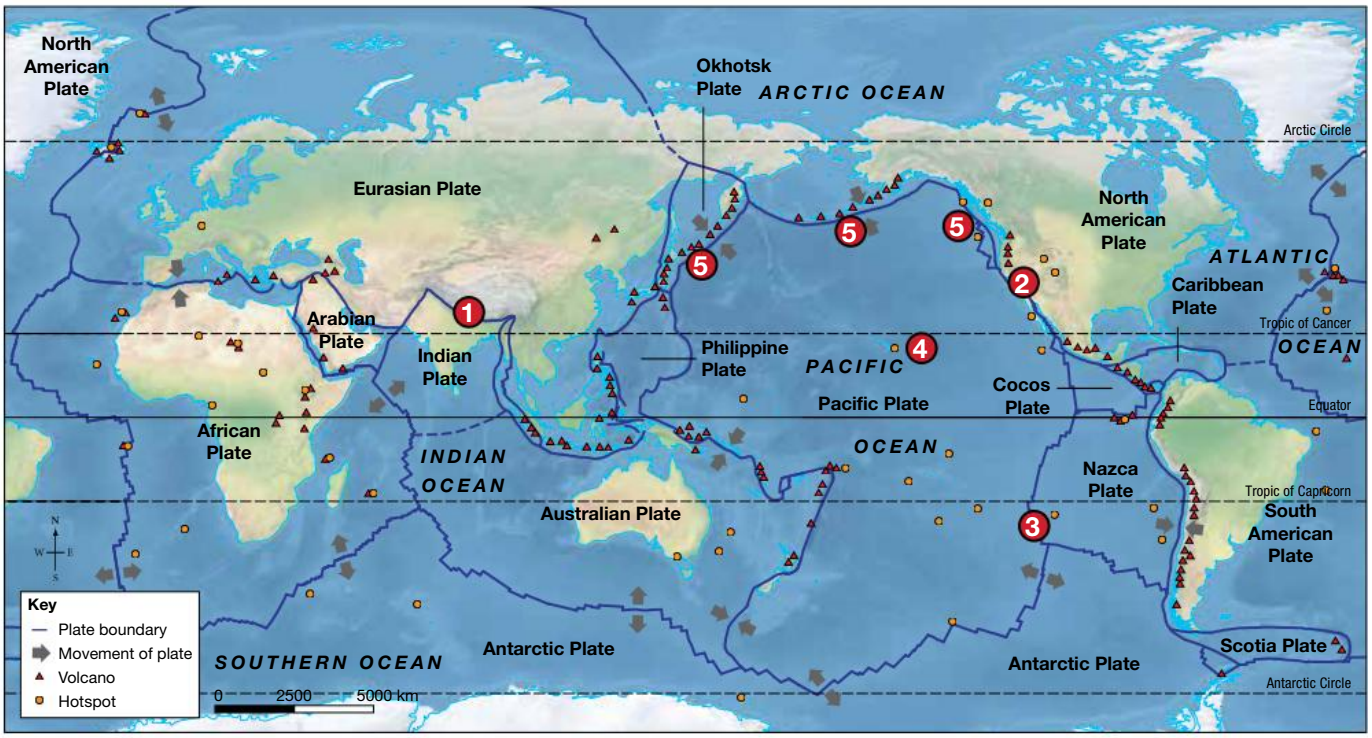
Scientific evidence shows that, about 225 million years ago, all the continents were joined.

1 Convergent plates

When two continental plates of similar density collide, the pressure of the **converging plates** can push up land to form mountains. The Himalayas were formed by the collision of the Indian subcontinent and Asia (see figure 1). The European Alps were formed by the collision of Africa and Europe.

When an oceanic and a continental plate collide, they are different densities, and the thinner oceanic plate is subducted, meaning it is forced down into the mantle. Heat melts the plate and pressure forces the molten material back to the surface. This can produce volcanoes and mountain ranges (see figure 2). The Andes in South America were formed this way.

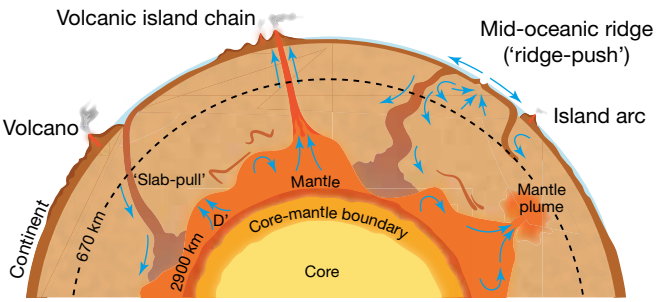
FIGURE 1 World map of plates, volcanoes and hotspots



Source: Spatial Vision

Subduction can also occur when two oceanic plates collide. This forms a line of volcanic islands in the ocean about 70–100 kilometres past the subduction line. The islands of Japan have been formed in this way. Deep oceanic trenches are also formed when this occurs. The Mariana Trench in the Pacific Ocean is 2519 kilometres long and 71 kilometres wide, and is the deepest point on Earth — 10.911 kilometres deep. If you could put Mount Everest on the ocean floor in the Marianas Trench, its summit would lie about 1.6 kilometres below the ocean surface.

FIGURE 2 The Earth's core is very hot, while its surface is quite cool. This causes hot material within the Earth to rise until it reaches the surface, where it moves sideways, cools, and then sinks.



2 Lateral plate slippage

Convection currents can sometimes cause plates to slide, or slip, past one another, forming **fault** lines. The San Andreas Fault, in California in the western United States, is an example of this (see figure 1).

fault an area on the Earth's surface that has a fracture, along which the rocks have been displaced

3 Divergent plates

In some areas, plates are moving apart, or diverging, from each other (for example, the Pacific Plate and Nazca Plate; see figure 1). As the **divergent plates** separate, magma can rise up into the opening, forming new land. Underwater volcanoes and islands are formed in this way.

divergent plate a tectonic boundary where two plates are moving away from each other and new continental crust is forming from magma that rises to the Earth's surface between the two

4 Hotspots

There are places where volcanic eruptions occur away from plate boundaries. This occurs when there is a weakness in the oceanic plate, allowing magma to be forced to the surface, forming a volcano. As the plate drifts over the hotspot, a line of volcanoes is formed (for example, Hawaii; see figure 1).

5 The Pacific Ring of Fire

The most active region in the world is the Pacific Ring of Fire. It is located on the edges of the Pacific Ocean and is shaped like a horseshoe (see figure 1). The Ring of Fire is a result of the movement of tectonic plates. For example, the Nazca and Cocos plates are being subducted beneath the South American Plate, while the Pacific and Juan de Fuca plates are being subducted beneath the North American Plate. The Pacific Plate is being subducted under the North American Plate on its east and north sides, and under the Philippine and Australian plates on its west side. The Ring of Fire is an almost continuous line of volcanoes and earthquakes. Most of the world's earthquakes occur here, and 75 per cent of the world's volcanoes are located along the edge of the Pacific Plate.

ACTIVITIES

IDENTIFY

1 Look at figure 2. How do convection currents help explain plate tectonics?
2 Refer to figure 1. Name three ***places*** where plates are converging. What mountain ranges, if any, are located in these ***places***?

EXPLAIN

3 Explain, in your own words, the meaning of subduction when referring to plate movements.
4 Name two locations where plates are moving apart. What is happening to the sea floor in these ***places***?
5 Describe the distribution of volcanoes shown in figure 1. What does this distribution have in common with the location of plate boundaries?

APPLY

6 Use different coloured strips of plasticine to make models showing how a collision of continental and oceanic plates differs from a collision of two continental plates. Have a go at explaining this to a member of your family.

PREDICT

7 Watch the **Drifting continents** video in your eBookPLUS (eles-0129) explaining how continents move. Based on the direction of movement, draw a sketch to show what you think the world's continents will look like many years into the future. Justify your predictions.

INVESTIGATE

8 Use the **Dynamic Earth** weblink in your eBookPLUS to explore the Earth's structure and the movement of the continental plates. Work through the activities and complete the challenges to investigate the movements beneath the Earth's crust. Use your findings to create a comic strip to explain how various landforms are created.

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eLesson
Drifting continents
Watch this video to learn more about how the continents were once all joined and how they have moved apart.
Searchlight ID: eles-0129

Interactivity
Mountain builders
Use this interactivity to examine the forces that create mountains.
Searchlight ID: int-3109

Weblink
Dynamic Earth

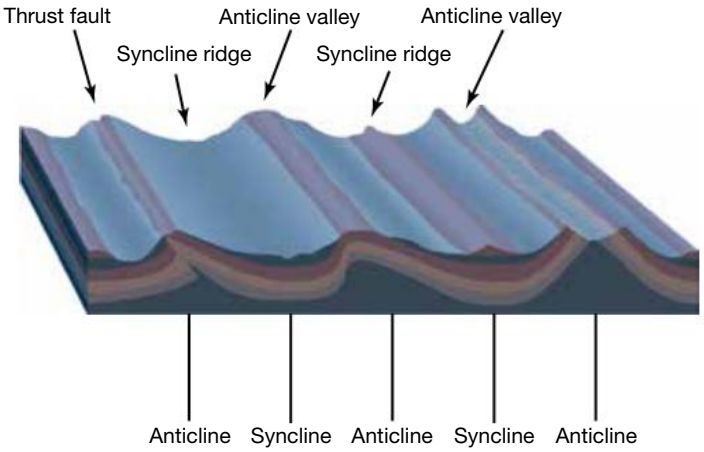
5.5 How do different types of mountains form?

5.5.1 Types of mountains

lithosphere the Earth's crust, including landforms, rocks and soil

The different movements and interactions of the **lithosphere** plates result in many different mountain landforms. Mountains can be classified into five different types, based on what they look like and how they were formed. These are fold, fault-block, dome, plateau and volcanic mountains. (Volcanic mountains are discussed in section 4.7.)

FIGURE 1 The formation of fold mountains



Fold mountains

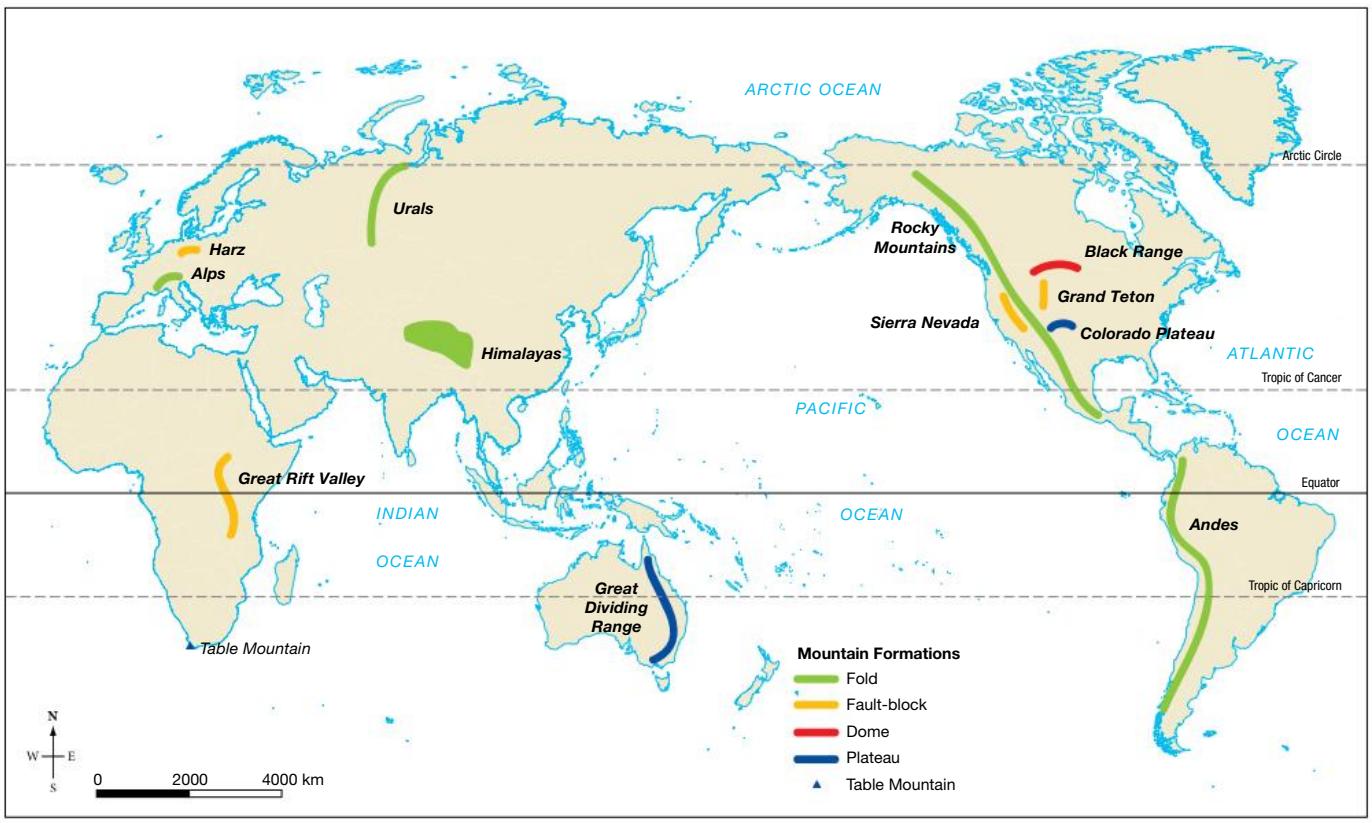
The most common type of mountain, and the world's largest mountain ranges, are fold mountains. The process of folding occurs when two continental plates collide, and rocks in the Earth's crust buckle, fold and lift up. The upturned folds are called anticlines, and the downturned folds are synclines (see figure 1). These mountains usually have pointed peaks.

Use the **Anticline and syncline** weblink in your eBookPLUS to see the formation of fold mountains.

Examples of fold mountains include:

- the Himalayas in Asia
- the Alps in Europe
- the Andes in South America
- the Rocky Mountains in North America
- the Urals in Russia (see figure 2).

FIGURE 2 Selected world mountains



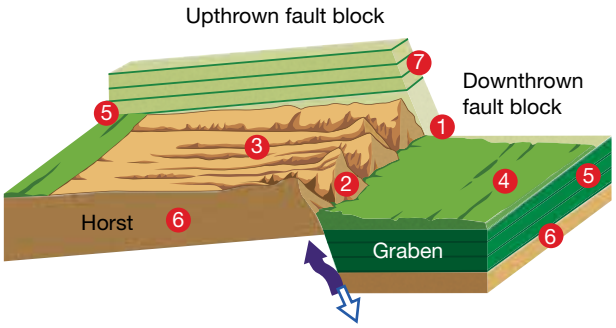
Source: Spatial Vision

Fault-block mountains

Fault-block mountains form when pressure within the Earth forces some parts of rock up and other parts to collapse down, along a fault line (or crack) in the Earth's crust. Instead of folding, the crust fractures (pulls apart) and breaks into blocks. The exposed parts then begin to erode and shape mountains and valleys (see figure 3).

Fault-block mountains usually have a steep front side and then a sloping back. The Sierra Nevada and Grand Tetons in North America, the Great Rift Valley in Africa (see figure 4), and the Harz Mountains in Germany are examples of fault-block mountains. Another name for the uplifted blocks is *horst*, and the collapsed blocks are *graben*.

FIGURE 3 The formation of fault-block mountains



1. Fault zone
2. Steep eastern face
3. Gentle western slope
4. Valley floors filled with sediments of cobbles, gravel and sand
5. Sedimentary rock layers
6. Bedrock
7. Sedimentary rock layers (5) now worn away.

eBook*plus*

Weblink
Anticline and syncline

Dome mountains

Dome mountains are named after their shape, and are formed when molten magma in the Earth's crust pushes its way towards the surface. The magma cools before it can erupt, and it then becomes very hard. The rock layers over the hardened magma are warped upwards to form the dome. Over time, these erode, leaving behind the hard granite rock underneath (see figure 5). Ben Nevis in Scotland is an example of a dome mountain (see figure 6).

Plateau mountains

Plateaus are high areas of land that are large and flat. They have been pushed above sea level by tectonic forces or have been formed by layers of lava. Over billions of years, streams and rivers cause erosion, leaving mountains standing between valleys. Plateau mountains are sometimes known as erosion mountains.

FIGURE 4 A cliff overlooking the Great Rift Valley in northern Tanzania. These are examples of fault-block mountains.

FIGURE 5 Very hot magma pushes towards the surface to form dome mountains.

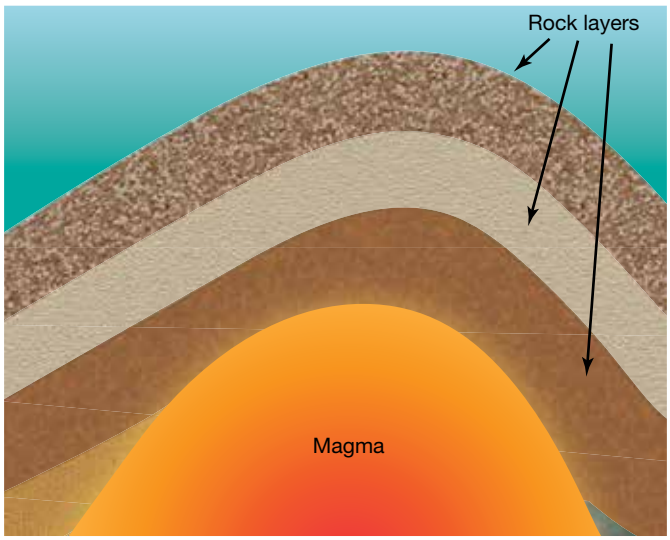


FIGURE 6 Ben Nevis in Scotland is a famous example of a dome mountain.

Pangaea the name given to all the landmass of the Earth before it split into Laurasia and Gondwana

CASE STUDY 1

How were the Himalayas formed?

Before the theory of tectonic plate movement, scientists were puzzled by findings of fossilised remains of ancient sea creatures near the Himalayan peaks. Surely these huge mountains could not once have been under water?

Since understanding plate movements, the mystery has been solved. About 220 million years ago, India was part of the ancient supercontinent we call **Pangaea**. When Pangaea broke apart, India began to move northwards at a rate of about 15 centimetres per year. About 200 million years ago, India was an island separated from the Asian continent by a huge ocean.

When the plate carrying India collided with Asia 40 to 50 million years ago, the oceanic crust (carrying fossilised sea creatures) slowly crumpled and was uplifted, forming the high mountains we know today. It also caused the uplift of the Tibetan Plateau to its current position. The Bay of Bengal was also formed at this time.

The Himalayas were thus formed when India crashed into Asia and pushed up the tallest mountain range on the continents (see figure 7).

The Himalayas are known as young mountains, because they are still forming. The Indo-Australian plate is still moving northwards at about 2 centimetres each year, making this boundary very active. It is predicted that over the next 10 million years it will travel more than 180 kilometres into Tibet and that the Himalayan mountains will increase in height by about five millimetres each year. Old mountains are those that have stopped growing and are being worn down by the process of erosion.

FIGURE 7 The movement of the Indian landmass to its current location

Source: MAPgraphics Pty Ltd Brisbane

CASE STUDY 2

Formation of the Sierra Nevada Range, United States

The Sierra Nevada Range began to rise about five million years ago. As the western part of the block tilted up, the eastern part dropped down. As a result there is a long, gentle slope towards the west and a steep slope to the east, as shown in figures 8 and 9.

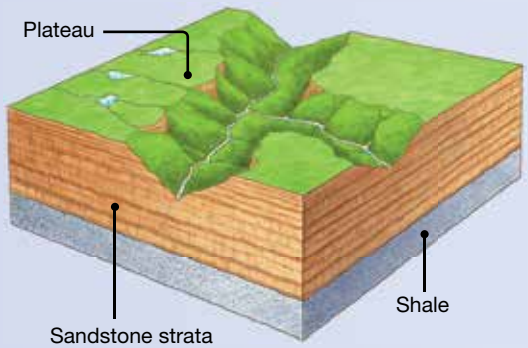
FIGURE 8 The Sierra Nevada range was formed by fault-block tilting.

FIGURE 9 Yosemite Valley in the Sierra Nevada mountains

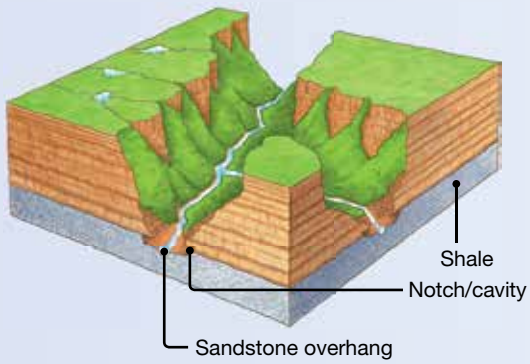
CASE STUDY 3

The Blue Mountains: Cliffs and gorges

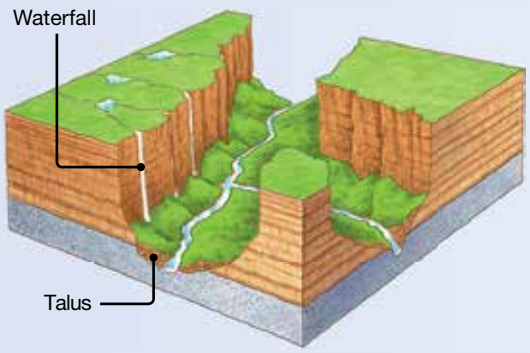
The Blue Mountains is a mountainous region located west of Sydney. It consists of a flat-topped mountain (a plateau) and sheer cliffs. Deep and narrow gorges, up to 760 metres deep, formed as rivers and creeks eroded the sandstone plateau over thousands of years.



Between 280 and 250 million years ago, about 500-metre layers of shales, siltstones and mudstones were laid by streams when they reached a shallow sea. Then, about 250 and 170 million years ago, large rivers deposited a 300-metre thick layer of sand on top of the shales. These layers were formed into sandstone by heat and pressure.



As creeks and rivers flowed across the plateau, they eroded through the plateau. The broken down sand and silt in the river water helped scour deeper into the plateau. When the rivers reached the shale layer they cut down even more easily as shale is relatively soft. Notches, or cavities, formed and undermined the more resistant sandstone.



The sandstone overhangs broke off and collapsed, leaving rubble. Shale provides soils on which vegetation can grow. Waterfalls form where they flow over harder sandstone.

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Interactivity
Grand peaks
Use this interactivity to learn about different types of mountains.
Searchlight ID: int-3110

ACTIVITIES

IDENTIFY

1 List one example of fold, fault, dome and plateau mountains. Where is each located?
2 State whether the following statements are true or false.
  a Fold mountains are the most common type of mountain in the world.
  b The Sierra Nevada Range was formed by the eastern part of a fault-block tilting up.

EXPLAIN

3 Use the **Fold mountains** weblink in your eBookPLUS to explain the formation of fold mountains.
4 Use the video to explain the formation of fault-block mountains.
5 How does the shape of each of the mountains shown in this section provide clues as to how they were formed? How have the effects of erosion ***changed*** these mountains?
6 Use figures 5 and 6 to explain the formation of dome mountains.
7 Sketch figure 6 and annotate it to show where erosion has taken place. Label ***places*** that have hard and weak rocks.
8 Draw a sketch of figure 11, noting the plateau and areas of erosion and weathering.

INVESTIGATE AND PREDICT

9 Refer to subtopic 5.4, which describes the formation of the Himalayas.
  a Provide an explanation why scientists found ancient sea fossils on top of the Himalayas.
  b Describe how the Himalayas were formed. How long did it take for the plate carrying India to crash into Asia? Explain why these mountains are described as 'young' mountains.
  c Based on the movements occurring, predict what might happen to the Himalayas in the future.

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Weblink
Fold mountains

5.6 How do earthquakes and tsunamis occur?

5.6.1 Earthquakes

Earthquakes and tsunamis are frightening events and often strike with little or no warning. An earthquake can shake the ground so violently that buildings and other structures collapse, crushing people to death. If an earthquake occurs at sea, it may cause a tsunami, which produces waves of water that move to the coast and further inland, sometimes with devastating effects.

focus the point where the sudden movement of an earthquake begins

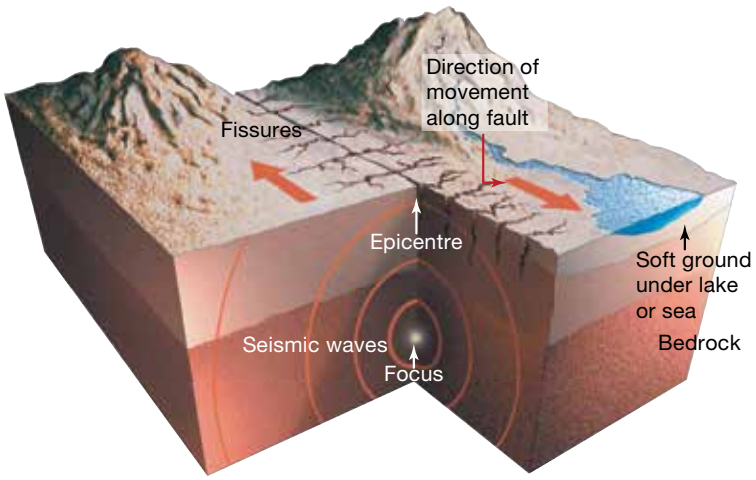
seismic waves waves of energy that travel through the Earth as a result of an earthquake, explosion, or a volcanic eruption

epicentre the point on the Earth's surface vertically above the focus

Earthquakes occur every day somewhere on the planet, usually on or near the boundaries of tectonic plates. The map in section 4.3, figure 1, shows a strong relationship between the location of plate boundaries and the occurrence of earthquakes. Weaknesses and cracks in the Earth's crust near these plate boundaries are called faults. An earthquake is usually a sudden movement of the layers of rock at these faults.

The point where this earthquake movement begins is called the **focus** (see figure 1). Earthquakes can occur near the surface or up to 700 kilometres below. The shallower the focus, the more powerful the earthquake will be. Energy travels quickly from the focus point in powerful **seismic waves**, radiating out like ripples in a pond. The seismic waves decrease in strength as they travel away from the **epicentre**. The energy released from an earthquake is measured on the Richter scale.

FIGURE 1 What happens in an earthquake?



The energy released at the focus can be immense, and it travels in seismic waves through the mantle and crust of the Earth. Primary waves, or P-waves, are the first waves to arrive, and are felt as a sudden jolt. Depending on the type of rock or water in which they are moving, these waves travel at speeds of up to 30 000 kilometres an hour.

Secondary waves, or S-waves, arrive a few seconds later and travel at about half the speed of P-waves. These waves cause more sustained up-and-down movement.

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› Haiti earthquake
› Banda Aceh tsunami

Surface waves radiate out from the epicentre and arrive after the main P-waves and S-waves. These move the ground either from side-to-side, like a snake moving, or in a circular movement.

Even very strong buildings can collapse with these stresses. The energy that travels in waves across the Earth's surface can destroy buildings many kilometres away from the epicentre.

Measuring earthquakes

Earthquakes are measured according to their magnitude (size) and intensity. Magnitude is measured on the Richter scale, which shows the amount of energy released by an earthquake. The scale is open-ended as there is no upper limit to the amount of energy an earthquake might release. An increase of one in the scale is 10 times greater than the previous level. For example, energy released at the magnitude of 7.0 is 10 times greater than the energy released at 6.0.

Earthquake intensity is measured on the Modified Mercalli scale, and indicates the amount of damage caused. Intensity depends on the nature of buildings, time of day and other factors.

CASE STUDY 1

The Nepal earthquake, 2015

A magnitude 7.3 earthquake struck Nepal on 25 April 2015. Hundreds of thousands of people were made homeless with entire villages flattened (see figure 2). The earthquake killed more than 8000 people and injured more than 23 000 people while also triggering an avalanche on Mount Everest which killed an additional 18 people. The earthquake epicentre was east of the district of Lamjung and the focus was approximately 15 kilometres deep. The earthquake triggered several aftershocks and caused Mount Everest to move 3 centimetres to the south-west.

Nepal is located on the boundary of two huge moving plates — the Indo-Australian and Asian plates — that collide, making it very prone to earthquakes (see figure 3). It is the collision of these plates that has created the Himalaya mountain range.

FIGURE 2 Damage caused by the Nepal earthquake in 2015

FIGURE 3 Location of Nepal

Source: Spatial Vision

5.6.2 Tsunamis

A tsunami is a large ocean wave that is caused by sudden motion on the ocean floor. The sudden motion could be caused by an earthquake, a volcanic eruption or an underwater landslide. About 90 per cent of tsunamis occur in the Pacific Ocean, and most are caused by earthquakes that are over 6.0 on the Richter scale.

A tsunami at sea will be almost undetectable to ships or boats. The reasons for this are that the waves travel extremely fast in the deep ocean (about 970 kilometres per hour — as fast as a large jet) and the wavelength is about 30 kilometres, yet the wave height is only one metre.

When tsunamis reach the continental slope, several things happen. Firstly, the wave slows down and, as it does, the wave height increases and the wavelength decreases; in other words, the waves get higher and closer together. Sometimes, the sea may recede quickly, very far from shore, as though the tide has suddenly gone out. If this happens, the best course of action is to head to higher ground as quickly as possible.

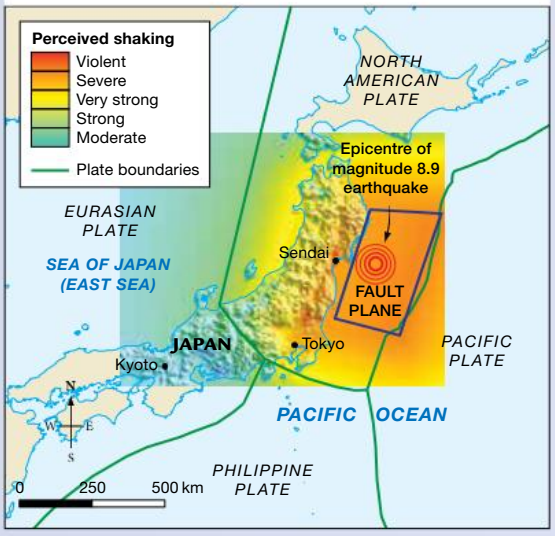
CASE STUDY 2

The Japanese tsunami, 2011

The region of Japan is seismically active because four plates meet there: the Eurasian, Philippine, Pacific and Okhotsk. Many landforms in this region are influenced by the collision of oceanic plates. Chains of volcanic islands called island arcs are formed, and an ocean trench is located parallel to the island arc (see figure 1 in section 5.4).

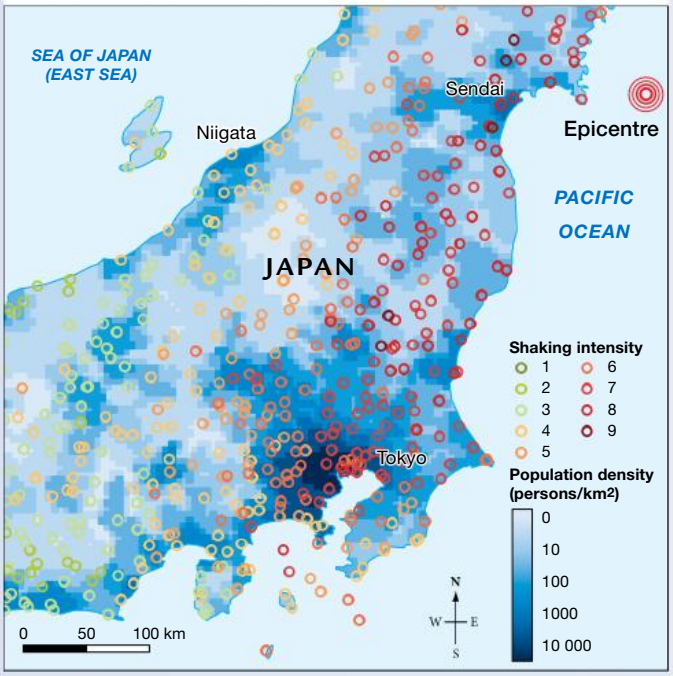
On 11 March 2011, an 8.9-magnitude earthquake struck near the coast of Japan. The earthquake was caused by movement between the Pacific Plate and the North American Plate (see figure 4). It occurred about 27 kilometres below the Earth's surface along the Japan Trench, where the Pacific Plate moves westwards at about eight centimetres each year. The sudden upward movement released an enormous amount of energy and caused huge displacement of the sea water, causing the tsunami. When the tsunami reached the Japanese coast, waves more than six metres high moved huge amounts of water inland. Strong aftershocks were felt for a number of days. Nearly 16 500 people were killed and 4800 were reported missing.

FIGURE 4 The location and magnitude of the earthquake that caused the Japanese tsunami



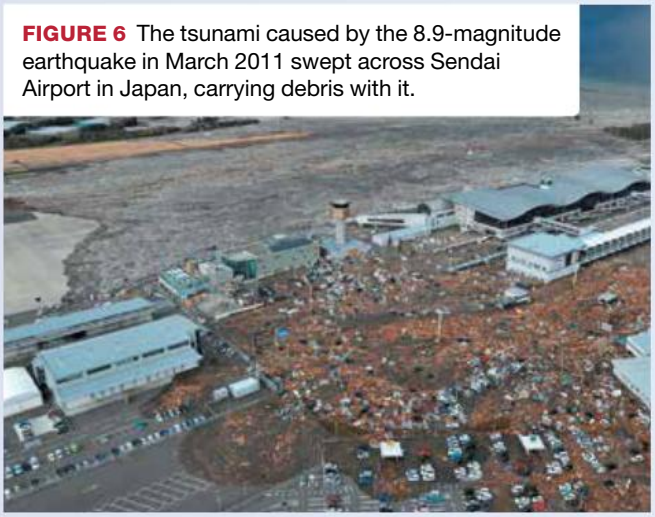
Source: Spatial Vision

FIGURE 5 This map shows the ground motion and shaking intensity from the earthquake across Japan.



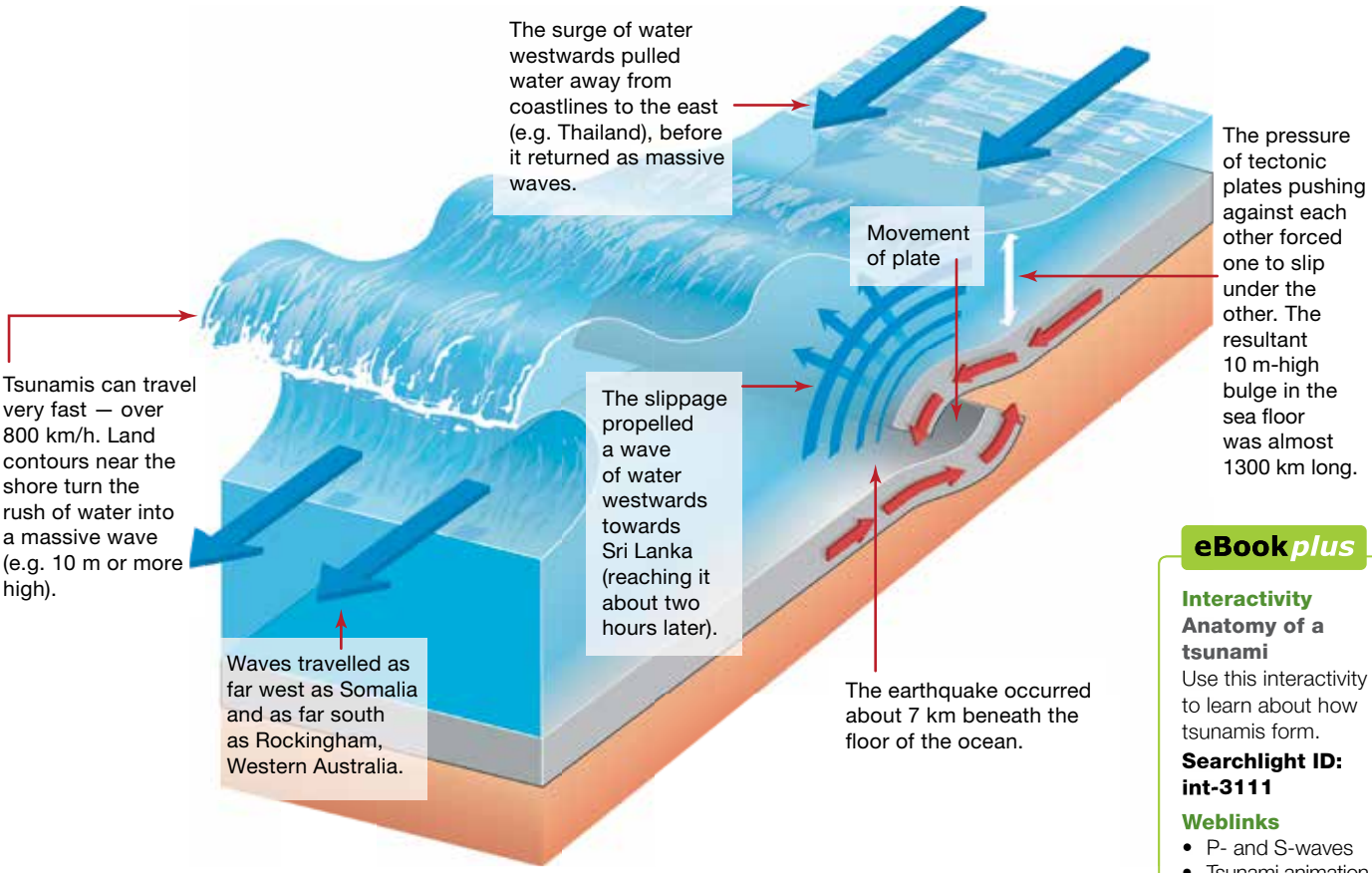
Source: Spatial Vision

FIGURE 6 The tsunami caused by the 8.9-magnitude earthquake in March 2011 swept across Sendai Airport in Japan, carrying debris with it.



A tsunami is not a single wave. There may be between five and twenty waves altogether. Sometimes the first waves are small and they become larger; at other times there is no apparent pattern. Tsunami waves will arrive at fixed periods between ten minutes and two hours.

FIGURE 7 The earthquake and subsequent tsunami in the Indian Ocean in 2004 occurred along the boundary between tectonic plates.



eBook*plus*

Interactivity
Anatomy of a tsunami
Use this interactivity to learn about how tsunamis form.
Searchlight ID: int-3111

Weblinks
- P- and S-waves
- Tsunami animation
- World's biggest tsunami

ACTIVITIES

IDENTIFY
1 What is the focus and epicentre of an earthquake?
2 How does an earthquake occur?
3 What does the Richter scale measure? How much more powerful is the magnitude of an earthquake at 7.0 than at 5.0?
4 Which plates are located in the New Zealand region?

EXPLAIN
5 Use the **P- and S-waves** weblink in your eBookPLUS to watch an animation of these waves. What is the difference between the waves? How fast do they travel? How is damage caused by the waves?
6 Study the **Tsunami animation** weblink in your eBookPLUS, and figure 7. Use your own words to explain how a tsunami occurs.

APPLY
7 Use an atlas or Google Earth to find the location of Lituya Bay. Draw a map to show the location. Use the **World's biggest tsunami** weblink in your eBookPLUS to listen to eyewitness accounts of the event. How does this help give you a sense of the ***scale*** of this event?
8 Study figure 4. Describe where the most violent shaking occurred as a result of the earthquake. How many plates meet in this region? What impact does this have?
9 Study figure 5.
- a Where in Japan was the greatest intensity felt?
- b What is the population density for Sendai, Tokyo and Niigata? How would this increase the impact of the earthquake?

PREDICT
10 Study the photo of the Japanese tsunami in figure 6.
- a Imagine you are a radio news reporter. Describe what you see and what might be happening to people in the area.
- b Imagine you were a Sendai resident. Describe what you would have done to take care of yourself.

11 Why would most Australians not know what to do if an earthquake occurred?

5.7 What are the impacts of earthquakes and tsunamis?

5.7.1 Impacts of earthquakes and tsunamis

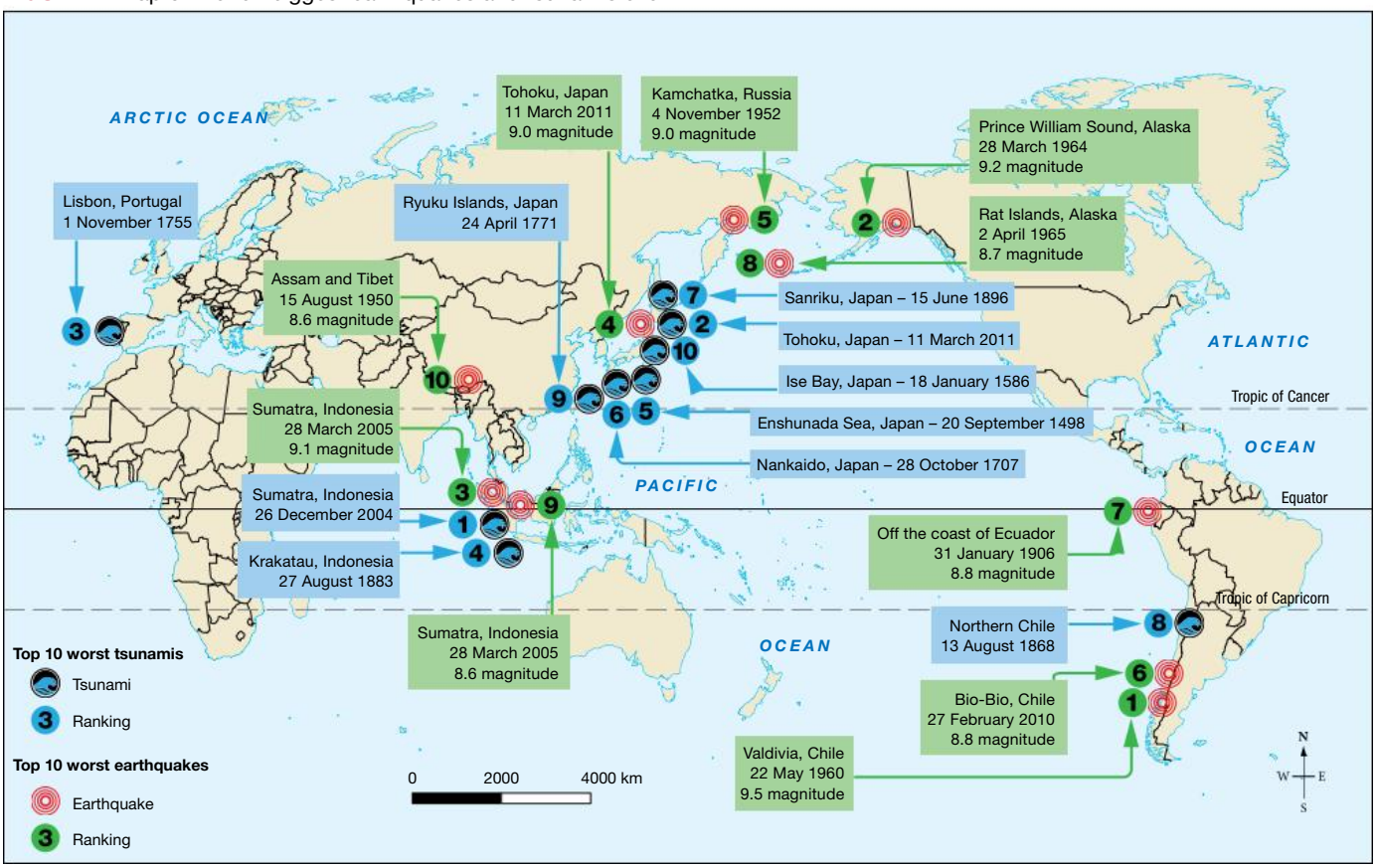
Earthquakes and tsunamis can have an enormous impact. The degree of impact can be affected by several factors: the size of the quake; its location; the density of the population near the epicentre; and whether there are any densely populated areas nearby. Poverty also plays a role, because it can increase the vulnerability of a country or region to such disasters. Measuring the event by the impact can be difficult. Should it be measured by the number of people killed and made homeless (social impact); the cost of recovery (economic impact); or the effect on the surroundings (environmental impact)?

5.7.2 Impact on people

The data in the map in figure 1, and in tables 1 and 2, show some of the worst earthquake and tsunami disasters that have occurred. The amount of damage and death they cause does not always relate to the magnitude of the earthquake. Some smaller magnitude earthquakes can have a devastating impact. Likewise, to measure the impact of a tsunami, we have to look at its effect on people, not at the magnitude of the earthquake (or volcano) that caused it, and not at the size of the waves, which are difficult to measure.

Less developed countries often do not have the resources to prepare adequately for an earthquake. Often, many people are housed in badly constructed buildings in densely populated areas on poor land which does not withstand an earthquake or tsunami event. When a disaster strikes, poorer countries often do not have the resources to act quickly and get help for relief efforts.

FIGURE 1 Map of the ten biggest earthquakes and tsunamis ever



Source: Spatial Vision

TABLE 1 Tsunamis shown in figure 1

Number on map and cause of tsunami	Description and impact
1. 9.1 earthquake, Sumatra, Indonesia	Tsunami 50 m high, reaching 5 km inland near Meubolah. 230 000 people died. Estimated damages of US$10 billion.
2. 9.0 earthquake, Tohoku, Japan	Tsunami waves of 10 m swept over the east coast of Japan. 19 000 people died. Caused nuclear emergency at Fukushima Daiichi nuclear power plant. $235 billion damages.
3. 8.5 earthquake, Lisbon, Portugal	Waves up to 30 m high struck towns along western Portugal and southern Spain. Earthquake and tsunami killed 60 000 in Portugal, Morocco and Spain.
4. Volcano, Krakatau, Indonesia	Tsunami linked to the explosion of the Krakatau volcano. Waves as high as 37 m demolished the towns of Anjer and Merak. Killed 40 000 people, with 2000 deaths caused by the volcanic eruptions rather than the tsunami.
5. 8.3 earthquake, Enshunada Sea, Japan	Homes were flooded and swept away; 31 000 people killed.
6. 8.4 earthquake, Nankaido, Japan	Waves up to 25 m high struck the Pacific coasts of Kyushyu, Shikoku and Honshin. Nearly 30 000 buildings were damaged in the affected regions and about 30 000 people were killed.
7. 7.6 earthquake (estimated), Sanriku, Japan	Tsunami was reported to have reached a height of 38.2 m, causing damage to more than 11 000 homes and killing around 22 000 people. Reports were also found of a corresponding tsunami hitting the east coast of China, killing around 4000 people and doing extensive damage to local crops.
8. Two 8.5 earthquakes, Northern Chile	Waves up to 21 m high affected the entire Pacific Rim for two or three days. Tsunami registered by six tide gauges as far away as Sydney, Australia. 25 000 deaths and estimated damages of US$300 million were caused along the Peru–Chile coast.
9. 7.4 earthquake, Ryuku Islands	Tsunami waves around 11–15 m high destroyed 3137 homes, killing nearly 12 000 people in total.
10. 8.2 earthquake (estimated), Ise Bay, Japan	Waves of 6 m caused more than 8000 deaths and a large amount of damage to a number of towns.

TABLE 2 Earthquakes shown in figure 1

Number on map and magnitude of earthquake	Description and impact
1. 9.5, Valdivia, Chile	Killed 1655 people, injured 3000 and displaced two million. Caused US$550 million damage. Two days later, Puyehue volcano erupted, sending ash and steam into the atmosphere for several weeks.
2. 9.2, Prince William Sound, Alaska	Resulting tsunami killed 128 people and caused US$311 million in damage.
3. 9.1, Sumatra, Indonesia	Killed 227 900 people, displaced 1.7 million in South Asia and East Africa. On 28 December, a mud volcano began erupting near Baratang, Andamar Islands.
4. 9.0, Tohoku, Japan	Earthquake caused tsunami that killed 19 000 people, injured 6000. Caused US$ tens of billions. Economic impacts huge, especially with the shutting down of a nuclear reactor.
5. 9.0, Kamchatka, Russia	Generated a tsunami that caused damage of US$1 million in Hawaiian Islands. Some waves over 9 m high at Kaena Point, Oahu. None killed.
6. 8.8, Bio-Bio, Chile	Killed at least 521 people, with 56 missing and 12 000 injured. More than 800 000 people displaced, with a total of 1.8 m people affected across Chile, where damage was estimated at US$30 billion.
7. 8.8, off the coast of Ecuador	Earthquake caused tsunami reported to have killed between 500 and 1500 people in Ecuador and Colombia.
8. 8.7, Rat Islands, Alaska	Generated a tsunami about 10 m high that caused damage on Shemya Island, plus US$10 000 in property damage from flooding on Amchitka Island. No deaths or injuries reported.
9. 8.6, Sumatra, Indonesia	Killed 1313, with more than 400 people injured by the tsunami as far away as Sri Lanka.
10. 8.6, Assam and Tibet	This inland earthquake caused widespread damages to buildings as well as large landslides. 780 people were killed in eastern Tibet.

Developed countries have strict building codes and better infrastructure to withstand disasters. They have warning systems and better communication. Usually, help is quick to arrive, with army and police personnel sent in to help with rescue efforts.

A study conducted by the Swedish Red Cross concluded that:

> when one compares the number of people killed per disaster against the income of the country involved, one finds a steep rise in mortality with decreasing income. There are over 3000 deaths per disaster in low-income countries compared with fewer than 500 per event in high-income countries.

5.7.3 Impact on the environment

The impact of an earthquake or tsunami on a human environment can be catastrophic. It can damage and destroy entire settlements. **Landslides** can be triggered by earthquakes, permanently changing the landscape.

landslide a movement of rock, debris or earth down a steep slope (for example a mountain or cliff)

Liquefaction

Liquefaction occurs when soil suddenly loses strength and, mixed with groundwater, behaves like a liquid. This usually occurs as a result of ground shaking during a large earthquake. The types of soils that can liquefy include loose sands and silts that are below the water table, so all the space between the grains is filled with water. Dry soils above the water table will not liquefy.

liquefaction a process whereby the shaking of an earthquake reduces or converts soil to liquid

Once a soil liquefies, it cannot support the weight of dry soil, roads, concrete floors and buildings above it. The liquefied soil comes to the surface through cracks, and widens them.

FIGURE 2 This landslide was caused by an earthquake in June 2008 in Honshu, Japan.

FIGURE 3 Cars are swallowed by liquefied soil on a road in Christchurch, New Zealand, 2011

eBookplus

Weblinks
- Liquefaction
- Sendai tsunami

ACTIVITIES

IDENTIFY

1 List the different impacts that earthquakes and tsunamis can have in the categories of social, environmental and economic impacts.

EXPLAIN

2 What is the relationship between income and disaster risk? Why is the risk of earthquakes and tsunamis higher in poor countries?

3 What is liquefaction? Why does it occur? Use the **Liquefaction** weblink in your eBookPLUS to view a video of liquefaction occurring in Tokyo, Japan.

4 'The strongest earthquakes result in the worst disasters.' Work in pairs or groups of three to agree, partially agree, or disagree with this statement. Use the data on these pages and particular examples to justify your response.

INVESTIGATE

5 Use the **Sendai tsunami** weblink in your eBookPLUS to look at satellite images showing areas before and after the 2011 Japanese tsunami. Choose two locations to draw sketches of before and after, and annotate your sketches to record the ***changes*** that have taken place.

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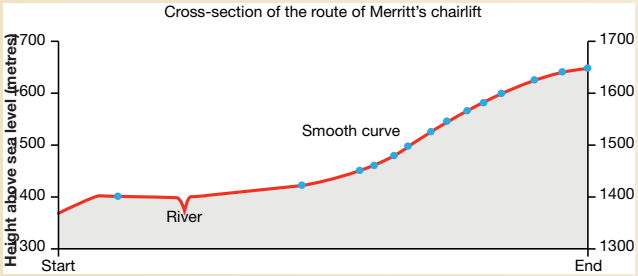
5.8 SkillBuilder: Drawing a simple cross-section

What are cross-sections?

A cross-section is a side-on, or cut-away view of the land, as if it had been sliced through by a knife. Cross-sections provide us with an idea of the shape of the land. We can use contour lines on topographic maps to draw a cross-section between any two points.



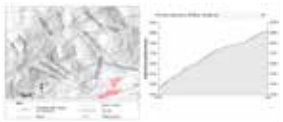
eLesson

Watch this video to learn how to draw a simple cross-section.

Searchlight ID: eles-1655

Interactivity

Try this interactivity to learn how to draw a simple cross-section.



Searchlight ID: int-3151

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5.9 SkillBuilder: Interpreting an aerial photo

What are aerial photos?

Aerial photographs are those that are taken from above the Earth from an aircraft. Aerial photos can reveal details that are not recorded on maps. It is easy to see landforms with distinct shapes, different landscapes, land uses, specific places and spatial patterns of the environment.

eLesson

Watch this video to learn how to interpret an aerial photo

Searchlight ID: eles-1654

Interactivity

Try this interactivity to learn how to interpret an aerial photo.

Searchlight ID: int-3150

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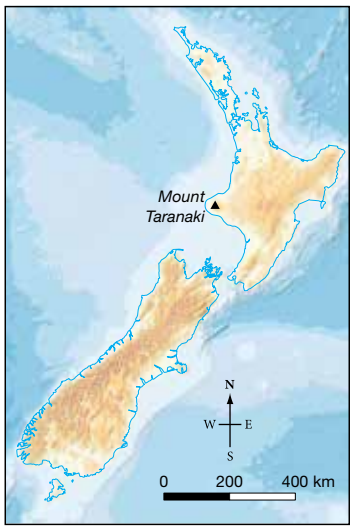
5.10 How are volcanic mountains formed?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

5.11 How did Mount Taranaki form?

FIGURE 1 Location of Mt Taranaki on the North Island of New Zealand



Source: Spatial Vision

5.11.1 Mount Taranaki

New Zealand's Mt Taranaki is named after the Maori terms *tara* meaning 'mountain peak' and *ngaki* meaning 'shining' (because the mountain is covered with snow in winter).

Mt Taranaki is 2518 metres high and is the largest volcano on New Zealand's mainland. It is located in the south-west of the North Island (see figure 1).

Mt Taranaki was formed 135 000 years ago by subduction of the Pacific Plate below the Australian Plate. It is a stratovolcano — a conical volcano consisting of layers of pumice, lava, ash and tephra (see figure 2).

The summit of Mt Taranaki is a lava dome in the middle of a crater that is filled with ice and snow. The mountain is considered likely to erupt again. There are significant potential hazards from lahars, avalanches and floods. A circular plain of volcanic material surrounding the mountain was formed from lahars (see section 5.12, annotation I) and landslides. Some of these flows reached the coast in the past. The volcano's lower flanks are covered in forest, and are part of the national park. There is a clear line between the park boundary and surrounding farmland (see figure 3).

FIGURE 2 Mt Taranaki has a near-perfect conical shape.

FIGURE 3 Aerial photo of Mt Taranaki

eBook*plus*

Weblink
Mt Taranaki live

GEOskills TOOLBOX

Understanding contour lines

Contour lines are used on topographic maps to show height about sea level. Each line joins points at the same elevation. This helps to show the shape of the land and patterns of landforms. If contour lines are very close, the land is steep. If the contour lines are further apart, there is more of a gradual slope.

ACTIVITIES

IDENTIFY

1 Where is Mt Taranaki located?
2 What is a stratovolcano?
3 Refer to figure 4.
  a What is the grid reference for the spot height of Mt Taranaki?
  b How many ski tows and lifts are there at the ski field? Calculate the length of each.
  c Name and give the grid reference of a lodge in which skiers could stay.

EXPLAIN

4 Mt Taranaki receives between 3200 mm and 6400 mm of rainfall each year. How would this contribute to the shape of this landform?
5 Describe evidence from the aerial photo in figure 3 that the national park has protected forests around the volcano.

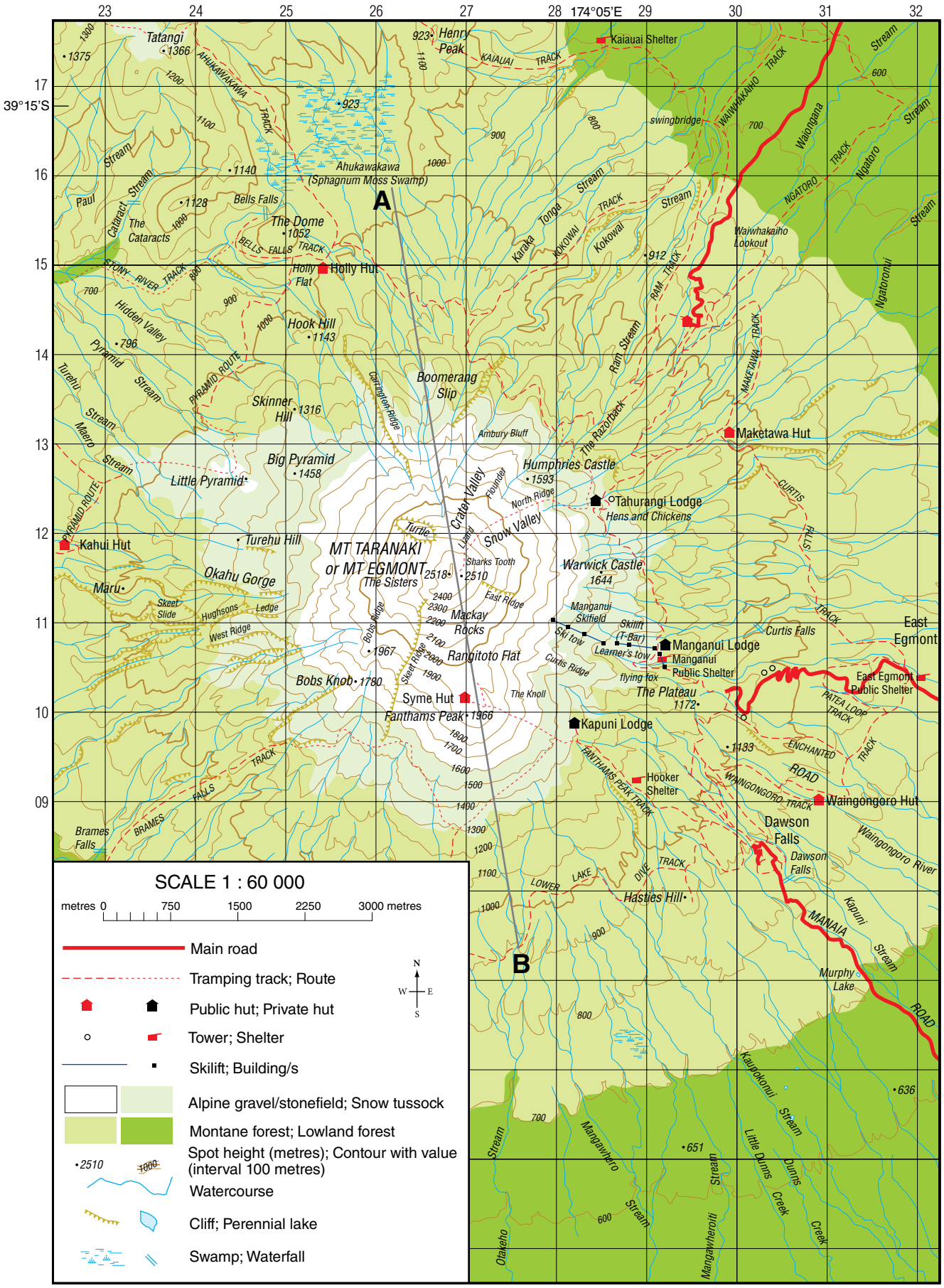
INVESTIGATE

6 Use the **Mt Taranaki live** weblink in your eBookPLUS to view Mt Taranaki using the webcam.

APPLY

7 Refer to figure 4 to complete the following.
  a Use the line already drawn on the topographic map to draw a cross-section. (See SkillBuilder 5.8 'Drawing a simple cross-section' in your eBookPLUS.)
  b Calculate the gradient from point A to the summit.
  c Calculate the gradient from point B to the summit.
8 a Use figures 2 and 3, together with your cross-section from question 7a, to describe where you think lava would flow if Mt Taranaki erupted.
  b Describe the potential ***changes*** to the human and natural ***environment*** if Mt Taranaki erupted.

FIGURE 4 Topographic map of Mt Taranaki



Source: MAPgraphics Pty Ltd Brisbane

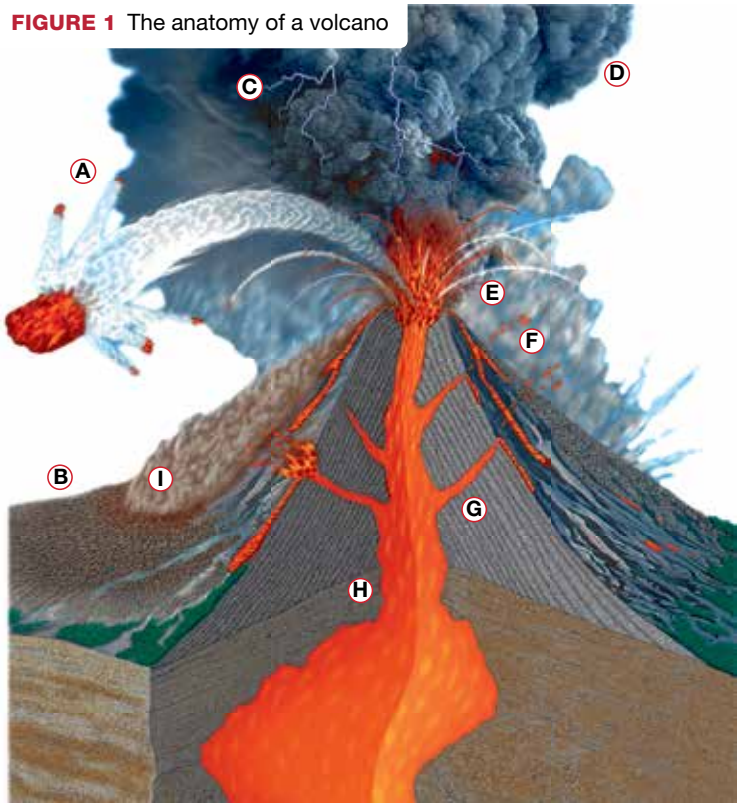
5.12 What is the anatomy of a volcano?

5.12.1 Volcanic eruptions

Volcanic mountains are formed when magma pushes its way to the Earth's surface and then erupts as lava, ash, rocks and volcanic gases. These erupting materials build up around the vent through which they erupted.

A volcanic eruption can be slow or spectacular, and can result in a number of different displays (see figure 1).

FIGURE 1 The anatomy of a volcano



Ⓐ A fragment of lava greater than 64 millimetres in diameter is called a volcanic bomb. They are often solid pieces of lava from past eruptions that formed part of the cone.

Ⓑ A pyroclastic flow is a superheated avalanche of rock, ash and lava that rushes down the mountain with devastating effects. The flow can travel at up to 240 kilometres per hour and reach temperatures of 800 °C. When Mt Pelée erupted in 1902, on the island of Martinique in the Caribbean, a pyroclastic flow covered the town of Saint-Pierre, killing all but two of the town's 30 000 inhabitants.

Ⓒ Lightning is often generated by the friction of swirling ash particles.

Ⓓ As rock is pulverised by the force of the eruption, it becomes very fine ash, and is carried by wind away from the crater as an ash cloud. Volcanic ash may blanket the ground to a depth of many metres. In the eruption of Mt Vesuvius in AD 79, volcanic ash completely covered two large towns: Pompeii and Herculaneum. Volcanic ash can also have a large impact on the global scale because of disruption to international air traffic, as seen during volcanic eruptions in Indonesia in 2015.

Ⓔ A volcanic cone is made up of layers of ash and lava from previous eruptions. If the volcano has not erupted for thousands of years (i.e. is dormant), these layers will be eroded away.

Ⓕ Lava may be either runny or viscous, and can flow for many kilometres before it solidifies, thereby building up the Earth's surface.

Ⓖ Pressure may force magma through a branch pipe or side vent. In the eruption of Mount St Helens in 1980, in the United States, the side of the mountain collapsed and the side vent became the main vent.

Ⓗ Where two plates move apart, molten rock from the mantle flows upward into a magma chamber. More rock is melted and erupts violently upwards. Magma is generally within the temperature range of 700 °C to 1300 °C.

Ⓘ When pyroclastic flows melt snow and ice, and mix with rocks and stones, a very wet mixture called a lahar can form. Lahars can flow quickly down the sides of volcanoes and cause much damage (see subtopic 4.8 for an example of a lahar). One lahar that formed in 1985 on Nevado del Ruiz volcano in Colombia travelled at up to 50 km/h and was up to 40 metres high in some places. A wall of mud, water and debris travelled 73 kilometres to the town of Armero, devastating it. Over 23 000 people died that night, and 5000 homes were destroyed.

5.12.2 Volcanic shapes

Volcanoes come in a variety of shapes and sizes, forming different landforms. There are four main types and each depends on:

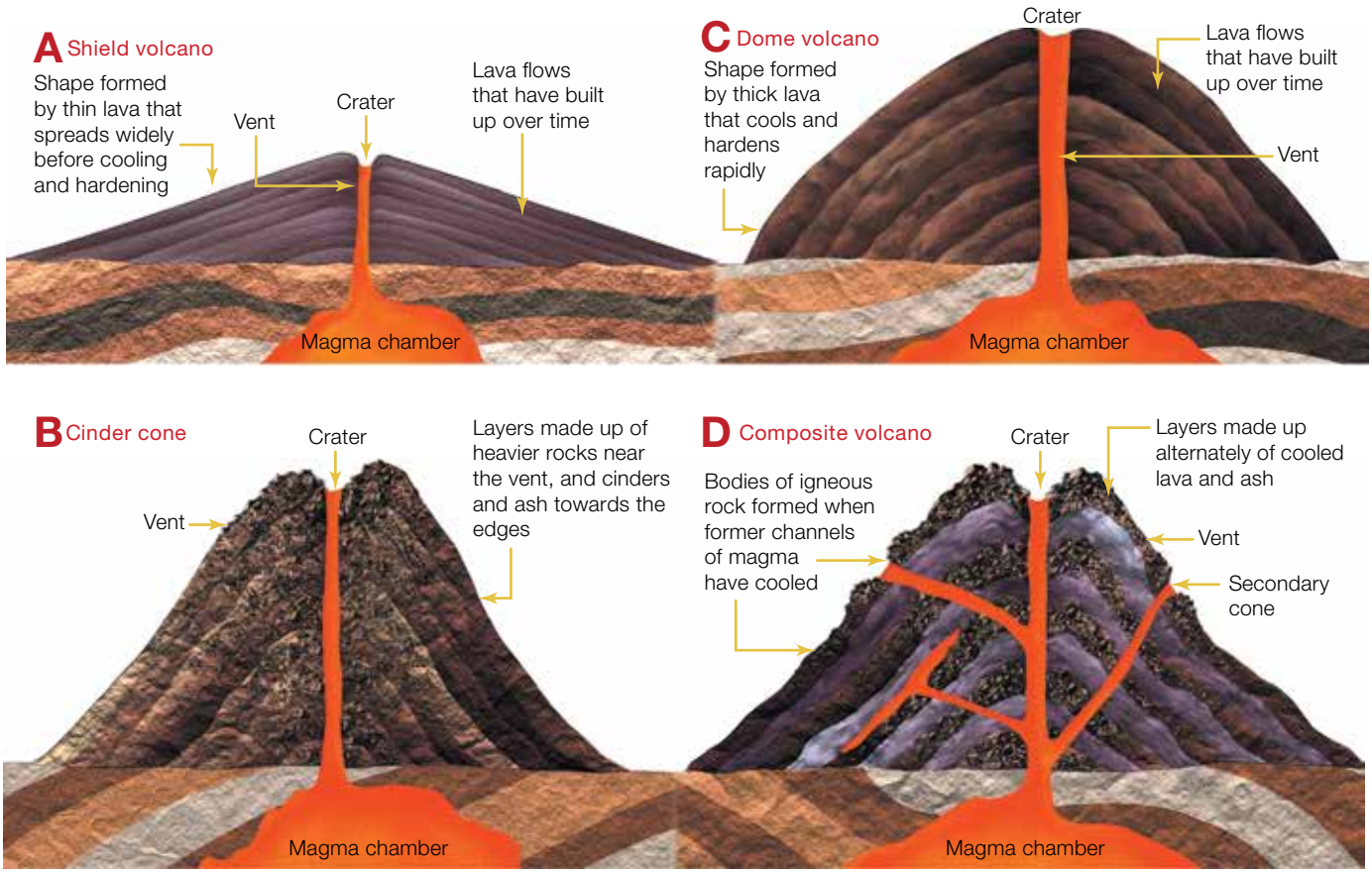
- the type of lava that erupts
- the amount and type of ash that erupts
- the combination of lava and ash.

If the lava is rich in silica (a mineral present in sand and quartz), it tends to be very runny and may flow for many kilometres before it cools and hardens to become rock. Volcanoes that erupt runny lava tend to have broad, flat sides (shield volcanoes). Those that erupt thick, treacle-like lava tend to have much steeper sides (dome volcanoes)(see figure 2, parts A and C).

Heavy ash material, like volcanic bombs, settles close to the crater while lighter ash is carried further away. Volcanoes that are built up through falls of ash are steep-sided cinder cones (see figure 2, part B).

The most common type of volcano is one built up of both ash and lava; this is called a composite volcano (see figure 2, part D).

FIGURE 2 Four volcanic landforms



ACTIVITIES

IDENTIFY

1 What are the three main factors that determine the shape of a volcano?

EXPLAIN

2 Explain how the different shapes of volcano shown in figure 2 are the results of different materials being ejected.

3 a Refer to figure 1. Describe, in detail, the ***changes*** to the ***environment*** that volcanic eruptions can cause.

b Which ***changes*** would impact on a small ***scale*** and which would impact on a larger ***scale***?

PREDICT

4 Investigate how to create a working model of a volcano, choosing one of the four main shapes to copy. Predict what will happen when your volcano erupts. Create your volcano, and observe what happens when it erupts. Compare your observations with your earlier predictions, describing the similarities and differences.

INVESTIGATE

5 Use the internet to find pictures of volcanic landforms and materials. These include crater lakes, geysers, calderas, fields of ash deposits, volcanic plugs, lava tubes, hummocks and pumice. You could also find pictures of the two types of lava: a'a and pahoehoe. Use your pictures to put together a field guide to volcanic landforms. Each page should contain a picture of the landform, a brief description and a ***place*** where it could be found — sometimes they are tourist attractions.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Lahars

5.13 How do volcanoes affect people?

5.13.1 The worst volcanic eruptions

Volcanic eruptions both create and destroy landscapes. Most volcanic eruptions do not strike randomly but occur in specific areas, such as along plate boundaries. In some ***places*** there are high concentrations of people living near volcanoes.

Most of the world's active above-sea volcanoes are located near convergent plate boundaries where subduction is occurring, particularly around the Pacific basin. This is also the location of settlements across many countries. Over many years, volcanic eruptions have caused deaths and great damage.

How can the worst volcanoes be measured? Should it be based on the number of people killed or the cost of the damage and destruction? Or should it be the size of the explosion?

TABLE 1 The worst volcanoes based on number of deaths

Volcano	Location	Date	Number of deaths
Mt Tambora	Indonesia	10–5 April 1816	92 000
Mt Pelee	West Indies	25 April–8 May 1902	40 000
Krakatau	Indonesia	26–28 August 1883	36 000
Nevado del Ruiz	Colombia	13 November 1985	23 000
Mt Unzen	Japan	1792	12 000–15 000
Mt Vesuvius	Italy	24 April AD 79	10 000+
Laki Volcanic System	Iceland	8 June 1783–February 1784	9 350
Mt Vesuvius	Italy	December 1631	6 000
Mt Kelut	Indonesia	19 May 1919	5 110
Mt Galunggung	Indonesia	1882	4 011

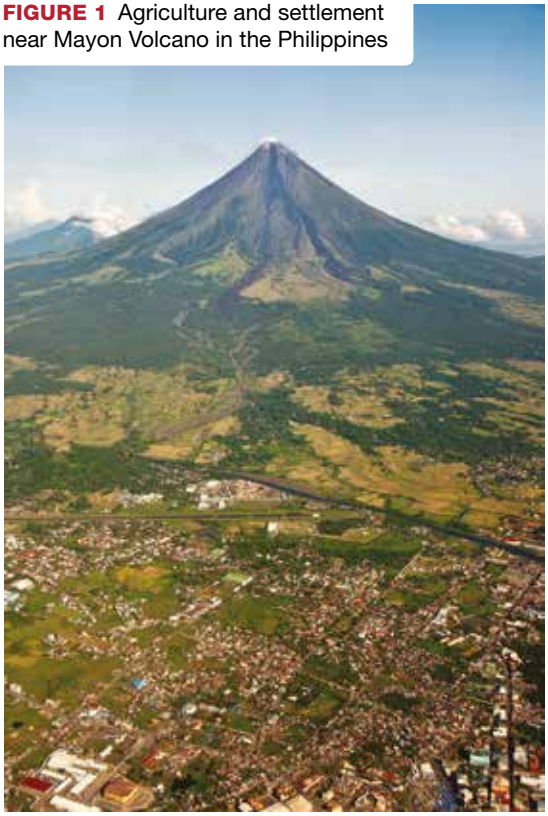
TABLE 2 The worst volcanoes based on economic impact

Volcano	Location	Date	Estimated loss (US$)
Sidoarjo mud volcano (Lusi)	Indonesia	May 2006, ongoing	$3 billion
Mt Eyjafjallajökull	Iceland	April 2010	$1.7 billion
Mt Unzen	Kyushu, Japan	June 1991	$1.5 billion
Mt St Helens	USA	May 1980	$860 million
Mt Pinatubo	Philippines	June–September 1991	$860 million
Soufrière Hills	Montserrat	Since 1995	$330 million
Tavuvur and Vulcan	Papua New Guinea	September 1994	$300 million
Nevado del Ruiz	Colombia	November 1985	$230 million
Eldfell	Iceland	January–February 1973	$200 million
Gamalama	Indonesia	September 1983	$150 million

5.13.2 Why do people live near volcanoes?

Geoscience Australia (a national organisation that provides geographic information to government) estimates that 180 million people in the Asia–Pacific region live within 50 kilometres of a dangerous volcano. There is also a strong relationship between the location of volcanoes and resources such as fertile soils, ore deposits and geothermal energy.

FIGURE 1 Agriculture and settlement near Mayon Volcano in the Philippines



Fertile soils

Some of the most fertile soils on Earth have come from volcanic deposits of ash that is rich in nutrients, and from the physical breakdown of volcanic rocks over thousands to millions of years.

Fertile volcanic soils have been very important for rice growing in Japan and large areas of the Indonesian archipelago, especially on the islands of Java and Bali. There is also prime agriculture located in regions of rich soil; for example, around Naples, southern Italy, which generally has poor soils, and in the Philippines as shown in figure 1.

Another region of fertile volcanic soil is the agricultural area of the North Island of New Zealand. **Volcanic loam** in this area helps produce crops and pasture. Other regions include the western plains of the United States and the Hawaiian Islands. There is a small percentage of rich basalt soils in Australia, including the volcanic plains in Victoria, the north coast of New South Wales, the Scenic Rim of south-east Queensland, parts of Tasmania, and the Atherton Tablelands in north Queensland.

volcanic loam
nutrient-rich soil derived from volcanic ash deposits

Geothermal energy

Geothermal energy can be used in locations where there are active or dormant volcanoes still producing heat deep under the Earth's surface. High-temperature hot springs and geysers produce steam, which can be used to drive turbines and generate electricity. At lower temperatures, the hot water can be used for home heating or to develop hot or warm springs at resort spas. Over one quarter of Iceland's electricity is generated from geothermal heat, and it provides heating for more than 85 per cent of its homes. The other main countries that make use of geothermal heat are the United States (in California), Italy, New Zealand and Japan.

geothermal energy
energy derived from heat in the Earth's interior

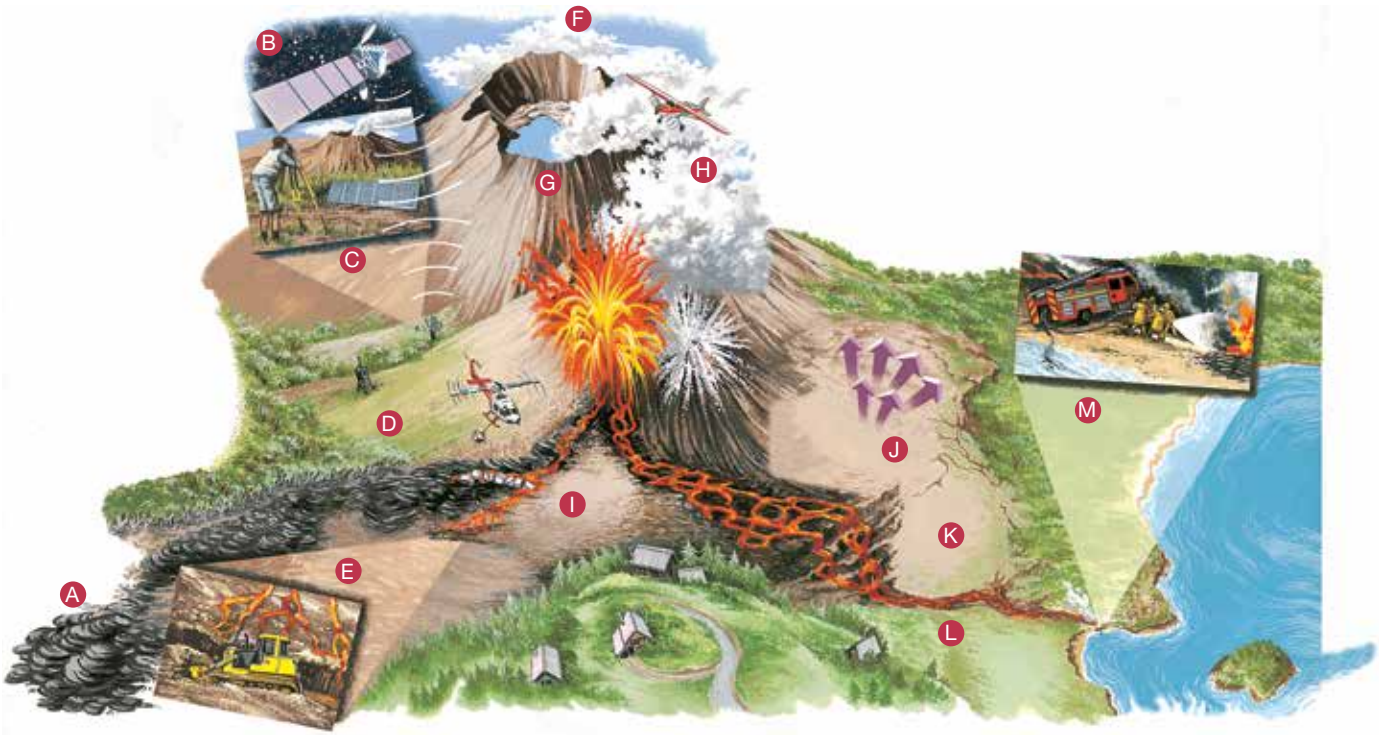
FIGURE 2 Volcanic landscapes provide us with a range of economic and cultural values. Heated water from 2000 metres below the surface is pumped up through drilling holes at a geothermal power plant in Svartsengi, Iceland. It is used to generate electricity and hot water for nearby communities. The 38 °C waters are then fed into a man-made lagoon for recreational and medicinal users to bathe in. The Blue Lagoon is one of Iceland's most popular tourist destinations.

5.13.3 How to prepare for volcanic eruption

Can volcanic eruptions be predicted? What are the warning signs? How can the risk of death, injury and damage be reduced?

With about 500 million people living close to active volcanoes, it is important to watch for ***changes*** and try to predict an eruption, hopefully giving nearby residents time to evacuate.

FIGURE 3 Predicting volcanic eruptions



- **A** Geologists study records of past eruptions by examining flow patterns of mud, lava and ash. From these patterns they can draw danger maps that pinpoint dangerous areas.
- **B** Satellites monitor changes in gas emissions and in the shape of the volcano. Specialised equipment can also measure heat increases.
- **C** Seismographs can detect the small earthquakes caused by rising magma. These are linked by transmitters to computers so that scientists can quickly detect changes.
- **D** Sound-measuring equipment was used to accurately predict an eruption in Mexico in 2000.
- **E** In 1983, an attempt was made to divert a lava flow away from the towns of Rocco and Rogalna on Mount Etna. A channel was dug and barriers erected. The lava slowed and solidified before reaching the towns.
- **F** Samples of gas can be collected and analysed. An increase in the amount of sulfur dioxide [SO_2] may indicate that magma is moving upwards.
- **G** A rise in the temperature of a crater lake often precedes an eruption.
- **H** It has been suggested that explosives could be used to breach crater walls, sending lava away from towns. This was first tried in Hawaii in 1935.
- **I** Helicopters have been used to drop concrete blocks in front of flowing lava.
- **J** As magma rises and collects in the magma chambers, the cone may bulge outwards, warning of possible eruptions. Sensitive tiltmeters on the ground and on satellites can detect this bulging.
- **K** Any bulging can also cause tiny cracks to appear.
- **L** Buildings in areas prone to ash eruptions should have steeply sloping roots so ash does not accumulate.
- **M** In 1973, sea water was sprayed onto lava that was threatening a town in Iceland. The lava cooled quickly and solidified.

People living in volcanically active regions are frequently provided with advice about how they should respond to volcanic eruption. Local authorities give information on what to do to prepare for a possible volcanic eruption, how to evacuate and what to do after an eruption (see figure 4).

FIGURE 4 Example of advice provided to people living near volcanoes

Before a volcanic eruption

- Prepare an emergency kit with items such as: a first aid kit; blankets and warm clothing; a torch; a working battery-operated radio; goggles and a mask; medications; a map of the local area.
- Store food and water supplies.
- Review and know your evacuation route or routes.
- Develop a household evacuation and preparedness plan.

During and after a volcanic eruption

- Seek shelter indoors. Once inside, close windows and doors. Block chimneys and other vents, to stop volcanic ash entering the house.
- Turn off any heating and fans as well as air conditioning systems.
- Move to high ground only if you can't find shelter.
- Wear long-sleeved shirts and long pants.
- Avoid exposure to poisonous gases.
- Remain indoors until you are told that it is safe to come out.
- Evacuate only if advised to do so by authorities.
- Stay clear of lava, mud flows, and flying rocks and debris.

ACTIVITIES

IDENTIFY

1 Make a list of the advantages and disadvantages of living near a volcano.

EXPLAIN

2 Is geothermal energy a renewable energy? Explain. How is this energy related to volcanic activity?

INVESTIGATE

3 Refer to an atlas map showing world population density, settlements and the location of volcanoes. Write two statements that describe the relationship between population density, settlements and volcano locations. How does this relate to people's risk?

4 Use the **Timetoast** weblink in your eBookPLUS to create a timeline of the worst volcanic eruptions, based on the information in the tables. Include images from the internet.

5 Draw a table like the one below to summarise the measures required for living with volcanoes.
- a Classify the information in figure 3 into the three columns of the table.
- b Which of these measures do you think are most effective? Give three reasons for your answer.

PREDICT

6 Watch the video about Mount Vesuvius and look at the information on this volcano in *myWorld Atlas*.
- a Where is Mt Vesuvius located? Which towns were destroyed by the volcano in AD79?
- b How many people live in this volcano's immediate region?
- c Will all the monitors provide enough warning of an eruption for the people of Naples? Explain.
- d What do the scientists in this video predict for a future eruption?
- e What is the red zone? How large do the scientists think it should be?

Predicting eruptions	Preparing for eruptions	Lessening the effects of eruptions

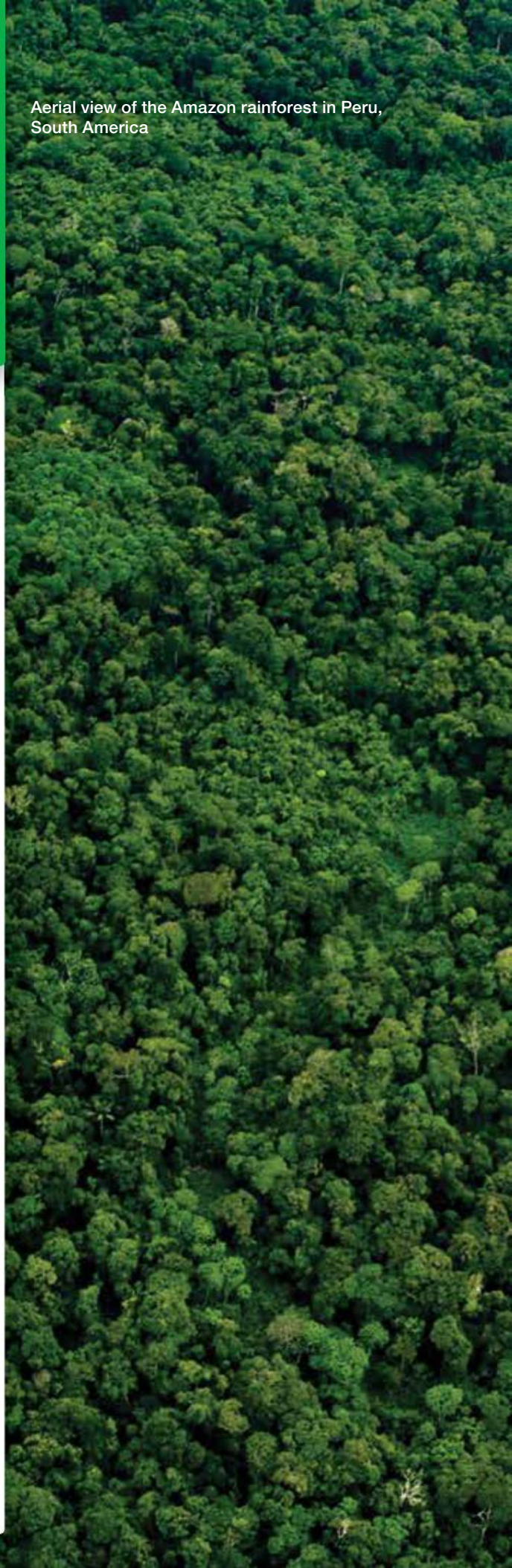
eBookplus
Weblink
Timetoast

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Mount Vesuvius

eBookplus ONLINE ONLY

5.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.



Aerial view of the Amazon rainforest in Peru, South America

CHAPTER 6

Rainforest landscapes

6.1 Overview

6.1.1 Introduction

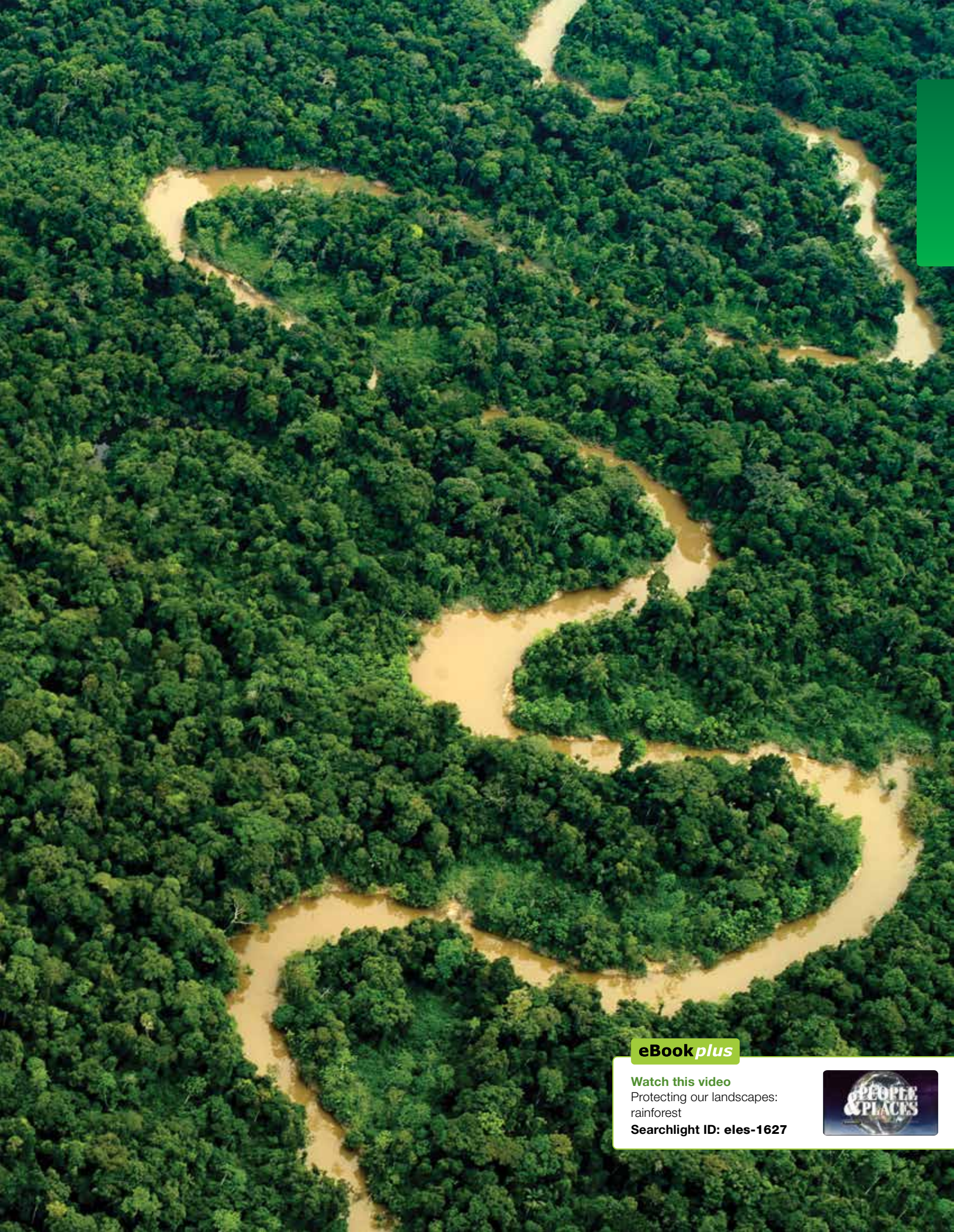
What do you know about rainforests? Did you know that rainforests have the greatest biodiversity of any forest environment? They contain complex layers that support thousands of species of plants and animals. The rainforest has supplied resources to all people, including indigenous communities. People are concerned that clearing large areas of rainforest is creating negative impacts that are unsustainable.

Starter questions

1. Create a mind map of all the words that come to your mind when you hear the word *rainforest*. Place these words into specific categories such as *animals*, *plants*, *colours* or *structure*.
2. Using magazines, newspapers, the internet and other resources, create a collage that represents a rainforest to you. What emotions does this image make you feel?
3. Refer to the image on these pages. Why do we call rainforests a 'green landscape'?
4. Try to list the things in your home that might originally have come from a rainforest. Have they ***changed*** from their original form? How do you think they got here?
5. Think of your favourite place, the place you most like visiting. How would you feel if that place was ***changed*** or destroyed and you could not visit or use it in ways you used to? What could you do about this?

Inquiry sequence

		Syllabus outcomes
6.1 Overview		
6.2 What are the characteristics of a rainforest?		GE4-1, GE4-7, GE4-8
6.3 SkillBuilder: Understanding thematic maps	eBook plus ONLINE ONLY	
6.4 What is a rainforest ecosystem like?		GE4-1, GE4-7, GE4-8
6.5 SkillBuilder: Creating and describing complex overlay maps	eBook plus ONLINE ONLY	
6.6 How have Australia's rainforests changed?		GE4-2, GE4-4, GE4-7, GE4-8
6.7 How is the Amazon rainforest changing?	eBook plus ONLINE ONLY	GE4-2, GE4-4, GE4-7, GE4-8
6.8 SkillBuilder: Drawing a précis map		
6.9 How do indigenous people use rainforests?		GE4-4, GE4-5, GE4-7, GE4-8
6.10 Why are rainforests disappearing?		GE4-4, GE4-5, GE4-7, GE4-8
6.11 How does deforestation affect the environment and people?		GE4-4, GE4-5, GE4-7, GE4-8
6.12 How can rainforests be conserved?		GE4-5, GE4-7, GE4-8
6.13 Investigating topographic maps: What are features of the Daintree rainforest		GE4-4, GE4-5
6.14 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	



eBook*plus*

Watch this video
Protecting our landscapes: rainforest
Searchlight ID: eles-1627

6.2 What are the characteristics of a rainforest?

6.2.1 Introducing rainforests

Forests that grow in constantly wet conditions are called rainforests. A rainforest is an example of a biome (a community of plants and animals spread over a large natural area). Rainforests are located wherever the annual rainfall is more than 1300 millimetres and is evenly spread throughout the year. While tropical rainforests are the best known, there are also other types.

equatorial near the equator, the line of latitude around the Earth that creates the boundary between the northern and southern hemispheres

Rainfall

Rainforests thrive in the hot and wet conditions experienced in the **equatorial** regions of the world. Most of the time the rainfall is extremely heavy, caused by thunderstorms. These heavy downpours, called **convectional rainfall**, result in very hot and humid conditions.

convectional rainfall heavy rainfall as a result of thunderstorms, caused by rapid evaporation of water by the sun's rays

6.2.2 Types of rainforests

Tropical rainforests

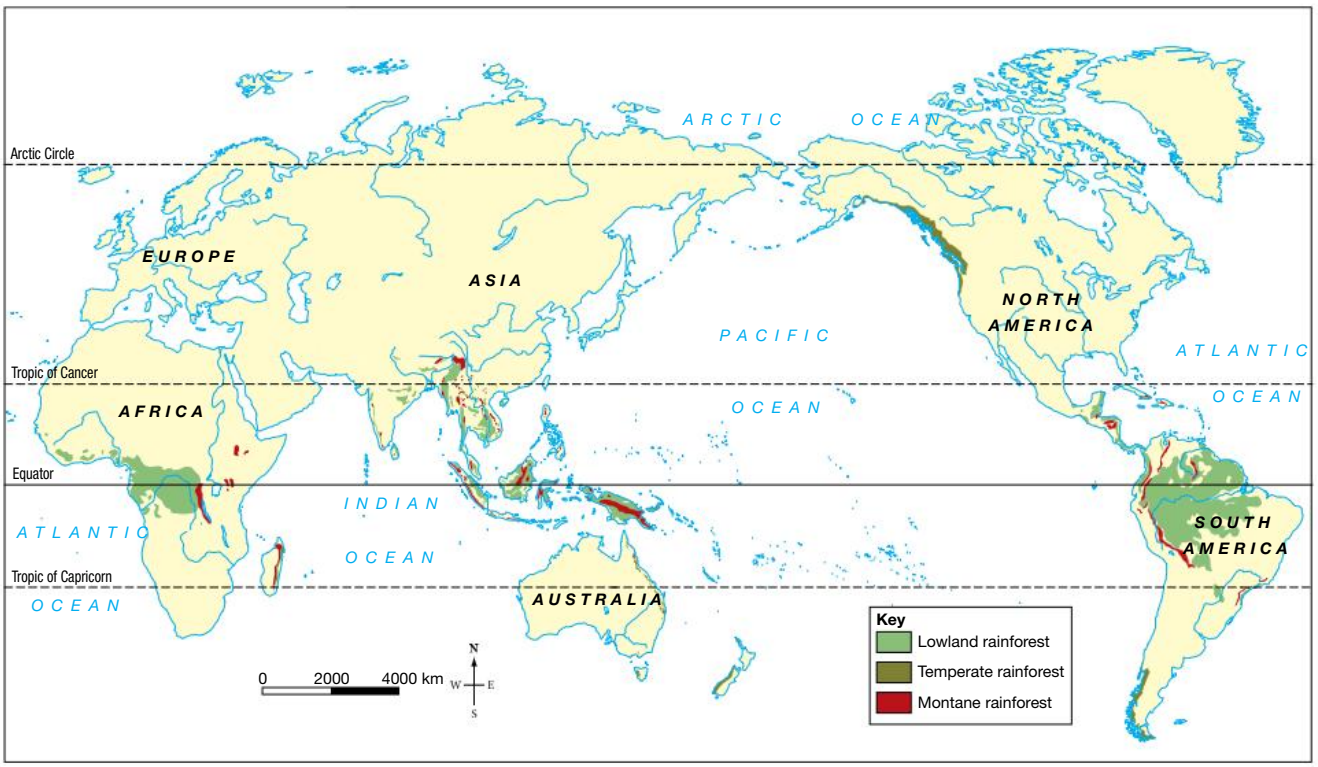
Tropical rainforests are located around the equator (see figure 1) where the temperatures are warm all year round and there is a lot of rainfall. Plants flourish in humid, moist tropical rainforests, which support a huge number of plants and animals — perhaps as many as 90 per cent of all known **species**. Poison-dart frogs, birds of paradise, piranha, tarantulas, anacondas, Komodo dragons and vampire bats are all found in tropical rainforests. Tropical rainforests can occur at different altitudes; they are called montane rainforests and lowland tropical forests.

species a biological group of individuals having the same common characteristics and able to breed with each other

Montane rainforests

Tropical rainforests that occur in the mountains, 1000 metres or more above sea level, are called montane rainforests. Montane rainforests have lower trees than lowland tropical forests and are almost always covered by clouds, making the leaves drip with moisture (see figure 2).

FIGURE 1 World rainforest types



Source: MAPgraphics Pty Ltd Brisbane

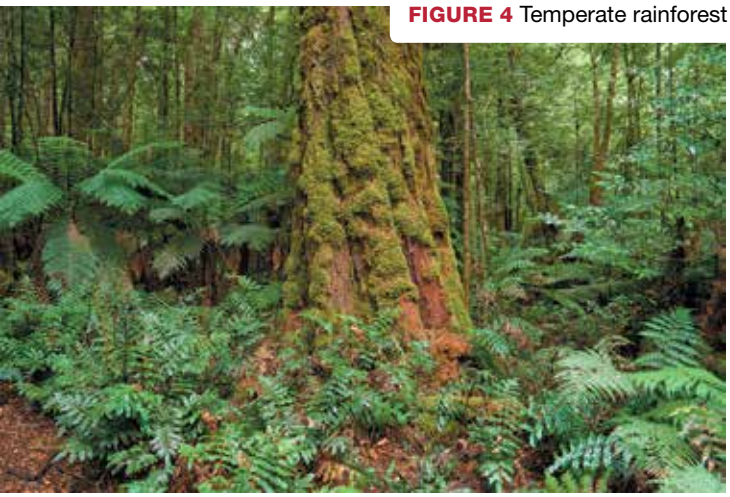
FIGURE 2 Montane rainforest

FIGURE 3 Lowland rainforest

Lowland tropical forest

Lowland tropical rainforests form the majority of the world's tropical rainforests (see figure 3). They grow at elevations generally below 1000 metres. Trees in lowland forests have a great diversity of fruiting trees, attracting animals and birds adapted to feed on their fruits. These rainforests are far more threatened than montane forests because of their accessibility, soils that are more suitable for agriculture and more valuable hardwoods for timber. Lowland forests occur in a belt around the equator, with the largest areas in the Amazon Basin of South America, the Congo Basin of central Africa, Indonesia and New Guinea.

FIGURE 4 Temperate rainforest



Temperate rainforests

The large area of the globe between the tropics and the polar regions (areas within the Arctic and Antarctic circles) is called the **temperate** zone, and rainforests can grow there too. Temperate rainforests occur in North America, Tasmania, New Zealand and China (see figure 4). Giant pandas, Tasmanian devils, brown bears, cougars and wolves all call temperate rainforests home.

temperate describes the relatively mild climate experienced in the zones between the tropics and the polar circles

6.2.3 Physical processes of a rainforest

Rainforests are the result of the interaction between the Earth's four main systems or spheres. For example, the trees in a tropical

rainforest (biosphere) rely on high levels of precipitation (hydrosphere), warm temperatures (atmosphere) and stability provided by soil (lithosphere) to thrive. Energy from the sun is stored by plants (biosphere). When humans or animals (biosphere) eat the plants, they acquire the energy originally captured by the plants.

GEOskills TOOLBOX

Thematic maps
A thematic map is a type of map that shows a particular theme; for example, the different climate types that occur across a geographic area. Several thematic maps can be used at once to determine interconnections that exist around the world.

ACTIVITIES

IDENTIFY

1 What conditions do rainforest ***environments*** thrive in?
2 What are the differences between montane and lowland rainforest ***environments***? What causes these ***changes*** in rainforest type?
3 Describe the distribution of rainforests around the world. Think about in which continents and between which latitudes they are found, the size and ***scale*** of them, and whether they are continuous or scattered.

EXPLAIN

4 Why are lowland rainforest ***environments*** more threatened by human activity than montane rainforests?
5 Why are montane forests often called 'cloud forests'?

INVESTIGATE

6 Refer to figure 1.
  a Use an atlas to help you name six countries in the Asia–Pacific region that contain rainforests.
  b What type of rainforest ***environment*** is found:
    i in north-eastern Australia
    ii along the western coastline of Canada?

APPLY

7 Why are rainforest ***environments*** able to support a large range of animals and plants?

eBookplus

Interactivity
Our living green dinosaurs
Use this interactivity to learn more about Australia's rainforests.
Searchlight ID: int-3112

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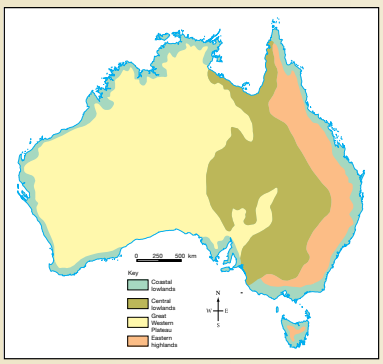
6.3 SkillBuilder: Understanding thematic maps

What is a thematic map?
A thematic map is a map drawn to show one aspect; that is, one theme. For example, a map may show the location of vegetation types, hazards, or weather. Parts of the theme are given different colours or, if only one idea is conveyed, symbols may show location.



eLesson
Watch this video to learn how to understand thematic maps.

Searchlight ID: eles-1658

Interactivity
Try this interactivity to learn how to understand thematic maps.

Searchlight ID: int-3154

6.4 What is a rainforest ecosystem like?

6.4.1 Rainforest characteristics

Rainforests are unique **ecosystems** consisting of four different layers — the emergent, canopy and understorey layers and the forest floor. Each layer can be identified by its distinct characteristics. Rainforests are actually a community of plants and animals working together to survive, linked in a food web.

ecosystem an interconnected community of plants and animals in a particular environment

microclimate specific atmospheric conditions within a small area

compost a mixture of various types of decaying organic matter such as dung and dead leaves

Emergents

These are the tallest trees, ranging in height from 30 to 50 metres. They are so named because they rise up or emerge out of the forest canopy. Huge crowns of leaves and abundant animal life thrive on plenty of available sunlight.

Canopy

This describes the array of treetops that form a barrier between the sunlight and the underlying layers. Their height can vary from 20 to 45 metres. This layer contains a distinct **microclimate** and supports a variety of plants and animals. The taller trees host special vines called lianas that intertwine the branches. Other plants called epiphytes use the tree trunks and branches as anchors in order to capture water and sunlight.

Understorey

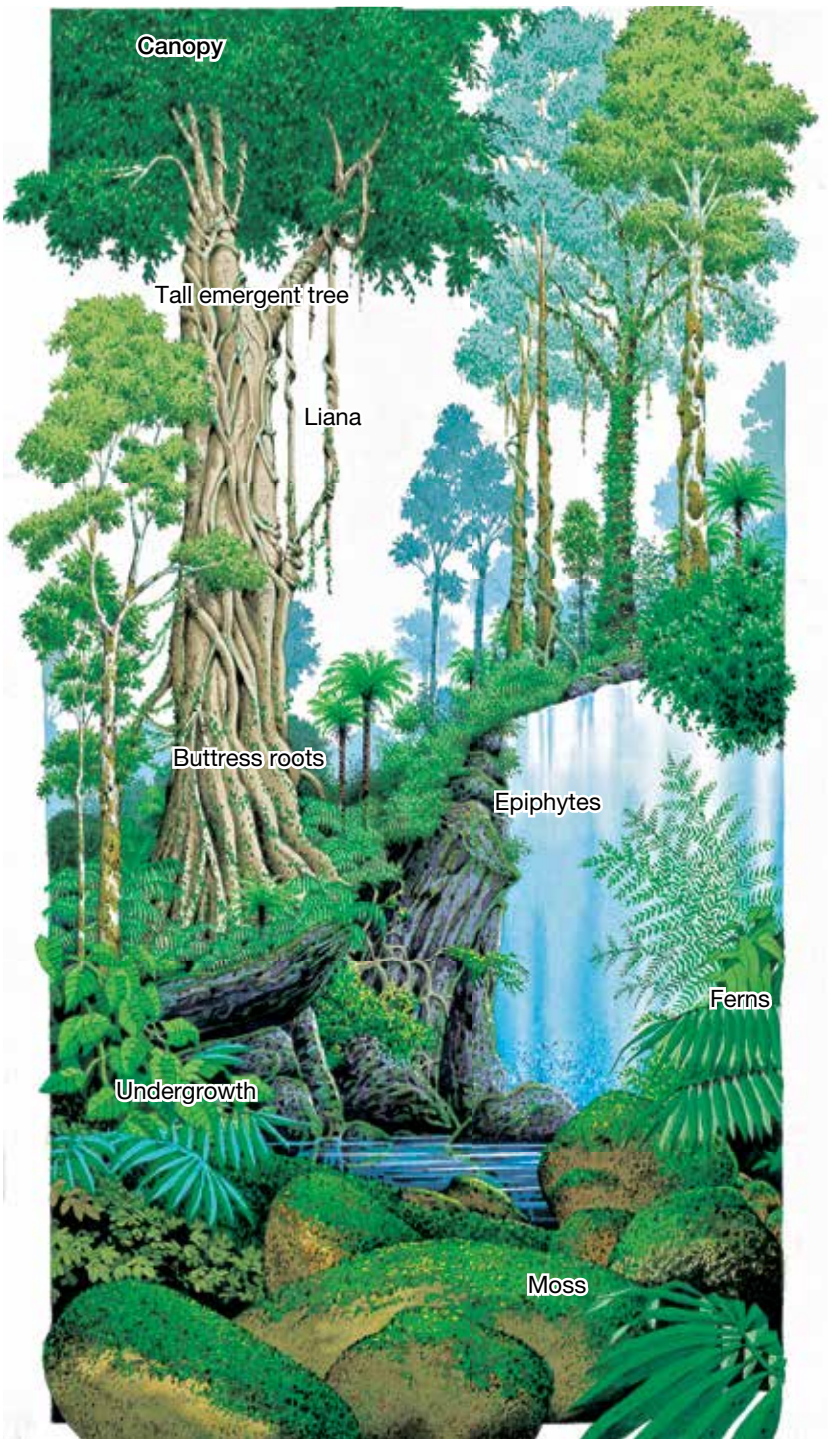
This layer contains a mixture of smaller trees, and ferns that receive only about five per cent of the sun's energy. Many animals move around in the darkness and humidity, using the vines as highways.

Forest floor

This bottom layer is dominated by a thick carpet of leaves, fallen trees and huge buttress roots that support the giant trees above. Rainforest soils give the impression of being fertile because they support an enormous number of trees and plants. However, this impression is wrong, as the soil in rainforests is generally poor. Leaves and other matter are recycled by the many organisms to create a living **compost**. The roots of trees must 'snatch' these nutrients from the soil before heavy rains wash them away and they are lost through a process called leaching.

Larger animals also roam through this layer in search of food.

FIGURE 1 Layers in a tropical rainforest



FOCUS ON FIELDWORK

Using Google Earth for virtual fieldwork

Google Earth is an excellent tool that can be used to visit lots of places all around the world. Use Google Earth to visit the Dorrigo National Park in New South Wales to view the layers of the rainforest.

FIGURE 2 Students using Google Earth to take a virtual field trip to Dorrigo National Park to learn about the vegetation

FIGURE 3 Dorrigo rainforest

ACTIVITIES

IDENTIFY

1 How many layers are there in a rainforest *environment*?
2 What are the tallest trees in the rainforest called?

EXPLAIN

3 Describe how conditions in the canopy layer differ from those on the forest floor.
4 Draw up and complete a table like the one below that summarises the features of a rainforest *environment*.

Layer	Height	Amount of light	Features

INVESTIGATE

5 Many rainforest animals live their whole life in the trees. Using the internet to help you, give some examples of these animals and conduct research into the habits of one animal.
6 Use the **Treehouse** weblink in your eBookPLUS (click on the picture, then select the *Jewels of the Earth* activity) to explore the layers of the rainforest and the plants and animals that inhabit them.

APPLY

7 In a rainforest, the soil below the trees is often poor and shallow, and the trees create their own nutrients. In one sentence describe how this happens, and draw a labelled sketch to illustrate the process.
8 What *change* might you expect in the success of plant growth if the rainforest trees are removed and crops are planted instead? Why?
9 Imagine you are a raindrop. Recreate your journey through a rainforest, passing through each of the forest layers. Read or act out your descriptions to the rest of the class.

eBookplus

Weblink
Treehouse

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6.5 SkillBuilder: Creating and describing complex overlay maps

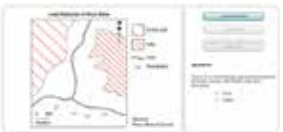
What is a complex overlay map?

A complex overlay map is created when one or more maps of the same area are laid over one another to show similarities and differences between the mapped information. Traditionally, the second map is on tracing paper that is attached to the original page. Complex overlay maps show relationships between factors — the similarities and the differences in a pattern.

eLesson
Watch this video to learn how to create and describe complex overlay maps.

Searchlight ID: eles-1656

Interactivity
Try this interactivity to learn how to create and describe complex overlay maps.



Searchlight ID: int-3152

6.6 How have Australia's rainforests changed?

ice age a geological period during which the Earth is colder, glaciers and ice sheets expand and sea levels fall. The last ice age was approximately 13 000 years ago.

gorge narrow valley with steep rocky walls

6.6.1 Australian rainforests today

Although hard to believe now, Australia was once mostly covered in rainforest! Even areas that today are deserts were once teeming with plant and animal life similar to those in the Amazon. This is because Australia was further north than it is today. Over the past 100 million years, however, a series of events has gradually reduced the area of Australia's rainforests (see figure 1).

The gradual movement of Australia as it separated from Gondwanaland and a series of **ice ages** have combined to make it a drier place (see figure 2). Rainforests have become confined mainly to the mountains and **gorges** of the Great Dividing Range and Tasmania. These areas have higher rainfall and fewer fires.

FIGURE 1 The development of Australian rainforests through time

Triassic period (245–208 mya)
- Foundation of Australian rainforests was occurring as massive volcanic eruptions laid down thick layers of ash near freshwater lakes.

Early Cretaceous period (144–95 mya)
- Australia, as part of Gondwanaland, was very close to the South Pole and experienced the same conditions as present polar regions. However, the climate was temperate, supporting plant life, and the first flowering plants appeared.

Late Cretaceous period (95–66.4 mya)
- The climate was temperate and humid; species found in rainforests today began to develop. Dinosaurs were still present.

Present

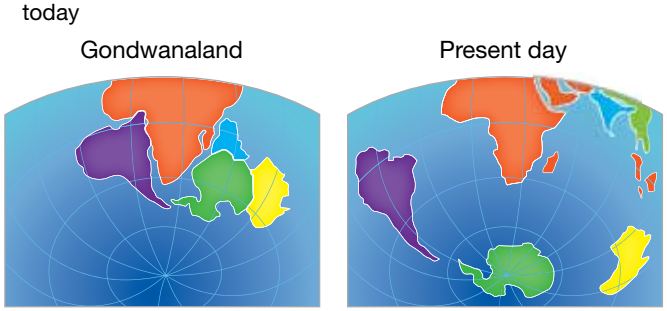
260 | 240 | 220 | 200 | 180 | 160 | 140 | 120 | 100 | 80 | 60 | 40 | 20

[Dates are expressed in mya — million years ago.]

Jurassic period (208–144 mya)
- Ash deposits developed into sedimentary rock; plants such as the cycad and southern pine first appeared.

Late Oligocene/early Miocene periods (25–20 mya)
- The whole of Australia was covered by rainforest at the start of this period, but by the end of the Miocene sclerophyll forest and grasslands were starting to emerge. The rainforests would have been similar to those of today.

FIGURE 2 Difference in the location of Australia when it formed part of Gondwanaland compared with its location today

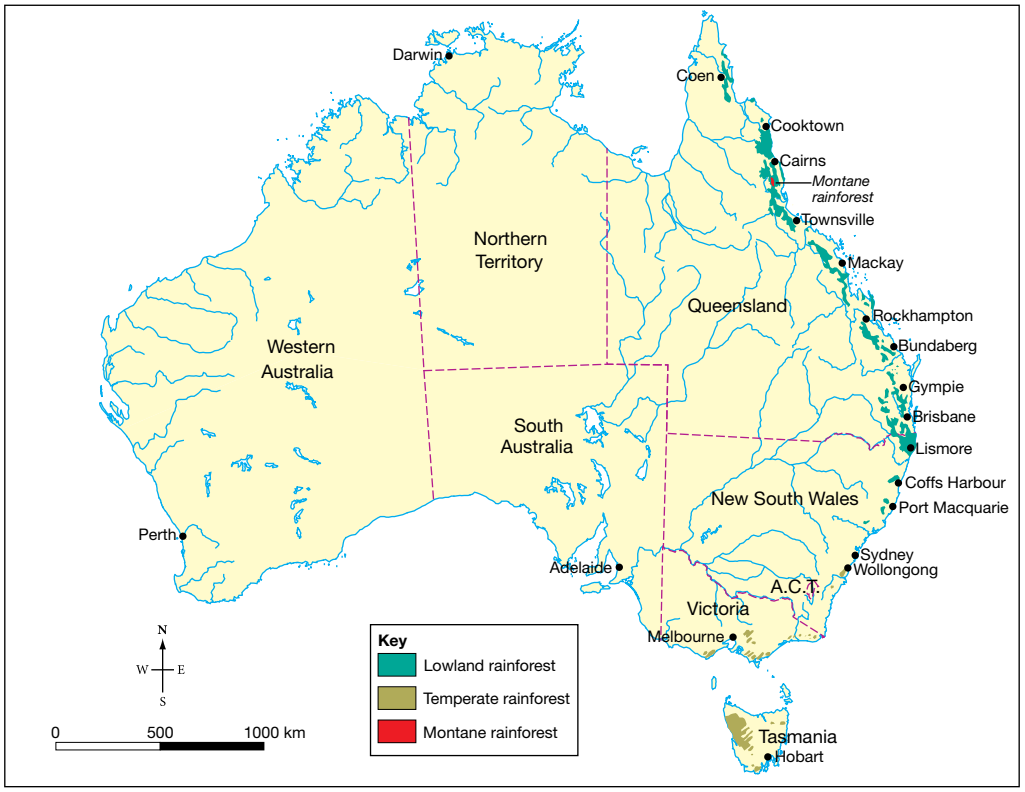


The farming practices of European immigrants have reduced much of the remaining rainforest — in the past 200 years, more than 70 per cent of these forests have been cleared.

Scientists have identified three major types of rainforest in Australia (see figure 3). There are examples of all three in Queensland. This diversity occurs nowhere else on Earth.

Much of Australia's tropical rainforests are now World Heritage areas. This means they have been listed by UNESCO as being of global importance. The Wet Tropics of Queensland are a World Heritage area containing some of the oldest rainforests in the world. They have the world's highest concentration of flowering plants, and have records that show Aboriginal groups are the world's oldest indigenous rainforest culture.

FIGURE 3 Australia's rainforest areas



Source: MAPgraphics Pty Ltd Brisbane

The indigenous inhabitants of the Daintree Rainforest in North Queensland are the Kuku Yalanji Aboriginal people, believed to have lived in this area for more than 9000 years. Their culture is uniquely adapted to the rainforest environment.

For the Kuku Yalanji, the natural world is often thought of in human terms and is closely linked to the people. Any changes to the environment are seen as changes to themselves. Because of the powerful properties attributed to most story places (sites with links to Dreamtime mythology) of the Daintree, the Kuku Yalanji regard damage and destruction to the environment as unacceptable.

The Kuku Yalanji people gather their food and medicine and many of their implements, weapons, fibres and construction material from plants in their environment (see figure 4). The natural patterns and cycles of the rainforest give important information about the food that is available. The plants are their calendar, marking the seasons. For example, when blue ginger (jun jun) is fruiting it is time to catch scrub turkey (diwan), and when mat grass (jilngan) is flowering it is time to collect the eggs of the scrub fowl (jarruka).

FIGURE 4 Rainforest plants were used to make goods such as these baskets that were used for storage, food collection, carrying personal possessions, and leaching poisons (from seeds) in fresh running water.

ACTIVITIES

IDENTIFY

1 List the reasons given in this section for the gradual disappearance of Australia's rainforest ***environments***.

2 What resources does the rainforest provide for the Kuku Yalanji people?

EXPLAIN

3 How has the ***scale*** of Australian rainforest ***environments changed*** over time?

4 Describe the location and distribution of Australia's remaining rainforest ***environments***. What factors have contributed to their survival here?

5 There are three major types of rainforest ***environments*** found in Australia. What makes Queensland's rainforests unique? Why is this possible?

6 Refer to figure 3. Why are there no rainforest ***environments*** on the western side of Australia?

7 Why do the Kuku Yalanji people regard damage to the Daintree rainforest as unacceptable?

INVESTIGATE

8 Use the **UNESCO Heritage** weblink in your eBookPLUS to complete the following.
- **a** On a map of Australia, locate and label Australia's World Heritage sites.
- **b** Which three sites have been added most recently?
- **c** Which two sites protect Australian rainforests?
- **d** The Wet Tropics of Queensland are particularly special because they border another World Heritage site. What is this other site?
- **e** What criteria does UNESCO use to determine whether a natural region should be placed on its list?

APPLY

9 Based on the history of Australia's rainforests and the protection now in place for the remaining forests, what do you think the future holds for this important resource?

eBookplus

Weblink
UNESCO Heritage

eBookplus ONLINE ONLY

6.7 How is the Amazon rainforest changing?

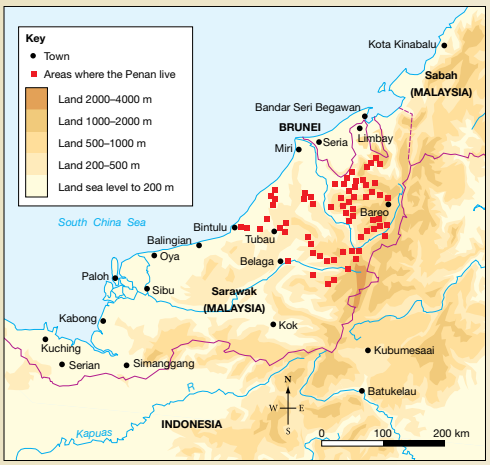
To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

6.8 SkillBuilder: Drawing a précis map

What is a précis map?

A précis map is a simplified map — the cartographer has decided which details to leave in and which to leave out. It is different from a sketch map, which includes all the main features.



Source: MAPgraphics Pty Ltd Brisbane

eLesson
Watch this video to learn how to draw a précis map.

Searchlight ID: eles-1657

Interactivity
Try this interactivity to learn how to draw a précis map.

Searchlight ID: int-3153

6.9 How do indigenous people use rainforests?

6.9.1 Indigenous rainforest peoples

It is difficult to accurately count all the people around the world who live in rainforests, but some estimates put the number as high as 150 million, including Indigenous people. While these people are usually described as living a traditional **subsistence** way of life, this is usually combined with selling and buying items such as their labour, their land and assorted forest products.

subsistence producing only enough crops and raising only enough animals to feed yourself and your family or community

The Huli of Papua New Guinea

Some 80 000 Huli people live in montane rainforest in the highlands of Papua New Guinea (see figure 1). Many still lead a traditional way of life. The land on which they live has steep hillsides and dense rainforest. In the mountains the rivers cut deep gorges, and as they reach flat areas they form swampy, fertile basins.

The Huli people today use a farming system known as **shifting agriculture**. A patch of rainforest is cleared and crops of sweet potato, sugar cane, corn, taro and green vegetables are planted. It is the role of the women to tend these gardens, and their individual huts are built next to the gardens. The men live together in a communal house and generally look after themselves.

When the soil of the garden no longer produces good crops, a new patch of rainforest is cleared, leaving the old one to recover naturally. The garden crops are supplemented by food that the men obtain by hunting. Wild and domesticated pigs are a common source of meat.

While most Huli people still live in their traditional lands, the influence of modern society is very obvious. Most Huli people wear some items of western-style clothing, and knives, cooking utensils and mirrors are common.

FIGURE 1 Location of Huli people in Papua New Guinea

Source: MAPgraphics Pty Ltd Brisbane

FIGURE 2 The Huli people of Papua New Guinea make wigs from their own hair, decorated with feathers from birds of paradise and colourful parrots.

The Penan of Borneo

The Penan people of Malaysian Borneo (see figure 3) are a truly **nomadic** rainforest people. Although their forest home has been largely destroyed by logging, about a thousand Penan people remain deep in the forest, following their traditional way of life.

The main food sources for the Penan people are the sago palm and other fruiting trees, but they are also extremely skilled hunters. They use blowpipes and poison darts to kill wild pigs and gibbons (see figure 4). Their knowledge of the rainforest has been built up over thousands of years, and the forest provides for all their needs. They do not use agriculture; instead, they follow the flowering cycle of the sago palm.

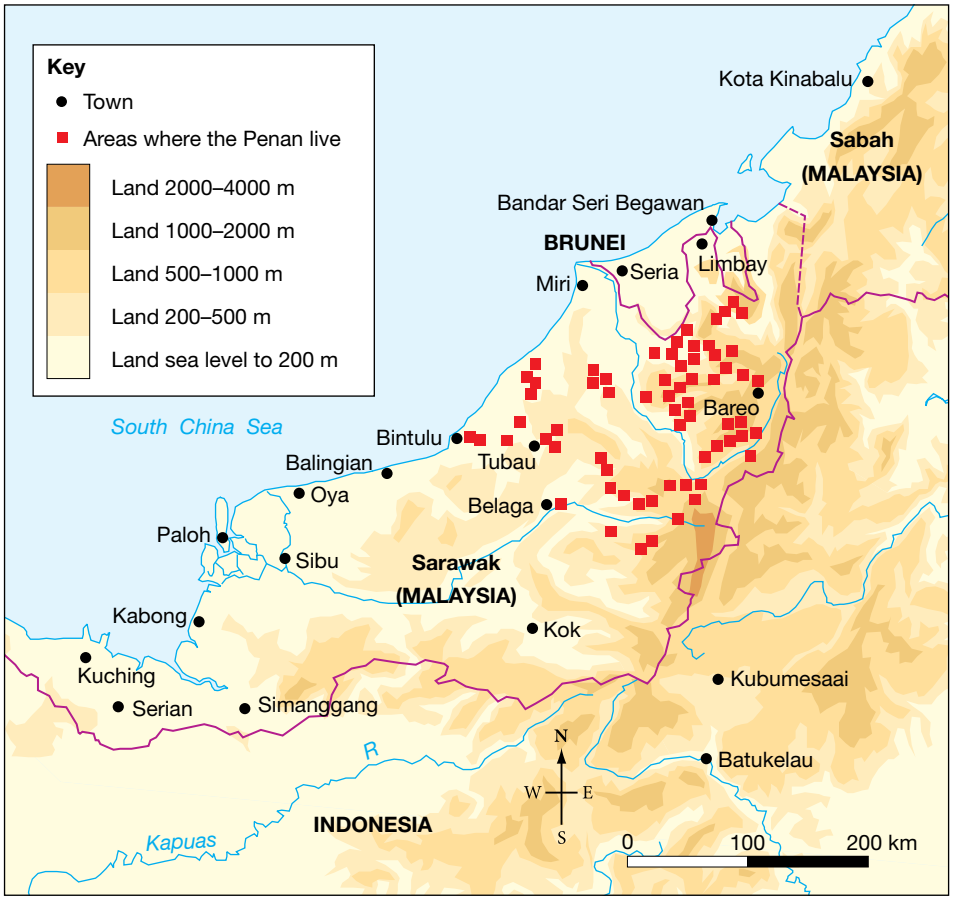
In order to survive in this environment, the Penan people have a strong culture of sharing. This applies not only to objects used in daily life, such as cooking utensils and blowpipes, but also to land. The idea of owning land does not exist in Penan culture.

The Penan people recently became well known to the outside world when they blockaded roads in the Malaysian rainforest to stop logging trucks and machinery moving into it.

shifting agriculture process of moving gardens or crops every couple of years because the soils are too poor to support repeated sowing

nomadic describes a group or tribes that move from place to place depending on the food supply

FIGURE 3 Where the Penan live



Source: MAPgraphics Pty Ltd Brisbane

FIGURE 4 A Penan hunter of Sarawak or Brunei can shoot a dart 50 metres from his blowpipe. About 1.2 metres long and completely straight, a blowpipe has a very accurate hole through the middle.

FIGURE 5 The houses of the Korowai and Kombai people can be constructed as much as 40 metres high in the forest's canopy.

The Korowai and Kombai of Papua

The Korowai and Kombai people live in the Indonesian province Papua, in the south-western part of the island of New Guinea. Mosquitoes, floodwaters and tribal rivalry have forced these tribes to build houses high up in the forest's canopy. They collect food (for example, sago) from the rainforest using traditional methods such as stone axes.

ACTIVITIES

IDENTIFY

1 Make a list of the similarities between the Huli people and the Penan people. Make another list of the differences between them. Use the photographs as well as the text in this section to help you.

EXPLAIN

2 The Penan use only rainforest resources to make their blowpipes. How do you think they do this? Use diagrams to illustrate your ideas.

3 Why is a blowpipe better than a rifle in the rainforest?

INVESTIGATE

4 Complete one of the following activities.

a In groups of two or three, use the internet to research other indigenous tribes living in rainforests around the world. Create a visual presentation or 'documentary' (using a program such as PowerPoint or Photo Story) to educate your classmates about the history of the tribe, their use of their ***environment***, and threats or ***changes*** they face. Examples of peoples you may like to investigate include the Kuna of Panama, the Yanomami of Brazil, the Mbuti of Central Africa and the Baka of Cameroon.

b In groups of two or three, use the internet to research indigenous tribes that live in or have a connection to the rainforest in Australia. Create a visual presentation or 'documentary' (using a program such as PowerPoint or Photo Story) to educate your classmates about the history of the tribe, their use of their ***environment***, threats or ***changes*** they face and their current relationship with the land.

5 Use the **Treehouse** weblink in your eBookPLUS (click on the picture then choose the *My world* activity) to let the community of Paso Caballos in northern Guatemala teach you about their lives in the rainforest.

PREDICT

6 Imagine that you live in a society in which no-one recognises individual ownership of anything. In groups of three or four, discuss the advantages and disadvantages of living in this type of society.

eBookplus

Weblink
Treehouse

6.10 Why are rainforests disappearing?

6.10.1 Reasons rainforests are disappearing

Rainforests have the potential to provide a wide variety of useful resources. The temptation to use these pristine areas is often too difficult for people to resist, especially if they live in poverty. As a result, all around the world, rainforests are being destroyed for economic gain. The main reasons for rainforests being cleared are shown in figure 1 and described below.

clearfelling a forestry practice in which most or all trees and forested areas are cut down

selective logging a forestry practice in which only selected trees are cut down

Commercial logging

There are two main types of logging: **clearfelling** and **selective logging**. When a forest is clearfelled, all trees are removed either by chainsaw or with heavy machinery such as bulldozers. In selective logging, only the best and most valuable trees are cut down. But in clearing forest to reach those trees, it is estimated that a hectare (10 000 square metres) of forest is destroyed for each log removed.

Farming

Rainforests grow in many developing countries. These countries struggle to provide the basic necessities of life for their people, and their populations are often rapidly increasing in size. In these countries, the land on which the forest grows is seen as more valuable than the forest itself.

FIGURE 1 Causes of deforestation in the Amazon, 2000–2005

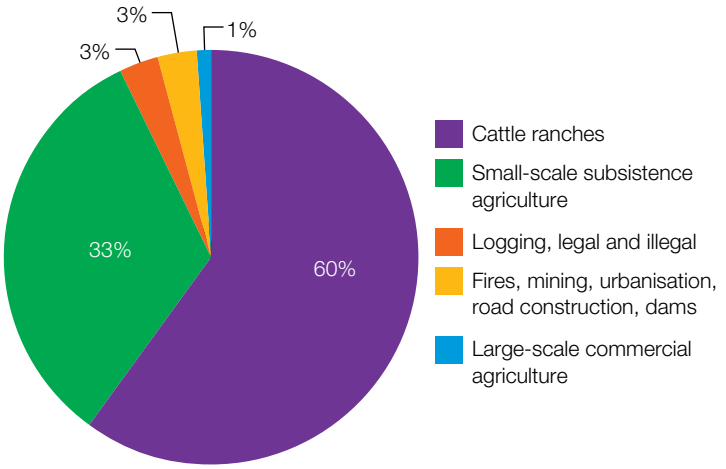


FIGURE 2 It is thought that up to 70 per cent of logging in Brazil and Indonesia could be illegal.

hydroelectric dam a dam that harnesses the energy of falling or flowing water to generate electricity

FIGURE 3 Blocks of rainforest in Peru burned to clear the area for agricultural use — here, maize seedlings have been planted in the clearing.

FIGURE 4 The Ok Tedi gold and copper mine in the Papua New Guinea rainforest. The damage that mining has caused to the surrounding forest environment can be clearly seen.

Highways create access to these areas, opening up parts of the rainforest once almost impossible to reach. Soon after the roads are built, settlers (called homesteaders) arrive. Claiming a piece of the forest that borders the road, the homesteaders chop down a few trees as timber for fencing or a house, and then set fire to the rest (see figure 3).

Once the initial 'land rush' is over and all the land beside the roads has been claimed, tracks and roads leading from the highways will push deeper and deeper into the forest. Soon an area of 50 kilometres either side of the highway will have been destroyed and replaced by small farms or large-scale commercial farms that raise beef or crops for export to the richer countries of the world.

Mining

Many rainforests are growing on land that also contains large energy and mineral deposits such as oil, gold, silver, bauxite, iron ore, copper and zinc (see figure 4). Mineral companies build roads to the deposits and set up large-scale mining and processing plants. These plants require large amounts of electricity, and this is often supplied by burning trees to create charcoal or by constructing vast **hydroelectric dams**.

Deep in the Brazilian rainforest, a 2000-square-kilometre dam has been constructed to provide electricity for aluminium smelters. The dam flooded the entire tribal lands of two native peoples, and is so large that it has altered the climate in the area, making it drier.

Another problem created by mining is the pollution of nearby rivers and streams from chemicals used in the processing plants. Rivers downstream from a vast goldmine in Papua New Guinea have been found to contain four times the safe limit of cyanide in the water. Cyanide is used to extract gold from rock.

ACTIVITIES

IDENTIFY
1 What is the difference between clearfelling and selective logging?
2 List four ***changes***/problems caused by mining operations in rainforests.

EXPLAIN
3 'Many homesteaders are unable to make a good living from the poor tropical soils.' Explain the reasoning behind this statement. You may like to revisit section 6.4 to help you with your response.

INVESTIGATE
4 Refer to figure 1. What percentage of deforestation is caused by agriculture in the Amazon?
5 Using the internet, research any economic activities that are supported by Australian rainforests.

PREDICT
6 As a class, discuss the potential long-term problems that could result from the continued commercial use of rainforest ***environments*** around the world. Develop a list of the top five potential problems.

APPLY
7 Many rainforest ***environments*** are located in developing countries. Why does this make the problem of rainforest destruction harder to solve?
8 Mining companies insist that mining in poorer countries brings benefits to the local community. Re-read section 6.9 on the Huli people of Papua New Guinea, and outline some of the benefits that mining could bring to these people. Then outline any problems that mining could cause for the Huli people. What conclusions can you reach?

6.11 How does deforestation affect the environment and people?

6.11.1 Impacts of deforestation

Deforestation of rainforests around the world is the major cause of problems in this ecosystem. The loss of unique **habitats** is the primary reason species are becoming endangered. Clearing creates smaller islands of vegetation, making it more difficult for animals to communicate and breed. People are also affected by the removal of the rainforest. While indigenous people may feel the effects first, others also experience negative consequences.

habitat the total environment where an animal lives, including shelter, access to food and water, and all of the right conditions for breeding

- About one hectare of rainforest is destroyed every second: this is about twice the size of a soccer pitch.
- Scientists estimate that 137 plants and animals are made extinct daily: that's 50 000 each year. Some haven't even been discovered yet!
- It is believed that in the year 1500 up to nine million indigenous people lived in the Amazon rainforest. The number is now lower than 200 000.
- The world loses about two per cent of its rainforest each year, but rates differ between countries.

Plants and animals

Islands in the forest

Many forests are cleared using fire. These fires will release millions of tonnes of carbon dioxide into the air, increasing the threat of global warming. At the same time, destroying the trees robs the planet of the natural system that helps regulate the amount of carbon dioxide in the air.

In many areas where forests are cleared, it has become a practice to leave behind 'islands' of rainforest. This is meant to assist in the natural regeneration of the forest and also to leave sufficient areas of the natural habitats of plants and animals that live in the rainforest. But is this working?

The islands that are left are often not big enough to ensure the survival of the large numbers of species that live there. For example, the endangered Queen Alexandra's Birdwing (the world's largest butterfly) is facing extinction as its distribution is being

FIGURE 1 The wingspan of the Queen Alexandra's Birdwing can reach 30 centimetres.

condensed into seven isolated blocks of rainforest measuring approximately 1–2 square kilometres in northern Papua New Guinea (see figure 1).

These remaining refuges are threatened by surrounding oil palm plantations.

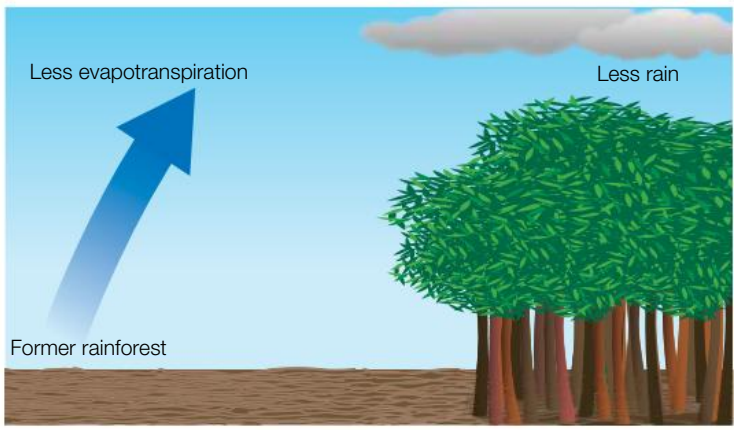
And there are other problems. When the forest is cleared, the exposed earth can quickly erode as the tree roots no longer hold the soil together, making the regrowth of vegetation slow. On steep slopes this can increase the risk of landslides, and sediments can flow into rivers.

During drought, the bare ground can become hot and barren. With the removal of the forest cover there is little moisture stored in the ground and a much lower rate of **evapotranspiration**. This in turn affects the water cycle, reducing the amount of rain that falls on the remaining islands of rainforest, and they quickly dry out (see figure 2). With the removal of the trees, no nutrients are returned to the soil through decaying leaf litter, which alters the nutrient cycle.

evapotranspiration the process by which water is transferred to the atmosphere from surfaces such as the soil and plants

FIGURE 2 Leftover pockets of rainforest are at risk from reduced rainfall and cannot survive drought conditions.

(a) Rainforest trees are cleared, with 'islands' left for regeneration.



(b) There is less evapotranspiration and less rain on forest 'islands'.

CASE STUDY

Deforestation in Indonesia and the orangutan

Nearly 10 per cent of the world's rainforests and 40 per cent of all Asian rainforests are found in Indonesia. Less than half of Indonesia's original rainforest area remains. Much of this is in Kalimantan, on the island of Borneo. Forests have been cleared for timber, for plantation crops such as palm-oil trees, and to make way for Indonesia's growing population, which is now more than 200 million. Fires lit to clear land in 1982 and 1997 resulted in wildfires that severely damaged large areas of rainforest in Kalimantan. Orangutans, Sumatran tigers and Javan hawk-eagles may disappear from Indonesia as their natural habitats disappear.

Orangutans are the largest tree-living mammals and the only great ape that lives in Asia. They survive only on the islands of Borneo and Sumatra. Current estimates are that orangutans have lost 80 per cent of their habitat in the last 20 years. In 1997–98, wildfires burned through nearly two million hectares of land in Indonesia, killing up to 8000 orangutans.

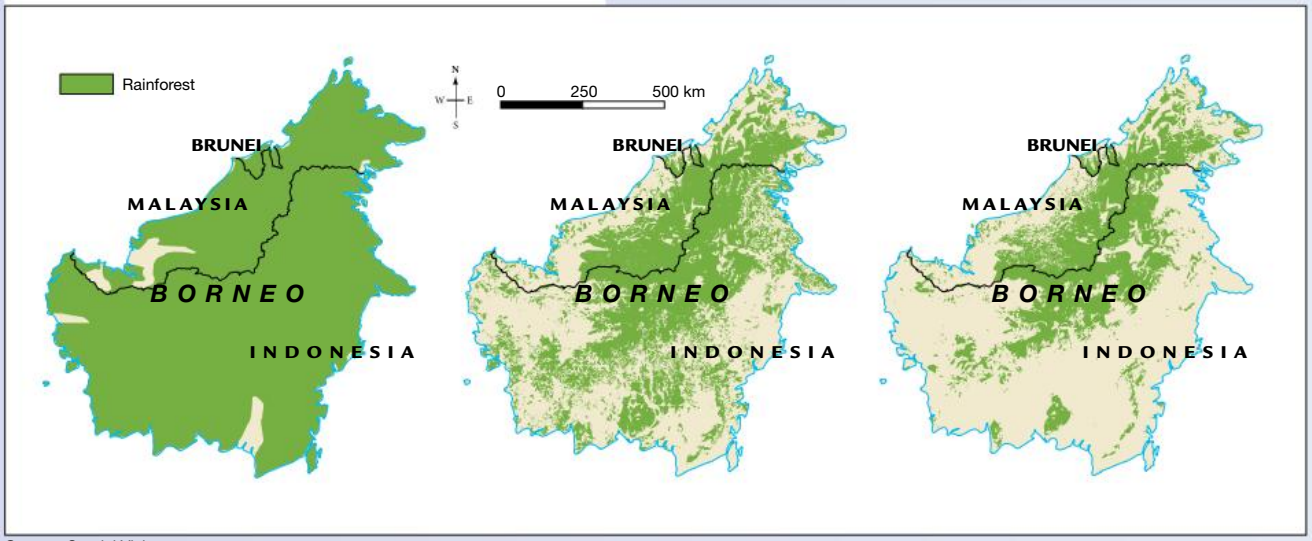
It is estimated that orangutan numbers have declined by more than 50 per cent in the last 60 years (see figure 4). The current orangutan population is believed to range between 45 000 and 69 000.

FIGURE 3 Mother and baby orangutan

FIGURE 4 Orangutan distribution in Borneo, 1930–2004

Source: Spatial Vision

FIGURE 5 Rainforest distribution in Borneo, 1950–2020



Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Orangutans

People

Indigenous people

As forests are cleared and new settlers move into the region, the indigenous people of the area are often displaced and their culture may disappear. The homesteaders bring new diseases to which indigenous people have no natural immunity. One tribe, the Nambiquara of Brazil, lost half its population to illness when a road was placed through their tribal land. Indigenous people aren't often given a choice about 'progress' coming to their section of the rainforest. As a result, tension can be created between these tribes and the government. In 1999 the Bakun Dam Project began in Malaysia, resulting in the eviction of approximately 10 000 indigenous people from their ancestral homeland. While they were resettled as compensation, the land provided was too small to support their traditional forms of hunting and agriculture and many failed to adapt to their new lifestyles.

Landslides

A landslide, the downward movement of earth and rocks on a slope, occurs in the lithosphere (see section 6.2). It can be caused by natural physical processes such as rainfall and earthquakes, or by man-made activities such as deforestation and road building. Usually, the roots of rainforest plants keep the soil together and add stability to mountainous areas. This is especially important during times of heavier rainfall. However, sometimes the ground becomes so waterlogged that the roots can't keep the soil in place and it slips downhill, creating a landslide. The risk of this increases if deforestation has taken place on the hillside, as there are no tree roots to provide added stability (see figure 6a and b).

FIGURE 6 A forested hillside (a) before and (b) after deforestation

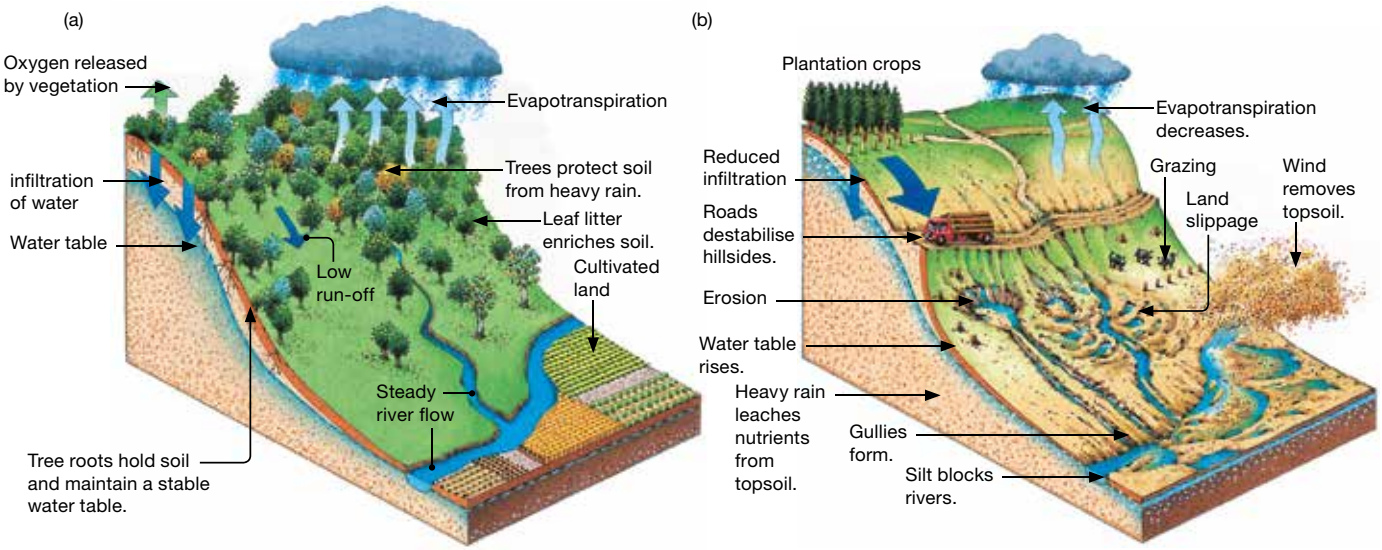


FIGURE 7 Landslides in intact forest in the Mata Atlantica rainforest, Brazil

Therefore, when these hills are cleared and settled by communities, the danger of property damage, and even death, increases. November 2011 saw 35 people killed in a landslide in the Colombian city of Manizales (see figure 8). Fourteen houses were destroyed, displacing up to 159 people. This mountainous, coffee-growing region used to be rainforest before it was cleared and settled.

Haiti is at a high risk of landslides because its people cut down trees to use as fuel. As a result, most of Haiti's natural forest has been destroyed (see figure 9). In 2004, Hurricane Jean hit the island; many of the 3000 people who died were caught in landslides.

FIGURE 8 Landslide in Manizales, Colombia, in November 2011

FIGURE 9 The deforestation in Haiti is clearly evident on its border with the Dominican Republic.

Disease

The arrival of new tropical diseases is a less obvious result of deforestation. As animal **hosts** disappear and new human settlers move into previously inaccessible areas, 'new' disease-causing microorganisms are transferred into the human population. The frequency of mosquito-borne diseases such as malaria has increased due to the creation of more water puddles, for example in ditches and tyre treads, that are an excellent breeding ground for the mosquito. It is estimated that malaria is responsible for the deaths of 20 per cent of the Yanomami people in Brazil and Venezuela. Today, more than 99 per cent of malaria cases in Brazil occur in the Amazon Basin region, even though the mosquitoes that carry the disease are found across 80 per cent of the country.

The outbreak of such diseases doesn't affect only the local area but the impact can also spread into other countries via people who visit these areas, unknowingly contract an illness and then travel home, spreading the disease along the way.

host an organism that supports another organism

ACTIVITIES

IDENTIFY

1 Name some species threatened by deforestation in Indonesia.
2 List the main threats to orangutans.
3 Why does disease affect indigenous people when deforestation occurs?

EXPLAIN

4 How does deforestation affect the lithosphere, atmosphere and biosphere? (Refer to section 6.2 to refresh your memory.)
5 Why does having separate small islands of vegetation make it more difficult for animals to communicate and breed?

INVESTIGATE

6 Refer to figures 4 and 5. Describe the relationship between the two sets of data shown on the maps.
7 Refer to figure 6. Write a paragraph that explains how deforestation results in the consequences illustrated in the diagram.
8 Research and create a list of 10 other animal species threatened by deforestation around the world. Choose one of these animals and report back to the class on its current location, the remaining population level and the main causes of deforestation. Present your report as a poster, PowerPoint presentation, movie (documentary), poem, song or drama performance.
9 Using the internet, investigate two different management strategies/policies/laws that have been implemented around the world to try to conserve the rainforest ***environment***. Note the positive and negative aspects of these strategies. Comment on their ability to support the ***sustainable*** use of rainforests. Discuss your results as a class. Create a summary on the board to evaluate all the options that are shared.

PREDICT

10 Indonesia recently granted a licence to a pulp paper producer to clear 50 000 hectares of forest near an orangutan sanctuary in Sumatra. What impact do you consider this might have on the orangutan population?
11 What could be some of the consequences if the rainforest ***environment*** continues disappearing at its current rate?

APPLY

12 Produce an A4-sized poster designed to publicise the rate and consequences of rainforest destruction. Your poster must include a colourful diagram and a short slogan based on the facts and figures presented in this section.
13 Why is it important to save species from extinction?

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Interactivity
Deforestation dilemma
Use this interactivity to explore the effects of deforestation.
Searchlight ID: int-3113

6.12 How can rainforests be conserved?

6.12.1 Options for the future

As people begin to realise the importance of rainforests, many have started to work towards preserving these valuable 'green dinosaurs'. Some methods of conservation are relevant only to governments and large companies, but some are relevant to you and the choices you make.

FIGURE 1 The drill, one of Africa's most endangered primates, has a safe haven in the Korup National Park in Cameroon.

Rescue package 1: Protect the remaining rainforests

While only six per cent of the world's rainforests are in a national park or reserve, there are many large areas of rainforest under protection. The number and size of these national parks are slowly increasing. The Korup National Park in Cameroon holds 126 000 hectares of Africa's richest untouched rainforest; the Khao Yai National Park in Thailand has 200 000 hectares, where the habitats of tigers, elephants and gibbons are protected; Costa Rica's rainforests are the most protected of all, with national parks and reserves covering almost one-third of that country.

Rescue package 2: Use the forest without destroying it

sustainable development economic development that causes a minimum of environmental damage, thereby protecting the interest of future generations

This is called **sustainable development**. It means that resources are taken from the rainforests but the forest remains largely intact. It has been estimated that a forest used this way is worth $12 000 a hectare, while it is worth only $300 a hectare if it is cleared for farming.

Timber users can now purchase timber from forests that are properly managed. A company in Mexico — the Forest Stewardship Council (FSC) — assesses forests around the world. If the forests comply with regulations, the timber is given the FSC stamp (see table 1). People who purchase that timber know the forest it came from is being responsibly managed.

TABLE 1 Countries with FSC-certified forests totalling more than 100 hectares

Country	Area of certified forest (hectares)
Bolivia	1 012 948
Brazil	1 463 718
Canada	4 253 822
Chile	376 364
Croatia	1 988 480
Germany	524 532
Guatemala	469 226
Indonesia	90 240
Ireland	438 000
Mexico	565 327
New Zealand	717 027
Poland	6 186 018
Russia	1 395 479
South Africa	1 496 970
Sweden	10 311 603
United Kingdom	1 144 386
United States	3 832 247
Zimbabwe	127 285

Rescue package 3: Use alternative timber

One further step is not to use rainforest timber at all. Many rainforest trees are now grown in plantations, and alternatives such as using steel beams in houses and recycled paper in cardboard help take the strain off the rainforests.

One alternative that has been developed is the processing of old coconut palms to create hardwood. The company that is developing this resource, Tangaloa, claims that there are enough non-productive coconut palms to produce timber equivalent to one million rainforest trees. If this concept proves popular, plantations of coconut palms could be grown specifically for this purpose (see figure 2).

FIGURE 2 Coconut plantation — could these palms help save the rainforests?

Rescue package 4: Act now!

While most of us do not have rainforests growing in our backyards, the choices we make each day can and do make a difference to the way resources are used around the world. There are many organisations that aim to conserve the world's remaining rainforests. Some of their suggestions are:

- use less wood and paper
- write to businesses that destroy the rainforest
- educate yourself about the importance of rainforests
- look for alternatives to rainforest products
- be an **ecotourist** — visit rainforests where your tourist dollars go towards education and conservation.

ecotourist a tourist who travels to threatened ecosystems in order to help preserve them

ACTIVITIES

IDENTIFY

1 What percentage of the world's rainforests are in national parks or reserves?
2 Which country has the most protected rainforests?
3 How are rainforest ***environments*** in Costa Rica protected?
4 Explain in your own words what the FSC does to help protect the rainforest ***environment***.

EXPLAIN

5 List two advantages and two disadvantages of each rescue package. Which of the four packages do you think offers the most hope for rainforest conservation and ***sustainability***? Explain why.
6 Why is it good to have a variety of action options?

INVESTIGATE

7 On a countries outline map of the world, create a choropleth map by shading in those countries with FSC-certified forests of over 100 000 hectares. Use lighter shades of one colour for countries with smaller areas of certified forest (such as 100 000–150 000 and 150 000–200 000 hectares), and darker shades of the same colour for countries with larger areas (250 000–500 000; 500 000–1 000 000; > 1 000 000 hectares).
8 Other methods to help conserve the world's rainforests include:
- breeding endangered rainforest animals in captivity, and then releasing them
- providing websites where sponsors can give money to buy some rainforest and put it into a reserve
- employing indigenous rainforest people to pick nuts and berries or even to breed butterflies for collectors.

Use the internet to find an example of each of these methods and list any others that you find while completing this research. Document your findings.
9 Design your own website encouraging people to donate money to save the rainforest ***environment***.

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Interactivity
Protecting or plundering rainforests
Use this interactivity to decide whether or not various strategies protect rainforests.
Searchlight ID: int-3114

6.13 What are the features of the Daintree rainforest?

6.13.1 Daintree rainforest

The Daintree National Park is home to one of the oldest surviving rainforests on Earth. The Daintree rainforest, located in Far North Queensland, is part of the Wet Tropics of Queensland that stretches along the north-east coast of Australia for 450 kilometres. This area was recognised as a World Heritage Area in 1988 for its significance to Australian geological history and biological diversity.

FIGURE 1 Northern Queensland

GEOskills TOOLBOX

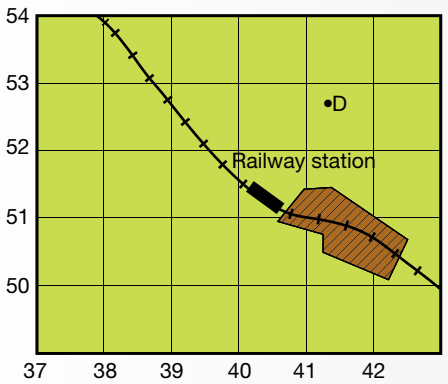
Using area and grid references

Grid lines run up, down and across topographic maps. They can be read the same way that latitude and longitude are read, by looking across the bottom for the number then up the side for the next number.

An area reference is a four-figure number, with AR at the beginning, that tells us the grid square in which to find a feature. The area reference of the railway station in the map below is AR4051.

A grid reference is a six-figure number, with GR at the beginning, that shows an exact point in the grid square. The third and sixth figures represent one-tenth of the distance between the two grid numbers. However, these divisions are not written on the map, so they must be estimated. The grid reference of the D on the map on the right is GR413527.

FIGURE 2 An example of an area and grid reference on a topographic map



ACTIVITIES

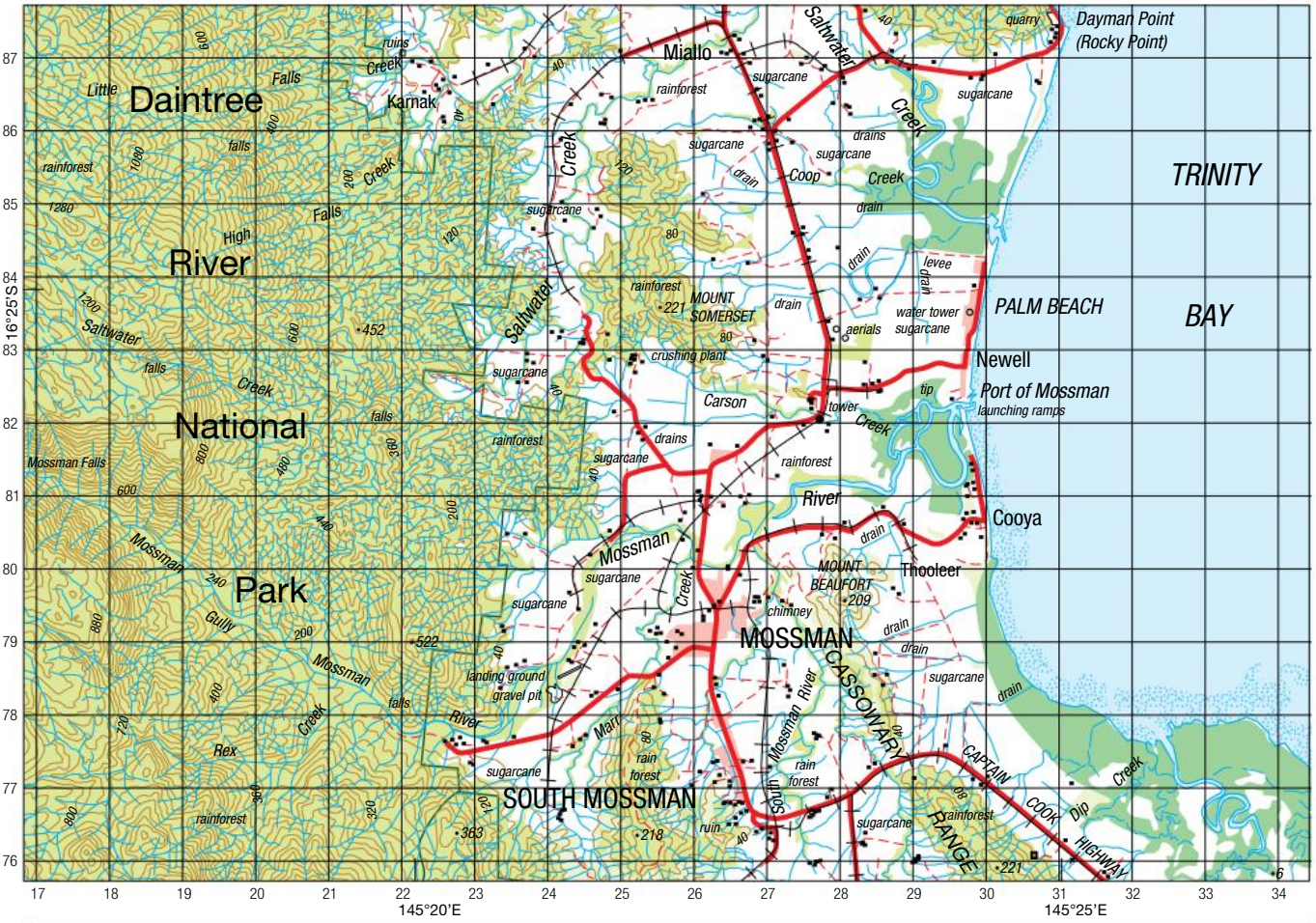
APPLY

1 List the types of vegetation that can be seen on the map.
2 List the features found at the following locations.
(a) GR298835 (b) GR298807 (c) GR268831 (d) GR307760
3 Describe what the landscape would look like if you were at the following locations.
(a) GR195768 (b) GR335765 (c) GR272867
4 Which of these locations is the highest: GR252763 or GR301759?
5 Give the six-figure grid references for:
(a) Dayman Point (b) Port of Mossman (c) Miallo.

PREDICT

6 Suggest impacts that the built environment could have on the Daintree.
7 A hotel chain has applied to the Queensland government for permission to build a resort in the Daintree. Assess this proposal from the perspectives of the developers, government, local residents, environmentalists and Kuku Yalanji people. Try to make a decision as to whether this project should be approved. This could be completed in small groups or debated as a class.

FIGURE 3 Topographic map extract of the south-eastern section of the Daintree River National Park



sealed unsealed

- Principal road; Built-up area
- Secondary road
- Minor road
- Single track railway; Station
- Aerial, tower; Mine
- Airport
- Building/s

kilometres 0 1 2 3 4 5 6 7 8 9 10 kilometres

- Vegetation: medium, dense; Mangroves
- Contour with value (interval 40 metres)
- Horizontal control point; Spot elevation
- Watercourse
- Intertidal flat
- National park

Source: MAPgraphics Pty Ltd, Brisbane

eBookplus ONLINE ONLY

6.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

CHAPTER 7

Fieldwork inquiry: How does a waterway change from source to sea?

7.1 Overview

7.1.1 Scenario and task

Task: Produce a report and presentation about the way in which your local catchment changes from the upper to the lower reaches.

Everybody lives in a catchment and its health is influenced by the activities in all areas within it. Your local water authority has received contradictory reports about the current state and health of your local catchment. As the reports are contradictory and the local water authority is not sure which is valid and which is not, they need to undertake a detailed study of the natural and built environments in the local catchment area. This will put them in an expert position to question and quash statements made by non-experts.

Your task

Your team has been commissioned by the local water authority to compile and present a report evaluating the current state of your local catchment. Your team must gather data to investigate how the catchment changes from the upper to the lower reaches. Your investigations will cover river characteristics such as depth, width and other channel characteristics, the fauna and flora in the area, and the land use in the catchment. In order to ensure that your report is accurate, your team can gather data about a local waterway and its immediate catchment by observing, collecting, interpreting and presenting your findings.

7.2 Inquiry process

7.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You can complete this project individually or invite members of your class to form a group. Save your settings and the project will be launched.

- **Planning:** Navigate to your Research Forum. You will need to research the characteristics of your local catchment area. In order to complete sufficient research, you will need to visit a number of sites within the catchment, comparing different locations upstream and downstream of one creek or river. Research topics have been loaded in the system to provide a framework for your research:
  - **What** sort of data and information will you need to collect at your fieldwork sites?
  - **How** will you collect and record this information?
  - **Where** would be the best locations to obtain data? You can determine this once you know which waterway(s) you are visiting.
  - **How** will you record the information you are collecting? Consider using GPS, video recorders, cameras and mobile devices (laptop computer, tablet, mobile phone).

Before going out into the field, examine topographic maps and aerial photos or satellite images of the relevant area to identify key landmarks (such as the location of your school, and the location of the waterway relative to the school). Locate the catchment boundary, the path of the waterway and the watercourse it contributes to. Construct a sketch map of the waterway — this map should show the catchment boundary/watershed, the river channel and the direction in which the water is flowing. Clearly note compass directions on the map. Gather spatial (mapped data) information about the region (using, for example, street directories, topographic maps, aerial photos and satellite images from sources such as Google Earth) and information about planning, population, land use, and flora and fauna. Refer to your Media Centre for potential sources of information.

Discuss with your group what you might already know about your catchment and then divide the research tasks between you. Discuss the information you will be looking for and where you might find it. Choose land use categories that you will be able to recognise and a mapping symbol to be used for each. The weblinks in your Media Centre will help you get started. You can view and comment on other group members' articles and rate the information they have entered.

7.2.2 Collecting and recording data

Depending on the catchment you visit, you could investigate some or all of the following:

- channel depth at various points across the stream
- channel width or cross-section
- stream flow velocity (how fast the water is flowing)
- flora transects
- fauna surveys
- land-use surveys.

Other relevant observations may include:

- condition of the waterway banks
- native and exotic vegetation
- cleared land
- evidence of erosion
- land-use zones
- potential pollution sources (including stormwater drains entering the waterway and sewage overflow points)
- building sites, industrial and residential areas
- pollution control devices
- erosion control.

Ensure that you take relevant measuring equipment into the field, and that several measurements are taken at each site. It is useful to divide tasks among groups and then share data when you are back at school. Use a copy of your map to record the information at each site.

7.2.3 Processing and analysing your information and data

Once you have collected, collated and shared your data, you will need to decide what information to include in your report and the most appropriate way to show your findings. If using spreadsheet data, make total and percentage calculations. Some measurements are best presented in a table, others in graphs or on maps. If you have used a spreadsheet, you may like to produce your graphs electronically. Use photographs as map annotations (either scanned and attached to your electronic map or attached to your hand-drawn map) to show features recorded at each site. You may also like to annotate each photograph to show the geographical features you observed. Describing and interpreting your data is important.

Visit your Media Centre and download the report template and the presentation planning template to help you complete this project. Your Media Centre also includes images, videos and audio files to help bring your presentation to life. Use the report template to create your report. Use the presentation template to create an engaging presentation that showcases all of your important findings.

7.2.4 Communicating your findings

You will now produce a fieldwork report and presentation of your findings. Your report should include all of the research that you completed and all evidence to support your findings. Ensure that your report includes a title, an aim, a hypothesis (what you think you will find, which is written before you go into the field), your findings and a conclusion. You will also need to recommend some type of action that needs to be taken to improve river management at the creek or river you visited.

7.3 Review

7.3.1 Reflecting on your work

Think back over how well you worked with your group on the various tasks for this inquiry. Determine strengths and weaknesses and recommend changes you would make if you were to repeat the exercise. Identify one area where you were pleased with your performance, and an area where you would like to improve. Write two sentences outlining how you might be able to do this.

Print out your Research Report from ProjectsPLUS and hand it in with your fieldwork report and presentation, and reflection notes.

Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

Suggested software

- ProjectsPLUS
- Microsoft Word or any other word processing tool
- PowerPoint or any other presentation tool

Media Centre

Your Media Centre contains:

- fieldwork data recording templates
- a report template
- a presentation template
- a selection of images and audio and video files to add richness to your presentation
- weblinks to sites to assist in your catchment research and to provide sample presentations
- an assessment rubric.

Many people like to travel to beaches like this popular one in Scheveningen, Holland, or to overseas cities, to experience differences other places offer

TOPIC 2

PLACE AND LIVEABILITY

Have you ever stopped to consider why you live where you do? What prompted your family to live there? Whether rural or urban, coastal or inland, small or large, different places are more 'liveable' for some people than for others. The question arises, how can the places in which we live contribute to people's wellbeing?

KEY INQUIRY QUESTIONS

- Why do people's perceptions of the liveability of places vary?
- What effects do environmental quality and access to services have on people's wellbeing?
- How can strong community identity and social connectedness enhance the liveability of places?
- What approaches can be used to improve the liveability of places?

SHENZHEN
CHICAGO
TEHRAN
Mahila
NEWYORK
Shenzheh
Lagos
ISTANBUL
Jakarta
SaoPaulo
KARACHI
DELHI
Beijing
TOKYO
LIMA
LosAngeles
London
BOGOTA
ESSEN
KOLKATA
Seoul
CAIRO
DELHI
TOKYO
SHANGH
Tehran
Dakarta
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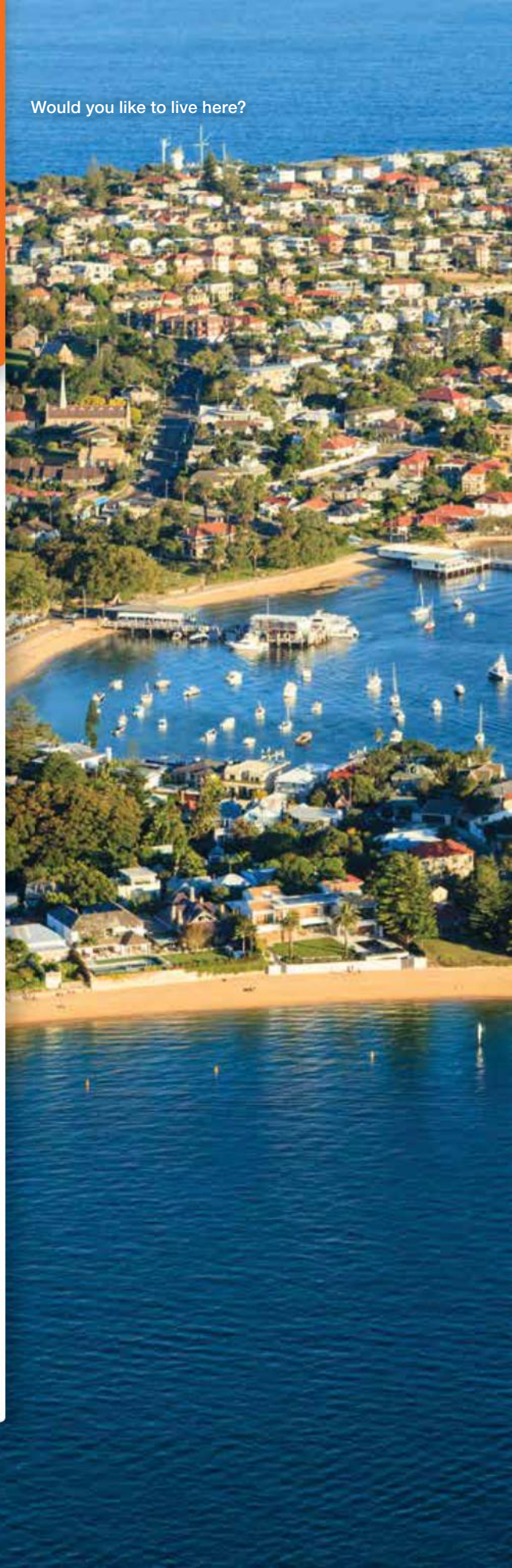


Would you like to live here?

CHAPTER 8

Where do Australians live?

8.1 Overview

8.1.1 Introduction

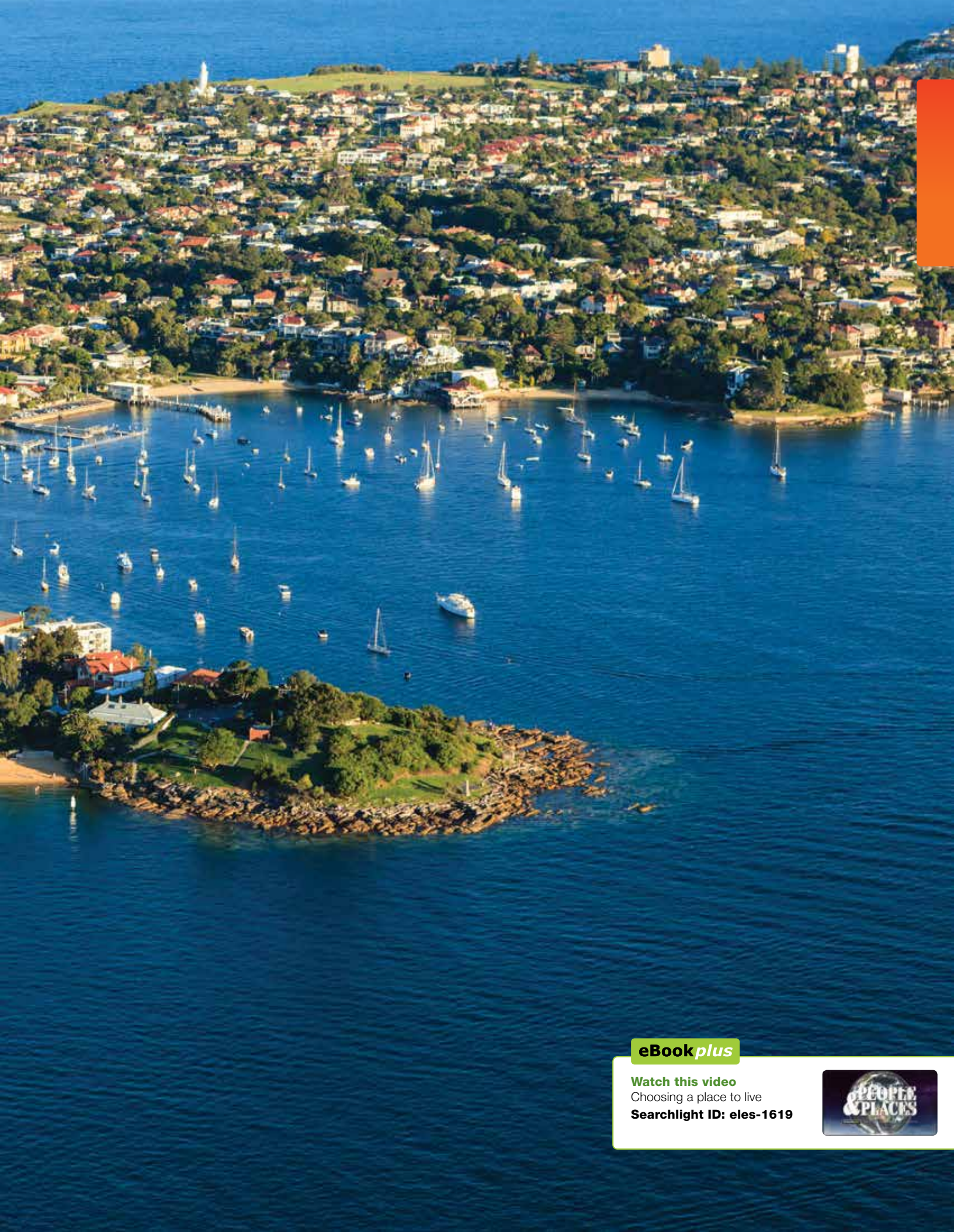
Why does your family live in the place, state, city, street or house that it does? Why do many Australians live in big cities near the coast? Have you thought about the reasons why your parents selected the place or environment in which you now live? People living in Australia have been making choices about where to live for many thousands of years. What factors have influenced the decisions made? Do people choose to live in places they feel are the most liveable? Let's try to work out why Australians choose to live in the places they do.

Starter questions

1. If you could live anywhere in the world, where would it be and why?
2. If your answer to question 1 is not in Australia, which part of Australia do you think is the most similar to the ***place*** you chose?
3. What are the geographic features of the place you would ideally like to live in? Geographic features can usually be mapped, and include climate, landscape, ***environment*** (either built or natural), jobs, culture, infrastructure, wealth and safety. Find an image of this ***place*** and annotate its geographic features.
4. Look at the image on this page. List the positive and negative aspects of living in this ***place***.

Inquiry sequence

		Syllabus outcomes
8.1 Overview		
8.2 What creates a sense of place?		GE4-1
8.3 Why do people live in certain places?		GE4-3, GE4-4
8.4 Where do you live and why?		GE4-3, GE4-4
8.5 SkillBuilder: Interpreting population profiles	eBook plus ONLINE ONLY	GE4-7
8.6 Why do Australians live in remote places?		GE4-4
8.7 What draws people to rural areas?		GE4-1, GE4-3, GE4-4
8.8 Investigating topographic maps: What draws people to Griffith?		GE4-1, GE4-3, GE4-4
8.9 Are rural communities sustainable?	eBook plus ONLINE ONLY	GE4-1, GE4-3, GE4-4
8.10 What are 'lifestyle' places?		GE4-4
8.11 Where is my place?		GE4-4
8.12 SkillBuilder: Constructing a basic sketch map	eBook plus ONLINE ONLY	GE4-7
8.13 Where would you like to live?		GE4-4
8.14 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	



eBook*plus*

Watch this video
Choosing a place to live
Searchlight ID: eles-1619

8.2 What creates a sense of place?

8.2.1 A sense of place

Places are central to the study of geography. This is because geographers are interested in where things are found on Earth and why they are there. But what exactly is a place?

place specific part of the Earth's surface that has been identified and given meaning by people

location where a point on the Earth's surface is to be found

region any area of varying size that has one or more characteristics in common

To understand what a place is, think about **location** and **region**. Each place has a unique identity that makes it different from other places. A combination of characteristics is specific to that place, making it individual. A sense of place comes from being aware of what makes that location significant and seeing its special qualities.

These may include:

- natural features, such as a harbour or natural spring
- human features — that is, built by people
- a combination of natural and human features.

Eventually, one or more of these features becomes a symbol of that place in people's minds; figure 9 is an example of this.

FIGURE 1 Greece — coastal settlement on the island of Santorini

FIGURE 2 Iceland — Northern Lights

FIGURE 3 Greece — Meteora of Kalampaka

FIGURE 4 Spain — a market place

FIGURE 5 Brazil — City of Rio de Janeiro

FIGURE 6 Hawaii — tropical reef snorkelling

FIGURE 7 India — the Taj Mahal in Agra

FIGURE 8 Morocco — desert landscape

FIGURE 9 Turkey — Anzac Cove

GEOskills TOOLBOX

Political maps

Figure 10 is a political map showing human features such as:

- the boundaries of countries
- capital cities
- major water bodies.

Political maps may also show state boundaries. Colour and labelling are used to clearly show neighbouring countries, and their comparative sizes. A political map often shows the capital city of each nation.

FIGURE 10 Political map of North and Central America

Source: Spatial Vision

ACTIVITIES

IDENTIFY

1. Study figures 1 to 9. Choose five of the images shown and list the special features about each ***place***. Consider natural as well as human features.
2. Refer to your answers to question 1. What was the most common feature in your responses?
3. Suggest reasons why these ***places*** have become famous around the world.

EXPLAIN

4. Conduct a survey of your class to find out each person's top five favourite ***places*** to visit in Australia or NSW. Collate the results in a table like the one below.

Place	Student A	Student B	Student C
Great Barrier Reef	✔		✔
Uluru		✔	✔
My grandparents' farm near Ballina, NSW		✔	

This table could also be set up electronically, using a spreadsheet program.

5 Graph the results to show the ranking of the ***places*** by percentage of the class; for example, 45 per cent of the class named Uluru in their top five ***places*** in Australia.

6 As a class, discuss the patterns shown by the graph. Suggest reasons to explain why people like or dislike certain ***places***.

INVESTIGATE

7 Why do you think people consider a ***place*** to be special? What makes people prefer one ***place*** over another ***place***? Ask two to three people these two questions, and record their responses in your workbook.

8 No matter where we live, we all live in the one ***place***: Planet Earth. A place is given meaning by people. Introduce a ***place*** that has special meaning to you. Where is it? What special feelings do you have when you are there? Include an image and annotate the natural (green arrows) and the human (blue arrows) features of the ***place***.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › New York

8.3 Why do people live in certain places?

8.3.1 Changes over time

People choose to live in specific places for a wide range of reasons. These reasons can be broadly divided into **pull factors** and **push factors**. The combination of reasons varies from person to person, and what is an advantage for one person may be seen as a negative by someone else.

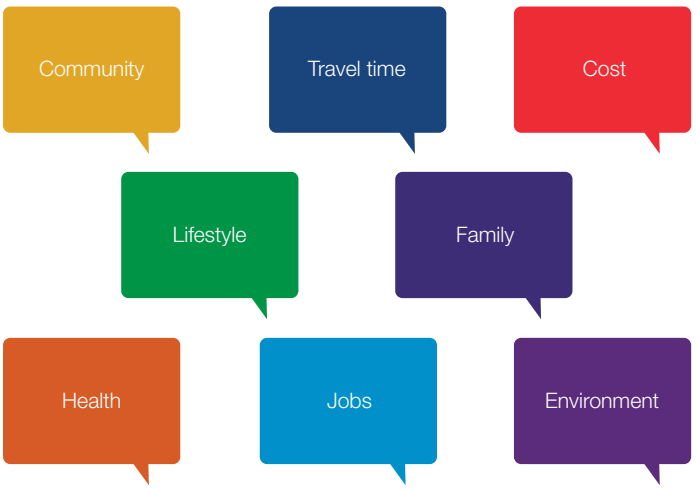
It is also true, though, that the reasons people choose to live in a place may change over time. 'Liveability' refers to what a place is like to live in. Over time, places change.

pull factors positive aspects of a place; reasons that attract people to come and live in a place

push factors reasons that encourage people to leave a place and go somewhere else

Some of the factors that influence the liveability of a place are shown in the figure below.

FIGURE 1 Factors that may influence where we choose to live

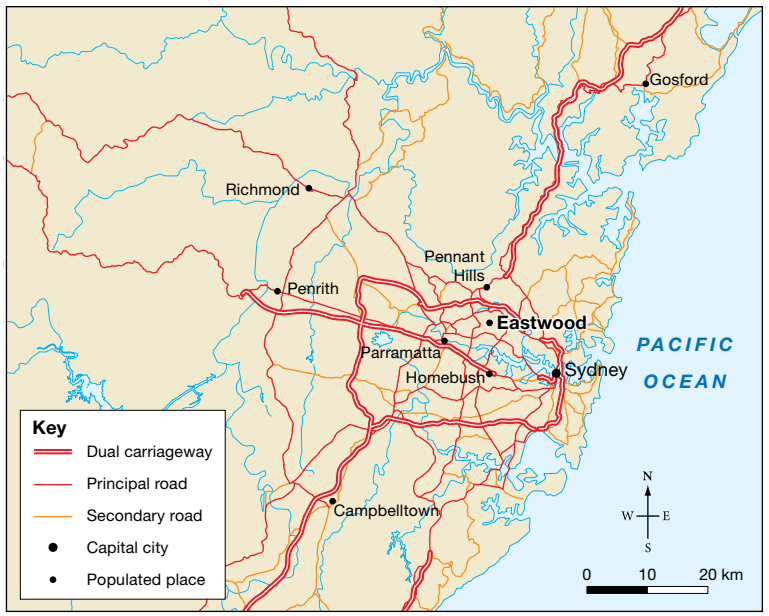


Many of these factors change throughout a person's life. For example, where a 20-year-old single person wants to live is often quite different from where someone in their forties, or someone with a partner and two teenage children, may want to live.

Eastwood is a Sydney suburb located 17 kilometres north-west of the Central Business District.

It is marked on the map of Sydney (figure 2). This map shows more of the area of Sydney, with little detail of what the suburb of Eastwood actually looks like.

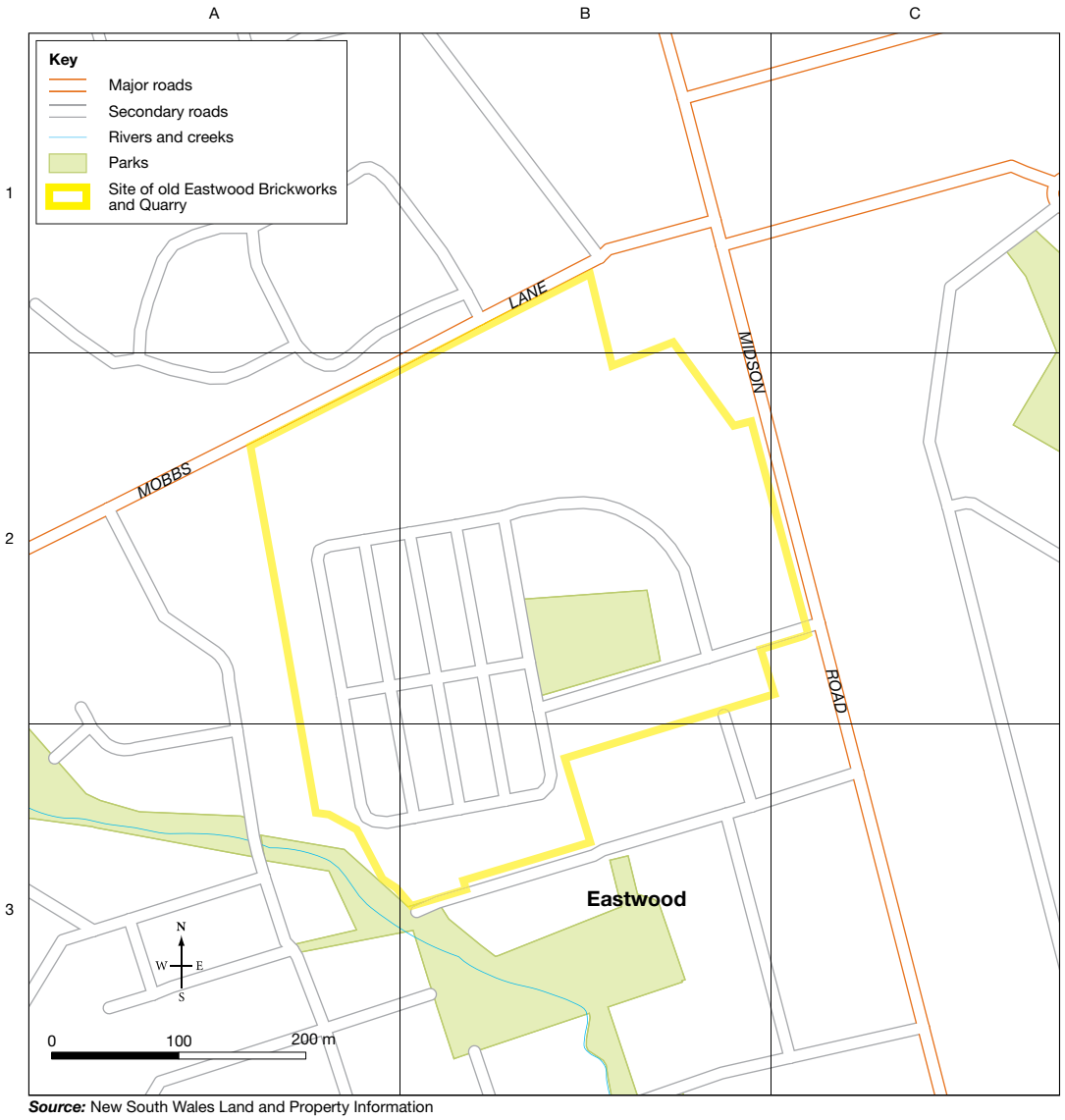
FIGURE 2
Map of Sydney showing the location of Eastwood



Source: Geoscience Australia

From 1913 until 2003, the Eastwood Brickworks operated at a site located at the corner of Midson Road and Mobbs Lane. This site is shown in figure 3.

FIGURE 3
A map showing the Eastwood Brickworks site



Source: New South Wales Land and Property Information

This map shows basic detail such as names of major roads, creeks and parks of the suburb of Eastwood. Figure 3, compared to figure 2, is said to have a larger scale: that is, it shows a larger amount of detail of a smaller area of land.

The Brickworks site contained a quarry, brick-making facilities, three brick kilns and two chimneys (figure 4). Bricks were in great demand for building as Sydney suburbs grew. Up to 35 000 bricks were made per day. Residents living near the site reported hearing blasting from the quarry and seeing dust in the air. The Eastwood Brickworks were an important source of jobs during its operation.

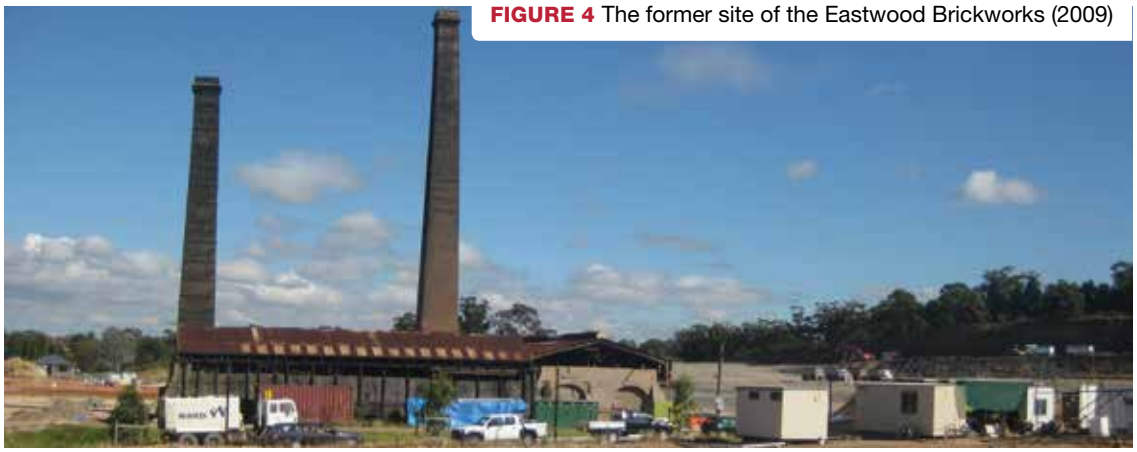


FIGURE 4 The former site of the Eastwood Brickworks (2009)

FIGURE 5 An artist's drawing of Eastwood Brickworks site (2003)

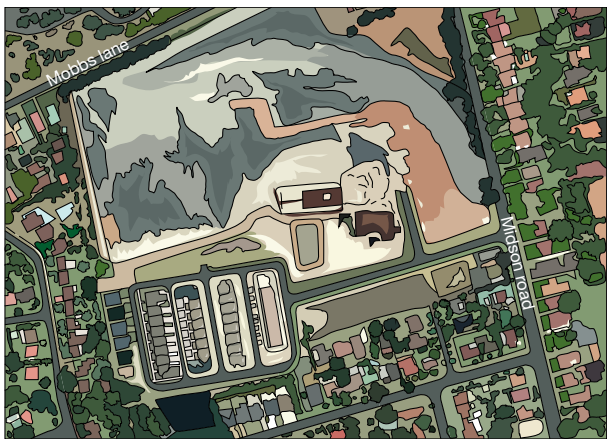


FIGURE 6 The former industrial site has been transformed into a residential zone (2009).

FIGURE 7 Aerial view of Eastwood residential estate (2015)

FIGURE 8 New housing has been built above the former brick kilns.

ACTIVITIES

IDENTIFY

1 Refer to figure 1. Imagine you have been asked to prepare a sign to highlight the positive features of the area in which you live. What factors would you promote about your suburb or town?
2 What impact would the industry at Eastwood have had on neighbouring residents of this industrial site?
3 Identify the push and pull factors for residents of Eastwood living beside the brickworks when it was an industrial site?

EXPLAIN

4 Refer to figure 3 and figures 5 and 7. Suggest a reason for the rounded shape of the housing estate at the north-east corner.
5 Suggest reasons why people would continue to live in an area that is changing around them.

APPLY

6 Present the answers using a column graph, correctly and fully labelled (see SkillBuilder 15.6 'Creating a simple column or bar graph').
7 As a class, discuss the pattern of reasons shown by the graph, and the possible explanations for this. For example, how important to people are social connections?

INVESTIGATE

8 Use Google Earth to find your town or suburb.
   a Use the historical imagery icon to display the range of images available for your location.
   b Move the slider along the timeline to show aerial views of changes to a place.
   c Select two times along the timeline to screen clip an image.
   d Annotate the changes that have occurred to the environment.
9 Suggest future changes to your suburb or town? What impact do you think this might have on the positive factors you identified in question 1?

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Interactivity
Push/pull factors
Use this interactivity to see how many factors you can correctly classify as either push or pull factors.
Searchlight ID: int-3089

FOCUS ON FIELDWORK

Investigating why a place is special

Using the tips in SkillBuilder 20.11 'Using advanced survey techniques — interviews', create a survey designed to explore the reasons for moving to or from a place or an environment. Why do you think people live where they do?

Surveys can be distributed digitally or face to face. Perhaps your questions may ask about the length of time lived at the current address and reasons for moving. Classify the responses using the four categories identified below in a table similar to the following example.

Student	Resources	Employment	Relationships	Lifestyle
Gina	Near major shops	Near my dad's work		
Miguel		Near my mum's work	Close to my family who came to Australia earlier Close to my father's best friend	
Daniel				Near the sea, as we all sail or surf

8.4 Where do you live and why?

8.4.1 How did I get here?

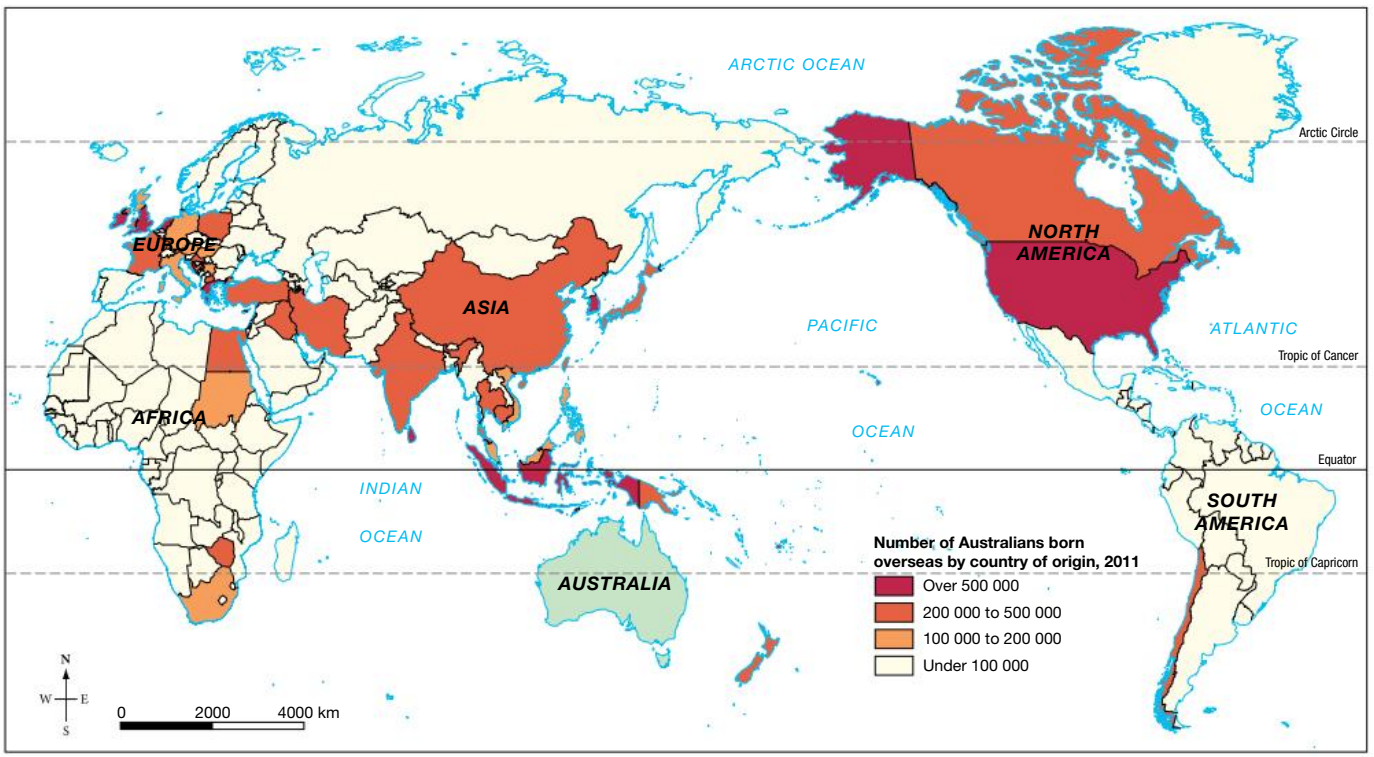
When we first learned to write our address, we often included our house number, street, town, city, state, country, continent, hemisphere, planet and universe. You could also identify your location with GPS coordinates, a grid reference or by use of latitude and longitude. Knowing the place where you are is important but so is how you got there.

Have you always lived where you are currently living, or did your family arrive from another place? What decisions were made by your parents or grandparents, which resulted in your family living in your place, house, state, country or hemisphere? Over 28 per cent of Australia's population were born overseas, and it is estimated that most will move homes between 11 and 12 times during their lifetime.

What is your story?

Activity 1 allows you to investigate the place where you live. It is a task of discovery, and will take you some time to complete. Your aim is to discover your family's migration story and why you live where you do. Does your family have a recent migration story or did your family arrive with the First Fleet? Do you have Aboriginal or Torres Strait Islander heritage? Did your grandfather build the house you live in or did your parents or carers build your house? How has the place your family lives in changed over time and space? Many Australians living here today, such as the people in figure 2 below, were not born here. In fact, in mid 2015, over a quarter of Australia's estimated resident population were born overseas. Figure 1 shows us that many Australians were born in the United Kingdom, New Zealand, and the United States of America.

FIGURE 1 Australians born overseas



Source: Spatial Vision

FIGURE 2 The story of four Australians who were born overseas

Cindy: When I lived in Bejing I was called Jing-Wei. I came to Sydney in 1988 to study economics at university. I became an Australian citizen in 1993. I now have three Australian children.

Andrew: I came to Perth with my wife and three children in 1993 just before Nelson Mandela was elected president of South Africa. We were concerned for our safety in Johannesburg and were keen to start a new life in a country with a similar climate and language. Now two of my brothers also live in Australia.

Lucy: My brother moved from Palmerston North in New Zealand to Melbourne for work in 2006 and I followed him the next year. I like living in a larger city. There is more going on and I get paid a lot more. One day I might return to New Zealand.

Deepak: My family moved from Delhi in 1988 when my father was offered a job in a computer company in Adelaide. There were not many Indian kids in my school but I studied hard and went to university. I now have three children and live in Newcastle.

ACTIVITIES

INVESTIGATE

1 This task allows you to discover your family's migration story and why you live where you do.

Step 1

What can you find out for yourself?

Your place

- What is your address? Write out your full address, including your hemisphere, latitude and longitude.
- Use Google Maps to locate and identify your house in your street. Download an **aerial view** and a **street view** of your house.
- Annotate your aerial photo or map to identify who lives in your house, including pets, and which parts of the house they use. You could illustrate the people who live in your house in a cartoon — like the stickers, or decals, of families that people put on their cars.
- Ensure that your map has a compass, approximate ***scale*** and appropriate title.

Step 2

Your neighbourhood

- Using Google Maps, download an aerial view of your street or at least the eight closest houses or dwellings.

Step 3

How long have you lived at this address?

If you have previously lived somewhere else, list and map your past addresses. How many times have you moved? Share with your class the information that you have collected so far.

Step 4

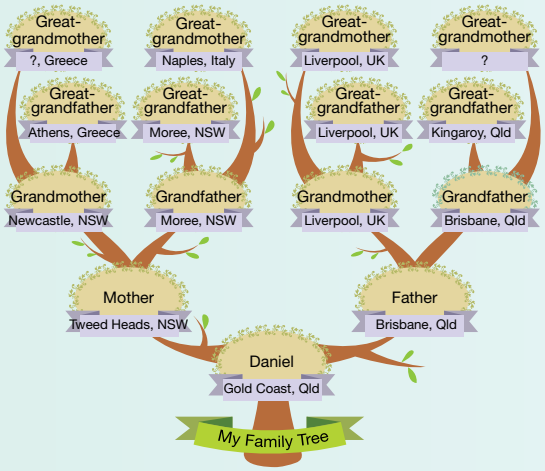
How did you get here?

To investigate the rest of your story, you will need to speak to your parents and possibly your grandparents. As you collect information about where your parents and grandparents were born, create a family tree of ***places***. Try to find out why and when your relatives came to Australia. Figure 3 illustrates how this may look.

- Where were your parents/carers born?
- Why did your parents move to where you now live?
- Why did your grandparents and great-grandparents move from their ***place*** of birth?

Use the **Family tree template** weblink in your eBookPLUS to create your family tree.

FIGURE 3 An example of what your family tree may look like



APPLY

2 Use your family tree, to create a map that shows this ***interconnection***.

Things to think about before starting your map:

- What ***scale*** and size of map will you need?
- Would you be better off having two maps? In the figure 3 example, Daniel's parents

aerial view an image taken from above an object; also known as a bird's-eye view

street view an image of a building taken from the road or footpath, at street level

eBookplus

Weblink
Family tree template

FIGURE 4 Immigrants arriving in Australia by plane, 1967

and grandparents mostly came from New South Wales and Queensland but most of his great-grandparents came from Europe. To map this information, he should use a world map plus a larger ***scale*** break-out or inset map of New South Wales and Queensland.

- Draw an arrow to indicate the movement between the two ***places***.
- What is an appropriate title for your map?
- Would you like to illustrate your map with images of your relatives, their houses, flags of the countries they came from or images of the transport that they used? If you wish to add images, you will need to have a larger ***scale*** base map than if you just used symbols.
- You could annotate the map with the reasons your relatives moved.

GEOskills TOOLBOX

Population profiles

A place will reflect the characteristics of the people who choose to locate there. Populations bring special qualities to a location and shape the type of community that develops. A population profile is based on Census data and it details factors such as age, gender, ethnicity, education and working characteristics. Population profiles for your local area provide clues about people living in your town or suburb.

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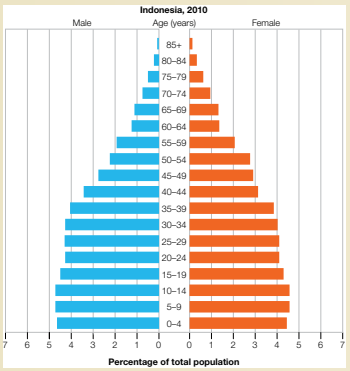
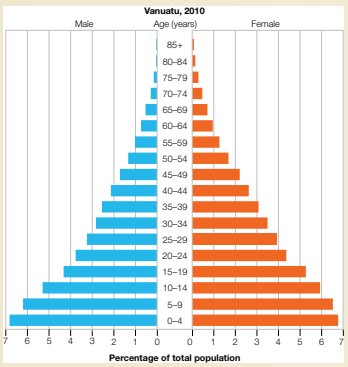
8.5 SkillBuilder: Interpreting population profiles

What is a population profile?

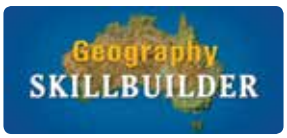
A population profile, sometimes called a population pyramid, is a bar graph that provides information about the age and gender of a population. The shape of the population profile tells us about a particular population. Comparing population pyramids of different places helps us try to understand how and why they may be similar or different.





eLesson

Watch this video to learn how to interpret population profiles.



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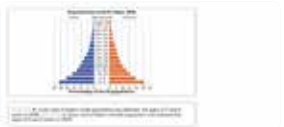
Interactivity

Try this interactivity to learn how to interpret population profiles.



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8.6 Why do Australians live in remote places?

8.6.1 Settling inland Australia

Inland locations, away from large cities and coastal areas, are attractive places for many Australians to live. Why do some people choose to live in places where their nearest neighbour may be 50 kilometres away or a weekly sporting activity involves a six-hour car trip? Why do they find remote places more liveable?

The general shift of Australia's population for the last 100 years has been towards the major cities and away from the country (see figure 1). The average age of farmers in Australia is about 53 years, which is 13 years older than the rest of the workforce. Most children of farmers leave the country and seek education and work opportunities in large cities. There have been many attempts by governments and private industry to encourage people to settle in remote locations situated far from major centres of population. Soldier settlements and mining developments are two such schemes.

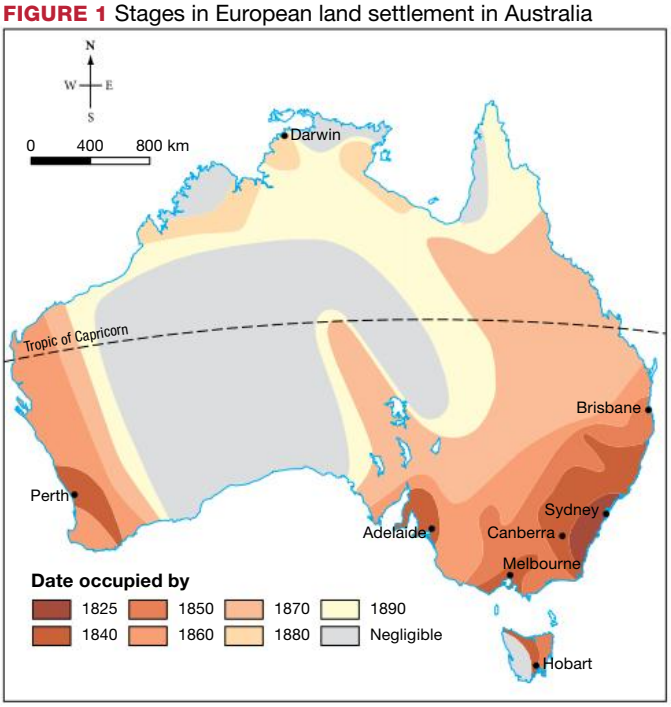
Government policy

The federal, state and local governments make decisions that shape patterns of settlement. In Western Australia, the future is uncertain for 274 Indigenous communities that rely on government funding for health, education, housing and social assistance. Remote settlements in WA are being assessed to determine what support they might need in the future; these decisions may impact where people choose to live. In New South Wales, local governments have combined to promote an Evocity project designed to attract people to regional centres.

Soldier settlement schemes

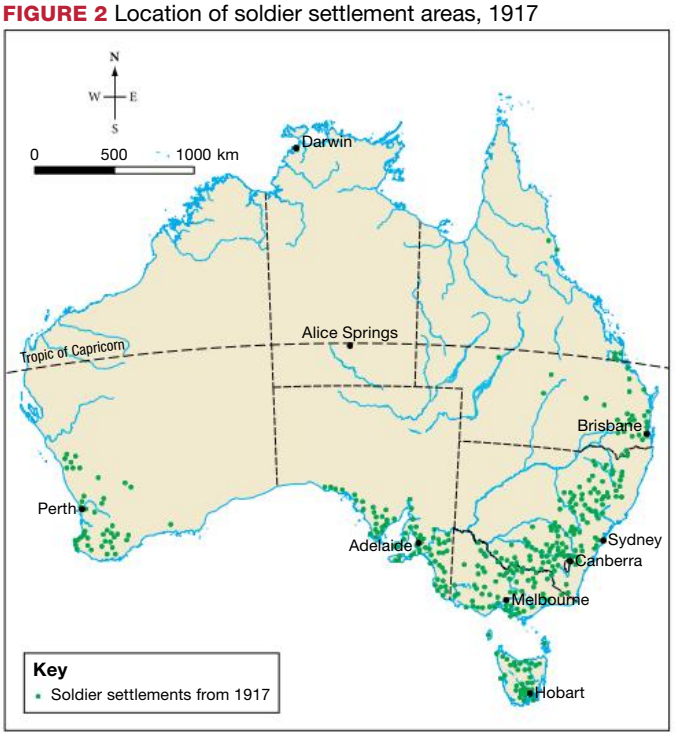
After both World War I and World War II, the state and federal governments of Australia began a program of providing land to returned soldiers (figure 2). The programs were designed to give soldiers work and to attract people to places that were sparsely inhabited at

FIGURE 1 Stages in European land settlement in Australia



Source: Spatial Vision

FIGURE 2 Location of soldier settlement areas, 1917



Source: Spatial Vision

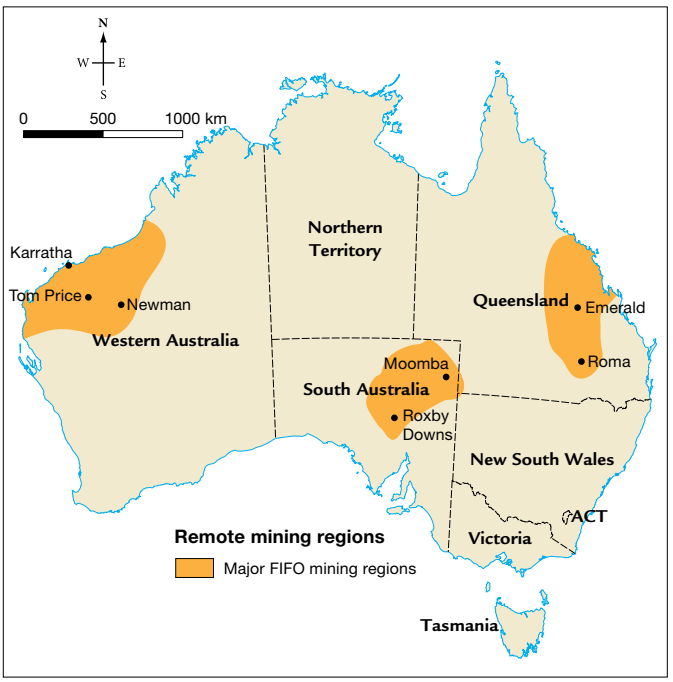
the time, such as Griffith and Dorrigo in New South Wales (see figure 2). The settlers were expected to stay on their land for five years and to improve the quality of the land they were farming. Many farmers are descendants of these soldiers and continue to work the land. Over 25 000 soldiers were resettled after World War I.

Mining developments

Mineral resources are being extracted at **remote** locations such as Broken Hill, The Pilbara and Tom Price. Workers are attracted to these areas by high wages and job opportunities. For example, a truck driver can earn $150 000 per year. Some workers **fly in and fly out (FIFO)** for their shifts. They live with their families in less remote places and fly in for a shift that may last several weeks, then flying home for their days off. Transport and communication technology enables the workers to be linked to work opportunities in isolated locations.

FIGURE 3 Soldiers returning from the war were offered opportunities to settle in remote locations.

FIGURE 4 Remote mining regions



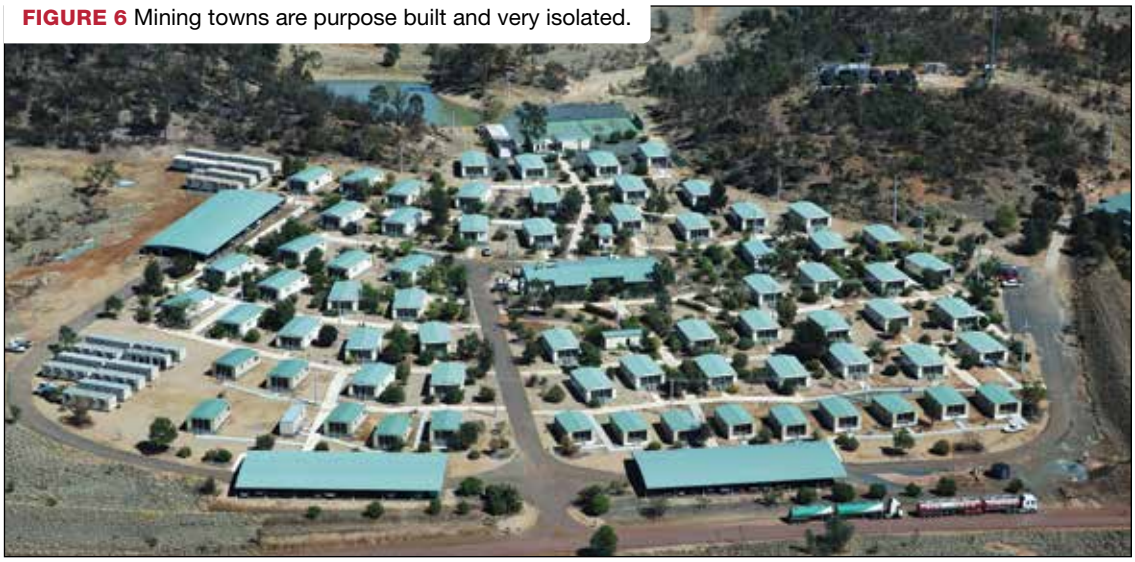
Source: Spatial Vision

FIGURE 5 Workers travel by plane from Brisbane to Tom Price in less than 5 hours.

remote describes a place that is distant from major population centres

fly in, fly out (FIFO) describes workers who fly to work in remote places, work 4-, 8- or 12-day shifts and then fly home

FIGURE 6 Mining towns are purpose built and very isolated.



eBook*plus*

Interactivity
Remote living
Use this interactivity to explore remote areas Australians live in.
Searchlight ID: int-3090
Weblinks
- Soldier settlement
- FIFO
- Distance Education

sparse thinly scattered or unevenly distributed; often used when referring to population density

ACTIVITIES

IDENTIFY

1 What makes a ***place*** remote?
2 What does FIFO stand for?
3 What challenges would **you** face living in a remote location?

EXPLAIN

4 Refer to figure 1, showing the history of Australia's settlement. Describe the ***change*** in European settlement of Australia between 1825 and 1860.
5 Refer to figure 2 and a map of Australia showing annual rainfall. Were soldier settlement areas located in ***places*** that receive good rainfall for farming?
6 Suggest reasons for the **sparse** settlement of areas targeted by the soldier settlement scheme?
7 What resources are being mined in each of the ***places*** shown in figure 4?
8 What might be an advantage to the mining companies of having FIFO workers?
9 Were any 1917 soldier settlements attempted in parts of Australia that today are remote mining regions with a FIFO workforce? Explain your answer using information from figures 2 and 4.

APPLY

10 Research one soldier settlement area using the **Soldier settlement** weblinks in your eBookPLUS. In your opinion, how successful was the scheme in populating a remote ***place***?
11 Using the **FIFO** weblink in your ebookPLUS, explore the challenges faced by communities in FIFO locations. Suggest strategies to overcome the issues being faced and to promote local employment in the current FIFO mining locations.

INVESTIGATE

12 How might people be encouraged to move from the coastal fringe to the more remote ***places*** of Australia? What could make you or your family move or relocate? Produce a short film, snappy slide show, or an advertising campaign that highlights the pull factors which might attract people to live in the more remote parts of Australia.

FOCUS ON FIELDWORK

Task

Discover why people might live in remote places.

Preparation

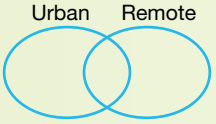
- What do you understand by *remote*?
- Consider the challenge of getting an education when you live 300 kilometres from the nearest school?
- What would you like to ask a teacher of remote students?

Fieldwork

Use the **Distance Education** weblink in your eBookPLUS to access the tourist sessions that run daily during school term. You will be able to talk with a teacher and to sit in a live session with the students.

Reflection

Prepare a Venn diagram to compare schooling in an urban place with schooling in a remote place.



myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Population of Australia

8.7 What draws people to rural areas?

8.7.1 Regional relocation

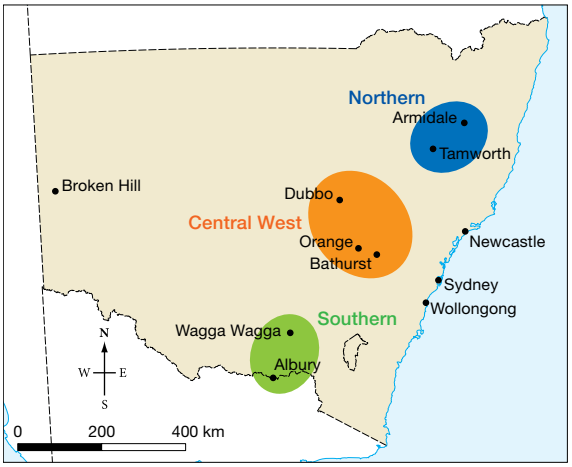
Rural areas offer a change of lifestyle and opportunity to people moving away from large urban places. Regional centres offer a range of employment opportunities in primary industries such as farming, mining and forestry or in manufacturing and service industries. A 'tree change' may offer a more relaxed and affordable lifestyle.

In New South Wales, capital city residents and industries are offered incentives to move to rural communities. Seven local council areas have worked together to promote Albury, Armidale, Bathurst, Dubbo, Orange, Tamworth and Wagga Wagga as centres of Energy, Vision and Opportunity; that is EVOCITIES. Residents are attracted to a cheaper lifestyle and less stressful commute to work and school (see figure 1). Industries can access larger areas of land, a local workforce and fewer water restrictions.

Well-developed internet and mobile phone technology enables new residents to maintain interconnections with family, friends and workplaces. Some people choose to move to rural locations but continue to work at their existing workplace electronically, or commute occasionally.

FIGURE 1 Tree change lifestyle opportunity

FIGURE 2 The location of Evocities in New South Wales



Source: Museums and Galleries of New South Wales.

8.7.2 Sustainable development

Evocity growth is being designed sustainably, while construction is environmentally sensitive to accommodate larger population numbers. The seven Evocity locations promote sustainable approaches to the supply of water, power and health services. Sixty-six per cent of Dubbo's growth in 2014 came from residents registered through the Evocities program.

FIGURE 3 Solar power is a renewable source of energy.

FIGURE 4 Water saving tanks for residential use

FIGURE 5 Connected and well-designed cycle ways

8.7.3 Sense of community

Most rural towns have a strong sense of community. Albury city council constructed two wood fired ovens in a centrally located, riverside park. Every second Sunday, Albury residents are invited to meet, learn, cook and share a meal together at this free activity (see figure 6) whilst Bathurst promotes a buy local campaign (figure 7).

FIGURE 6 Albury community wood fired oven

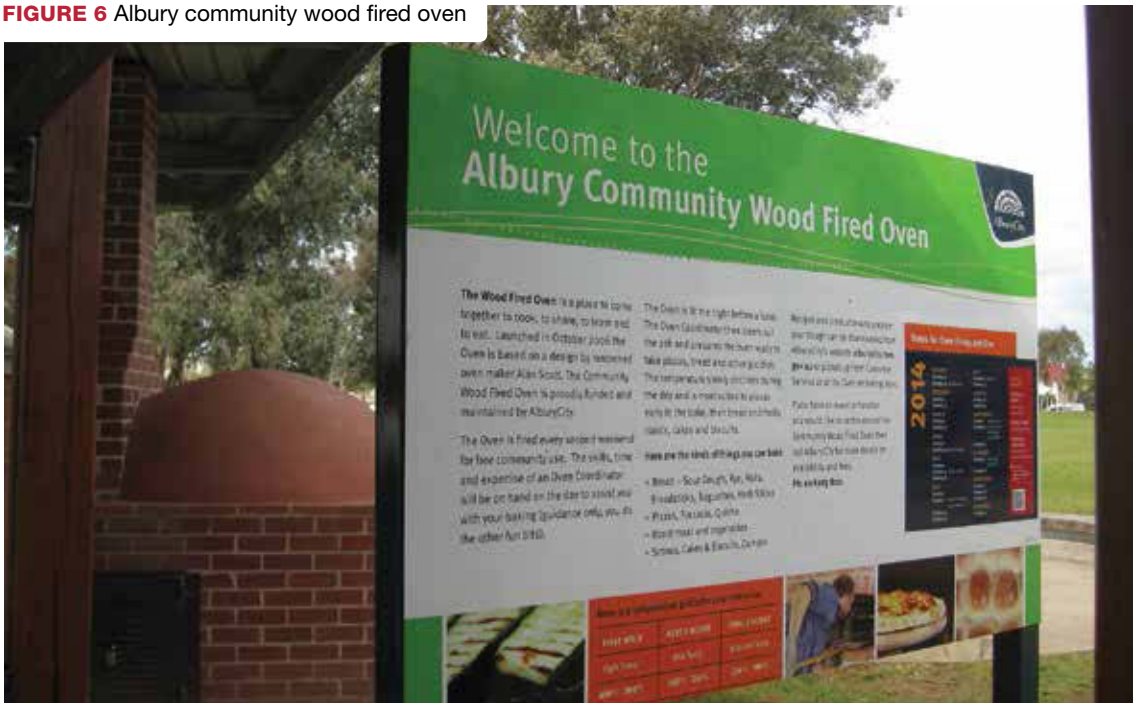


FIGURE 7 Bathurst's Buy Local campaign is designed to promote community.

ACTIVITIES

IDENTIFY

1 What is an Evocity?
2 Refer to figure 3 to name the Evocities located in New South Wales.

EXPLAIN

3 Suggest reasons for the development of Evocities in rural areas.
4 Suggest one Evocity location that would best suit your family's circumstances.
5 Suggest reasons for this choice.
6 What concerns would you have about leaving your home to settle in this ***place***?

INVESTIGATE

7 Use the internet to research the ways that new residents in your local area are welcomed into the community.

APPLY

8 Figure 1 shows people holding a cartoon demonstrating reasons to locate to an Evocity. As illustrator for a local newspaper, prepare a series of cartoons to encourage people to move away from the coastal fringe to more remote ***places*** of Australia.
9 Produce a short film, a snappy slide show, an infographic or an advertising campaign that highlights the pull factors that might attract people to live in more remote parts of Australia.

8.8 What draws people to Griffith?

8.8.1 Griffith and surrounding region

A unique sense of place exists in this rural New South Wales town. Griffith supports a growing population of more than 26 000 people, with large numbers of overseas born residents having arrived from parts of Italy and India.

FIGURE 1 Farms in the Griffith area support businesses in the town.

Around Griffith, water is directed into channels that run through the settlement and farming areas. A reliable water supply and available farmland attracted many settlers to this area after irrigation was introduced in 1912.

Griffith is located within rich farming lands of the Murrumbidgee Irrigation Area. The climate in this area is semi-arid (warm, with unreliable rainfall) and the area supports a variety of agricultural industries such as viticulture, fruit growing and rice production. The picking, processing and distribution of locally grown rural products provides employment and training opportunities for seasonal workers and the local population during harvesting periods.

ACTIVITIES

IDENTIFY

1 Using the figure 2 map key, copy the symbol for each of the following features into your notes.
   - a Orchard or vineyard
   - b Watercourse or canal (irrigation channel)
   - c Built up area

2 What land use is found at:
   - a AR 1099
   - b AR 1105?

3 What is the direction of the town of Widgelli (AR 2000) from Griffith Airport (AR 1409)?

4 What is the direction of Yenda (AR 2509) from Widgelli (AR 2000)?

5 What man-made feature is found at GR 180095?

6 What is the height of the land at GR 091084?

APPLY

7 Compare the pattern made by irrigation channels with that made by natural waterways such as Mirrool Creek. Describe your findings.

8 There are many farms in the Griffith region, which means there are many people in the area to support shops, businesses, schools and cultural activities. However, in some parts of Australia, farms are very big and it is a long way to the nearest neighbours. Anna Creek, a beef cattle property in northern South Australia, is 24 000 square kilometres (2 400 000 hectares). The property is in a semi-arid region of South Australia, where vegetation is sparse and the nearest town for supplies is 170 kilometres away.
   - a Use the scale to calculate the number of square kilometres covered by the map in figure 2.
   - b How does this compare to the single farm of Anna Creek?
   - c At which location, Anna Creek or Griffith, would you be most likely to satisfy each of the following wishes: to play in a sports team every week; to regularly buy clothes; to collect data about lizards; to grow a lush lawn; to safely learn to drive; to have a private airstrip?

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8.9 Are rural communities sustainable?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

FIGURE 2 Topographic map extract of Griffith

Source: Land and Property Information, NSW.

8.10 What are 'lifestyle' places?

sea change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small coastal town

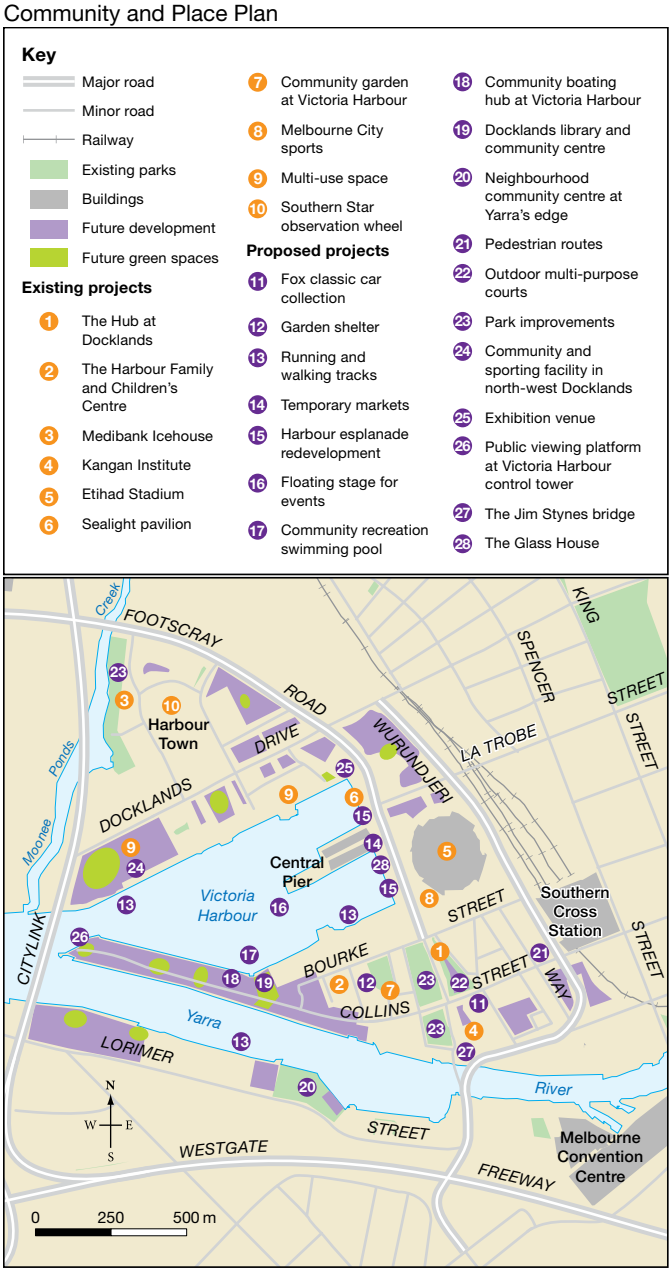
tree change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small country town, in the bush, or on the land as a farmer

8.10.1 Melbourne Docklands

A growing number of people are choosing to live in residential complexes that provide special access to shared recreational and community spaces. Many of these complexes are being built in locations that are undergoing change. During the 1990s, the healthy state of the growing Australian economy meant more people were earning higher incomes. This gave them access to a greater choice of lifestyles.

For some people, 'lifestyle choice' means escaping the rush of the modern urban society by choosing a **sea change** or **tree change**. For others, it means 'downsizing' into a smaller home, moving closer to the city centre, and its restaurants, cinemas and public transport. As a response to the large demand for this lifestyle, governments have been able to re-zone older industrial areas and to transform the land into a variety of lifestyle complexes. Such places offer the convenience of employment, residences, recreation and services all in one location. They also change older industrial areas into more vibrant communities.

FIGURE 1 The future by 2022 and beyond: Docklands Community and Place Plan



Source: Spatial Vision

Planned development and lifestyle amenities

The Docklands development in Melbourne was designed to be the face of a new-look Melbourne: a new community identity of restaurants, entertainment and apartment living (see figure 1). Docklands is a suburb of Melbourne, located two kilometres west of the central business district (CBD). It has a population of over 5700 people. It was planned that Docklands would be a 24-hour city for visitors and local residents. It occupies 200 hectares — an area bigger than Melbourne's central business district (which is about 175 hectares).

The local residents of this 24-hour city rely on public transport, as few have cars (see table 1). Most residents are professionals (see table 2).

FIGURE 2 Convenient access to restaurants

TABLE 1 Number of cars per dwelling

Number of registered motor vehicles	Docklands (%)	Australia (%)
None	26.8	8.6
One motor vehicle	51.9	35.8
Two motor vehicles	16.2	36.1
Three or more vehicles	3.0	16.5
Number of motor vehicles not stated	2.0	3.0

TABLE 2 Selected occupations of people

Occupation	Docklands (%)	Australia (%)
Professionals	37.7	21.3
Managers	21.5	12.9
Community and personal service workers	6.5	9.7
Technicians and trade workers	5.7	14.2
Labourers	2.1	9.4
Machine operators and drivers	1.2	6.6

The lifestyle complexes offer a more convenient lifestyle for busy people. Many of the lifestyle complexes being constructed in locations close to the city include a range of facilities such as gymnasiums and swimming pools and provide security (figure 4). High-density living provides convenience but may result in a loss of privacy. In Rio de Janeiro (figure 5), lifestyle places, occupied by more affluent residents, contrast sharply with the shantytowns or favelas.

FIGURE 3 High-density living arrangements

FIGURE 4 Shared community facilities

FIGURE 5 A Rio de Janeiro lifestyle complex

FIGURE 6 Security measures and restricted public access to lifestyle living areas

ACTIVITIES

EXPLAIN

1 Study figures 2 to 4. Identify the features in the photographs that indicate that the people living in these ***places*** have the resources to choose to live in such ***environments***.

2 Create a cartoon that summarises the differences between a sea ***change*** and a tree ***change***.

3 Refer to the two living spaces shown in figure 5.
- **a** What similarities and differences can you see in the living spaces shown in figure 5?
- **b** What factors lead to the differences evident in these two spaces?

4 Refer to table 1.
- **a** Identify two key facts the table reveals about the number of cars Docklands residents have compared to the average for other Australian suburbs.
- **b** Think of a reason to explain this.

5 Refer to table 2.
- **a** Identify two key facts the table reveals about Docklands residents compared to the average for other Australian suburbs.
- **b** Think of a reason to explain this.

6 Refer to figure 1. Which features (existing or proposed) would make Docklands a 24-hour suburb?

APPLY

7 Use online resources to investigate the current state of the Docklands development in Melbourne. Identify the planned zones and features that are in operation and those that have been changed, removed or not built.

8 Based on your research, do you believe that the Docklands ***space*** provides an enjoyable lifestyle for the people who live there? Give reasons for your answer.

INVESTIGATE

9 In groups of four, use a graphics software program to create a concept wheel that explores the meaning of the word *lifestyle*. Display all the wheels in a class electronic presentation.

10 As a class, compare and discuss the lifestyle wheels that you produced in question 9. Is there a common view of lifestyle that is representative of the whole class?

8.11 Where is my place?

8.11.1 The place I live in

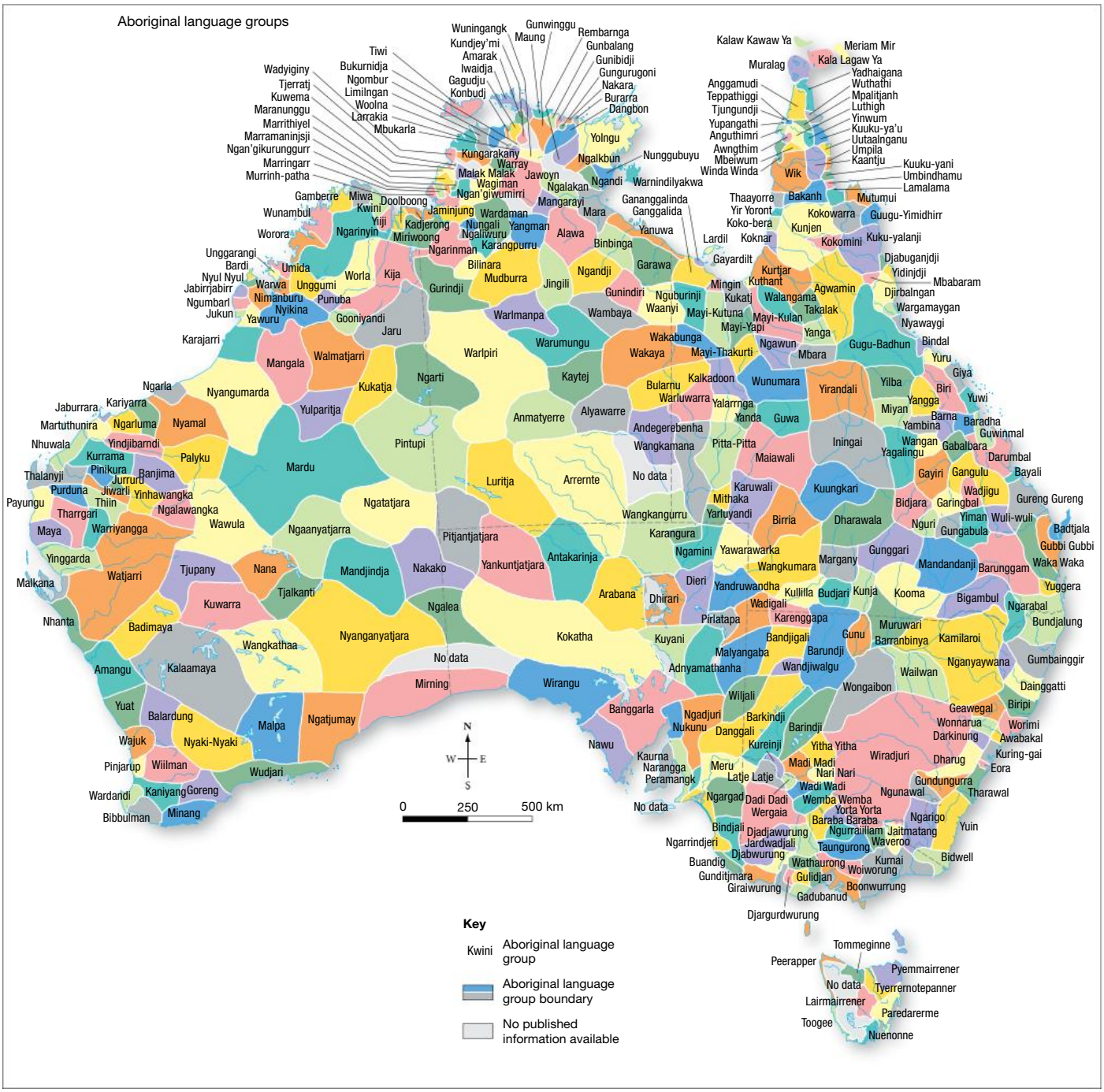
What is your neighbourhood or local place like? All of us live in a community, and these are often centred around the place where we live, go to school or work. Teenagers have different types of local places that have special meaning for them, each one at a different scale: their bedroom, home and neighbourhood.

When you live in a neighbourhood, you become familiar with all the things that help to create the character of the place. Sometimes a neighbourhood is made up of people who have similar interests

and beliefs, whether these be cultural, sporting, environmental or job-related. Other neighbourhoods have a mixture of people from different backgrounds, creating a vibrant, multicultural community identity. The fact that Australian neighbourhoods can be so different is what makes Australia such an interesting place to live in.

Neighbourhoods have always existed in Australia. The 'country' that is special to a particular group of Indigenous Australians is often based on language. There are about 29 clan groupings within the *environment* and *space* that the Sydney metropolitan area occupies today. Each tribe controlled a region that had definite boundaries (figure 1). Within each tribe, there were different dialects that overlapped. These dialects were spoken by different clans — groups of related families. Thus, these nations saw, and often still see, their neighbourhood as the region in which people spoke the same language and had the same customs, such as marriage rituals. People were, and are, socially connected.

FIGURE 1 The places belonging to the First Australians



Source: Spatial Vision

8.11.2 Describing our neighbourhoods

mental map a drawing or map that contains our memory of the layout and distribution of features in a place

Because nearly 90 per cent of Australians live in towns and cities, most people are likely to live in a street that is part of a suburb, town or city, and which itself is part of a state or territory. On the other hand, there are Australians who do not live in urban areas, but still live in their own communities that are just as distinctive as neighbourhoods in towns and cities. How can we describe where our local place is and what it is like? Sometimes, people try to use words to do this, but it is not an easy task. Geographers have no such trouble, however; they can use maps.

FIGURE 2 Mental map of Jayden's local place (by Jayden)

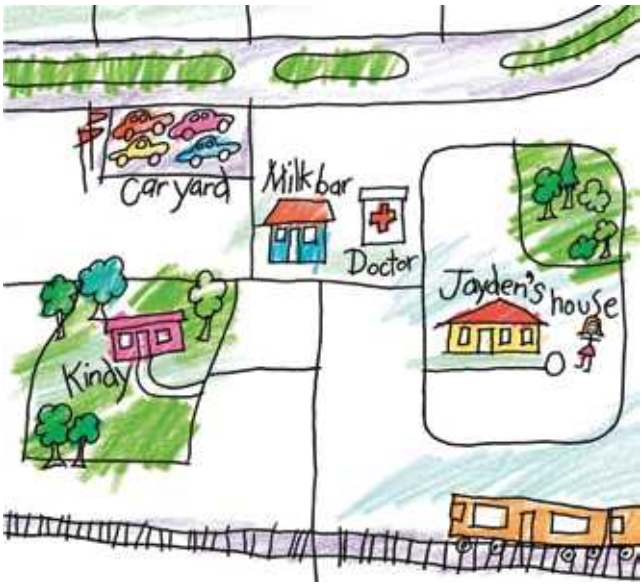


FIGURE 3 Mental map of Jayden's local place (by Annette, Jayden's mother)

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Interactivity
How did they live here?
Use this interactivity to discover how Indigenous Australians survived in the Australian environment.
Searchlight ID: int-3091

sketch map a simple labelled drawing of an area using a bird's-eye view

ACTIVITIES

IDENTIFY

1 Figures 2 and 3 show two mental maps of the same neighbourhood ***place***. One is drawn by Jayden, a Year 7 boy, and the other is drawn by his mother. Compare the two maps by drawing up a table like the one below and filling in the spaces.

	Features that are different	Features that are similar
Land use		
Transport		
Street layout		
Relative sizes		
Names of places		
Other		

EXPLAIN

2 Suggest reasons to explain the major similarities and differences between the maps drawn by Jayden and his mother. Think about factors such as age, duties during the day, transport and friendships.

APPLY

3 Create a **sketch map** of your neighbourhood or local ***place***. Locate your house in the centre of the sheet and work outwards from there. The map should be as detailed as possible. Include features such as:
- streets and their names
- houses of friends or family
- shops, parks, trees, post boxes, telephone poles, pedestrian crossings, railway lines and stations
- anything you can remember, but the map must be drawn from memory.

Present the map using geographical rules (BOLTSS). Since you are not drawing the map to a ***scale***, write 'Not to scale' in the correct position. Remember to use conventional colours and symbols as far as possible. Compare your mental map to an actual map of your neighbourhood.

a In what ways was your map accurate?
b Which features did you not mark on your map?
c Which parts of your neighbourhood did you know well and which did you not know well?
d Think of reasons to explain your answers to (c).

GEOskills TOOLBOX

Sketch maps

A sketch map is a simple, labelled drawing of an area using a birds-eye view. Figures 2 and 3 show Jayden's neighbourhood. The sketch map is not supposed to record everything that you can see; it summarises the more important features of a place.

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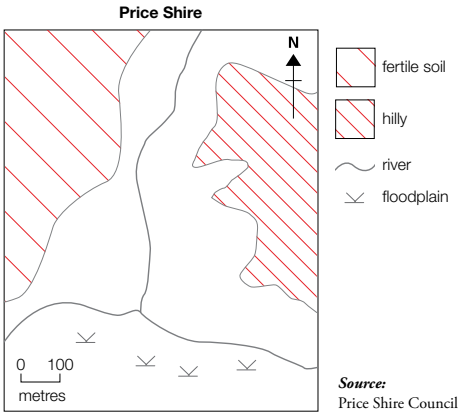
8.12 SkillBuilder: Constructing a basic sketch map

What is a sketch map?

A sketch map is a map drawn from an aerial photograph or developed during field work that identifies the main features of an area. Sketch maps are used to show the key elements of an area, so other more detailed characteristics are not shown.



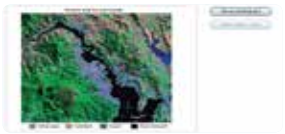
eLesson

Watch this video to learn how to construct a basic sketch map.

Searchlight ID: eles-1661

Interactivity

Try this interactivity to learn how to construct a basic sketch map.



Searchlight ID: int-3157

FOCUS ON FIELDWORK

Why do people choose to live here?

Preparation

Identify properties in an area that has real estate signs or advertisements promoting the selling points of the property. This may also be accessed by looking at Real Estate sites online.

Fieldwork

Record the points being promoted on a at least three signs.

What are the common selling points for properties selling in your chosen area?

Reflection

Create your own sign (no more than 100 words) to promote the special features of a place of your choice. To communicate a sense of place, include an image.

8.13 Where would you like to live?

8.13.1 What makes this place so liveable?

Where is your favourite place in Australia? Have you been to a holiday paradise, one that you think would be the perfect place to live? Is the climate perfect, the scenery spectacular? Is it safe, fun and the place for adventure? Is this place in a city, in the wilderness or in the next street? Is it paradise because your friends or family live there or because of the natural or built environment?

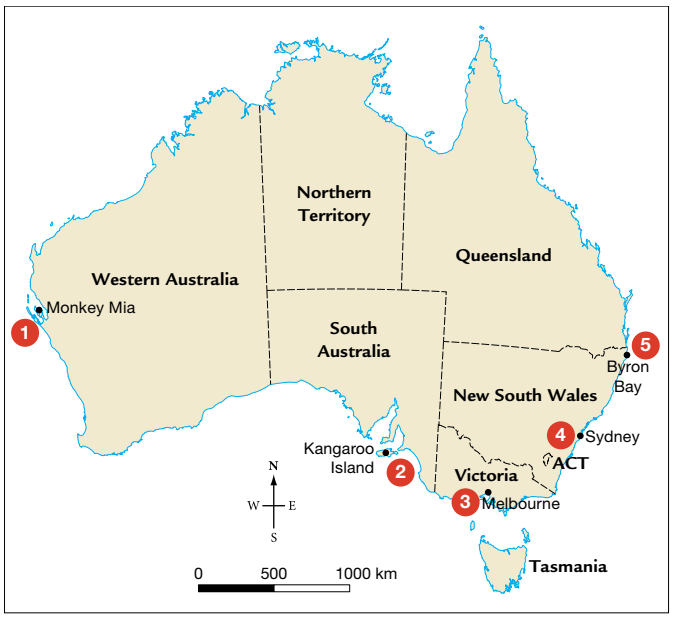
Among the most popular and beautiful tourist destinations in Australia are the Great Barrier Reef, Uluru, Melbourne, Sydney, the Gold Coast, the Great Ocean Road, Monkey Mia, Kakadu, the Tasmanian Wilderness, the Blue Mountains, Port Arthur, Byron Bay, Kangaroo Island and Ningaloo Reef. Many of these places have unique landscapes, located within naturally stunning environments. Four of these are predominantly **built environments**: Sydney, Melbourne, the Gold Coast and Port Arthur. The remaining 11 places are best known for their natural, often remote, and almost **wilderness** environments.

built environment a place that has been constructed or created by people

wilderness a natural place that has been almost untouched or unchanged by the actions of people

Some of these wonderful places are found in or close to cities and large towns; some have significant local populations; and some are quite remote. They are all places that attract large numbers of visitors every year. People come to see or experience an aspect of the local environment that brings them pleasure. These places are often perfect for a holiday but they may also be a place to live. Is it mostly the excitement of a big city, natural beauty, or some other factor that makes you decide which place is the most liveable?

FIGURE 1 Five of Australia's most popular places for tourists



Source: Spatial Vision

1 Monkey Mia is an environment where you can experience natural wildlife by interacting with dolphins. Monkey Mia is located in Shark Bay on the coast of Western Australia, 850 kilometres north of Perth. For over 40 years, a small pod of dolphins has come ashore to connect with beachgoers. The Department of Environment and Conservation provides staff who supervise the feeding of fish to these dolphins each day. It is an unusual opportunity for people to see wild dolphins up close, quite near to the shore. Monkey Mia is a place of great natural beauty without a huge tourist resort attached. Most visitors camp. It is an important stop on the around-Australia tourist trail. Fewer than 800 residents currently live near the Monkey Mia Resort.

2 Kangaroo Island is a place of natural beauty. It is Australia's third largest island, found about 160 kilometres south of Adelaide. It is a wildlife lover's paradise, being home to many native Australian animals in their natural habitats, including koalas, kangaroos, seals and penguins. It has remote, unspoiled beaches and interesting rocky outcrops. Although first settled in the late 1830s, its present population of over 4200 is the highest it has ever been. It was originally settled as a fishing and farming community but today is better known as a tourist destination.

3 Melbourne is the second-largest and most **liveable city** in Australia (2011 and 2014). It is the capital of Victoria and home to about 4.1 million residents. It is an attractive destination for tourists, who visit to enjoy its major sporting and cultural events, shopping, restaurants and theatre. Melbourne is located beside Port Phillip Bay and on the Yarra River. It is not a city known for its beautiful natural environment but it has become known for its distinctive laneways, bars and café culture.

liveable city a city that people want to live in, which is safe, well planned and prosperous and has a healthy environment

4 Sydney is a built environment in a beautiful setting and is Australia's largest and oldest city. It is often called the 'Harbour City'. Sydney is popular with both domestic and international tourists and is home to 4.6 million residents. It has many attractions, including restaurants, beautiful beaches, theatres, galleries and iconic landmarks. It has a beautiful natural environment with varied experiences provided by the built environment. This makes it an extremely popular destination for everyone.

5 Byron Bay is a beachside town in northern New South Wales, located 160 kilometres south of Brisbane. Byron Bay is a very relaxed place with a local community that includes many artists and retired hippies. It is an important surfing place, with easy access to offshore reefs and stunning beaches. It has become a popular place for 'schoolies' end-of-year celebrations. Byron Bay has a population of about 30 000 people, who rely heavily on tourism and agriculture for their income.

ACTIVITIES

IDENTIFY

1 Brainstorm a list of the features of your most liveable ***place***.
2 Is there a ***place*** in Australia that you have been to or heard about that is your most liveable ***place***? Locate this ***place*** on a map and use images from the internet or magazines to explain how it fulfills your list of features from question 1 above.

EXPLAIN

3 Is your most liveable ***place*** in a natural or a built ***environment*** or a mixture of the two?
4 What would be the advantages and disadvantages of living in your most liveable ***place***?
5 After reading the paragraphs numbered 1 to 5, which of these ***place*** is most similar to your most liveable ***place***? Explain your answer.

APPLY

6 If you were looking for a ***place*** to retire, which of the ***places*** in figure 1 would be best and why?
7 If you wished to work as a national park ranger, which of the ***places*** in figure 1 would be best and why?
8 If you were planning a career in the theatre, which of the ***places*** in figure 1 would be best and why?
9 If you wished to live in a relaxed coastal ***environment*** close to a capital city, which of the ***places*** in figure 1 would be best and why?

THINK

10 Design a map of your most liveable ***place***. Consider the natural and built ***environments***; distance to a city, services, job and recreational opportunities; climate; and lifestyle. Annotate your map to explain why this is where you would like to live. Use the **Nothing like Australia** weblink in your eBookPLUS to help find your ideal location.

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Weblink
Nothing like Australia

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8.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

The places people live in around the world have many different characteristics and features.

CHAPTER 9

People and places

9.1 Overview

9.1.1 Introduction

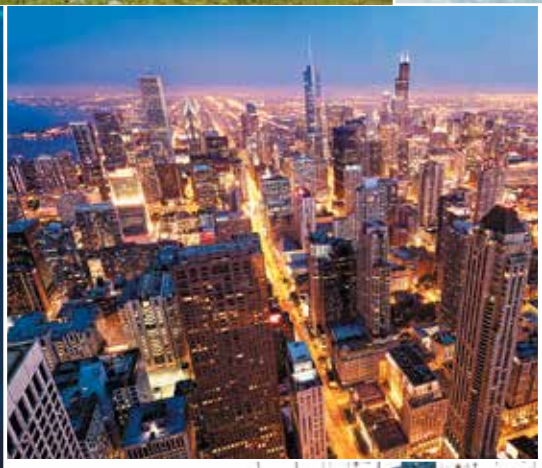
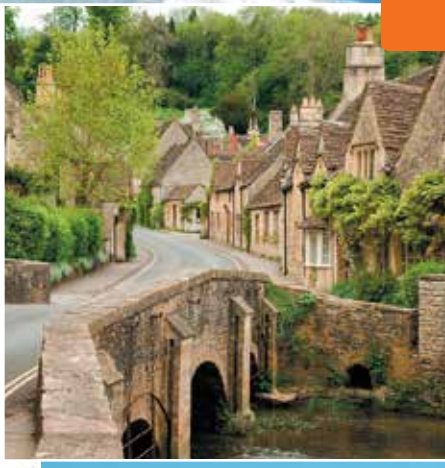
We all live in different places. Places are important to people, whether they are rural or urban, remote or central, permanent or temporary. But no two places are alike; they differ in aspects such as their appearance, size and features. In your mind's eye, try to picture the similarities and the differences between places such as a country town, a popular tourist destination, a remote village overseas, a scientific base in Antarctica, an Indigenous community and a mining town. You may think of others to add to this list.

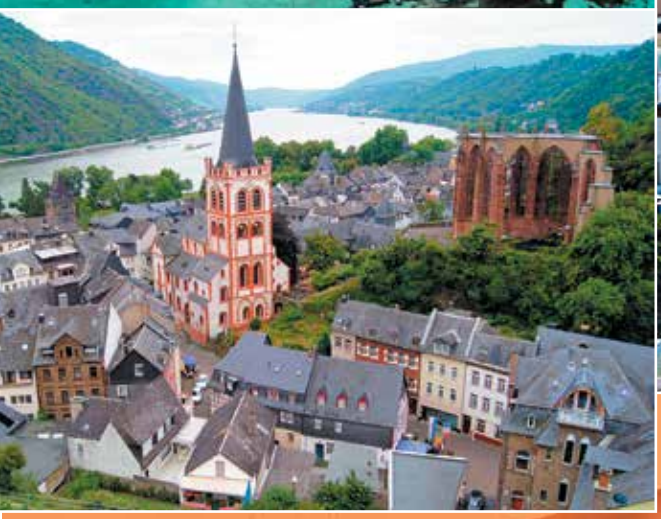
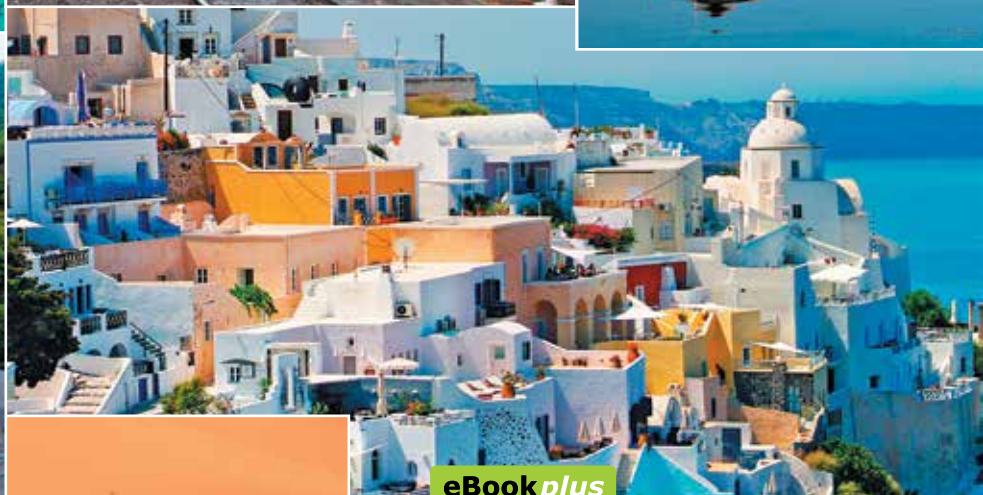
Starter questions

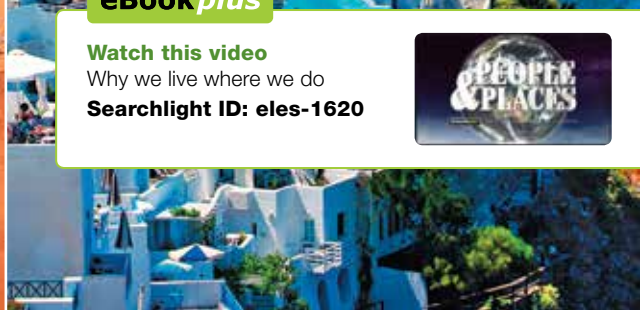
1. Brainstorm, as a class or individually, a list of other types of ***places*** in which people live around the world.
2. Choose three examples of ***places*** on your list that have been strongly influenced by the quality of the ***environment***. Explain how the ***place*** is influenced by the ***environment***.
3. Other than ***environmental*** qualities, what influences the characteristics of a ***place***?
4. How true is it that 'no two places are the same'? Use images on these pages, or ***places*** you know, to support your opinion.

Inquiry sequence

		Syllabus outcomes
9.1 Overview		
9.2 Where do most Australians live?		GE4-1
9.3 SkillBuilder: Understanding satellite images	eBook plus ONLINE ONLY	GE4-7
9.4 SkillBuilder: Using alphanumeric grid references	eBook plus ONLINE ONLY	GE4-7
9.5 Services and facilities important to wellbeing		GE4-1, GE4-3
9.6 How does distance affect lifestyle?		GE4-3, GE4-6
9.7 What is life like in a rural town?		GE4-4
9.8 Environmental quality and liveability	eBook plus ONLINE ONLY	GE4-3
9.9 Investigating topographic maps: What makes Mount Etna a dangerous place to live?		GE4-3, GE4-4, GE4-7, GE4-8
9.10 What influences community identity?		GE4-4, GE4-6
9.11 What are remote settlements like?		GE4-1, GE4-3
9.12 What is Old Delhi like?	eBook plus ONLINE ONLY	GE4-1, GE4-7
9.13 How is modern India changing?	eBook plus ONLINE ONLY	GE4-1, GE4-3
9.14 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	



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Watch this video
Why we live where we do
Searchlight ID: eles-1620

9.2 Where do most Australians live?

9.2.1 Historic settlements and transport networks

Does the availability of rainfall explain why modern Australians live where they do? Could it also be warmer weather, good soils, and access to the coast, mineral resources, people and flat land?

Approximately two-thirds of Australia's population live in capital cities. Australia is a large, dry and isolated country. The availability of fresh water is an important factor to consider when looking at where people live.

Australia's first large European settlements were all built close to rivers and harbours, which provided safe anchorage for their sailing ships. The early settlers and convicts, along with their possessions and food, were all transported from Europe by ship. These settlers were quite wary of the unknown inland of the continent, so they clung to the coast and relied on sea transport. The sea allowed goods to be imported and exported; it provided fishing, whaling and sealing; and it brought cooler weather due to onshore breezes. Rivers, provided water for household, industrial and agricultural use, as well as a safe port for passengers and cargo.

Sydney, Melbourne, Brisbane, Hobart, Adelaide and Perth were generally the first settlements in each colony. They have maintained their importance as their state's largest city and its centre of government, transport and commerce. Big cities are great places to live because they provide many opportunities for work, education, healthcare and recreation.

FOCUS ON FIELDWORK

Looking at and listening to your place

Geographers are particularly interested in:

- the location of things
- the distance between things
- the distribution patterns we can see when we produce a map
- the connection between places and the environment
- the connection between places and the community.

Work in pairs to gather data to complete a sound-map report of *your place*. *Your place* can be the schoolyard, backyard or your local park.

Step 1: Obtain a map or construct a sketch map (see SkillBuilder 8.12 'Creating a sketch map') of your selected place.

Step 2: Label the different land uses in and around your selected place. Include streets, theatres, classrooms, creeks, vegetation and so on.

Step 3: Identify five different locations at *your place*. Mark these places on your map. Take note of the approximate distance between each place. You may want to take a trundle wheel or a GPS with you.

Step 4: Walk to each of the five places and listen to the surrounding sound. You may want to close your eyes to concentrate. At each location, write down the sounds that you can hear. What do you hear first? With added concentration, what other sounds can you hear?

Step 5: Write down all the noises and sounds that you hear. Repeat this step for all of the locations.

Based on the information you have gathered, write a report to describe:

- what you heard at each location
- what created the sound at each location
- what impact the sounds had on your wellbeing
- how the sounds reflect the type of community you live in and your surrounding environment.

Land use

Since 1788, people have changed the natural environment by clearing vegetation and using the land for building cities and farms and creating the services people need.

Figure 2 shows the different types of land use in Australia. Climate and soil play a large role in determining how the land is used to grow crops and raise animals.

Extensive land use is where there are large areas of farm land with few workers and not many cows or sheep per hectare.

Intensive land use is where farms are smaller, but have more workers and machinery to produce high yields per hectare; examples are dairy and poultry farms, orchards, vegetables and feedlots. Compare this land use map to a rainfall map in your atlas. Does more rain tend to fall in the intensive or the extensive land use regions?

In places where rainfall is low or unreliable, such as central Australia, grass growth is seasonal. This semi-arid interior does not support the variety of land uses that are possible closer to the coast. Over 80 per cent of Australia's population lives within 500 kilometres of the coast between Brisbane and Adelaide; some are on farms but most are in regional towns and capital cities.

Jobs

People need to work in order to provide for their basic needs. Figure 1 shows that the majority of jobs in 2013 were in the sectors of services (health, finance, education and administration), retail trade and construction. Most of these job opportunities are available in major cities and regional centres, which are generally close to the coast and in areas of higher rainfall.

There are fewer job opportunities in dry and remote regions of Australia. Agriculture and mining provide some chances for employment in these places. Some jobs are also available in manufacturing (processing the output of farms and mines) and in services, such as healthcare and tourism. According to the Australian Bureau of Statistics, 25 per cent of new jobs created in

FIGURE 1 Australia's job sectors, 2013

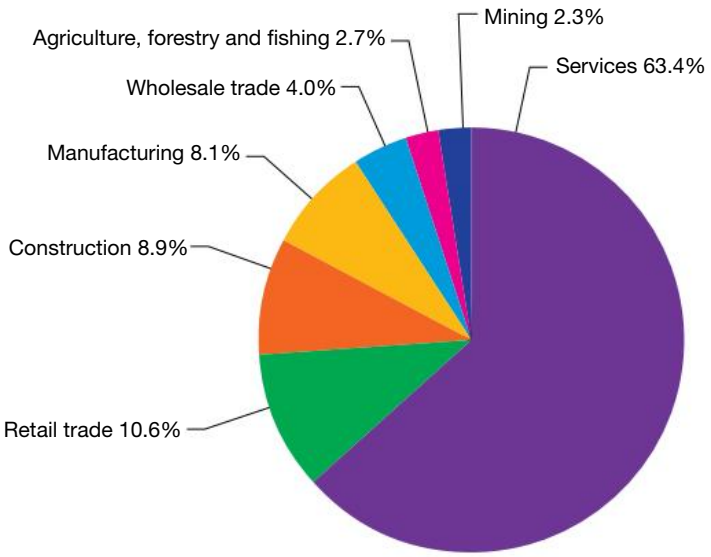
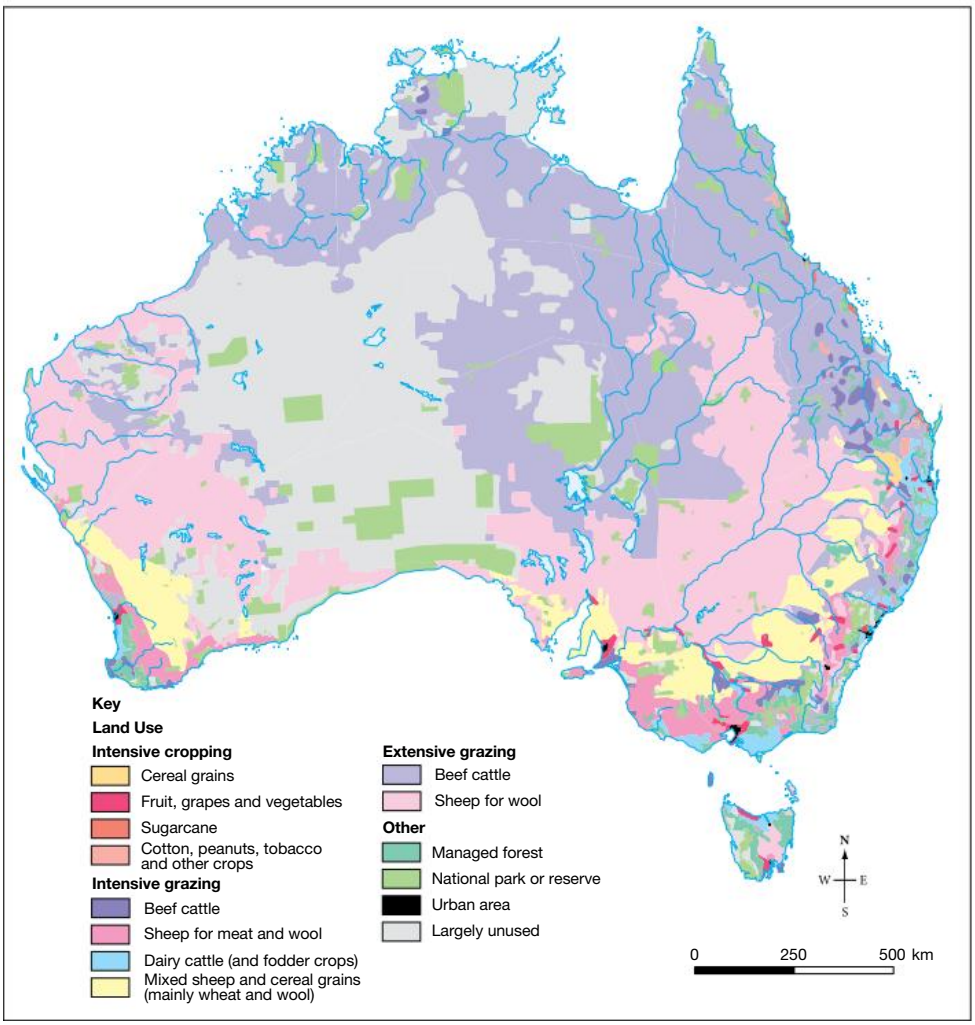


FIGURE 2 The major land use regions of Australia



Source: MAPgraphics Pty Ltd, Brisbane

the next 10 years will be in the services sector, especially healthcare, but these will mostly be in the cities. Mining jobs in remote places are expected to increase but not by enough to push them above their current two per cent of total employment in Australia. Remote mining sites have skills shortages that require employers to pay very high wages to attract workers.

ACTIVITIES

IDENTIFY

1 State four reasons why the state capital cities were settled.
2 In Australia, are more workers employed in mining or in manufacturing?

EXPLAIN

3 What is the difference between intensive and extensive land use? Give examples of each type.
4 Study a rainfall map of Australia (*Jacaranda Atlas Eighth Edition*, page 40) and the land use map of Australia (figure 2). Approximately how many millimetres of annual rainfall do areas of (a) intensive farming receive and (b) extensive farming receive?
5 Study the human features map of Australia (*Jacaranda Atlas Eighth Edition*, page 45). (a) What are the approximate populations of the capital cities? (b) Why do you think the majority of the population lives there?

APPLY

6 What are the future problems with water use in Australia? Support your answer with statistics.
7 'Water is the main reason to explain where Australians live.' Write a paragraph that agrees with this statement and another that disagrees with this statement.

INVESTIGATE

8 What are the future problems with water use in Australia? Support your answer using statistics.
9 Are there regions of intensive agriculture found in ***places*** with much less rainfall? Where are they? What might these farmers do to increase the available water for their crops?

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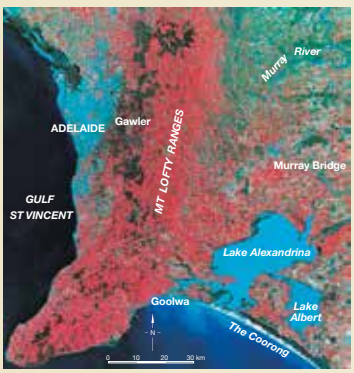
9.3 SkillBuilder: Understanding satellite images

What are satellite images?

Satellite images are images that show parts of our planet from satellites in space and transmitted to stations on Earth. Satellite images help geographers observe a much larger area of the Earth's surface than photographs taken from an aircraft.



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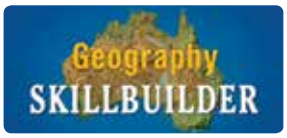

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Interactivity
Try this interactivity to learn how to understand satellite images.

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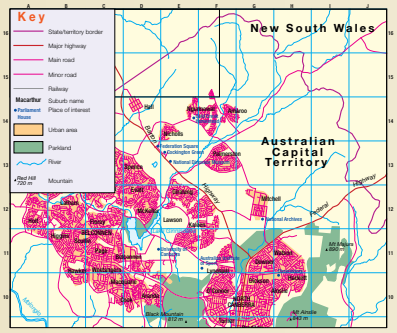
9.4 SkillBuilder: Using alphanumeric grid references

What are alphanumeric grid references?

Alphanumeric grid references are a combination of letters and numbers that help us locate specific positions on a map. Letters and numbers are placed alongside the gridlines, just outside a map. The grid, letters and numbers allow you to pinpoint a place or feature by stating its alphanumeric grid reference.



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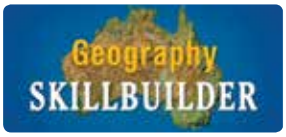
Watch this video to learn how to use alphanumeric grid references.



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Interactivity

Try this interactivity to learn how to use alphanumeric grid references.

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9.5 Services and facilities important to wellbeing

9.5.1 Services and facilities

Wellbeing refers to a good or satisfactory condition of existence. It includes lots of different aspects of a person's lifestyle such as health, happiness, prosperity and welfare.

Services and facilities are very important to a person's wellbeing. They can impact nearly every part of a person's lifestyle. Services and facilities vary but they provide support and infrastructure to a place as well as contribute to a sense of community.

9.5.2 Transport and roads

The way people get from place to place is important. Whether it is to visit friends, go on holidays or to work, travel (near or far) is an essential part of daily life and wellbeing. Aeroplanes, trains, buses, cars and bikes are examples of the transport used by people to get from place to place.

FIGURE 1 It is important for roadways to be well maintained and safe for people to use.

9.5.3 Education

Having access to quality schools and childcare programs is important to a child's development. Families often choose to live near schools where they would like their child to attend. Playgrounds and parks are also appealing to families.

FIGURE 2 Mountains of waste in New Delhi, India, put people at risk of diseases and illness.

FIGURE 3 Waste collection in Australia

9.5.4 Water

Access to clean water for drinking, washing and bathing prevents lots of transmittable diseases and infections. Access to clean water is readily available in Australia; however, it can be very difficult in other parts of the world. According to the World Health Organization over one billion people do not have access to safe drinking water.

9.5.5 Waste

In Australia, garbage is collected on a weekly or fortnightly basis. It is a service provided by local and state governments to remove waste. This waste can then either be recycled or become landfill. It does not pile up in the cities or suburbs. In New Delhi, waste is piled up on the outskirts of the city. Not only does it cause physical disease and illness, but it also decreases the quality of the air.

Another important service to human wellbeing is sanitation. Human wastes are removed from houses and buildings via sewerage pipes and systems to sewerage facilities, where it is treated to remove harmful materials and then flushed back into the ocean or even used as drinking water.

9.5.6 Healthcare

Health services include medical centres, hospitals, aged care facilities, dentists, optometrists, psychologists, physiotherapists and more. Access to these types of services and facilities allows people to maintain good physical and mental health.

9.5.7 Shopping centres

Shopping centres offer more than retail therapy. They can also offer other services, such as banking, travel agents, dry cleaning or technological repairs, which can contribute to wellbeing.

FIGURE 4 Shopping centres offer lots of convenient services and facilities.

9.5.8 Cafes and restaurants

Cafés and restaurants contribute to a sense of community. They are places where families and friends can meet and dine in a social atmosphere.

9.5.9 Variations in access to services and facilities

Access to services and facilities varies according to where you live. There is a great difference between the services and facilities available in urban, rural and remote areas. There is even more of a contrast in services and facilities between more economically developed and less economically developed countries.

Urban areas have the most access to a wide range of services and facilities. Rural areas and particularly remote areas have less access to a range of services and facilities. Due to the geographic location of these rural and remote communities, it can be difficult to attract enough professionals to service the community.

In Australia, seven of NSW's regional cities have formed the Evocities campaign which aims to attract people (and their qualifications) from the city, with the purpose of increasing the quality of infrastructure, business numbers, facilities, lifestyle and population growth. The Evocities include Albury, Armidale, Bathurst, Dubbo, Orange, Tamworth and Wagga Wagga.

ACTIVITIES

IDENTIFY

1 Define *wellbeing*.
2 Provide a list of services and facilities in your local area.

EXPLAIN

3 Why is healthcare important to wellbeing?
4 What types of services and facilities do shopping centres offer? Try to think of your local shopping centre to assist you.

APPLY

5 What services and facilities do you think your local community is missing?

INVESTIGATE

6 Use the **Evocity** weblink in your eBookPLUS to view the seven evocities.
   a What are the benefits of moving to an Evocity?
   b Which of the Evocities would you move to?
   c Describe the services and facilities in the Evocity you would move to.
   d Explain how the services and facilities contribute to the wellbeing of your selected Evocity.

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Weblink
Evocity

9.6 How does distance affect lifestyle?

9.6.1 Travelling for football

People who live in rural areas often have to travel, sometimes over long distances, to access goods, services and social events. While some see this travel as a problem, others believe that the advantages of rural life outweigh any inconvenience.

In **sparsely populated** parts of Australia, there are huge distances between towns. For example, the West Australian Football League runs a talent academy in the north of the state. Boys in the 15- and 16-year age group from the Gascoyne, Broome and Pilbara regions are selected to attend training camps. The camps are held in Broome, Port Hedland, Karratha and Fitzroy Crossing (see figure 1). Some players will travel hundreds of kilometres from their home to a training camp.

sparsely populated describes a region in which few people live

9.6.2 The biggest classroom

For some isolated students, it is not possible to travel to a school every day. Instead, the lessons come to them. The Broken Hill School of the Air has a very big classroom; it serves an area of approximately 250 000 square kilometres, and students can live up to 300 kilometres from the school.

Lessons are provided by satellite, written material, fax, telephone and personal contact. Sometimes several students gather at one location and a teacher will conduct classroom lessons.

Camps are also held so that students can mix with their peers.

FIGURE 1 Major regions in Western Australia

Source: Spatial Vision

FIGURE 2 A game between Yardgee and Bayulu — towns that are approximately 200 kilometres apart in the Kimberley region of Western Australia

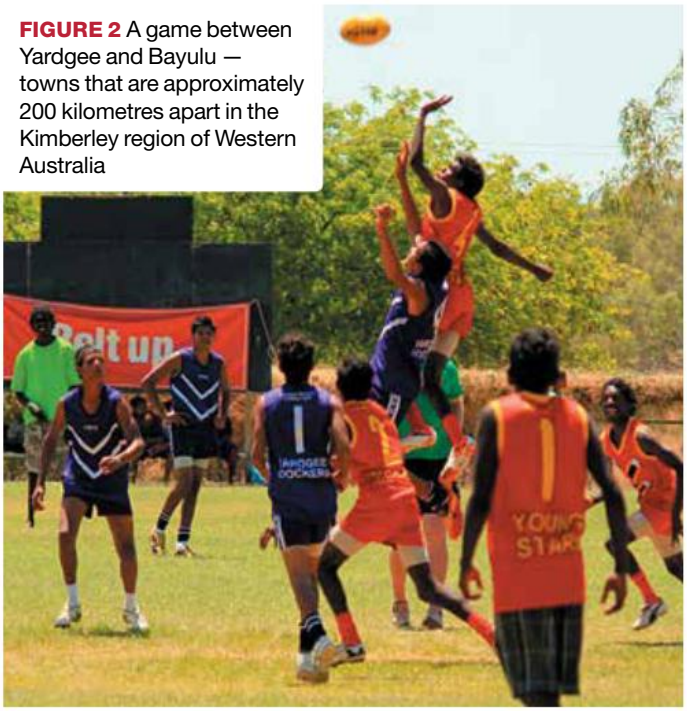
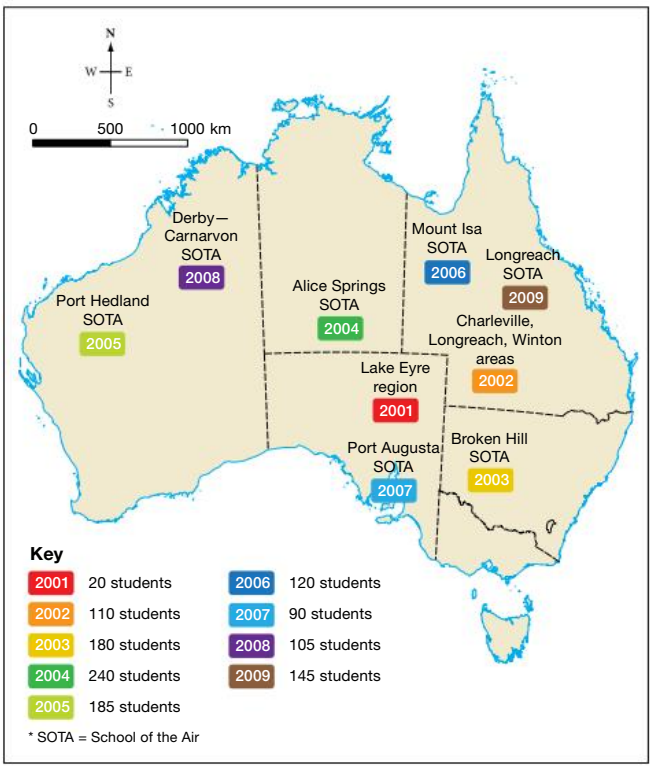


FIGURE 3 School of the air — a lesson conducted by voice and online

9.6.3 Flying scientist

Phil Higgins and his wife Suzanne fly to small schools and outback farms to take science equipment and lessons to students. Sometimes families will gather at a farmhouse for the lessons; at other times the Flying Scientist (nicknamed Phiggles) will visit a rural school. The lessons are so highly regarded that families will drive up to 600 kilometres to attend.

FIGURE 4 Places visited by the Flying Scientist, 2001 to 2010. The Flying Scientist has taken science to children in very isolated places.



Source: Spatial Vision

9.6.4 Shopping

People who live a long way from major towns have always made use of mail order catalogues. Mail order and online goods may take longer to arrive, but the buyers have access to the same goods as anyone who lives in an urban area.

9.6.5 Flying Doctor

The Royal Flying Doctor Service (RFDS) was started in 1928 by the Reverend John Flynn. Its goal is to support those who live in, work in or visit remote areas, and it now deals with about 300 000 patients a year. On any given day, the RFDS might attend to people who have been injured, become unwell or need to be moved to hospital. The service also provides health clinics, immunisation, advice over the phone and education programs.

9.6.6 Other

- *Tertiary study.* There are also a number of university and TAFE college campuses in **regional centres** such as Ballarat, Wagga Wagga, Ipswich, Albany, Alice Springs, Mount Gambier and Burnie.
- *Communication.* There is now mobile phone coverage for 90 per cent of Australia's population. People in very **remote** places can use satellite phones.

regional centre the main town in a region

remote describes a place that is distant from major population centres

ACTIVITIES

IDENTIFY

1 a Refer to figure 4 and identify the states visited by the Flying Scientist in each year from 2001 to 2010.
b Identify how many students attended these classes.

2 Identify two ways in which rural residents buy goods without going to a shop.

3 How can someone access healthcare even though a doctor is hundreds of kilometres away?

EXPLAIN

4 a Describe at least three ways in which life has improved for young people in isolated rural ***places***.
b Explain what you think has had the greatest impact on reducing the disadvantages of isolation.

INVESTIGATE

5 How does the size of the area served by the School of the Air compare to the size of the state in which you live? Your atlas may help.

6 a Refer to figure 1. Measure the distance travelled and the direction travelled by footballers from: Newman to Karratha; Carnarvon to Broome; Paraburdoo to Port Hedland; Kununurra to Port Hedland.
b Take one of the answers to the previous question and work out where you could end up if you travelled that far and in that direction from your home.

PREDICT

7 Think about the following statement: 'As the internet is used for more and more things, people in isolated ***places*** will have the same access to goods and services as those in the cities.' Organise your thoughts under the headings of Yes, No and Maybe.

APPLY

8 Gather data from your class or school to find out how far students travel to reach your school. Produce a map to show the area from which students are drawn.

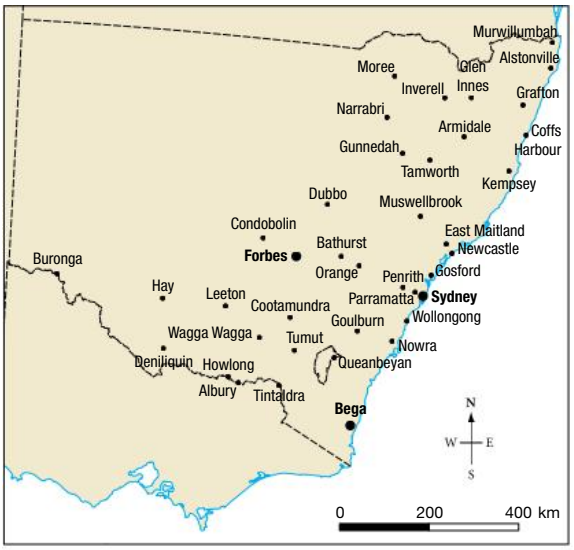
9.7 What is life like in a rural town?

9.7.1 The attraction of the country

Country towns come in all shapes and sizes. They can be small centres with a post office and general store or they can be substantial towns. Living in a country town can be very different to living in a city.

Even though most Australians live in large urban centres, the rural or country regions are very important because this is where food is grown, water is sourced, natural resources are extracted and ecosystems can flourish. Many Australians travel to country places for holidays and many dream of moving to the country. The attractions of country places include cheaper housing, less traffic and a greater sense of safety.

FIGURE 1 Map of New South Wales



Source: Spatial Vision

9.7.2 Demography

The demographic characteristics of country places are influenced by location and activities in the surrounding area.

For instance, Forbes is located approximately 380 kilometres from Sydney. It receives regular rainfall and has fertile soil. It is part of the NSW wheat belt, producing large quantities of wheat and cereal crops. This is the largest employment sector in the town.

Another town, Bega, is located approximately 421 kilometres south of Sydney. It has moderate temperatures and high annual rainfall. The dairy industry is the dominant source of employment. Bega is most renowned for its cheese factory.

GEOskills TOOLBOX

Population pyramids

Population pyramids, or population profiles, show the age and gender of a population. The left side of the pyramid represents the male population and the right side of the pyramid represents the female population. As you can see, the pyramid is separated into age brackets. Each age bracket represents a percentage of the population who are male or female.

At right is an example of the population pyramid for Sydney, 2013.

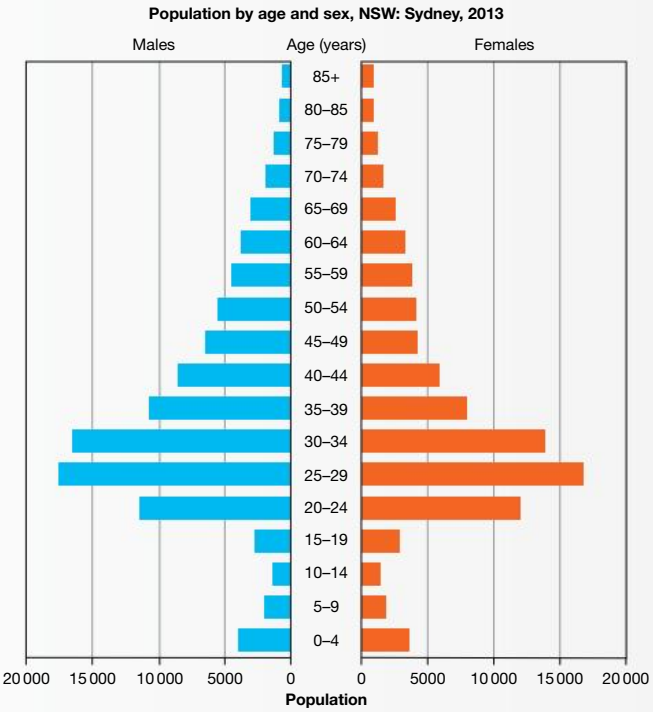


FIGURE 2 Population pyramid for Sydney, NSW (2013)

9.7.3 A sense of belonging

In the country there are opportunities to be involved in a wide range of community activities. Activities might have an economic focus (such as fundraising), an environmental focus (such as Landcare) or a social focus (such as youth groups). A common outcome of all activities is the way they contribute to a sense of connectedness or belonging.

All towns, whether large or small, offer different ways people can become involved in the community. Sport is a popular choice for people to be active and it is also an opportunity to meet new people. Sports offered in a small town like Forbes include: rugby union, soccer, netball, tennis, basketball, swimming and dragon boating. Cultural and entertainment activities, such as brass bands, dance groups, museums and galleries, are also available.

TABLE 1 Population projection data for Bega and Sydney

Age	Bega	Sydney
0–4	1 596	7 750
5–19	5 885	12 953
20–29	2 501	59 021
30–39	2 810	50 944
40–49	3 951	25 656
50–59	5 851	18 435
60–69	5 510	13 349
70–79	3 442	6 606
80 and over	1 885	3 655
Population (2014)	33 431	193 366

FIGURE 3 Forbes' annual camel race is held on Good Friday.

ACTIVITIES

IDENTIFY

1 In which direction would you travel from Bega to reach Sydney? In which direction would you travel from Forbes to Sydney?
2 Identify three reasons why country ***places*** are important.

EXPLAIN

3 Work with a partner to create a list of social, economic and ***environmental*** characteristics of a country town.
4 What are three opportunities in your community for young people to feel socially connected?

INVESTIGATE

5 Study the 2013 data in the population pyramid in figure 2.
   a What percentage of the population is in your age group?
   b What percentage of the population is in your parents' age group?
   c What percentage of the population is in your grandparents' age group?
   d Describe the overall shape of the population pyramid.
   e Based on its population pyramid, what issues could Sydney face in the future?
6 Indigenous Australians have always had a sense of belonging to a ***place***, and elements of the natural ***environment*** are honoured on their flags. Find out what the Aboriginal flag and the Torres Strait Islander flag look like. What aspects of the natural ***environment*** are represented on each of these flags?
7 As a class or group, brainstorm the meaning of the term *country life*. Construct a list of words that describe your agreed view. Find images to represent your words and create a collage to represent rural living.
8 Create a class list of country towns that you know. Locate these on a map and, for each town, provide the following information about its location: latitude, distance and direction from the state capital city, and distance and direction to a natural feature. Refer to an atlas. Find out about the services the towns offer.

APPLY

9 In Australia, the trend is for people to move away from the country to the major cities. Suggest three reasons why you think this happens.

eBook*plus*

Interactivity
Country town services
Use this interactivity to analyse the services found in Leongatha. Classify them as to whether they would appeal to people aged under 18 or to people 60 and over.
Searchlight ID: int-3092

eBook*plus* ONLINE ONLY

9.8 Environmental quality and liveability

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

9.9 What makes Mount Etna a dangerous place to live?

9.9.1 Natural hazards

Natural hazards threaten the environmental quality and in turn the liveability of a place. The risks associated with natural hazards are potentially very dangerous to people. The risks include destruction of housing, infrastructure, environments and loss of life.

A natural hazard refers to the risk of a natural event which has the potential to cause catastrophic damage to both physical and human environments. Drought, floods, tropical storms, cyclones, volcanoes, fires, tsunamis, earthquakes and landslides are all examples of natural hazards. The actual destruction of the landscape due to a natural hazard is called a natural disaster. The risk of natural hazards and previous natural disasters reduce the environmental quality of a place.

9.9.2 Mount Etna, Italy

Mount Etna is Europe's most active volcano. It is approximately 3323 metres high and situated on the island of Sicily, Italy (37°N, 15°E). The slopes of Mount Etna are home to 5 million people (25 per cent of the island's population). Figure 1 shows Mount Etna in the background and the city of Catania in the foreground. The city of Catania is located only 35 kilometres from Mount Etna.

Why is Mount Etna dangerous?

Mount Etna poses a direct threat to the populations living on its slopes — it is a very active volcano! To improve the liveability and to decrease the threats to the population, Italian authorities have tried several methods, including dams and channels, to redirect lava flows away from the communities.

ACTIVITIES

For all of the activities, refer to figure 2, a topographic map extract of Mount Etna, Italy.

IDENTIFY

1 State the altitude of Mount Etna.
2 Write the scale of the map as a ratio.
3 State the contour interval of the map.
4 What are the two types of vegetation that surround Mount Etna?
5 Which direction was the photographer facing when they took figure 1?
6 Describe the contour pattern of Mount Etna.
7 Describe the location of the highway.
8 Give the area reference for the following locations:
   a Misterbianco
   b Acireale
   c Bronte.
9 Give the grid reference for the following locations:
   a Mount (Monte) Piniteddu
   b spot height 1316 to the east of Bronte
   c where the highway crosses the railway in the south-east quadrant.

EXPLAIN

10 Describe, using evidence, the types of transport people use to connect with other ***places***.
11 Explain how the transport routes improve the connectedness between ***places***.

PREDICT

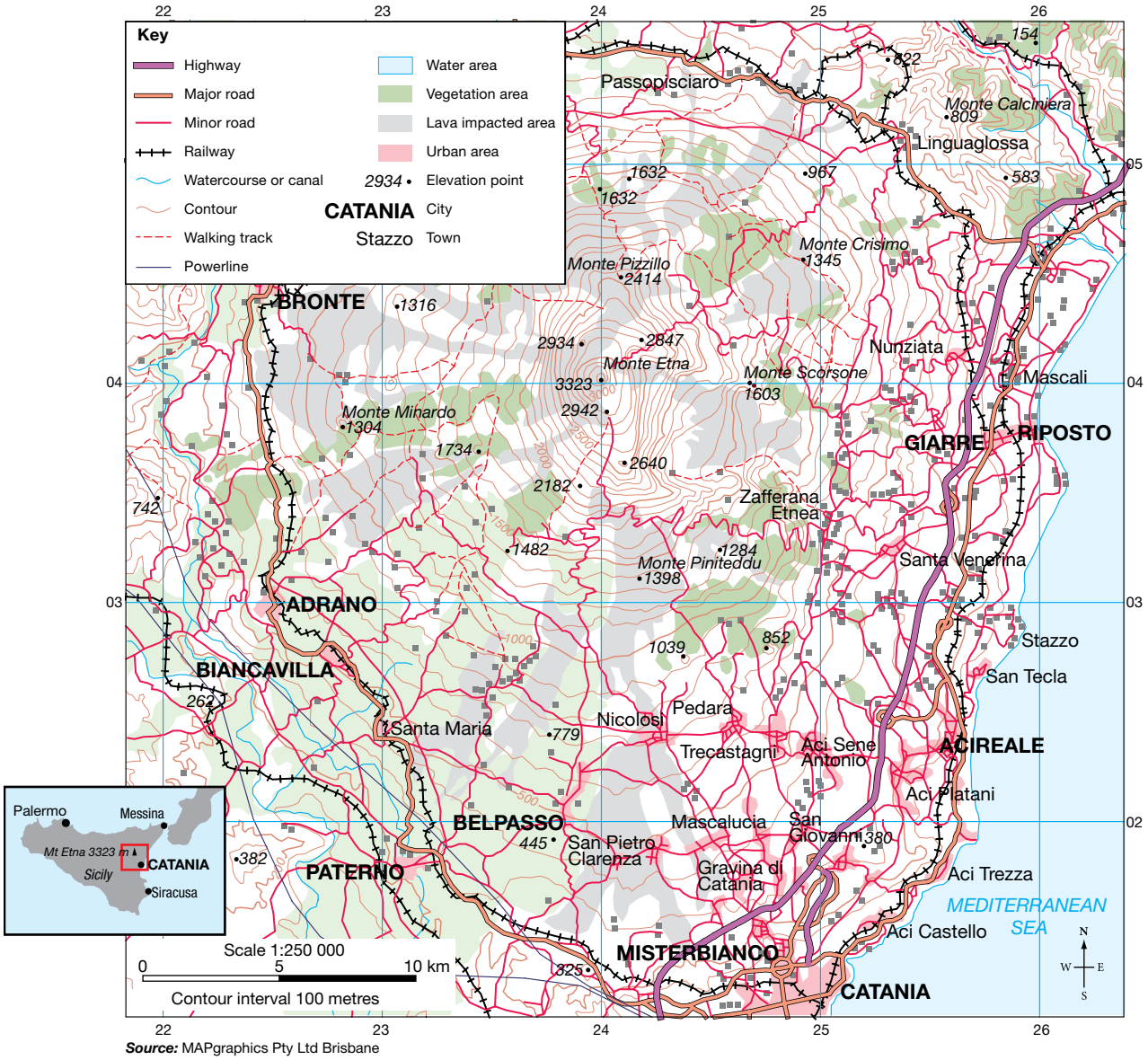
12 a If Mount Etna erupted, which ***places*** would be affected by the lava flow?
   b What would be the predicted impact to the nearby towns?
   c What would be the potential ***environmental*** impacts of this?
   d How could people plan to protect their homes from lava flow?

INVESTIGATE

13 When was Mount Etna's latest eruption?
14 Where do you think the safest ***place*** to live in Australia would be and why?

FIGURE 1 Mount Etna

FIGURE 2 Topographic map extract of Mount Etna



Source: MAPgraphics Pty Ltd Brisbane

9.10 What influences community identity?

9.10.1 Culture

A community shares a common interest or location. Communities connect face-to-face and increasingly via electronic devices.

Community identity is closely linked to culture. There are many different aspects of culture such as clothing, family heritage, language, food, music, dance and architecture. All of these elements influence the way in which communities express, celebrate and share their culture. These elements also become symbols of a culture.

FIGURE 1 A lion dance performed in Foshan City, China, to celebrate Chinese New Year. These dances bring good luck for the year ahead.

9.10.2 Environment

The physical and human environment reflects the values of the community. The ways in which the environment is displayed, developed and connected influence how it is perceived. The abundance or lack of features can shape the way people utilise or appreciate a space. For example, a green area with lots of grass and trees would be used very differently to an area with high-density buildings in a business district.

9.10.3 Public events

Public events and festivals are important ways for a community to express and share their values. It is also how community groups grow in numbers — especially communities who connect over a common interest. The RSPCA is an independent community-based charity; its aim is to prevent animal cruelty and promote the humane treatment of animals. They are also reliant on volunteers to be involved in animal shelters and to run the adoption program. In May every year, they have their major fundraiser, the Million Paws Walk, where pet owners and their pets walk to raise money to support the RSPCA programs. The walk attracts over 80 000 people and 45 000 pets each year. It is considered to be a huge success in meeting their aim as a community group who supports animal rights.

FIGURE 2 The RSPCA's annual fundraiser, the Million Paws Walk, around Albert Park Lake in Melbourne 2015.

9.10.4 Religious beliefs

Religious architecture and celebrations are noticeable features amongst a community. Temples, churches, mosques and synagogues are often elaborate buildings where members of the community can practise their faith. For example, the Blue Mosque (figure 3) in Istanbul, Turkey, is a prominent feature of the cityscape. Saint Basil's Cathedral (figure 4) in Moscow, Russia, is an important place of worship to the Catholic community.

FIGURE 3 The Blue Mosque is one of the many mosques within Istanbul, Turkey, where Muslims can practice their religion.

FIGURE 4 Saint Basil's Cathedral in Moscow, Russia, is an important place of worship for the local Catholic community as well as travelling tourists.

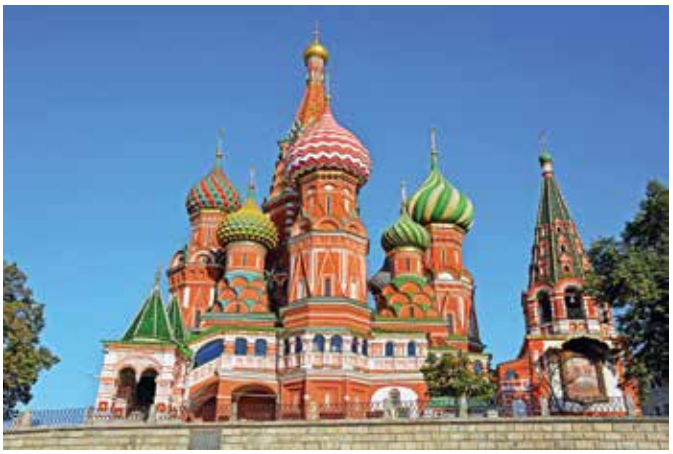


FIGURE 5 The changes in the types of technologies used around the world

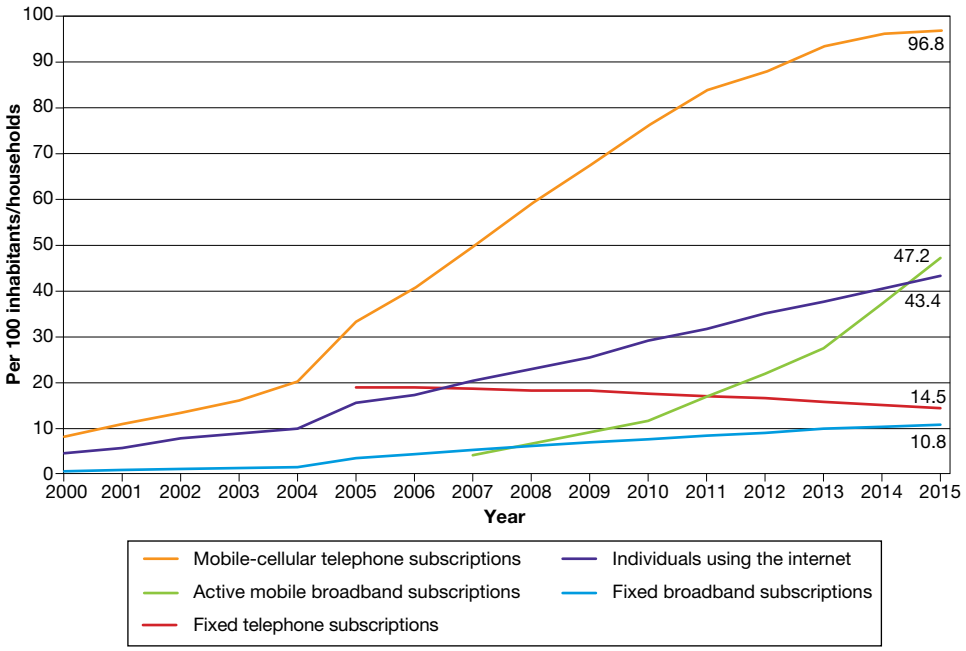


FIGURE 6 Some of the various technologies that have changed the way we interact and communicate with other people

9.10.5 Factors that enhance connectedness

Technology

In all of its forms, technology is bringing people closer together. For example, the development in aviation technology allows people to meet in person; but, even more so, advancements in information and communication technology (ICT) allow people to interact online via email, social media and gaming networks. The National Broadband Network (NBN) is being installed across Australia to allow fast and reliable internet connectivity. Wireless communications and mobile technology have dramatically changed the way people access, store and transfer information.

Transport

The movement of people within and between neighbourhoods is an important issue in towns and cities. The bicycle is now seen as a way of increasing mobility, reducing traffic congestion, reducing air pollution and boosting health. Bicycle tracks encourage recreational riding for all ages and dedicated bicycle paths along main routes encourage people to commute by bicycle, rather than car, to work and school.

FIGURE 7 Special bicycle lanes, marked in red, increase the safety of bike riding in urban areas.

Open spaces

Open spaces, also known as parks and green places, contribute to the atmosphere and attractiveness of a community. These can include: foreshore reserves, botanical gardens, dog parks and pocket parks. Open spaces need to be well maintained and have an appeal to the general public. Quality open spaces become attractive for people to use as venues for meditation, exercise, barbeques, picnics and even weddings.

FIGURE 8 Centennial Parklands in Sydney, NSW, is an open space for recreational activities.

ACTIVITIES

IDENTIFY

1 Define culture.
2 State the types of technology you use on a daily basis.
3 Refer to figure 5 to answer the following questions:
   a How many people had mobile phone subscriptions in 2015?
   b What is the difference between individuals using the internet in 2001 compared to 2015?
   c What is the approximate percentage of people who had fixed (wired) broadband subscriptions in 2015?
4 Use information from figure 5 to explain how technology has changed the way people connect with each other.

EXPLAIN

5 Explain how public events shape community identity.
6 Describe reasons why religion and religious celebrations are such an important part to identity.
7 Why are open spaces considered to be such an important part of community identity?
8 Provide an explanation of how you use technology to connect with other people.

APPLY

9 Create a picture collage of a community you are a member of. Focus on culture, environment, public events and religion (if applicable).

PREDICT

10 How can community identity change over time?
11 How can communities adapt to change?
12 When did fixed telephone subscriptions decline? Provide reasons why this might have happened.

9.11 What are remote settlements like?

9.11.1 Way up north

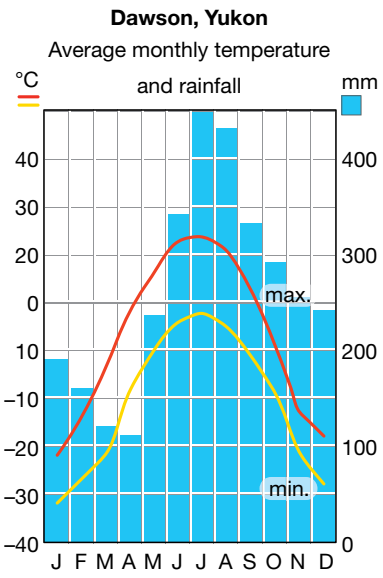
Life in some towns is strongly influenced by geography. It is now possible to live in extreme conditions and be socially connected while enjoying access to a wide range of goods, services and community activities.

FIGURE 1 Location of Dawson, Yukon, Canada

Source: Spatial Vision

Dawson, with a population of 2000, is the second-largest city in the Canadian state of Yukon. At the latitude of 64°N, it is only about 360 kilometres from the Arctic Circle.

FIGURE 2 Climate graph, Dawson



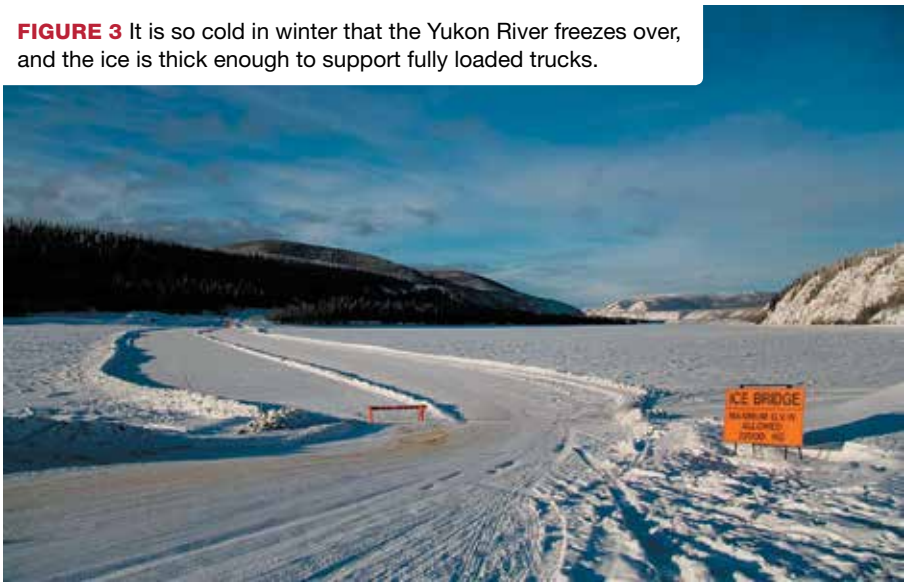
Dawson is a long way from neighbouring towns. It is 770 kilometres from the next town to its north (Inuvik) and 810 kilometres from Anchorage, the largest town in Alaska.

9.11.2 Climate

TABLE 1 Average hours of sunlight at Dawson, Yukon, and Longreach, Queensland

Month	Dawson, latitude 64°N	Longreach, latitude 23°S
January	5.5	13
February	8.5	13
March	12.0	12
April	15.0	12
May	18.0	11
June	21.0	11
July	20.0	11
August	16.5	11
September	13.0	12
October	10.0	13
November	7.5	13
December	4.5	14

FIGURE 3 It is so cold in winter that the Yukon River freezes over, and the ice is thick enough to support fully loaded trucks.



Settlement

The site of Dawson, on the junction of the Yukon and Klondike rivers, was always an important hunting and meeting site for indigenous people, who still live in the area. The harsh climate deterred white settlers from the area until gold was discovered in 1896. The population grew by thousands every week, quickly reaching 30 000.

However, most people did not stay long. Living conditions were very poor: people lived in tents and huts; they had no power, water or sewerage; and crops would not grow in the low temperatures. The **permafrost** also made it difficult to dig the foundations for buildings. Furthermore, it turned out that the gold was not accessible: it was in gravel that was frozen for most of the year.

permafrost a layer beneath the surface of the soil where the ground is permanently frozen

Today

Today the town has **infrastructure**, and housing is solid and heated. The community of Dawson operates year round, with the climate having a strong influence on activities. A road to Alaska has encouraged tourism, and new mining techniques have increased goldmining.

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communication systems, water and power lines

The weather conditions mean that some jobs, such as road-making and building, cannot be done in the winter. Some of those employed in these industries move south in the winter, either for work or holidays.

The town of Dawson is no longer completely isolated in winter. Internet and phone connections allow communication; snow-ploughing and spreading of sand keep the roads open most of the time; and planes fly in and out all year.

The weather influences many aspects of social life in Dawson. The 'Thaw di Gras' carnival celebrates the end of winter, and music festivals and a kayak marathon take place in summer. Winter is the time

of snowmobile treks, skiing and the famous Yukon Quest dog-sled race from Whitehorse (Yukon) to Fairbanks (Alaska). During the race, dogs and mushers (sled drivers) need protection from the cold, but if the weather warms to minus 4°C, it becomes too hot for the dogs to travel during the day.

ACTIVITIES

IDENTIFY

1 Refer to the map in figure 1. How far is Dawson from Whitehorse, the state capital?

2 a What influenced indigenous people to live in the Dawson area?
  b Why did people move to Dawson in 1897?
  c What influences people to live in Dawson nowadays?

EXPLAIN

3 List at least four ways in which the natural ***environment*** has influenced the settlement of this area.

4 What factors have improved liveability in Dawson?

5 a Construct a multiple bar or column graph to show the average number of hours of sunlight at Dawson and Longreach. (See SkillBuilder 15.6 'Creating a simple column or bar graph'.)
  b On your graph, use colour, shading or symbols to show summer and winter at each location.
  c Write one statement that is true for both Dawson and Longreach about their hours of sunlight.
  d Imagine you live in Dawson, where the school year is from August to June. In which months would you arrive or leave in the dark?

6 Activities in Dawson include volleyball, curling, film festivals, craft, dances, motorcycle riding, gold panning, softball, writing workshops and outhouse races. Which of these would occur only in summer? Which would occur only in winter? Which could occur all year?

INVESTIGATE

7 Use the **Bureau of Meteorology** weblink in your eBookPLUS to find the average monthly temperatures for your location. Present the statistics for the minimum and maximum temperature in a graph (see SkillBuilder 10.4 'Drawing a climate graph'). Compare your graph to the one provided for Dawson. Write three clear statements comparing the average monthly temperatures of Dawson and your location. Write three clear statements comparing the monthly rainfall for Dawson and your location.

PREDICT

8 Which months of the year would be most popular for tourists visiting Dawson City? Provide at least two reasons to support your answer.

9 How do you think the climate would make school life in Dawson different from your life?

APPLY

10 What do you think happened to the early buildings when the heating from houses warmed the soil and melted the permafrost?

11 How have people tried to overcome the disadvantages of this location?

eBookplus
Weblink
Bureau of Meteorology

eBookplus ONLINE ONLY

9.12 What is Old Delhi like?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

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9.13 How is modern India changing?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

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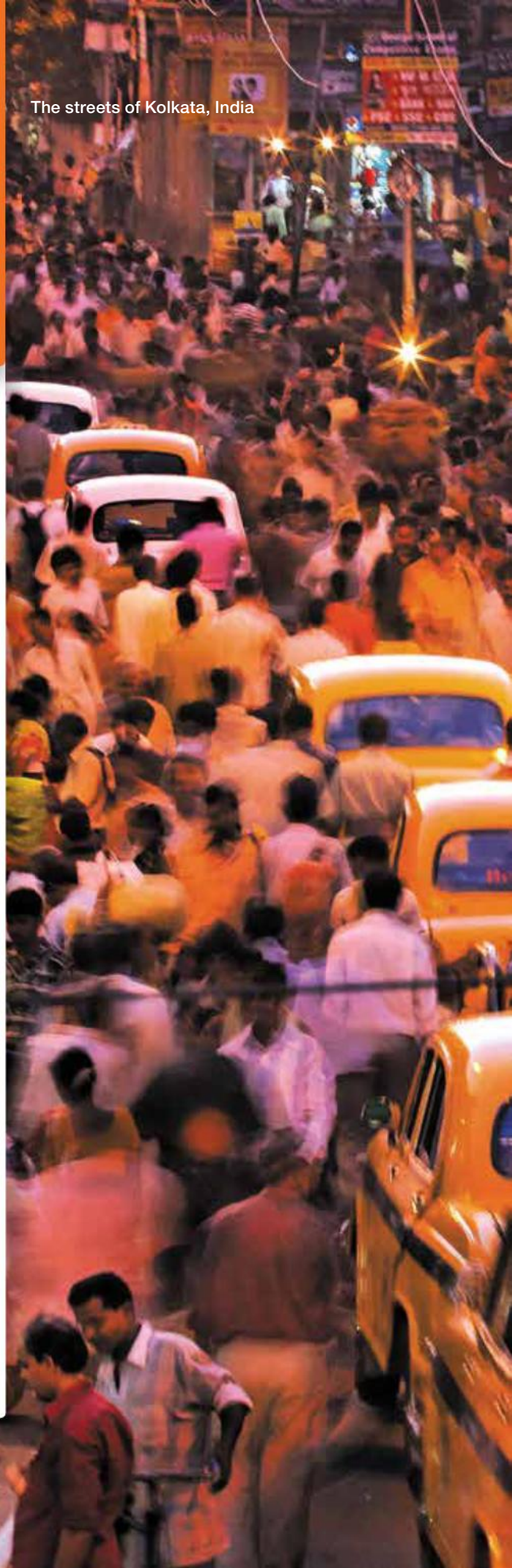
9.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.



The streets of Kolkata, India

CHAPTER 10

Liveable places

10.1 Overview

10.1.1 Introduction

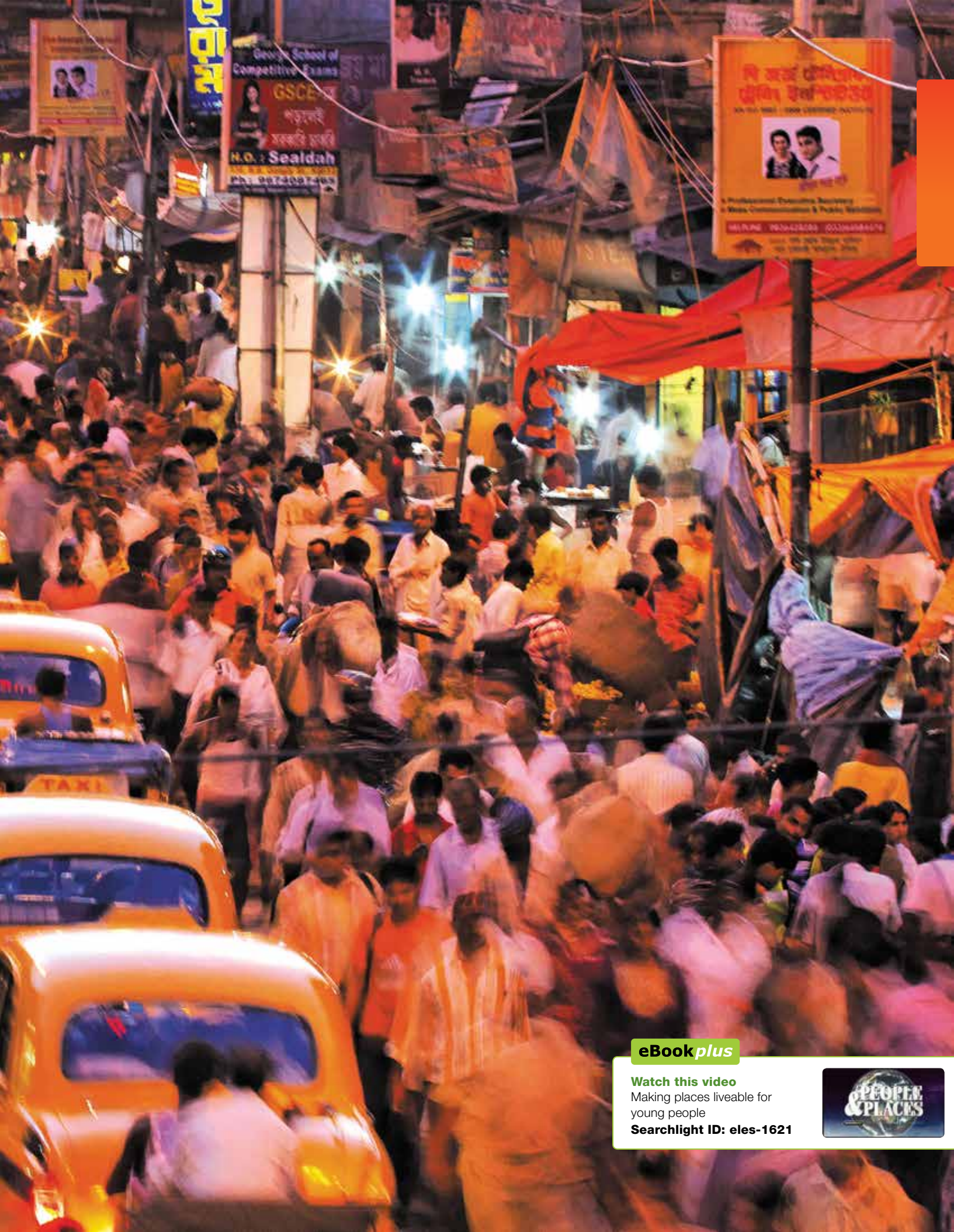
Your quality of life is influenced by many factors, such as climate, landscape, community facilities, the location of your home, the sense of community identity, and links to other settlements. You probably have an idea of a street, town, city or suburb where you would like to live, and your opinion may be quite different from those of others. This is because other people see different factors as important. This chapter will look at how people define and improve liveability.

Starter questions

1 What would be the good things about living in the city shown here?
2 What would be the more challenging aspects about living in this city?
3 a What similarities and differences are there between this ***place*** and where you live?
b In which of these two ***places*** would you prefer to live and why?

Inquiry sequence

		Syllabus outcomes
10.1 Overview		
10.2 What is liveability?		GE4-6
10.3 What makes a place liveable?		GE4-3, GE4-4
10.4 SkillBuilder: Drawing a climate graph	eBookplus ONLINE ONLY	GE4-1, GE4-7
10.5 Where are the most liveable cities?		GE4-1, GE4-8
10.6 What makes Melbourne the world's most liveable city?	eBookplus ONLINE ONLY	GE4-7, GE4-8
10.7 How can liveability be improved?		GE4-3, GE4-4, GE4-6, GE4-8
10.8 Investigating topographic maps: What is liveability like in Badu and Moa?		GE4-6
10.9 Port Moresby — a less liveable city?		GE4-6
10.10 Dhaka — a less liveable city?	eBookplus ONLINE ONLY	GE4-4, GE4-6
10.11 What makes a place liveable for you?		GE4-1, GE4-8
10.12 SkillBuilder: Creating and analysing overlay maps	eBookplus ONLINE ONLY	GE4-1, GE4-7
10.13 How could my community be made more liveable?		GE4-6, GE4-7, GE4-8
10.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	



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Making places liveable for young people
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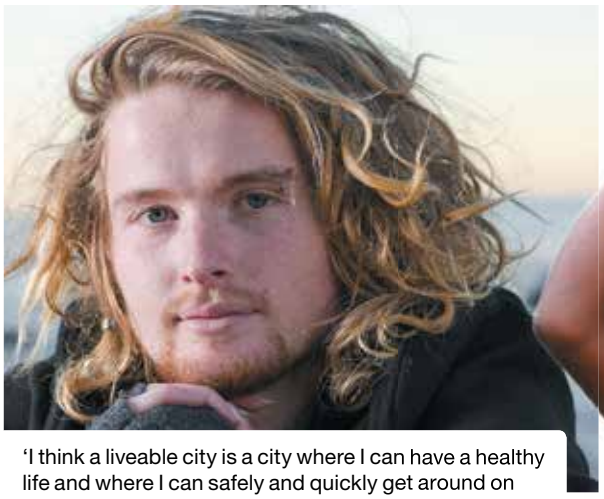
10.2 What is liveability?

10.2.1 What do people think about liveability?

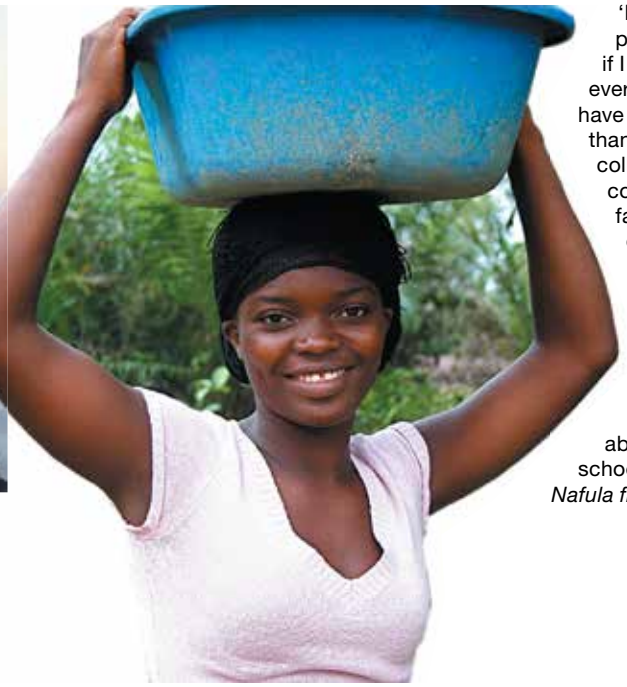
Liveability can be defined as 'the features that create a place that people want to live in and are happy to live in'. It is usually measured by factors such as safely, health, comfort, community facilities and freedom.

community a group of people living in a particular region

Here are some examples of what people think about the liveability of their **community**. They come from different places and they are all trying to explain what liveability means to them.



'I think a liveable city is a city where I can have a healthy life and where I can safely and quickly get around on foot or by bicycle, public transport or even by car — as a last resort. A liveable city is a city for everyone, including children and old people, rich and poor, and people of different religions, races and fitness levels. A liveable city should be attractive, and have good schools, a choice of things to do and fresh air.'
John from Perth



'I think that a place is liveable if I have food every day, I do not have to walk more than 10 minutes to collect water for cooking and my father has work close by, so he is home for dinner. Liveability means warm weather, enough rain and being able to go to school every day.'
Nafula from Kenya

'Liveability means that I have a good job, good food, a nice house, a newish car, nice neighbours and a community that cares about my family and me.'
Oscar from western suburbs of Sydney

'A liveable place is somewhere I can have a computer and a television and a bed of my own in my own room. I would like a bike to get to school, three meals a day and two sisters. A liveable place would be clean, safe and modern. My grandmother and aunty would also live with us.'
Jing from a village in rural China

‘Liveability is all about the **natural environment**. I think a place is liveable if the air is clean, there is plenty of water in the river and there is a healthy forest nearby. Being able to grow your own food, use renewable energy and live a simple life are all a part of what is important to me and can make a place liveable.’
Joy from Huon Valley, Tasmania

‘The community is what makes a place liveable. Being connected with my neighbours, through the community gardens, food co-op, volunteer network at our kids’ school and the car-share scheme all make me feel a valued member of my community. I like knowing people who care and that we all care for each other.’
Laura from Bristol, United Kingdom

natural environment elements such as wind, soil, flowing water, plants and animals that influence the characteristics of an area

‘Liveable cities have housing that is close to jobs, services and transport and is available for all income levels. Neighbourhoods are pedestrian-friendly with green spaces and lively retail sectors. They are mostly car-free, and have good schools and public buildings. A liveable city needs lots of different choices — choices in ways to live, places to work, shop and eat, and locations to linger in — whether alone or with other people.’
Alex, property developer from New York

‘A liveable community offers many activities, celebrations and festivals that bring all of its residents together. Every year at Carnevale, my whole neighbourhood comes together to dance the samba. I would never wish to live anywhere else.’
Raul from Rio de Janeiro

‘The place that I think would be the most liveable is Darwin. It has great footy grounds, public transport, good food, good houses, good shops and good schools. Where I live, my house is a dump and I cannot get anywhere unless I walk. I would like to live in Darwin and play football.’
Sam from near Alice Springs

ACTIVITIES

EXPLAIN

1 Write a statement, similar to those in this section, about the community that you live in and what makes it liveable.

2 Would the statement of liveability in your community be different if you were blind, unemployed, elderly or unable to speak English? Write what you think a community liveability statement would be for two such residents of your community.

INVESTIGATE

3 Carefully read the different opinions about what makes a place liveable.
- **a** Make a list of the common themes mentioned by these people.
- **b** Is there a shared common definition of what makes a place liveable? Discuss the differences with your class.
- **c** On a map of the world, show the location of each ***place*** mentioned in this section.
- **d** Does the ***place*** in which each person lives appear to influence their definition of the term *liveability*? Discuss this with your class.

4 **a** Ask a much older person to describe the living conditions in the community they lived in as a teenager. Record or write down their memories.
- **b** Do you think the current liveability of your community is better than that described by the older person? Provide an example to support your view.

PREDICT

5 **a** Think about your community 50 years from now. What ***changes*** do you think will happen during this time? Consider the **distribution** of houses, the type of houses, the amount of traffic, the age of the population, the community facilities and other aspects you think will be significant.
- **b** What type of inventions might improve liveability?

APPLY

6 We have described liveability here in a general sense. Provide examples of how living conditions ***change*** from time to time. Are the ***changes*** in your examples due to natural events or human activities?

7 **a** Which viewpoint or viewpoints about liveability do you agree with more than others? Give reasons for your answer.
- **b** As a class, discuss your answer to question 7(a), and see if there are any patterns within the group.

distribution the way things are spread across an area

10.3 What makes a place liveable?

10.3.1 Who says which is the most liveable?

Liveability is measured by several different international surveys. The Quality of Life Index, Happy Planet Index, Most Liveable Cities Index, Mercer Quality of Living Survey and the Global Liveability Ranking are examples of some of these. Your *Jacaranda Atlas Eighth Edition* (p. 168) has illustrated some of their recent results.

Several international organisations have created lists of the world's most liveable cities. These organisations each compare data and produce a table that ranks the liveability of cities. This information is collected for workers considering overseas transfers or for companies that may need to compensate workers who are transferred to a low-ranked city. The figures can also be used to attract migrants or investment. The various rankings compare a large number of cities; however, not all cities in the world are included in each survey.

Liveability surveys were created by international organisations who collect and compare data on different cities around the world. The data is then placed in a table that ranks how liveable a city is.

Cities that are considered to be the most liveable meet lots of different criteria to ensure safety, education, income and culture of the community. The criteria used to produce rankings vary from survey to survey. They generally include some the following:

- stability or personal safety (crime, terror threats and civil unrest)
- healthcare
- culture and environment (religious tolerance, corruption, climate and potential natural disasters)
- education
- infrastructure (transport, housing, energy, water and communication)
- economic stability
- recreational and sporting facilities
- availability of consumer goods (food, cars and household items).

10.3.2 Characteristics of less liveable cities

According to the Economist Intelligence Unit, civil unrest, acts of terror and violence have resulted a decline in liveability in some cities around the world. Conflict of any kind is damaging to a city's ranking. It decreases the quality of infrastructure, burdens hospitals and reduces the availability of goods, services and activities available to the community.

TABLE 1 The five least liveable cities

Country	City	Rank (out of 140)	Overall Rating (100 = ideal)
Libya	Tripoli	136	40
Nigeria	Lagos	137	39.7
PNG	Port Moresby	138	38.9
Bangladesh	Dhaka	139	38.7
Syria	Damascus	140	29.3

10.3.3 Liveability and sustainability

Australia's major cities often rate amongst the most liveable. Liveability, however, is not always the same as sustainability. Sustainability considers how well a community is currently meeting the needs and expectations of its population and how well it will be able to continue providing for its population.

Indicators that a place is sustainable include:

- low working hours to meet basic needs
- high renewable energy use, low non-renewable energy use
- plenty of recycling and composting
- low vehicle kilometres travelled
- good water, forest, marine health
- high air quality
- biodiversity
- healthy living
- easy access to education.

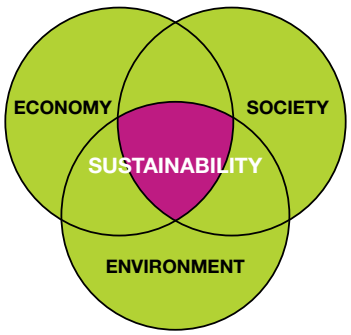


FIGURE 1 To achieve sustainability, a city's environmental, economic and social aspects must all be considered.

ACF sustainable city index

The Australian Conservation Foundation's sustainable cities index tracks progress on sustainability in Australia's 20 largest cities. It calculates a score based on 15 different indicators: air quality, ecological footprint, **green buildings**, water, **biodiversity**, health, density of settlement, wellbeing, transport, employment, climate-change readiness, education, food production, public participation and household debt.

In 2010, there were only small differences between the 20 largest cities. Some key findings were:

- the Sunshine Coast had the best air quality
- Brisbane scored highly in the health category
- Townsville displayed biodiversity
- Canberra and Melbourne had many green buildings
- Sydney rated highest in population density
- Perth had a very high rate of car ownership.

TABLE 2 Australian cities sustainability index, 2010

	Position	Score
Darwin	1	119
Sunshine Coast	2	121
Brisbane	3	123
Townsville	4	129
Canberra (Queanbeyan)	5	133
Hobart	6	139
Melbourne	7	142
Gold Coast (Tweed)	8	143
Cairns	9	145
Bendigo	10	150
Toowoomba	11	152
Sydney	12	161
Launceston	13	163
Adelaide	=14	165
Ballarat	=14	165
Albury–Wodonga	15	167
Wollongong	16	171
Newcastle	17	172
Geelong	18	174
Perth	19	183

Source: www.acfonline.org.au/sites/default/files/resources/2010_ACF_SCI_Report_Comparative-Table_and_Fact-Sheets.pdf

green building building that requires fewer resources when being built, and uses power and water efficiently

biodiversity the rich variety of all life forms on Earth, including plants and animals

ACTIVITIES

IDENTIFY

1 List three criteria included in a liveability survey.
2 What factors make a city less liveable? Why do these factors make a city less liveable?
3 Which cities in the world are least liveable?
4 Which cities have experienced:
  a increases in liveability?
  b decreases in liveability?
  c Suggest what might have led to these changes.

EXPLAIN

5 Describe the distribution of the least liveable cities around the world.
6 How many of the least liveable cities are found on each continent?
7 How many of the least liveable cities are found in each hemisphere?
8 How can ***sustainability*** be linked to liveability? Give examples and reasons to support your answer.

APPLY

9 Refer to table 2 and a map of Australia in your atlas. Use these to decide whether each of the following statements is true or false. Provide reasons to support each choice.
  a More than half of the top 10 sustainable cities are located on the coast.
  b The cities out of the top 10 are all located south of latitude 30°S.
  c New South Wales has the greatest number of sustainable cities in the top 20.

PREDICT

10 What do you think could be done to improve a city's liveability ranking?

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
Christie Walk
Mawson Lakes

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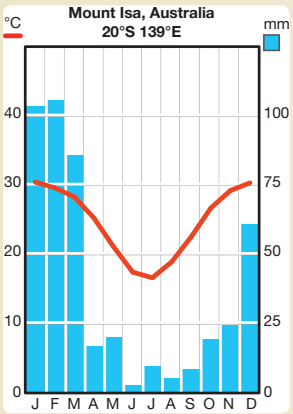
10.4 SkillBuilder: Drawing a climate graph

What are climate graphs?

Climate graphs, or climographs, are graphs that show climate data for a particular place over a 12-month period. They combine a column graph and a line graph. The line graph shows average monthly temperature, and the column graph shows average monthly precipitation (rainfall).



eLesson
Watch this video to learn how to draw a climate graph.

Searchlight ID: eles-1644

Interactivity
Try this interactivity to learn how to draw a climate graph.

Searchlight ID: int-3140

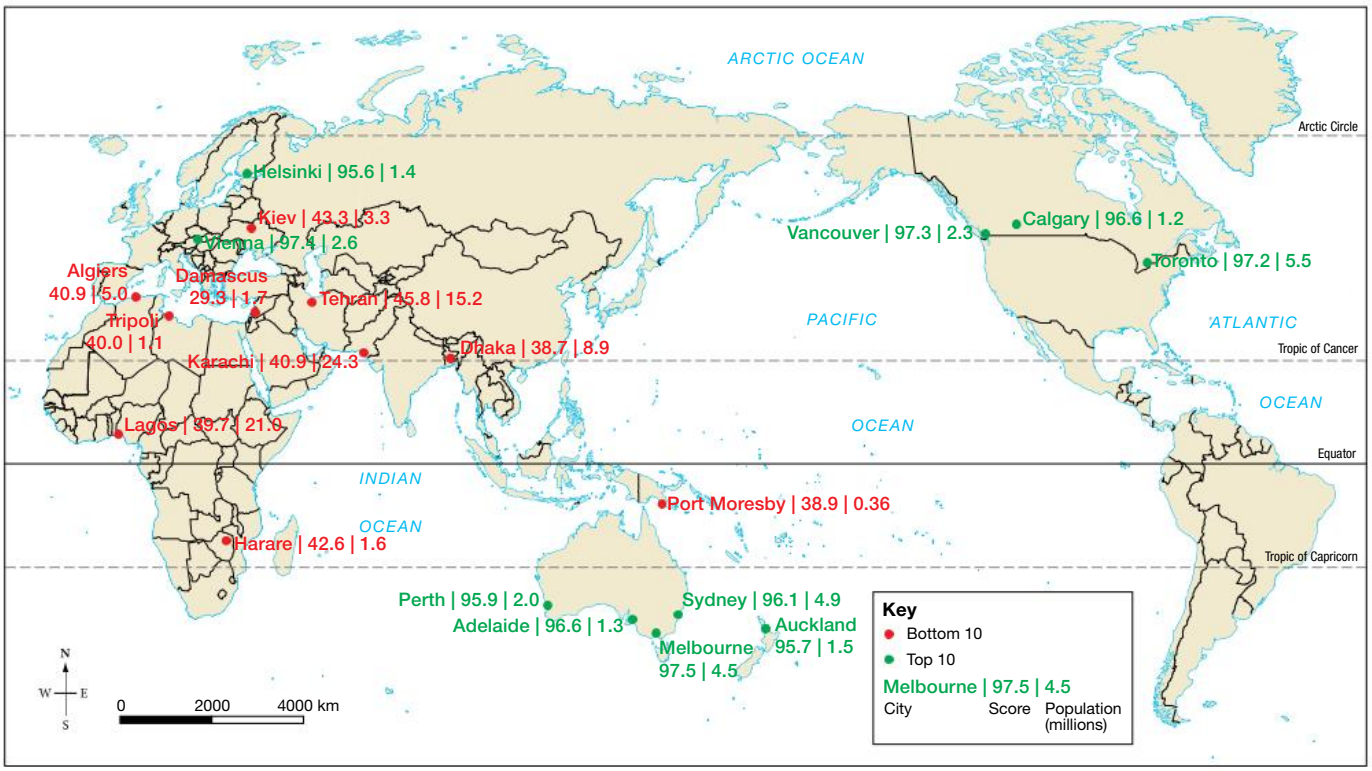
10.5 Where are the most liveable cities?

10.5.1 City liveability

Everyone likes to be able to tell you they are the best, or in the top 10 of some category. Cities are no different. If you look at the official websites for many international cities, they will tell you that they are the safest, wealthiest, fastest-growing or have the best events calendar. Being able to boast that a city is the world's most liveable is great publicity.

Figure 1 shows the top 10 and bottom five in the global cities liveability rankings, as released by the Economist Intelligence Unit (EIU) in August 2015. These rankings are updated each year, so it is possible for you to log on to get the most recent rankings. This survey ranks 140 cities; a score of 100 equates to the perfect or ideal city. For the past few years, Melbourne, Vancouver and Vienna have dominated the top rankings.

FIGURE 1 City liveability ranking, top 10 and bottom 5



Source: Economist Intelligence Unit (EIU), August 2015.

10.5.2 What do these top 10 liveable cities have in common?

Looking at the locations of the most liveable cities, you can see most are found in Australia, Canada or Europe. They are all mid-sized cities and rarely have more than four million inhabitants. These cities have quite low **population density**, low crime rates, and infrastructure that copes quite well with the needs of the local community. They are found in places where the climate is **temperate**, perhaps with the exception of Toronto, Calgary and Helsinki, which do have very cold winters. The top cities also tend to be modern cities, not much more than 300 years old. They have been planned so that people can travel around them by both public and private transport. They are also found in some of the world's wealthiest or most developed nations.

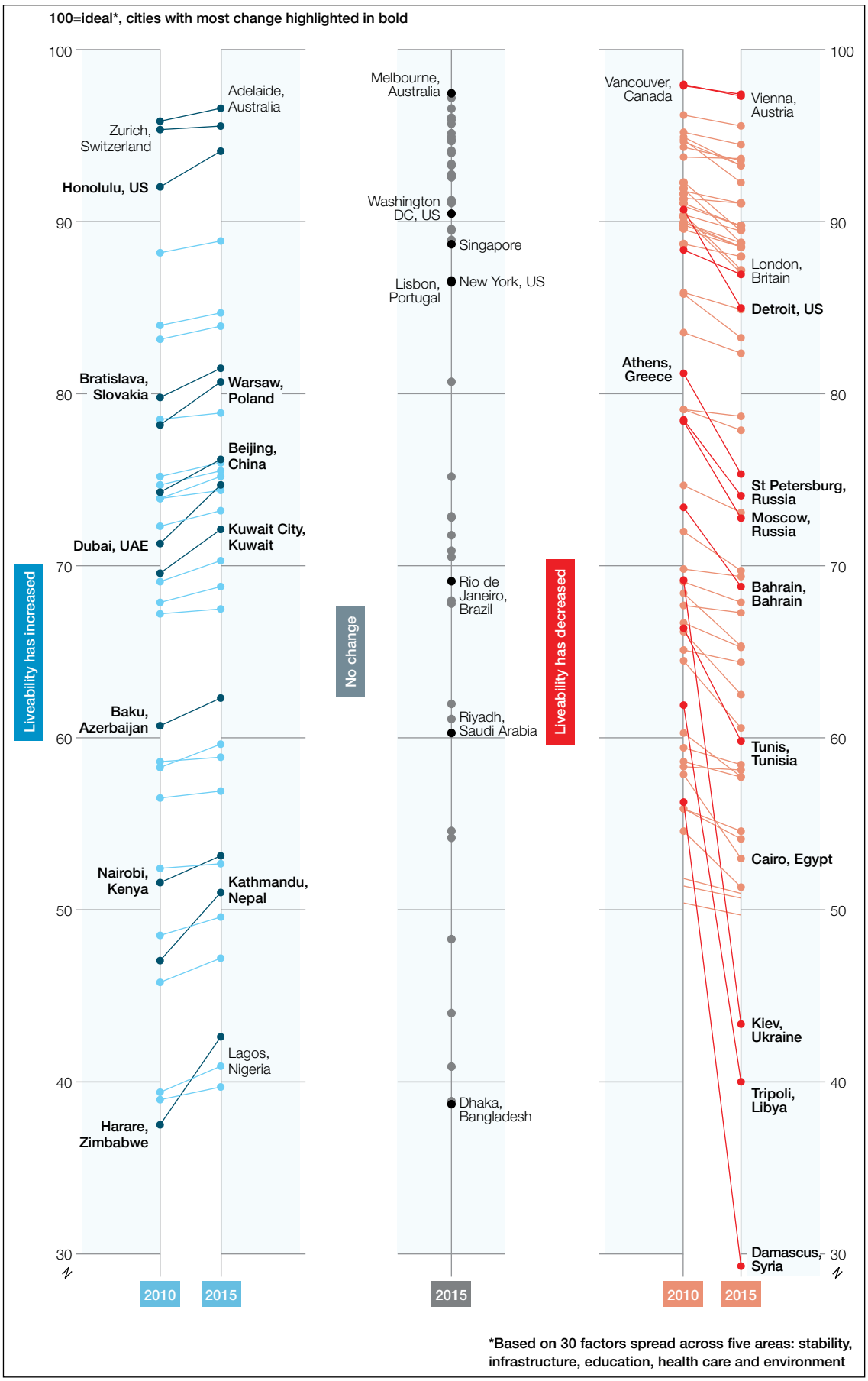
Australian and Canadian cities perform better than cities in the United States due to the higher crime and congestion rates in US cities.

Figure 2 shows the recent change in liveability. Some cities have increased, some have decreased whilst other have experienced no change at all.

population density the number of people living in a square kilometre

temperate describes the relatively mild climate experienced in the zones between the tropics and the polar circles

FIGURE 2 City 'sustainability index'



Source: Economist Intelligence Unit

GEOskills TOOLBOX

Line graphs

Line graphs measure change over a period of time. Multiple line graphs can be drawn to compare multiple groups over the same period of time. Line graphs are simple to construct, whereby you draw a series of points that are then joined together by straight lines.

Figure 2 compares the change in the liveability of cities between 2010 and 2015. The scale on the *y* axis determines how much a city has increased, decreased or stayed the same. For example, Honululu (USA) has increased by approximately 4 points. In contrast, Damascus (Syria) has decreased by approximately 27 points on the liveability index.

ACTIVITIES

IDENTIFY

1 Define population density.
2 What do the top 10 most liveable cities have in common?
3 Which cities experienced no change in ***sustainability*** between 2010 and 2015?

EXPLAIN

4 Why do Australian and Canadian cities outperform the United States in liveability?
5 a List three cities that improved their ***sustainability*** index between 2010 and 2015.
b How might these cities have improved their ***sustainability*** between 2010 and 2015?
6 a List three cities that experienced a decline in ***sustainability*** between 2010 and 2015.
b Suggest reasons why these cities' ***sustainability*** declined between 2010 and 2015.

APPLY

7 Why might people be interested in the liveability and ***sustainability*** survey results?
8 What is the advantage of comparing data collected from 2010 and 2015?

INVESTIGATE

9 Select one of the top 10 liveable cities and one of the bottom five liveable cities. Use the internet to find a news article for each city about why your chosen city is/is not liveable. Stick the new article in your exercise book and write a paragraph explaining how it reflects an increase or decrease in liveability in your chosen cities.

eBookplus

Interactivity
My most liveable city
Use this interactivity to work out which city you would like to live in based on your own criteria.
Searchlight ID: int-3095

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10.6 What makes Melbourne the world's most liveable city?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

10.7 How can liveability be improved?

10.7.1 Sustainable development goals

Many countries cannot afford to provide infrastructure for their growing population. The underlying cause of very low liveability is poverty. Reducing poverty is fundamental to improving living conditions in many parts of the world.

In 2015, the United Nations replaced the Millennium Development Goals with the Sustainable Development Goals. There are 17 goals that have an economic, social and environmental focus (see figure1). Within the goals, there are 169 targets which aim to improve liveability across the world by 2030.

Australia's aid program

global citizen someone who is aware of the wider world, tries to understand the values of others, and tries to make the world a better place

The Australian government recognises that we are **global citizens**, and it supports an overseas aid program through its agency Australian Aid (see figure 2). Overseas aid helps improve outcomes in health, education, economic growth and disaster response in many locations.

FIGURE 1 Sustainable Development Goals

Australian Aid runs projects to improve living conditions, often working with other countries or with **non-government organisations (NGOs)**. NGOs also run programs of their own. Well-known NGOs include World Vision, CARE Australia and the Red Cross. Aid from Australia is given to many countries around the world. The Australian government gives particular preference to the Indo–Pacific region.

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

Small changes, big results

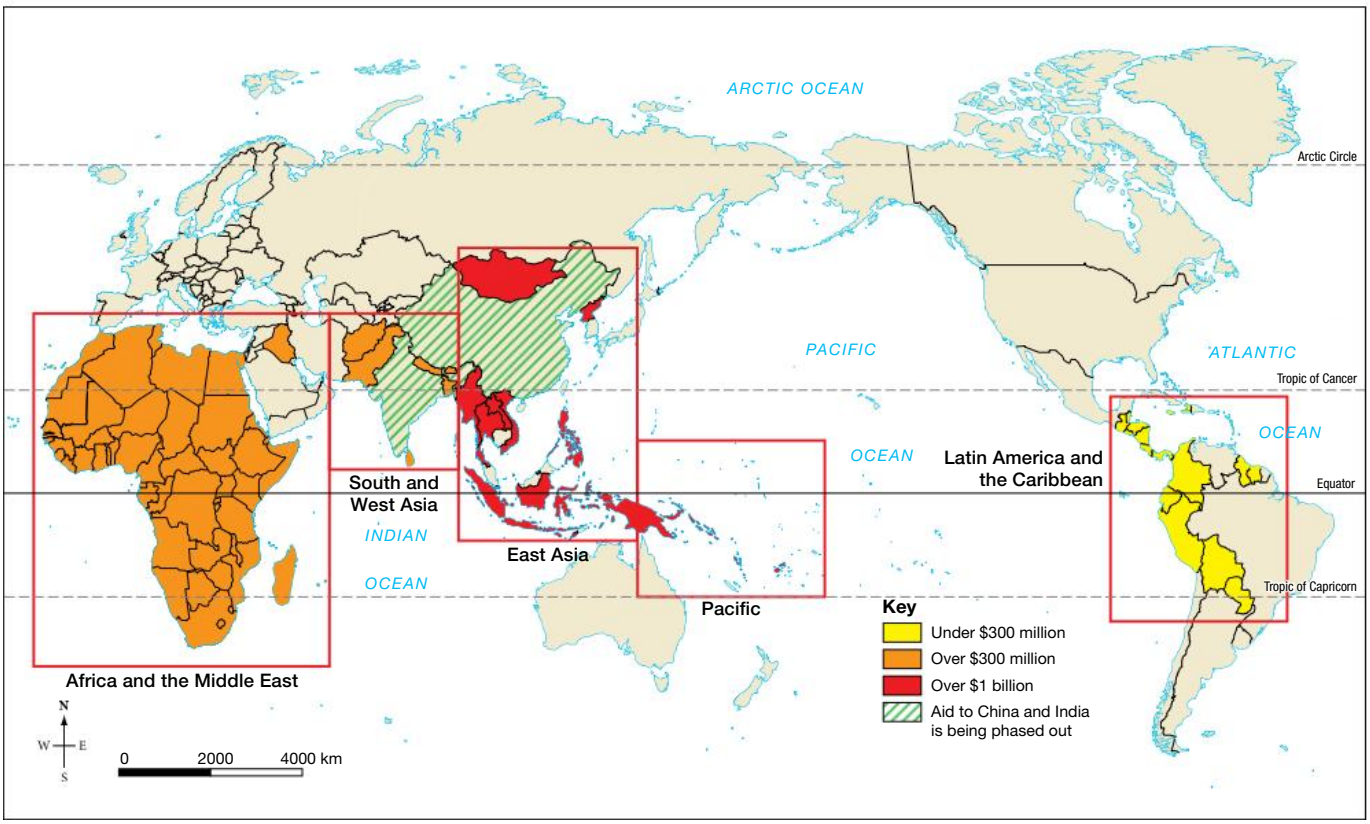
Simple technology can make an enormous difference to people's lives in developing countries (see figure 3).

FIGURE 2 Australian Aid logo

Australian Aid

In addition, a small amount of money can sometimes create a big difference to an individual or community group. Microfinance, or microcredit, is a system of lending small amounts of money, perhaps $150. The borrowers are usually women, and the money is used to invest in something that can generate income. A person might buy an animal for milking and breeding, equipment for basket-making, stock for a store, or materials for jewellery-making. The loan must be repaid, but at a low interest rate, and further loans can be taken out.

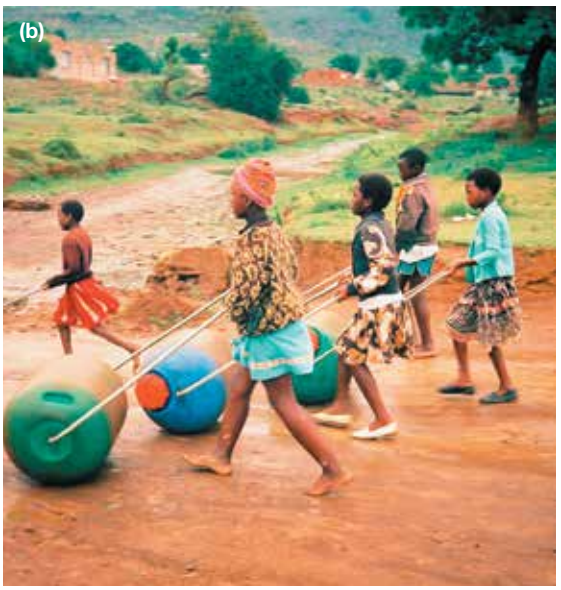
FIGURE 3 Regional distribution of Australian aid, 2015–16



Source: Spatial Vision

FIGURE 4 Examples of projects to address Sustainable Development Goals. (a) A child immunisation clinic on the Kokoda Track (b) Building schools and improving education in Indonesia (c) Planting grasses in Fiji to stabilise sea banks

FIGURE 5 Appropriate technology. (a) Electricity in Nepal is not available to all houses, so a solar lamp increases the opportunities to read. (b) In South Africa, people push hippo rollers, which make it easier to collect water from distant wells and bring it home.



appropriate technology technology designed specifically for the place and the people who will use it. It is affordable and can be repaired locally.

eBook*plus*

Weblink
Sustainable development

ACTIVITIES

IDENTIFY

1 a Which organisation developed the Sustainable Development Goals?
b How many goals are there?
c What is the aim of the Sustainable Development Goals?
2 By which date are the goals to be achieved?

EXPLAIN

3 Study the images in figure 4. Which Sustainable Development Goals have been addressed in these projects?

INVESTIGATE

4 Refer to figure 3. Identify the region in which each of these aid-receiving countries is located: Afghanistan, East Timor, Ethiopia, Nicaragua, Vanuatu.
5 Prepare a report about the work of one NGO involved in programs that aim to improve liveability in an overseas country. Include background information about the location of the project (country and locality); statistical data about living conditions (such as life expectancy, access to safe water, doctors per 100 000 people); and ***environmental*** conditions. Describe the NGO and its project and how it is aiming to improve liveability.

APPLY

6 Choose one of the sustainable development goals. Use a visual organiser to explain how achieving this goal will improve liveability. Take into account the flow-on effects and the impact on people, the economy and the ***environment***.
7 Use the **Sustainable development** weblink in your eBookPLUS to research the targets within each of the Sustainable Development Goals. Write a paragraph explaining how the goals are related. In your opinion, are they achievable?
8 Select one NGO that the Australian government works with and create a report describing what they do to help improve liveability.

10.8 What is liveability like in Badu and Moa?

10.8.1 Badu and Moa islands

Both of these islands are located 40–60 kilometres off the far north Queensland coast in the Torres Strait. Moa Island has a small population of approximately 240 people. Badu Island has a slightly larger population of around 850 people.

These small isolated communities rely on the ocean to provide food and as a pathway for trade. Their livelihood is threatened by climate change, particularly rising sea levels. Communities on the islands are heavily reliant on regular rainfall and have reservoirs to ensure a secure clean water supply. More recently, septic tanks and drainage facilities have been installed improving the environmental health of the islands. Through water security and the development of infrastructure, an increasing number of tourists are travelling to Badu and Moa Islands.

FIGURE 1 Moa Island is the second largest island in the Torres Strait.

ACTIVITIES

IDENTIFY

1 State the vegetation types on Badu and Moa Islands.
2 What is the direction of Saint Pauls from Badu?
3 What is the height of Mt Augustus?
4 Calculate the population density of each of the islands.
5 What are the human features located on these islands?

6 List some of the physical features located on these islands that would appeal to tourists.

EXPLAIN

7 Based on what you can see on the map, how liveable do you think islands are? Support your answer with evidence from the map.

8 Explain, in detail, which of the ***sustainability*** goals impact the liveability of these islands.

PREDICT

9 Identify a combination of human and natural features that might have influenced people to:

- **a** visit the islands as a tourist.
- **b** permanently move to the islands.

10 **a** you could make these islands more liveable, what would you do?

- **b** Create a list of 5 changes you would make to make them more liveable.
- **c** Provide reasons why you would make these changes and how they would make it more liveable.

FIGURE 2 Topographic map extract of Badu Island and Moa Island in the Torres Strait

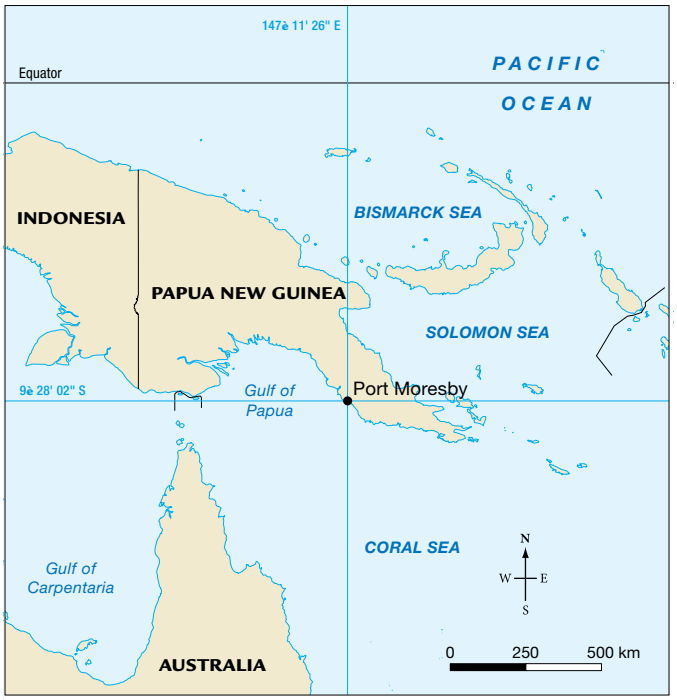
Source: Geoscience Australia.

10.9 Port Moresby — a less liveable city?

10.9.1 Environment

The United Nations measures people's quality of life using the Human Development Index (HDI). In 2000, Papua New Guinea was ranked 133 in the world; in 2013 its ranking had dropped to 157. Its largest city, Port Moresby, is ranked as one of the least liveable cities in the world. The city faces many challenges to meet the needs of its people and improve the standard of living.

FIGURE 1 Location map of Port Moresby



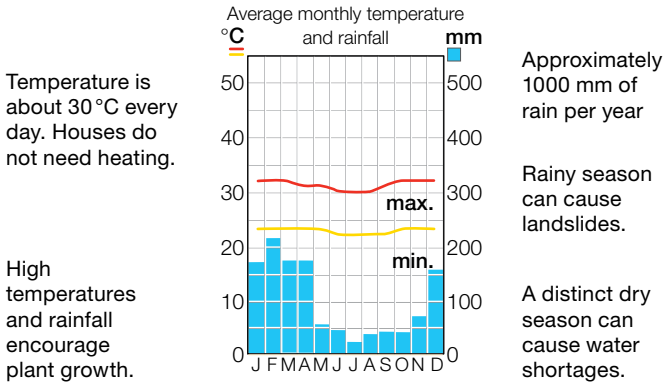
Source: Spatial Vision

Port Moresby, the capital of Papua New Guinea (PNG), is located on the south-eastern coastline. Its population is approximately 350 000, and it is the largest city in PNG.

10.9.2 Safety

The crime rate in Port Moresby is very high, and the city has a reputation as one of the most dangerous in the world. Crimes are often very violent, and gang-based crime is common. There are not enough police, and many crimes are never solved. Travellers are advised to be very careful, to not wear obviously expensive jewellery, and to avoid travelling at night.

FIGURE 2 Climate graph for Port Moresby



10.9.3 Health

The government in Papua New Guinea spends little on preventative measures such as clean water. It also spends little on healthcare. For instance, not all pregnant women can give birth in a hospital, which leads to many complications in childbirth.

- Low spending on equipment
- Shortage of medicine
- Not enough doctors and nurses
- Treatable diseases are common.
- Average life expectancy is about 65 years.
- Highest HIV/AIDS infection rate in the Pacific region

FIGURE 3 A ward in Port Moresby Hospital

10.9.4 Education

School facilities in PNG are quite poor, and attendance rates are very low, particularly for girls. Poor bus services, lack of interest and inability to pay school fees all influence the attendance rate. Only a small proportion of students complete year 12. The **literacy rate** of 55 per cent is quite low by world standards.

literacy rate the proportion of the population aged over 15 who can read and write

10.9.5 Economy

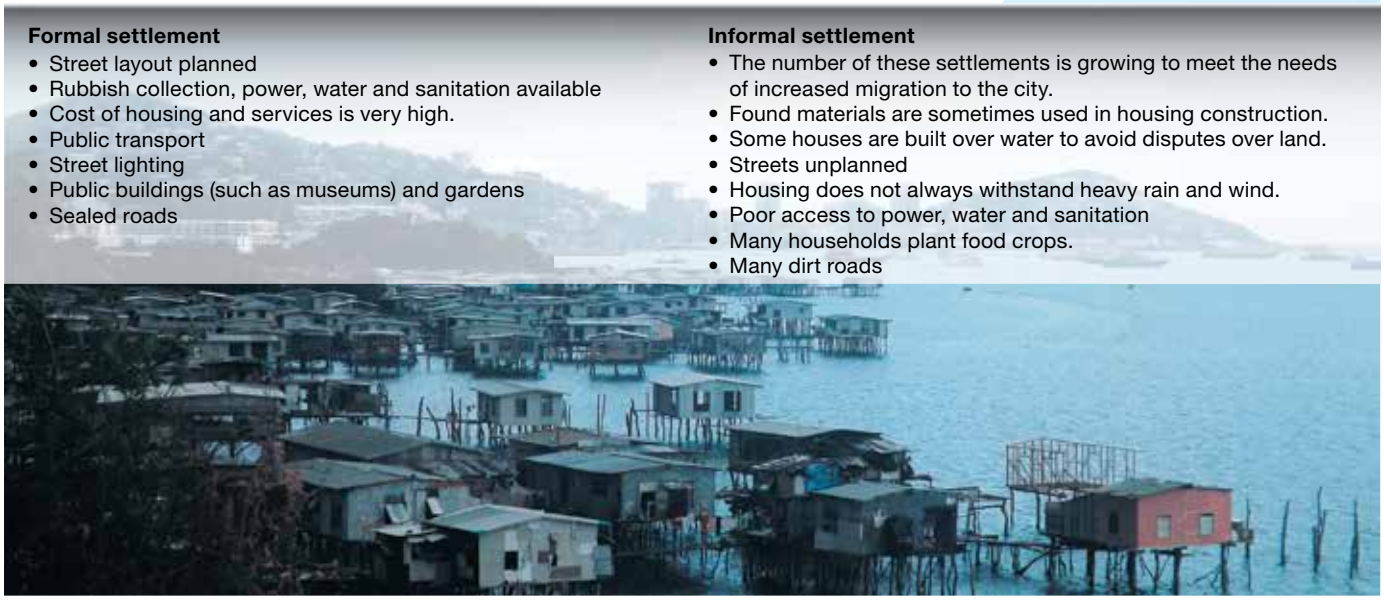
The government in PNG provides no welfare. Fortunately, many families can take advantage of the good growing conditions to produce food to eat and sell. Unemployment is very high, and most work is found in the **informal sector**. Many businesses in this sector involve selling food and other goods. About half the population lives on less than $1 a day.

Life is difficult for girls, and there is much discrimination. Girls do not all get access to school; their literacy rate is lower than that of boys; child-bearing begins at a young age; and the level of violence against women is among the highest in the world.

informal sector jobs that are not officially recognised by the government as official occupations and that are not counted in government statistics

10.9.6 Infrastructure

FIGURE 4 Port Moresby is a mixture of high-rise urbanised landscapes and village landscapes.



ACTIVITIES

IDENTIFY

1 Refer to figure 1. At what latitude is Port Moresby?
2 Why don't all children attend school?
3 In which sector of the economy do most people find work?
4 What do you think is the difference between a formal settlement and an informal settlement?

EXPLAIN

5 How does environmental quality (such as climate) influence living conditions in Port Moresby?
6 Why are travellers advised to be careful in Port Moresby?
7 Refer to figure 3. Which is the biggest health issue facing Port Moresby? Why?
8 Use the **Slum life** weblink in your eBookPLUS to watch a video showing life in slums. Explain how slums are part of the process of city growth.

INVESTIGATE

9 What is the difference between the population of Port Moresby and the biggest city in your state or territory?
10 a Compare the literacy rate in Papua New Guinea and Australia.
b Compare the life expectancy in Papua New Guinea and Australia.

APPLY

11 Use Google Earth to 'fly' to Port Moresby.
a Would you describe the distribution pattern of the buildings as clustered, scattered or linear (in a line)?
b Do you think the distribution of the buildings would make it easier or harder to improve transport, water, power and safety? Justify your answers.

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Interactivity
Environmental quality
Use this interactivity to look more closely at how environmental quality affects where people live.
Searchlight ID: int-3096
Weblink
Slum life

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10.10 Dhaka — a less liveable city?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

10.11 What makes a place liveable for you?

10.11.1 Liveability studies

A study of a region's liveability will reflect its natural characteristics and human characteristics. All communities would like a safe, healthy and pleasant place to live, a sustainable environment, the chance to earn a liveable wage, reliable infrastructure and opportunities for social interaction.

The findings of a liveability survey will be influenced by a range of factors.

- Where a person lives influences their access to services, employment and environmental features, and their address may influence their perception of the quality of the region.
- Different age groups have different views and needs.
- Current economic conditions influence a person; for example, a major employer may have closed or opened.
- Environmental conditions affect a person; for example, a region may be experiencing drought.
- Government policies influence infrastructure, housing assistance, and grants to local sports clubs.

To find out about the liveability of an area, a number of themes need to be investigated. Some of these can be gained from **census** statistics, while others can be gained only through surveys and fieldwork.

In any community there will usually be agreement about some things that improve liveability. All groups accept that safe water, sealed roads and a reliable power supply are important.

census an official count or survey of a population, which often seeks and records other information about people. The Australian Bureau of Statistics conducts a national census every five years.

FIGURE 1 Community wish list: some aspects of liveability are common to all groups and some are desired by particular groups.

Community wish list

- Playgrounds
- Paths for prams
- Primary schools
- Single-person housing
- Family housing
- Friendly community
- Shopping nearby
- Paths for scooters
- Health services
- Public transport
- Neighbourhood house
- Parks and gardens
- Public seating
- Recognition of those from non-English-speaking backgrounds
- Financial security
- University of the Third Age

If a community wants to obtain certain kinds of items on its liveability 'wish list', it sometimes needs help from national, state or local government. Examples of such items include major roads, railways and desalination plants. Sometimes, though, a wish-list item is best obtained by an individual or community. This is the case when setting up sporting clubs, youth groups and local music events.

TABLE 1 Matching liveability indicators to key themes

Measure	Examples of indicators	
Social	• Population characteristics (gender, age) • Education (primary, secondary, tertiary) • Health (life expectancy, health-centre attendance, length of walking tracks, smoking rates, weight, chronic diseases) • Safety (perception, crime rates, road deaths and injuries, work safety)	• Volunteering • Voting • Aged care accommodation • Access to public transport • Membership of clubs and organisations • Diversity (ethnicity)
Environmental	• Biodiversity • Planning for the future • Water access • Waste management • Ecological footprint	• Public spaces • Household recycling • Weather • Land clearing
Economic	• Employment • Variety of businesses • Income • Financial stress • Housing types	• House ownership • Infrastructure • Internet access • Power • Car ownership

collate to organise the findings of fieldwork

FOCUS ON FIELDWORK

Looking at your school environment

Geographers are particularly interested in:

- the location of things
- the distance between things
- the distribution patterns we can see when we produce a map
- the movement between places
- the connection between places
- the changes that happen over time.

How can you apply these concepts when finding ways of improving your school environment? Work in pairs to gather the data needed for the following fieldwork task. Each student will complete a report of findings.

Step 1: Study the distribution of resources and landscapes over space in the schoolyard.

- Obtain an outline map of the schoolyard.
- Walk around the schoolyard and identify different categories of land use. Design a key for your map and mark in the land uses on your map.
- As you walk around the schoolyard, also note the landscape (slopes, swamp, bare ground, concrete and so on). Record the information about the landscape on your map. You may add to your key or annotate the map. You may also wish to use an overlay. (See SkillBuilder 10.12 'Creating and analysing overlay maps'.) You could also add images.
- Describe the distribution of land uses in the schoolyard. Can you identify regions? Mark these on your map. Consider using an overlay. Is there any interconnection between the landscape and land use?

Step 2: Study the patterns of movement in the schoolyard.

- Choose two places that students often walk past.
- Record the number of students who pass and the direction of travel in two five-minute sessions.
- Add this information to your map. Which are the busiest walkways in the schoolyard?

Step 3: Make recommendations for improvements to the schoolyard.

Based on the information you have gathered, describe:

- pleasing aspects of the schoolyard
- disappointing aspects of the schoolyard
- your three most effective suggestions for improving the schoolyard.

Mark the location of the proposed changes on your map. You may include images of proposed changes.

Conduct a short survey of ten other students to find out what they think about your three suggestions for improving the schoolyard.

When conducting your survey, there are three types of questions you need to ask: those that seek an opinion, those that seek a fact and those that seek a suggestion.

- To seek opinions, try to ask for a rating. For example, *There should be more seats in the schoolyard. Do you (a) strongly disagree? (b) disagree? (c) neither agree nor disagree? (d) agree? (e) strongly agree?*
- To seek facts, ask for a structured response. For example, *How often do you use the seating by the oval? (a) Every day (b) 1–3 times a week (c) A few times a month (d) A few times a year (e) Almost never.*
- To seek suggestions, use open-ended questions. For example, *What sorts of plants do you think should be planted along the front fence?*

Create one question for each of your suggestions. Cover each type of question. Ensure you have your map with you when you ask the questions.

Collate, or gather, the survey data for each question. For each question, count the number of responses that are the same, and present the result in words, in a table or in a graph. (You might choose a bar graph, for example. See SkillBuilder 15.6 'Creating a simple column or bar graph'.) There might be a clear trend in the responses or there might be variety in the responses.

To what extent do your survey findings support your suggestions? Describe the result.

ACTIVITIES

IDENTIFY

1 What are the three themes used when investigating liveability? Why do you think these are chosen?

EXPLAIN

2 Refer to table 1 and identify two aspects that could be placed in a different theme. Justify your suggested change. Suggest one more indicator that should be included. Into which theme would it belong?

3 Refer to figure 1 and use an organiser like a Venn diagram to compare and contrast the liveability wish lists for young families and older people.

INVESTIGATE

4 Find a local news story about a change to liveability in your area. Is the ***change*** economic, social or environmental? Is the ***change*** predicted to be positive or negative? Will the ***change*** be permanent?

APPLY

5 How could the improvement in liveability for one age group actually help the liveability of another age group? Provide an example.

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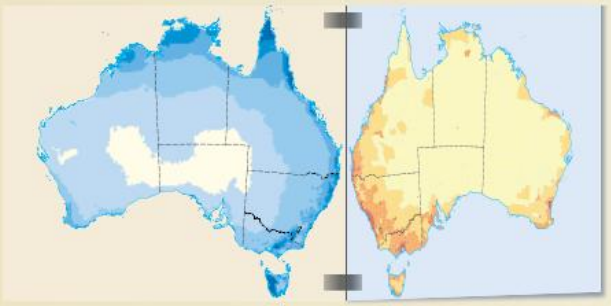
10.12 SkillBuilder: Creating and analysing overlay maps

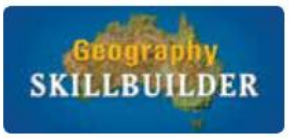
What are overlay maps?

An overlay map usually consists of two or more maps of the same area. A base map is overlaid with a transparent overlay, showing different information. Overlay maps allow users to see the relationships between the information on two or more maps.



eLesson

Watch this video to learn how to create and analyse an overlay map.



Searchlight ID: eles-1645

Interactivity

Try this interactivity to learn how to create and analyse an overlay map.

Searchlight ID: int-3141

10.13 How could my community be made more liveable?

10.13.1 Transport strategies

People in towns and cities are always looking for strategies to improve their living conditions. A community is made up of people from a range of age groups, a number of different land uses, a range of needs and a variety of interests. Ideas and plans for improvement may be overarching or targeted.

The movement of people within and between neighbourhoods is an important issue in towns and cities. The humble bicycle is now seen as a way of increasing mobility, reducing traffic congestion, reducing air pollution and boosting health. Bicycle tracks encourage recreational riding for all ages (see figure 1) and dedicated bicycle paths along main routes (see figure 2) encourage people to **commute** by bicycle, rather than car, to work and school.

commute to regularly make a journey such as from home to work

FIGURE 1 Recreational riding along a trail mainly designed for bicycles

In 1965, a group in Amsterdam, the Netherlands, introduced the idea of bike sharing — public bicycles that are hired, usually for short trips. This first attempt was not a success, but the idea persisted. Modern bike-sharing systems have overcome problems of theft and vandalism by using easily identifiable specialty bicycles, monitoring the bicycles' locations with radio frequency or GPS, and requiring credit-card payment or smart-card-based membership to check out bicycles. In some places, bicycles can be located on your mobile phone, and there are more links between bicycles and existing public transport. Today there are more than 500 cities in 49 countries that have bike-sharing programs, with a combined fleet of over 500 000 bicycles. Bike-sharing programs are an example of a popular strategy that is aimed at improving liveability for a range of ages and locations within a community.

An example of a successful bike-sharing scheme is in Paris. The Vélib was introduced in 2007 and quickly doubled in size. By 2012, bicycle trips in the city had grown by 41 per cent. Bike sharing is part of a plan to reduce car traffic and pollution in Paris, which includes closing streets to cars on weekends, reducing speed limits, encouraging bus travel and extending bicycle lanes.

FIGURE 2 Special bicycle lanes increase the safety of bike riding.

Research task

Liveability in my community

1 Identify a ***space*** in your neighbourhood that you think could be improved for teenagers. It may be one that is currently attractive, or it may be a least favourite ***space***.
2 Provide an image (photograph, diagram or map) of this ***space***. Annotate the image to describe its current characteristics. Also, state what the space is used for.
3 Identify the key concerns about this ***space***. You might think about safety, tolerance, ***sustainability***, access, inclusiveness, services, ***environmental*** quality, health and respect.
4 How would you improve this ***space***? Provide a suggestion to address each of your concerns.
5 Provide a new image to show the impact of your proposals. This could be a diagram, sketch, annotated photograph, model or whatever helps communicate what the impacts might be.
6 Which are your two most important suggestions? What criteria did you use to choose these suggestions? Which suggestion is most likely to be implemented? Why?
7 Create a short survey to show 10 people your idea about the improved space. Record your data in a series of pie charts.

FIGURE 3 Barangaroo is a 22-hectare waterfront renewal project on the western Harbour foreshore of Sydney's CBD near Darling Harbour. This was once one of Sydney's oldest industrial sites. This area has been designed to enhance the wellbeing of the community. It aims to:

- be carbon-neutral by generating solar renewable energy on site for the public areas
- provide recycled water from Barangaroo to the CBD
- use recycled water for flushing toilets, irrigation and fire sprinklers
- generate zero waste
- provide access to and facilities for walking, cycling and recreation, including a 2.2 kilometre foreshore walk.

More than 50 per cent of Barangaroo will be public space.

FIGURE 4 Melbourne's City Square, bordered by Swanston and Collins Streets, Flinders Lane and the Westin Hotel, has been designed as a liveable multi-use outdoor space. Trees have been planted to provide shade, accessible tram stops built, cafes established, and bins, grassed areas and seating provided for locals and visitors.

ACTIVITIES

IDENTIFY

1 What are three advantages of increasing bicycle riding?
2 What problems were faced by the first bike-sharing scheme?

EXPLAIN

3 Use the **Bike sharing** weblink in your eBookPLUS and scroll down to the link '(See data.)'. This will take you to an Excel document. Use this document to answer the following questions.
   a In 2012, how many bike-sharing programs were there in each of these regions?
      • Asia–Pacific
      • Europe
      • Latin America
      • Middle East
      • North America
   b Name at least two countries with bike-sharing programs in each of these regions.
   c Which region has the most programs?
   d Which region has had programs for the longest period of time?
   e Which region has introduced programs most recently?
   f Which region has the greatest number of bicycles? Is this the same region that has the greatest number of programs?
   g Explain how you could present data about bike-sharing programs on a map. Provide examples of how you would show:
      • countries with programs
      • the number of programs per country
      • the number of bicycles per country.

INVESTIGATE

4 Find out about a bike-sharing scheme in Australia or overseas. Describe its location and the region it covers. Provide three other key facts about the scheme.

eBookplus
Weblink
Bike sharing

eBookplus
ONLINE ONLY

10.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

CHAPTER 11

Geographical inquiry: What is my place like?

11.1 Overview

11.1.1 Scenario and task

Task: Create a blog that presents demographic characteristics of your local place.

Every person has their own idea of what their local place is like. For some people, this area can be very large; for others, it can be quite small. It really depends on where you go in your everyday life. For example, homes of relatives or friends, sports clubs, shops and parks. This means that it does not matter if your map representing your place is a different size or shape to those of friends who live in the same area. The differences simply reflect what you do and think as an individual person.

When you draw a mental map of your local place, you identify the features that you think give your neighbourhood a sense of place. All local areas have these special features that create the character or personality of the place. Many of these features can be identified on maps of the area. But there are also characteristics of your local area that you may not know about. How do you find out about these?

The Australian Bureau of Statistics (ABS) is the Commonwealth Government's organisation that has the responsibility to collect, collate and report information about Australia's people. Every five years, the ABS conducts a major survey of all Australians, as they are living on one specified day of the year. This is called the census. The ABS then compiles this information and releases it for publication, which is when it is used by governments, businesses, companies and individuals to plan for the future.

Your task

Create a blog that presents demographic characteristics of your local place. The Australian Bureau of Statistics (ABS) website (www.abs.gov.au) provides a pathway for you to find out the demographic characteristics of your chosen postcode area.

11.2 Inquiry process

11.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You will write your blog entries individually, but you could work in groups of three to share your research in the ProjectsPLUS Research Forum and create your blog. Save your settings and the project will be launched.

- **Planning:** You will need to research the demographic characteristics of your chosen local place. Locate and print a map of your chosen place to accompany the data you find. Navigate to your Research Forum. Use the research topics to select the characteristics you are interested in exploring for your place. Note that if you would like to focus on a particular issue that is not on the list, obtain permission from your teacher before starting the task.

11.2.2 Collecting and recording data

For this inquiry, go to the Australian Bureau of Statistics (ABS) website (www.abs.gov.au) and select the 'Census' page. Click on 'Data & analysis' in the menu at left and choose 'QuickStats'. Under 'QuickStats Search', select the most recent census year, type your postcode or place name into the search box and select 'Go'. This will bring a map of your local area and related data onto the screen. Choose either People, Families or Dwellings to gather information about.

- **Going further**
  - Compare the changes to your place over time. Choose the same topic for different census years and compare the data.
  - Compare your local area with another local place in your region or city. The other place could be next to yours or a long distance away.

11.2.3 Processing and analysing your information and data

Having collected the information about your local place, you now need to study the data and describe the patterns you have found.

1. How does your place compare with the neighbouring places?
2. What do the combinations of characteristics you have chosen tell you about the community in your postcode?
3. What do the charts tell you that you did not know about the different places in the region where you live?
4. If you have looked at change over time, compare the two charts and describe how the distribution of that characteristic changed over the years. Suggest reasons to explain these changes.

Visit your Media Centre and download the blog planning template to help you develop your blog. You will also see a sample blog on which you can model your own task. Your Media Centre also includes images, videos and audio files to help bring your blog to life.

11.2.4 Communicating your findings

Use an online blogging site to set up your group's blog and then enter all of the required blog entries. Be sure to create a headline for your article and add relevant tables, graphs, images and videos. Your article should emphasise the important facts, and how and why they have changed over time.

11.3 Review

11.3.1 Reflecting on your work

Think back over how well you worked with your group on the various tasks for this inquiry. Determine strengths and weaknesses and recommend changes if you were to repeat the exercise. Identify one area where you were pleased with your performance, and an area where you would like to improve. Write two sentences outlining how you might be able to do this.

Print out your Research Report from ProjectsPLUS and hand it in with your blog and reflection notes.

Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

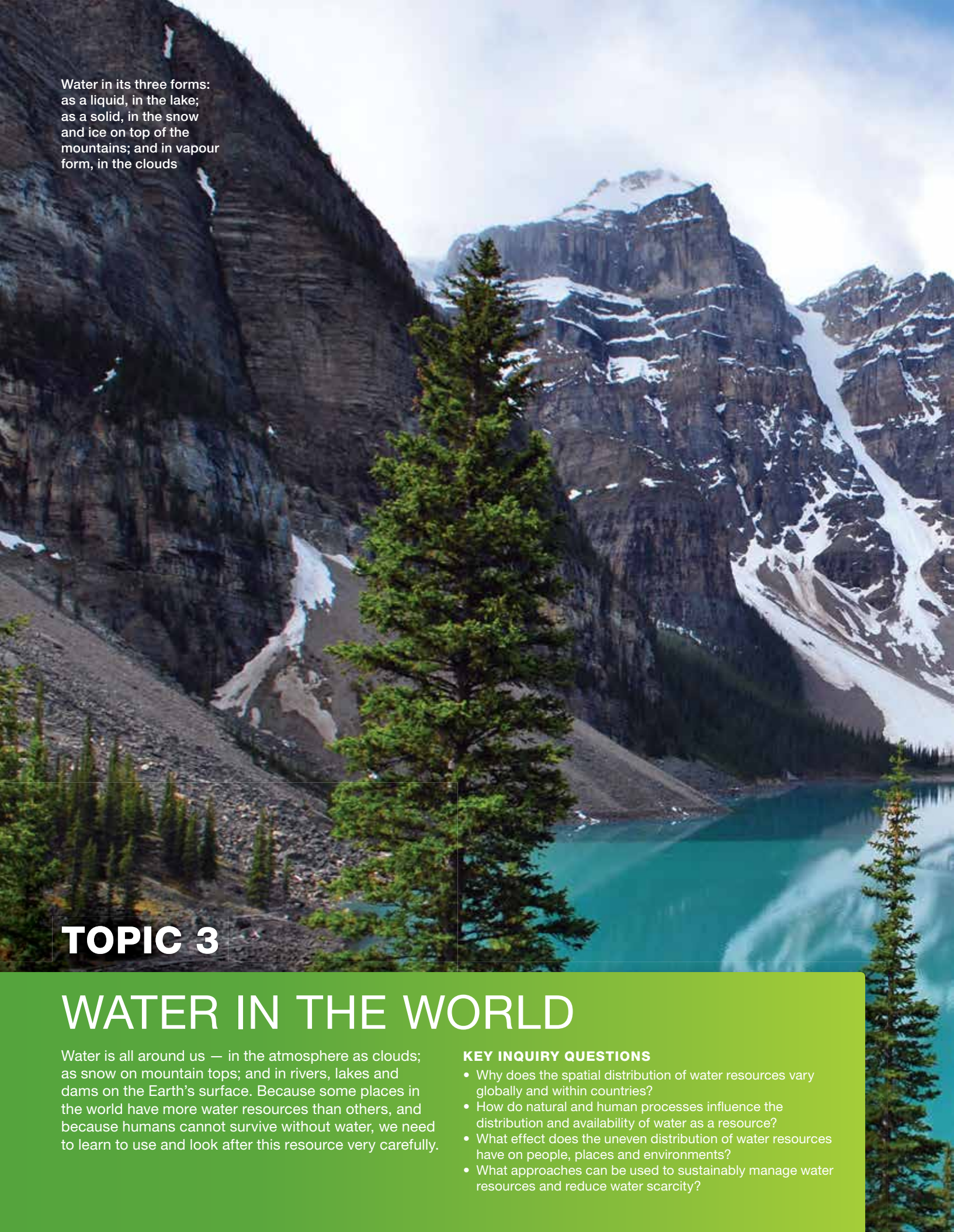
Suggested software

- ProjectsPLUS
- Microsoft Word
- Online blogging site

Media Centre

Your Media Centre contains:

- a blog model
- a feature article scaffold
- a selection of images and audio and video files to add richness to your blog
- weblinks to research sites and blogging websites
- an assessment rubric.



Water in its three forms: as a liquid, in the lake; as a solid, in the snow and ice on top of the mountains; and in vapour form, in the clouds

TOPIC 3

WATER IN THE WORLD

Water is all around us — in the atmosphere as clouds; as snow on mountain tops; and in rivers, lakes and dams on the Earth's surface. Because some places in the world have more water resources than others, and because humans cannot survive without water, we need to learn to use and look after this resource very carefully.

KEY INQUIRY QUESTIONS

- Why does the spatial distribution of water resources vary globally and within countries?
- How do natural and human processes influence the distribution and availability of water as a resource?
- What effect does the uneven distribution of water resources have on people, places and environments?
- What approaches can be used to sustainably manage water resources and reduce water scarcity?

This picture shows what all of Earth's water would look like if it were contained in a sphere, in comparison with the size of the Earth. The blue sphere representing all of Earth's water has a diameter of 1385 kilometres.

CHAPTER 12

Water in the world

12.1 Overview

12.1.1 Introduction

Viewed from space, the Earth is a sphere of blue. Water covers most of our planet. We depend on water for life; in fact, no life is possible without it. Water is a precious and finite resource, yet most of the Earth's water is too salty for humans, animals or plants to use. A number of factors affect where water is available around the globe and as a result, water is not distributed equally around the planet. Weather is one factor that influences the level of precipitation experienced in different places.

Starter questions

1. Describe how the weather affects your everyday life.
2. List some natural resources that are used by your family on a daily basis.
3. List two natural ***environments*** that have a lot of water. Name where they are or show their location on a map.
4. Why do you think water is thought of as a precious resource? Justify your answer.

Inquiry sequence

		Syllabus outcomes
12.1 Overview		
12.2 What is a resource?		GE4-1, GE4-2, GE4-8
12.3 Is water a renewable resource?		GE4-1, GE4-2, GE4-8
12.4 SkillBuilder: Interpreting diagrams	eBookplus ONLINE ONLY	GE4-7, GE4-8
12.5 How much water is there in the world?	eBookplus ONLINE ONLY	GE4-1, GE4-2, GE4-8
12.6 How is groundwater used as a resource?		GE4-1, GE4-2, GE4-3, GE4-8
12.7 How does water flow through catchments?		GE4-1, GE4-2, GE4-3, GE4-8
12.8 What factors affect water availability?		GE4-2, GE4-3, GE4-7, GE4-8
12.9 What is the difference between weather and climate?		GE4-2, GE4-3, GE4-7, GE4-8
12.10 SkillBuilder: Reading a synoptic chart	eBookplus ONLINE ONLY	GE4-7, GE4-8
12.11 Investigating topographic maps: How does water flow down the Haast River?		GE4-2, GE4-3, GE4-7, GE4-8
12.12 Why does the wind blow?	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-7, GE4-8
12.13 How strong is the wind?	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-7, GE4-8
12.14 Review	eBookplus ONLINE ONLY	GE4-1, GE4-2, GE4-3, GE4-7, GE4-8
Key terms	eBookplus ONLINE ONLY	

eBook*plus*

Watch this video
A world of water
Searchlight ID: eles-1616

12.2 What is a resource?

12.2.1 Global supply

We depend on natural resources to survive. We need water to drink, soil to produce our food, and forests and mines to supply other materials. Natural resources are raw materials that occur in the environment and which are necessary or useful to people. They include soil, water, mineral deposits, fossil fuels, plants and animals.

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

Renewable resources are those that can be replaced in a short time. For example, solar energy is a renewable resource that can be used for heating water or generating electricity. It is never used up and is constantly being replaced by the sun.

fossil fuels fuels that come from the breakdown of living materials, and which are formed in the ground over millions of years. Examples include coal, oil and natural gas.

Non-renewable resources are those that cannot be replaced in a short time. For example, **fossil fuels** such as oil, coal and natural gas are non-renewable because they take thousands of years to be replaced.

We cannot make more non-renewable resources; they are limited and will eventually run out. However, renewable natural resources are things that can grow or be replaced over time if they are carefully managed. Forests, soils and fresh water are renewable.

FIGURE 1 Many resources are required to provide a family with breakfast.

Some renewable resources will always be available for use regardless of human activity, such as energy from the sun or tides. However, human activities can impact on our ability to use some renewable resources such as water or soils. We can have a negative impact on the quality of these resources or their ability to regenerate. For example, chemical dumping could make water undrinkable or overfishing could reduce the ability of a fish species to reproduce at a rate to sustain the population.

uranium radioactive metal used as a fuel in nuclear reactors

The global distribution of natural resources depends on geology (the materials and rocks that make up the Earth) and climate. Some minerals are rare and are found in only a few locations. For example, **uranium** is found mainly in Australia. Several countries in the Middle East, such as Saudi Arabia and Iran, have rich oil resources but are short of water. Many countries in Africa, such as Botswana, have mineral resources but lack the money to mine and process them.

subsistence farming a form of agriculture that provides food for the needs of only the farmer's family, leaving little or none to sell

The human activities of agriculture, fishing, logging and mining all depend directly on natural resources. In developing countries, traditional forms of agriculture such as **subsistence farming** and nomadic herding are still common. These activities are sustainable if farmers move on when an area

becomes unproductive, allowing the land to recover. However, poverty and population growth mean that many people now clear forests for farms and overgraze or overcrop small plots of land, resulting in deforestation and land degradation.

FIGURE 2 Natural resources — renewable and non-renewable

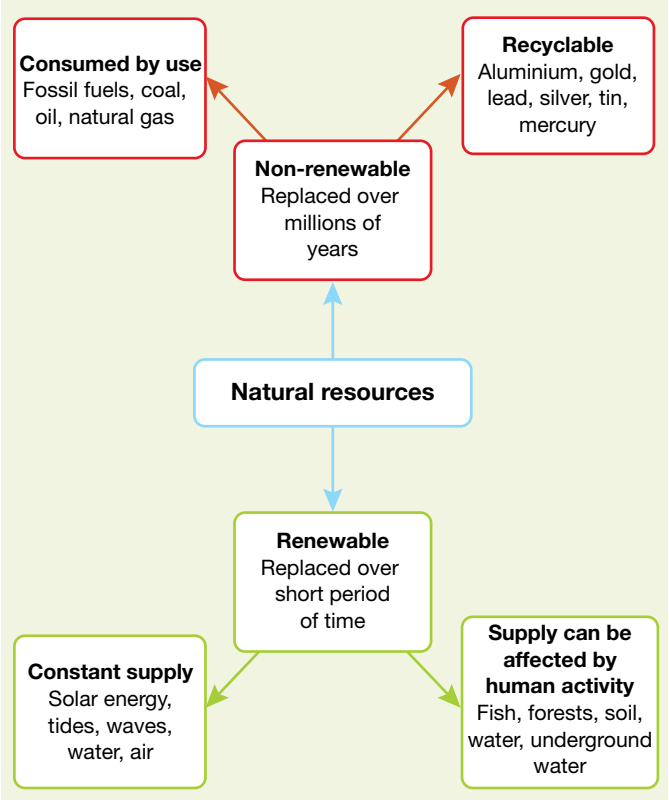
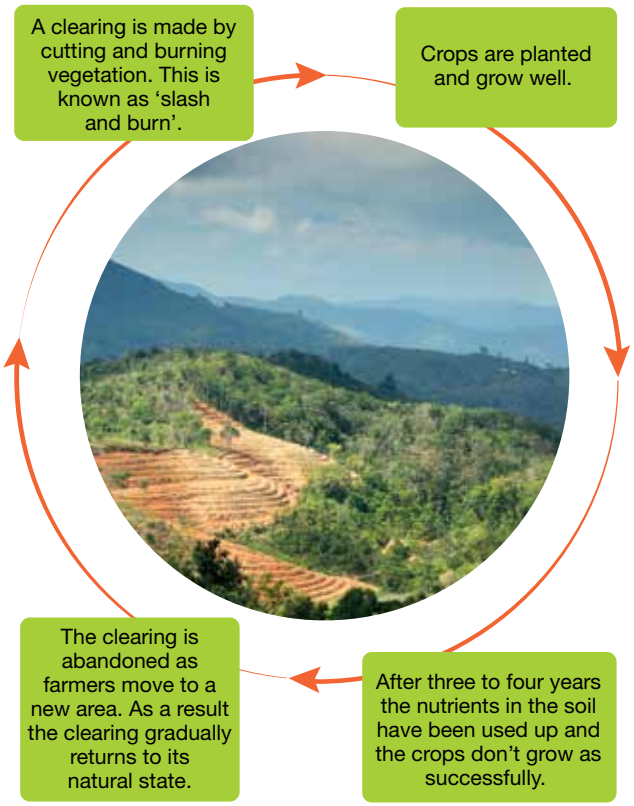


FIGURE 3 The process of shifting cultivation



Farms in developed countries are usually much larger. For example, the Anna Creek cattle station in South Australia is 24 000 square kilometres, the size of Belgium. In contrast, an average intensive rice farm in Bali is only about one hectare. This is about four times the size of an Australian quarter-acre block of land. Unsustainable agricultural practices in developed countries include the overuse of water, fertilisers and pesticides. For example, fertilisers help crops to grow, but when they end up in rivers and oceans as run-off, they cause algal blooms and damage coral reefs.

ACTIVITIES

IDENTIFY

1 What is a natural resource?
2 Outline the difference between renewable and non-renewable resources.
3 List three examples of non-renewable resources that can be recycled.

EXPLAIN

4 Which renewable resources are most affected by human activity? Why?
5 When it comes to using natural resources, there are two main problems people face. What are they and why are they important?
6 What does *the sustainable use of natural resources* mean?
7 Why is shifting cultivation a ***sustainable*** form of agriculture?

APPLY

8 Refer to figure 3. Use the internet to research who uses shifting cultivation around the world. Choose one case study and report back to the class about their way of life. Examples of these may include tribes from the Amazon, Congo Basin or Papua New Guinea. Compare your chosen tribe's way of life with your way of life, and explain how it differs when it comes to using resources and accessing food. Upon completion of the presentations, discuss as a class why you think Australian farmers do not use shifting cultivation as their method of agricultural production.
9 What did you have for breakfast today? What resources would have been required to provide it?
10 What are examples of fossil fuels that you use in order to maintain your lifestyle?
11 Create a table that lists 10 renewable and 10 non-renewable resources used by your family. Be specific; for example, list timber used in your furniture. From your list, note some of the waste and pollution that may be created in the use or creation of these resources. How could this be reduced to improve ***environmental sustainability***?

12.3 Is water a renewable resource?

12.3.1 Water as a resource

A renewable resource is one that can replenish or replace itself in a relatively short period of time. Water is an example of a renewable resource.

eBookplus

Interactivity
Water works
Use this interactivity to learn how the water cycle works.
Searchlight ID: int-3077

The amount of water on Earth has not changed since the beginning of time; there is only a finite, or fixed, amount. The water used by ancient and extinct animals and plants millions of years ago is the same water that today falls as rain. The amount of water cannot be increased or decreased. It is cycled and recycled, and constantly changes its state from gas, to liquid, to solid, and back.

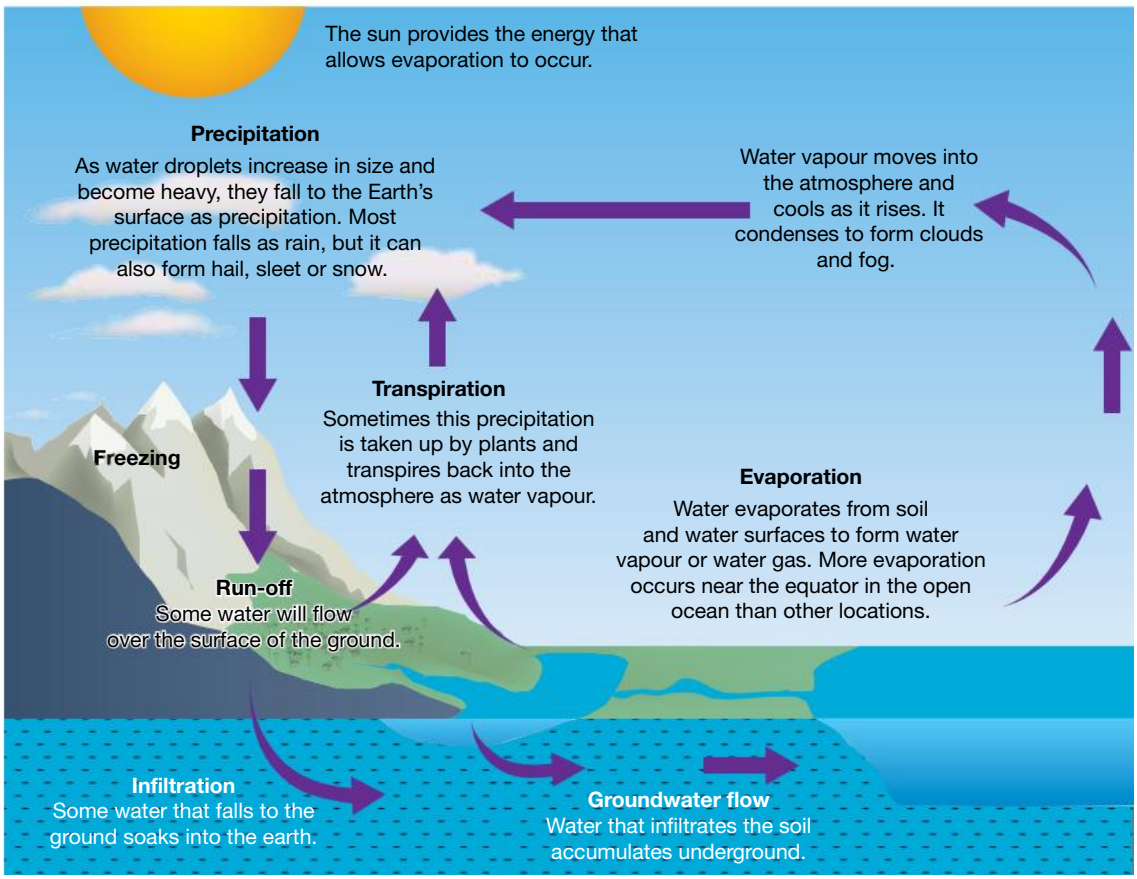
Despite there being a finite amount of water on Earth, it is viewed as renewable because it is in a constantly changing state from gas, to liquid, to solid and back. If water is managed properly it can be renewed or recycled and then reused continuously.

The water cycle

All the water on Earth moves through a cycle that is powered by the sun. This cycle is called the water cycle, or **hydrologic cycle**. Water is constantly changing its location (through constant movement) and its form (from gas, to liquid, to solid). Evaporation, condensation and freezing of water occur during the cycle.

hydrologic cycle another term for the water cycle

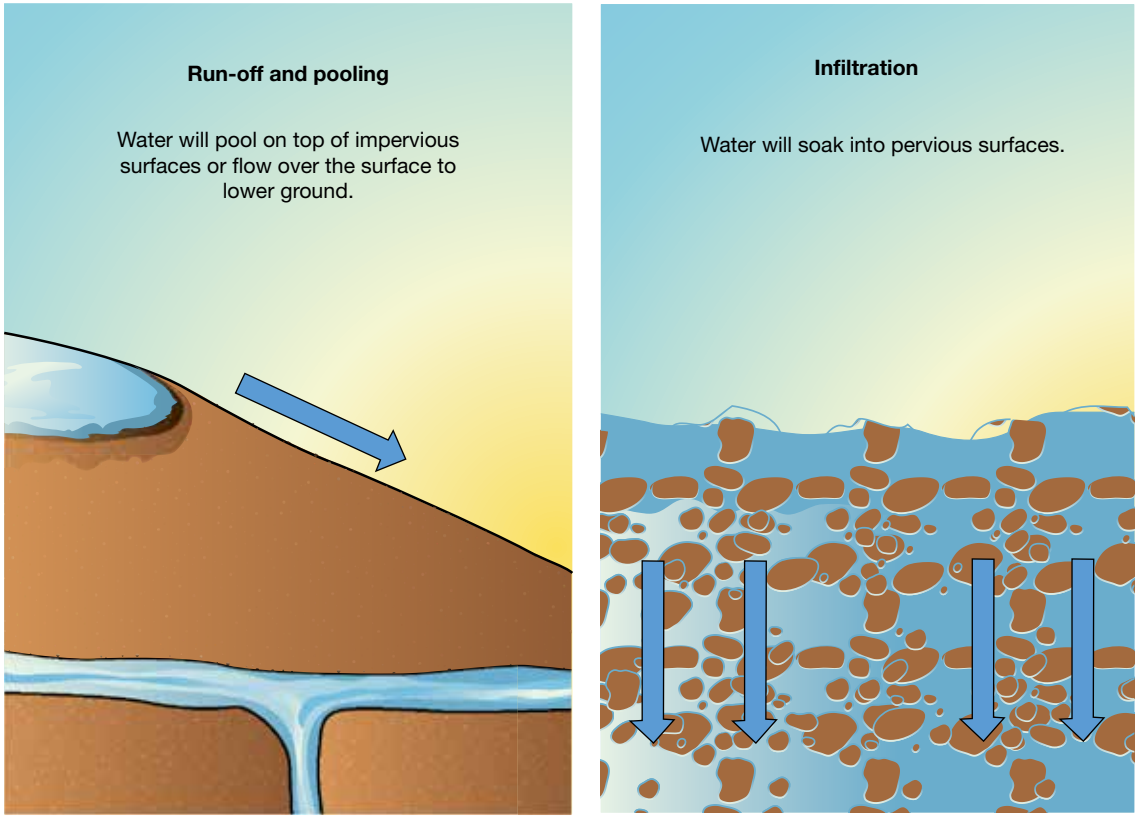
FIGURE 1 The water cycle



Key processes in the water cycle are precipitation, infiltration, run-off, storage, evaporation, evapotranspiration and condensation. In some locations and climates water will also freeze as part of the water cycle. Water is stored in oceans, lakes and rivers. The sun's heat changes water from its liquid form into a gas. This is known as evaporation. When the water vapour rises and cools it condenses, and when it becomes heavy enough it will fall back to earth as precipitation. If the land is very steep

or the soil is very hard, water is likely to run off to lower ground. If the soil is permeable (having small spaces or gaps) the water may infiltrate underground. Water that has infiltrated will become part of groundwater flow beneath the earth's surface. This water will either accumulate in underground storage or slowly make its way to streams and rivers.

FIGURE 2 Run-off and infiltration are processes in the water cycle.



GEOskills TOOLBOX

Interpreting diagrams

Diagrams provide a way to present complex information in a visual form. They can be useful to show processes, relationships or abstract ideas. Examine SkillBuilder 12.4 'Interpreting diagrams' in your eBookPLUS. Examine the diagram of the water cycle in figure 1.

1 Describe the water cycle.
2 List one difference and one similarity between transpiration and condensation.
3 Explain how infiltration, groundwater and run-off are related.

ACTIVITIES

IDENTIFY

1 Is water a renewable or a non-renewable resource?
2 List all the ways that water can be used as a resource.
3 Name two ***places*** where water stays in the same ***place*** for the longest.

EXPLAIN

4 Using the information about the water cycle, write and present 'The incredible journey of water'. Focus on various ***interconnections*** between water and the ***environment***. Include diagrams and photographs, and present your story electronically, as a poster, a written piece, a drama piece or a song.
5 How does the water cycle prove that we are using the same water that the dinosaurs used — in other words, that it is finite (limited)?

PREDICT

6 With a global population that is increasing by about 78 million people each year, how will it be possible for the finite water on Earth to be shared fairly?

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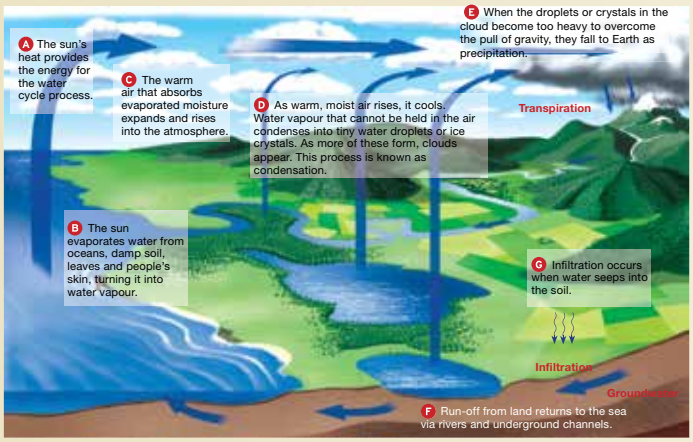
12.4 SkillBuilder: Interpreting diagrams

What are diagrams?

A diagram is a graphic representation of something. In geography, it is often a simple way of showing the arrangement of elements in a landscape and the relationships between those elements. Diagrams also have annotations: labels that explain aspects of the illustration.



eLesson

Watch this video to learn how to interpret a diagram.

Searchlight ID: eles-1636

Interactivity

Try this interactivity to learn how to interpret a diagram.

Searchlight ID: int-3132

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12.5 How much water is there in the world?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

12.6 How is groundwater used as a resource?

12.6.1 What is groundwater?

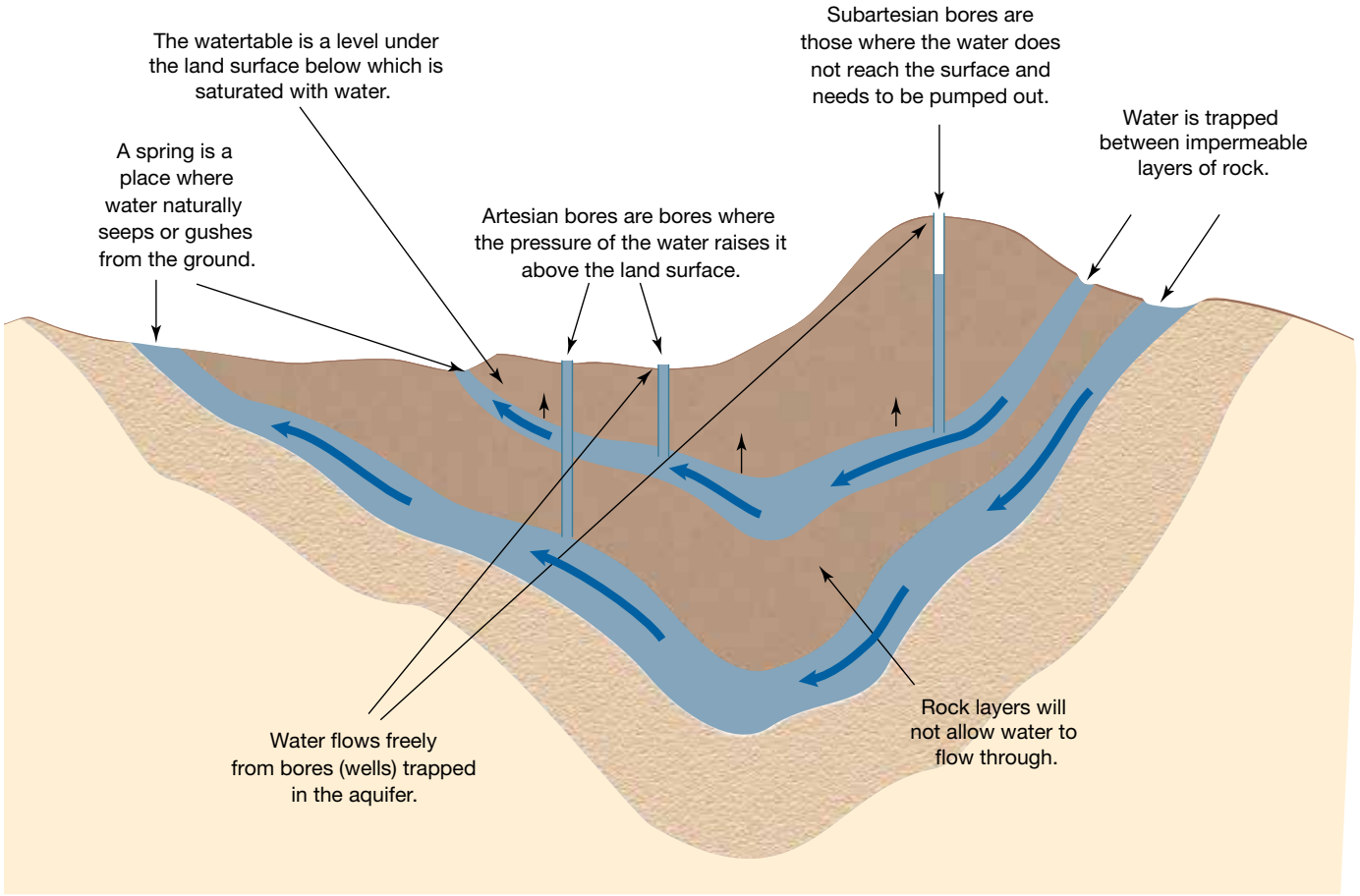
An important part of the water cycle, groundwater is the water that is found under the Earth's surface. Many settlements — especially those in arid and semi-arid areas — rely on groundwater for their water supply.

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater. Water can move along an aquifer.

When rain falls to the ground, some flows over the surface into waterways and some seeps into the ground. Any seeping water moves down through soil and rocks that are permeable; that is, they have pores that allow water to pass through them. Imagine pouring water into a jar of sand or pebbles; the water would settle into the spaces between the sand or stones.

Groundwater is water held within water-bearing rocks, or **aquifers**, in the ground. These work like sponges. They hold water in the tiny holes between the rock particles.

FIGURE 1 An artesian aquifer



An **artesian aquifer** occurs between impermeable rocks, and this creates great pressure. When a well is bored into an artesian aquifer, water often gushes out onto the surface. This flow will not stop unless the water pressure is reduced or the bore is capped (sealed).

Groundwater and surface water are interconnected — they depend on each other. Groundwater is only replenished when surface water seeps into aquifers. This is called **groundwater recharge**, and it is affected by whether there is a lot of rain or a drought is occurring.

artesian aquifer an aquifer confined between impermeable layers of rock. The water in it is under pressure and will flow upward through a well or bore.

groundwater recharge a process in which water moves down from the Earth's surface into the groundwater

Global groundwater resources

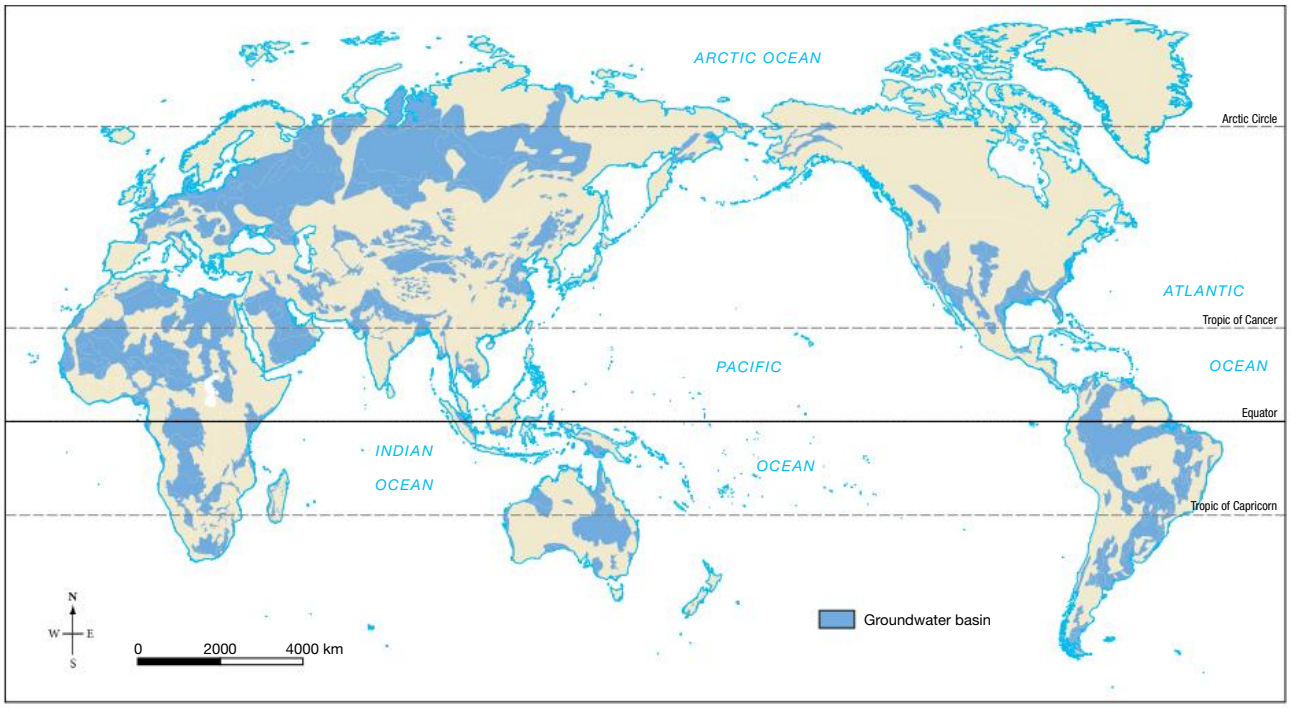
Approximately two per cent of the Earth's water occurs as groundwater, compared with 0.1 per cent as rivers and lakes and 94 per cent as oceans.

About 1.5 billion people in the world rely on groundwater for their survival. Some groundwater is fresh and can be used for drinking. Other groundwater can be brackish or even saltier than the sea.

Groundwater is vital for drinking, irrigation and industry use. Some industries bottle and sell spring and mineral water, and make soft drinks and beer. Bore water is used to water suburban gardens and parks, golf courses and crops. Groundwater is also important to the natural environment in wetlands and in supporting unique plants and animals. Groundwater keeps many of our rivers flowing, even when there are long periods without rain.

FIGURE 2 The water in this mound spring in South Australia has taken over two million years to move to the surface from recharge areas in northern Queensland. It can take up to 1000 years to move about one metre.

FIGURE 3 The world's major groundwater basins



Source: Spatial Vision

Troubled waters

For many years now, more and more water has been taken out of the ground. People believed it was unlimited, but it is in danger of running out in some areas, owing to the large number of wells pumping water.

If people use more groundwater than is being recharged, aquifers may dry up. Groundwater is very slow-moving and can take many years to move into deep aquifers. For this reason, groundwater is a finite and non-renewable resource, and is often referred to as *fossil water*.

eBookplus

Interactivity
Water beneath us
Use this interactivity to check your knowledge of groundwater.
Searchlight ID: int-3078
Weblink
Bubbl.us

ACTIVITIES

IDENTIFY

1 What does the word *permeable* mean?
2 What is groundwater recharge?

EXPLAIN

3 What is the difference between an aquifer and an artesian aquifer? Use a diagram to help you.
4 Draw a diagram to show how surface water reaches the watertable to become groundwater.
5 Describe conditions that might result in a watertable rising or falling.
6 Outline how groundwater and surface water are ***interconnected***.
7 Describe the groundwater resources in North Africa and West Asia (the Middle East). (Refer to the 'Regions' resource in your eBookPLUS.)

APPLY

8 Refer to figure 3 to describe the location of the world's groundwater regions.

PREDICT

9 Imagine that the world's groundwater continues to be used faster than it can be replaced. Use the **Bubbl.us** weblink in your eBookPLUS to brainstorm all the possible consequences this will have on people and the ***environment***.

INVESTIGATE

10 Water is a renewable resource. Why is groundwater sometimes thought of as fossil water and as a non-renewable resource? Write your answer as a newspaper article titled 'Out of sight, out of mind'.

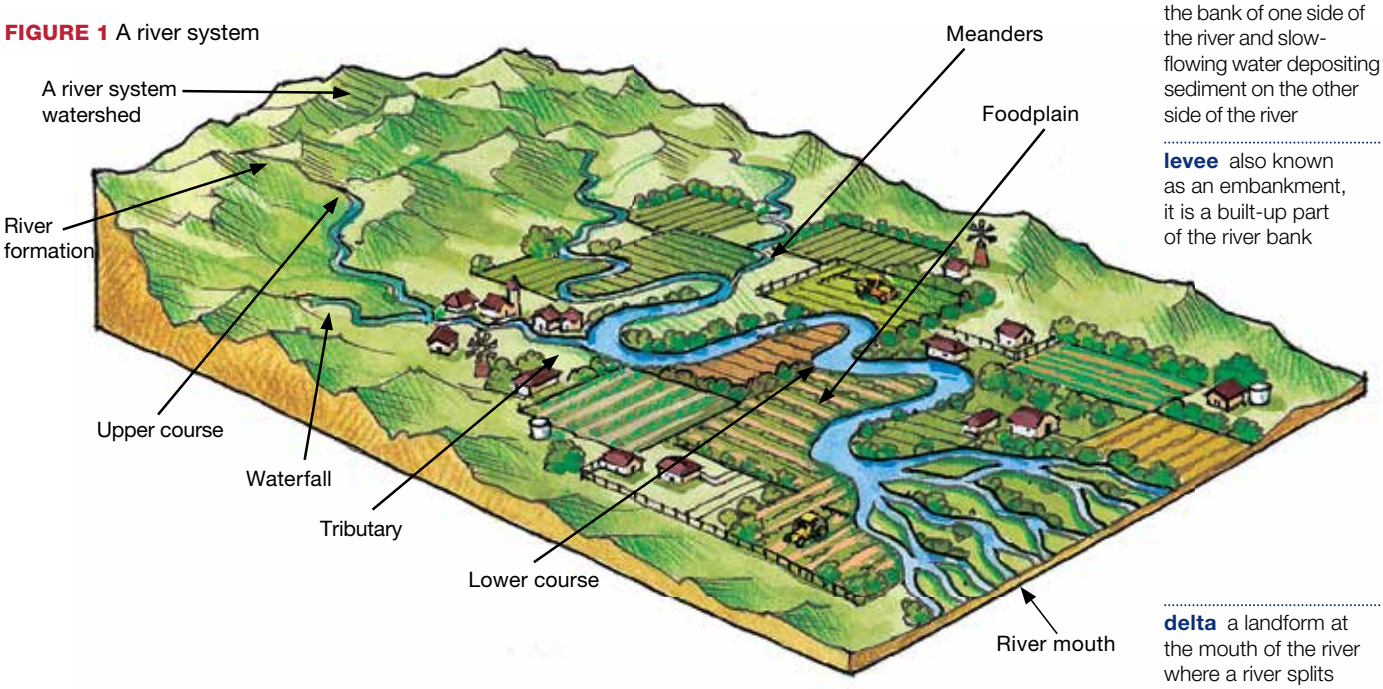
myWorldAtlas Deepen your understanding of this topic with related case studies and questions
› Salisbury Council — Aquifer storage, transfer and recovery

12.7 How does water flow through catchments?

12.7.1 The upper catchment

A catchment is an area of land surrounded by hills or mountains where water collects. The mountains that surround the area separate it from adjoining catchments. These boundary mountains are called watersheds.

FIGURE 1 A river system



floodplain the area of land next to the river, usually reaching to the base of the mountains surrounding the catchment. It experiences flooding during peak rainfall periods.

meander a curve in a river caused by fast-flowing water eroding the bank of one side of the river and slow-flowing water depositing sediment on the other side of the river

levee also known as an embankment, it is a built-up part of the river bank

delta a landform at the mouth of the river where a river splits into smaller streams and sediment is deposited to create an arch of land reaching out into the sea

Water in the catchment begins in the headwaters. These are steep-sided channels found in the most elevated parts of the catchment. The headwaters often contain fast-flowing water following periods of rainfall. This fast-flowing water will often carry sediments from the upper part of the catchment into lower areas.

12.7.2 The mid reaches of the catchment

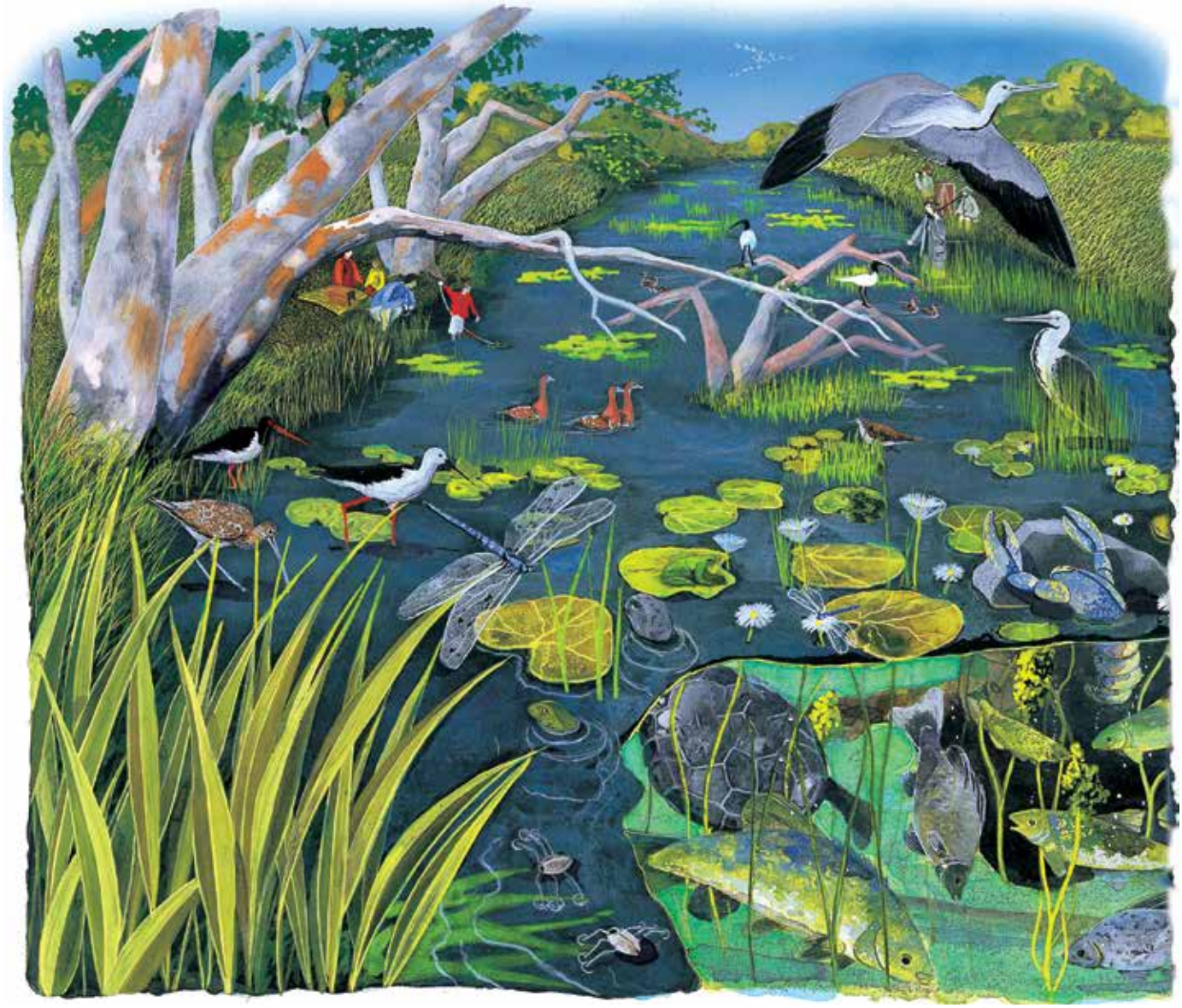
The water flows from the upper part of the catchment into the **floodplain** in the mid reaches of the catchment. The water begins to slow down. As the water slows it will deposit sediment from the upper catchment. This begins to create landform features such as **meander**s, ox-bows and **levees**.

12.7.3 The lower catchment

All rainwater that enters the catchment makes its way to the lowest part of the catchment, eventually flowing down into rivers, lakes, creeks or the sea. Where a river meets the sea the water often slows down again and deposits more sediment. This creates a **delta** where the river breaks into smaller streams.

FIGURE 2 The watershed catchment or drainage basin of a river system

FIGURE 3 This artwork depicts a wetland habitat and some of the wildlife it supports.



FOCUS ON FIELDWORK

Visit a local creek or pond

Observation
Observe the area surrounding the creek or pond. Make some basic notes about the area.

Consider: Are the banks steep or gentle? Is there a lot of vegetation surrounding the area? Does the water look clean or is there evidence of pollution? What human impacts can you observe?

Observe aspects such as colour, odour, and the presence of algae, surface film or oil slicks. Ratings from 1 (excellent) to 5 (extremely poor) can be used and recorded.

Sketch map
Draw a sketch map of the area. Annotate your sketch map with important features or land uses surrounding the study area.

Field sketch
Create a field sketch of the area. To draw your field sketch choose an appropriate scale and then divide your page into foreground, middle ground and background. Draw the skyline in your sketch first and then draw lines showing the main features. Lastly draw in more detailed information such as vegetation, pathways, fences, etc. Field sketches are an important tool to help you interpret photographs or remember details of an environment when you are no longer able to see it.

Measuring river width
Stretch a tape measure 20 centimetres above the water from one bank to the other, measuring from where the dry bank meets the water. Take your reading directly above the tape at several locations and calculate an average.

Measuring the water depth
While the tape measure is stretched across the river or creek, use a metre ruler to measure the depth. Record the depth every 50 centimetres (or 30 centimetres if the creek is small). Make sure the ruler only just touches the riverbed, and record each measurement as it is taken.

Collecting and recording data: animal species
Biodiversity in water is studied by taking a small area of water and investigating the number and diversity of animal species. It is measured by ponding or water sampling. Choose a number of sites in the water and ensure that they contrast with each other: there should be clear, muddy, deep, shallow, moving and still sites, for example. The materials needed for ponding include a fine net; a white plastic ice-cream container; a magnifying glass; a notebook and pencil for recording the number and variety of species; a camera for photographing specimens; and an identification chart or book.

Using a net, scoop the water and examine any aquatic organisms that you find. Refer to an identification chart for aquatic organisms and record the information. You may also like to collect photographic evidence of each scoop.

Collecting and recording data: vegetation
Examine plants found in and around the river or pond. Collect photographic evidence of each species. Use a vegetation chart to identify the plants and record the information.

1 Create a document, e-portfolio or multimedia presentation collating your 'Focus on fieldwork' activities.
2 Use Google Earth, or other sources of virtual maps or satellite images, to provide maps and images of your field site at a variety of scales. Describe the location of your field site in relation to New South Wales and the surrounding area. Provide the latitude and longitude of your field site.
3 Find secondary information about your local creek or pond. This could include websites, newspaper articles or pamphlets. Summarise the key points for each item of secondary information.
4 Scan or photograph your field sketch and sketch map and import your photographs from your fieldwork activities. Examine the data you have collected. Write a few sentences explaining each of your fieldwork techniques and findings.
5 Explain how your **primary data** relates to the **secondary data** you have collected. Does your primary data support the secondary data? Are there differences between your primary data and the secondary data?

primary data
information that you have collected where the researcher uses fieldwork techniques

secondary data
information that has been collected by another person. This could include websites, books or pamphlets.

ACTIVITIES

EXPLAIN
1 What is the difference between a watershed and a catchment?
2 Describe how water flows from the upper catchment to the lower catchment.

12.8 What factors affect water availability?

12.8.1 Latitude

Places near the equator tend to be hotter and more humid than places near the poles. As a result, there is generally more precipitation in low latitude areas than those in higher latitude areas.

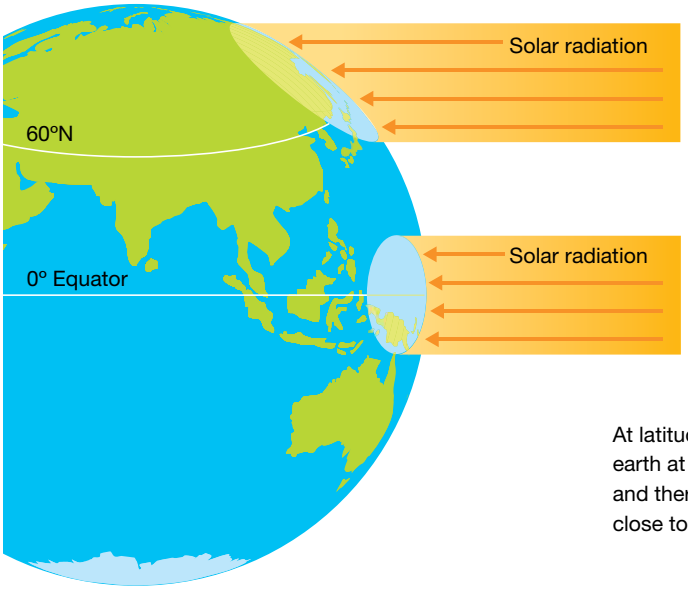
12.8.2 Altitude

As altitude increases rainfall also increases. Condensation occurs as air cools in higher altitudes. The air can no longer hold moisture and precipitation occurs. This precipitation is often in the form of snow.

12.8.3 Ocean currents

Warm ocean currents generally increase the rate of evaporation and result in higher rainfall. Cold ocean currents reduce the amount of evaporation and as a result less rainfall occurs.

FIGURE 1 Temperatures are higher at low latitudes (closer to the equator) because incoming solar radiation has a smaller area of the Earth to heat.



12.8.4 Distance from the sea

Areas close to the sea will receive more rainfall than places further from the sea. This is due to high levels of evaporation over the ocean. As the air mass moves across the land it will drop this moisture.

12.8.5 Geology

Some rocks and soils are more permeable than others. This means they can absorb moisture. Impermeable rocks and soils result in more run-off and higher rates of evaporation. As a result more precipitation occurs.

12.8.6 Topography

As discussed earlier, snow often falls on the top of mountains. However, topography can also affect precipitation on the lower parts of mountains. On the windward side of the slope of the mountain precipitation occurs. On the leeward side of the mountain less precipitation occurs. The leeward side is the side of the mountain that is protected from the wind. This is known as the rainshadow effect.

12.8.7 Climate change

The majority of climate scientists believe that climate change will have an impact on rainfall patterns. Climate models have shown that areas in the northern latitudes are likely to experience more rain, and areas closer to the equator and mid latitudes will receive less rain. Some regions will experience droughts, while others will experience high rainfall and even flooding. Already, in the last 100 years, global rainfall patterns have changed. In some areas such as North America, South America, northern Europe, and northern and central Asia, rainfall has increased significantly. In other areas such as the Sahel, the Mediterranean, southern Africa, and parts of Asia, rainfall has decreased.

FIGURE 2 How rain shadow deserts form

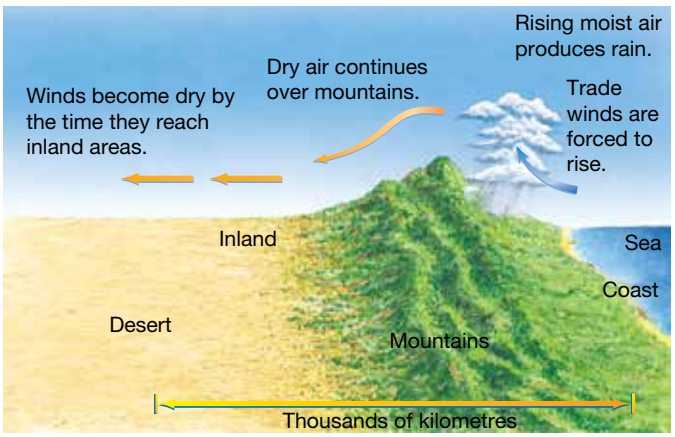
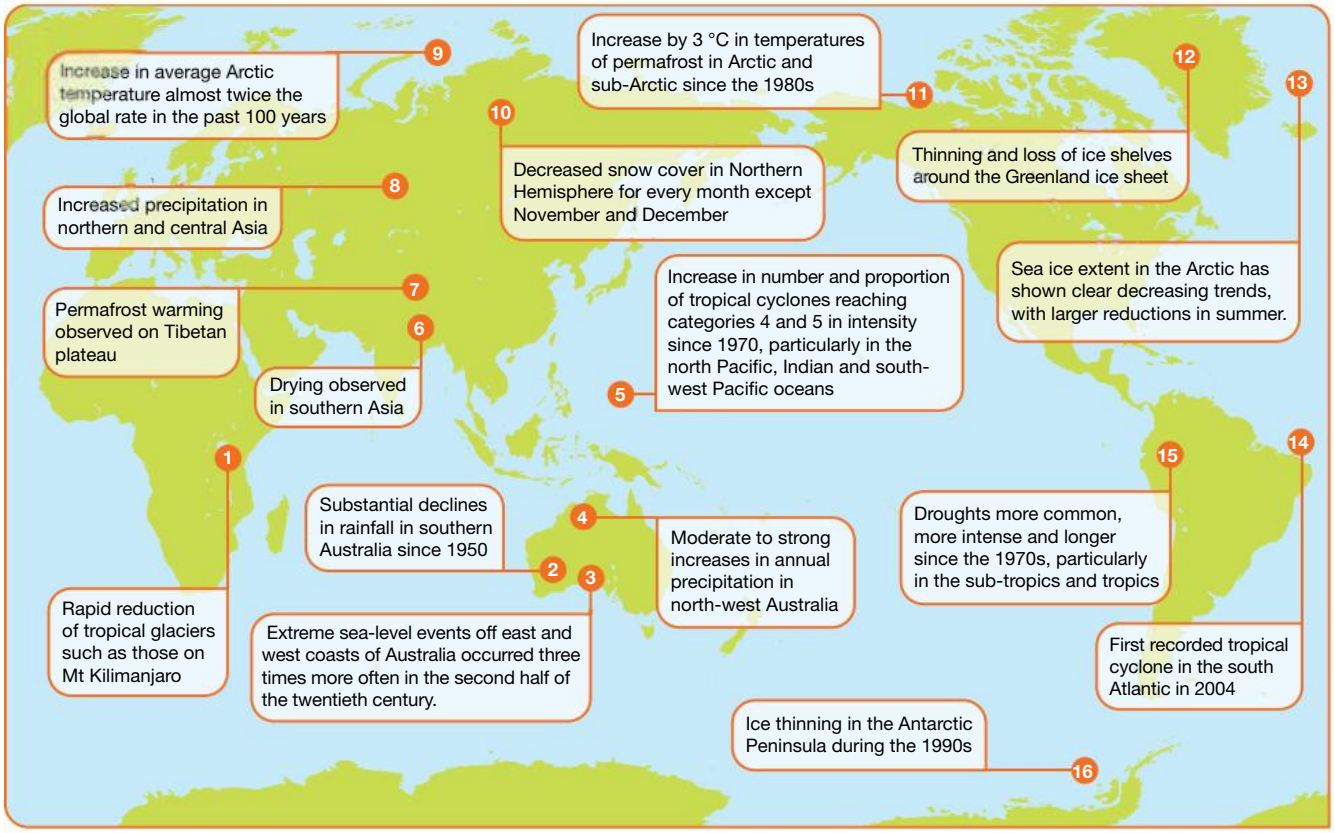


FIGURE 3 Observed evidence of climate change



Source: The Garnaut Climate Change Review, 2008, pages 76–7

FOCUS ON FIELDWORK

Observing clouds

Create a cloud identification chart

To create a cloud identification chart, begin by creating a file and adding the names of different types of clouds. Include cirrocumulus, cirrus, cirrostratus, cumulonimbus, cumulus, stratus, altostratus, altocumulus, nimbostratus and stratocumulus. Find images that show the different types of clouds and paste them into your file. Be sure to include the source of the image. Print your chart to use in the field.

Create a cloud cover sheet

Create a 10 by 10 grid that takes up most of an A4 page and print it onto an overhead sheet.

Observations

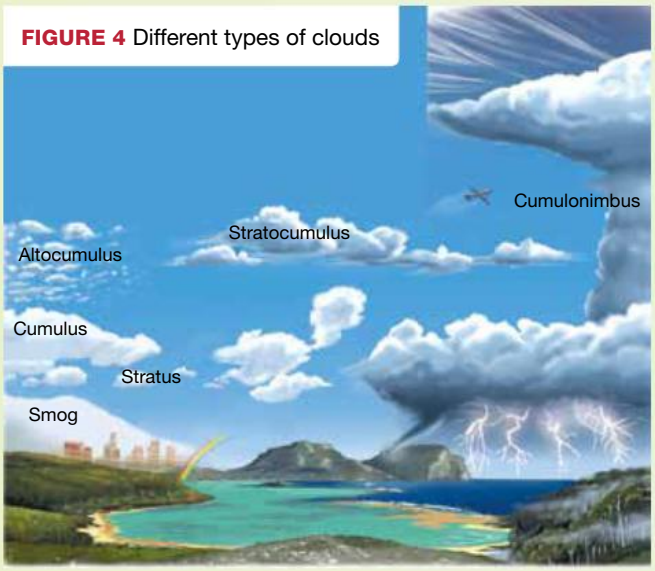
Use a compass to find north and face that direction. Use your cloud identification chart to identify the clouds that can be seen looking north. Hold up the cloud cover sheet and count how many squares contain clouds. This will allow you to determine the percentage cloud cover. Repeat this activity facing east, south and west. Compare your answers with your classmates.

1 Identify the different types of clouds.

2 Are some clouds similar to each other? Describe how they are similar.

3 Why might it be useful to know the percentage of cloud cover?

FIGURE 4 Different types of clouds



4 What factors do you think might affect the types and percentage of cloud cover that you observed?

ACTIVITIES

IDENTIFY

1 Describe how topography and altitude can influence precipitation.
2 Create a diagram that demonstrates your understanding of how ocean currents have an impact on rainfall.

EXPLAIN

3 Explain the relationship between the ocean and rainfall. In your answer, use the words 'evaporation', 'distance' and 'currents'.

PREDICT

4 Use the **Bureau of Meteorology** weblink in your eBookPLUS to investigate rainfall patterns in your local area. Using the information you now have about the factors affecting rainfall, how would you explain these rainfall patterns?
5 Work in groups of three to list what might happen to people and the ***environment*** in regions that:
   a will receive more rainfall than they do now
   b will receive less rainfall than they do now.
   Complete a consequence chart for each change.

APPLY

6 Study figure 3 and an atlas.
   a Name three ***places*** that are predicted to receive more run-off due to climate change.
   b Name three ***places*** that are predicted to receive less run-off due to climate change.
   c Compare these six ***places*** with a global rainfall map. Which of the following statements is true? (Rewrite any false ones and make them true.)
   - Most ***places*** with very low rainfall have lower run-off.
   - All ***places*** with very high rainfall experience increased run-off.
   - The ***places*** with the greatest ***change*** in run-off will be northern Russia and northern Canada.

eBookplus

Weblink
Bureau of Meteorology

12.9 What is the difference between weather and climate?

12.9.1 How does weather change?

Our Earth is surrounded by a band of gases called the atmosphere. It protects our planet from the extremes of the sun's heat and the chill of space, making conditions just right for supporting life. The atmosphere has five different layers. The layer that starts at ground level and ends about 16 kilometres above Earth is called the troposphere. Our weather is the result of constant changes to the air in the troposphere. These changes sometimes cause extreme weather events.

Droughts, floods, cyclones, tornadoes, heatwaves and snowfalls — even cloudless days with gentle breezes — all begin with changes to the air in the troposphere. The five main layers in the Earth's atmosphere all differ from one another. For example, the troposphere contains most of the **water vapour** in the atmosphere. As a result, this layer has an important link to **precipitation**.

water vapour water in its gaseous form, formed as a result of evaporation

precipitation the form of water falling from the sky, such as rain, snow or hail

All weather conditions result from different combinations of three factors:

- air temperature
- air movement
- the amount of water in the air.

The sun influences all three.

First, the sun heats the air. It also heats the Earth's surface, which in turn heats the air even more. How hot the Earth's surface becomes depends on the season and the amount of cloud cover.

Second, the sun causes air to move. This is because the sun heats land surfaces more than it heats the oceans. As the warm air over land gets even warmer, it expands and rises. When hot air rises, colder air moves in to take its place.

Third, the sun creates moisture in the air. The heat of the sun causes water on the Earth's surface to **evaporate**, forming water vapour. As this water vapour cools, it condenses, forming clouds. It may return to Earth as rain, dew, fog, snow or hail.

evaporate to change liquid, such as water, into a vapour (gas) through heat

At times these three factors — temperature, air movement and water vapour — can create extreme weather events. Very high air temperatures influence heatwaves; rapidly rising air plays a part in the formation of cyclones; and excess rain can create flooding.

FIGURE 1 Australia experiences a diversity of weather, which has a major effect on how we live.

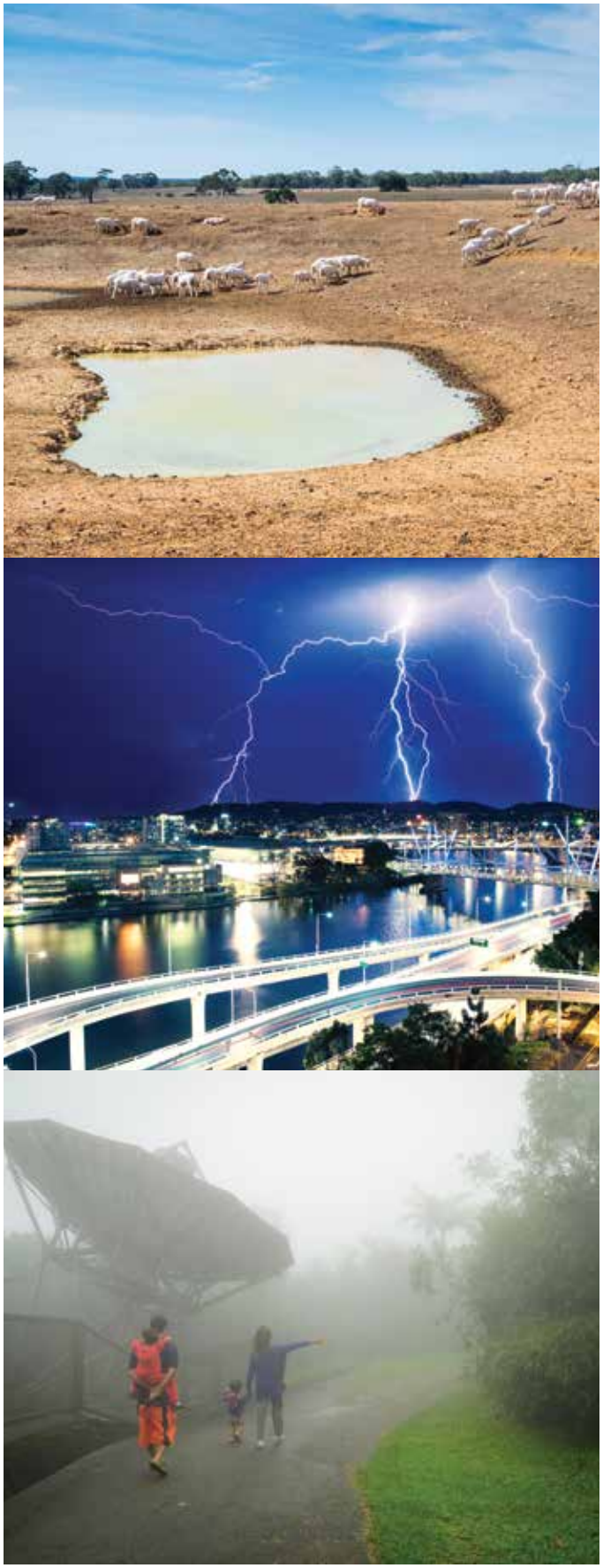
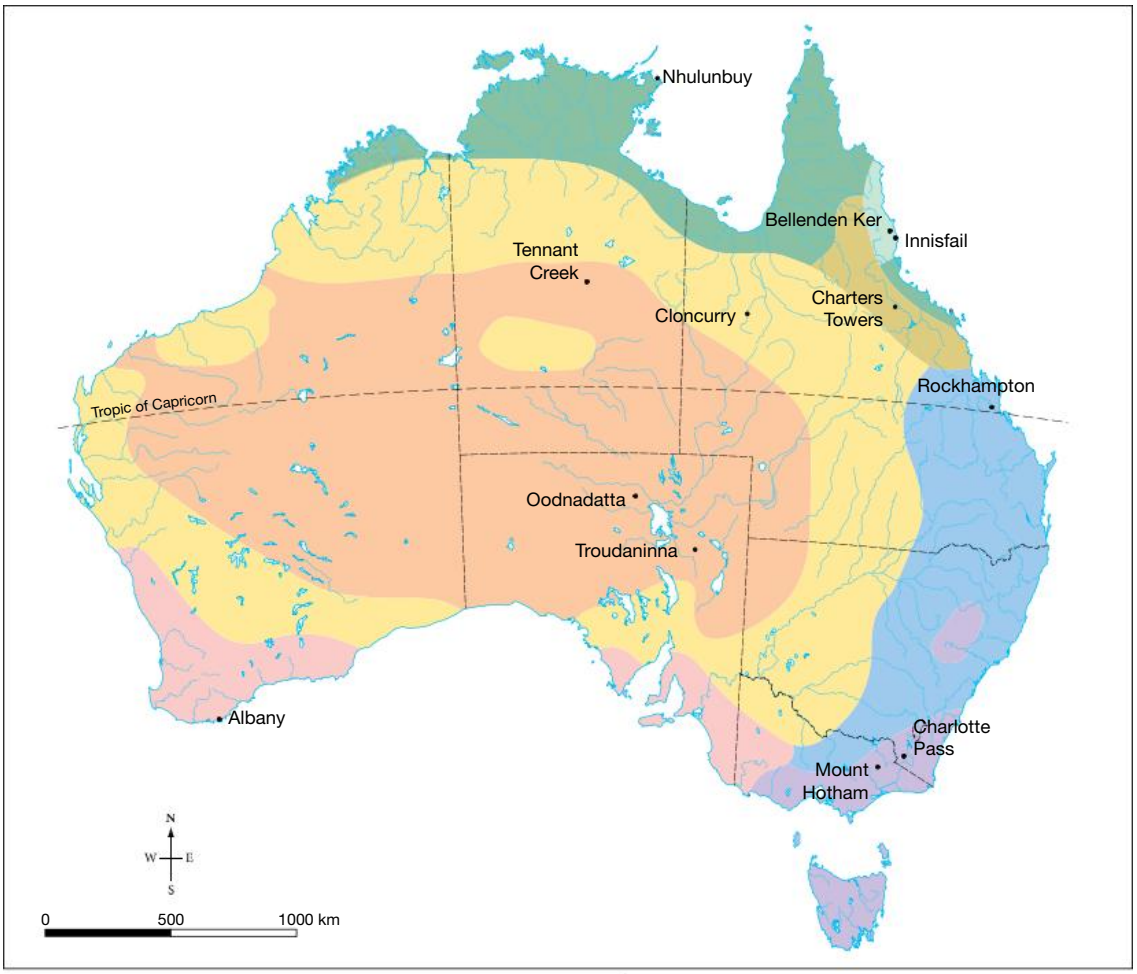


FIGURE 2 Structure of the Earth's atmosphere (not to scale)

FIGURE 3 Climatic zones of Australia



Key

Climatic zones

- Tropical wet and dry — Hot all year; wet summers; dry winters
- Tropical wet — Hot; wet for most of the year
- Subtropical wet — Warm; rain all year
- Subtropical dry winter — Warm all year; dry winters
- Mild wet — Mild; rain all year
- Subtropical dry summer — Warm all year; dry summers
- Hot semi-desert — Hot all year; 250–500 mm of rain
- Hot desert — Hot all year; less than 250 mm of rain

Source: Spatial Vision

12.9.2 Weather and climate: what is the difference?

Weather is the day-to-day, short-term change in the atmosphere at a particular location. Extreme weather events are often described as unexpected, rare or not fitting the usual pattern experienced at a location.

Climate is the average of weather conditions that are measured over a long time. Places that share the same type of weather are said to lie in the same climatic zone. Because of the size of the Australian continent, its climate varies considerably from one region to another. Synoptic charts provide a visual representation of weather information for a place including rainfall, wind and air pressure. Examine SkillBuilder 12.10 'Reading a synoptic chart' in your eBookPLUS to learn more about how to read a synoptic chart, or weather map.

ACTIVITIES

IDENTIFY

1 What is the name of the layer of the atmosphere where all Earth's weather happens?
2 Define the term *troposphere*.
3 In which levels of the atmosphere are the following features found?
  a Most passenger planes
  b Orbiting satellites
  c Burning meteors
  d The Aurora lights

EXPLAIN

4 Explain the difference between weather and climate.
5 Draw three diagrams to help you explain the factors that influence the following weather conditions:
  a air temperature
  b air movement
  c the amount of water in the air.

APPLY

6 In a magazine or newspaper or online, find a photograph that shows an example of one type of weather. Paste the picture in the centre of a page and add labels about the impact of that weather on the ***environment*** (for example, creating puddles) and on what we do (such as the clothes people wear).

PREDICT

7 Look carefully at the photographs in figure 1.
  a Describe the weather event in each photograph.
  b How would each weather event affect people's lives?
8 Look carefully at the map of Australia's climatic zones in figure 3. Predict which two settlements, or ***places***, might be at risk of flood. Make sure you explain why you chose them.
9 Look at the ***environment*** outside the window.
  a What is the weather like? Do you think it matches the climatic zone in which you live? Explain.
  b Now check to see, using figure 3. If your answers are different, explain why this may have occurred.
10 Describe how the weather affected you yesterday.

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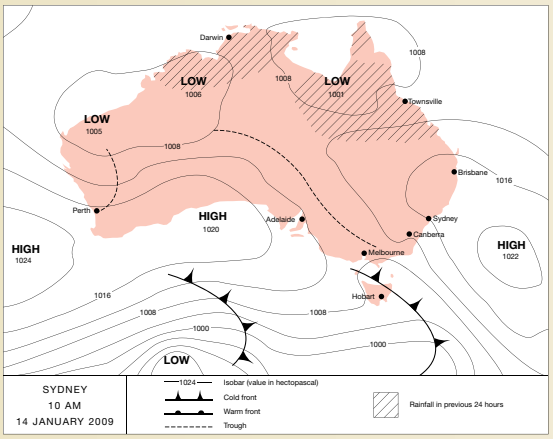
12.10 SkillBuilder: Reading a synoptic chart

What are synoptic charts?

Synoptic charts, or weather maps, show weather conditions over a larger area at any given time. They appear every day in newspapers and on television news. Being able to read a synoptic chart is a useful skill because weather affects our everyday life.



eLesson
Watch this video to learn how to read a synoptic chart.

Searchlight ID: eles-1637

Interactivity
Try this interactivity to learn how to read a synoptic chart.

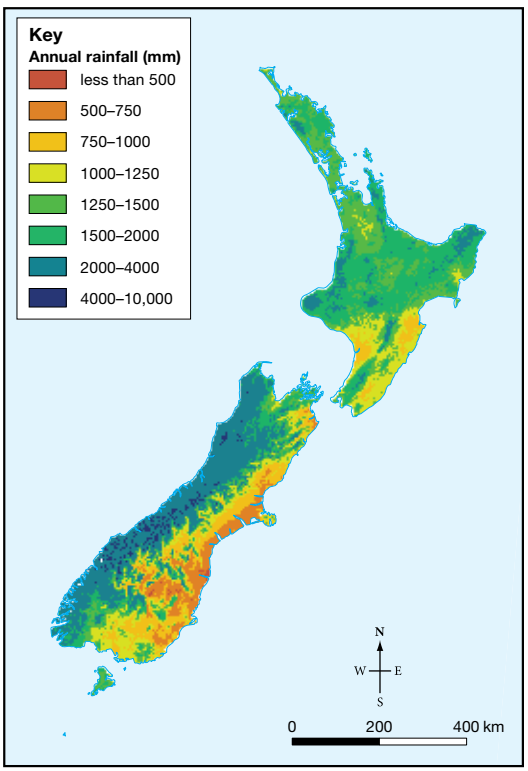
Searchlight ID: int-3133

12.11 How does water flow down the Haast River?

12.11.1 New Zealand's Haast region

Haast is a World Heritage site located on the west coast of the southern island of New Zealand (see figure 1). The region is untamed, with majestic mountains, pristine lakes and rugged coastlines. The Haast River discharges as much as 6 cubic kilometres of water annually, and the catchment extends into the Southern Alps. There are some areas of seasonal and permanent snows and very high rates of run-off in the region due to the steep mountainous terrain (see figure 2).

FIGURE 1 Annual rainfall, New Zealand



Source: WorldClim

FIGURE 2 The Gates of Haast

ACTIVITIES

IDENTIFY

1 Name the feature located at:
- **a** GR 315134
- **b** GR 300152
- **c** GR 282138
- **d** GR 313126.

2 State the height of:
- **a** Mt Swindle spot height in AR3013
- **b** Plover Crag spot height in AR3114
- **c** Mosquito Hill spot height in AR2813.

3 What is the local relief in AR2813?

4 Describe the location of swamp areas found in the Haast region.

5 Examine figure 1. Would you describe Haast as being in a high, medium or low rainfall area?

EXPLAIN

6 A tributary is a stream that flows into a larger river. Why are there so many tributaries that flow into the Haast River?

7 The Gates of Haast (unlabelled) are located at GR 310117. Examine figure 2 and then locate the Gates of Haast on the topographic map, figure 3. Explain the reasons for a high volume of river flow in this area.

APPLY

8 Explain how each of the following factors could affect water availability in the Haast region.
- **a** Latitude
- **b** Altitude
- **c** Topography
- **d** Climate change

9 With reference to the locations listed in questions 1–4, describe how the water cycle might function in this region.

PREDICT

10 Possible impacts of climate change are increased rainfall in north-eastern New Zealand and reduced snow cover. Consider how this may affect river flow in the Haast region. Predict the possible impacts of this for local communities and environments.

FIGURE 3 Topographic map extract of Haast, New Zealand

Source: LINZ Data Service. License: Creative Commons Attribution 3.0 New Zealand https://data.linz.govt.nz/license/attribution-3-0-new-zealand/

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12.12 Why does the wind blow?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

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12.13 How strong is the wind?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

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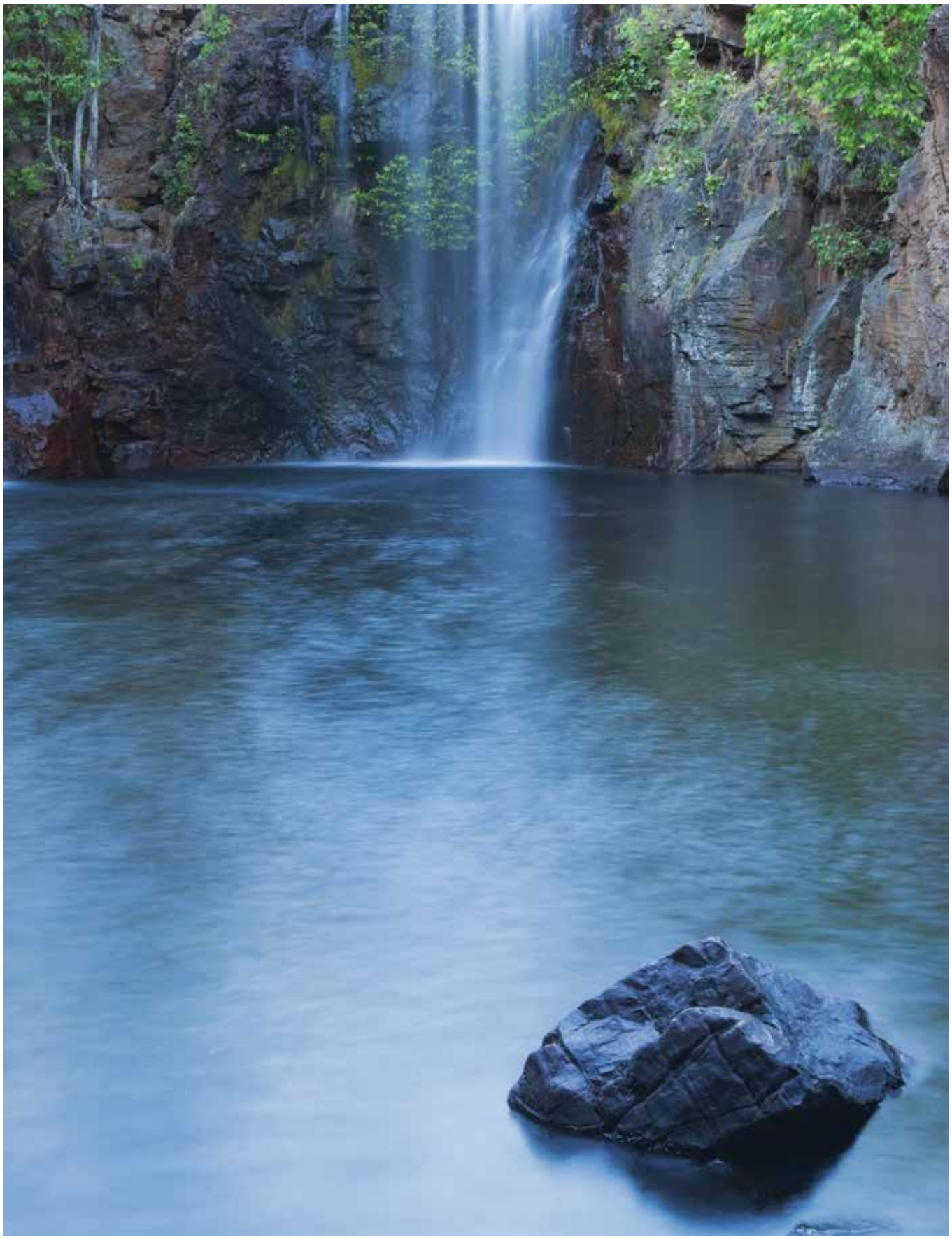
12.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.



Traditional methods are used to fish sustainably.

CHAPTER 13

Water resources and the water cycle

13.1 Overview

13.1.1 Introduction

Water is an important resource used by people. It has great economic, cultural, spiritual and aesthetic value. The health and wellbeing of a community can be greatly impacted by its access to water, and water can be central to the beliefs and practices of indigenous cultures. Access to water is a basic human right. The amount of available fresh water on Earth needs to be shared among an ever-growing global population. It is a resource that must be used carefully so that current and future populations can have adequate supplies.

Starter questions

1. List some of the different ways water is used in our lives.
2. How would your life be different if you didn't have easy access to water?
3. Do you value water? What are the different ways in which water can have a value to you?
4. Watch the video using the **Introduction to water** weblink in your eBookPLUS. List all the ways that water is used by people, animals, plants and the environment. How much of the Earth is covered by water? How much of this water can be used by people?

eBookplus

Weblink
Introduction to water

Inquiry sequence

		Syllabus outcomes
13.1 Overview		
13.2 How is water used by people?		GE4-2, GE4-3, GE4-7, GE4-8
13.3 SkillBuilder: Drawing a line graph	eBookplus ONLINE ONLY	GE4-7, GE4-8
13.4 What is the value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.5 SkillBuilder: Annotating a photograph	eBookplus ONLINE ONLY	GE4-7, GE4-8
13.6 What is the economic value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.7 How does access to water improve health?		GE4-2, GE4-3, GE4-7, GE4-8
13.8 What is the cultural and spiritual value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.9 How do Indigenous people use water?		GE4-2, GE4-3, GE4-5, GE4-7
13.10 How is water significant to indigenous people?		GE4-2, GE4-3, GE4-5, GE4-7
13.11 What is the aesthetic and social value of water?		GE4-2, GE4-3, GE4-7, GE4-8
13.12 What is virtual water?		GE4-2, GE4-3, GE4-5, GE4-7
13.13 Investigating topographic maps: How is water valued in Noosa?		GE4-2, GE4-3, GE4-5, GE4-7
13.14 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	

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Watch this video
Water: a vital resource
Searchlight ID: eles-1615

13.2 How is water used by people?

13.2.1 Who uses the most water?

There are three main uses made of water by all people: growing food, producing goods and electricity, and using it in the home. The amount of water consumed for each of these uses differs from one place to another. The problem remains that while the total amount of fresh water is fixed, the amount used per person is increasing.

It is interesting to look at water consumption on a global scale. With the global average at 1240 cubic metres per person, per year, some countries consume more water than others. Examples of countries that consume nearly twice as much as the global average are the United States and Thailand. Some countries that consume the least amount of water per person are Peru, Somalia and China.

13.2.2 What is water used for?

Figure 1 shows that most of the world's water is used in agriculture, to grow food for the world's increasing population. This is especially the case in the drier parts of the world where there is not enough rainfall to grow crops or grass for animals. There is a strong interconnection between the amount of rainfall in a region and the amount of water used in agriculture.

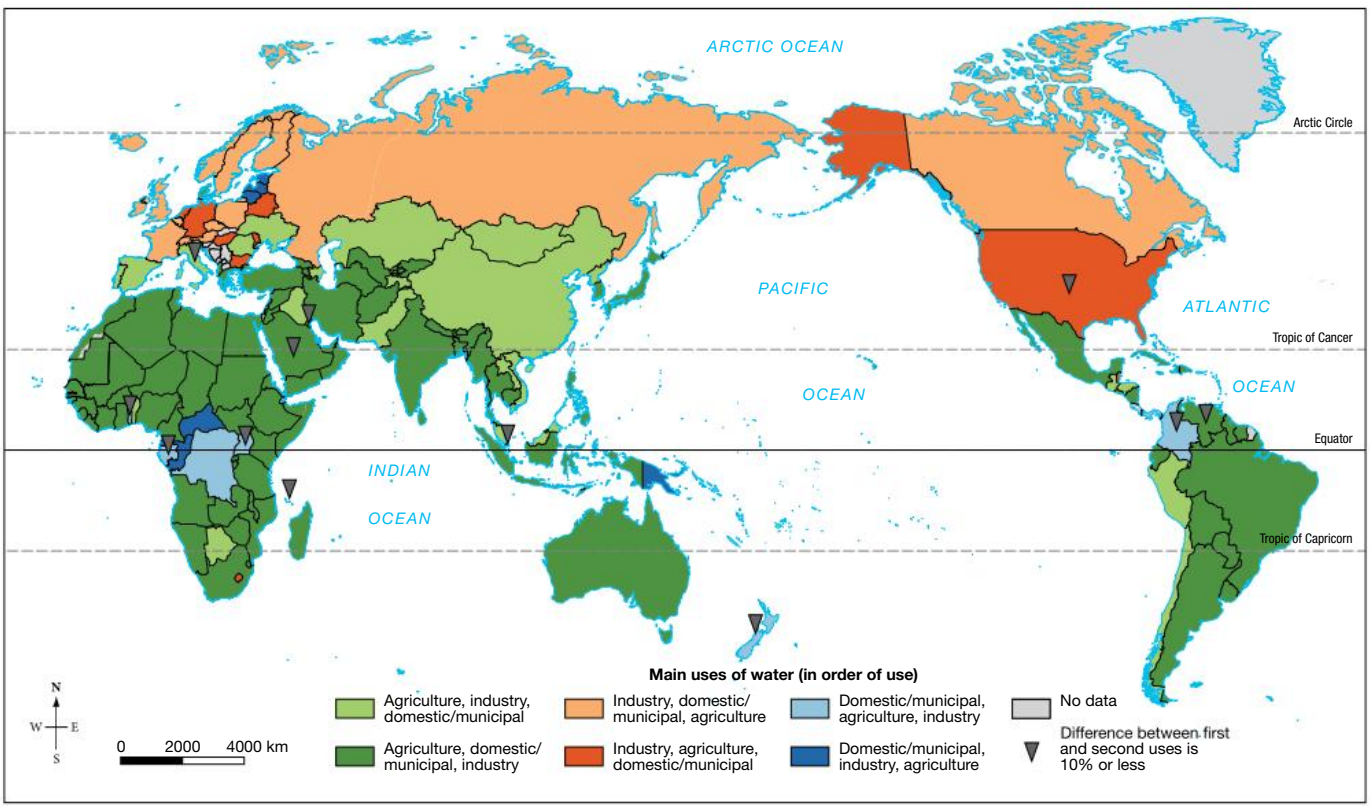
It is interesting to see how this pattern varies in different countries. In some countries, the water used in agriculture and industry is greater than the amount of water used in homes for domestic use. In other places, people consume more water for domestic use than for either agriculture or industry.

13.2.3 How is water used in Australia?

Agriculture is an important industry in Australia, and it is our thirstiest industry. It produces most of our food requirements and contributes enormously to Australia's export earnings.

Around 70 per cent of Australia's fresh water is used as irrigation for farming. Many crops are grown in dry areas where up to half the available water evaporates from the soil surface or seeps down too low into the ground for plant roots to reach it. Therefore, more water is applied than is actually needed by plants. In manufacturing industries, most water is used to produce food, beverages and paper.

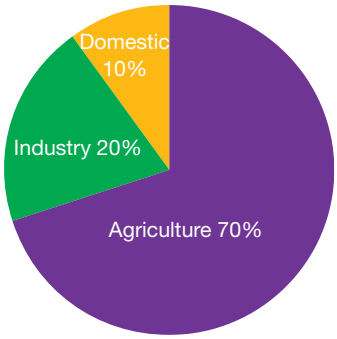
FIGURE 1 Countries in the world differ in their use of water.



Source: Spatial Vision

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
› How is water used in Australia?
› North-west Europe

FIGURE 2 World water use



In many areas in Australia where rainfall is limited or highly seasonal, farmers irrigate their crops with water stored in dams, with groundwater or with water from major rivers. Irrigation is a very important use of water in Australia. Most large-scale farming could not provide food for Australia's population without using water from rivers, lakes, reservoirs and wells.

There is high demand for irrigation water during summer when river flows are low, and low demand for irrigation water during winter when river flows are high. This reverses the natural pattern of river flow.

TABLE 1 Fresh water use in Australia

Types of use of fresh water	%
Agriculture • (pasture 35%) • (crops 27%) • (rural and domestic stock 8%)	70
Urban	12
Horticulture	10
Industry	3
Mining	2
Services	2
Hydro-electricity	1

TABLE 2 Fresh water used to irrigate different crops in Australia

Crop type	Water (gigalitres)	%
Livestock, pasture, grains and other agriculture	8795	56
Cotton	1841	12
Rice	1643	11
Sugar	1236	8
Fruit	704	5
Grapes	649	4
Vegetables	635	4

Note: One gigalitre = 1 000 000 000 litres or one thousand million litres or 400 Olympic-sized swimming pools

FIGURE 3 Australia is one of the most irrigated countries in the world.

ACTIVITIES

IDENTIFY

1 What is most of the world's water used for?

EXPLAIN

2 Why might some countries use more water in industry than in agriculture or domestic use?

3 Use the data in tables 1 and 2 to draw two line graphs. Use the data from your graphs to describe how water is used in Australia. Which crops use the most water? Which use the least?

INVESTIGATE

4 Watch the video about three rivers in Africa and look at the information on these rivers in *myWorld Atlas*. Use the atlas map to trace the flow of the river and upload images to the map showing all the different water uses in the video.

5 Study figure 1 and decide which of the following statements are true and which are false.

- **a** Australia uses most water for agriculture, then industry, then domestic/municipal.
- **b** Countries in North Africa use most water for industry, then domestic/municipal, then agriculture. (Refer to the 'Regions' resource in your eBookPLUS.)
- **c** Belarus uses most water for industry, then agriculture, then domestic/municipal.
- **d** Colombia uses most water for agriculture, then domestic/municipal, then industry.
- **e** Belize uses most water for industry, then agriculture, then domestic/municipal.
- **f** Malaysia uses most water for industry, then agriculture, then domestic/municipal.

Rewrite the statements that are false and make them true.

APPLY

6 Now use your atlas to look at patterns in figure 1 and compare them to a map that shows global wealth.

- **a** Name a country with low wealth and high water use in industry.
- **b** Name two wealthy countries that do not have high water use in industry.
- **c** Can you write a general statement about wealth and water use? Add two exceptions to your general statement.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Three rivers in Africa

GEOskills TOOLBOX

Drawing a line graph

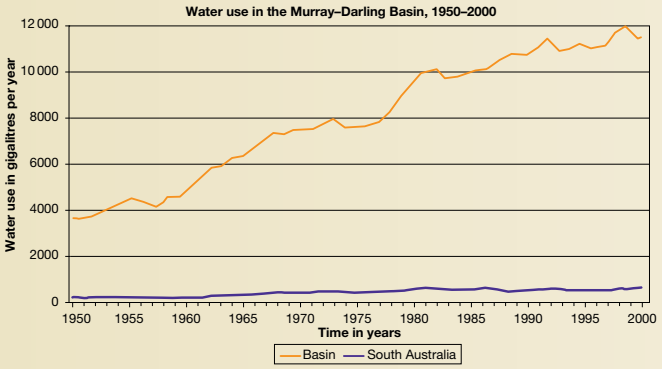
Line graphs represent data as points drawn on a graph and joined together with a line. Often line graphs are used to show change over a period of time. Examine SkillBuilder 13.3 'Drawing a line graph' in your eBookPLUS to learn more about how to draw a line graph.

eBookplus ONLINE ONLY

13.3 SkillBuilder: Drawing a line graph

What is a line graph?

A line graph displays information as a series of points on a graph that are joined to form a line. Line graphs are very useful to show change over time. They can show a single set of data, or they can show multiple sets which enables us to compare similarities and differences between two sets of data at a glance.



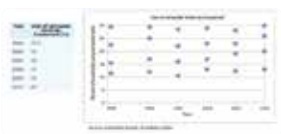
eLesson

Watch this video to learn how to draw a line graph.

Searchlight ID: eles-1635

Interactivity

Try this interactivity to learn how to draw a line graph.



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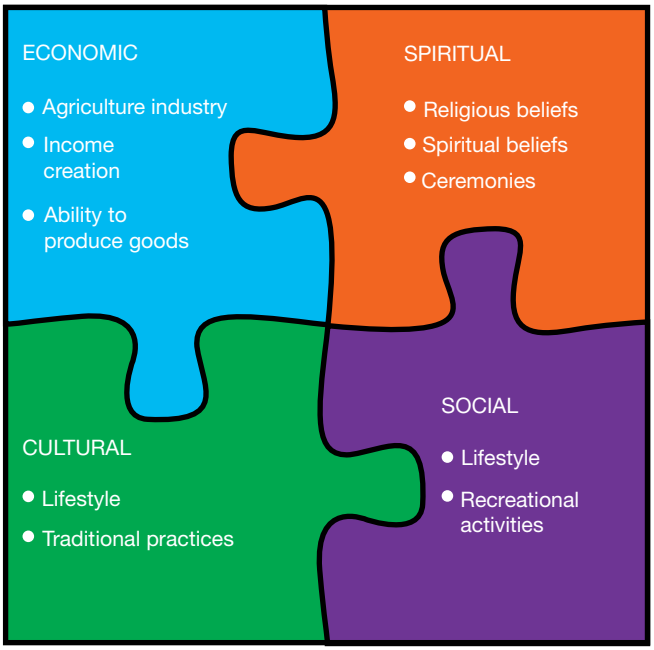
myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Mediterranean basin

13.4 What is the value of water?

13.4.1 How does water quality change?

Value refers to how important something is or what it is considered to be worth. The value people place on water will vary according to their standard of living, income, culture, location and the way they use water. In this way the value of water is subjective. This means that people have different opinions or perspectives. People who live in cities in developed countries with easy access to piped water may not value water as much as farmers in rural areas in the same country. Those living in developing countries with no or limited access to water are likely to feel that water has a much higher value.

FIGURE 1 The different values of water



The value of water and the way that it can be used is determined by the quality of the water.

Different pollutants — faeces (human and animal), food wastes, pesticides, chemicals and heavy metals — can come from industrial wastewater, domestic sewage, cars, gardens, farmland, mining sites and roads, and flow into waterways.

Some countries, cities and local areas are better than others at providing services and enforcing laws to prevent pollutants from entering water. Some of the worst polluted rivers and lakes in the world include rivers and **aquifers** in China (such as the Songhua River and the Yellow River), the Citarum River in Indonesia, the Yamuna and Ganges rivers in India, the Buriganga River in Bangladesh and the Marilao River in the Philippines.

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater. Water can move along an aquifer.

13.4.2 How clean is your river?

FOCUS ON FIELDWORK

Fieldwork investigating waterways

Some schools are located close to a waterway, even if it is a highly modified one like a concrete drain. Conducting fieldwork at a local waterway will help you to better understand national and global issues.

The aim is to investigate the physical properties of a river or creek at various points along its length, and to make observations of the water quality and any evidence of human impact. Does the quality of the water change between upstream and downstream sites? Are there human factors that can account for these changes? Differences may be more obvious if the waterway passes through a built-up area or a farm.

The following activities should be undertaken at each site and recorded on paper or directly onto a database on a laptop computer or other mobile device. Use a map and camera to record observations about the surroundings of each site, especially the amount of vegetation and possible human impact. Use GPS to record and map your location at each site.

Temperature

Aquatic plants and animals have a particular temperature range in which they can survive. High water temperatures can result in reduced oxygen available for plants and animals. It is useful to compare temperature readings with biodiversity counts to investigate this relationship. Place the bulb of a thermometer in the water for five minutes and record the result.

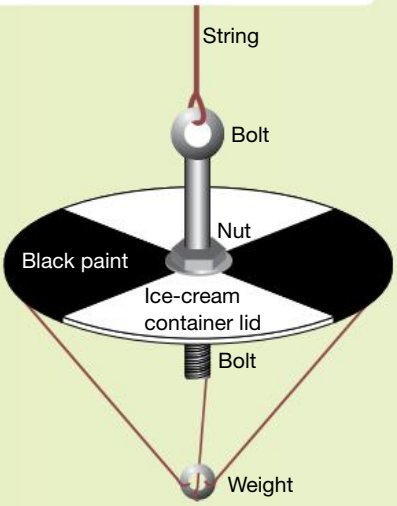
pH

We use pH to measure the acidity or alkalinity of water on a scale of 1 to 10. Drinking water should have a pH reading of around 6. A reading either side of this may indicate that water is polluted. You can test pH by taking a sample of water and using pH paper or chemical reagents.

(*continued*)

FIGURE 2 The Citarum River in Indonesia is one of the most polluted rivers in the world.

FIGURE 3 You can create a simple Secchi disc and use it to measure turbidity.



Turbidity

Water that lets little sunlight through is said to be turbid. Turbidity is the amount of suspended sediment in water — sediments such as clay, silt, industrial waste or sewage.

FIGURE 4 Students measuring river water quality

A Secchi disc (see figure 3) is used to measure turbidity. This can be made using an ice-cream lid, string, a weight and black paint.

Lower the disk into the water, making sure there are no waves or ripples, cloud or glare. Do not wear sunglasses when making the reading. When it is only just visible, record the depth in centimetres. The lower the number, the greater the turbidity.

Salinity

Salinity measures the amount of salt in the water. To measure salinity, you will need to use an electrical conductivity meter, or EC meter, which can be bought from science equipment suppliers. Place the meter into the water and take a reading off the screen.

GEOSkills TOOLBOX

Annotating a photograph

Photographs can provide an accurate representation of an area you are studying. By adding annotations, or labels, additional information can be recorded that draws attention to particular features of the photo. Examine SkillBuilder 13.5 'Annotating a photograph' in your eBookPLUS.

1. Take a photo of the field site you visited. Import it into a Word document.
2. Use text boxes and arrows to annotate your photograph showing where you undertook your testing and the results for pH, salinity, turbidity and temperature at each location.

FIGURE 5 Student investigating river water

ACTIVITIES

IDENTIFY

1 How do rivers become polluted?
2 What is an aquifer?

EXPLAIN

3 You will need to organise and present the information you collected in a field report. This can be presented in Google Maps, or as a Prezi presentation, web page or multimedia report. Determine some headings for your report such as a main title; introduction and background; data and findings; and conclusion. Arrange your data and choose the best way to represent it, whether in the form of graphs, tables, two maps, overlays, or photo displays and diagrams. Write an analysis of your data by describing it in detail. Draw conclusions and provide an evaluation of the field trip.
4 You should alert your local council to your findings by inviting someone to a presentation or sending a link to your findings to an appropriate representative. Is there action that needs to be taken to improve this waterway?

INVESTIGATE

5 Work in groups to investigate one of the other polluted rivers mentioned in the text. Show where it is located on a map. What does it look like? What has caused the pollution? Is anything being done to improve conditions?

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13.5 SkillBuilder: Annotating a photograph

Using annotated photographs in geography

Photographs are used to show aspects of a place. Annotations are added to photographs to draw the reader's attention to what can be seen and deduced.

eLesson

Watch this video to learn how to annotate a photograph.

Searchlight ID: eles-1633

Interactivity

Try this interactivity to learn how to annotate a photograph.

Searchlight ID: int-3129

13.6 What is the economic value of water?

13.6.1 Rice farming and aquaculture in Asia

The **economic** value of water must include all the different ways that we use water to produce a good or service. This includes drinking water, water used for irrigation, water used for **industry** and in recreation, and power generation. It can also relate to the importance of water as a breeding ground and nursery for fish stocks. In Australia and many other countries, the basic

economic a system made up of producing, buying and selling goods and services

industry the production of goods and services

economic value of water is recognised in the charges we pay to access piped water. Water plays a significant role in the production of food through the agricultural industry. It can contribute to domestic food security and the reduction of poverty.

In Asia, rice forms the main staple food for the majority of the population. The world's top five rice producers in 2014 were all found in Asia — China, India, Indonesia, Vietnam and Thailand. Rice cultivation is best suited to areas with a tropical climate, with warm temperatures and high amounts of rainfall. Rice production requires a high amount of water availability. Rice is an important form of foreign income particularly in Thailand, India and Vietnam.

FIGURE 1 Terraced rice fields

FIGURE 2 A Vietnamese farmer in a rice field

Aquaculture, also known as aqua farming, involves breeding and harvesting plants and fish in water environments. It can include farms in both salt water and fresh water. The aqua farms are set up in ponds, cages, on rafts and long lines (for shellfish).

Overfishing, destructive fishing practices and pollution have taken a toll on fish populations in the wild. As wild fish populations have plunged, fish catches by traditional means have declined, and aquaculture is a way of addressing this shortage. Aquaculture contributes to world fish supplies and food security in Asia.

FIGURE 3 An aquaculture worker feeding fish

Aquaculture is heavily concentrated in Asia, in areas where there are tropical climates, vast coastlines and large inland water bodies. These features can make many Asian countries suitable for aquaculture industries.

Aquaculture is an important source of foreign income and an important factor in encouraging economic development. Aquaculture can support local communities by generating employment and income, and provides a means to significantly improve standards of living. Often, traditional aquaculture operations tend to be small-scale and farmer owned and managed, providing autonomy to the owner. Aquaculture can often complement other farming practices such as rice farming, and a rice–fish culture has developed in some regions of China and India. Aquaculture provides opportunities for participation of both the men and women of the community. Much of the daily management and often the sale of the products is carried out by women.

Despite the economic benefits of aquaculture, it also has a number of environmental impacts. These include natural habitat destruction, release of chemical and organic effluent, and the depletion of wild fish stocks.

ACTIVITIES

IDENTIFY

1 Outline the importance of water as an economic resource.

EXPLAIN

2 Explain how important water is for rice production in Asia.

3 Explain the importance of fish farming and aquaculture in South-East Asia.

INVESTIGATE

4 Use the internet to research the environmental impacts of aquaculture such as natural habitat destruction, release of chemical and organic effluent, and the depletion of wild fish stocks. Share your findings with your class.

13.7 How does access to water improve health?

13.7.1 How does dirty water affect health?

Water has great value in improving the health and living standards of people around the world.

Nearly 900 million people in the world have no access to clean water, and 2.6 billion people have no safe way of disposing of human waste. Lack of toilets means many people defecate in open spaces or near the same rivers from which they drink. It is estimated that 90 per cent of sewage in poor countries ends up flowing straight into rivers and creeks.

This is an unacceptable situation. Dirty water and lack of proper hygiene kill 3.3 million people around the world every year, most of them children younger than five. People who are sick are often unable to work properly, to look after their families or to attend school, adding to the poverty cycle they may already be in. The diseases that can be passed on to people as a result of contaminated water include diarrhoeal diseases such as cholera, typhoid and dysentery. Malaria, a disease transmitted by mosquitoes, kills about a million people every year.

13.7.2 How can water-borne diseases be reduced?

People use different methods to treat the water they have collected. They can let it stand and settle, strain it through a cloth, filter it, add bleach or chlorine, or boil it. Some people do not treat their water at all.

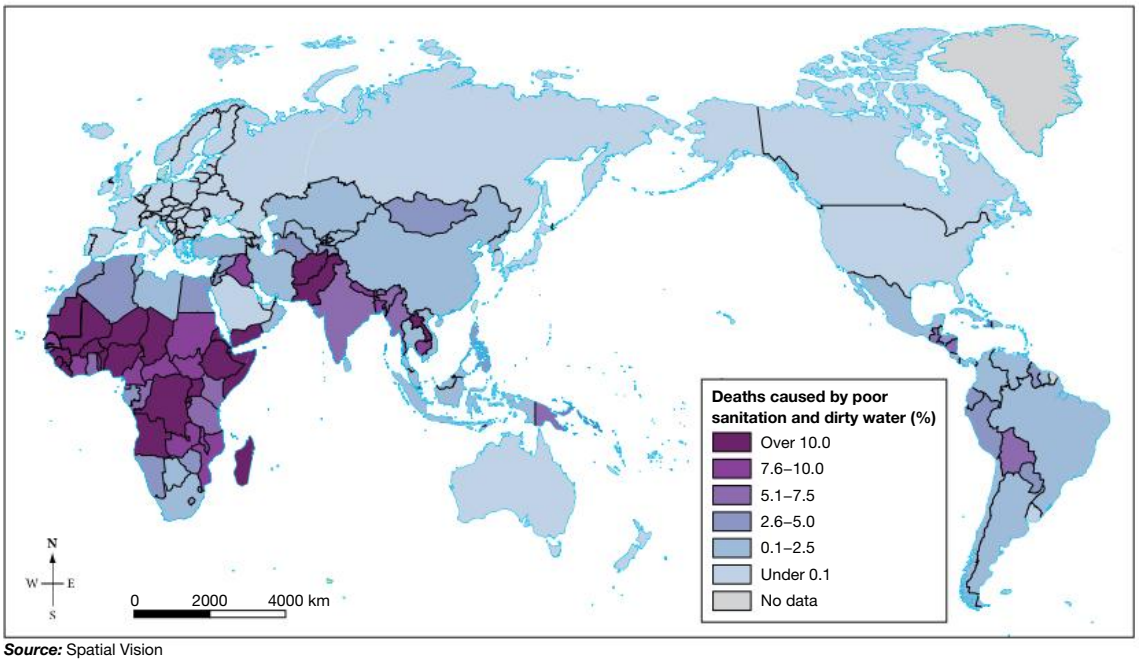
When there is barely enough water to drink or to cook with, it is difficult for people to set aside water for washing hands and cleaning clothes. However, hygiene and sanitation are very important for health.

A number of aid groups, such as WaterAid, Water.org, CARE and A Glimmer of Hope, work on projects to improve sanitation and access to clean water. Washing hands, building cheap and effective toilets and teaching the community about good hygiene all help to reduce disease.

13.7.3 Millennium Development Goals

In 2000, the United Nations agreed on eight Millennium Development Goals (MDGs) to combat global poverty. Each MDG had measurable targets, and the UN aimed to reach them by 2015. Water and sanitation came under goal 7, target 3: it aimed to halve, by 2015, the proportion of the population without sustainable access to safe drinking water and basic sanitation.

FIGURE 1 Deaths caused by poor sanitation and dirty water



Source: Spatial Vision

FIGURE 2 Collecting water that is unsafe to drink

Data from **UNICEF** and the World Health Organization show that the water target was reached in 2010, when 1.8 million more people had access to safe water than in 1990. There are still 780 million people who need access to improved drinking water but, as of 2015, 91 per cent of the world's people have improved drinking water.

The water target is progressing better than the sanitation target. In 2015, 1 in 3 of the world's population lived without access to improved sanitation. The vast majority live in Asia and sub-Saharan Africa. At current rates the sanitation target of 75 per cent will be missed.

The maps in figures 4 and 5 show there are regional patterns to success or failure of these targets, particularly in large parts of Africa.

The Sustainable Development Goals have replaced the Millenium Development Goals. Goal 6 is based on clean water and sanitation.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › World health

CASE STUDY

Community-led total sanitation (CLTS), Nigeria

WaterAid went to a village called Olorioko in the state of Ekiti to see if they could improve the sanitation. When they arrived, there were very high rates of illness and death due to water-related diseases. The people in the village used the bush near their houses as their toilet.

CLTS leaders developed a relationship with the villagers and taught them how faeces can enter their food and make them sick. Once this was understood, the people wanted to change their practices so this would no longer happen. Action plans were drawn up and eventually the villagers created clean water points, built simple but effective toilets, and were given lessons in sanitation.

The health of the entire village has improved and they are also increasing their wealth. The CLTS project, which started in Bangladesh some years ago, has been a success and is spreading throughout Nigeria.

Use the **Health is wealth** weblink in your eBookPLUS to learn about a community-led sanitation project.

FIGURE 3 Location of Nigeria in Africa

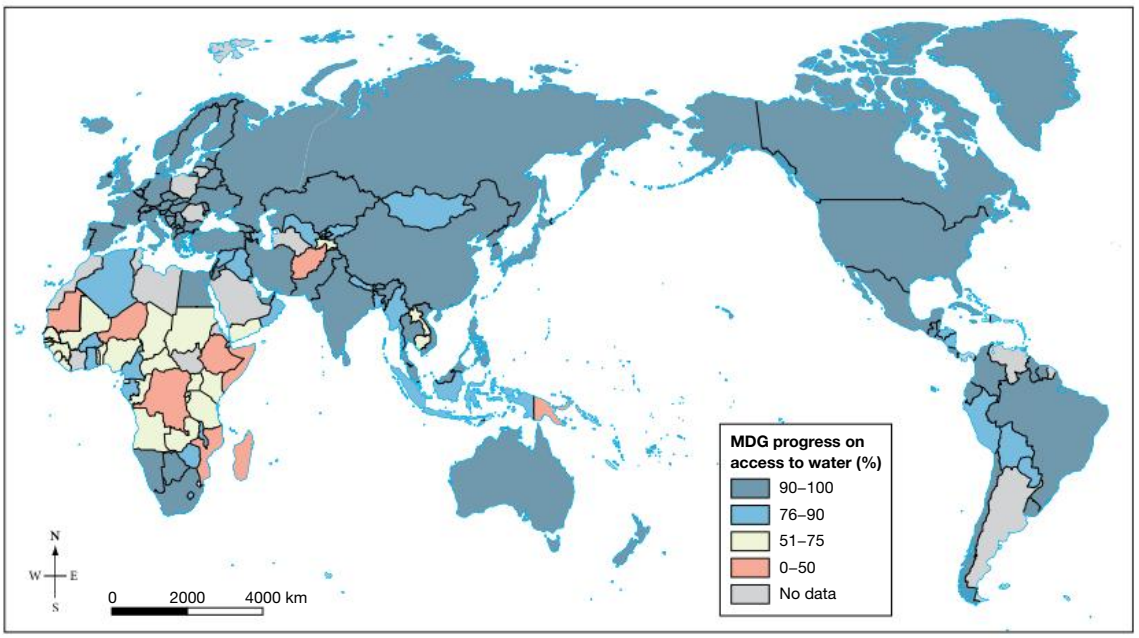
Source: Spatial Vision

UNICEF United Nations Children's Fund: a UN program that provides humanitarian and developmental assistance to children and mothers in developing countries

eBookplus

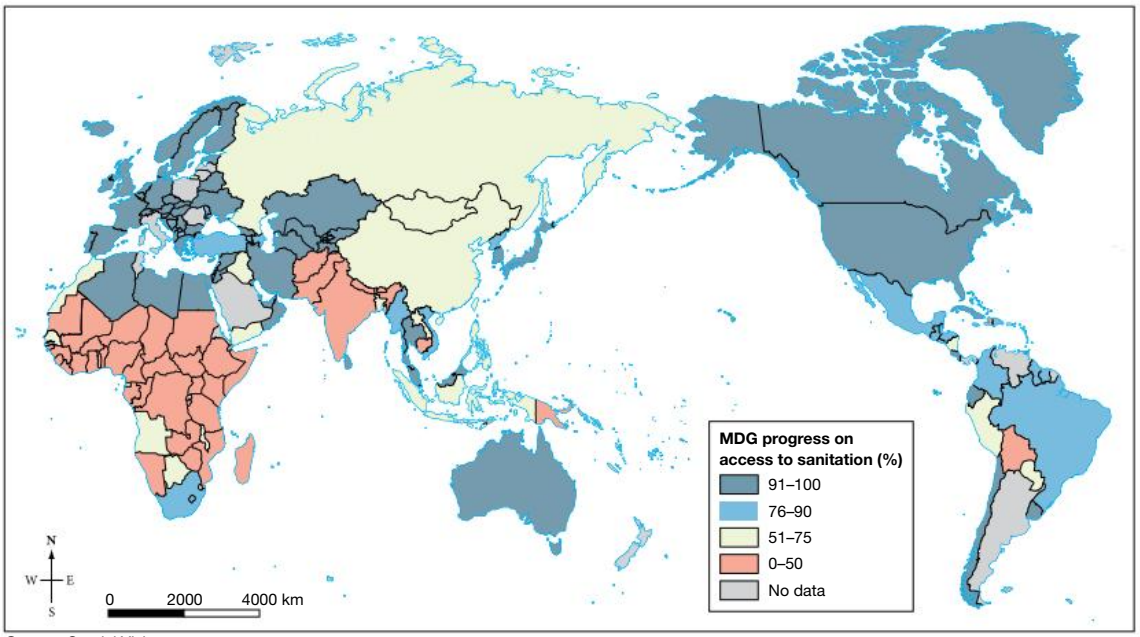
Weblink
Health is wealth

FIGURE 4 MDG progress on access to water



Source: Spatial Vision

FIGURE 5 MDG progress on access to sanitation



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 How many people in the world do not have access to clean water or sanitation?
2 Describe Nigeria's location in Africa and in relation to other countries and ***places***.
3 What does CLTS stand for?

EXPLAIN

4 Study figure 1. Look at sub-Saharan and North Africa. (See the 'Regions' resource in your eBookPLUS.)
   a Name three coastal and two landlocked countries in these regions.
   b How many countries in this region suffer deaths caused by poor sanitation and dirty water?
   c Name the continents and regions that have the fewest deaths.
   d Why do you think this *spatial* pattern exists? (*Hint:* look at maps in your atlas that show wealth.)
5 Explain what the community-led total sanitation project aims to do.
6 Use the information in the maps to explain how the MDGs are being achieved for water and sanitation. Explain this for each world region. Use the **WHO/UNICEF** weblink in your eBookPLUS to see an interactive world map showing specific figures for water and sanitation.

PREDICT

7 What might happen to people's health in North and sub-Saharan Africa if access to water and sanitation is not improved?
8 A number of aid agencies are working in countries and regions to improve access to sanitation and clean water. Choose one of those listed in this chapter and find out more about what they are doing. How will their work make a difference to the living conditions of the people they are helping?

APPLY

9 Work in groups of three or four. Use the data and facts in these pages to plan a day of promoting knowledge about this issue at your school. Make particular reference to North and sub-Saharan Africa, and find out what is being done by aid organisations to improve the situation in these regions. Plan a video presentation that is interesting and catchy and will help people understand the action needed to improve access to clean water and sanitation. Use video and video editing programs and internet research in your planning.

eBookplus

Weblink
WHO/UNICEF

13.8 What is the cultural and spiritual value of water?

13.8.1 The importance of water

In some communities water is central to the livelihoods and cultural practices of their people. Water is integral to some sacred landscapes for Aboriginal and Torres Strait Islanders, and as a result these locations have significant spiritual value.

CASE STUDY

Stories help map the location of water

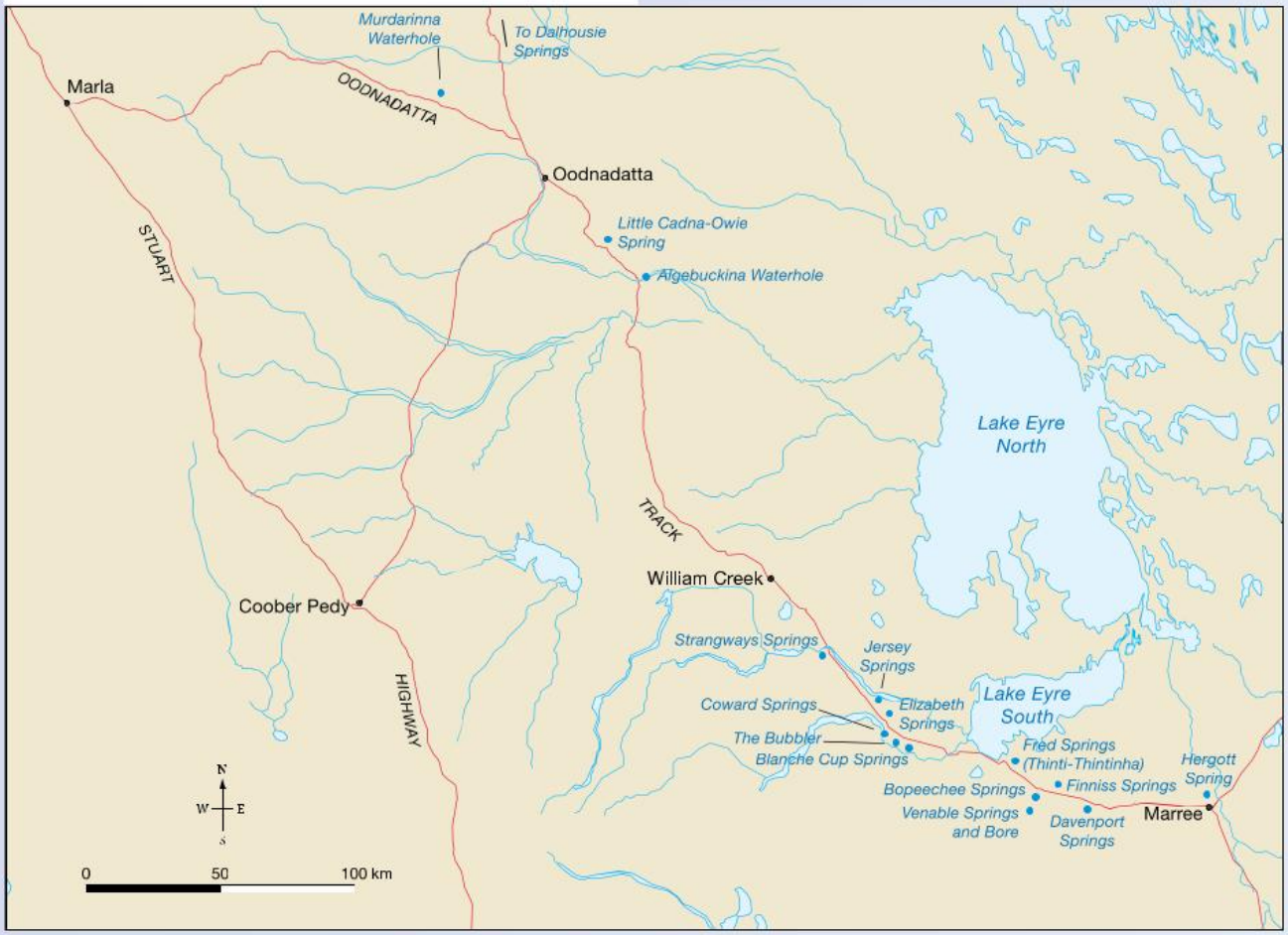
Australian Aboriginal knowledge of the land and how to survive in it has been passed from generation to generation through **Dreaming** Stories. During the dry seasons and periods of drought, Aboriginal people congregated at the mound springs. These springs were linked by traditional Aboriginal song and story lines, and are often connected to rain-making rituals.

Dreamtime stories

1 Thutirla Pula (Two Boys Dreaming)

This is one of the most important stories of the Wangkangurru and other people of Central Australia. Thutirla Pula is how the spirits of The Dreaming first crossed the desert they call Munga-Thirri (land of sandhills). One of the most important songlines is the story of the Two Boys Dreaming. The story tells of two boys crossing the Simpson Desert, through Queensland and back to just north of Witjira (Dalhousie) in the Finke River area. The songline contains information on every waterhole or soak that was known in the Simpson Desert. Following this songline meant you could cross the Simpson Desert using available groundwater along the way, taking 600 kilometres off the usual journey south of the Simpson Desert to Lake Eyre, then back north along the Diamantina River.

FIGURE 1 Groundwater springs along the Oodnadatta Track



Source: Spatial Vision

2 Bidalinha (or the Bubbler)

The Kuyani ancestor Kakakutanha followed the trail of the rainbow serpent Kanmari to Bidalinha (or the Bubbler) where he killed it. He then threw away the snake's head, which is represented by Hamilton Hill, and cooked the body in a dirga, or oven, which is now Blanche Cup. Kakakutanha's wife, angry at missing out on the best meat from the snake, cursed her husband, and he went on to meet a gruesome death at Kudna-ngampa (Curdimurka). The bubbling water represents the movements of the dying serpent.

FIGURE 2 The Old Bubbler on the Oodnadatta Track, where the Dreamtime serpent died

3 Thinti-Thintinha Spring (Fred Springs)
The willy wagtail (or thunti-thuntinha) danced his circular dance to create this spring and the surrounding soils, which are easily airborne in windy conditions. The moral to the story is that, while it is easy to catch the skilful little willy wagtail, you must never do so because of the terrible dust storms that may follow.

4 Kewson Hill: the Camp of the Mankarra-kari — the Seven Sisters
The Seven Sisters came down here to dig for bush onions (yalkapakanha). As they peeled the onions, they tossed the skins to one side, creating the dark-coloured extinct mound spring on the south-west side of the track. The peeled bulbs created the light-coloured hill (yalka-parlumarna) to the north-east, also an extinct mound spring.

5 Dalhousie Springs
Dalhousie Springs is a popular oasis in the arid desert region of the northernmost part of South Australia.

FIGURE 3 Fed by the thermal waters of the Great Artesian Basin, the water in Dalhousie Springs is between 34 and 38 °C.

ACTIVITIES

EXPLAIN
1 Why were Dreaming Stories important to Aboriginal people in the Oodnadatta region?

INVESTIGATE
2 Research a community in Asia and explain the cultural or spiritual significance of water to that community.

Dreaming in Aboriginal culture, the time when the Earth took on its present form, and cycles of life and nature began, also known as The Dreamtime. Dreaming Stories pass on important knowledge, laws and beliefs.

13.9 How do Indigenous people use water?

13.9.1 Groundwater sources

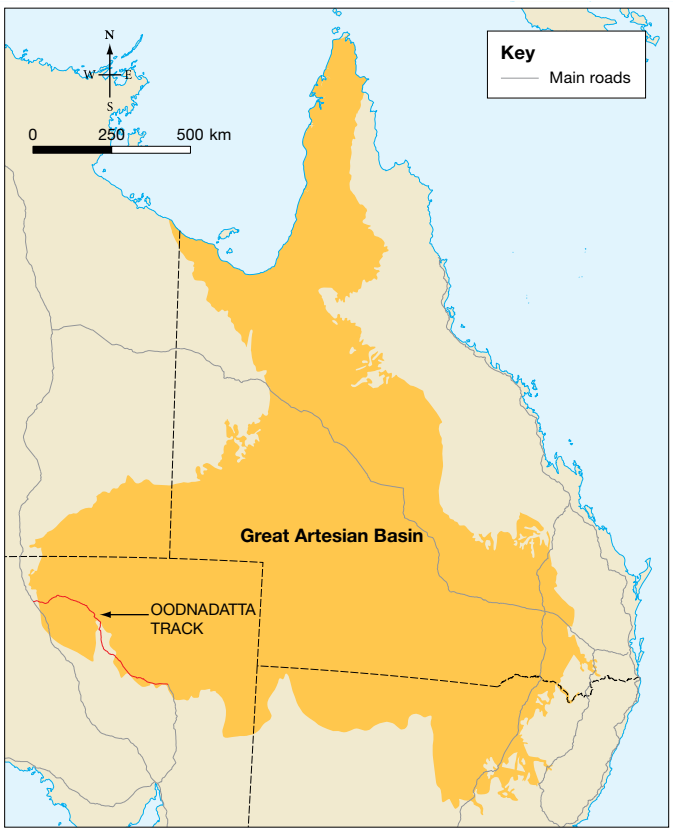
Aboriginal people have lived in the Australian landscape for thousands of years, and they have had the knowledge to survive many changes and challenges. In order to obtain water in the country's dry regions, particularly in Australia's deserts, they have needed to know where to find groundwater.

There are many groundwater sources throughout Australia that have long been used by Aboriginal people. One of these sources is **soaks**: groundwater that comes to the surface, often near rivers and dry creek beds, and which can be identified by certain types of vegetation. Another source is **mound springs**: mounds of built-up minerals and sediments brought up by water discharging from an aquifer.

Mound springs of the Oodnadatta Track

The Oodnadatta Track is located in the north-east of South Australia. The track follows the edge of the Great Artesian Basin and the south-western edge of Lake Eyre and, along its route, groundwater makes its way to the surface in several locations.

FIGURE 1 Location of the Oodnadatta Track and Great Artesian Basin, one of the world's largest groundwater basins



Source: Spatial Vision

FIGURE 2 The Oodnadatta Track passes close to the Old Ghan, the Great Northern Railway.

The Oodnadatta Track crosses the traditional lands of three Aboriginal groups. In the south, between Lake Torrens and Lake Eyre, are the Kuyani people; most of the west of Lake Eyre has been traditionally occupied by the Arabana people; and to the north is the land of the Arrernte people.

Many springs have cultural significance today for local Aboriginal people, whose ancestors relied on the springs as water sources and as sacred sites for important ceremonies. Knowledge of the springs in this region has been passed down over many generations through Dreaming stories.

This knowledge was also passed on to explorers and settlers. John McDouall Stuart followed this track to complete the first crossing of Australia's interior from south to north in 1862; the overland telegraph was constructed along its pathway; and the Great Northern Railway, which made the land of the Northern Territory accessible for white settlement, followed the same route.

soak place where groundwater moves up to the surface

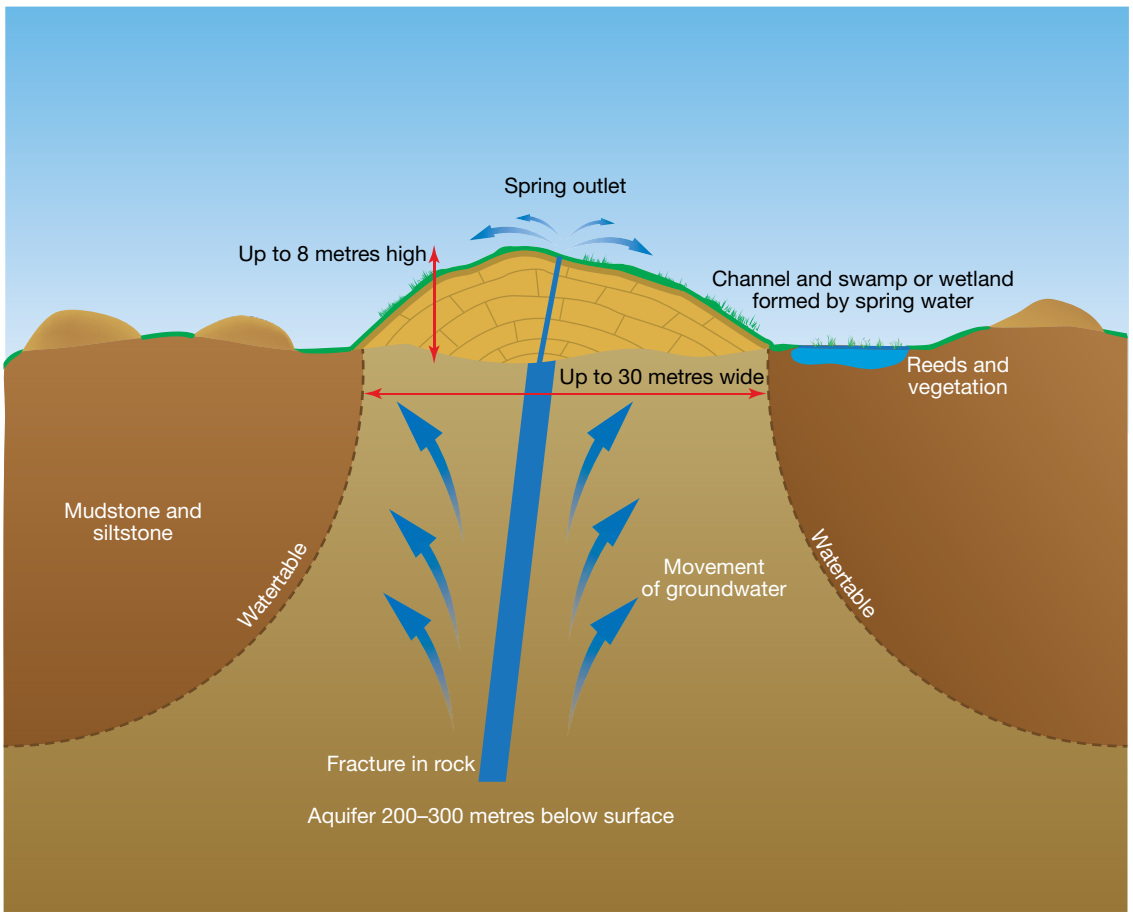
mound spring mound formation with water at its centre, which is formed by minerals and sediments brought up by water from artesian basins

Mound springs were very important for Australian Aboriginal people. They could rely upon springs as reliable sources of water in a very harsh, dry environment.

Old campsites and animal remains provide evidence that they remained there for varying time periods. However, because the plant and animal life around these regions is quite sparse, people had to move regularly and travel away from the springs when rainfall allowed that to occur.

Because the springs were strung out over hundreds of kilometres, they were also part of an important network of trading and communication routes across Australia. As Aboriginal people moved around the region, they traded goods and communicated with other groups. This interconnection between groups allowed them to trade resources such as ochre, stone and wooden tools, bailer shells, and pituri. Pituri is a spindly shrub used by Aboriginal people during ceremonies and to spike waterholes to catch animals for food.

FIGURE 3 Cross-section of a typical mound spring



ACTIVITIES

EXPLAIN

1 Why is groundwater so important to the communities in this region today?
2 How do Dreaming stories help map the groundwater in this region?

INVESTIGATE

3 Use Google Earth and enter the search terms Oodnadatta or William Creek to locate the Oodnadatta Track. Describe the landscape you see. Why is finding groundwater so important in this ***environment***?
4 Use an atlas or Google Earth to locate Dalhousie Springs, Birdsville, Lake Eyre and the Diamantina River. See if you can follow the Two Boys Dreaming story and show how following the story saved a lot of time travelling across the desert.

13.10 How is water significant to indigenous people?

13.10.1 World indigenous cultures

Water is very important to both indigenous and non-indigenous peoples across the world, and is used for many different purposes. Water is important to both groups for different reasons. Water has a spiritual importance to indigenous peoples and they have strong connections with the natural world.

This Indigenous Peoples' Water Declaration shows the importance of water. This declaration came from a meeting in 2008 in north-east Arnhem Land, Northern Territory, where a group of indigenous people from around the world met to discuss water management issues.

> We, the indigenous peoples from all parts of the world assembled here, reaffirm our relationship to Mother Earth and responsibility to future generations to raise our voices in solidarity to speak for the protection of water. We were placed in a sacred manner on this earth, each in our own sacred and traditional lands and territories, to care for all of creation and to care for water.
>
> ***Source:*** www.indigenouswater.org

13.10.2 Aboriginal and Torres Strait Islanders

Depending on where Aboriginal people lived, they traditionally collected surface water from creeks, rivers and waterholes; from underground water supplies such as soaks and springs; or directly from plants, including tree roots.

Recently, evidence collected from oral histories, Dreaming Stories, rock art, artefacts, ceremonial body painting, and historical records left by missionaries, surveyors, settlers and explorers shows that Indigenous Australians managed their water carefully. They channelled and filtered their water, covering it to keep it clean and to stop it from evaporating. They also created wells and tunnel reservoirs.

Aboriginal seasons are closely linked to water. Use the **Miriwoong seasonal calendar** weblink in your eBookPLUS to see an example of one Aboriginal calendar where seasons, water and activities are closely linked.

13.10.3 Water and Aboriginal culture

In a report on the cultural values of water for the Anmatyerre people in the Northern Territory it was stated:

> Our cultural values of water are part of our law, our traditional owner responsibilities, our history and our everyday lives. Everyone and everything is related. Our law has always provided for the values we place on water. It is the rules for men, women and country. Anmatyerre Law is strong today, but it is invisible to other people. Australian law should respect Anmatyerre Law so we can share responsibility for looking after water.

The rainbow serpent is a key symbol of creation, but its journey from underground to the surface also represents groundwater rising to the top via springs. The creation of water sources and where to find them was often told in stories or through artwork. Use the **How the water got to the plains** weblink in your eBookPLUS to hear one story that describes how billabongs appeared in the dry inland plains, told by Butchulla elder Olga Miller.

eBookplus

Interactivity
Thutirla Pula
Use this interactivity to check your understanding of how Indigenous and non-Indigenous Australians have used groundwater resources in the Lake Eyre region.
Searchlight ID: int-3079

Weblinks
- Miriwoong seasonal calendar
- How the water got to the plains

eBookplus

Weblink
Water Dreaming

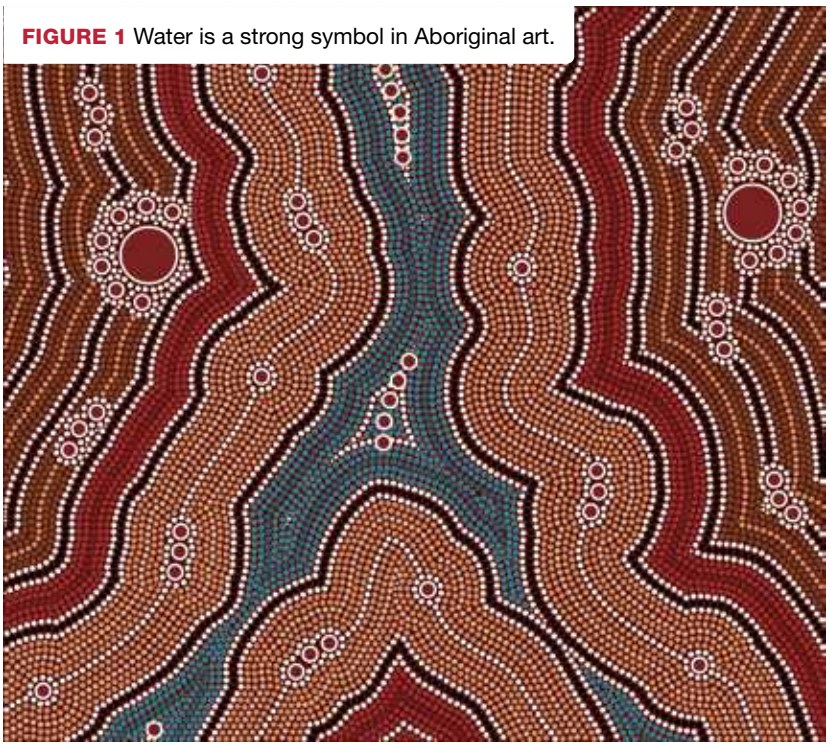


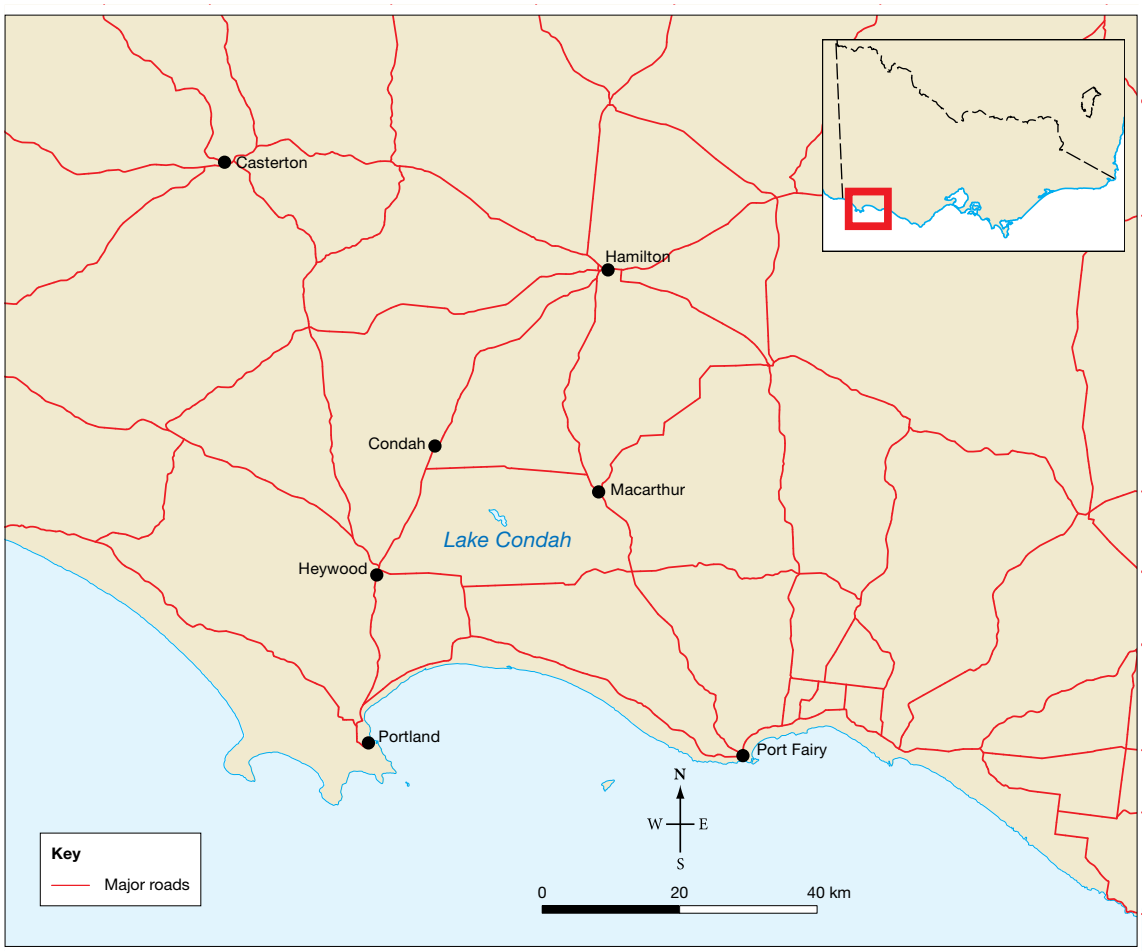
FIGURE 1 Water is a strong symbol in Aboriginal art.

Use the **Water Dreaming** weblink in your eBookPLUS to hear an interview with artist Malcolm Maloney Jagamara.

An Indigenous water project

On 30 March 2008, the Victorian government returned the heritage-listed Lake Condah in Victoria to the Gunditjmara traditional owners. Lake Condah is considered one of Australia's earliest and largest aquaculture ventures. Aquaculture is the growing and harvesting of animals and plants in a water environment. The Gunditjmara people want to preserve their culture while engaging in tourism, water restoration and sustainability projects. One example is the plan to restore the ancient stone aquaculture system at the lake for eel farming.

FIGURE 2 Location map of Lake Condah



Source: Spatial Vision

ACTIVITIES

IDENTIFY
1 From what sources did Aboriginal people collect water?
2 Define *aquaculture*.

EXPLAIN
3 What does evidence show about traditional Aboriginal Australians managing water supplies?

INVESTIGATE
4 Use the **Miriwoong seasonal calendar** weblink in your eBookPLUS to learn more about water seasons and food. How is water closely associated with Indigenous activities in this region?
5 Look at the Miriwoong interactive calendar.
- a Which Australian region does this calendar represent?
- b How are the seasons divided? How does this compare with a European calendar?
- c How are seasons and water linked in this calendar?

6 Use Google Earth to locate the Wabma Kadarbu Mound Springs Conservation Park. Place a pin on this location. Now zoom in and out to help you complete the following.
- a Where is this park located in South Australia? Where is this ***place*** in relation to where you live? Use distance and direction in your answer.
- b What is the name of the nearest road?
- c Describe the surrounding area.
- d Why would these springs be so important to Aboriginal people and European explorers?
- e Do some research to find out why these springs are protected today.
- f Use Google Maps to annotate this area with your findings. Include photos that you find using the internet.

APPLY
7 Use the **How the water got to the plains** weblink in your eBookPLUS to listen to the Dreaming Story. How is Aboriginal culture closely associated with ***place*** and ***environment***?

eBook*plus*

Weblinks
- Miriwoong seasonal calendar
- How the water got to the plains

13.11 What is the aesthetic and social value of water?

13.11.1 The value of water

Water can have an aesthetic value. Aesthetics is about to the nature and appreciation of beauty, and can be used to describe the way people respond to the environment. It includes the way people interact with a place through their senses and the emotions they experience.

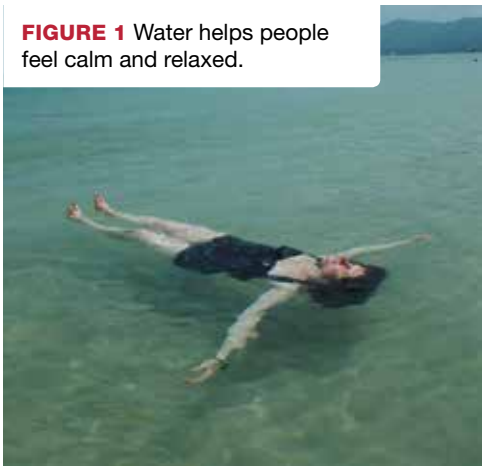


FIGURE 1 Water helps people feel calm and relaxed.

Water contributes to the visual quality of an environment. Houses and units near rivers, lakes and the ocean tend to be much more expensive than properties some distance from the water. In part, this takes into consideration the aesthetic value of a water view. People enjoy being able to watch the waves breaking, or to watch sailboats on a lake from their homes.

Together with vegetation, water is one of the most important features of an environment in providing emotional and psychological benefits to people. Water is required for basic human survival, and environments that contain a large amount of

FIGURE 2 The aesthetic characteristics of water

Water with high aesthetic value	Water with low aesthetic value
Pristine Little odour Clear Transparent Blue or slightly green colour Free from floating debris, scum and oil	Polluted Smelly Murky Opaque Dark green to brown colour Floating debris, scum and oil

CASE STUDY

The aesthetic value of the Great Barrier Reef

When people visit the Great Barrier Reef they feel a sense of beauty, naturalness and remoteness. The amazing contrasting colours of the water ranging from deep, dark blues to iridescent bright aqua contribute to the natural beauty of the reef. The bright white sand, the green islands and the unusual shapes of the reefs and cays create beautiful mosaic patterns in the water.

FIGURE 3 The beauty of living creatures, and vegetation above and below the waters surrounding Fitzroy Island on the Great Barrier Reef in Queensland

water make people feel safe and nurtured. Being close to water and appreciating its beauty can help people feel relaxed and calm.

Water also has a social value as it helps people to undertake activities that help to maintain a healthy lifestyle and social interactions. People are able to undertake many activities such as swimming, kayaking, sailing, and a range of other water sports.

ACTIVITIES

IDENTIFY

1 Define *aesthetics*.

EXPLAIN

2 Why would it be important to have clear water in an area where there are swimming activities?

3 Examine the photographs of Fitzroy Island on the Great Barrier Reef (figure 3). What features can you observe in these photographs that contribute to the aesthetic value of water?

FOCUS ON FIELDWORK

Environmental Perception Form

Visit a local area that has water such as a river, lake or beach. Examine the site and fill in the table below. The aim of this activity is to obtain some qualitative data from your visit. This can be difficult to measure with numbers and there is no absolute, correct answer. Recreate the table below and put a tick in the box which you think best indicates your feelings.

	1	2	3	4	5	
Beautiful						Ugly
Fresh						Smelly
Healthy						Chaotic
Moving						Motionless
Quiet						Noisy
Clean						Dirty
Light						Dark

1 Did the site you visited mainly receive high ratings or low ratings?

2 Describe your fieldwork site in one paragraph. Try to use synonyms (similar words) rather than the words in the Environmental Perception Form.

3 What changes would you suggest be made to this environment to improve its aesthetic value?

4 Explain how changes to this environment could impact on the social and mental wellbeing of local residents and visitors.

13.12 What is virtual water?

13.12.1 Virtual water

The water we consume is not just what we use in cooking, drinking, washing, flushing or in the garden. Water is used to manufacture everything we use: mobile phones, toys, cars and newspapers. This **virtual water** needs to be considered in our water footprint — that is, the water used to produce all our goods and services.

virtual water all the water used to produce goods and services. Food production uses more water than any other production.

Virtual water is also known as embedded water, embodied water, or hidden water. It includes all the water used to produce goods and services. Food production uses more water than any other production.

Hidden in a cup of coffee are 140 litres of water used to grow, produce, package and ship the beans. That is roughly the same amount of water used by an average person daily in Australia for drinking and household needs. There is a lot of water hidden in a hamburger too: 2400 litres. This includes the water needed to grow the feed for the cattle over a number of years, to grow wheat for the bread roll, to grow all the other ingredients in the hamburger, and to process all the food.

Virtual water varies from food to food. For example, it takes about 3400 litres of water to grow one kilogram of rice, whereas it takes 200 litres to grow one kilogram of cabbage. Regions that are water

stressed and that export food and other products (such as Australia and some countries in Africa and Asia) are also effectively exporting their precious water in these goods.

A country that imports rice, rather than growing it locally, therefore saves 3400 litres of water for every kilogram it imports. Some countries (such as Japan) have very little land on which to grow food; other countries have very few cubic metres of renewable water per person. Singapore, for example, has only about 130 cubic metres per person. Both types of countries survive by virtual water imports: they import food rather than attempt to grow and produce all their food themselves. This means that small, wealthy countries can import food that needs a lot of water to produce, and export products that need little water to produce. This makes water available for other domestic purposes such as drinking and cooking.

The major exporters of virtual water are found in North and South America (the United States, Canada, Brazil and Argentina), South Asia (India, Pakistan, Indonesia, Thailand) and Australia. The major virtual water importers are North Africa and the Middle East, Mexico, Europe, Japan and South Korea.

13.12.2 What is a water footprint?

water footprint the total volume of fresh water that is used to produce the goods and services consumed by an individual or country

The **water footprint** of an individual or country is the total volume of fresh water that is used to produce the goods and services consumed by the individual or country. It includes the use of:

- blue water (rivers, lakes, aquifers)
- green water (rainfall used for crop growth)
- grey water (water polluted after agricultural, industrial and household use).

Not all goods consumed in one particular country are produced in that country — some foods and products are imported. Therefore the water footprint consists of two parts: use of domestic water resources and use of water outside the borders of the country.

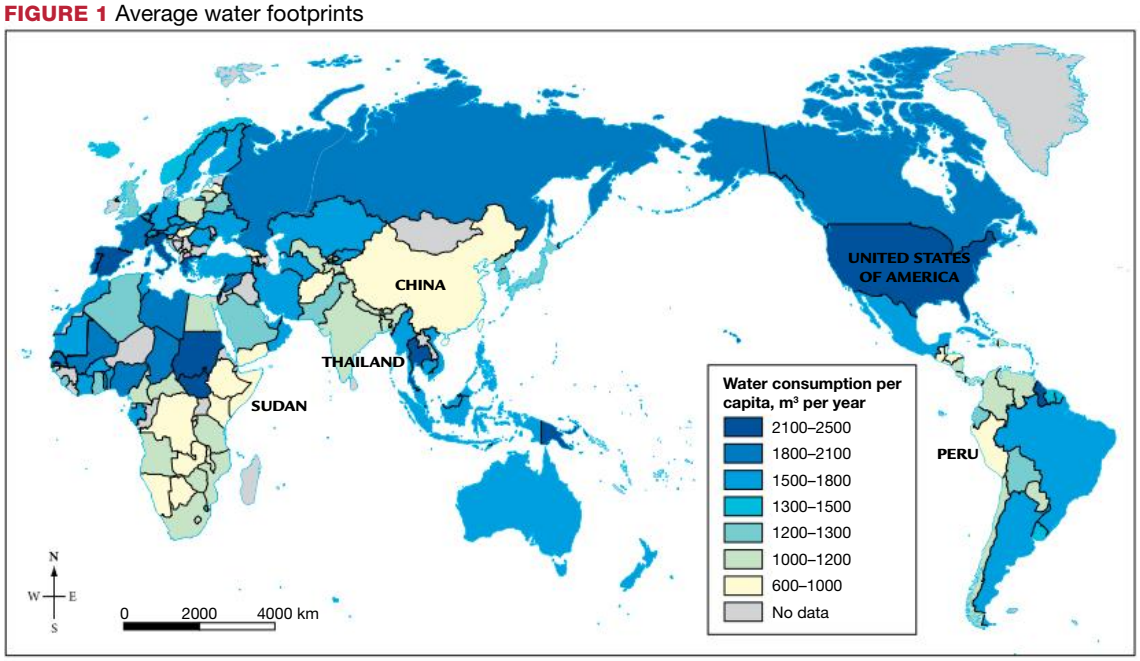
The world average water footprint is 1240 cubic metres per person per year. China has an annual footprint of 700 cubic metres per capita, while the United States has 2500 cubic metres per capita.

Japan, with a footprint of 1150 cubic metres per person per year, has about 65 per cent of its total water footprint outside the borders of the country, meaning a lot of its water is imported in the form of consumer goods and food. On the other hand, only about seven per cent of the Chinese water footprint falls outside China.

TABLE 1 The water used to grow food varies from product to product.

Food item	Unit	Global average water (litres)	Food item	Unit	Global average water (litres)	Food item	Unit	Global average water (litres)
Apple or pear	1 kg	700	Cucumber or pumpkin	1 kg	240	Olives	1 kg	4400
Barley	1 kg	1300	Dates	1 kg	3000	Orange	1	50
Banana	1 kg	860	Eggs	1	200	Paper	1 A4 sheet	10
Beef	1 kg	15500	Goat meat	1 kg	4000	Peach or nectarine	1 kg	1200
Beer (from barley)	250 mL	75	Groundnuts (in shell)	1 kg	3100	Pork	1 kg	4800
Bread (from wheat)	1 kg	1300	Hamburger	1	2400	Potato	1 kg	4800
Cabbage	1 kg	200	Lamb	1 kg	6100	Rice	1 kg	3400
Cheese	1 kg	5000	Leather	1 kg	16600	Soya beans	1 kg	1800
Chicken	1 kg	3900	Lettuce	1 kg	130	Sugar (from sugar cane)	1 kg	1500
Chocolate	1 kg	24000	Maize	1 kg	900	Tea	250 mL	30
Coconut	1 kg	2500	Mango	1 kg	1600	Tomato	1 kg	180
Coffee (roasted)	1 kg	21000	Millet	1 kg	5000	Wheat	1 kg	1300
Cotton shirt	1	2700	Milk	250 mL	250	Wine	125 mL	120

FIGURE 1 Average water footprints



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 Explain the difference between virtual water and a water footprint.

2 Outline the differences between blue, green and grey water.

EXPLAIN

3 Refer to figure 1.

- **a** Describe the patterns you notice over ***space*** of countries with (i) very high and high water footprints and (ii) very low and low water footprints.
- **b** How is the ***scale*** of footprints different for these groups?

4 Use a blank world map and choose two colours to show the main importers and exporters of virtual water. Describe the ***spatial*** patterns of the map you have drawn.

INVESTIGATE

5 Study table 1. Choose three meat, five grain, two dairy, two non-food, four fruit, four vegetable and two processed products from the list. Create a bar graph to show how much water is used to produce a vegetarian diet and a meat-based diet. Which diet uses more water?

6 Use the **Just add water** weblink in your eBookPLUS to listen to an audio program about the water footprint in food production.

- **a** What is the relationship between water-stressed countries and food production?
- **b** Give an example where the water footprint figure is in conflict with the opinion of farmers.
- **c** Find as much information as you can about a product produced in Wodonga that includes both virtual and domestic water.

APPLY

7 Conduct a debate on the following statement: That people should eat less meat in order to consume less water.

8 Compare the data for North Africa and West Asia (the Middle East) in figure 1. You could also consult maps showing global fresh water availability, distribution of global rainfall, as well as maps showing rainfall and climate in Australia. (Refer to the 'Regions' resource in your eBookPLUS.) Write three summary statements that describe the amount of rainfall, water use (including water footprints) and water availability for these two regions. How do these patterns compare with Australia?

9 Describe how water footprints ***interconnect places*** often far away from each other.

eBookplus

Interactivity
Unreal
Use this interactivity to explore the amount of virtual water in our food.
Searchlight ID: int-3080

Weblink
Just add water

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. › Our water footprint

13.13 How is water valued in Noosa?

13.13.1 Noosa's beaches and river

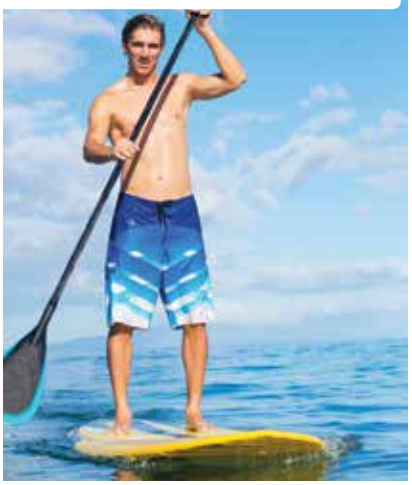
Noosa is about 140 kilometres north of Brisbane, Queensland, between the mouth of the Noosa River and the headland of Noosa National Park. Noosa demonstrates how water can have value in different ways.

FIGURE 1 Visitors enjoy the spectacular views from Noosa National Park.

Noosa is a popular tourist destination and, as such, the water at nearby beaches and in local rivers and lakes contributes an economic value to the area. Hotels with water views will charge tourists higher prices than rooms without water views. Similarly, Noosa's water has an aesthetic value — it is visually appealing and is part of the attraction of Noosa. People enjoy looking out into the ocean or over the river. The psychological and cultural value of water helps visitors relax and unwind, and the many water-based activities in Noosa such as cruises, canoeing and kite-surfing contribute to the culture of place.

FIGURE 2 An oblique aerial photograph of Noosa

FIGURE 3 Many activities for holiday makers at Noosa are water-based.



ACTIVITIES

IDENTIFY

1 State the ***scale*** of the map in a sentence.
2 State the contour interval of the map.
3 State the feature at the following area references:
  a AR 0376
  b AR 0470
  c AR 0583.
4 State the distance from the breakwater at AR 0781 to the causeway at AR 0380.
5 State the altitude of:
  a the spot height at AR 1081
  b the sewage treatment works at AR 0878
  c the caravan park at AR 0780.
6 List different ways in which people use the water around Noosa. What evidence is there for these uses on the map?

EXPLAIN

7 Explain why you think the settlements around Noosa have developed in their current locations.
8 Explain why the settlements located in AR 1079 and AR 0880 are separated.

APPLY

9 Throughout this chapter we have examined the economic, aesthetic, cultural and spiritual value of water. How do you think the settlement patterns around Noosa have been influenced by:
  a the economic value of water
  b the aesthetic value of water
  c the cultural and spiritual value of water?

PREDICT

10 Predict how increased tourism and development around Noosa may have an impact on the value of water in the future.

FIGURE 4 Topographic map of Noosa

Source: Department of Natural Resources and Mines, QLD.

eBookplus ONLINE ONLY

13.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au.**

This wetland environment has been transformed by water scarcity.

CHAPTER 14

Water scarcity and management

14.1 Overview

14.1.1 Introduction

Every person on the planet interacts with the weather on a daily basis. Sometimes we feel hot, sometimes we feel cold. Climate patterns affect water availability in Australia and around the world. Change in the weather and climate patterns also affects the environment. If there is too little rain, drought can develop, sometimes producing heatwaves — days of dry, hot weather. If there is too much rain, flooding will occur. Changes to climate patterns can make water availability very unpredictable, and places that once had water readily available may now suffer from water scarcity. Water management can help communities and individuals gain more predictable access to water.

Starter questions

1. List three things you would expect to happen if an area did not get its usual rainfall for a long time.
2. How would water scarcity impact on the way you live your life?
3. List two natural ***environments*** that have very little water. Name where they are or show their location on a map.
4. What are ways you could manage water use in your own home?

Inquiry sequence

		Syllabus outcomes
14.1 Overview		
14.2 Where are Australia's water resources?		GE4-1, GE4-2, GE4-7, GE4-8
14.3 How does Australia's climate affect water availability?		GE4-1, GE4-2, GE4-7, GE4-8
14.4 What differences are there in water availability globally?		GE4-1, GE4-2, GE4-7, GE4-8
14.5 Does everyone have enough water?		GE4-3
14.6 SkillBuilder: Constructing a pie graph	eBookplus ONLINE ONLY	GE4-7, GE 4-8
14.7 What is water scarcity?		GE4-3
14.8 SkillBuilder: Reading and describing basic choropleth maps	eBookplus ONLINE ONLY	GE4-7, GE 4-8
14.9 What strategies can address water scarcity?		GE4-3, GE4-5
14.10 How can water be managed?		GE4-3, GE4-5
14.11 Investigating topographic maps: What are sources of water at Whataroa?		GE4-3, GE4-5
14.12 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	

eBook*plus*

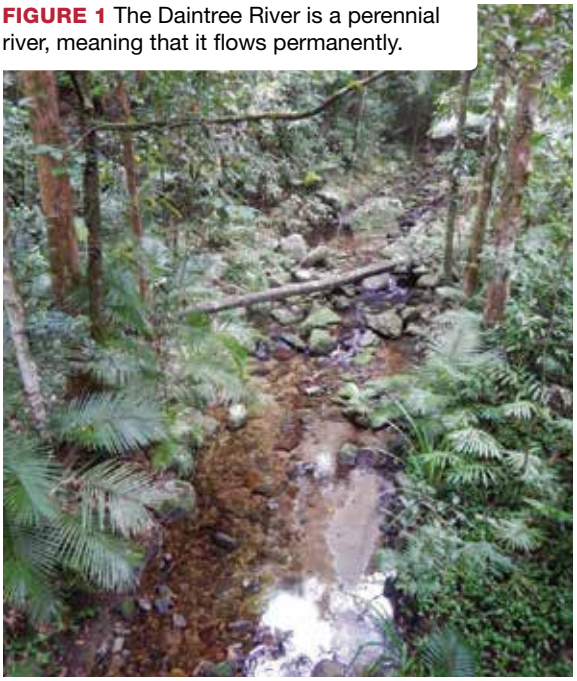
Watch this video
Of droughts and flooding rains
Searchlight ID: eles-1617

14.2 Where are Australia's water resources?

14.2.1 Australia's rivers and lakes

The amount of water on Earth has not changed since the beginning of time; there is only a finite, or fixed, amount. The water used by ancient and extinct animals and plants millions of years ago is the same water that falls today as rain. The amount of water cannot be increased or decreased. It is cycled and recycled, and constantly changes its state from gas, to liquid, to solid and back.

FIGURE 1 The Daintree River is a perennial river, meaning that it flows permanently.



Water is a resource. Like any other resource, it has no value in itself, but has great value when a use is found for it. Environments where water is found are also a resource. A river can be the site of a settlement that provides transport as well as food. A riverine environment that includes fish, birds, wildlife, wetlands, plants and micro-organisms is also valuable as a living system and can therefore be regarded as a resource.

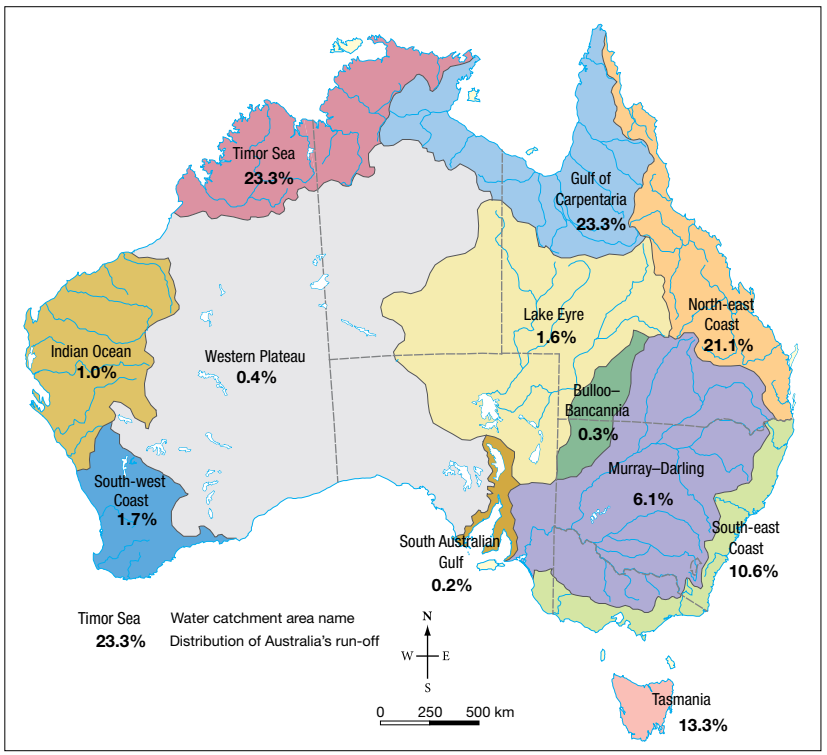
Australia has limited freshwater resources.

Australia's rivers

Rivers can be either perennial (permanent flow) or non-perennial (only flow at certain times, usually seasonally). Many rivers in Australia are non-perennial, particularly in drier parts of the continent. Only a small proportion of rainfall received makes its way into river systems, and as a result the flow of rivers in Australia is extremely variable.

The area of land which contributes water to a river and its tributaries is called a drainage basin. Major drainage basins (large catchments) in Australia are shown in figure 2. The major rivers in Australia are shown in the table below.

FIGURE 2 Australia's drainage basins



Source: MAPgraphics Pty Ltd Brisbane

TABLE 1 Major rivers in Australia

Major rivers	States
Murray–Darling	New South Wales, South Australia, Victoria
Murrumbidgee	New South Wales, Australian Capital Territory
Lachlan	New South Wales
Cooper	Queensland, South Australia
Flinders	Queensland
Diamantina	Queensland, South Australia
Gascoyne	Western Australia
Goulburn	Victoria

Australia's lakes

Australia's largest lakes are Lake Eyre and Lake Torrens. Generally, Australia's lakes do not hold much water compared to lakes found elsewhere around the world.

FOCUS ON FIELDWORK

How does water flow around your school?

Prepare a tour of your school site that includes a visit to a grassed area and a location that has little or no vegetation covering.

Field site 1: Grassed area

1 Photograph your field site
2 Gently pour water onto a grassed surface area. Record and observe what happens to the water flow.
3 Scoop a small sample of the soil into the jar and shake it.

Field site 2: Area with little or no vegetation

1 Photograph your field site
2 Gently pour water onto an area with little or no vegetation. Record and observe what happens to the water flow.
3 Scoop a small sample of the soil into the jar and shake it.
4 Describe the difference in water run-off and infiltration between the two field sites.
5 Annotate your photographs from your fieldwork demonstrating water movements, pooling and areas of infiltration.
6 Describe and explain the characteristics of the soil samples from your field sites. You may comment on moisture, soil texture, the location where the sample was collected.
7 Predict how the water movements may change with a surface that is already wet.
8 In a catchment, heavy rainfall creates fast-flowing and murky water flow. What do you think the impact of this will be?

ACTIVITIES

IDENTIFY

1 What is a drainage basin?
2 What is the difference between perennial and non-perennial rivers?
3 Locate significant rivers in Australia including the Burdekin, the Hunter, the Daly, Victoria, the Gascoyne, Ord, Fitzroy, Leichhardt, Tamar and Derwent.

EXPLAIN

4 Choose one of the rivers listed in question 3, or in the table. Create a multimedia presentation that follows the flow of the river from its source to the mouth of the river. Describe the size of the river, ***environments*** it passes through, settlements and important features along the river.

INVESTIGATE

5 Visit the **Australian Groundwater Explorer** weblink in your eBookPLUS.

You can manoeuvre around the map and zoom in and out using just buttons on the map.

In the left-hand column you can select the information you would like displayed on the map as different map layers. Click on the boxes to choose the layer you want to display. Explore the location of river regions, groundwater management areas and sedimentary basins.

Along the top of the map you can see a range of icons that give you extra functionality.

Write a summary of the location of Australia's groundwater resources.

eBookplus

Weblink
Australian Groundwater Explorer

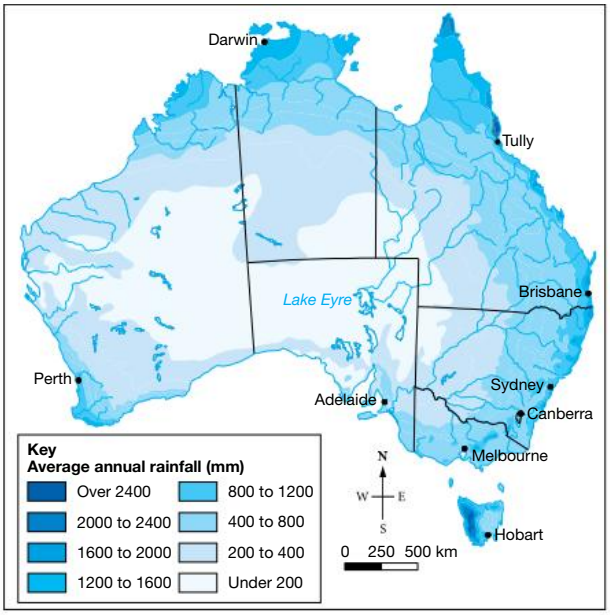
14.3 How does Australia's climate affect water availability?

14.3.1 Dry, variable and evaporated

Australia's **climate** is the most important factor affecting how much water is available for drinking, use by humans, for plant growth, in river flows and a range of other purposes. Australia is the driest inhabited continent (only Antarctica is drier), and there is very little fresh water available for our use. Rain falls unevenly across the country and from season to season.

climate long-term weather patterns in an area

FIGURE 1 The amount of rain that falls in Australia varies from place to place, as this rainfall map shows.



Source: Spatial Vision

The driest part of Australia is around the Lake Eyre Basin, and the wettest locations are places in north-east Queensland and western Tasmania. Rainfall is also highly variable, meaning that the amount of rainfall can vary or change from year to year. For example, one year a location might have very high rainfall, the next year it might have very low rainfall, and the following might be an average year.

rainfall variability the change from year to year in the amount of rainfall in a given location

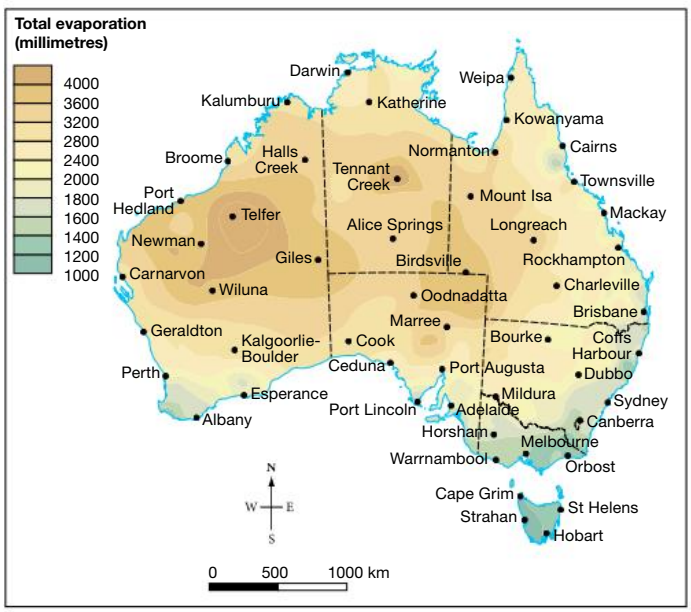
Rainfall variability is the way rainfall totals in a given area vary from year to year. For example, if an area has low rainfall variability, it means rainfall will tend to be fairly consistent from one year to the next. Many coastal areas show this kind of rainfall pattern. In contrast, high rainfall variability means rainfall is likely to be irregular from one year to the next; there may be heavy rainfall in some years and little or no rainfall in others. Desert areas in central Australia tend to have low rainfall and high rainfall variability.

Australia's seasons result in variations in rainfall. In northern Australia a wet season is experienced from November to April, and a dry season from May to October. Some parts of southern and south-western Australia experience winter rain peaks. Rainfall is more evenly distributed throughout the year in most parts of Australia.

Another problem for Australia is that most of its rainfall does not end up in rivers; much of it evaporates. Of all the water carried by the world's rivers, Australian rivers contain only one per cent of that total — even though Australia has five per cent of the world's land area. On average, only 10 per cent of our rainfall runs off into rivers and streams or is stored as groundwater. This figure drops to 3 per cent in dry areas and rises to 24 per cent in wetter places. The rest evaporates, is used by plants, or is stored in lakes, wetlands or underground storages. Areas in central Australia are very dry and, as a result, have high **evaporation** rates. Coastal areas have lower evaporation rates because they are close to the sea.

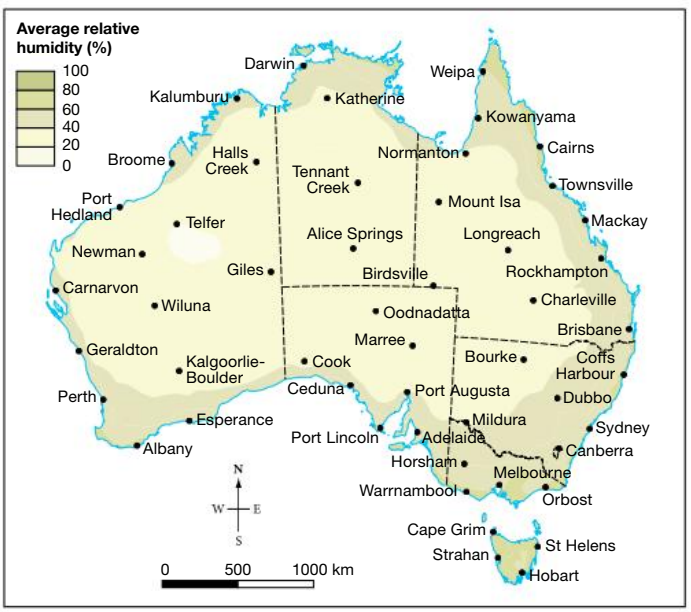
evaporation the process by which water is converted from a liquid to a gas and thereby moves from land and surface water into the atmosphere

FIGURE 2 Average annual evaporation, Australia



Source: Spatial Vision

FIGURE 3 Average relative humidity across Australia



Source: Spatial Vision

Relative humidity is a measure of the air's moisture content expressed as a percentage of the maximum moisture the air can contain at a certain temperature. Keep in mind that warm air can contain more moisture than cool air. Relative humidity does not measure the exact amount of moisture in the air because that depends on air temperature. For example, if Brisbane has a day of 30 °C and Melbourne has a day of 15 °C, and the relative humidity in both places is 60 per cent, there will be much more moisture in the air in Brisbane than in Melbourne.

Relative humidity tends to be higher in coastal regions, as is rainfall. Relative humidity tends to be higher in the parts of Australia that have very high rainfall, such as north Queensland and western Tasmania.

relative humidity the amount of moisture in the air

FOCUS ON FIELDWORK

Weather conditions

In small groups, without looking directly at the sun, observe the atmosphere above your school over a period of 5 days.

- Measure and record the temperature of the air using a thermometer.
- Measure and record wind direction.
- Estimate the percentage of the sky covered by cloud.
- Create a cloud identification chart or use the **Cloud identification** weblink in your eBookPLUS to help you identify the cloud type.

Prepare and complete a table like the one below to record your findings.

Date	Time	Air temperature (°C)	Wind direction	Cloud cover (%)	Cloud type

1 Is there a pattern that emerges from your findings?
2 Why do you think this may be the case?

eBookplus

Interactivity
Hot and dry
Use this interactivity to learn more about the interconnection between rainfall and evaporation in Australia.
Searchlight ID: int-3081

Weblink
Cloud identification

ACTIVITIES

IDENTIFY

1 Which two regions receive the most rainfall in Australia?
2 Which two regions receive the least rainfall in Australia?
3 Which region has the most variable rainfall?
4 What is rainfall variability?
5 What is relative humidity? Use figure 3 to find the relative humidity of the ***place*** where you live.

EXPLAIN

6 Why does Australia have high evaporation rates?
7 Study the rainfall, humidity and evaporation maps. Fill in the missing word in the following statements in order to describe the ***interconnections*** between these features of our climate.
Areas with low rainfall and low humidity tend to have a _____ evaporation rate.
Areas with high rainfall and high humidity tend to have a _____ evaporation rate.

INVESTIGATE

8 Find the ***place*** where you live on the map of Australia. Study the three maps in this section and complete a table like the one below. Compare where you live with another ***place*** in your state or territory and a place a long way from where you live.
9 Find out the average rainfall for Lake Eyre and the wettest locations and heaviest rainfalls in north-east Queensland and western Tasmania. Record the rainfall variability, evaporation and relative humidity. What differences are there between these locations?
10 Australia has high evaporation rates and high rainfall variability. List all the ways that this ***environment*** makes water delivery to people a challenge.

	Average rainfall	Rainfall variability	Average annual evaporation	Relative humidity
Where I live: _____				
Another place in my state/territory: _____				
A place far from where I live: _____				

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. **› Australia: weather and climate**

14.4 What differences are there in water availability globally?

eBookplus

Weblink
Planet Earth, fresh water

drainage basin the entire area of land that contributes water to a river and its tributaries

14.4.1 Where is the world's water?

Water is not evenly distributed around the world, and is not equally available at all times. Many areas of the world have inadequate water supply to address the needs of the population. Many places have high annual rainfall averages meaning that they have periods with high rainfall and high water availability, and other periods of low rainfall and low water availability. Nearly 70 per cent of the world's fresh water is stored in glaciers and ice caps, and as a result is not readily available for human use.

FIGURE 1 The biggest swimming pool in the world, in Algarrobo, Chile

The factors that have an impact on water availability are latitude, altitude, ocean currents, distance from the sea, geology, topography and climate change. This is discussed in subtopic 12.8. Use the **Planet Earth, fresh water** weblink in your eBookPLUS to find out more about water.

14.4.2 The world's largest swimming pool

The constructed lagoon in San Alfonso del Mar resort, Algarrobo, Chile, measures 1013 metres (just over one kilometre) in length, covers an area of eight hectares and holds 250 000 cubic metres of water — 100 times more than an Olympic-size swimming pool.

14.4.3 The world's largest freshwater river

The Amazon River in South America is the second longest river in the world and is by far the largest by water flow. It has the largest **drainage basin** in the world and approximately one-fifth of the world's total river flow.

FIGURE 2 The river with the world's greatest water flow is the Amazon River.

The **discharge** from it is about 7000 cubic kilometres every year, or 219 million litres of water every second. In contrast, Australia's largest river in terms of water flow, the Mitchell River, discharges an average of only 12 cubic kilometres each year.

discharge the volume of water that flows through a river in a given time

14.4.4 The waterfall with the most water

The flow rate at Niagara Falls' main falls has been measured at around 2.6 million litres per second — enough water to fill an Olympic swimming pool in about one second.

14.4.5 The place on Earth with the most rainy days

The wettest place in the world (based on the average number of rainy days received each year) is Mt Wai'ale'ale in Hawaii. The summit is 1569 metres above sea level and receives over 350 days of rain each year. Mt Wai'ale'ale records an average of up to 13 000 millimetres of rain per year. In some years, rain has been known to fall for 360 days per year!

14.4.6 The wettest place in the world

The wettest place in the world (based on the yearly average total) is Mawsynram, India, which receives an average of 11 870 millimetres (nearly 12 metres) of rain each year. It has a subtropical highland climate with a long monsoon season.

14.4.7 The biggest dam

The Three Gorges Dam in China is the world's largest dam and hydro-electricity plant.

FIGURE 3 Niagara Falls

FIGURE 4 Mt Wai'ale'ale averages over 350 rainy days each year.

FIGURE 5 Women in the potato fields of Mawsynram wear rain protection made of leaves and cane.

FIGURE 6 The Three Gorges Dam produces the most hydro-electricity in the world.

14.4.8 Where is the highest number of desalination plants in the world?

Places with little water often build desalination plants to convert sea water to fresh water. The Persian Gulf has the highest number of desalination plants in the world, with Saudi Arabia the world's largest producer.

FIGURE 7 Al-Jubail, the largest desalination plant in the world, is located on the Persian Gulf in Saudi Arabia.

eBookplus

Weblink
Iguazu Falls

ACTIVITIES

IDENTIFY

1 Use the **Iguazu Falls** weblink in your eBookPLUS to watch the first half of a video about these falls.
   - **a** Where are the Iguazu Falls located?
   - **b** How wide are these falls?
   - **c** How much water flows over the falls each second when they are in flood?
   - **d** What is the size or ***scale*** of the flooded area of the Parana River?

EXPLAIN

2 How many Olympic-sized swimming pools would fit into the world's largest swimming pool? Find its location on Google Earth or in an atlas.

INVESTIGATE

3 Conduct some research to find the location and name of the longest river in the world and the river with the second-highest discharge.

4 How much does it rain where you live? How does this compare with the wettest place in the world?

5 Use a blank outline world map to locate the ***places*** mentioned in this section. Annotate your map with the water facts for which each ***place*** is famous.

6 Climate maps give you clues about why each location holds amazing records. Look at your atlas and match the location of the ***places*** with these facts. Make a list of the geographic features that contribute to each amazing fact.

7 Conduct some research to find the following information: the ***place*** in the world where the most rain fell in a single 24-hour period; the ***place*** in Australia that has the record for the wettest year; the wettest town in Australia. Compare each of these with where you live.

14.5 Does everyone have enough water?

14.5.1 The human right to water

Access to water is a human right that is protected by many international agreements, yet not everyone has access to this life-giving resource.

Everyone has the right to enough safe, accessible and affordable water for all their needs. Water is more important to survival than food. In hot conditions, a person can survive up to three weeks without food but only two or three days without water.

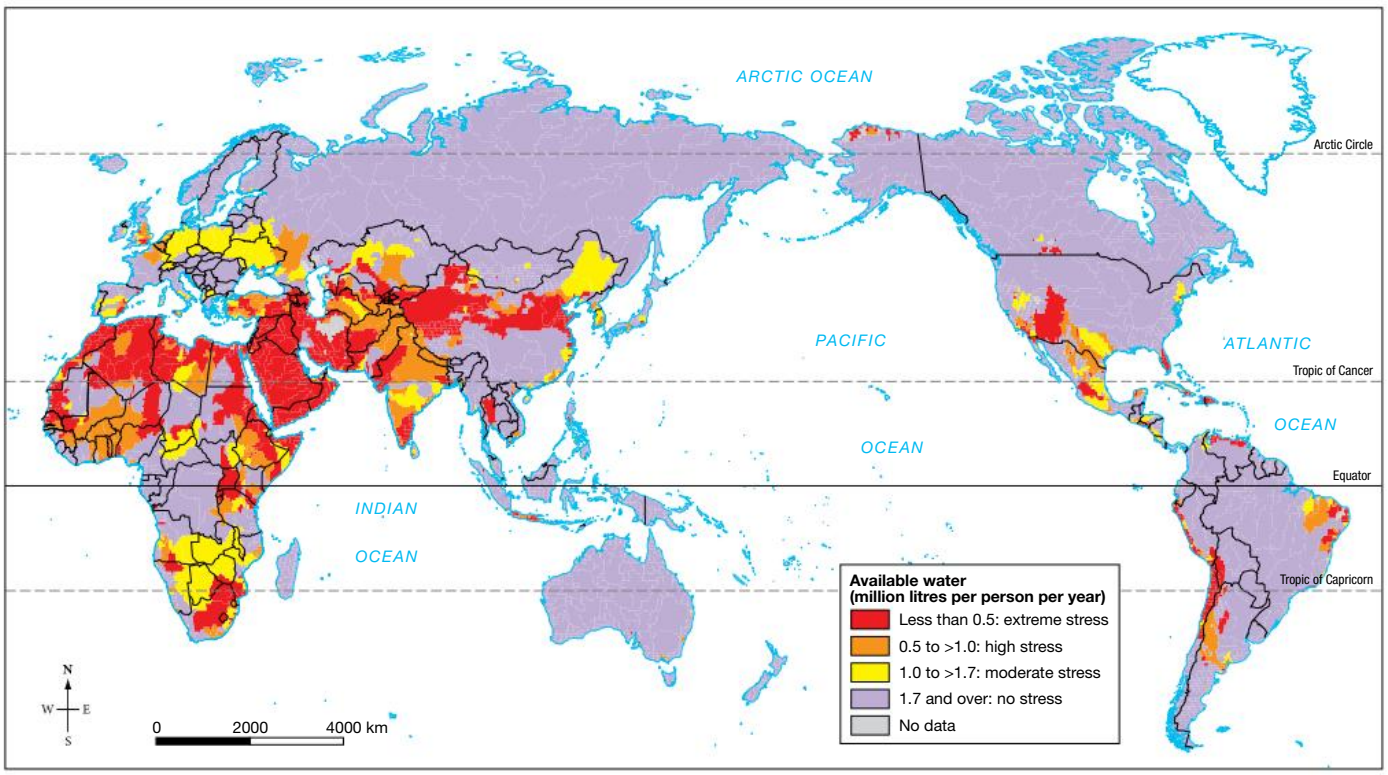
People need access to **improved drinking water**, yet over 880 million people use unclean drinking water. Water is also needed to cook food, to bathe, to wash dishes and clothes, and to flush toilets. However, with the global population increasing and a fixed amount of water on Earth, some regions are suffering water scarcity. Water scarcity occurs when the demand for water is greater than the available supply.

Ideally, each individual needs one cubic metre (1000 litres) of drinking water per year, about 100 cubic metres for other personal needs, and 1000 cubic metres to grow all the food that he or she consumes. **Water stress** occurs when there is not enough water available for all demands. A country with less than 1000 cubic metres of renewable fresh water per capita (per person) is under water stress.

improved drinking water water that is safe for human consumption

water stress a situation that occurs when annual water supplies drop below 1700 cubic metres of renewable fresh water per person

FIGURE 1 Global fresh water availability

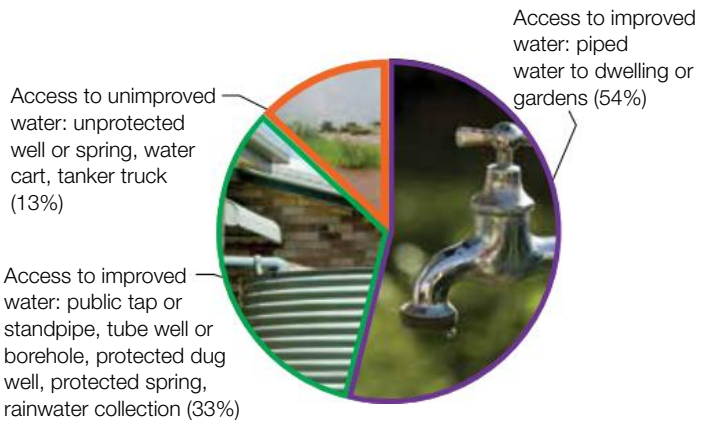


Source: Spatial Vision

Around 1.1 billion people have inadequate access to water. A major reason for this scarcity is the difference between where people live and where rain falls. Other reasons include water being used for agriculture and industry in regions where it is dry, and water being so polluted it cannot be used.

By 2025, it is estimated that two billion people will be living in regions where there is not enough water. The problem of lack of water is often worse in rural areas, so many people move from the countryside into towns and cities, hoping for a better water supply. These people are sometimes called water refugees. However, the water in some cities is also inadequate because it is in short supply or is very polluted.

FIGURE 2 Some people have access to cleaner water than others.



14.5.2 The water carriers

People who do not have water at home have to travel to get water. Water is very heavy and difficult to carry. The burden of this water-fetching usually falls on women, who carry the heavy load on their head or back. For some people, the trip to a water supply and back can take hours each day. The average distance that women in Africa and Asia walk to collect water

is six kilometres. The average weight they carry on their heads is about 20 kilograms — the usual weight of a suitcase taken on a flight. The World Health Organization estimates that over 40 billion work hours are lost each year in Africa alone, just collecting drinking water.

Use the **Burden of thirst** weblink in your eBookPLUS to watch a video about water scarcity in East Africa.

eBookplus

Weblink
Burden of thirst

FIGURE 3 Drought conditions can reduce water quantity and quality.

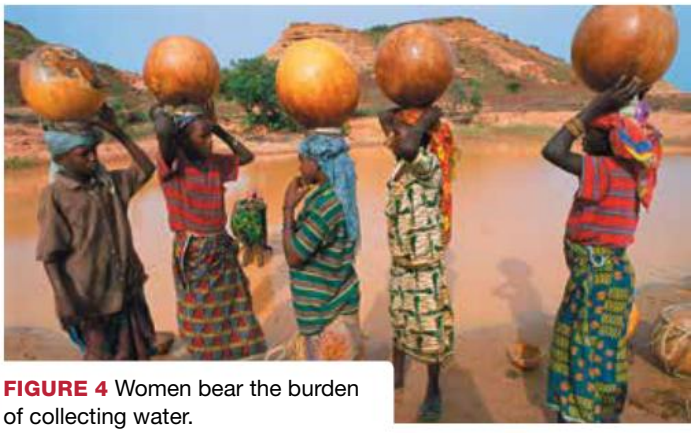


FIGURE 4 Women bear the burden of collecting water.

GEOskills TOOLBOX

Interpreting a pie graph

A pie graph is a circular diagram that has been divided into slices. The diagram shows data for a particular topic; for example, the total fresh water available globally. Each slice in the graph represents a proportion of the whole. Examine SkillBuilder 14.6 'Constructing a pie graph' in your eBookPLUS.

Examine figure 5.

1. State the proportion of women who collect and carry water in Africa.
2. State the proportion of children who collect and carry water in Africa.
3. Suggest reasons why a larger proportion of women and girls collect and carry water than men and boys.

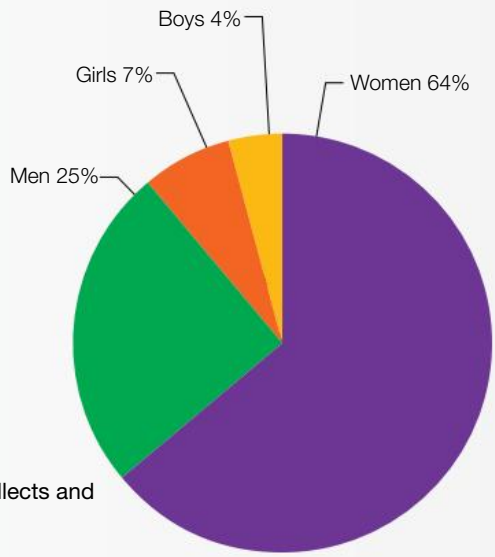


FIGURE 5 Who collects and carries the water?

ACTIVITIES

IDENTIFY

1. Why is access to water a human right?
2. Define the terms *water scarcity* and *water stress*.

EXPLAIN

3. Outline the difference between improved and unimproved water supplies.
4. Describe the impact on a country if it is under water stress or water scarcity.
5. There is a difference in water quality across Australia. Is your water supply 'improved'? Explain.
6. What might be meant by the term *water refugee*?

INVESTIGATE

7. Study figure 1. Name three countries that are water stressed and experience water scarcity.
8. Geographers like to look at patterns over ***space***. Find an atlas map showing population density and compare it with figure 1. Refer to countries in North Africa and West Asia in your answers. (Refer to the 'Regions' resource in your eBookPLUS.)
   a. Name three countries that have high population densities and are under water stress.
   b. Name three countries that have high population densities and are experiencing water scarcity.

c Name countries with low population densities experiencing water stress or scarcity.

Use figure 1 to describe water scarcity in North Africa.

APPLY

9 Study figure 5. Women are the main water carriers in ***places*** where there is water stress and scarcity. Discuss with another student how this would affect a woman's health, education, family life and food production. Draw a consequence map of your ideas.

10 Describe what the impact would be on the lives of women and children if there was a well with clean water in every village or town.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.

- The Dead Sea — overcoming water scarcity
- Russia and Eurasia

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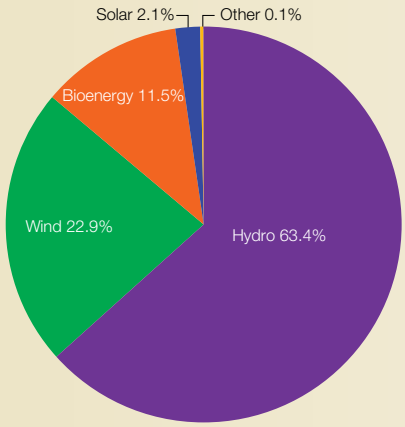
14.6 SkillBuilder: Constructing a pie graph

What is a pie graph?

A pie graph, or pie chart, is a graph in which slices or segments represent the size of different parts that make up the whole. The size of the segments is easily seen and can be compared. Pie graphs give us an overall impression of data.



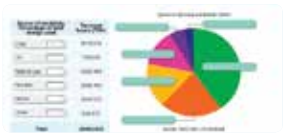
eLesson

Watch this video to learn how to construct a pie graph.

Searchlight ID: eles-1632

Interactivity

Try this interactivity to learn how to construct a pie graph.



Searchlight ID: int-3128

14.7 What is water scarcity?

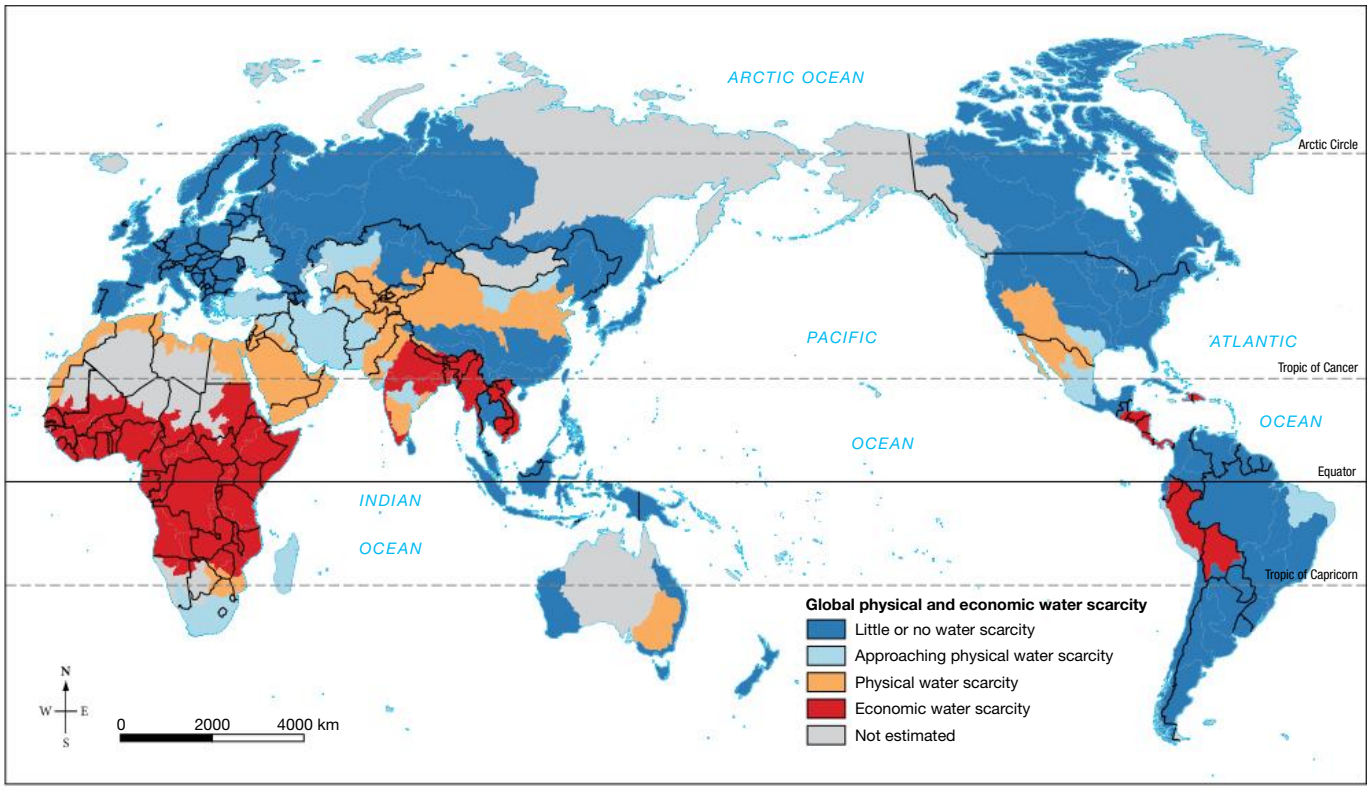
14.7.1 What are the causes of water scarcity?

Water scarcity is when a large group of people, over a long period of time, do not have access to safe, affordable water to be able to satisfy their needs for drinking, washing or their livelihoods. Globally, 1.1 billion people lack access to water and 2.7 billion find water scarce for at least a month a year. Water is vital for drinking, sanitation and food production. Water use is increasing at more than twice the rate of global population growth, and an increasing number of regions are experiencing chronic water shortages. Unsustainable use of water has resulted in stressed water systems, the drying up of lakes, aquifers and rivers, and the disappearance of over a half of the world's wetlands.

water scarcity when annual water supplies drop below 1000 cubic metres per person. *Absolute water scarcity* describes the situation when annual water supplies drop below 500 cubic metres per person.

There are two main types of water scarcity — physical and economic. Economic water scarcity results from a lack of investment in water-related infrastructure. Physical water scarcity refers to when water is not abundant enough to meet all demands.

FIGURE 1 Global physical and economic water scarcity



Source: International Water Management Institute (IWMI)

GEOskills TOOLBOX

Choropleth maps

A choropleth map uses shading and colour to show the spatial patterns of a particular theme; for example, water scarcity. It usually shows numerical data and often uses darker shades to represent abundance and lighter shades to show less of a measurement. Refer to SkillBuilder 14.8 'Reading and describing basic choropleth maps' in your eBookPLUS.

Refer to figure 1 above.

1 Describe the areas affected by little or no water scarcity.
2 Explain why these areas might have little or no water scarcity.
3 Describe the regions most affected by economic water scarcity.
4 Why do you think these regions are likely to be affected by this type of water?

Uneven distribution of water resources occurs naturally. As discussed in chapter 12, factors such as latitude, altitude, ocean currents, distance from the sea, geology and topography naturally have an impact on the amount of water available in certain places. Places that receive less rainfall are more likely to suffer from water vulnerability or water scarcity.

There is also a range of human uses that contribute to water vulnerability and water scarcity.

FIGURE 2 Water scarcity has an impact on both landscapes and environments, as seen in this mangrove area.

Population

Over 40 per cent of the world's population live in river basins that are under stress, and this is likely to increase as the world's population increases. Further pressure on local water supplies will result as people withdraw more water and pollution increases.

Agriculture

Agriculture consumes around 70 per cent of the world's accessible fresh water. Due to inefficiencies and leaky irrigation systems much of this water is wasted. Many irrigation systems draw on groundwater to supplement supplies and, as a result, many of these groundwater sources are being used at unsustainable rates and are being depleted. Farmers also use fertiliser and pesticides to help their crops grow and to reduce pests; however, when these chemicals make their way into local waterways, this can further reduce the amount of potable fresh water available.

Energy production

Every year 580 billion cubic metres of fresh water globally is used in energy production. This equates to about 15 per cent of the world's fresh water. Water is used to cool thermal power plants, in drilling and refining processes, and rivers can be diverted for hydro-electric schemes. This use can threaten both quantity and quality of water supplies. If power plants are built in areas with limited water resources, this can have direct impact on water availability for local communities. If water is used in processing, it can result in the creation of polluted water known as slurry.

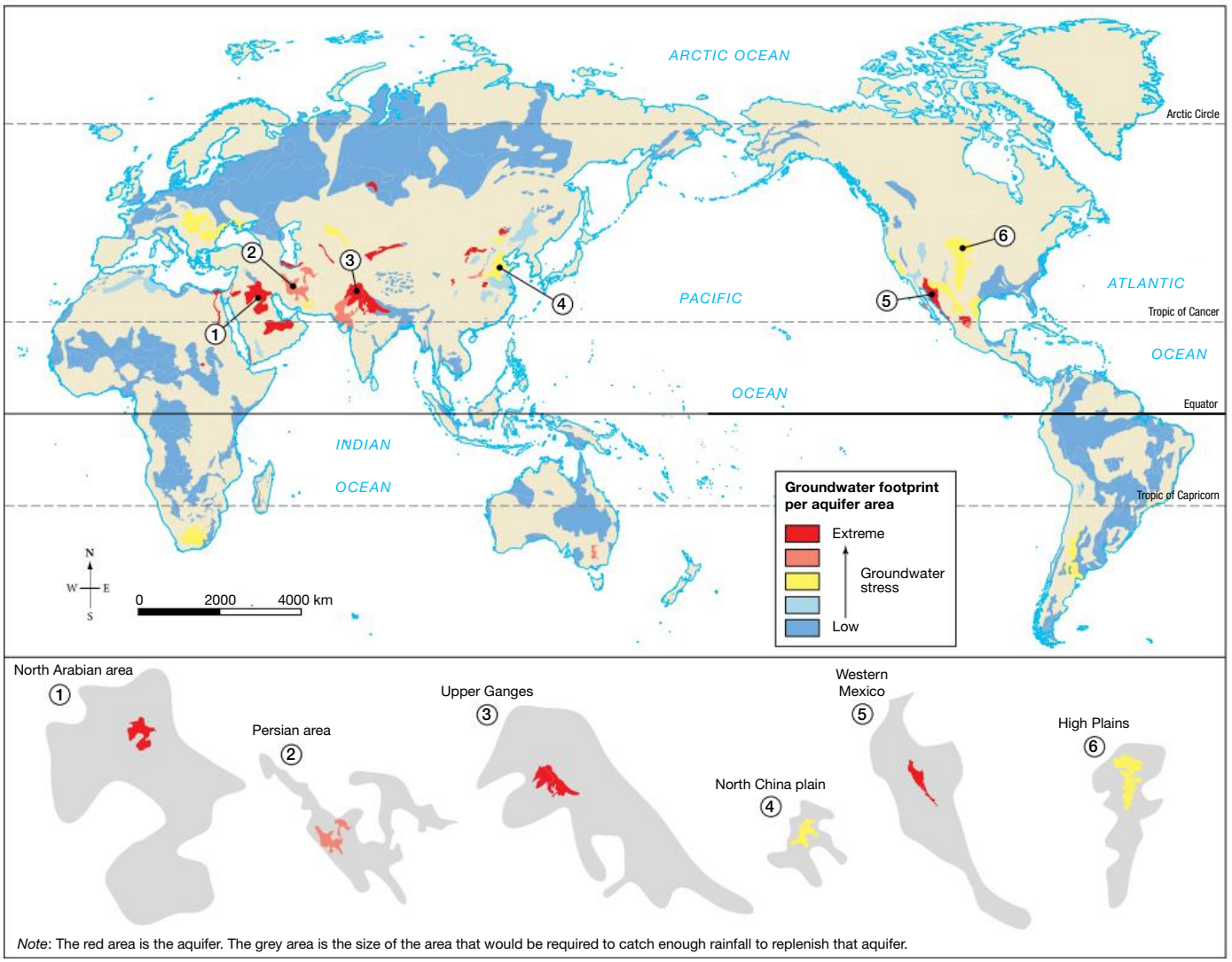
Climate change

Climate change is expected to drastically modify weather patterns, and result in an increasing number of droughts and floods in particular areas. This will make seasonal predictions and crop planning more difficult. The disappearance of glaciers and pack ice will restrict water availability in downstream communities. Based on the existing climate change scenario, it is anticipated that by 2030 half of the world's population will live in areas of high water stress. The impact of climate change on water availability will disproportionately impact on equatorial regions that rely heavily on water received from rainfall rather than irrigation for agriculture.

Ownership

There is concern regarding the sale of long-term water rights to investors along with the sale of land in some African countries such as Mali and Sudan. This jeopardises water access for local farmers, traditional water users and downstream users.

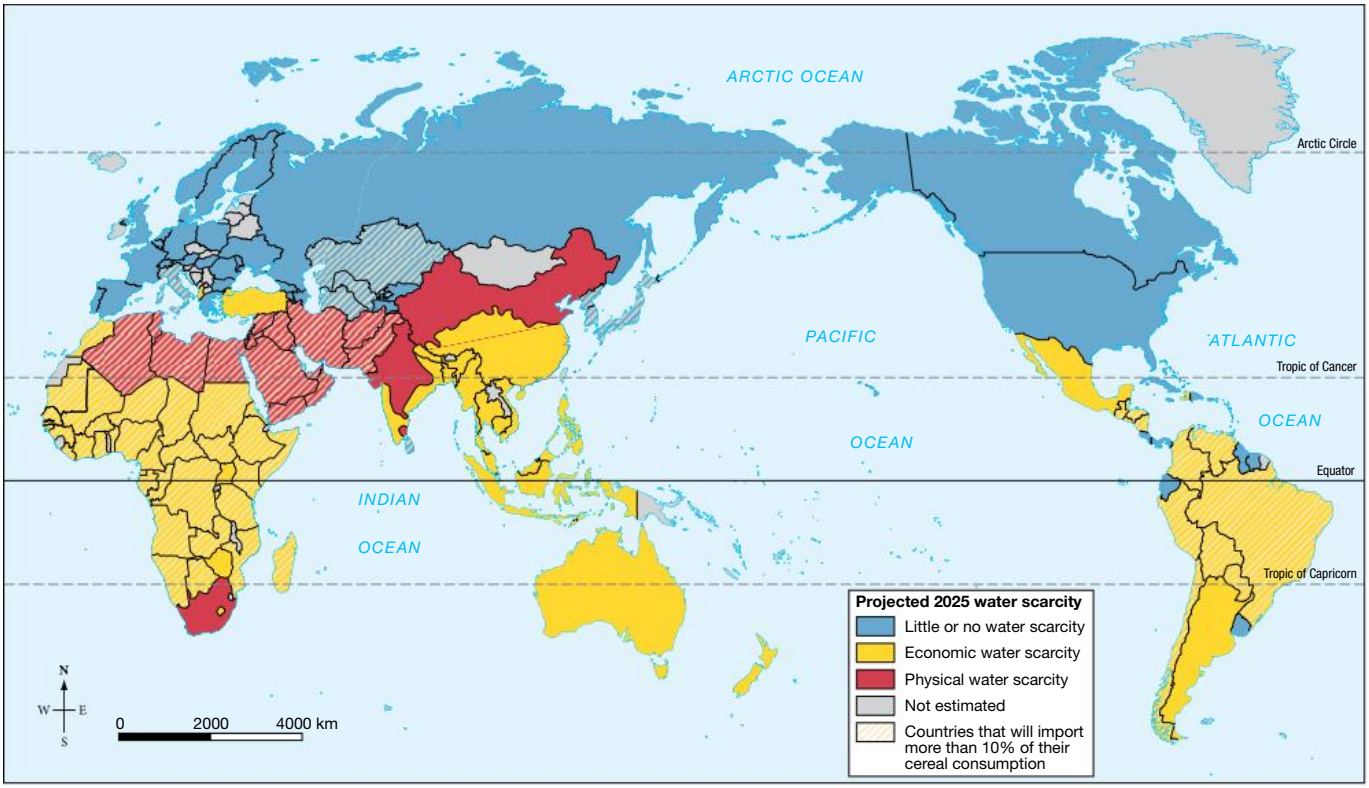
FIGURE 3 Global areas of groundwater stress



Note: The red area is the aquifer. The grey area is the size of the area that would be required to catch enough rainfall to replenish that aquifer.

Source: BGR & UNESCO 2008: Groundwater Resources of the World 1 : 25 000 000. Hannover, Paris.

FIGURE 4 Global projected water scarcity



Source: Spatial Vision

FIGURE 5 Individuals and communities are affected by water scarcity in Kathmandu.

ACTIVITIES

IDENTIFY

1 What is the difference between water scarcity and water stress?
2 What is the difference between physical water scarcity and economic water scarcity?

EXPLAIN

3 Why are there differences in water availability naturally? How do these factors result in water scarcity?
4 What is the link between water scarcity and population growth?

APPLY

5 Create a flow chart that shows how water scarcity impacts on the quality of life of people affected.
6 Examine figure 6, a cartoon on water scarcity. Describe how this demonstrates the unequal impacts of water scarcity on different regions and communities.
7 Draw your own cartoon or illustration showing the impact of water scarcity on communities or individuals.

FIGURE 6 Difference in access to water globally

PREDICT

8 How will climate ***change*** affect water scarcity in the future?

INVESTIGATE

9 Research a region or country that is likely to experience water scarcity as a result of climate ***change***. Explain the impact this will have on the quality of life of people, the economy of the region or country, and the ***environment***.

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14.8 SkillBuilder: Reading and describing basic choropleth maps

What is a basic choropleth map?

A basic choropleth map is a shaded or coloured map that shows the density or concentration of a particular aspect of an area. The key/legend shows the value of each shading or colouring. The darkest colours usually show the highest concentration, and the lightest colours usually show the lowest concentration.

eLesson

Watch this video to learn how to read and describe a basic choropleth map.

Searchlight ID: eles-1706

Interactivity

Try this interactivity to learn how to read and describe a basic choropleth map.

Searchlight ID: int-3286

14.9 What strategies can address water scarcity?

14.9.1 United Nations

In 2000, the United Nations Millennium Development Goals were set to reduce extreme poverty. Some of the targets set related to improving access to water. While 11 per cent of the world's population are still without access to safe drinking water, between 1990 and 2015 2.6 billion people gained access to improved drinking water. This was achieved through the provision of piped water supplies and protected wells. One of the Sustainable Development Goals, developed in 2015, aims to provide universal access to water and sanitation by 2030.

14.9.2 Role of governments

Governments are responsible for some of the practical management of water sources to reduce the severity of water scarcity. To achieve this, they need to create and enforce laws and fund institutions to regulate water use. Governments need to listen to the views and take into account the needs of different stakeholders such as local residents and businesses, and monitor the needs of the environment. They have to manage conflict between different groups over water use; coordinate water management across boundaries; and ensure that management zones take into account natural boundaries, such as catchments, to ensure effective management.

Governments may fund innovations in water management such as recycling, purification, 3D modelling and simulations, screens to separate salt water and fresh water, and desalination.

14.9.3 Role of non-government organisations

Non-government organisations (NGOs), such as The Water Project, provide training and finance for construction of water projects for communities in sub-Saharan Africa. This involves activities such as digging wells, constructing dams, protecting springs and water filtration.

Environmental NGOs like the World Wide Fund for Nature (WWF) undertake small-scale local projects to measure water use and the impacts of this use on river basins. They provide funding to advance the science of water conservation and promote methods of sustainable water use.

14.9.4 Role of communities

The ability of communities to address water scarcity is limited by access to funding and the much larger government structures in place. Communities can ensure that they have effective local government representation so that they are able to voice their concerns. They can collaborate with competing stakeholders to try to bring about equitable access to existing water sources.

FIGURE 1 Young children in Zambia travel many miles to fetch water for their families.

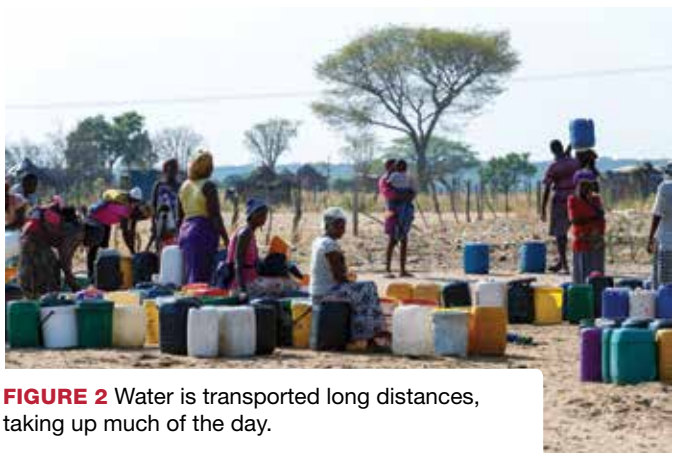


FIGURE 2 Water is transported long distances, taking up much of the day.

14.9.5 Role of individuals — what can you do?

It is generally very difficult for people in water-scarce areas to address water scarcity and options are often limited. They may be forced to drink contaminated water, or use water from the same sources that animals use to drink and bathe. Individuals and communities may become involved in conflict in their fight to maintain access to water sources. Individuals can improve their access to water by fixing leaks in pipes and taps, and reducing pollution of local water sources.

Individuals in more developed countries with abundant water sources are much more able to reduce their water consumption. They can do this by using water-efficient appliances and taps, using water-efficient methods of cooking, and reducing the use of running water in cleaning food, brushing teeth and rinsing dishes.

FOCUS ON FIELDWORK

Monitor water use at home

Locate your council water meter. If you live in an apartment or duplex, this may be on common property. As water flows through the meter it will register water usage. Measure your household water usage each day over a period of a week. For consistency, try to take the measurements at the same time each day. Note any differences in your household each day; for example, extra or fewer people.

Develop a way of recording and displaying your results and observations.

1. What was the average daily water use for your household over the measurement period?
2. What factors do you think contributed to differences in daily water usage?
3. Are there any strategies you could put in place to significantly reduce water usage in your home?
4. Research the average daily water use in five different countries. How does your average daily household water use compare to water use by people in those other countries?

FIGURE 3 A water meter in a suburban garden

ACTIVITIES

IDENTIFY

1. What proportion of the world's population is still without access to safe drinking water?

EXPLAIN

2. Explain how the Millennium Development Goals to reduce poverty relate to addressing water scarcity.
3. Describe the importance of the role of governments in helping to address water scarcity.

INVESTIGATE

4. Research one example of how an NGO has assisted a community in improving their access to fresh water. Describe the role that the NGO played, providing statistics that show how access to water was improved, and describe the impact of these changes on quality of life within the community. Include a map showing the location of the community and the project.

14.10 How can water be managed?

14.10.1 Managing our water supply

More water cannot be created, but it can be managed better. With a growing global population, and the predicted changes due to **climate change**, the pressure on this finite resource requires a number of solutions.

climate change a change in the world's climate. This can be very long term or short term, and is caused by human activity.

Introducing effective water management can be a challenge at any scale, whether local, national or global. It needs the cooperation of all users, including farmers, industry, individuals, and upstream and downstream people in different countries or different states. With all the competing demands on water, management is often easier to approach at a local scale.

Because agriculture uses the greatest amount of water, it makes sense to make irrigation systems more efficient. The aim is to get more production for every drop of water used. Some irrigation systems waste up to 70 per cent of their water through leaks and evaporation, so changing the irrigation method can save water. Other management practices include recycling, using desalinated water, and using stormwater.

Managing water across borders

About 260 drainage basins across the world are shared by two or more countries. Thirteen river basins are shared by five or more countries. Depending on their location in the catchment, some countries can suffer reduced access to water because of other countries' usage. This shows the interconnection between places — what happens in one place affects another. Diverting rivers, building dams, taking large amounts of water out for irrigation, and creating pollution can all lead to conflict between countries, states and political groups.

FIGURE 1 Kurnell desalination plant in southern Sydney provides water to the city's population. It is powered by wind energy produced in Canberra.

FIGURE 2 The Jordan River passes through three countries, and has tributaries in the north that flow in from another two countries.

Source: Spatial Vision

Country disputes have occurred in the Nile Basin in north Africa, along the Mekong River in Asia, the Jordan River Basin in West Asia (the Middle East) and along the Silala River in South America. This can also happen within a country, which has happened with the Murray–Darling Basin in Australia, across four states and one territory.

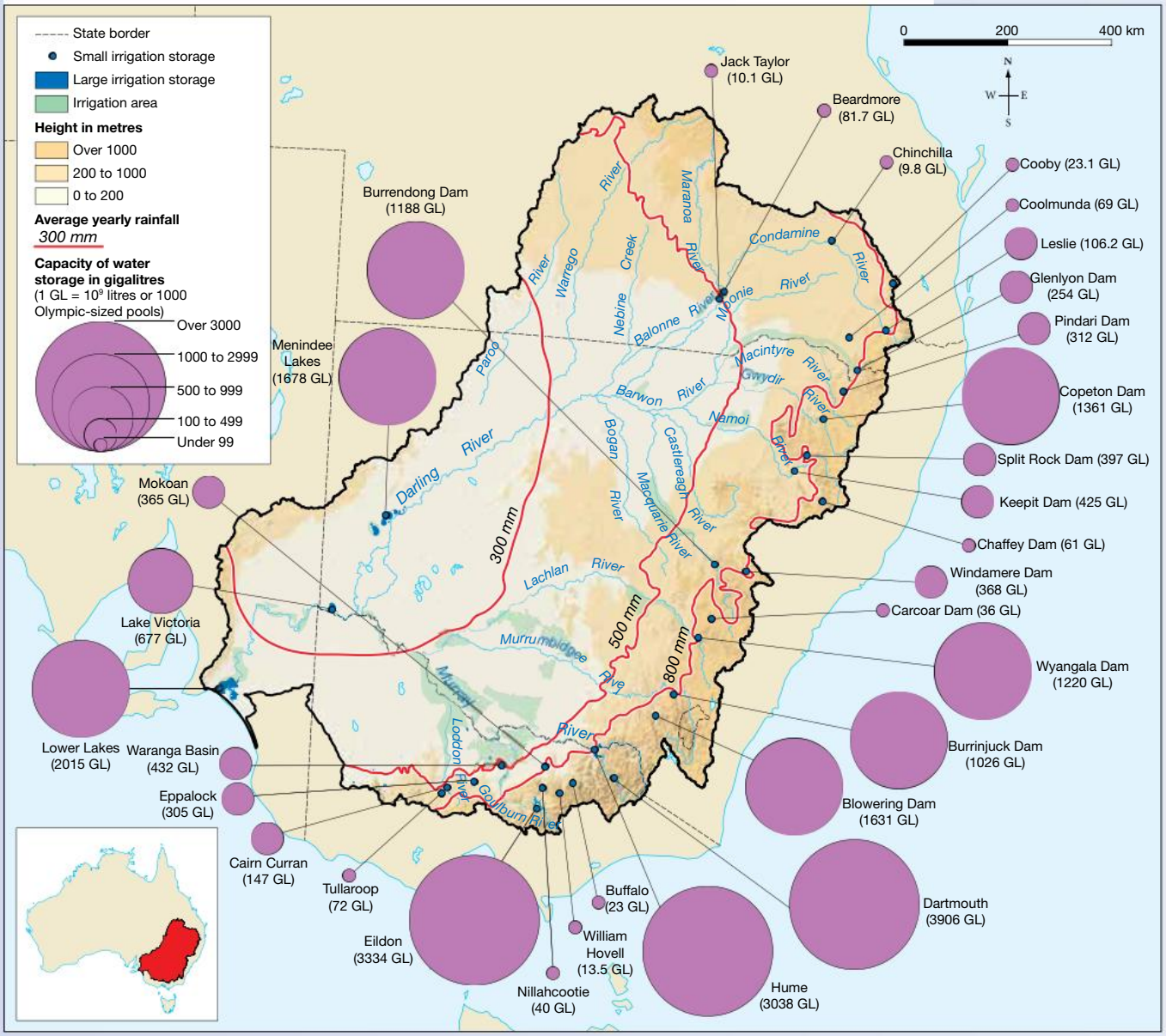
CASE STUDY

Managing water within a country: The Murray–Darling Basin

The Murray–Darling Basin (MDB) is Australia's largest catchment area, covering 14 per cent of the country's total landmass. It stretches across four Australian states (Queensland, New South Wales, Victoria and South Australia) and the Australian Capital Territory, and includes 23 separate river catchments. This is a changed system, in which water is taken out all along its length for storage in dams and use in irrigation. During long periods of drought, little water reaches the Murray mouth, often causing it to close. The Queensland floods in the summers of 2011 and 2012 provided the largest river flows for the MDB in many years.

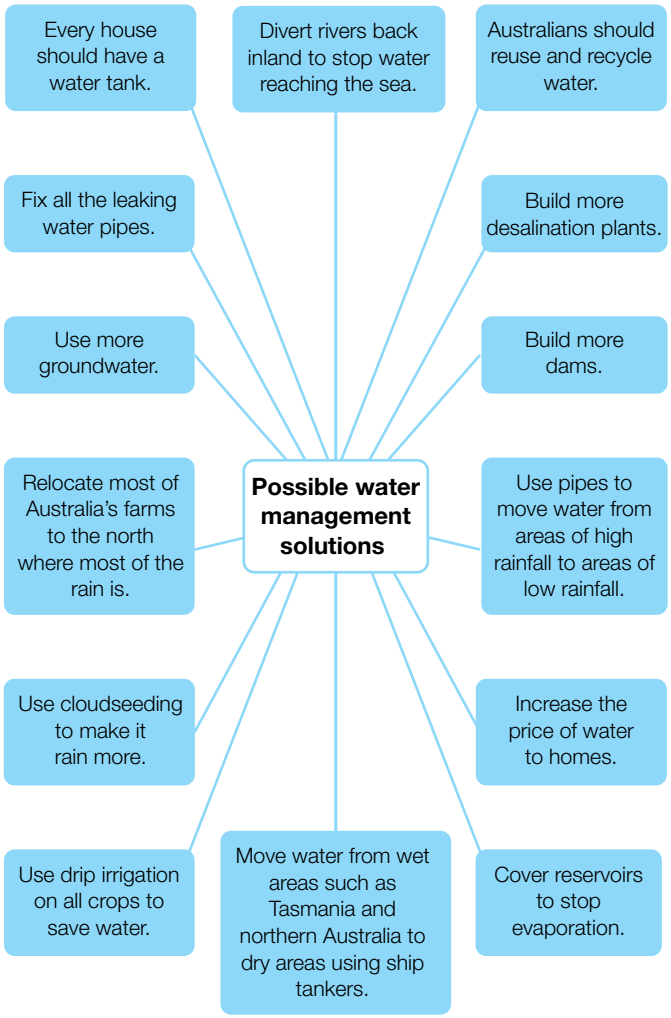
Over the years the management of this river system was the responsibility of each of the four states and the territory, resulting in a lot of conflict. In 2008, the Commonwealth Government took control of the MDB and prepared plans for how it should be managed. There is still controversy over the decisions being made.

FIGURE 3 Map of the Murray–Darling Basin. The Australian Government has been managing the basin.



Source: Spatial Vision

FIGURE 4 Possible water management solutions



Some countries sign international agreements or treaties to try to share water between nations. These include the Rhine and Danube rivers in Europe, the Nile River in north Africa, the Ganges and Brahmaputra rivers in Asia and the Parana River in South America.

Other examples of water basins that are shared by states within a country are the Colorado River and Ogallala Aquifer in the United States, and the Kaveri River in India. The Great Artesian Basin in Australia shares groundwater between Queensland, New South Wales, South Australia and the Northern Territory.

Other water management solutions for Australia

Over recent years, and especially after prolonged droughts, many different solutions have been suggested to solve our water problems. Some of these seem impractical, such as towing icebergs from Antarctica; others have generated much discussion, such as fixing all the leaking pipes in towns, cities and outback bores.

Each of the suggestions has to be considered in light of various factors: cost, impact on people, impact on the environment, technology, and politics.

14.10.2 Managing water use at home

About 50 per cent of household water in Australia is used in the garden. Inside the house, approximately 80 per cent of water used is in the shower, toilet and laundry. It is predicted that our growing Australian population will, by 2051, need nearly twice as much water as we do now.

Policy changes such as water restrictions can reduce water usage. Some restrictions include bans on hosing down driveways, washing cars with hoses and watering private lawns, and cutting back sprinkler use during the day.

The long drought experienced by Australia between about 2003 and 2010 forced many governments to offer rebates on purchases of water-saving products. Items and services included buying and installing water tanks and grey water systems; dual flush toilets; water-saving shower heads and water-efficient washing machines. People were encouraged to spend money on these in order to save water.

FOCUS ON FIELDWORK

Conducting a survey on water management

People in your local community can be a valuable source of information. Surveys are an important fieldwork tool to help you understand the perceptions or feelings of people about a particular issue. Consider what you want to know about water management in your local area. Formulate five questions to ask.

Consider how you will present the information that you collect. If you will want to create graphs, it is advisable to give your respondents options to choose from, such as multiple choices or a Likert scale (for example, a rating from 1 to 5). If you want to write paragraphs explaining your answers then you can leave the questions open — that is, where the answer cannot have a 'yes', 'no' or other singular word answer.

When you have written your survey questions, consider who you will ask and when you will approach them. If you do not feel comfortable approaching people in person, you may choose to use online survey tools and post a link to your survey online or email people directly.

When you have collected your survey data, write a summary of your findings and explain how these findings could inform decisions about water management in your local area.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.

- Salisbury Council — Aquifer storage, transfer and recovery
- Murray–Darling Basin

ACTIVITIES

IDENTIFY

1 Why is it difficult to manage water when the water supply crosses country or state borders?

INVESTIGATE

2 Conduct some further research to find out how water is being managed along the Jordan River in West Asia.

3 Investigate the use of desalination in countries in West Asia (the Middle East). (Refer to the 'Regions' resource in your eBookPLUS.)

4 Watch the video on the Murray–Darling Basin and look at the information on this region in *myWorld Atlas*. Find out about the MDB plan and how it will help manage water.

PREDICT

5 If water were oil, leaking pipes would be fixed immediately. However, there is still a perception that water is not as valuable as oil, so the same investment is not made in it. Imagine you work for an advertising company and have to convince your audience that water is more valuable than oil. Film your advertisement and use a video editing tool to create music and voiceovers. Present this to your class and your school.

APPLY

6 Use the **Catchment detox** weblink in your eBookPLUS to play the catchment-in-crisis game. See if you can manage the catchment so that agricultural, personal, industrial and environmental needs are all met.

What might be the best water solutions for Australia?

7 Study the list of possible water solutions shown in figure 4 and choose the ones that are most likely to work.

You will work in pairs to conduct some research about one of the proposed methods. There will be advantages and disadvantages for each. You will need to use the internet and libraries to find your information, and you will need to find out:

- how the solution will be carried out, including the technology that might be used
- which ***places*** in Australia are most likely to be involved and why (this might include rainfall data, Google images or maps, and photographs)
- how much it will cost and who will pay
- what impact the solution will have on the ***environment***
- what impact there will be on people
- whether there are any political implications
- where the solution will work best (shown on a map).

Presenting your information

Any data collected needs to be presented in an appropriate way. Climate data could be represented as a climate map; a satellite image or photograph could be annotated with notes; models or plans of the solution could be drawn.

Sharing your information

The class will need to share all the information found so that a decision can be made about the most probable solutions. Share via a presentation (such as a Prezi), a class wiki or blog.

Making a decision

Conduct a class vote to remove five of the 14 solutions immediately after the information sharing. Do this by writing each solution on a board and voting on each one. You will be left with nine water management solutions.

Diamond ranking activity

Use the remaining nine solutions to complete a diamond ranking. Make a copy of the nine solutions and write these on separate cards or sticky labels. Individually, use the information you shared about the solutions to rank the solutions from the most viable to the least viable from the top of the chart. It is often easier to work on the two extremes, top and bottom, and then continue working from there.

Once you have your ranking, work in groups of four. Explain why you chose the ranking and see whether each of you can agree on the same ranking. Work together as a class and discuss the solutions again and see if you can arrive at a class ranking.

Conclusion

Write a short report, and include in it the final ranking of water management solutions for Australia. Include the discussions and explanations in your report.

Now write a letter to your local state or territory water authority, outlining what you consider to be the three best management solutions for Australia and why.

8 Conduct a debate on the following statement: There is enough water for all purposes if it is managed well.

eBookplus

Interactivity
Ways forward
Use this interactivity to find out about water use and management solutions around Australia.
Searchlight ID: int-3082

Weblink
Catchment detox

14.11 What are sources of water at Whataroa?

14.11.1 Whataroa region

Whataroa is a town on the northern edge of the South West New Zealand (*Te Wahipounamu*) World Heritage site. It is an area of abundant water and incorporates Fiordland, glaciers and spectacular lakes.

Visitors travel from the town down the Waitangitaona River to view the White Heron Sanctuary, the only breeding area of the white heron (kotuku). Glaciers and snow feed the Whataroa River and its tributaries. The South Westland Maori used the area to hunt birdlife and for fresh-water fishing.

FIGURE 1 Ice on Franz Josef Glacier

FIGURE 2 View of Franz Josef Glacier

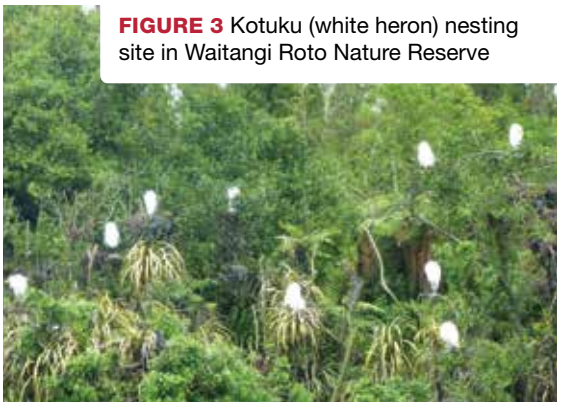


FIGURE 3 Kotuku (white heron) nesting site in Waitangi Roto Nature Reserve

ACTIVITIES

IDENTIFY

1 Examine the north-west quadrant of figure 4. What is the grid reference of:
   - **a** Waitahi Bluff
   - **b** Abut Head
   - **c** Lake Rotokino?

2 What is the direction of:
   - **a** The Forks (AR3720) from Harihari (AR4021)
   - **b** Abut Head (AR 3722) from Whataroa (AR3820)
   - **c** Franz Josef Glacier (AR3718) from Te Taho (AR3921)?

3 What is the height of:
   - **a** Mount Hercules (AR3819)
   - **b** Mount Cloher (AR3819)
   - **c** Drummond Peak (AR3718)
   - **d** Bamford Knob (AR3919)
   - **e** Mount Price (AR3820)?

4 In what direction are the following creeks flowing?
   - **a** Potters Creek (AR3719)
   - **b** Guant Creek (AR3820)
   - **c** Vine Creek (AR3920)
   - **d** Oroko Creek (AR3721)
   - **e** Hughes Creek (AR3919)

EXPLAIN

5 Describe the distribution of swamps in the vicinity of Whataroa. Explain why you think they may be located where they are.

6 Find Franz Josef Glacier in AR3718 and examine the photo in figure 2. Provide a grid reference of where the photographer could have been standing when taking the photograph. Justify your answer.

INVESTIGATE

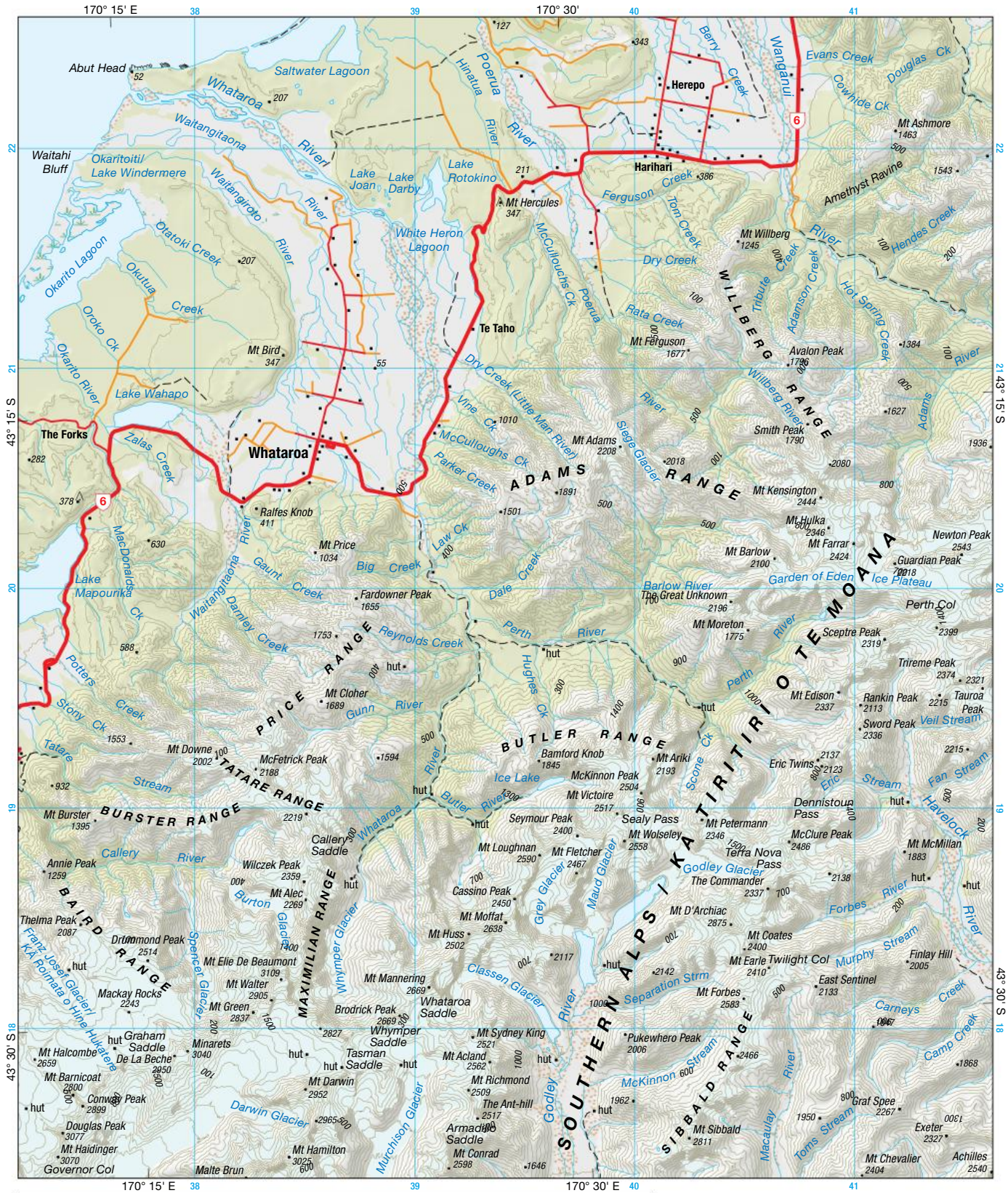
7 Locate White Heron Lagoon. Research the kotuku and the White Heron Sanctuary. Describe why this location would make a suitable breeding ground for the white heron.

eBook*plus* ONLINE ONLY

14.12 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au.**

FIGURE 4 Topographic map of the Whataroa area



Source: LINZ Data Service. License: Creative Commons Attribution 3.0 New Zealand https://data.linz.govt.nz/license/attribution-3-0-new-zealand/

Wind farm in a storm: the positive power of the wind

CHAPTER 15

Too much wind, too much water

15.1 Overview

15.1.1 Introduction

People have long harnessed the power of the wind and water for energy. We harness them to produce electricity around the globe. But strong winds and water flow can also cause great destruction, especially when accompanied by heavy rain. These winds can tear roofs from houses and pull trees from the ground.

Starter questions

1 a What areas at your school are exposed to wind and where are the more sheltered spots?
b How is wind shown in the image on this page?
2 List as many examples as you can of the way the wind influences you. Include positive and negative influences.
3 As a class, brainstorm a list of extreme weather events related to the wind and water.
4 Have you ever experienced an extreme weather event? Describe how it made you feel.

Inquiry sequence

		Syllabus outcomes
15.1 Overview		
15.2 How is a natural hazard different from a natural disaster?		GE4-1
15.3 SkillBuilder: Cardinal points: wind roses	eBookplus ONLINE ONLY	GE4-7
15.4 Why does it flood?		GE4-2, GE4-3, GE4-5
15.5 What are the impacts of floods?		GE4-2, GE4-3, GE4-5
15.6 SkillBuilder: Creating a simple column or bar graph	eBookplus ONLINE ONLY	
15.7 How do places around the world manage floods?		GE4-5
15.8 How do tornadoes impact people and environments?		GE4-2, GE4-3, GE4-5
15.9 What was the impact of the May 2013 tornado in the United States?	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-5
15.10 What is a cyclone?		GE4-5, GE4-7
15.11 What impact did Cyclone Yasi have?	eBookplus ONLINE ONLY	GE4-5, GE4-7
15.12 What are the impacts of typhoons in Asia?		GE4-5
15.13 How do we respond to extreme weather and water events?		GE4-5
15.14 How do we manage extreme weather and water events?		GE4-5
15.15 Investigating topographic maps: How does flooding affect the Narrabeen lagoon?		GE4-5
15.16 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	

eBook*plus*

Watch this video
Wind hazards
Searchlight ID: eles-1618

15.2 How is a natural hazard different from a natural disaster?

natural hazard an extreme event that is the result of natural processes and has the potential to cause serious material damage and loss of life

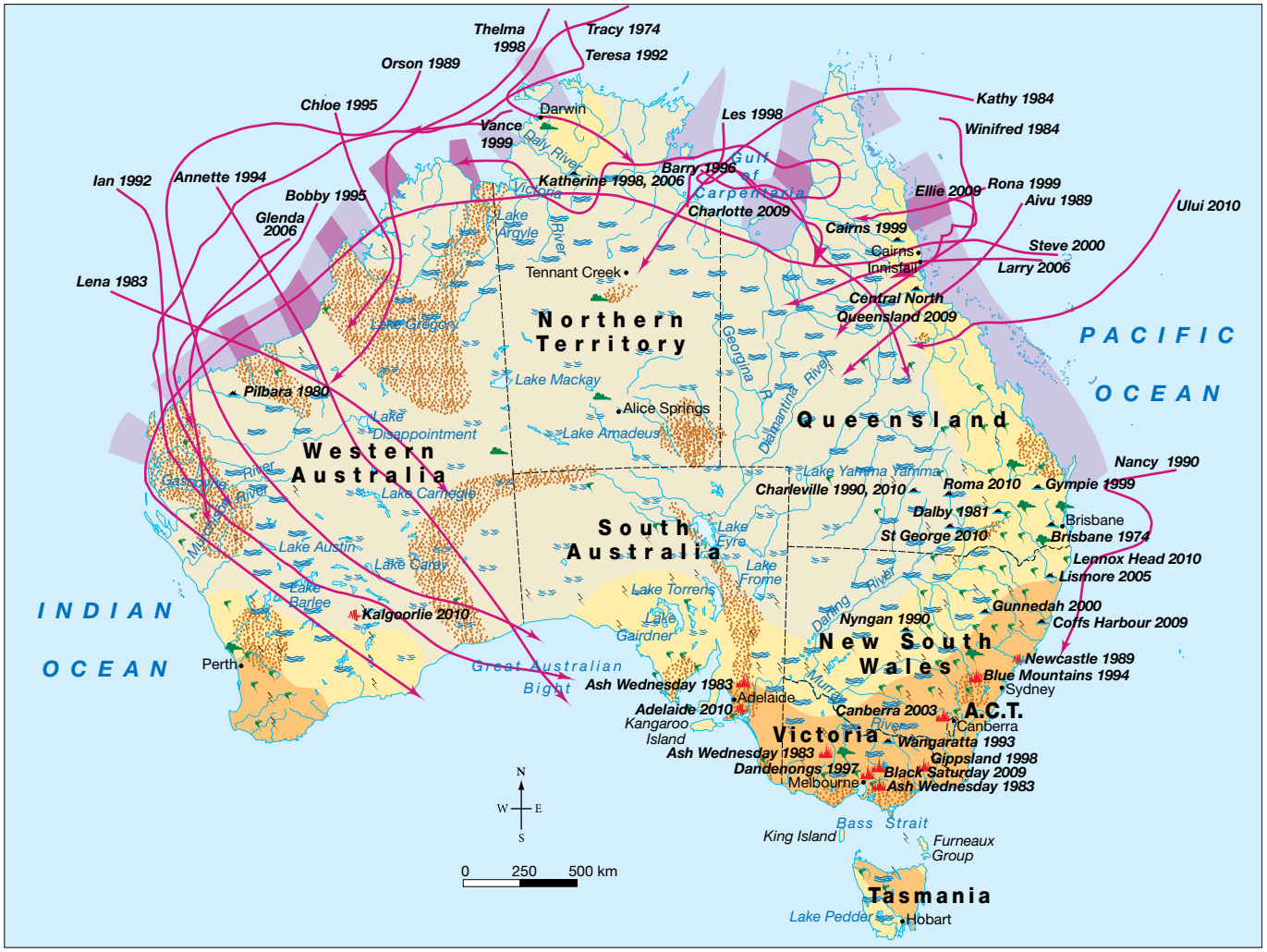
natural disaster an extreme event that is the result of natural processes and causes serious material damage or loss of life

15.2.1 Natural hazards

Australia is prone to a wide variety of natural hazards, which range from drought and bushfire to flooding. Many of these events are part of the weather's natural cycle. However, human actions such as overgrazing, deforestation and the alteration of natural waterways have sometimes increased the impact of these hazards.

A **natural hazard** is an event that is a *potential* source of harm to a community. It is the result of natural processes and may cause serious damage to buildings, roads, communication, transport and loss of life. In contrast, a **natural disaster** occurs as a result of a hazardous event that dramatically affects a community.

FIGURE 1 Australia's natural hazards and disasters



Source: MAPgraphics Pty Ltd, Brisbane

Cyclones
Approximate number of coastal crossings since 1959
- 6 to 10
- 11 to 16
- Major cyclone

Earthquakes
- Risk area
- Major earthquake

Severe storms
- At least one recorded severe thunderstorm (non-tornadic)
- At least one recorded tornado
- At least one severe thunderstorm per year (on average)
- At least one severe thunderstorm per year (on average) and at least one recorded tornado

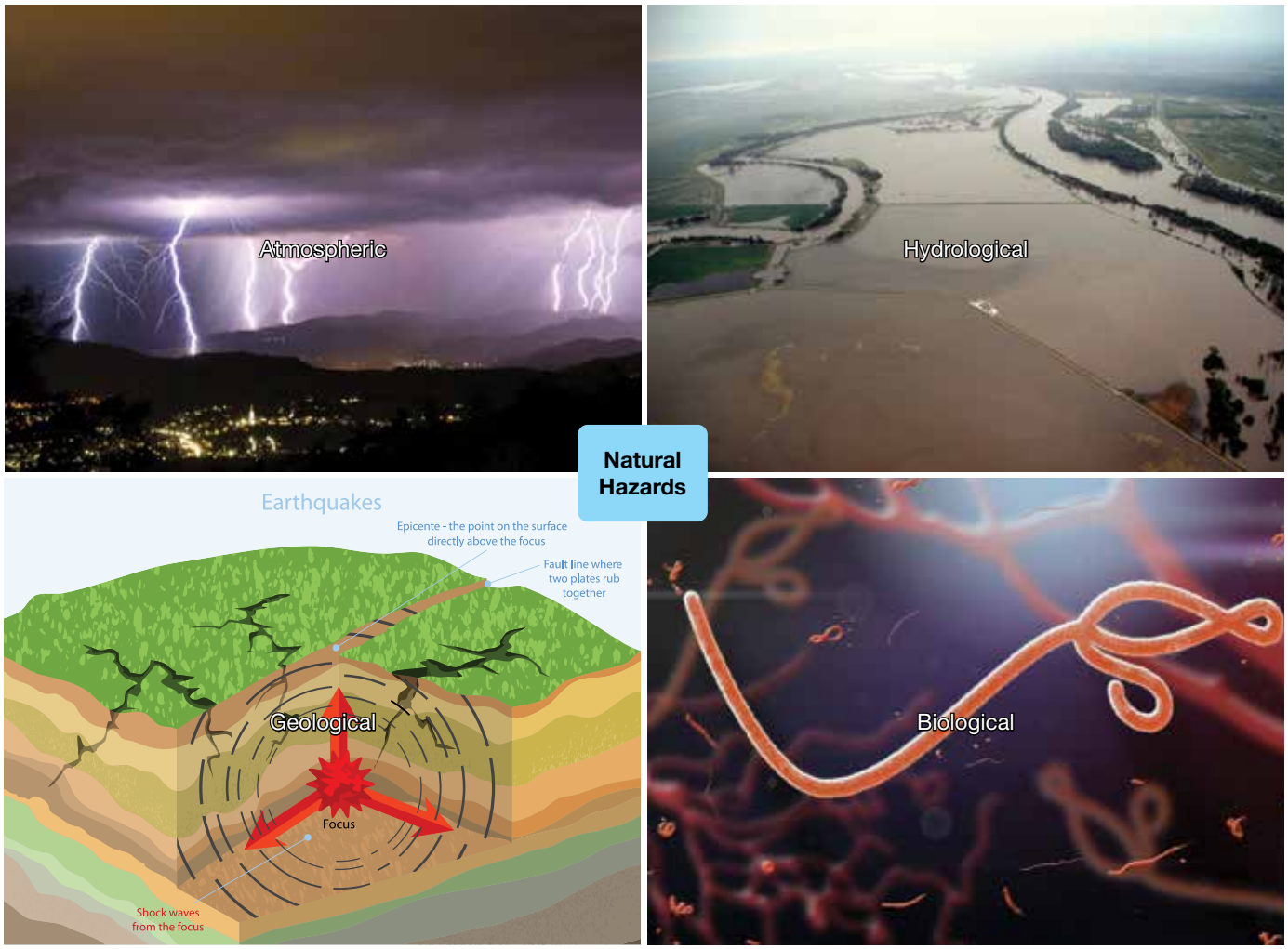
Bushfires
- Areas subject to forest, grass and scrub fires of moderate risk to people
- Areas subject to disaster fires
- Major bushfire

Floods
- Potential flash flooding
- Potential flash flooding (greater frequency)
- Major flood

Atmospheric and hydrologic hazards

The four broad types of natural hazards are:
1. **atmospheric** — for example, cyclones, hailstorms, blizzards and bushfires
2. **hydrological** — for example, flooding, wave action and glaciers
3. **geological** — for example, earthquakes and volcanoes
4. **biological** — for example, disease epidemics and plagues.

FIGURE 2 The four types of natural hazards



Natural hazards that are closely linked to the weather are categorised into atmospheric and hydrologic types. Some natural hazards are influenced by the actions of people and where they choose to locate built-up areas. After a period of sustained rainfall, a flood may occur in low-lying areas. Humans can influence the severity of a flood by building on floodplains and not planning for a potential disaster.

15.2.2 Impacts of a natural disaster

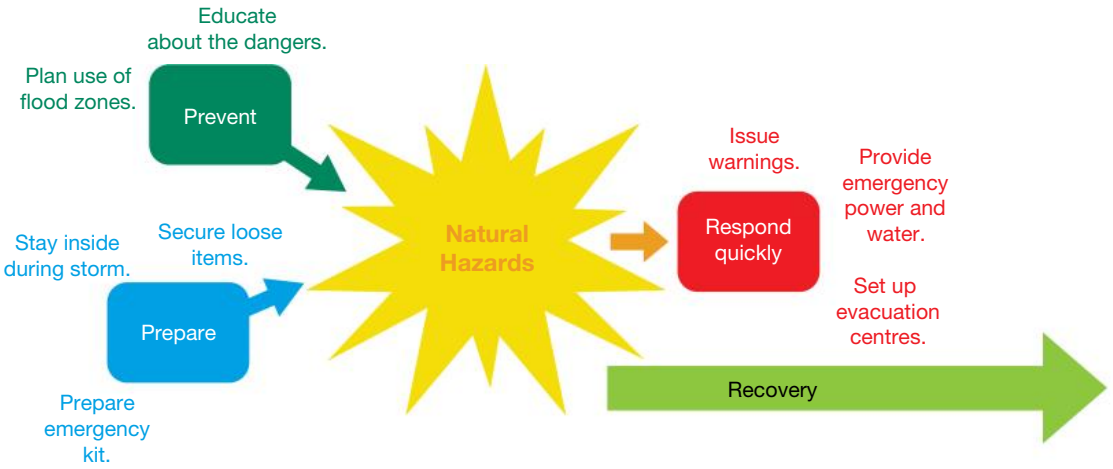
A variety of atmospheric and hydrologic hazards occur around the world. Some places tend to experience particular types of hazards more frequently than other locations. Figure 1 shows that different types of hazards are more likely to occur in different parts of Australia. For example, areas of northern Australia are more **vulnerable** to the threat of tropical cyclones. The communities living in these parts have decided that the benefits of living there outweigh the risk of natural hazards. The ability of an area to recover from the impact of a natural hazard may be hampered by a lack of resources. People may lose their personal belongings, homes and livestock which are often linked to their incomes. However, in regions that are adequately prepared, and where there is support to cope and rebuild, people recover more quickly.

vulnerable the state of being without protection and open to harm

15.2.3 Responding to natural hazards

When hazardous events take place in populated areas, a disaster can occur more easily. Action that is designed to prepare, prevent and respond quickly and that involves individuals, groups and the government allows recovery to occur more effectively (see figure 3).

FIGURE 3 Strategies to respond to natural hazards

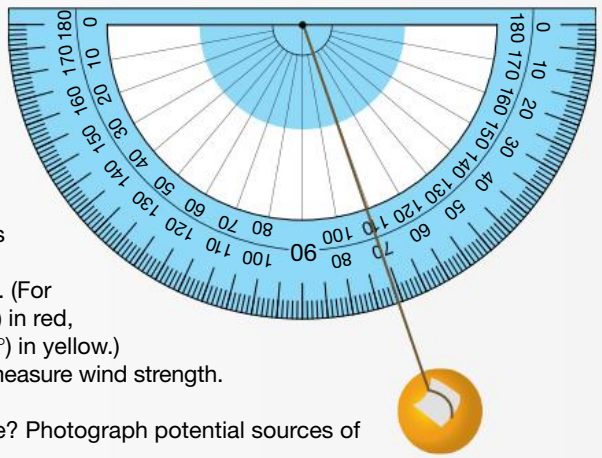


GEOskills TOOLBOX

Measuring wind speed

A wind rose is a visual way to show wind direction. It is a record of the number of times that the wind being measured blows from a particular direction. It is important to remember that wind is named by the direction it blows *from*.

FIGURE 4 An instrument to measure wind strength



1 a Design and create an instrument to measure wind strength. (This could be a length of ribbon about 30 centimetres long held above your head or a ping-pong ball threaded onto string and taped to a protractor.)
b Create a simple plan of the school or your home. Select four sites based on the amount of open space to compare wind strength.
c Create a 'wind scale' for use in the field to indicate wind strength. (For instance, mark your wind scale by indicating strong wind (0°–30°) in red, medium-strength wind (30°–60°) in orange, and a breeze (60°–90°) in yellow.)

2 On a windy day, in small groups, visit each of the selected points to measure wind strength.
a Apply your 'wind scale' at each location and shade the area.
b Imagine extreme wind conditions. What hazards exist at each site? Photograph potential sources of harm in strong winds.

3 Compare two of the sites investigated using specific reference to your wind scale and the images of potential hazards.

ACTIVITIES

IDENTIFY

1 How do natural hazards and natural disasters differ?

EXPLAIN

2 Explain how a flood is both a natural and human hazard.
3 Explain why the risk of experiencing a natural disaster depends on the geographical location of a community.
4 Describe key ***changes*** that natural hazards and natural disasters can cause to an ***environment***.

APPLY

5 Refer to figure 1.
a What types of natural disasters occur most often in Australia?
b Describe the location of Australia's cyclone hazard zone.
c Give one example of a community that has suffered a bushfire disaster.
d What type of hazards are communities around Newcastle subject to?
e What would be the likely impact of a large earthquake occurring in the earthquake risk area in the Northern Territory?

6 Investigate the ways a natural hazard has created challenges for heavily populated areas.

eBookplus

Interactivity
Hotspot Commander: natural hazards
Use this interactivity to explore Australia's natural hazards.
Searchlight ID: int-3083

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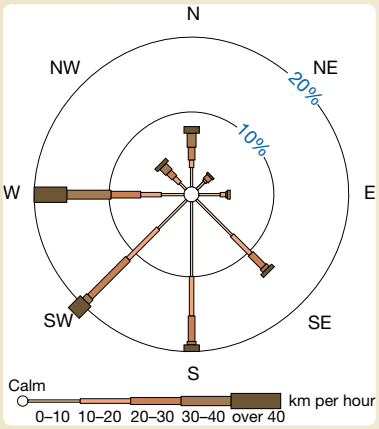
ONLINE ONLY

15.3 SkillBuilder: Cardinal points: wind rose

What are wind roses?

A wind rose is a diagram that shows the main wind features of a place, in particular wind direction, speed and frequency. Wind directions can be divided into eight or sixteen compass directions.



eLesson

Watch this video to learn how to interpret wind roses.

Searchlight ID: eles-1638

Interactivity

Try this interactivity to learn how to interpret wind roses.

Searchlight ID: int-3134

15.4 Why does it flood?

15.4.1 Why does it flood?

Even though Australia is the driest of all the world's inhabited continents, there are periods of very heavy rainfall and **flood**. Flood disasters in Australia damage property, kill livestock, and cause the loss of human life. Since 1788 more than 2000 people have died in floods, equalling the number of deaths from cyclones. In some cases, entire sections of a town have been washed away, as in 1852, when one-third of the town of Gundagai disappeared.

flood inundation by water, usually when a river overflows its banks and covers surrounding land

Floods are an unusual accumulation of water that overflows from rivers, lakes or the ocean onto land that is not normally covered by water. The flooding can be caused by a number of factors including storms, and low pressure systems such as cyclones, typhoons and hurricanes. Heavy rainfall during storms can lead to a rapid rise in water level over a very short period of time. This is known as flash flooding. The water is unable to soak into the ground quickly, and so it runs down to the river and rushes towards the sea. Fast-moving floodwater (figure 1) causes great risk to property and human life because there is less time to prepare. Riverine flooding (figure 2) occurs when the rivers burst their banks and cover the surrounding land. It is a relatively slower process and may isolate communities for many weeks. There are other forms of flooding including those caused by storm surges and tsunamis that lead to seawater flooding.

FIGURE 1 Flash flood in Toowoomba, Queensland, 2011

FIGURE 2 Damage left in Toowoomba after the flash flood

15.4.2 Floods and floodplains

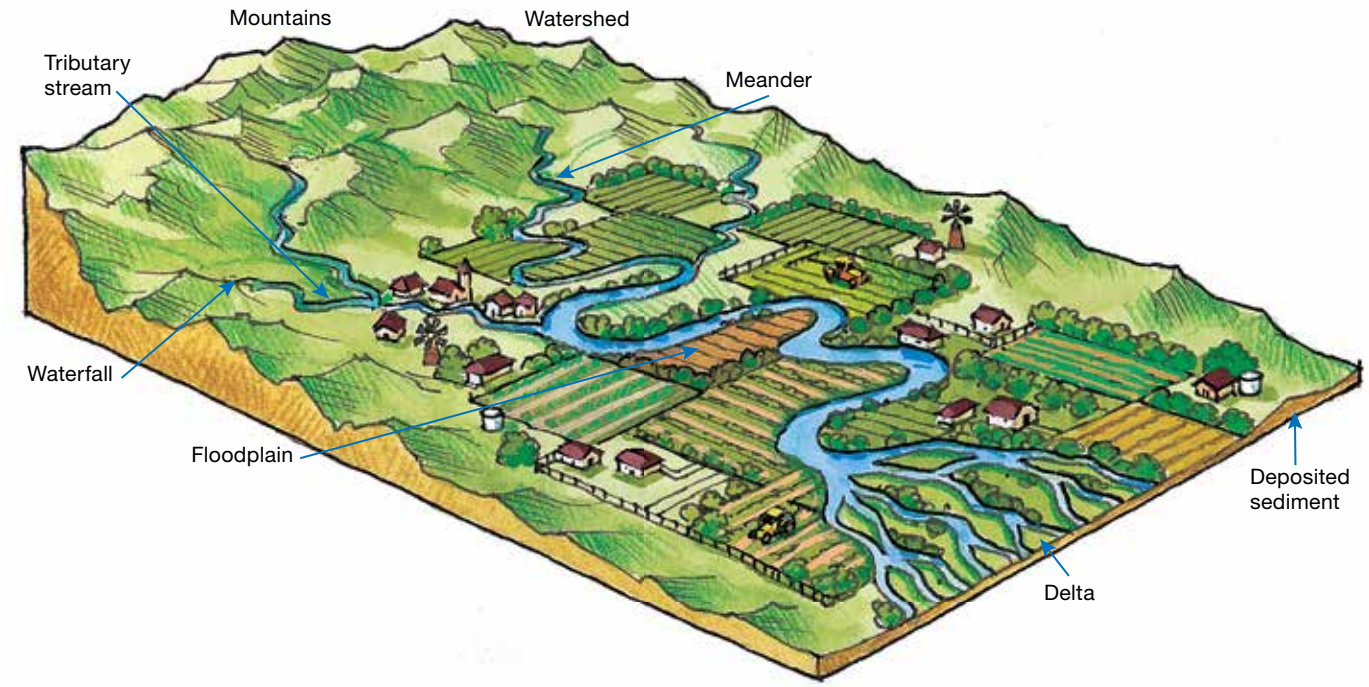
Floods are a natural occurrence, but they are a natural hazard to humans, who tend to build farms, towns and transport routes in areas such as floodplains. A floodplain (figure 3) is an area of relatively flat land that borders a river and is covered by water during a flood. Floodplains are formed when the water in a river slows down in flat areas. The river begins to meander and gradually deposits **alluvium**, which builds up the floodplain and other landforms such as deltas.

alluvium the loose material brought down by a river and deposited on its bed, or on the floodplain or delta

These fertile, flat areas are used for farming and settlement around the world. In Australia, many of our richest farmlands are on floodplains, and towns are often built on them, close to rivers. Such towns are subject to flooding. The possibility of flood is also increased when vegetation in **catchment areas** has been cleared or modified. Native vegetation can slow down run-off and reduce the chance of flooding.

catchment area the area of land that contributes water to a river and its tributaries

FIGURE 3 Flat, fertile floodplains are often preferred areas for settlement and farming.



15.4.3 La Niña and floods

A La Niña event in Australia is often associated with floods. La Niña is virtually the opposite of El Niño. Very cold waters dominate the eastern Pacific, and the oceans off Australia are warmer than normal. Large areas of low pressure extend over much of Australia; warm, moist air moves in, and above-average rainfall occurs. There can also be torrential rain and widespread floods.

La Niña events in Australia occurred in 2010–2011, when many parts of Queensland, New South Wales and Victoria were flooded (figure 4).

FIGURE 4 Rockhampton, Queensland, (a) before and (b) during the 2011 flood

ACTIVITIES

IDENTIFY

1 What is a flood?
2 What is a floodplain?

EXPLAIN

3 Why is alluvium important to agriculture?
4 Construct a simple flow diagram to show the process of a La Niña event (see section 15.4.3).

PREDICT

5 Should people continue to build on floodplains? Why or why not? Create a poster that will warn people about the consequences if they continue to develop on floodplain regions.

APPLY

6 Why do floods occur on floodplains and in deltas?
7 Create an overlay map to show the distribution of water in the aerial photos of Rockhampton before and after the 2011 flood. Estimate the percentage of the area covered in both maps. (See Skillbuilder 10.12 'Creating and analysing overlay maps' in your eBookPLUS.) Describe the ***changes*** to the ***environment***.
8 How might the effects of floods in urban ***spaces*** differ from effects in rural ***spaces***?

15.5 What are the impacts of floods?

15.5.1 Impacts of flooding

The impact of flooding will depend on a number of factors including steps taken to prepare, prevent and respond quickly to the event. The disruption flooding causes to an environment and space can be extensive and recovery can take many years.

When the Brisbane River broke its banks on 11 January 2011, many residents were shocked by the devastation left in its wake. Across the world in Brazil, devastating floodwaters were also having a huge impact on the people and the land.

CASE STUDY 1

Queensland, Australia, 2010–2011

Country background

Australia is considered a developed nation with a strong economy. Australians earn on average $38 200 per person. Approximately 22.3 million people reside in Australia, with 4.6 million of those living in Queensland. About 84 per cent of all Australians are located within 50 kilometres of the coast.

Why?

The flooding that affected this region was due to a strong La Niña event. Long periods of heavy rain over Queensland catchments caused rivers to burst their banks.

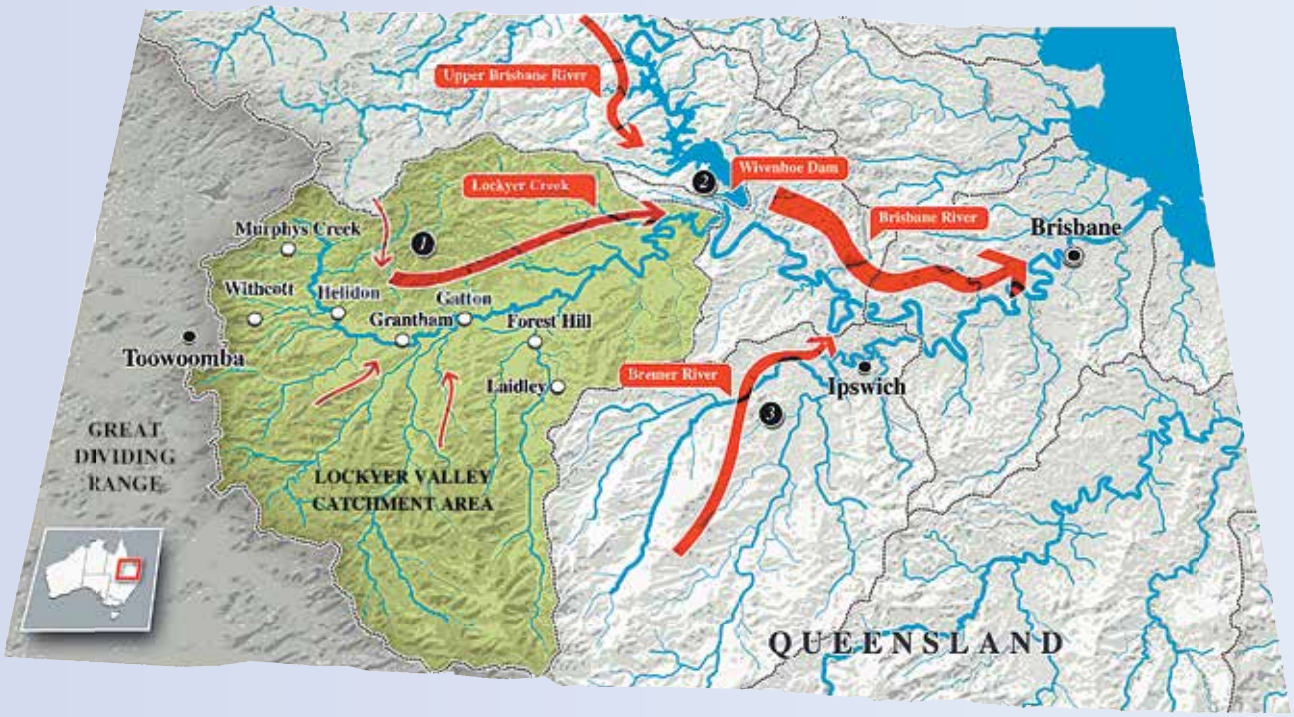
Impacts

- Three-quarters of the state was declared a disaster zone.
- At least 70 towns and over 200 000 people were affected.
- There were 35 deaths.
- Cost to the Australian economy is estimated at least $10 billion.
- Up to 300 roads were closed, including nine major highways.
- Over 20 000 homes were flooded in Brisbane alone.
- There was massive damage and loss of property.

Assistance and recovery

- $1.725 billion is being raised by the Federal Government via a flood levy in the tax system.
- $281.5 million is in the Disaster Relief Appeal set up by the then Premier, Anna Bligh.
- Over $20 million was donated to aid agencies such as the St Vincent de Paul Society to help those suffering.
- About $1.2 million was raised through charity sporting events such as Rally for Relief, Legends of Origin and Twenty20 cricket.
- The Australian Defence Force was mobilised to help with the clean-up.
- The Mud Army was formed: 55 000 volunteers registered to help clean up the streets, and thousands more unregistered people joined them.
- Improvements will be made to dam manuals to help manage the release of water from dams during floods.

FIGURE 1 Anatomy of a flood



Town heights above sea level in metres: Toowoomba 700 m Murphys Creek 704 m Withcott 262 m Helidon 143 m Grantham 110 m Gatton 111 m Forest Hill 95 m Laidley 135 m Ipswich 54.8 m Brisbane 28.4 m

1. Floodwaters from **Lockyer Creek**, which flows into **Brisbane River**. The Lockyer Valley was hit by more than 200 mm of rain.
2. More than 490 000 million litres were released from **Wivenhoe Dam** into Brisbane River.
3. Floodwaters from the **Bremer River**, which is also fed by the **Lockyer Valley**. After passing Ipswich, where it burst its banks, the Bremer flows into the Brisbane River.

CASE STUDY 2

State of Rio de Janeiro, Brazil, 2011

Country background

Brazil is considered a developing nation. Brazilians earn on average $10 200 per person per year. Approximately 198 million people reside in Brazil, with 650 000 living in the three towns worst affected by the flooding.

Why?

Due to the equivalent of a month's rain falling in 24 hours, flash flooding occurred in a mountainous region in Rio de Janeiro State and Sao Paulo State. Hillsides and riverbanks collapsed due to landslides. It is believed that illegal construction and deforestation may have contributed to the instability of the land.

Impacts

- Approximately 900 people died — most of them in poverty-stricken areas with poor housing conditions and no building policies.
- Forty per cent of the vegetable supply for the city of Rio de Janeiro was destroyed.
- Around 17 000 people were left homeless.
- There was widespread property damage, most of it to homes built riskily at the base of steep hills.

Assistance and recovery

- $460 million was set aside by the President for emergency aid and reconstruction.
- Troops were deployed to help.
- There were donations of clothes and food to the area from other Brazilians.
- About $450 million was lent by the World Bank.
- Support was given by internal and international charities.

FIGURE 2 Areas affected by the floods in Brazil, 13 January 2011

Source: Spatial Vision

FIGURE 3 Hills collapsed after the heavy rains, destroying homes.

ACTIVITIES

IDENTIFY

1 When did the floods in Queensland and Brazil occur?

EXPLAIN

2 a Explain, in your own words, the three causes of the Brisbane floods.
b Explain the causes of the Brazilian floods.
c Compare the causes of these two floods by identifying the similarities and differences between them.

3 a Compare the ***scale*** of these floods.
b Give reasons for the differences in the ***scale*** of these floods.

4 In a table, classify (in point form) the impacts on people, the economy and the ***environment*** of the Brisbane and Brazilian floods.

5 Why do you think the impacts differed?

6 How were the responses to the floods in Brisbane and Brazil similar? How and why do you think they were different?

PREDICT

7 Suggest a few strategies that could be implemented to lessen the impact of floods if they occurred in these regions again.

APPLY

8 Imagine you had to evacuate your home because it was under threat from a flood. What five things would you take with you, and why?

9 Describe the ***interconnection*** between Brisbane and the areas to its west in relation to the January 2011 Brisbane flood.

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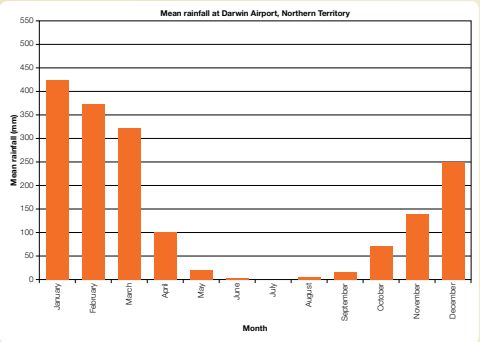
15.6 SkillBuilder: Creating a simple column or bar graph

What are column or bar graphs?

Column graphs show information or data in columns. In a bar graph the bars are drawn horizontally and in column graphs they are drawn vertically. They can be hand drawn or constructed using computer spreadsheets.



Source: Bureau of Meteorology

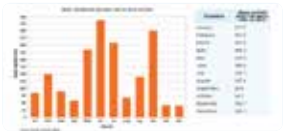
eLesson

Watch this video to learn how to create a simple column or bar graph.

Searchlight ID: eles-1639

Interactivity

Try this interactivity to learn how to create a simple column or bar graph



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15.7 How do places around the world manage floods?

15.7.1 Managing floods

Floods occur in many countries around the world. It is important for these countries to learn how to effectively live with this natural hazard. Managing the effects of floods is important if the amount of damage caused is to be minimised. Unfortunately, not all countries have the same resources to tackle this problem. Those countries that are able to invest in flood-prevention **infrastructure** have a greater chance of reducing the risk of flood.

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communications systems, water and power lines

The most common form of flood management is to build a barrier that prevents excess water from reaching areas that would suffer major damage. Levees (see figure 2), **weirs** and dams are a few examples of structures that are built to contain floodwaters. Dams that are used to stop flooding need to be kept below a certain level to allow space for floodwater to fill. Wivenhoe Dam in south-east Queensland was built in response to the floods in 1974 (see figure 1). However, there was some debate about whether this dam could have been used more effectively during the 2010–2011 floods.

weir a barrier across a river, similar to a dam, which causes water to pool behind it. Water is still able to flow over the top of the weir.

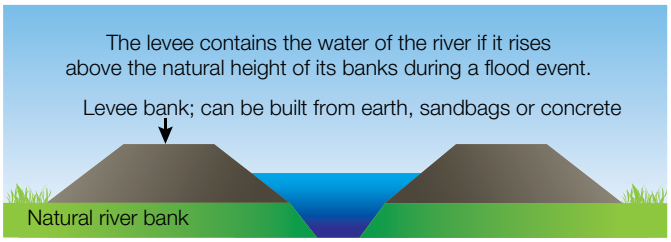
To prevent London being flooded during unusually high tides and storm surges, the city constructed the Thames Barrier, a system of floodgates that stretch across the width of the river (see figure 3). The barrier is triggered if predicted water levels are above a certain height. If this happens, the gates rise to stop the incoming water. Once the water recedes, the danger has passed and the gates are lowered.

Another way to manage the risk of damage from floods is to stop building on low-lying land that is guaranteed to flood. Unfortunately, in many urban areas this land has been developed, which increases the chance of property damage in a flood.

FIGURE 1 Lake Wivenhoe, Queensland, at 190 per cent capacity, January 2011

Since 2006, the Brisbane City Council has offered a residential property buy-back scheme. This scheme gives people the opportunity to sell their property to the council if they live in a low-lying area that has a 50 per cent chance of flooding every year. People will not be allowed to build on this land again. For this initiative to be successful, it is essential that the price offered by the council is similar to what the owners would get in a private sale; otherwise there is no incentive to use it.

FIGURE 2 An artificial levee



Unfortunately not all countries have the finances to fund property buy-backs or large-scale barrier building. Bangladesh, for example, experiences annual flooding during the **monsoon** season. In response to this, homes are usually built on raised land above flood levels or on stilts.

monsoon the rainy season in the Indian subcontinent and South-East Asia

In order to prepare the population for the arrival of floods, Bangladesh has developed a flood forecasting and warning system that can be broadcast via newspapers, television, radio, the internet and email. Regrettably, due to the growing population in the capital of Dhaka, building is now occurring on low-lying land that was previously used to store floodwater (see figure 4). As a result, many people are still being affected by flooding. In 1998, 65 per cent of Bangladesh was inundated. Twenty million people needed shelter and food aid for two months.

FIGURE 3 The Thames flood barrier, seen here with its gates up

FIGURE 4 In Dhaka, homes are built on stilts to avoid the floodwaters.

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Interactivity
Responding to floods
Use this interactivity to learn more about common flood control measures.
Searchlight ID: int-3085

Weblink
Bureau of Meteorology

ACTIVITIES

IDENTIFY
1 What flood management techniques are being used in Brisbane?
2 Where are you at most risk from flood when building?

EXPLAIN
3 Look at figure 2 and use it to help write a definition for the term *levee*.
4 How can an early warning system reduce the risk of a flood disaster?
5 Why might population growth increase the risks from floods?

INVESTIGATE
6 Use the **Bureau of Meteorology** weblink in your eBookPLUS to find out more about flood warnings. Prepare an information sheet that could be released to a rural community about to be affected by a major flood event. It should include tips on what to do before, during and after the event. Search for the area you live in and check any flood warnings it has had in the past.

APPLY
7 What do you think would happen if a dam, built to prevent floods, was already full to capacity and the area received more heavy rainfall? What might be some of the consequences?

15.8 How do tornadoes impact people and environments?

15.8.1 What is a tornado like?

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Weblink
Tornadoes 101

Tornadoes (or twisters) are violent, wildly spinning columns of air that drop down from cloud and make contact with the ground. They are different from cyclones in that they form over land rather than over water. Unlike cyclones, they are not dependent on a supply of warm water to keep them going. Use the **Tornadoes 101** weblink in your eBookPLUS to watch a video about how tornadoes form, the damage they cause and how to survive them.

Tornadoes are ranked using a scale called the Enhanced Fujita scale (see table 1). Five categories of wind speed are estimated, based on the damage left behind. These are not wind speed measurements, because most wind speed measuring devices are destroyed during tornadoes, and because the tornadoes die out so quickly.

TABLE 1 The Enhanced Fujita scale, like the Beaufort scale, links tornado categories to the damage caused.

Scale	Wind speed		Share of all tornadoes	Potential damage
	mph	km/h		
EFO	65–85	105–137	53.5%	Minor or no damage. Some roof, gutter or siding damage; broken branches
EF1	86–110	138–178	31.6%	Moderate damage. Roofs severely stripped; mobile homes overturned or badly damaged; loss of exterior doors
EF2	111–135	179–218	10.7%	Considerable damage. Roofs torn off; house foundation shifted; mobile homes destroyed; cars lifted off ground
EF3	136–165	219–266	3.4%	Severe damage. Entire storeys of houses destroyed; severe damage to large buildings; trains overturned; trees debarked
EF4	166–200	267–322	0.7%	Extreme damage. Whole frame houses levelled; cars and other large objects thrown and small missiles generated
EF5	More than 200	More than 322	Less than 0.1%	Total destruction. Houses levelled off foundation and swept away; steel-reinforced concrete structures critically damaged; tall buildings collapsed

Widely used in the United States and Canada, the Enhanced Fujita scale is a new version of the original Fujita scale and was designed to expand the descriptions of damage caused at different wind

speeds. It also includes descriptions of damage to both the natural and human environments. Within the human environment, the Enhanced Fujita scale includes reference to differences in the construction quality of buildings.

15.8.2 Where is Tornado Alley?

In an average year, twisters kill 80 people and injure more than 1500. Tornadoes can occur anywhere, but most occur during spring and summer in a part of the United States known as **Tornado Alley** (see figure 2). The worst tornado on record was the Tri-State tornado in March 1925. It destroyed towns across Missouri, Illinois and Indiana, killing 689 people.

The year 2011 ranks third in the history of the United States for the greatest number of strong to violent tornadoes. This number was surpassed only in 1974 and 1965.

FIGURE 1 Anatomy of a tornado

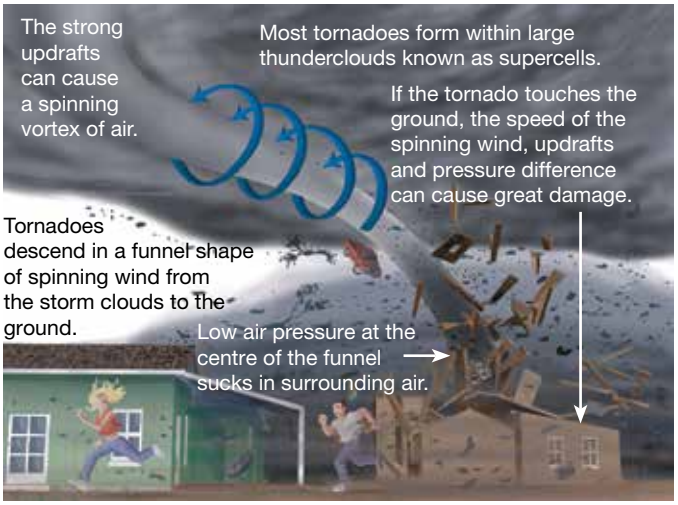
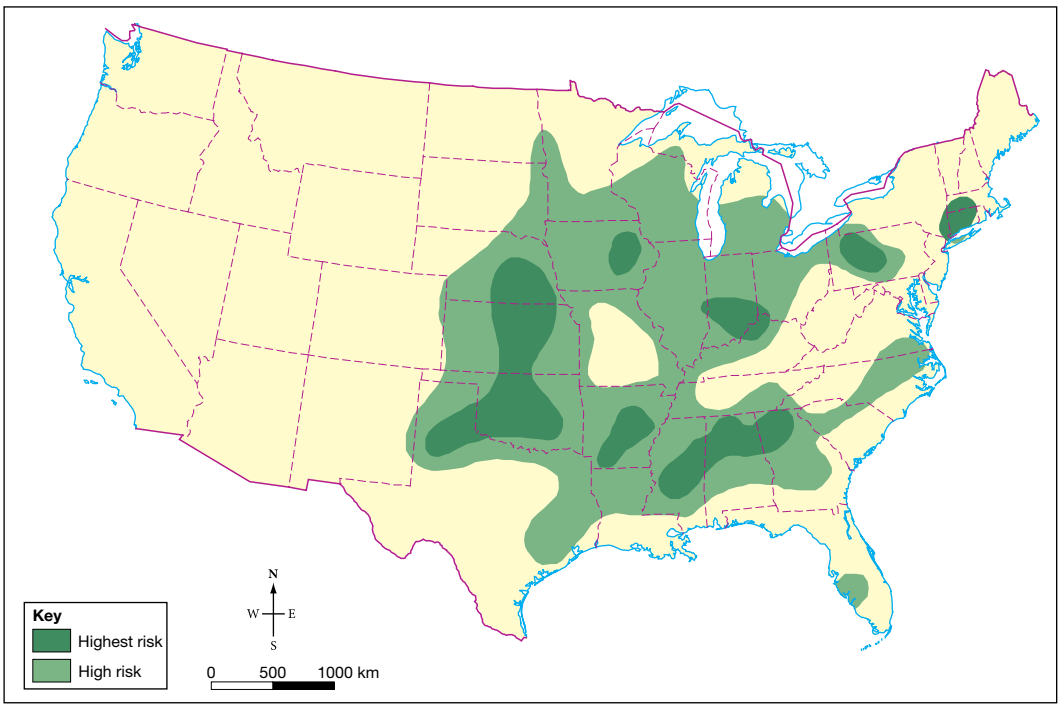


FIGURE 2 Map of Tornado Alley, showing areas of highest risk and high risk



Source: MAPgraphics Pty Ltd Brisbane

Tornado Alley
a region of the central United States, across which tornadoes are most likely to form. The core states are Texas, Oklahoma, Kansas, Nebraska, eastern South Dakota, and the Colorado Eastern Plains.

storm shelter
underground shelter where people can take refuge from a tornado

Living in Tornado Alley

The people who live in Tornado Alley are well aware of the potential disaster that they face each year during spring and summer. Building codes have been strengthened, requiring all new buildings to have strong roofs and foundations that are tethered to the structure. Most neighbourhoods have early-warning sirens that sound when a tornado is imminent. Most homes have basements or underground **storm shelters** that provide protection for people during a tornado.

Sydney experienced record-breaking wind speeds of 213 kilometres per hour during a severe storm on 16 December 2015. The Bureau of Meteorology classified the event as a tornado and the southern Sydney suburb of Kurnell was declared a disaster zone. Safety warnings were issued through social media (see figure 4) and flights were cancelled or redirected. Busy streets were blocked due to storm damage and flooding (see figure 5).

FIGURE 3 Joplin, Missouri, where 158 people were killed in May 2011, after a tornado carved a 22-kilometre path of destruction through the town

FIGURE 4 Bureau of Meteorology warnings are issued via social media.

FIGURE 5 The extent of flooding is conveyed swiftly by social media.

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Interactivity
Spiralling twister
Use this interactivity to test your knowledge of tornadoes.
Searchlight ID: int-3088

ACTIVITIES

IDENTIFY

1 When are tornadoes most likely to occur? Give reasons for your answer.
2 What is Tornado Alley and where is it?

EXPLAIN

3 Refer to pages 312 and 315. Explain the difference between a cyclone and a tornado.
4 Refer to figure 1. What is the ***interconnection*** between large thunderclouds and tornadoes?
5 Do you think we have tornadoes in Australia? Explain.

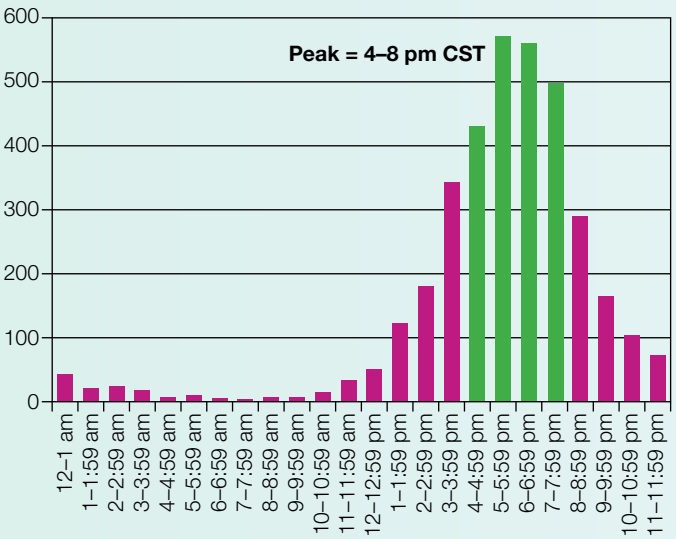
INVESTIGATE

6 Tornado Alley is well known, but it is not the only ***place*** in the world where tornadoes occur. Use the internet to find other locations where tornadoes occur regularly. Investigate one region and one tornado that has taken place. Using ICT, make a short movie clip of the event. Include information about the ***scale*** of the tornado. You must also cover the aftermath, detailing the impact on both the natural and built ***environments***.

APPLY

7 Refer to figure 2. How does the ***scale*** of risk of tornadoes occurring vary within the United States?

FIGURE 6 Hourly tornado frequency, 1950–2009



8 Study figure 6.
  a During which hours of the day are tornadoes more likely?
  b Suggest a reason for this pattern.
9 Imagine you are equipping a storm shelter. What 10 items could your shelter not do without? Justify your choices.

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15.9 What was the impact of the May 2013 tornado in the United States?

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15.10 What is a cyclone?

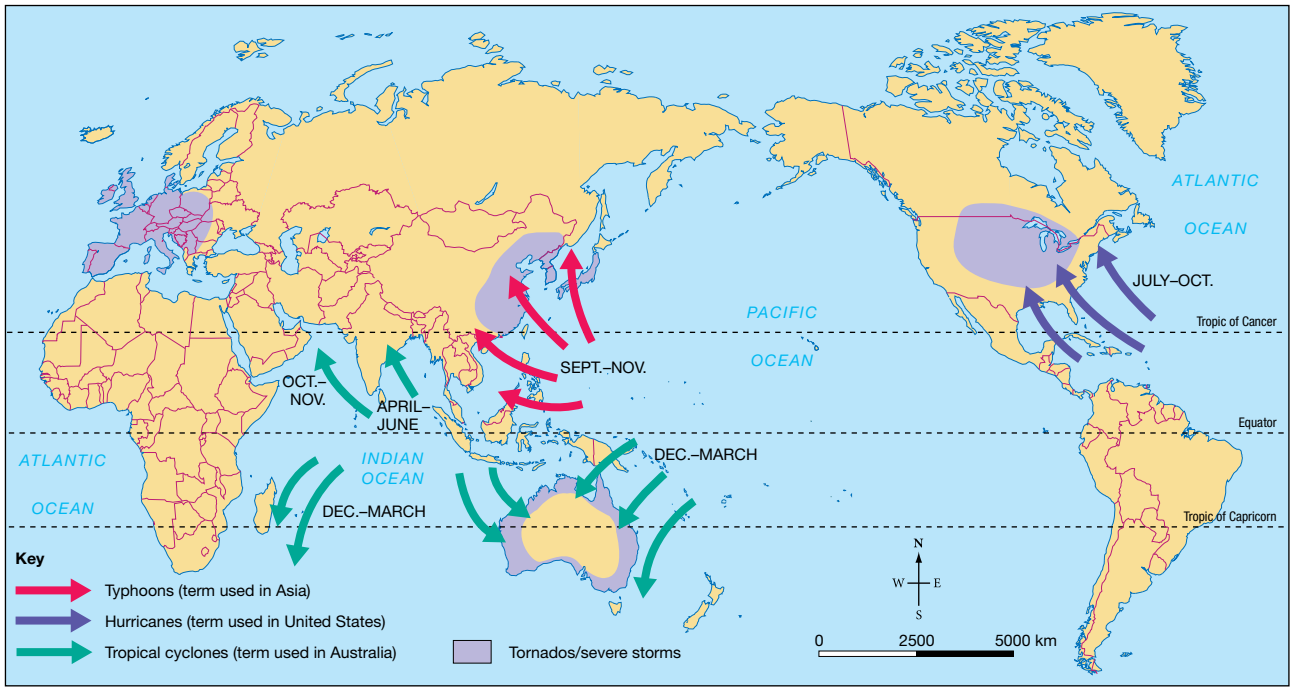
15.10.1 How are cyclones formed?

Tropical **cyclones** (called hurricanes in the Americas and typhoons in Asia) can cause great damage to property and significant loss of life. Some 80 to 100 tropical cyclones occur around the world every year in tropical coastal areas located north and south of the equator. Australia experiences, on average, about 13 cyclones per year.

cyclone intense low pressure system producing sustained wind speeds in excess of 65 km/h. It develops over tropical waters where surface water temperature is at least 27 °C.

Cyclones form when a cold air mass meets a warm, moist air mass lying over a tropical ocean with a surface temperature greater than 27 °C. Cold air currents race in to replace rapidly rising, warm, moist air currents, creating an intense low pressure system. Winds with speeds over 119 kilometres per hour can be generated.

FIGURE 1 World distribution of tropical cyclones by names used in different regions



Source: MAPgraphics Pty Ltd, Brisbane.

Cyclones are classified using the scale in table 1.

Figure 2 shows the continuous cycle of evaporation, condensation and precipitation associated with cyclones. At first the winds spin around an area about 200 to 300 kilometres wide. As the winds gather energy by sucking in more warm moist air, they get faster. In severe cyclones, winds may reach speeds of 295 kilometres per hour. The faster the winds blow, the smaller the area around which they spin; this is called the eye. It might end up being only about 30 kilometres wide. Around the edge of

the eye, winds and rain are at their fiercest. However, in the eye itself, the air is relatively still, and the sky above it may be cloudless.

gale force winds winds with speeds of over 62 kilometres per hour

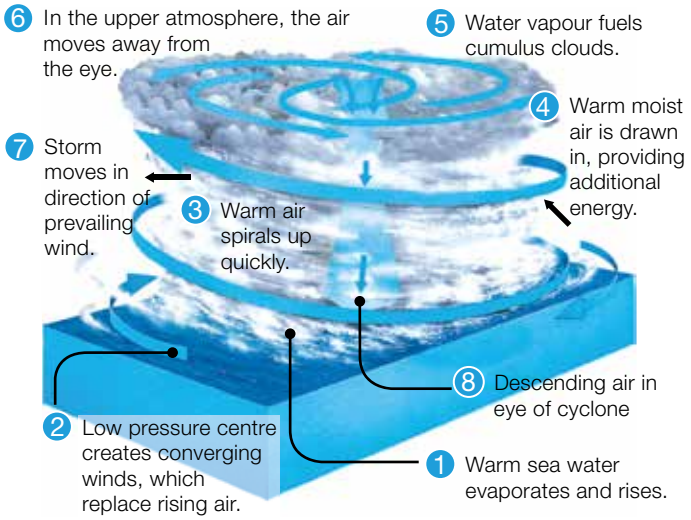
torrential rain heavy rain often associated with storms, which can result in flash flooding

storm surge a sudden increase in sea level as a result of storm activity and strong winds. Low-lying land may be flooded.

TABLE 1 Classification of cyclones using the Saffir–Simpson scale

Category	Wind gust speed	Ocean swell	Damage
1	Less than 125 km/h	1.2–1.6 m	Mild damage
2	126–169 km/h	1.7–2.5 m	Significant damage to trees
3	170–224 km/h	2.6–3.7 m	Structural damage, power failures likely
4	225–279 km/h	3.8–5.4 m	Most roofing lost
5	More than 280 km/h	More than 5.4 m	Almost total destruction

FIGURE 2 How a cyclone forms. The winds within a cyclone spin because of the rotation of the Earth. In the Southern Hemisphere, they rotate in a clockwise direction. In the Northern Hemisphere, they rotate in an anticlockwise direction.



What damage is caused by tropical cyclones?

Tropical cyclones can cause extensive damage if they cross land. **Gale force winds** can tear roofs off buildings and uproot trees. **Torrential rain** can often cause flooding, as can **storm surges**.

When a tropical cyclone approaches or crosses a coastline, the very low atmospheric pressure and impact of strong winds on the sea surface combine to produce a rise in sea level, as shown in figure 3.

FIGURE 3 Flooding caused by storm surges

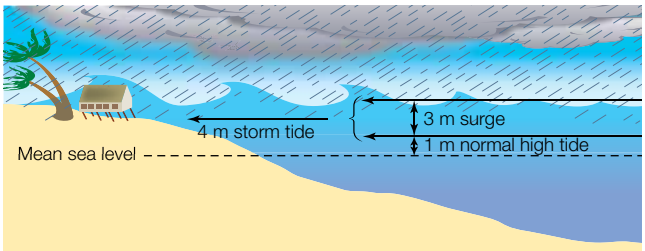


FIGURE 4 Satellite image of Typhoon Maysak, 31 March 2015

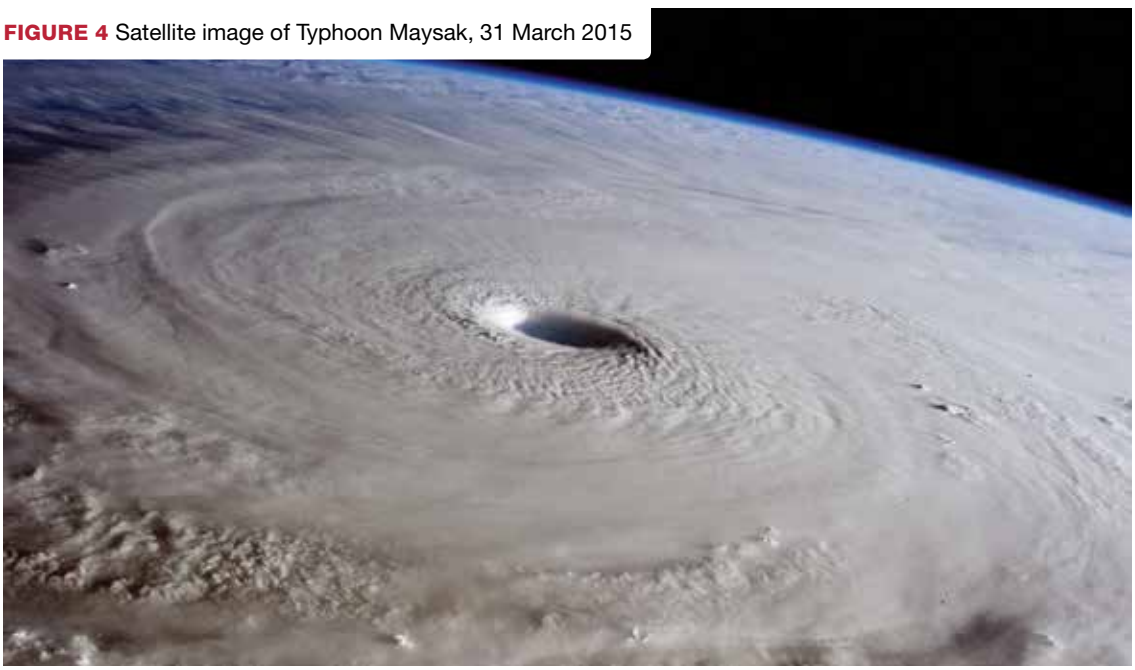


FIGURE 5 Cyclone damage to homes in Vanuatu, March 2015

ACTIVITIES

IDENTIFY

1 What conditions do tropical cyclones need in order to develop?
2 What names are given to tropical cyclones in other places?

EXPLAIN

3 Why do tropical cyclones die out if they move inland?
4 Explain the ***changes*** that a storm surge can cause to a coastal area.
5 How does the ***scale*** of a cyclone vary?
6 What is the ***interconnection*** between the warmth of seawater and cyclones?

PREDICT

7 Describe how the damage would differ between a category 1 and category 5 cyclone.
8 Why do you think many people are killed after the eye of the storm has passed over an area?
9 Cyclones are associated with destructive winds and the displacement of large volumes of water. What emergency strategies should be introduced in coastal areas to manage the risk of cyclones to humans and the ***environment?***

APPLY

10 Refer to figure 1, showing the world pattern of tropical cyclones.
   a When do most cyclones occur north of the equator? When do most cyclones occur south of the equator? Suggest a reason for this difference.
   b Name the parts of Australia most at risk from cyclone activity.
11 If the water source for cyclones is the ocean over which they form, explain why strong winds and flooding occur in ***places*** located inland from the coast.
12 Technology allows us to view cyclones on a global ***scale***. Refer to figure 4 and figure 5. What are the benefits of using these images to understand the power of cyclones?

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Interactivity
Spiralling sea storm
Use this interactivity to test your knowledge of how a cyclone forms.
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› **Cyclones and tornadoes**
› **Cyclone Nargis**

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15.11 What impact did Cyclone Yasi have?

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15.12 What are the impacts of typhoons in Asia?

15.12.1 What happened when Typhoon Haiyan struck?

Typhoons, hurricanes and tropical cyclones are all natural hazards that involve intense low pressure systems. They develop in different places and develop different wind patterns; however, they can all be very destructive to spaces and environments. An average of 20 major storms hit the Philippines a year. Typhoon Haiyan was the 25th tropical storm to enter Philippine waters in 2013. Some of the most impoverished areas of the Philippines were destroyed by this storm.

typhoon the name given to cyclones in the Asian region

intensify to become stronger

What happened when Haiyan struck?

Typhoon Haiyan (locally known as Yolanda) developed into a category 5 storm over the Pacific Ocean and directly affected countries such as the Philippines, Palau, Vietnam and China. Strong wind gusts of up to 314 kilometres per hour, heavy rain and waves taller than palm trees were experienced in parts of the Philippines on 8 November 2013. As figure 1 shows, the storm **intensified** over the Philippines then weakened as it moved out to the South China Sea and South-East Asia.

FIGURE 1 Typhoon Haiyan left a trail of destruction across Asia.

FIGURE 2 The storm surge from typhoon Haiyan led to widespread flooding.

Philippines

More than a million people living in low-lying areas were forced to flee as the strong winds caused massive waves. Super Typhoon Haiyan led to the deaths of more than 6500 people, 27 000 people were injured, and nearly 2000 are still listed as missing. Entire villages were flattened by winds and a storm surge damaged or swept away homes, roads, airports, farms, water and power supplies (figure 2). Typhoon Haiyan is considered to be one of the strongest storms ever to hit land.

The access to fresh water by communities affected by a typhoon is seriously affected. Water sources are contaminated by sea water and disease. Power supplies are cut and residents have to wade through waist-deep water while also dodging debris. **Shanty towns** may be transformed into floating garbage dumps.

shanty towns slum settlements housing the poor on the outskirts of major cities in developing nations. They lack basic services such as clean water, sanitation and electricity.

Farming and tourist industries were devasted by Typhoon Haiyan. Rice paddies, sugarcane plantations and coconut palms will need to be replanted and allowed to grow. The Philippines in normal times accounts for more than 40 per cent of the world's exports of coconut oil. Many tourists cancelled bookings to popular tourist resorts such as Boracoy, so jobs and valuable export income are lost (figure 3).

FIGURE 3 After the typhoon, debris littered the land as a result of devastating winds and flooding.

FIGURE 4 An aerial photograph of Tacloban city, Philippines, taken before the typhoon

FIGURE 5 Tacloban city bore the brunt of the typhoon's power.

Vietnam

Tourist communities were impacted when Typhoon Haiyan cut a path through northern Vietnam. Around 600 000 people around Ha Long Bay were ordered to evacuate from low-lying areas to community shelters, and advised to bring enough food and water supply for three days. Hundreds of flights were cancelled and boats were ordered to return to ports.

Palau

All homes on the island of Kayangel in Palau's north were destroyed during Typhoon Haiyan. Early warnings of the storm allowed residents to prepare their homes or evacuate. During the storm, radio communication was cut off but some mobile networks allowed communities to keep informed through text messages. Residents who ignored an order to evacuate were left in shelters with no access to power. It was estimated that it would take three to five months to restore water and power supplies to the island.

ACTIVITIES

IDENTIFY

1 What is a typhoon?
2 What areas were affected by Typhoon Haiyan? Describe how they were affected.
3 Does a typhoon need to cross the coastline to cause damage or loss of life? Explain.

EXPLAIN

4 Describe the ***scale*** of Typhoon Haiyan. Why did this typhoon cause devastation to a wide area spanning several countries?
5 Account for the extent of damage experienced in low-lying ***environments***.

PREDICT

6 What short-term risks and long-term risks do you think the residents of typhoon-affected communities face? Explain.

APPLY

7 What is the attraction of Boracoy and Ha Long Bay for tourists? Prepare a tourist campaign designed to promote and reassure tourists that they should choose each of these ***places*** for their next holiday.
8 Why is access to fresh water so limited after a major storm event?
9 Describe the ***interconnection*** between Typhoon Haiyan and the Philippines, Vietnam and Palau.

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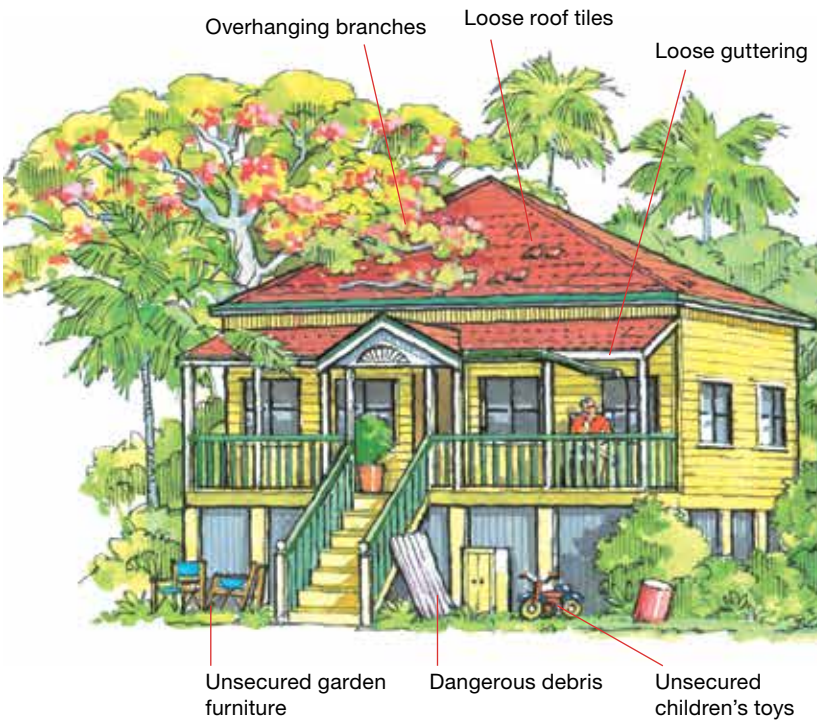
- **Hurricane Sandy**
- **Cyclone Nargis**

15.13 How do we respond to extreme weather and water events?

FIGURE 1 An unprepared home



15.13.1 How do I prepare?

With today's modern technology we have access to a wealth of information that enables individuals and communities to prepare themselves for the wild winds over which they have no control. In many cases, the winds also bring vast amounts of rainfall and the land is often inundated. While we can in some ways prepare for such events, it is inevitable that both the natural and built environment will be impacted.

People who live in disaster-prone areas should know the risks associated with the potential hazards they face and the time of the year when they are at greatest risk. In Queensland, for example, where tropical cyclones bring flooding rains, houses are often built on stilts.

The key to survival is to be prepared. Securing your home and having an emergency kit are two important things that can be done on a continuing basis.

FIGURE 2 A well-prepared home

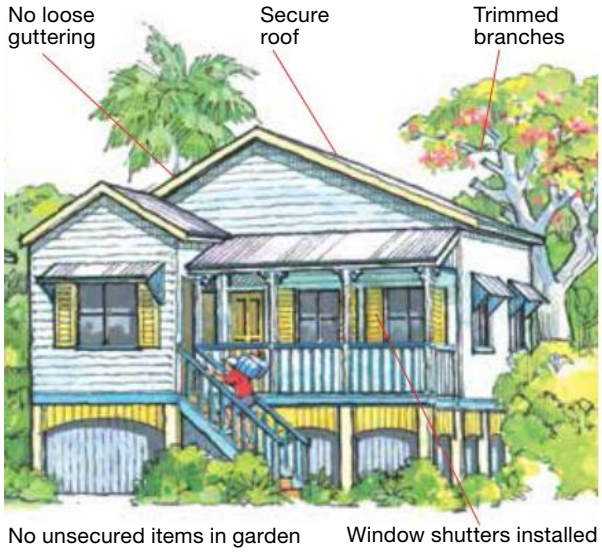


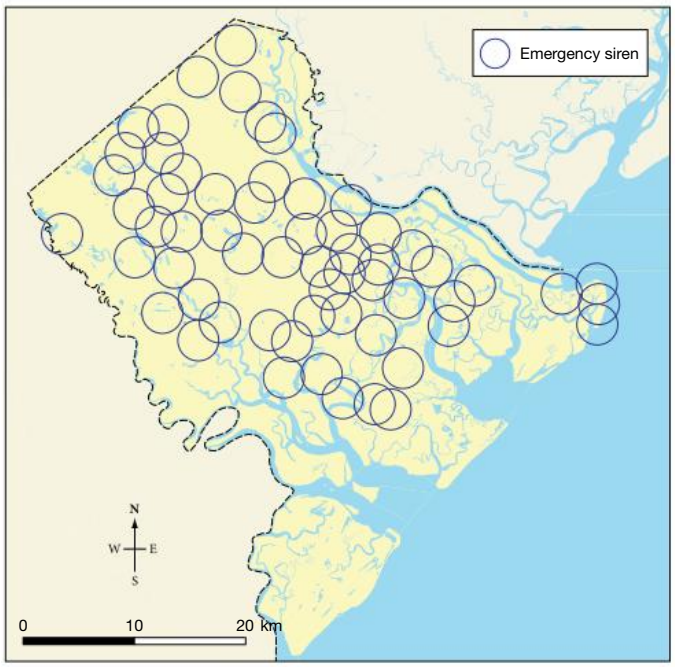
FIGURE 3 An emergency kit

15.13.2 What happens in Chatham County?

Chatham County is located in the US state of Georgia. It has a population of approximately 270 000 and occupies an area of 1637.6 square kilometres.

On average, Chatham County expects up to 19 severe thunderstorms each year. As Georgia lies in Tornado Alley, people in Chatham can also expect an average of six tornadoes each season. In order to assist residents, a network of early-warning sirens has been installed in places where people typically tend to gather. Ninety-five per cent of the county is covered. When the sirens give out their distinctive, extended wail, residents know to seek shelter. Most homes and public buildings in the county are equipped with storm cellars.

FIGURE 4 Location of sirens in Chatham County



Source: Spatial Vision

FIGURE 5 Entrance to a storm cellar

Did you know?

- Dwellings in regions that are prone to snow and heavy rain have steeply sloping roofs to prevent the build-up of water, ice and snow on the roof. In contrast, houses in hot, dry climates often have flat roofs.
- When cyclones and tornadoes are approaching, you should turn off all power.

- A small room such as a bathroom is the safest place to take refuge if you do not have access to a storm cellar.
- Special building codes exist in areas prone to tornadoes and cyclones, with their associated strong winds.
- Shutters on windows help keep water out and reduce the likelihood of injury from broken glass.

FOCUS ON FIELDWORK

Responding to a flood hazard

Task
Devise a plan for a response to a flood at your school, in your town or suburb

Preparation
Create a map of a part of your school, town or suburb *most likely* to flood.
Consider the image shown in figure 6.

Fieldwork
In small groups, decide which of the strategies used in the image would be appropriate for your site. Propose locations for each strategy shown in figure 6. Propose two evacuation points and photograph them.

Reflection
In your opinion, what makes a good evacuation point? Which of your evacuation points is best? Justify your reasons.

FIGURE 6 Flood hazard warning sign

ACTIVITIES

EXPLAIN
1 Study figures 1 and 2. Explain to the people who live in the house shown in figure 1 what they need to do to prepare their home for the next cyclone season. Identify particular hazards and the potential risks they pose.
2 Explain why the homes shown in figures 1 and 2 are elevated.
3 What do you think poses the biggest threat — wind or water? Justify your choice.
4 What have people in Chatham County done to deal with hazards in their ***environment***?

PREDICT
5 What do you think the people who live in figure 2 are preparing for? Give reasons for your answer.

APPLY
6 The residents of the house shown in figure 2 live in a ***place*** that has been placed on cyclone alert and have asked you for advice. They have begun preparing an emergency kit like the one shown in figure 3. Other than food, what items would you suggest they include?
7 What items do you think you would need in a blizzard that you would not need in a thunderstorm, tornado or tropical cyclone? Explain.
8 Which regions within Chatham County are not well covered by sirens? Use evidence from the map to suggest a reason for this.

15.14 How do we manage extreme weather and water events?

15.14.1 How do we predict extreme events?

Climate change is any change in climate over time, whether due to natural processes or human processes. Evidence shows that extreme weather events are occurring more frequently in a range of places. Around the globe, temperatures are increasing, polar ice is melting and sea levels are rising. Studies of this change to the environment assist in the development of management strategies to help vulnerable communities.

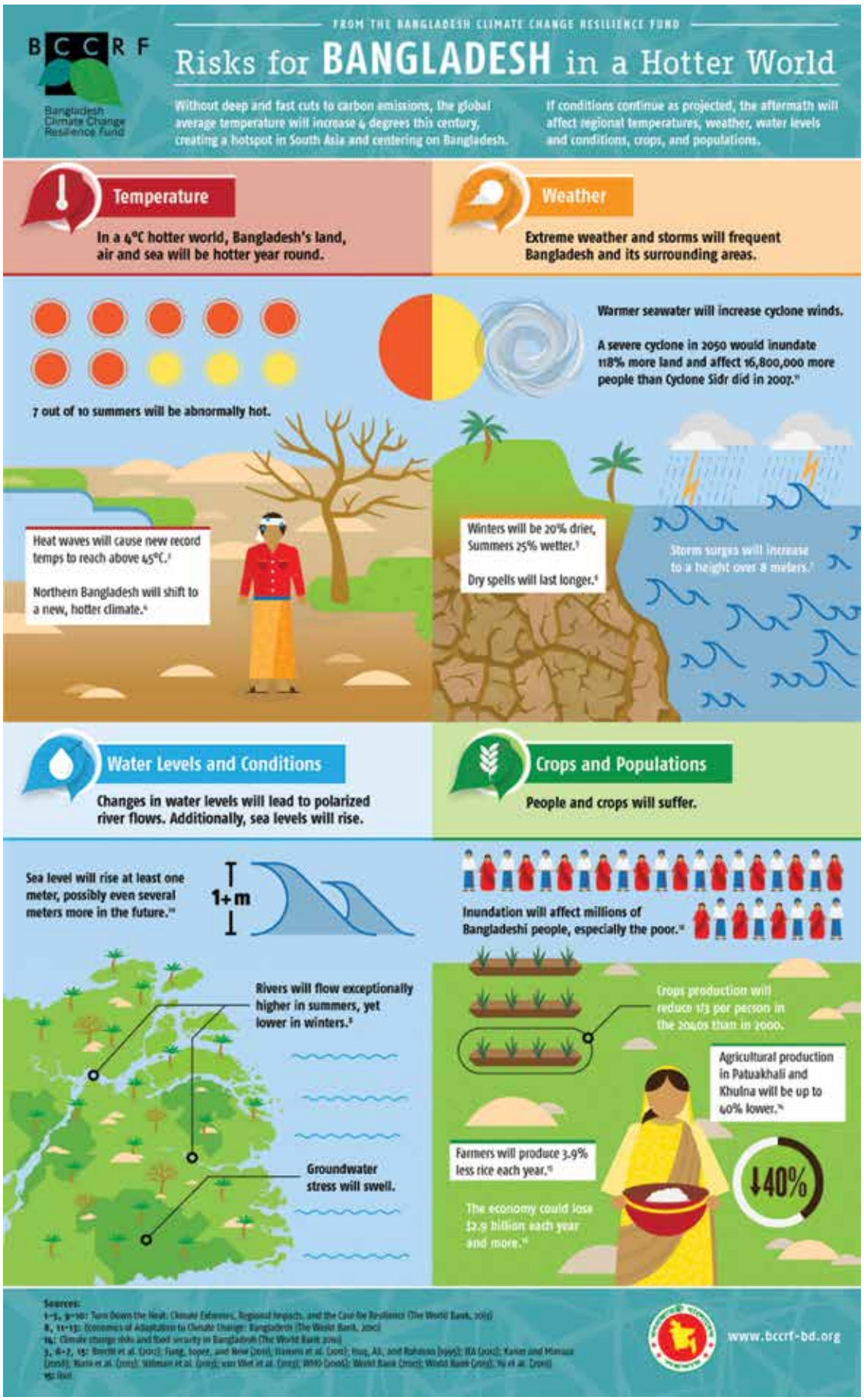
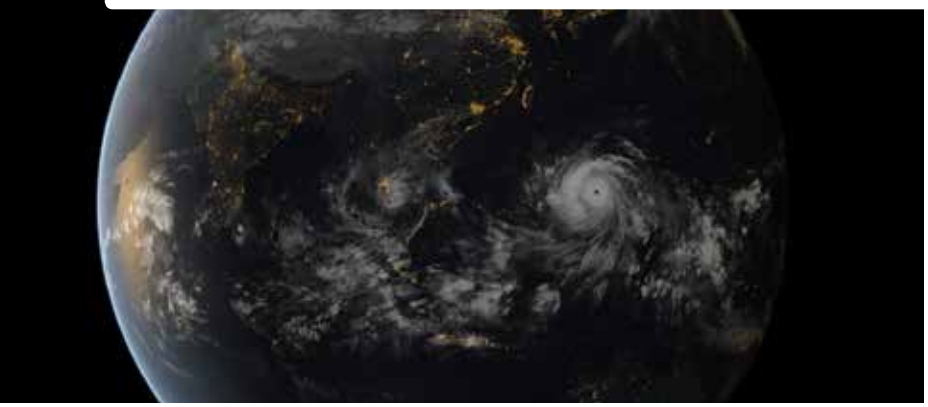


FIGURE 1 Predicted changes to our environment as a result of climate change

FIGURE 2 This global view of a tropical cyclone provides a valuable perspective on the threat of a hazard.



In response to changes to weather events, efforts are being made to ensure natural hazards are being closely monitored on a global scale. Satellite technology is being used to examine the development and movement of intense weather patterns. This data is analysed and shared, enabling us to develop a better understanding of current patterns and to develop future policy. Images of the development of a cyclone show atmospheric measurements such as wind strength, temperature, rainfall intensity and air pressure. Forecasts enable emergency services to predict when a hazard such as a cyclone will reach land and put communities at risk of harm.

FIGURE 3 Social media warning of tropical cyclone threats based on Rapidscat technology

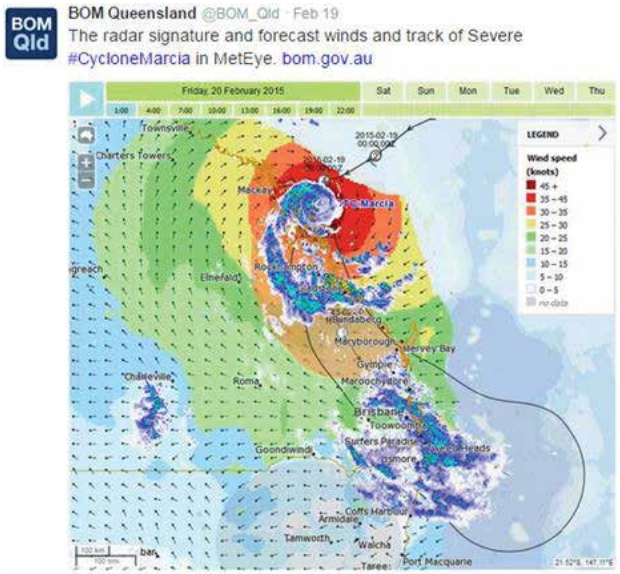
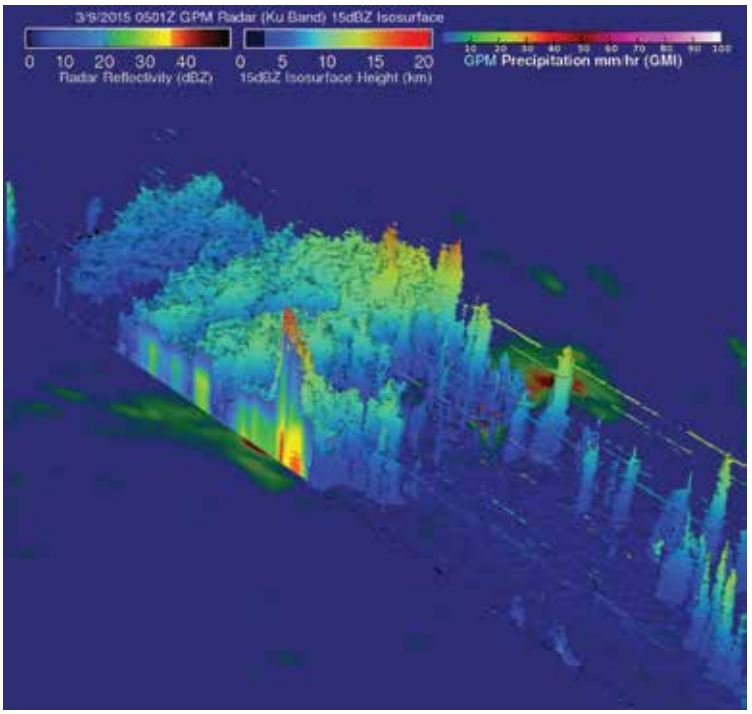


FIGURE 4 The anatomy of Cyclone Pam is visible as radar technology measures the storm.



15.14.2 Responses

When forecasts suggest that an extreme weather event will affect a particular region, responses are put into place to protect and prepare communities. Warnings are issued to fishing boats along the coast advising them to return to shore; residents of low-lying places may be evacuated to safer areas; and emergency supplies of water, shelter and medical supplies are organised.

Being interconnected

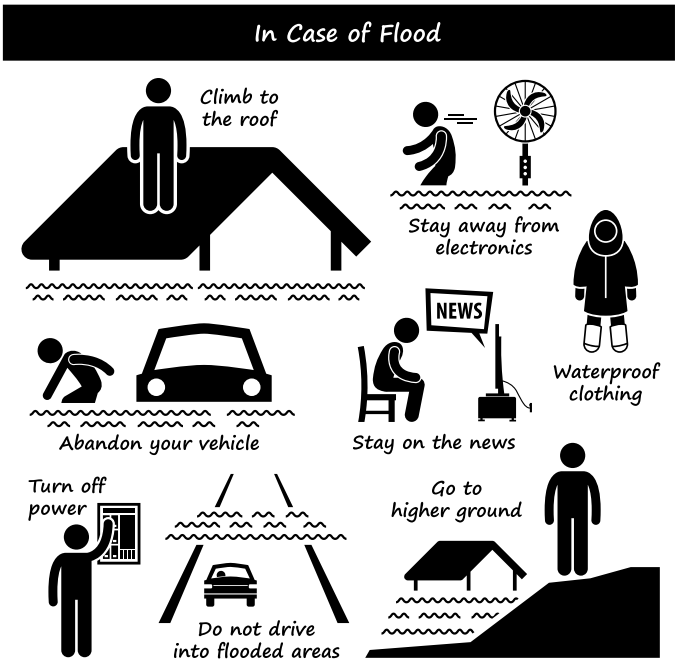
Local people are usually the first to start rescue and relief efforts. The governments of countries affected by severe natural hazards are initially overwhelmed by the community need. Water, health, power, communication and transport services may all need to be restored. Governments may pledge emergency support in the form of monetary aid, skilled personnel and emergency rations of bottled water, medical supplies, and food and temporary shelters for the displaced and homeless. Defence personnel may be deployed to ensure that unlawful activities do not occur. The National Critical Care and Trauma Response Centre based in northern Australia can respond quickly to national and international disasters. Many non-government organisations (NGOs) also provide for the emergency needs of the homeless and injured. Individuals around the world can contribute to the efforts of these organisations through donations and volunteer efforts.

FIGURE 5 Safe water supplies are difficult to access during a hazard, as flooding and burst pipes lead to water contamination and disease.

FIGURE 6 Power supplies can be cut and live power can cause danger within the community.

FIGURE 7 After the disaster, law and order need to be restored.

FIGURE 8 A simple education message designed to prepare people for flooding



How can we plan for the future?

Minimising the risks of future hazards is important. This can be done by constructing sea walls to secure coastal areas vulnerable to erosion; urban planning; educating people at risk; and developing a warning system to alert local communities.

ACTIVITIES

IDENTIFY

1 Outline the ways we can become more ***interconnected*** when an extreme weather event occurs.
2 What can *you* do as an individual to respond to communities in need?

EXPLAIN

3 Why is climate ***change*** linked to extreme weather events?
4 Explain how the use of technology enables us to be better prepared for extreme weather events using specific examples.

INVESTIGATE

5 'Climate change is being blamed for the higher incidence of extreme weather events.' Working with a partner, select one extreme weather event and suggest two reasons to support this statement and two reasons that argue against this claim.
6 In many isolated communities or communities located in poorer developing regions, there are often low levels of literacy and limited resources to respond to natural hazards. Develop a poster or a short video presentation designed to communicate a survival message to people in these areas.

15.15 How does flooding affect the Narrabeen lagoon?

15.15.1 Narrabeen lagoon

Narrabeen lagoon is 55 square kilometres in size and is the largest coastal lagoon in the Sydney region. The suburbs around the lagoon support a large number of residents. Residents and tourists are attracted to the area to enjoy a range of outdoor recreational opportunities such as fishing, kayaking, cycling, sailing, walking and picnics.

The main body of Narrabeen lagoon is fed by stream flow that drains off surrounding elevated suburbs. The lagoon is connected to the sea by a narrow channel that is often blocked by sand movement along North Narrabeen beach. Severe storms can result in flooding of the low-lying suburbs and roads. Rainfall totals and river levels are monitored throughout the catchment, and warnings are issued to motorists and residents when flooding is predicted.

FIGURE 1 Road closures disrupt traffic during flooding.

ACTIVITIES

IDENTIFY

1. What is the direction of stream flow along Deep Creek?
2. What is the area reference of:
   - a Cromer Heights
   - b Sanctuary Island
   - c the lagoon mouth (where the lagoon flows out to the sea)?
3. Identify the human feature found at:
   - a GR 989375
   - b GR 945400
   - c GR 958408.

EXPLAIN

4. Which areas in figure 2 are less likely to flood in the Narrabeen lagoon region? Why?
5. The Wakehurst Parkway is an important link between places in Sydney's north.
   - a Where do you think the flood gates that block the road during flooding are located?
   - b Use evidence from the map to explain why you think this would be a good location for the gates.

APPLY

6. Use a digital drawing tool to download the map image and to highlight the areas that you think are likely to flood.
7. Which areas would require residents to evacuate during flooding? Explain why.

INVESTIGATE

8. Research the methods used to warn local residents of flooding. Select one method to evaluate. What is good about this method of communication? What are some of the problems associated with using this method of communication?

FIGURE 2 Topographic map extract of Narrabeen Lakes

Source: Land and Property Information, NSW.

eBook*plus* ONLINE ONLY

15.16 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

CHAPTER 16

Fieldwork inquiry: What is the water quality of my local catchment?

16.1 Overview

16.1.1 Scenario and task

Task: Produce a report and presentation about the water quality of a local catchment or waterway.

Water is our most valuable resource, and the management of this vital resource should be a priority at a local, regional and global scale. Everybody lives near a catchment — there is usually a river, creek, drain or other waterway close to your home, school or neighbourhood. If you live in an urban area, the creek may have been highly modified and may look like a concrete drain. Water quality in these waterways will vary from place to place and is influenced by many factors.

Water quality can affect health in many ways. Rivers and streams act as drainage systems. When it rains, water transports rubbish, chemicals and other waste into drains and, eventually, rivers.

Your task

Your team has been selected to research the water quality of a local catchment or waterway and produce a report and presentation on your findings. Be sure to measure water quality at different locations along the river, creek or stream, and try to determine the causes of different water quality.

16.2 Inquiry process

16.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You can complete this project individually or invite members of your class to form a group. Save your settings and the project will be launched.

- **Planning:** Navigate to your Research Forum. You will need to research the characteristics of your local catchment area. In order to complete sufficient research, you will need to visit a number of sites within the catchment, comparing different locations upstream and downstream of one creek or river. Research topics have been loaded in the system to provide a framework for your research:
  - **What** sort of data and information will you need to study water quality at your fieldwork sites?
  - **How** will you collect and record this information?
  - **Where** would be the best locations to obtain data? You can determine this once you know which waterway(s) you are visiting.
  - **How** will you record the information you are collecting? Consider using GPS, video recorders, cameras and mobile devices (laptop computer, tablet, mobile phone).

16.2.2 Collecting and recording data

It is important that you have some knowledge of the fieldwork location before you visit the site. Access to topographic maps and Google Earth will help you become familiar with the location. Using these tools, complete a sketch map of the waterway(s) and label the sites you are going to visit. You can then scan your sketch map and have it available electronically on the field trip. Alternatively, use Google Maps to record all the sites you visit. Ensure that you bring all the equipment and resources you will need to collect the data with you to each site. It would be useful to work in groups to collect the data, with each group collecting different data at each site. Use the supplied data collection templates electronically on your mobile device, or print copies.

16.2.3 Processing and analysing your information and data

Once you have collected, collated and shared your data, you will need to decide what information to include in your report and the most appropriate way to show your findings. If using spreadsheet data, make total and percentage calculations. Some measurements are best presented in a table, others in graphs or on maps. If you have used a spreadsheet, you may like to produce your graphs electronically. Use photographs as map annotations (either scanned and attached to your electronic map or attached to your hand-drawn map) to show features recorded at each site. You may also like to annotate each photograph to show the geographical features you observed. Describing and interpreting your data is important. There are broad descriptions that can also be made of your findings, which might include the following.

- Where is water quality highest (best) in the waterway studied?
- Is water quality better in the upper reaches of the river or creek?
- Does an urban waterway have better water quality than a rural waterway?
- Does surrounding land use have an impact on water quality?
- Do large waterways have better water quality than smaller waterways?
- What were the main contributors to poor and good water quality?
- How does surrounding vegetation impact on water quality?

Visit your Media Centre and download the report template and the presentation planning template to help you complete this project. Your Media Centre also includes images, videos and audio files to help bring your presentation to life. Use the report template to create your report. Use the presentation template to create an engaging presentation that showcases all of your important findings.

16.2.4 Communicating your findings

You will now produce a fieldwork report and presentation to present your findings. Your report and presentation should include all of the research that you completed and all evidence to support your findings. Ensure that your report includes a title, an aim, a hypothesis (what you think you will find, which is written before you go into the field), your findings and a conclusion. You will also need to recommend some type of action that needs to be taken to improve water quality in the creek or river you visited.

16.3 Review

16.3.1 Reflecting on your work

Think back over how well you worked with your group on the various tasks for this inquiry. Determine strengths and weaknesses and recommend changes if you were to repeat the exercise. Identify one area where you were pleased with your performance, and an area where you would like to improve. Write two sentences outlining how you might be able to do this.

Print out your Research Report from ProjectsPLUS and hand it in with your fieldwork report and presentation, and reflection notes.

Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

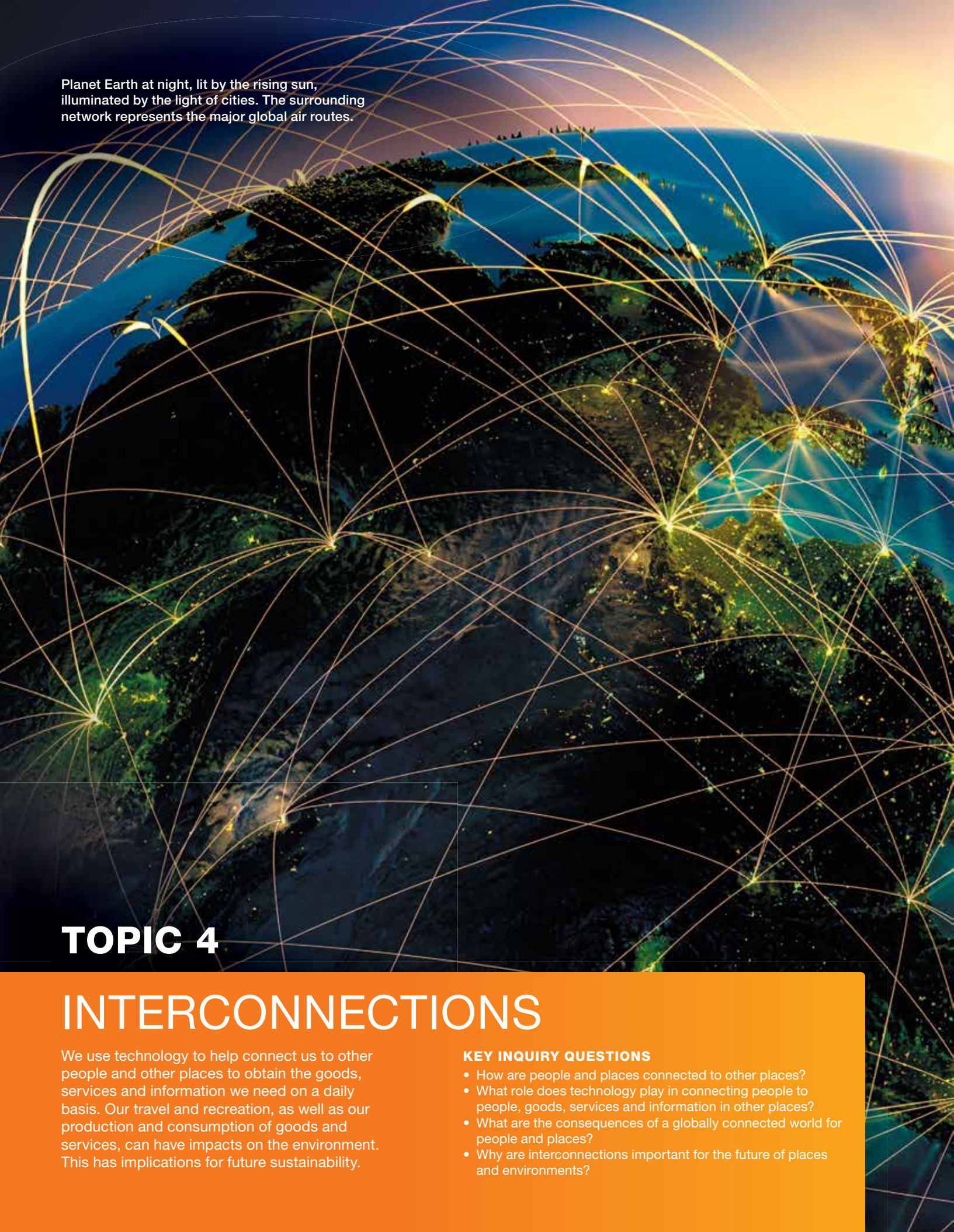
Suggested software

- ProjectsPLUS
- Microsoft Word or any other word processing tool
- PowerPoint or any other presentation tool

Media centre

Your Media Centre contains:

- fieldwork data recording templates
- a report template
- a presentation template
- a selection of images and audio and video files to add richness to your presentation
- weblinks to sites to assist in your catchment research and to provide sample presentations
- an assessment rubric.



Planet Earth at night, lit by the rising sun, illuminated by the light of cities. The surrounding network represents the major global air routes.

TOPIC 4

INTERCONNECTIONS

We use technology to help connect us to other people and other places to obtain the goods, services and information we need on a daily basis. Our travel and recreation, as well as our production and consumption of goods and services, can have impacts on the environment. This has implications for future sustainability.

KEY INQUIRY QUESTIONS

- How are people and places connected to other places?
- What role does technology play in connecting people to people, goods, services and information in other places?
- What are the consequences of a globally connected world for people and places?
- Why are interconnections important for the future of places and environments?

People move to and from many different places for many different reasons.

CHAPTER 17

Personal connections

17.1 Overview

17.1.1 Introduction

The World Tourism Organization estimates that by 2030, five million people will move each day. Where will these people go and what will influence their choices? What impact will these choices have on the places they visit?

Starter question

1 Explain how tourism ***interconnects*** people and ***places***.

Inquiry sequence

		Syllabus outcomes
17.1 Overview		
17.2 Why do we travel?		GE4-2, GE4-3, GE4-4
17.3 Travel patterns		GE4-2, GE4-3, GE4-4
17.4 SkillBuilder: Constructing and describing a doughnut chart	eBook plus ONLINE ONLY	GE4-2, GE4-3, GE4-4
17.5 Sport, recreation and leisure		GE4-2, GE4-3, GE4-4, GE4-5
17.6 Cultural tourism		GE4-2, GE4-3, GE4-4, GE4-5
17.7 Impacts of travel		GE4-2, GE4-3, GE4-4, GE4-5
17.8 SkillBuilder: Creating a survey	eBook plus ONLINE ONLY	GE4-2, GE4-3, GE4-4, GE4-5
17.9 SkillBuilder: Describing divergence graphs	eBook plus ONLINE ONLY	GE4-2, GE4-3 GE4-4, GE4-5
17.10 Future trends and sustainability		GE4-4, GE4-5
17.11 Sustainability and ecotourism		GE4-4, GE4-5
17.12 Investigating topographic maps: How does nature drive tourism in Victoria Falls?		GE4-2, GE4-3, GE4-4, GE4-5
17.13 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	

eBook*plus*

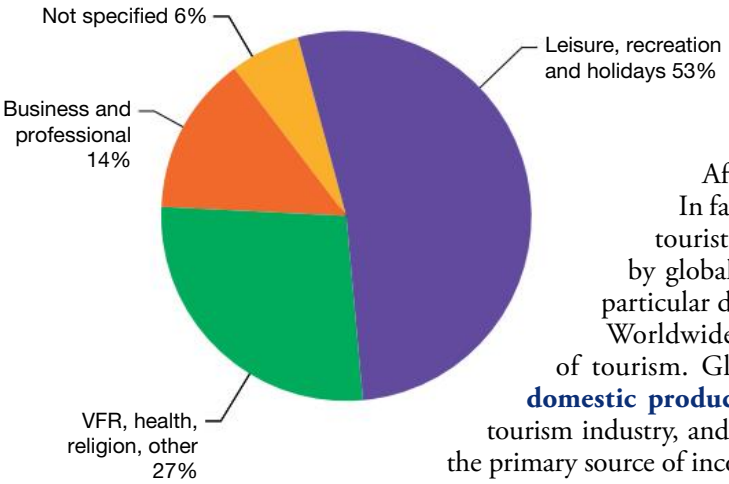
Watch this video
Making connections
Searchlight ID: eles-1722

17.2 Why do we travel?

17.2.1 What is tourism and why is tourism important?

Travel is the movement between places, often a journey between distant geographical locations. Tourism is the temporary movement of people away from the places where they normally work and live. This movement can be for business, leisure or cultural purposes (see figure 1), and it involves a stay of more than 24 hours but less than one year.

FIGURE 1 Purpose of people's travel, 2014



gross domestic product (GDP) the value of all the goods and services produced within a country in a given period of time. It is often used as an indicator of a country's wealth.

Global tourism is expected to increase by 3.3 per cent a year between 2010 and 2030 to reach 1.8 billion by 2030. This is despite global economic issues, political change in the Middle East and Africa, and a range of natural disasters. In fact, some of the world's most popular tourist destinations were those affected by global concerns. Figure 2 illustrates why particular destinations are popular.

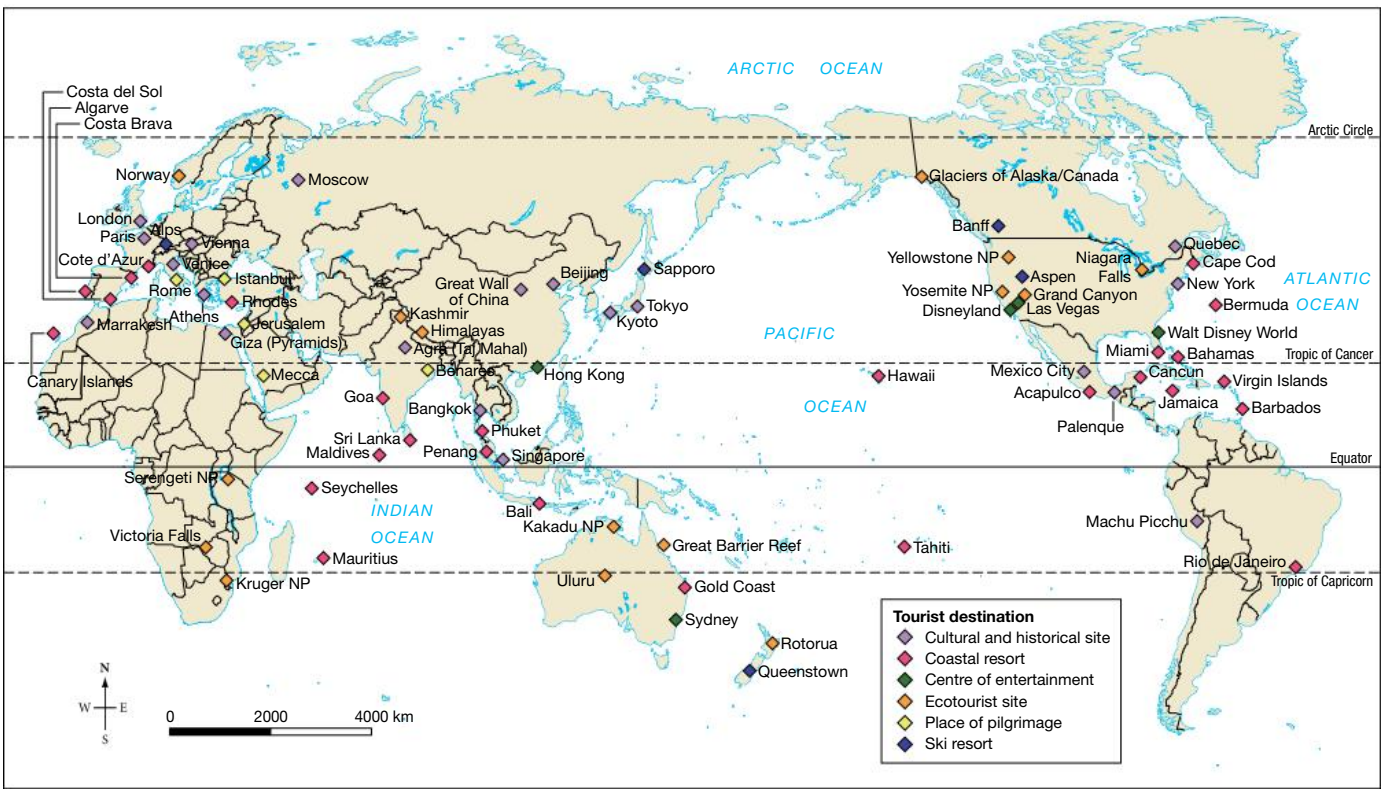
Worldwide, 308 million jobs exist because of tourism. Globally, around six per cent **gross domestic product (GDP)** is directly linked to the tourism industry, and for many developing countries it is the primary source of income.

17.2.2 Why is tourism increasing?

Tourism has increased dramatically over the last 50 years and continues to grow. Advances in transport technology have reduced not only travel times but also cost.

- Today, you can fly from Australia to Europe in around 20 hours, whereas 40 years ago the same journey took six weeks by boat.

FIGURE 2 Types of tourist destinations



Source: Spatial Vision

FIGURE 3 Four kinds of tourist — are all tourists the same?

Organised mass tourist
- Least adventurous
- Purchases a package with a fixed itinerary
- Does not venture from the hotel complex alone; is divorced from the local community
- Makes few decisions about the holiday

Individual mass tourist
- Similar to the organised mass tourist and generally purchases a package
- Maintains some control over their itinerary
- Uses accommodation as a base and may take side tours or hire a car

The explorer
- Arranges their own trip
- May go off the beaten track but still wants comfortable accommodation
- Is motivated to associate with local communities and may try to speak the local language

The drifter
- Identifies with local community and may live and work within it
- Shuns contact with tourists and tourist hotspots
- Takes risks in seeking out new experiences, cultures and places

- Today, airline and tour companies offer a range of cut-price deals, and the increased number of competitors for the tourist dollar means that travel is more affordable.
- Increased awareness and knowledge of the world has sparked people's desire to see new places and experience different cultures.
- In general, the travelling public has more leisure time and more disposable income, making both domestic and international travel viable.

17.2.3 What are the latest trends in tourism?

Tourism is an important component in world economies. One in 12 jobs worldwide is linked either directly or indirectly to the tourism industry. In the first part of the twenty-first century, this industry grew by almost 45 per cent, from 674 million international arrivals in 2000 to 1134 million in 2014. It is predicted that this figure will rise to 1.6 billion in the year 2020 (see figure 4).

Tourists added US$1245 billion to the global economy in 2014 — almost twice the expenditure of the year 2000.

17.2.4 Factors shaping the future of tourism

Tourism is no longer just for the elite. Improvements in transport and technology have increased our awareness of the world around us. Improved living standards, increased leisure and greater disposable incomes have all created opportunities for people to travel and to experience new places and cultures. These factors are also shaping the tourist of the future (see figure 5). A particular growth area is the 18–35 market — young people travelling while studying, taking a break from study, or seeing the world before they settle down. The other major area of growth is the over-60 age bracket.

FIGURE 4 Contribution of tourism to the world economy

FIGURE 5 Factors shaping the future of tourism

Predictions also suggest that Africa and the Asia–Pacific region will be particular growth areas, attracting more and more of the tourist dollar.

Countries such as Kenya and Tanzania offer a different type of tourist experience. Kenya, for instance, offers:

- safety
- beaches and a tropical climate
- safari parks and encounters with lions and elephants
- a unique tribal cultural experience with the **Maasai** people.

Maasai an ethnic group of semi-nomadic people living in Kenya and Tanzania

The resulting influx of tourists to Kenya has led to the establishment of **national parks** to protect endangered wildlife and promote this aspect of the tourism experience. Money flowing into the region helps improve water quality and infrastructure such as water pipes, roads and airports.

national parks a park or reserve set aside for conservation purposes

The true challenge for the future, however, is to ensure that:

- money remains in the local economy rather than in the hands of developers, and is used to improve local services, not just tourist services
- the need of indigenous tribes to farm the land is balanced with tourist development
- tourist numbers are controlled, to ensure that the environment is not damaged.

17.2.5 Medical tourism

Medical tourism involves people travelling to overseas destinations for medical care and procedures. The low cost of travel, advances in technology and lengthy waiting lists caused by increased demand for elective surgery are turning medical tourism into a multi-billion dollar industry.

Medical tourism only used to be for cosmetic procedures, such as face-lifts and tummy tucks, but the range of services offered has expanded dramatically over recent years. It now includes:

- knee replacements
- hip replacements
- fertility treatments (IVF)
- surrogacy services, and
- complex heart surgery.

Countries all over the world are attracting patients for a variety of reasons, which include:

- the high standard of medical care or the
- outstanding reputation of particular facilities
- savings on the cost
- reduced or no waiting time
- the opportunity to include a holiday and luxury accommodation as part of the package.

Asia is the market leader in the medical tourism industry, with Thailand and India

FIGURE 6 Cost savings that can be made by having medical treatment in Asia versus Australia

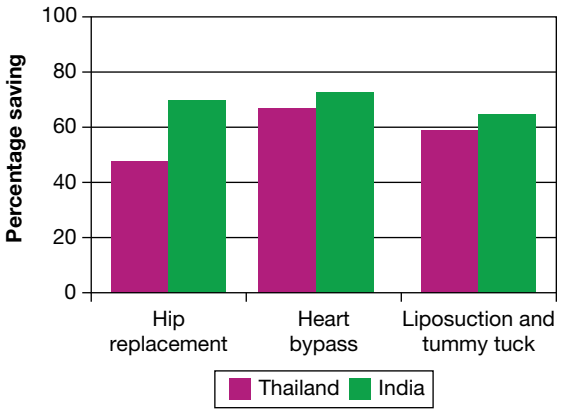
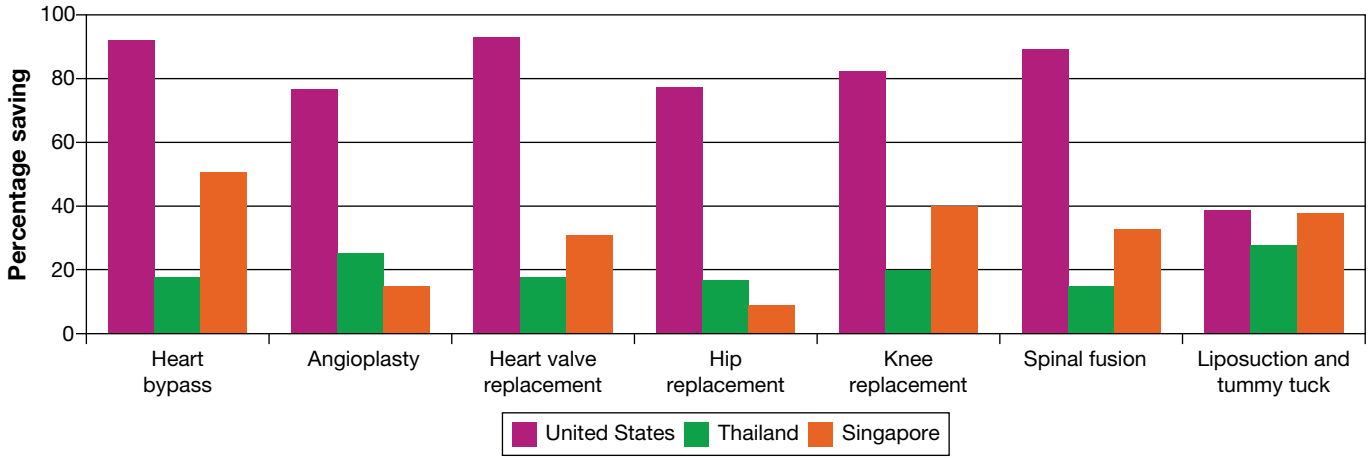


FIGURE 7 Cost savings that can be made by having medical procedures carried out in Malaysia versus the United States, Thailand or Singapore



vying for the number one spot. Thailand is slightly more expensive, but offers a better tourist experience and has greater services available. India is less expensive and boasts state-of-the-art facilities staffed by Western medical staff, predominantly from the United States. Figures 6 and 7 show the savings made between developed and developing countries. Medical tourism is expected to add more than US$8.5 billion to Asian economies this year.

GEOskills TOOLBOX

Linear scale

Many graphs such as the column graphs in figures 6 and 7 will use a linear (or line) scale. This means the values (for example percentages, dollars or years) change in equal increments. This makes it easy to see the differences between different categories.

ACTIVITIES

IDENTIFY

1 What is a tourist?

2 Why do you think tourism is one of the fastest growing industries?

EXPLAIN

3 Using your atlas as a primary source of information, select three ***places*** from different categories shown in figure 2 that you might like to visit.

- **a** Calculate the distance between them.
- **b** Explain how you would travel to each.
- **c** Explain what you might expect to see and do in each ***place***.
- **d** Work out how long it might take to visit each ***place***.
- **e** Describe each location using geographical concepts such as latitude and longitude, direction and ***scale***.
- **f** Explain why you have chosen each ***place***.

INVESTIGATE

4 What type of tourist are you? Make a sketch of yourself, similar to the one shown below.

Annotate your cartoon to describe yourself as a tourist, using information in this section to help you. Include information about your ideal holiday and explain why you appear as you do in your cartoon.

APPLY

5 In 2014, 1133 million tourist movements were recorded globally. How many movements is this per day?

6 **a** Using information in this section, predict how many tourists there will be in 2020. What percentage increase does this represent?

- **b** Which ***places*** do you think will be the most popular?
- **c** What impact do you think these increases will have on the ***environment***?
- **d** Will this result in small-***scale*** or large-***scale change***?
- **e** Do you think these numbers are ***sustainable***? Explain.

7 Tourism expenditure increased by 160 per cent between the year 2000 and the year 2014, from $475 billion to $1245 billion. Using these figures as a guide, predict how much income might be generated through tourism by 2030.

8 Look back over your responses to the last three questions. What does this tell you about the importance of tourism? Explain.

9 **a** Explain what you understand by the term *sustainable tourism*.

- **b** Describe an example of tourism that would be considered ***sustainable***.
- **c** Describe an example of tourism that would not be considered ***sustainable***. Suggest what ***changes*** might be needed to make it ***sustainable***.

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.

› **World tourism**
› **Victoria Falls**

17.3 Travel patterns

17.3.1 Why is global tourism on the rise?

Tourism is one of the world's largest industries. Even when global economies are experiencing a downturn, people still travel. After natural disasters, countries rely on the return of the tourist dollar to help stimulate their economies. However, the spread of tourism is not uniform across the globe.

FIGURE 1 Backpackers spend more, travel further and stay longer than other tourists.

Over time, travel has become faster, easier, cheaper and safer. Economic growth has meant that many now have more money to spend and can afford to travel. Increases in annual leave have provided people with more time to travel. For example, Australians and New Zealanders can take long-service leave, which is often spent on an extended overseas trip. It has also become more fashionable for young people to spend time seeing the world during their 'gap year' and to travel before commencing **tertiary study**, establishing a career and raising a family (see figure 1).

tertiary study the educational level following the completion of high school, e.g. university

mature-aged describes individuals aged over 55

developed describes countries with a highly developed industrial sector, a high standard of living, and a large proportion of people living in urban areas

Many young travellers see backpacking as the optimum way to travel. Generally this group:

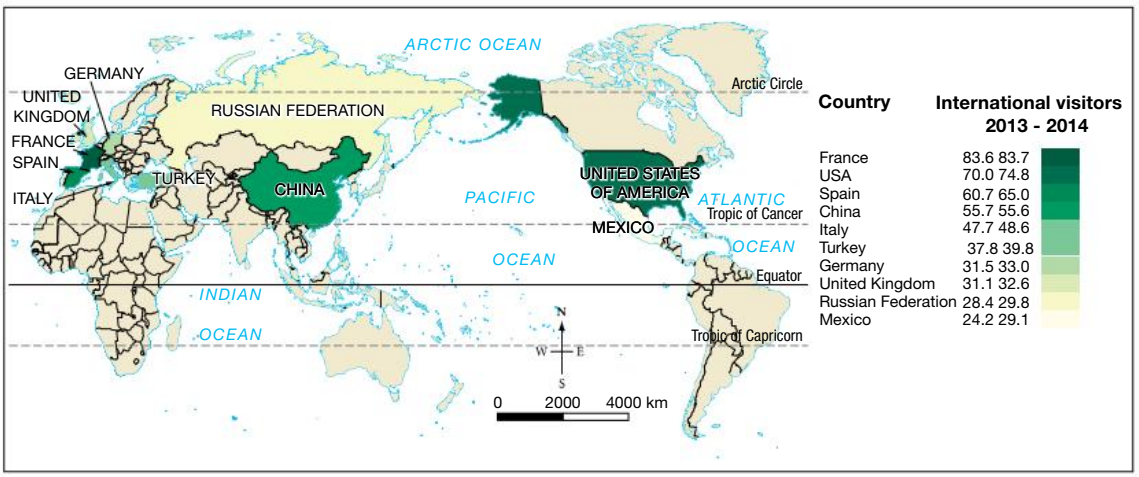
- is on a tight budget
- wants to mix with other young travellers and local communities
- has a flexible itinerary
- seeks adventure
- is prepared to work while on holiday to extend their stay.

At the other end of the scale, there has also been a dramatic growth in **mature-aged** tourist movements. The number of older people in **developed** countries is growing. In many instances, they have older children who are no longer dependent on their parents for support. Some of these travellers have savings, access to superannuation funds, and the opportunity to retire early; thus, they have both the time and the money to travel.

17.3.2 What countries are top 10 destinations?

As each tourist enters or leaves a country, they are counted by that country's customs and immigration officials. This data is collected by the World Tourism Organization, and the results can be shown spatially (see figure 2).

FIGURE 2 World's top 10 tourist destinations



Source: World Tourism Organization (UNWTO)

17.3.3 Who spends the most?

Figure 2 shows the countries that attract the most tourists, but which countries do these tourists come from, and what do they spend? Figure 3 shows the top 10 countries in terms of the money they spend on international tourism. Figure 4 shows the per capita expenditure of the world's top 10 tourist spenders.

FIGURE 3 World's top 10 tourist spenders by expenditure

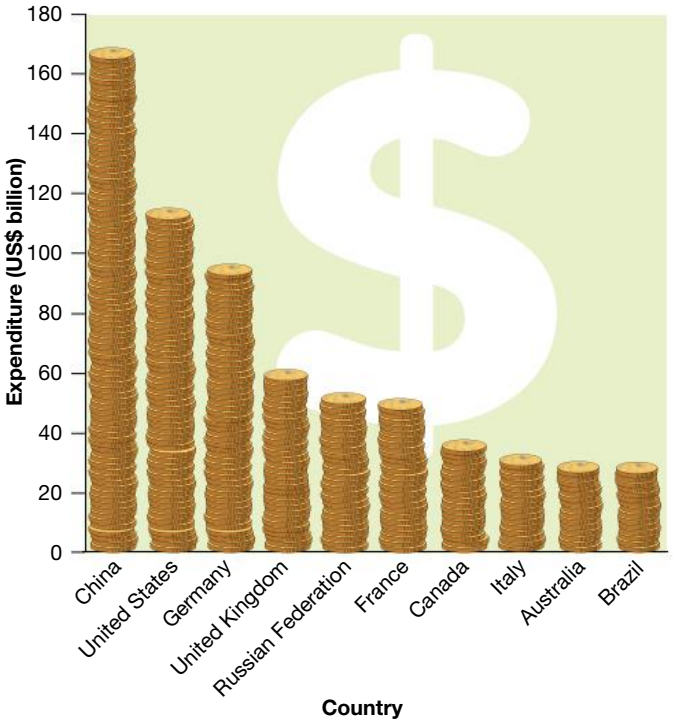
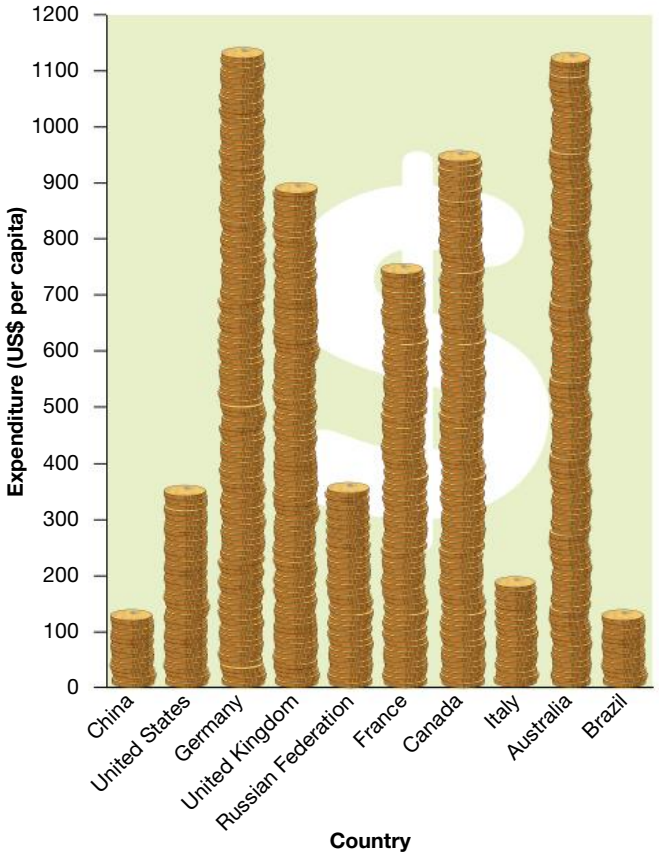


FIGURE 4 World's top 10 tourist spenders per capita



17.3.4 Where do people stay?

The growth of home sharing sites such as Airbnb has enabled people to have a more authentic experience of another culture by allowing tourists to stay in local homes rather than in hotels. Many people use these sites to let out their own homes to other tourists while they themselves are on holiday, therefore engaging in a form of house swapping.

TABLE 1 World's top 5 hotel owners, 2014

Company	Headquarters (country)	Total hotels	Total rooms
Intercontinental Hotels Group	UK	4967	686 876
Hilton Worldwide	USA	4115	678 630
Marriott International	USA	3783	653 719
Wyndham Worldwide	USA	7485	645 423
Choice Hotels	USA	6303	602 663

The growth of Airbnb has been huge. In 2010, there were roughly 50 000 stays in the northern hemisphere summer. By 2015, this had increased to 17 million. While this growth is significant it has not meant that people no longer stay in hotels. Many hotels are now repositioning themselves with new boutique hotels to take advantage of 'ageless millennials'. These are people who are aged between 40 and 70 and have adopted the love of technology, trends and social media, usually associated with 'millennials', to communicate.

ACTIVITIES

EXPLAIN

1 Carefully study figures 2 and 3 and answer the following.
- **a** On which continents are the top 10 destinations located?
- **b** Which continents are generating the most in tourism spending?
- **c** Describe the ***interconnection*** between destinations and tourism spending.

2 What is the difference between a mature-age tourist and a backpacker? With the aid of a Venn diagram, show the differences in the needs of these two groups of tourists.

INVESTIGATE

3 The three main types of tourist attraction are natural, cultural and event attractions. Use a dictionary to help you write your own definition of each term. For each of the countries shown in figure 2, try to find an example of each type of attraction. Use the map in figure 2, section 17.2, to help you.

PREDICT

4 a On a blank outline map of the world, locate and label the capital cities of each of the top 10 tourist destinations.
- **b** Plot a trip from your nearest capital city to all 10 of these ***places***, covering the shortest possible distance, and returning to your capital city. Use the ***scale*** on the map to estimate the distance travelled.
- **c** Calculate the time it might take to complete this journey.

5 a Find out the average cost of a one-week stay in one of the hotel chains shown in table 1.
- **b** How much income would this room generate if it was occupied for each night of the year?

6 a What are the advantages/disadvantages of using a room- or house-sharing site such as Airbnb?
- **b** What would be the advantages/disadvantages of using this service to the local community in which this accommodation is situated?

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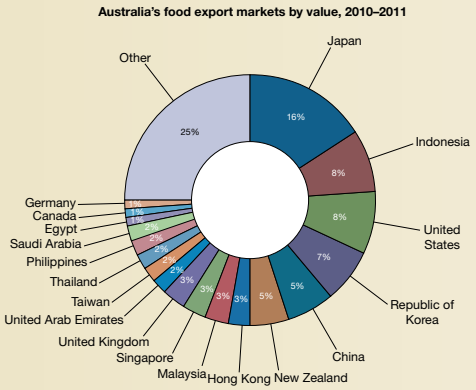
17.4 SkillBuilder: Constructing and describing a doughnut chart

What is a doughnut chart?

A doughnut chart is a circular chart with a hole in the middle. Each part of the doughnut is divided as if it were a pie chart with a cut-out. Presenting the parts in order from largest to smallest makes it easy to interpret.



eLesson

Watch this video to learn how to construct and describe a doughnut chart.

Searchlight ID: eles-1738

Interactivity

Try this interactivity to learn how to construct and describe a doughnut chart.

Searchlight ID: int-3356

17.5 Sport, recreation and leisure

17.5.1 How are tourism and sport connected?

Sport tourism involves people travelling to view or participate in a sporting event. It is an expanding sector of the tourism industry, currently adding $700 billion to global economies each year. It is estimated that, on average, 12 million international trips are made to view sporting events. But what impact does this have on people and places?

Governments spend millions of dollars to attract people to sporting events such as the Olympics, the cricket, soccer and rugby world cups, and motor racing events, to name just a few. These events also trigger:

- construction of new stadiums
- expansion and upgrades of transport networks
- improvements to airport facilities
- clean-ups of cities in readiness for the arrival of tourists.

Sports tourists fall into two broad categories: those who like to watch and those who want to participate. The latter view sport as a part of their leisure and recreational activities (see figure 1). A common trait in all sports tourists is their passion and willingness to spend money to induge this passion.

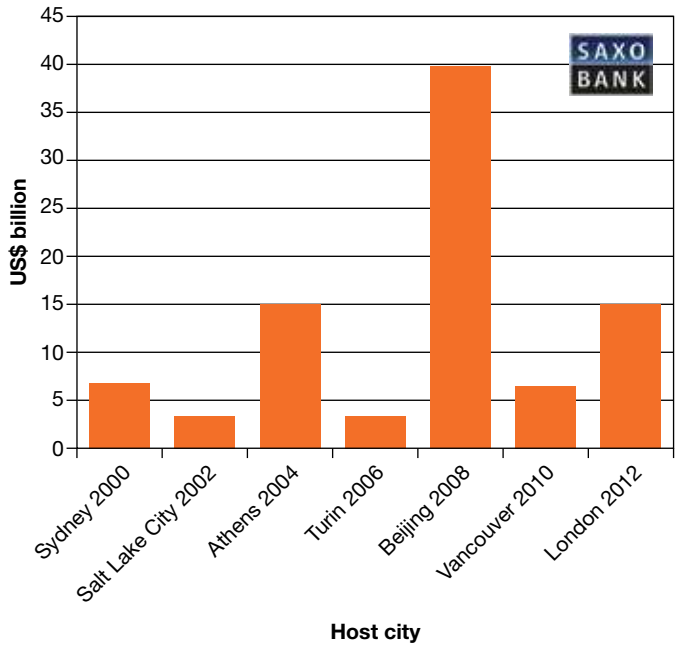
FIGURE 1 On the course — recreational tourism

17.5.2 Are the Olympics a tourist bonanza?

Major sporting events such as the Olympics translate into improved infrastructure, and provide the host city with considerable international exposure. Does this bring in more tourists and justify the capital outlay? (See figure 2.)

The general consensus is that the costs associated with hosting a one-off major event, such as the soccer World Cup or the Olympic Games, do not meet the anticipated outcomes. Statistics show that three million tourists visited the United Kingdom in August 2012 (their Olympic year) — five per cent *less* than in the previous year. Tourism spending, however, went up by nine per cent, in part because of spending on Olympic tickets. In addition, many UK residents chose to holiday overseas rather than remain at home during the Olympic Games. Organisers were also frustrated by the number of empty seats in many of the venues. On the plus side, however, building the Olympic village provided a £6 billion boost to the building and construction industry.

FIGURE 2 Olympics expenditure (both summer and winter games), including infrastructure



Source: Saxo Bank

But what happens to the people who originally lived on the site of the proposed new venues and athletes' village? Quite simply, they are moved on. While they may receive some compensation, land values go up in the shadow of renewed development. Residents simply cannot afford to live in the new developments, nor can they afford to renovate their existing dwelling. In the lead-up to the Beijing Olympics, 1.5 million Chinese people were forced out of their homes to make way for Olympics venues.

Once the event is over, many of the stadiums are under-used, and it can take years to recover from the cost of staging the event. The city of Montreal, for instance, took 30 years to pay back the equivalent of US$6 billion (in today's money) in Olympic spending.

eBook*plus*

Interactivity
Are the Olympics worth gold?
Use this interactivity to further your understanding of the economic impacts of the Olympic Games.
Searchlight ID: int-3337

17.5.3 What is the status of other sports events?

It has generally been accepted that regular sporting events can have financial benefits. In 2014, eight per cent of international tourists visiting the United Kingdom included a sporting event on their itinerary. Most popular was soccer, because of the opportunity to see some of the world's most talented athletes playing in some of the UK's top teams. Official figures show that these fans spent an average of £850 — far more than the average £570 spent by the rest of the tourist population.

Overall, sports tourists stay longer and are not deterred by the weather. Sports and recreation tourism is growing by 14 per cent annually compared with 5 per cent for the rest of the tourism sector.

FIGURE 3 The opening ceremony of the London Olympic Games

FIGURE 4 The Barmy Army comprises thousands of fans who come to Australia to cheer on the English cricket team.

But it is not just football that attracts the crowds. The English cricket team is followed around the world by its unofficial cheer squad, nicknamed the Barmy Army. Other 'fanatics' based in Australia organise 58 tours to 57 destinations each year, taking in some of the biggest sporting events both at home and abroad.

FOCUS ON FIELDWORK

Personal connections

Primary data collection — destination survey
Primary data is vital to a geographer when they are trying to collect and analyse information. Interviews, questionnaires and surveys provide an excellent source of primary data that is straightforward to collect and tailor-made for the task being carried out. Conduct some primary research by comparing popular potential tourist destinations along with the reasons for travel. You could survey your classmates or use your online connections. When your information has been collected, create a table to show the most popular destinations as well as the most common reasons for travel. What other ways do you think you could display your findings?

ACTIVITIES

IDENTIFY

1 **a** Is someone who goes to a local football match a tourist? Explain.
b What if that person travels interstate? Explain.

EXPLAIN

2 Brainstorm a list of sports that might spend money to attract tourists. Categorise these as **hard** and **soft sport tourism** events.
3 Compile a table that highlights the positives and negatives of sport tourism. Choose two positives and two negatives. For each, explain the impact it has on people and ***places***.

APPLY

4 The Phillip Island Grand Prix racing circuit is located 100 kilometres south of Melbourne, Victoria. The island is linked to the mainland by a bridge. The area is popular for its beaches and wildlife, but it is also home to a racing circuit. More than $110 million is generated annually from the circuit's car and bike activities with major events bringing more than 65 000 people to the island.
a What facilities would be needed to cater for such a large influx of people?
b Figure 3 in section 17.7 shows how the tourist dollar can flow from one job to the next. Complete a diagram like this for the Phillip Island Grand Prix circuit.
c Do you think this is an example of ***sustainable*** tourism? Justify your point of view.

hard sport tourism tourism in which someone travels to either actively participate in or watch a competitive sport as the main reason for their travel

soft sport tourism tourism in which someone participates in recreational and leisure activities, such as skiing, fishing and hiking, as an incidental part of their travel

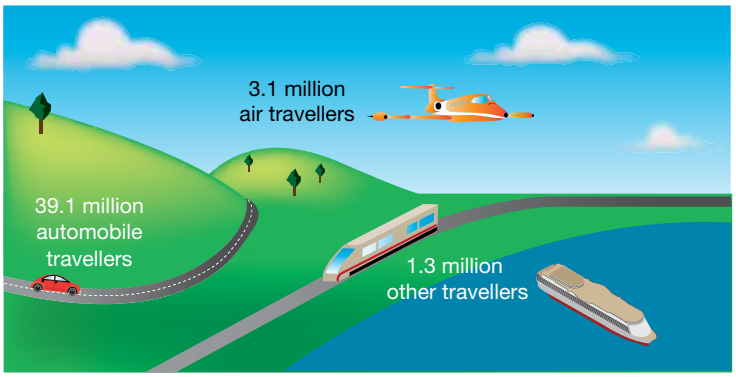
myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
› Sport
› The FIFA World Cup

17.6 Cultural tourism?

17.6.1 What is the impact of Thanksgiving?

Cultural tourism is concerned with the way of life of people in a geographical region. It is usually connected to elements that have shaped their values or culture, such as a shared history, traditions or religion. It may be linked to unique events, such as the celebration of Chinese New Year or Thanksgiving in the United States. Whatever the reason, the mass movement of people associated with these events has a significant impact on both people and places.

FIGURE 1 Thanksgiving and modes of transport



Thanksgiving is held in the United States on the fourth Thursday in November. It dates back to the seventeenth-century celebration of the harvest. Today it is a time for families to get together and give thanks for what they have.

The holiday period runs from Wednesday to Sunday. In 2014, around 46.3 million people travelled an average of 883.5 kilometres to celebrate with family and friends (see figure 1). As millions of people travel across the country, transport systems are stretched to the limits, creating delays and traffic congestion. Because the holiday season is so close to the start of winter, the weather can further complicate people's travel plans, especially those who live in the northern states. Early winter storms can bring ice and snow, resulting in airport closures and impassable roads.

Surprisingly, in 2012, the cost of travel decreased around the time of Thanksgiving. Travellers paid less for fuel, car hire, accommodation and airfares. However, economic conditions in the United States have meant that the average American spent less.

new moon the phase of the moon when it is closest to the sun and is not normally visible

winter solstice the shortest day of the year, when the sun reaches its lowest point in relation to the equator

17.6.2 What is the impact of Chinese New Year?

Chinese New Year is the longest and most important of traditional Chinese holidays. Dating back centuries, it is steeped in ancient myths and traditions. The festivities begin on the first day of the first month in the traditional Chinese calendar, and last for 15 days. They conclude with the lantern festival on Chinese New Year's Eve, a day when families gather for their annual reunion dinner. It is considered a major holiday, and it influences not only China's geographical neighbours but also the nations with whom China has economic ties.

Of special significance is the fact that the date on which Chinese New Year occurs varies from year to year. This date coincides with the second **new moon** after the Chinese **winter solstice**, which can occur any time between 21 January and 20 February.

Chinese New Year, or Lunar New Year, is celebrated as a public holiday in many countries with large Chinese populations or with calendars based on the Chinese lunar calendar (see figure 2). The changing nature of this holiday has meant that many governments have to shift working days to accommodate this event.

FIGURE 2 To ensure prosperity and good fortune in the year ahead, parades, dragons and lion dances feature in Chinese New Year celebrations.

FIGURE 3 The long way home for Chinese New Year

Source: Spatial Vision

In China itself, many manufacturing centres close down for the 15-day period, allowing tens of millions of people to travel from the industrial cities where they work to their hometowns and rural communities. This means that retailers and manufacturers in overseas countries such as the United States and Australia have to adjust their production and shipping schedules to ensure they have enough stock on hand to deal with the closure of factories in China. For those shopping online, goods simply will not be available and will be placed on back order.

The logistics of movement in China

Chinese New Year has been described as the world's biggest annual movement of people. In China, over a five-day period in 2014, 92 500 buses moved 82 million people per day; 14 700 extra flights and 800 additional train services were scheduled. The Ministry of Transport has introduced online ticketing, but the website crashed and now there are problems with scalpers. Some would-be commuters tried for hours to log on, while others queued for up to six days only to find there were no more tickets. One airline traveller flew from Beijing to Kunming in southern China via Bangkok because he could not get a direct flight (see figure 3). Road networks were monitored from the air as tens of thousands made the journey on motorcycles.

eBookplus

Weblink
Thanksgiving

ACTIVITIES

EXPLAIN

1 In your own words, explain what is meant by the term *cultural tourism*.
2 Why are Thanksgiving and Chinese New Year regarded as cultural events?

INVESTIGATE

3 As a class, brainstorm a list of cultural or celebratory events that occur in Australia.
4 Use the internet to find out more about either Chinese New Year or Thanksgiving. Investigate the history, myths and traditions associated with your chosen event. Prepare an annotated visual display comparing your finding with a cultural or celebratory event in Australia. Make sure you include references to the *scale* of your chosen event and the *place* in which it occurs.

APPLY

5 Copy the table below into your workbook and fill it in. Use the **Thanksgiving** weblink in your eBookPLUS to find out more and help you complete your table.
   a What is the preferred mode of transport for Thanksgiving and for Chinese New Year? Suggest reasons for differences in travel arrangements. In your response, include reference to the ***scale*** of movement.
   b Make a list of problems associated with the mass movement of people.
   c Select one of the problems you have identified and explain the impact it might have on people, ***places*** and the ***environment***. Suggest a strategy for the ***sustainable*** management of this problem in order to reduce its impact.
6 Write a paragraph explaining how cultural events can ***change*** people, ***places*** and the ***environment***.

	Thanksgiving	Chinese New Year
Number of trips		
Most common form of transport		
Length of holiday period		
Purpose of trip/activities		

17.7 Impacts of travel

17.7.1 Do the benefits outweigh the costs?

Travelling, and more specifically tourism, seems like the perfect industry. It can encourage greater understanding between people and bring prosperity to communities (see figure 2). However, tourism development can also destroy people's culture and the places in which they live (see figure 1). There is sometimes a fine line between exploitation and sustainable tourism.

Many travellers don't consider or are unaware of the consequences their choices have on both the environment and people of the destination they are visiting. Conversely, many tourists leave their holiday destinations feeling uplifted by their positive experiences and seek to return the favour. The following mind maps outline just some of the impacts that tourism has on people and places.

eBook*plus*

Interactivity
Tourism trauma
Use this interactivity to further your understanding of the effects of tourism.
Searchlight ID: int-3335

FIGURE 1 The negative impacts of tourism

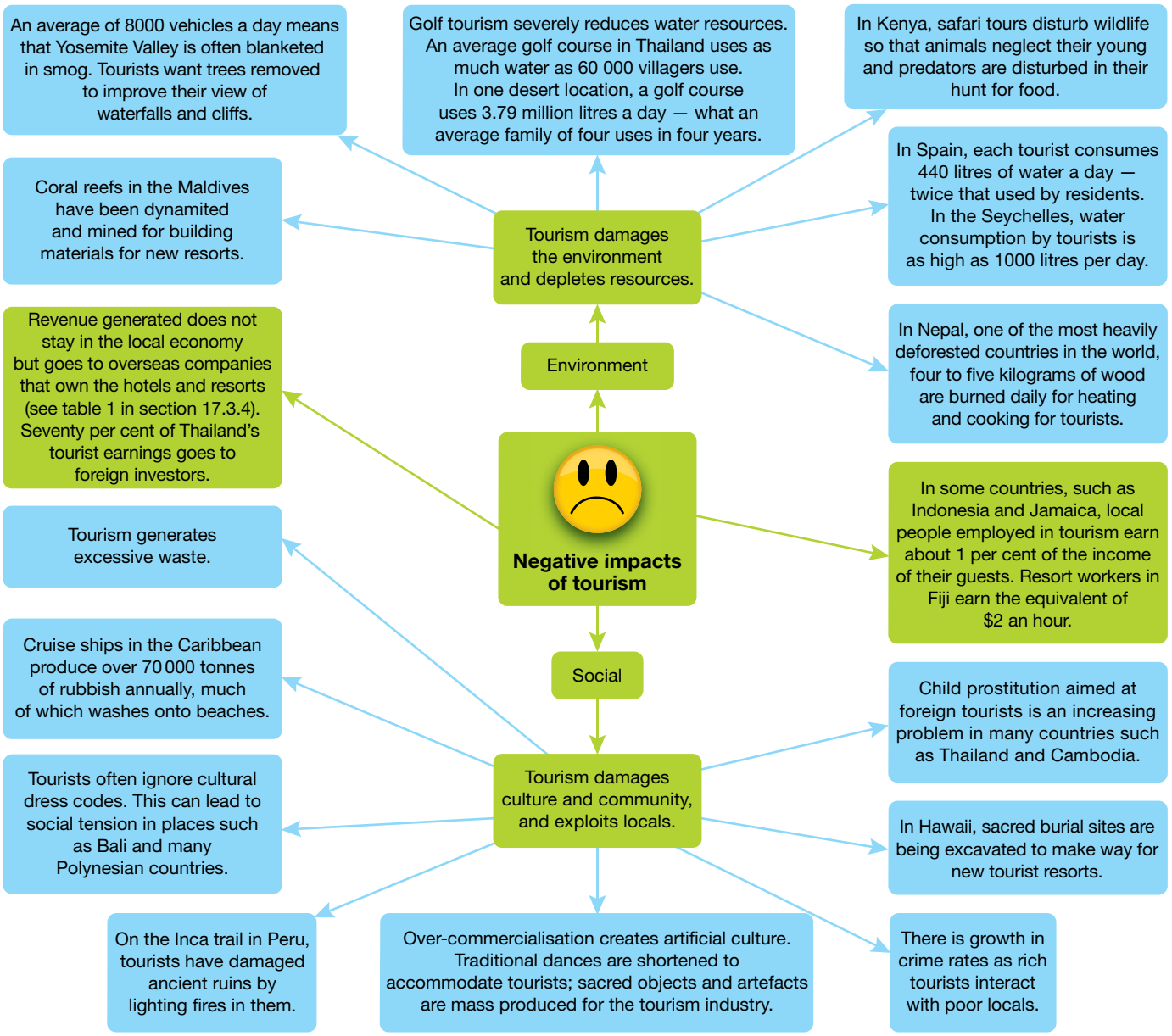
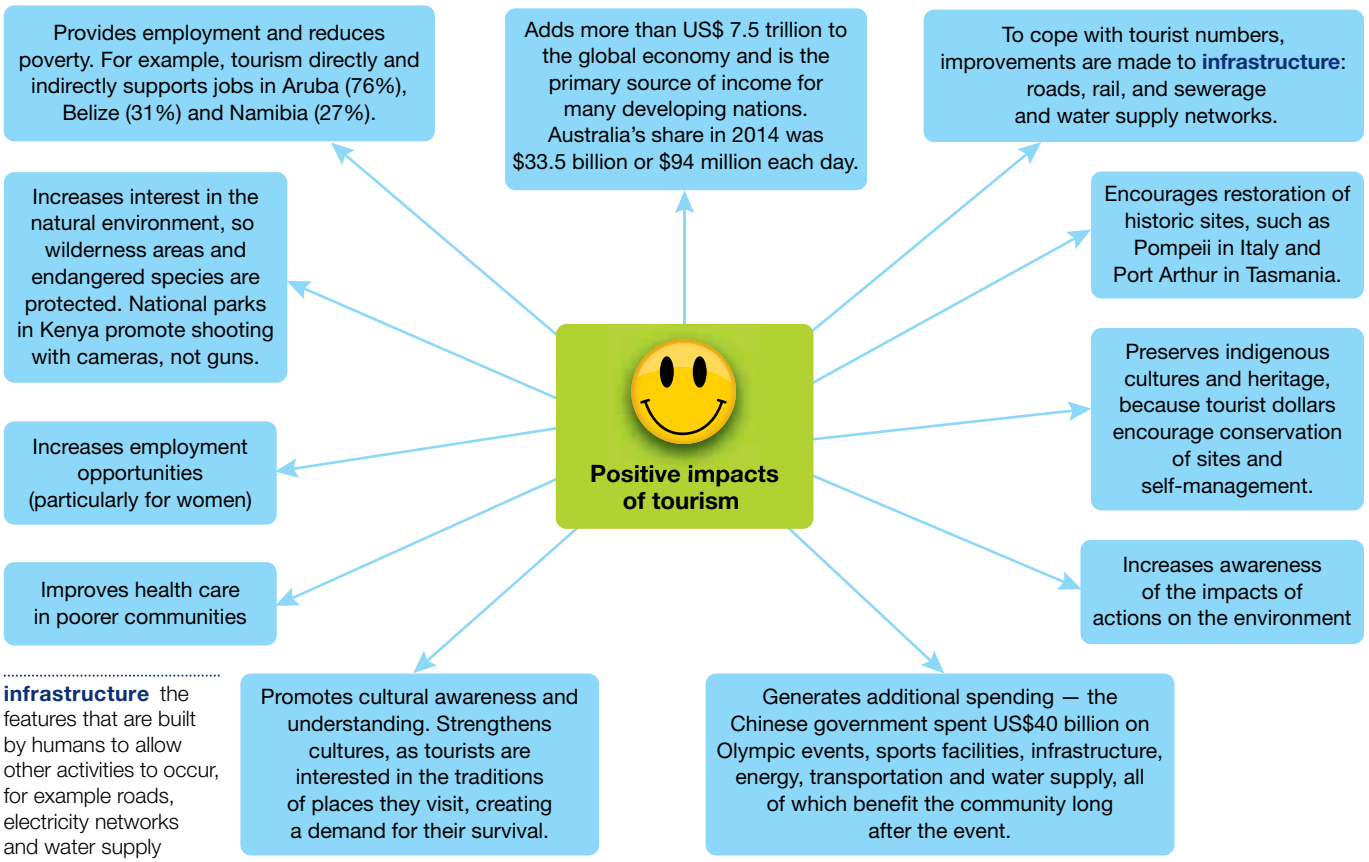


FIGURE 2 The positive impacts of tourism



infrastructure the features that are built by humans to allow other activities to occur, for example roads, electricity networks and water supply

GEOskills TOOLBOX

Flow diagrams

A flow diagram can illustrate how an idea or thing can link to another and then another. It is a good way of showing how certain examples can be connected back to an original concept.

ACTIVITIES

EXPLAIN

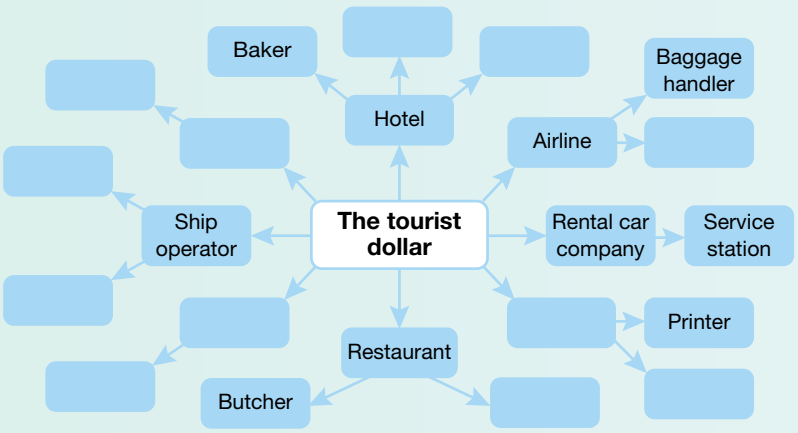
1 Using figures 1 and 2, explain how tourism can have both positive and negative effects.

2 **a** Figure 3 shows how the tourist dollar can flow from one job to the next. Those jobs in the centre of the diagram interact directly with the tourist, while those on the outside do not. Copy the diagram into your workbook at an enlarged size. Complete it by adding other jobs. Add to it if you can. Study your completed diagram and write a paragraph explaining the ***interconnection*** between tourism and the economy.

b Repeat this exercise looking at either the social or ***environmental*** impacts.

3 The type of ***interconnection*** shown between industries in figure 3 is sometimes called the multiplier effect. Explain what you think this means.

FIGURE 3 One view on tourism



4 The impact of tourism can be classified as ***environmental***, cultural and economic. Study figure 1, showing the negative impacts of tourism. Working in groups of three, select an impact from each group. Explain the ***scale*** of each impact and devise a strategy for ***sustainable*** tourism.

5 Which of the following would be the best to develop as a tourist resource in your region: art gallery, museum, cinema complex or sports stadium? Justify your answer.

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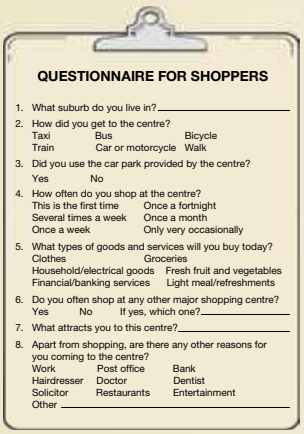
17.8 SkillBuilder: Creating a survey

What is a survey?

Surveys collect primary data. A survey involves asking questions, recording and collecting responses, and collating and interpreting the number of responses. Surveys are useful because they provide statistics for a specific topic that might not be available by any other means.



QUESTIONNAIRE FOR SHOPPERS

1. What suburb do you live in?_____
2. How did you get to the centre?
   Taxi Bus Bicycle
   Train Car or motorcycle Walk
3. Did you use the car park provided by the centre?
   Yes No
4. How often do you shop at the centre?
   This is the first time Once a fortnight
   Several times a week Once a month
   Once a week Only very occasionally
5. What types of goods and services will you buy today?
   Clothes Groceries
   Household/electrical goods Fresh fruit and vegetables
   Financial/banking services Light meal/refreshments
6. Do you often shop at any other major shopping centre?
   Yes No If yes, which one?_____
7. What attracts you to this centre?_____
8. Apart from shopping, are there any other reasons for you coming to the centre?
   Work Post office Bank
   Hairdresser Doctor Dentist
   Solicitor Restaurants Entertainment
   Other _____

eLesson

Watch this video to learn how to create a survey.

Searchlight ID: eles-1764

Interactivity

Try this interactivity to learn how to create a survey.

Searchlight ID: int-3382

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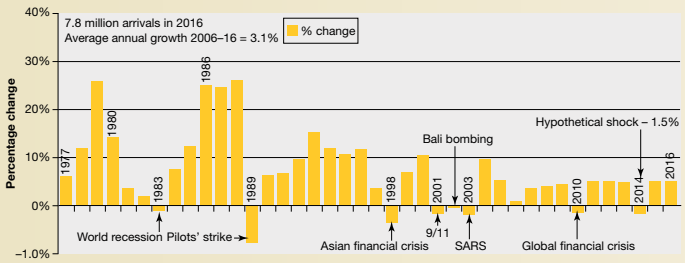
17.9 SkillBuilder: Describing divergence graphs

What is a divergence graph?

A divergence graph is a graph that is drawn above and below a zero line. Those numbers above the line are positive, showing the amount above zero. Negative numbers that are shown indicate that the data has fallen below zero. A divergence graph allows you to identify changes away from the normal in a trend.



eLesson

Watch this video to learn how to describe a divergence graph.

Searchlight ID: eles-1739

Interactivity

Try this interactivity to learn how to describe a divergence graph

Searchlight ID: int-3357

17.10 Future trends and sustainability

FIGURE 1 The Stern family of Colorado spent their Fourth of July holiday in weightlessness during a Zero Gravity Corporation flight on 4 July 2010. Eminent British scientist Stephen Hawking (foreground) has also been a passenger.

mass market the market for goods that are produced in large quantities

bucket list a list of things a person wants to do before they die or 'kick the bucket'

17.10.1 Space tourism

One hundred years ago most travel was undertaken for the purposes of work, migration or war. Only the very wealthy were able to travel for leisure. Since the 1950s we have seen an increase to global tourism of 4400 per cent. Today tourism and travel is a **mass market** product. The growth of package holiday and 'bucket and spade' culture during the past half century along with the growth of low-cost airlines has seen tourism shift from being just about two weeks of sun and fun to ticking items off people's **bucket list**.

Travel to space is an emerging industry. In 2004 the first non-government organisation launched a manned craft into space twice in two weeks. Since then we have had individual tourists stay on the international space station whilst people are already booking to stay in hotels on the moon.

Zero Gravity Corporation celebrates 10 years of weightless flights

A company that makes some of the thrills of spaceflight more accessible to regular folks has hit a major milestone — 10 years of weightless flights.

The Virginia-based Zero Gravity Corp. (Zero G) has now been flying customers on a specially modified Boeing 727 jet for a decade. The plane, known as G-Force One, flies in parabolic arcs that generate brief periods of weightlessness.

Customers usually pay $4 950 for this experience, which can be exhilarating and nauseating at the same time. (G-Force One is sometimes referred to as a "vomit comet.") But the company is knocking 20 percent off the price for all future flights this year.

"We've flown over 500 weightless flights with more than 12,000 clients, including notables like Stephen Hawking, James Cameron, Kate Upton, Halle Berry, Martha Stewart, Sharon & Ozzy Osbourne and Rob Dyrdek. It's been amazing!" Terese Brewster, ZERO-G president and chief operating officer, said in a statement. "In celebration of our 10-year anniversary, we want to say 'thank you' by discounting all remaining 2015 seats."

Source: Mike Davis 25/09/2015 Space.com

17.10.2 The sustainability dilemma

People recognise the benefits that responsible and sustainable tourism can bring to destinations, in terms of employment and the preservation of cultural and natural heritage. However, we are also aware of the growing contribution that flying makes to global warming. Currently aviation accounts for 2 per cent of all CO^2 emissions and 12 per cent of CO^2 from the transport industry. How can we align a desire to visit other cultures in a thoughtful way alongside a conscience that calls for the reduction in our everyday carbon emissions?

17.10.3 What's next?

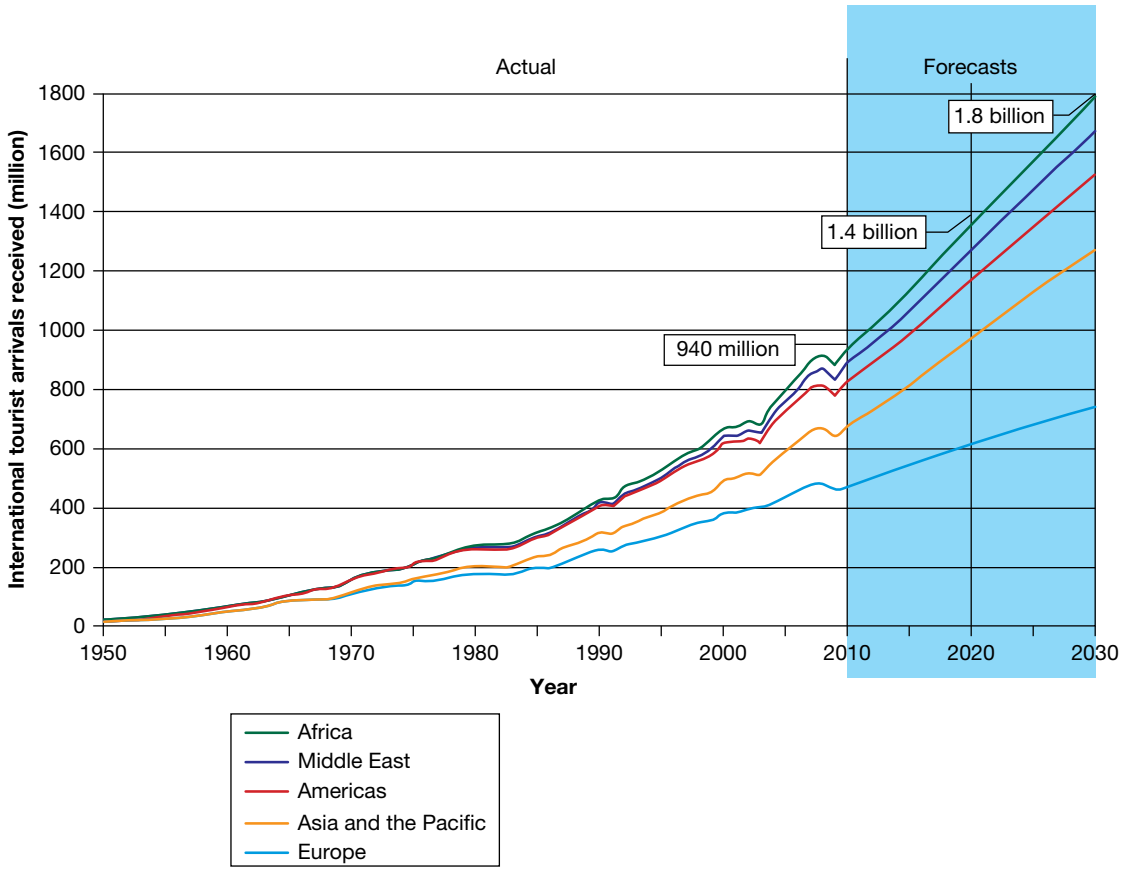
As the cost of flying increases, the 'local' approach to travelling will become more appealing. A new term has emerged in the travel industry of 'geo-local'. In other words, holidaymakers will travel less far from home. We'll begin to travel more often within our own countries and continents, and less frequently

beyond them. Australians may begin to travel more to bush homesteads in rural settings, sleeping 'under the stars' and eat bush tucker. Holidaymakers will increasingly discover that the exoticness of the unknown doesn't have to take the form of a safari through the Africa Savanna.

Tourism will no longer be dominated by Westerners either. We'll see residents of India and China becoming more mobile than ever before, from a leisure perspective. Already, hotels in India and China, that once hosted Western visitors almost exclusively, are beginning to see the proportion of domestic guests rise, in some cases overtaking the number of foreign guests.

By 2020, we'll also see the majority of hotels getting their produce, employees, materials, services and the like from sources within their immediate vicinity. We may see a new type of '10-kilometre hotel' — for which all food and materials will have been sourced from within a 10-kilometre radius. In addition, these hotels can provide energy and water for guests on a metered system, and separate charges for each will appear on their bill. Discounts will be offered for those visitors who keep their energy and water use below average.

FIGURE 2 Trends and forecasts in tourist arrivals



ACTIVITIES

IDENTIFY

1 What are the reasons for the increase in tourism since the 1950s?

2 Read the article entitled 'Zero Gravity Corporation celebrates 10 years of weightless flights'.
- **a** Why would families like the Stern family choose to go on a Zero G holiday?
- **b** What modifications do you think would need to be made to the aircraft and why?

INVESTIGATE

3 Find a company that offers space flight holidays. What are the costs and physical requirements for potential passengers?

4 Design a centre for space tourists. What would be the major obstacles to overcome in the construction of the centre?

APPLY

5 **a** Refer to figure 2. Which region is projected to have the greatest increase in tourist arrivals between 2010 and 2030?
- **b** What is the total and relative increase in tourism numbers between 2010 and 2030?
- **c** List the advantages of a geo-local holiday.
- **d** Plan your own geo-local holiday — where would you like to go and why?
- **e** What are the implications for the tourism industry for the changing nature of where tourists are coming from?

17.11 Sustainability and ecotourism

ecotourism tourism that interprets the natural and cultural environment for visitors, and manages the environment in a way that is ecologically sustainable

17.11.1 Ecotourism and the environment

Tourism has the capacity to benefit environments and cultures or destroy them. **Ecotourism** has developed in response to this issue. The aim is to manage tourism in a sustainable way. This might be through educational programs related to the environment or cultural heritage, or through controlling the type and location of tourist activities or the number of tourists visiting an area.

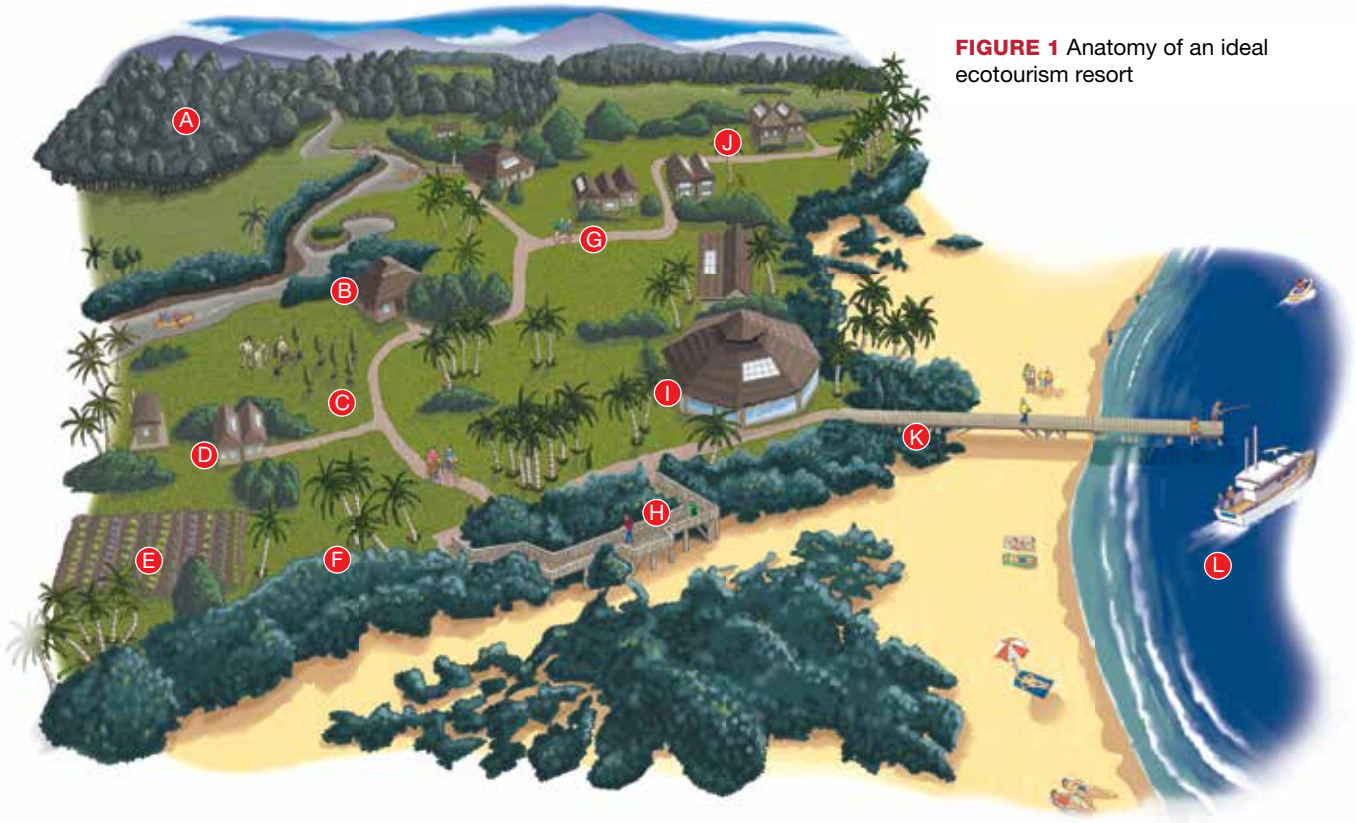
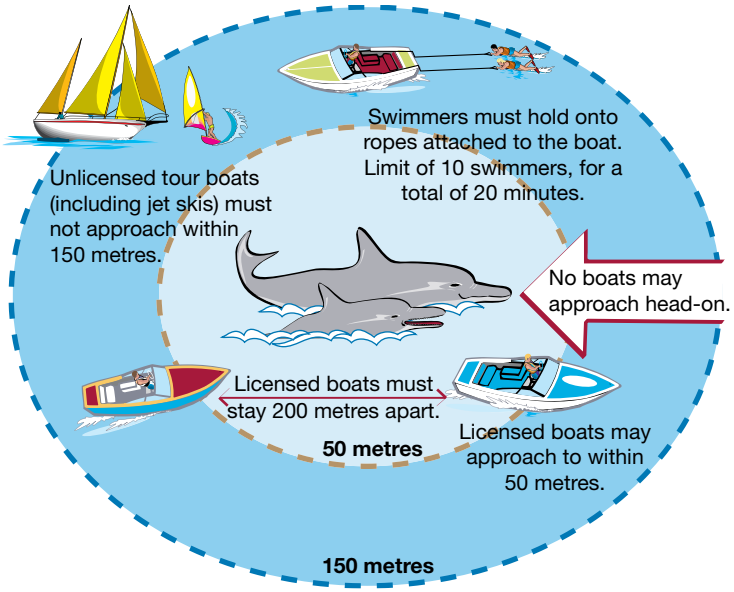


FIGURE 1 Anatomy of an ideal ecotourism resort

- **A** The natural bush is retained and native plants are used to revegetate or landscape the area.
- **B** Composting toilets treat human waste, and worm farms consume food waste. Water is treated with ultraviolet light rather than chlorine. Recycling is practised; for example, grey water is used in irrigation and toilet systems.
- **C** Visitors are encouraged to improve and maintain the environment by using paths or planting trees.
- **D** Buildings blend in with the natural landscape, and local materials are used. Buildings are often raised to prevent damage to plant roots. During construction, builders prevent contamination of the local environment by having workers change shoes and by washing down equipment to keep out foreign organisms.
- **E** Local organically grown produce is used, and craft markets and stalls might also be established and run by indigenous communities, supporting the local economy, creating jobs and reducing poverty.
- **F** There is no golf course, because of the high water use and need for pesticides it would require.
- **G** Low-impact, non-polluting transport such as bicycles are provided for guests.
- **H** Walking trails include educational information boards.
- **I** An information centre helps visitors understand the environment. Local indigenous people are employed to educate visitors about their culture.
- **J** Electricity is generated through solar panels on the roofs of eco-cabins.
- **K** Boardwalks are built over sensitive areas such as sand dunes to protect them from damage. Boardwalks might also be constructed in the tree canopies.
- **L** Trained guides educate tourists about coral reefs and native vegetation, and show visitors how to minimise their impact.

FIGURE 2 Regulations for contact with dolphins



Ecotourism differs from traditional tourism in two main ways.

- It recognises that many tourists wish to learn about the natural environment (such as reefs, rainforests and deserts) and the cultural environment (such as indigenous communities).
- It aims to limit the impact of tourist facilities and visitors on the environment.

Ecotourism is the fastest growing sector in the tourism industry, increasing at around 10 to 15 per cent per year.

Ecotourism Australia (EA) is an organisation that aims to promote ecotourism throughout Australia and the region. It was established in 1991 and has been a world leader and winner of many awards for its work in the field. The organisation aims to establish best practice in the tourism industry and provide information and certification for businesses that share the values of sustainability. In 2014, the value of tour operators certified by EA exceeded $1 billion. This proves the importance of ecotourism and that it is not just a niche segment of the industry.

ACTIVITIES

IDENTIFY

1 How does an ecotourism resort differ from a traditional tourist resort?

EXPLAIN

2 Use a mind map to explore further ***changes*** that could be made to the resort shown in figure 1 to make it even more ***environmentally*** friendly. Would you describe your ***changes*** as small-***scale*** or large-***scale***? Justify how these ***changes*** might be more ***environmentally sustainable***.

INVESTIGATE

3 Visitors to ecotourism resorts are often attracted by brochures that emphasise the resort's ***environmental*** policies. These brochures also set out guidelines to follow in order to minimise visitor impact.

a Design and produce a brochure for the ecotourism resort illustrated in figure 1. Use ICT tools and techniques to maximise the brochure's impact.

b Add another eco-activity to the island and devise strategies to educate tourists and minimise their impact on the ***environment***.

APPLY

4 One of the most famous examples of wildlife-based ecotourism in Australia is Monkey Mia in Western Australia. Here the wild dolphins come into shore and tourists are able to feed them.

a What rules and other techniques are used to control the interaction between dolphins and tourists?

b Predict potential problems that might occur between dolphins and tourists.

c Do you think this is an example of ***sustainable*** ecotourism? Give reasons for your answer.

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Interactivity
Sustainable sightseeing
Use this interactivity to further your understanding of how ecotourism differs from traditional tourism.
Searchlight ID: int-3336

myWorldAtlas Deepen your understanding of this topic with related case studies and questions.
- **Kadadu National Park**
- **Wilsons Promontory**
- **Ningaloo Reef and ecotourism**

17.12 How does nature drive tourism at Victoria Falls?

17.12.1 Tourist mecca

Victoria Falls, or Mosi-oa-Tunya, has been recognised as a World Heritage site due to its spectacular waterfalls. The Falls attract several hundred thousand visitors from around the world each year, which has led to the development of numerous tourist businesses to cater to them.

FIGURE 1 Oblique aerial photo of Victoria Falls

UNESCO has deemed Victoria Falls to be a site of exceptional natural beauty and of geological importance. The main falls, located on the Zimbabwe side of the border with Zambia, drop in excess of 100 metres. Due to the outstanding universal value posed by this collection of waterfalls, a significant tourism industry has sprung up on both sides of the border. Victoria Falls cover an area of 6860 hectares. The region is used for a variety of tourist activities including rafting, helicopter flights, walking with lions, abseiling and bungee jumping, bush walks, mountain biking, jet boats, horseback and elephant back safaris, as well as fly fishing.

ACTIVITIES

IDENTIFY

1 Describe the main vegetation types on the map.
2 What physical feature forms a natural boundary between Zambia and Zimbabwe?
   a A gorge
   b A perennial lake
   c A dam
3 What physical feature can be found at AR7415?
4 Give the area reference for Canary Island.
5 What is the contour interval of the map?
6 In what direction is Main Falls from Lwando Island?
7 What is found at GR757183?
8 Calculate the distance by road from the boat club to Big Tree.
9 How do people staying in Livingstone, Zambia, get to Victoria Falls?
10 Refer to figure 1.
   a In what direction would the photographer have been facing when they took the photo?
   b What natural features would attract visitors to Victoria Falls?

INVESTIGATE

11 List as many human features on the map as you can that have been built because Victoria Falls is a tourist destination.
12 What would be some of the main impacts of the tourist facilities, established in and around Victoria Falls, on the ***environment*** and on people who live in this region?
13 Evaluate the impacts (positive and negative) of tourism to this area.
14 How might Victoria Falls allow for the ***interconnection*** of people from different cultures?

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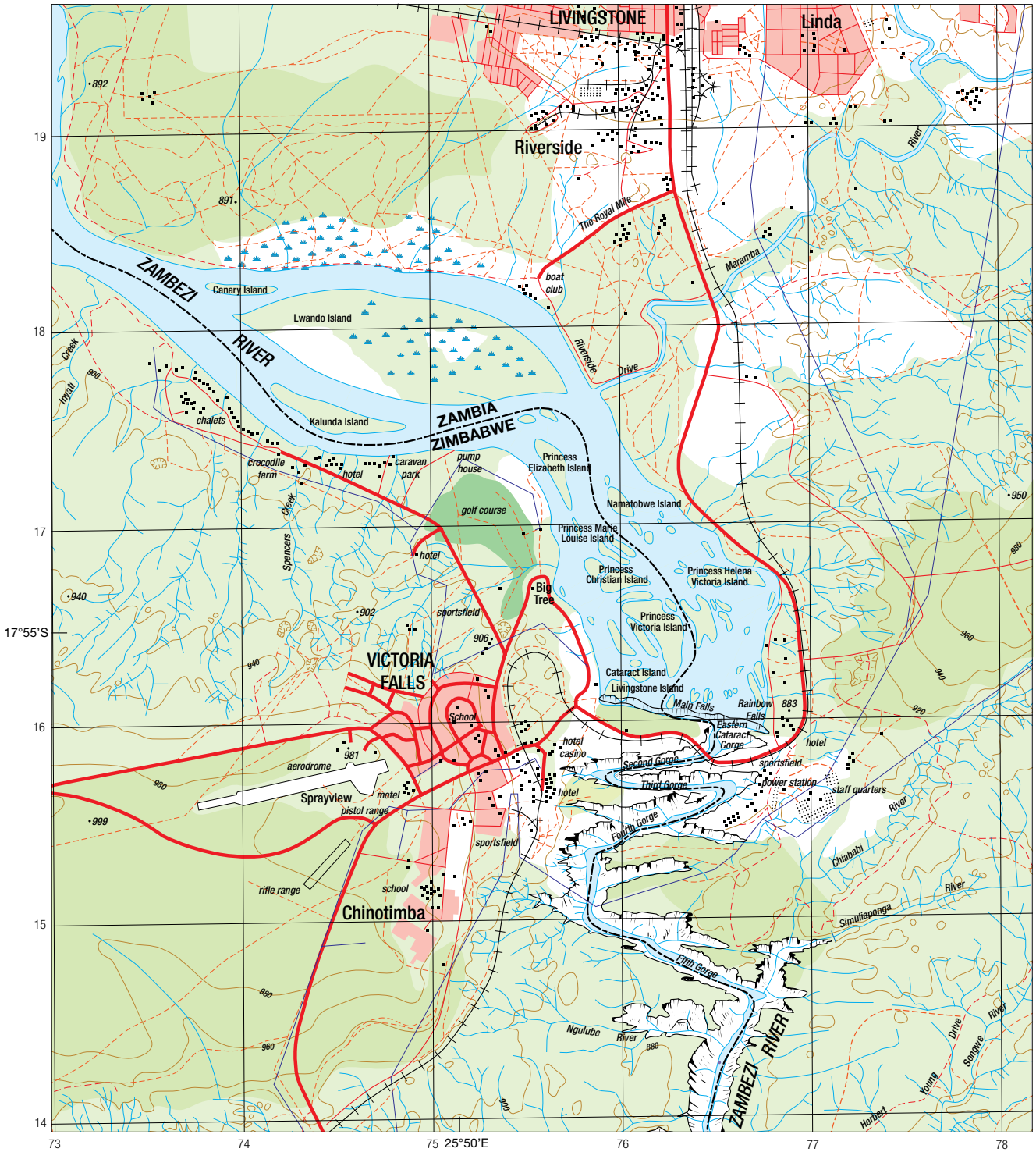
17.13 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

FIGURE 2 Topographic map extract of Victoria Falls, Zambia and Zimbabwe



SCALE 1 : 50 000

kilometres 0 1 2 3 kilometres

N W E S

sealed unsealed

- Principal road; Built-up area
- Secondary road
- Track; Building/s
- Single track railway
- Powerline
- International boundary

960 Quarry; Contour with value (interval 20 metres)

•665 Golf course; Spot height (metres)

Sparse bush; Dense bush

Watercourse; Waterfall; Marsh

Gorge; Perennial lake; Dam

Source: Spatial Vision

Technological interconnections

CHAPTER 18

Technology connecting people

18.1 Overview

18.1.1 Introduction

Transport and technology connect people and places, enhancing access to goods, services and information. Developments in transport technologies have resulted in a shrinking world with vastly reduced travel times and costs. Our ability to communicate has been transformed by technology. While the benefits of these developments are enormous, these benefits are not equally shared, and with the advantages comes a range of consequences that must be addressed.

Starter questions

1. In what ways do you benefit from technology in your daily life? How does technology assist you in communicating in your day-to-day life?
2. Is technology integral to maintaining your relationships?

Inquiry sequence

		Syllabus outcomes
18.1 Overview		
18.2 Transport and technology		GE4-2, GE4-3, GE4-5
18.3 Investigating topographic maps: How do we use Port Botany?		GE4-2, GE4-3, GE4-4, GE4-5
18.4 Transport connecting people with places		GE4-2, GE4-3, GE4-5
18.5 Differences in connections of people and places		GE4-2, GE4-3, GE4-5
18.6 SkillBuilder: Interpreting topological maps	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-5
18.7 How do we communicate?		GE4-2, GE4-3, GE4-4, GE4-5
18.8 ICT and increased connection to services and information		GE4-2, GE4-3, GE4-4, GE4-5
18.9 ICT and increased connection to people		GE4-2, GE4-3, GE4-4, GE4-5
18.10 Impacts of global connectivity on people and places		GE4-2, GE4-3, GE4-4, GE4-5
18.11 SkillBuilder: Constructing and describing isoline maps	eBookplus ONLINE ONLY	GE4-2, GE4-3, GE4-4, GE4-5
18.12 Review	eBookplus ONLINE ONLY	
Key terms	eBookplus ONLINE ONLY	

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Watch this video
Moving around
Searchlight ID: eles-1723

ten pound Pom the name given to British migrants who migrated to Australia after World War II. The fare to Australia was subsidised by the Australian government and cost only £10.

Hummer a type of car originally built for use by the US army; they are now often used in cities as stretched limousines

18.2 Transport and technology

18.2.1 Transport changes

When European settlement occurred in Australia a little over 225 years ago, it took people eight months to make the voyage by boat. After World War II, a new policy saw the advent of the '**ten pound Pom**', an assisted immigration scheme that allowed people from Britain to travel by boat to Australia for 10 pounds ($20). That journey took eight weeks. An average individual travelling on one of the earliest commercial flights on a return journey between London and Sydney would need to spend two and a half years salary. By 2015, this had been reduced to just eleven days salary for the same return journey.

FIGURE 1 Inflight entertainment

18.2.2 Planes

Air travel has become increasingly more accessible in the past 30 years. Once a luxury item, only for the upper classes, air travel has become more accessible over time. The increased size of aircrafts such as the A380, the largest passenger airline in production, along with the growth of low cost airlines such as Jetstar, EasyJet and Air Asia X, is responsible for the rapid increase in accessibility to average consumers. Some of the benefits are:

- greater numbers of passengers able to travel at once
- online access to information on discount tickets and travel information
- reduced travel times
- increased comfort
- increased reliability and aircraft safety
- better services (such as inflight entertainment; see figure 1).

FIGURE 2 An advertisement for a Model T Ford. In order to speed up the production process, Henry Ford started to produce only black cars, famously saying 'Any customer can have a car painted any colour that he wants so long as it is black'.

18.2.3 Automobiles

The car has come a long way since the first Model T Ford rolled off the assembly line in Detroit, USA, in 1908 — it was the first mass-produced vehicle (see figure 2). Today there are over 105 car manufacturers worldwide with some of these offering between 15 and 30 different models of new vehicles every year. The changes to car manufacturing and design over the years have seen cars continue to become more comfortable and connected, and more suited to a greater variety of people's needs. With an overdependence upon oil and dwindling supplies of this finite resource, there is now a shift in manufacturing away from big high-consumption vehicles towards more energy-efficient cars such as a Prius or Tesla (see figures 3 and 4). The **Hummer**, with its high fuel consumption, is no longer in production.

FIGURE 3 Tesla charging

FIGURE 4 Tesla promotion

Tesla electric motors have only one moving piece: the rotor. As a result, Model S acceleration is instantaneous, silent and smooth. Step on the accelerator and in as little as 3.0 seconds Model S is traveling 100 km per hour, without hesitation, and without a drop of gasoline. Model S is an evolution in automobile engineering.

Source: Tesla.com.au

18.2.4 Shipping

With globalisation connecting consumers and producers more than ever before, advancements in shipping, and the growth of the maritime industry have been at the heart of driving this growth. The growth in the transportation of dry goods alone has increased from 1162 million tonnes in 1970 to 6704 million tonnes in 2014. Today, super container ships are found operating out of every major port on Earth, and are now able to carry up to 18 000 containers each. If you were to stack the containers from a single ship in a line they would reach from the Sydney Opera House to either Merewether beach in Newcastle, Lithgow past the Blue Mountains or Seven Mile Beach in Shoalhaven, a distance of almost 110 kilometres. The unit of measurement used to show a ship's cargo-carrying capacity is TEU (see figure 5 and table 1). One unit is equal in width to a standard shipping container.

FIGURE 5 Growth of container ships

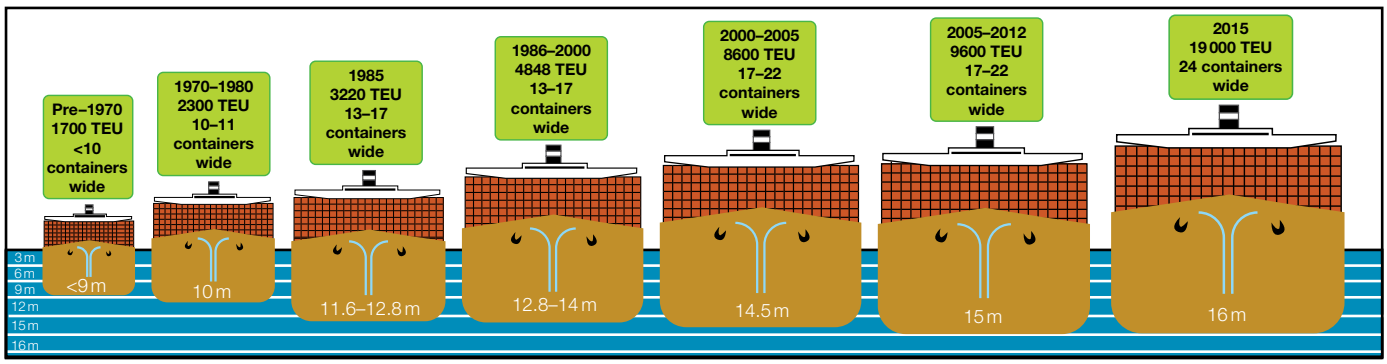


TABLE 1 Largest ports in the world by volume of containers

Rank	Port and country	Volume (million TEU) 2014
1	Shanghai, China	35.28
2	Singapore	33.9
3	Shenzhen, China	24.03
4	Hong Kong, SAR, China	22.30
5	Busan, South Korea	19.45
6	Ningbo-Zhou Shan, China	18.65
7	Qingdao, China	16.62
8	Guangzhou Harbour, China	16.16
9	Jebel Ali, Dubai, United Arab Emirates	15.24
10	Tianjin, China	14.05

ACTIVITIES

IDENTIFY

1 What are the benefits of the ***changes*** to planes and air travel?

EXPLAIN

2 Why did it take so much longer to afford to fly in the period just after World War II compared to 2015?

3 Look at figures 3 and 4 and suggest why Tesla is a growing car company and why Hummer no longer exists.

APPLY

4 Look at table 1 and identify which country has the most ports in the top 10. Suggest implications for this country as well as for other countries such as Australia.

5 a Refer to figure 5. How many pre-1970 ships would be needed to carry the same number of containers as a ship built after 2012?

b Why have the changes occurred to these ships and what are the impacts (positive and negative)?

INVESTIGATE

6 Look at figure 2. Why did Henry Ford start to make cars in only one colour?

18.3 How do we use Port Botany?

18.3.1 Port Botany

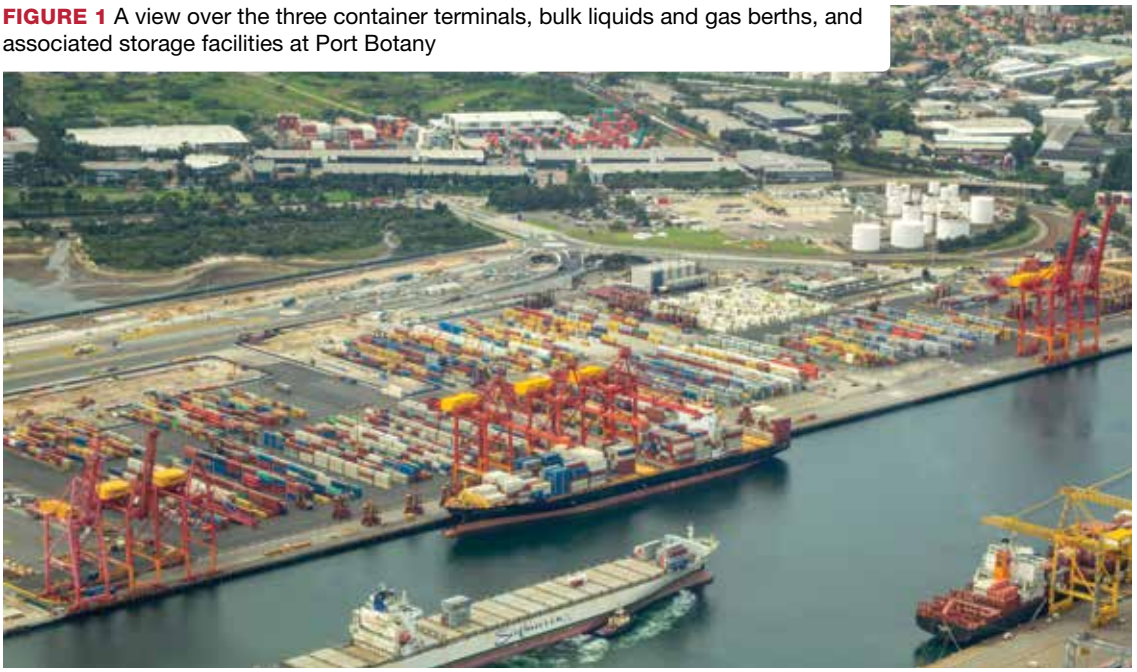
Port Botany, located in Botany Bay, is the major shipping port in Sydney and New South Wales. It is Australia's second largest container port. Some of the Bay has needed to be dredged to provide ships with deep water channels to pass through while land has been reclaimed to provide land on which to build the port.

18.3.2 Trade facilities and links

Today Port Botany covers an area of 237 hectares and consists of three container terminals, a bulk liquids and gas facility, and a bulk liquids storage and distribution complex that is connected to underground pipelines. These pipelines include aviation fuel to Sydney Airport, and chemicals and gas to nearby Botany Industrial Park.

Cargo moves through Port Botany either to or from over 170 overseas countries. The port is adjacent to the Port Botany Freight Line, a dedicated rail freight line for container freight distribution and collection of export containers from regional areas of New South Wales. Over 80 per cent of import containers through Port Botany are delivered within a 40 kilometre radius of the port.

FIGURE 1 A view over the three container terminals, bulk liquids and gas berths, and associated storage facilities at Port Botany



ACTIVITIES

IDENTIFY

1. Calculate the length of train track from Port Botany to the junction at GR 354413.
2. What evidence is there that Port Botany is well serviced by road transport facilities?
3. What is the main physical feature at La Perouse point in AR3637?
4. What is the gradient between the spot height adjoining the Macquarie Watch Tower in AR3637 and the bulk liquid storage facility in AR3439? Why would the gradient of an area be an important consideration when establishing a port?
5. What is the area of the Port Botany container terminal south of Brotherson Dock and bound by the rail line, Friendship Road and Charlotte Road?
6. What feature is located at GR347393? Why is it located there?

APPLY

7. Ports are used to transport both imports (goods coming into a country) and exports (goods leaving a country). What is the major item stored south of Friendship Road? Do you think this would be for importing or exporting? Justify your answer.
8. Sydney's Kingsford Smith airport is located about 7 kilometres north-west of Port Botany. Why do you think they chose to locate the airport there?

FIGURE 2 Topographic map extract of Port Botany

Source: Land and Property Information, NSW.

18.4 Transport connecting people with places

18.4.1 Public transport

Public transport provides a relatively low-cost way for people to interconnect with places, and can reduce traffic congestion and pollution. For students, it is often the only way to get around. Sometimes, however, it can seem like too much bother, perhaps because one service does not connect to another or because there are not enough services running, especially near your house.

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communications systems, water pipes and power lines

Public transport use is considerably higher in capital cities than in other parts of Australia, partly because cities have relatively large populations and better public transport **infrastructure**. But how satisfied are we with our current public transport provision? Figure 1 provides some answers, at least for people in the Sydney region.

18.4.2 Our changing needs

With any population growth, governments at all levels must consider how they will meet changing transport needs. ICT developments have allowed us to make better decisions for our use of public transport. For example, have you used the internet or an app to find the fastest way to get from A to B? Service quality, frequency and infrastructure are generally the biggest concerns in the provision of a public transport system. However, the affordability of public transport is equally important, because many low-income people depend upon public transport to access jobs, services, education and recreation.

patron a customer, especially a regular one

mobility the ability to move or be moved freely and easily

Sydney has the highest rate of public transport usage among the Australian capital cities, with 26.3 per cent of people being regular **patrons**. Its users make the most of bus, rail and ferry options to commute to work and study. A community group, the Sydney Alliance Transport Team, has a vision for a world-class public transport system in Sydney — one that is regular, reliable, clean, safe and easy to use, regardless of health, wealth, age or **mobility**. It would be planned, integrated and connected to where people live, work and play, and would satisfy the following equation:

$$400{:}15{:}1\ SCA^2$$

This equation means:

- access to transport is within 400 metres
- transport arrives every 15 minutes
- it requires only 1 ticket
- it is **s**afe, **c**lean, **a**ccessible and **a**ffordable.

Figures 2 and 3 show the results of some of the Sydney Alliance Transport Team's research into how well Sydney is satisfying this vision.

FIGURE 1 Satisfaction with transport in Sydney, 2014

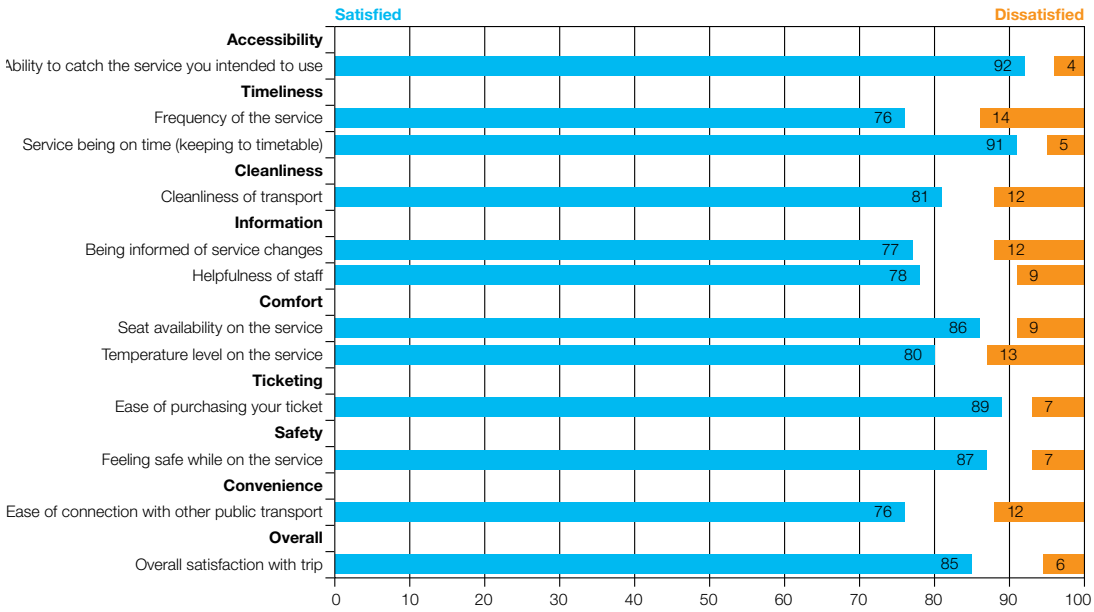


FIGURE 2 In this map, those who live within the pink shaded areas have some form of public transport within 400 metres of their residence.

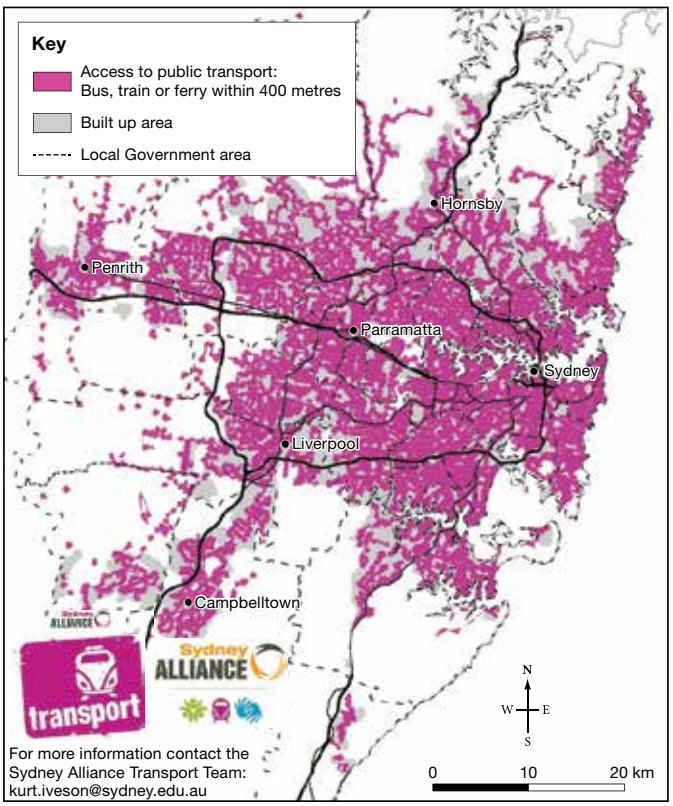
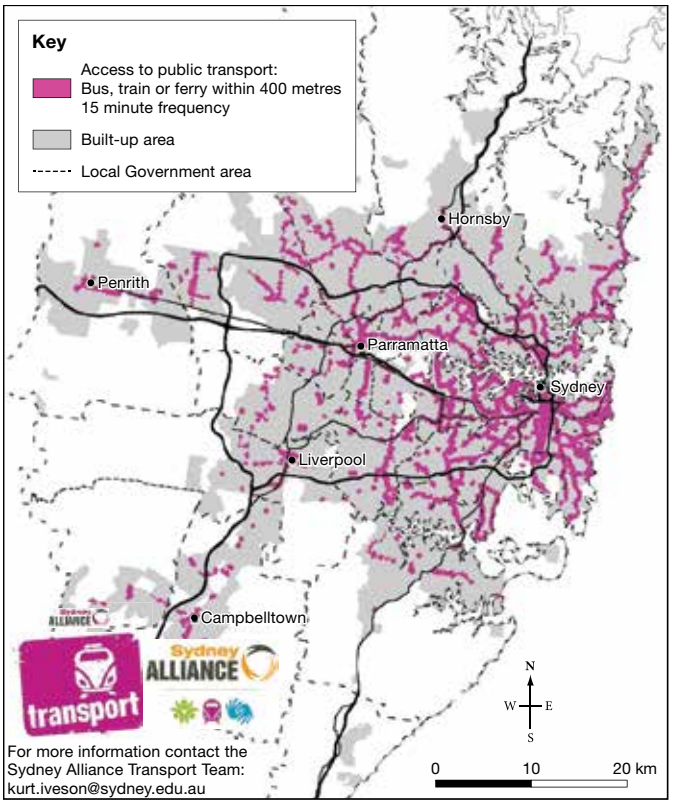


FIGURE 3 In this map, those who live within the pink shaded areas have some form of public transport within 400 metres which also arrives at least every 15 minutes during the day.



Public transport is one of the key components used when compiling liveability scores for suburbs and cities. Many suburbs that score poorly overall or that have low rankings receive these scores because they do not possess the same levels of infrastructure and public transport as other suburbs. This is usually because older, more established suburbs have existing networks and tend to be located closer to major centres of trade and entertainment.

ACTIVITIES

IDENTIFY

1 Refer to figure 1. What are some aspects of Sydney's public transport that users are satisfied or dissatisfied with? Provide examples, using data to support your answer.

EXPLAIN

2 Do you use public transport? Why or why not?

3 a How ***interconnected*** is the ***place*** in which you live? What types of public transport are available to you? What distances do you need to travel to reach a bus stop or a train station?

b What types of public transport are required for you to access your closest international airport?

INVESTIGATE

4 a As a class, pick a location on the other side of town. Using your rail, bus or other public transport provider website, find out how long it would take to travel from your school or home to this point on:

- a Monday morning at 9.00 am
- a Sunday evening at 6.00 pm.

b What did you notice about the travel times? Were they different? Why do you think this is the case? Create a map of your journey, using an appropriate key to show rail, bus and other modes of transport.

APPLY

5 Refer to figures 2 and 3. Although most areas of Sydney have public transport within 400 metres, very few have services running every 15 minutes. What does this mean for people who live in those ***places*** without a regular service? How would it affect their daily lives?

6 Consider the Sydney Alliance Transport Team's vision. Do you think it will be possible to achieve their goal of ***interconnectedness***? What measures will need to be put into place to ensure they can satisfy their vision?

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Interactivity
Off the rails
Use this interactivity to compare public and private transport across selected cities.
Searchlight ID: int-3333

18.5 Differences in connections of people with places

18.5.1 Public transport in Perth, Melbourne and Copenhagen

Despite the best efforts of governments and service providers, there is no doubt that some people are better connected by public transport than others. 'Black spots' for public transport leave many without access to essential services, and they can force people into cars because there simply are no alternatives.

liveable city
an informal name given to cities if they rank highly on a reputable annual survey of living conditions

Perth, Melbourne and Copenhagen are three of the world's most **liveable cities**, but they have three very different public transport systems.

Figure 1 shows us the average number of public transport trips per capita per year in a number of cities that have been ranked as among the world's most liveable in recent years. The average across these 14 cities is also shown in figure 1. Figure 2 shows the length of roads per capita in the same cities, and the average for those cities. Australian cities, which are generally larger in size and sprawl, do not rate well in either of these areas. Table 1 compares the three cities in terms of size, population, intensity of public transport services, and the number of residents who live within 30 minutes of an **activity hub**. Figure 3 shows us how well Melbourne is achieving network coverage — that is, which areas of Melbourne are interconnected by public transport and which are public transport black spots. Below figure 3 is an excerpt from a study of the frequency of public transport and travelling speeds.

activity hub
a centre for business activities that may or may not be the central business district

FIGURE 1 Number of public transport trips per year, per person, in the world's most liveable cities

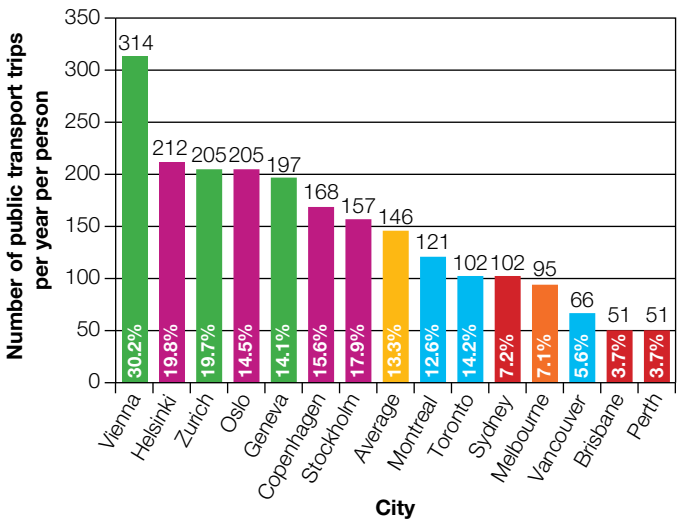


FIGURE 2 Length of roads per person in the world's most liveable cities

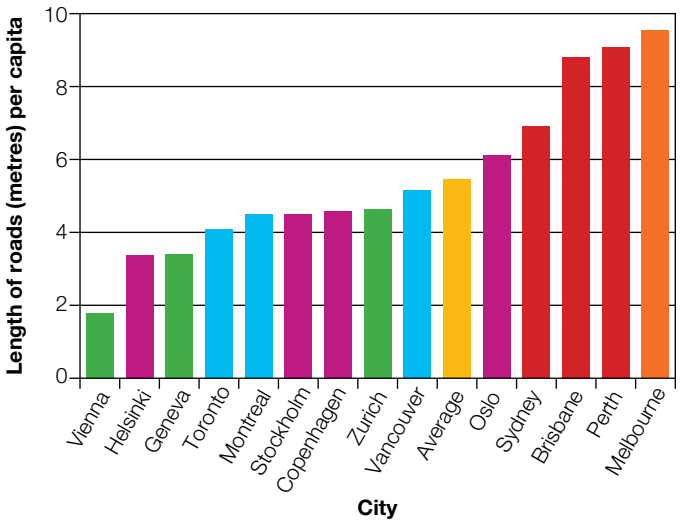
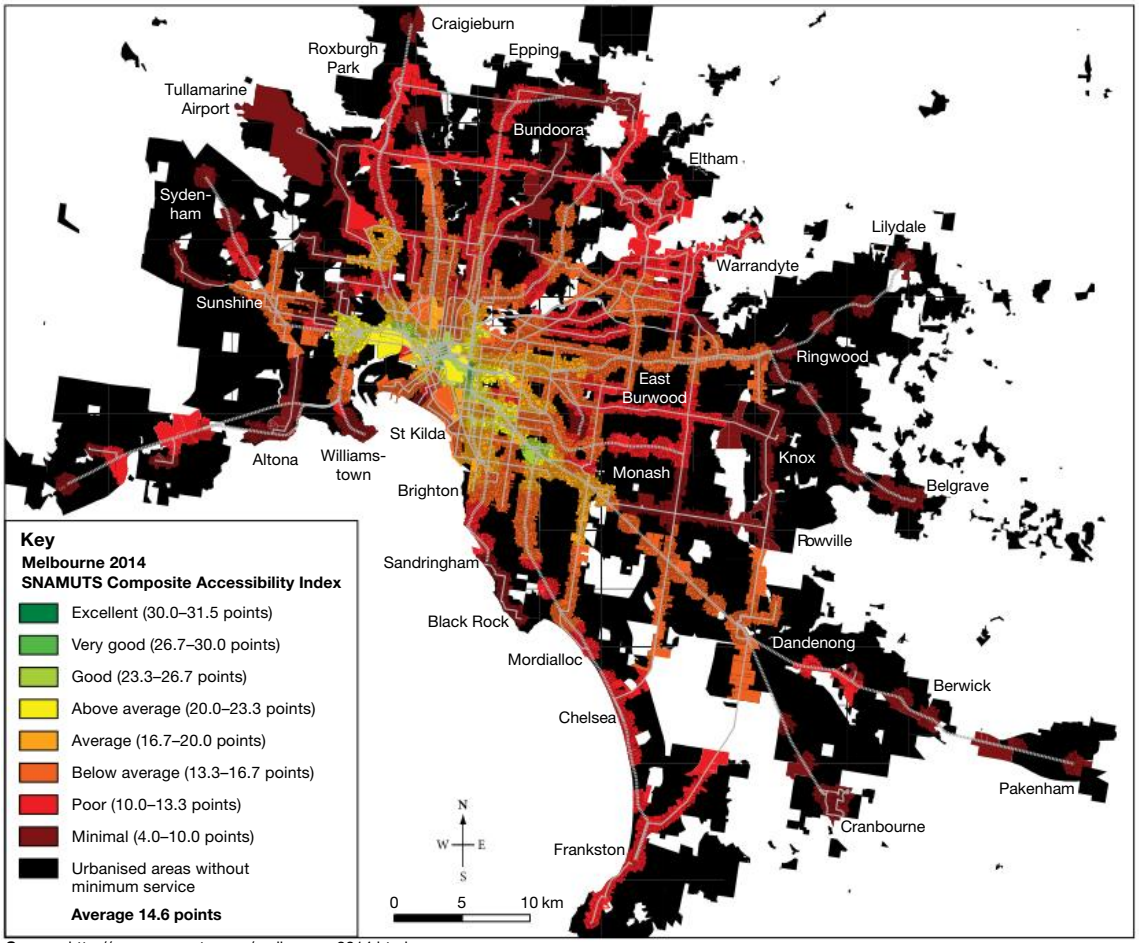


TABLE 1 Key data for three liveable cities

Indicator	Perth (2011)	Melbourne (2011)	Copenhagen (2012)
Residents in metropolitan area (million)	1.73	4.00	1.85
Residents and jobs per hectare (higher = denser)	22.9	28.3	34.7
Average number of residents and jobs within 30-minute public transport travel time from an activity hub	10.6%	9.3%	29.7%

Source: Curtis, C. and Scheurer, J. *Spatial Network Analysis for Multimodal Urban Transport Systems (SNAMUTS)*

FIGURE 3 Melbourne's public transport accessibility



Source: http://www.snamuts.com/melbourne-2014.html

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Interactivity
City connections
Use this interactivity to determine how accessible various places are to cities.
Searchlight ID: int-3334

Both Copenhagen's population and the length of its suburban rail network are about half the size of Melbourne's. But while Melburnians need to arm themselves with a veritable library of timetables if they wish to make liberal use of their train system, Copenhageners merely need to memorise three figures (such as 14, 34, 54) for the minutes past the hour trains depart [from] their station — for 20 hours a day, every day. During business hours, the 20-minute frequency is increased to 10 minutes on all routes, and express services with fixed stopping patterns operate on most of the network throughout the day. Commercial speed across the network is 51 km/h (Melbourne: 40 km/h), and every resident uses the system 53 times per year on average (Melbourne: 38).

Source: *The Economic Benefits of Investing In Public Transport in Melbourne* by Jan Scheurer, Jeff Kenworthy, Peter Newman

ACTIVITIES

IDENTIFY

1 Refer to figure 1. In which cities are the most and fewest public transport trips made per person?

EXPLAIN

2 Refer to the text extract in this section.
- **a** Explain how Copenhagen and Melbourne rail networks differ. You may wish to refer to the size and ***scale*** of the system or the density of service.
- **b** Do you think it is easier or harder to travel on Copenhagen's rail network, compared with Melbourne? Explain your answer.

INVESTIGATE

3 Using the internet, locate maps of the railway networks of Perth, Melbourne and Copenhagen. Note the ***scale*** of the maps. Can you identify the major differences? Look closely at the shape of the rail network. Is it radial? Does it have clusters? Is there a strong ***interconnection*** present between rail lines? Are there noticeable black spots where no rail lines seem to travel?

APPLY

4 The federal and state governments continue to invest in new infrastructure. You can see from the data in figure 2 that Australian cities seem to have many more kilometres of roads than European cities.
- **a** What reasons could contribute to these differences?
- **b** Find out about a new road project in your city or community. What are the ***environmental*** impacts of building new roads? Why do we need them? You may choose to divide into two teams, planners and eco-warriors, and present different views to the class.

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18.6 SkillBuilder: Interpreting topological maps

What is a topological map?

Topological maps are very simple maps, with only the most vital information included. These maps generally use pictures to identify places, are not drawn to scale and give no sense of distance. However, everything is correct in its interconnection to other points.

eLesson

Watch this video to learn how to interpret a topological map.

Searchlight ID: eles-1736

Interactivity

Try this interactivity to learn how to interpret a topological map.

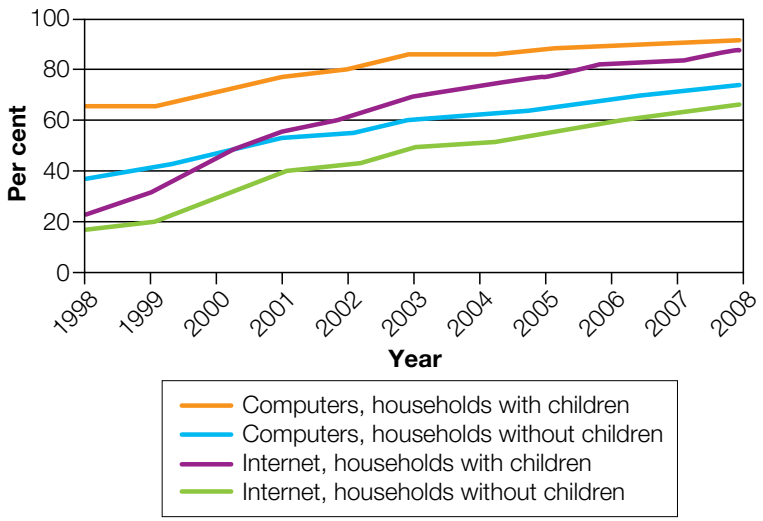
Searchlight ID: int-3354

18.7 How do we communicate?

18.7.1 How do we use the internet?

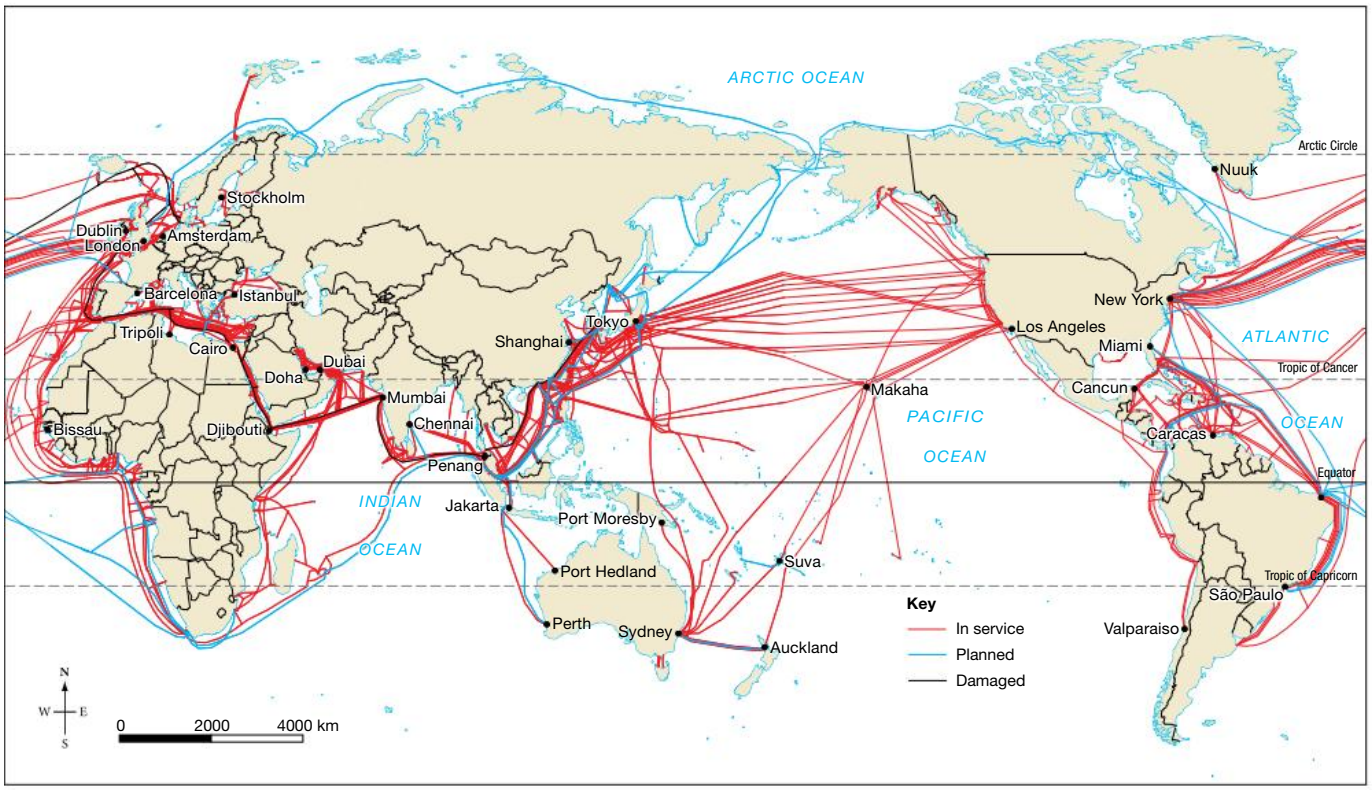
Youth culture is strongly linked to the use of communication technology. More than 800 million adults in the world lack basic literacy skills, yet the boom in information and communication technology is skyrocketing. A survey of 12-year-olds showed that in 97 per cent of the countries surveyed, the inhabitants received at least one television channel. However, less accessible were personal computers (23 per cent) and the internet (9 per cent). Internet use among youths in developed countries is increasing at a rapid rate.

FIGURE 1 Household computer and internet access



Internet access in Australia is continually changing. Both the number of people and the ways in which people access the internet are changing. This is reflective of new technology and greater access for more people (see figure 1). Internet communication is not just done via satellite. There are also fibre optic cables under the sea that help link the network of networks that is the internet, as shown in figure 2. These cables improve the speed of the internet in Australia. New cable, that connects Australia to the United States via New Zealand, has assisted in the creation of the national broadband network (NBN). (See also subtopic 20.6.)

FIGURE 2 The location of underwater fibre optic cables, which help connect the world's internet network



Source: Spatial Vision

18.7.2 Web 1.0, 2.0 and 3.0.

The World Wide Web is a way of accessing and spreading information on the internet. The original **web 1.0** was considered to be read only (see figure 3). Web 1.0 allowed users only to search and read information. **Web 2.0** technology enabled the sharing of online information and ideas that anyone has created. It was the second generation of the World Wide Web, and enables collaboration and exchanging of information online. Web 2.0 is popular because it is an easy form of communication technology to use. Different types of web 2.0 applications include Facebook and YouTube.

Web 3.0 or the Semantic web is the latest progression and allows for greater understanding and mobile connection. For example, if you use your browser to search for a particular song online, the next time you open that browser and start searching you will be given suggestions based on your likes and those of other people with similar interests. The key features of web 3.0 are:

- real-time
- ubiquitous (always connected, always with you)
- location aware
- sensors
- tailored, smaller screen
- high-quality camera and audio.

web 1.0 read-only version of the web. It enabled users only to search and read information.

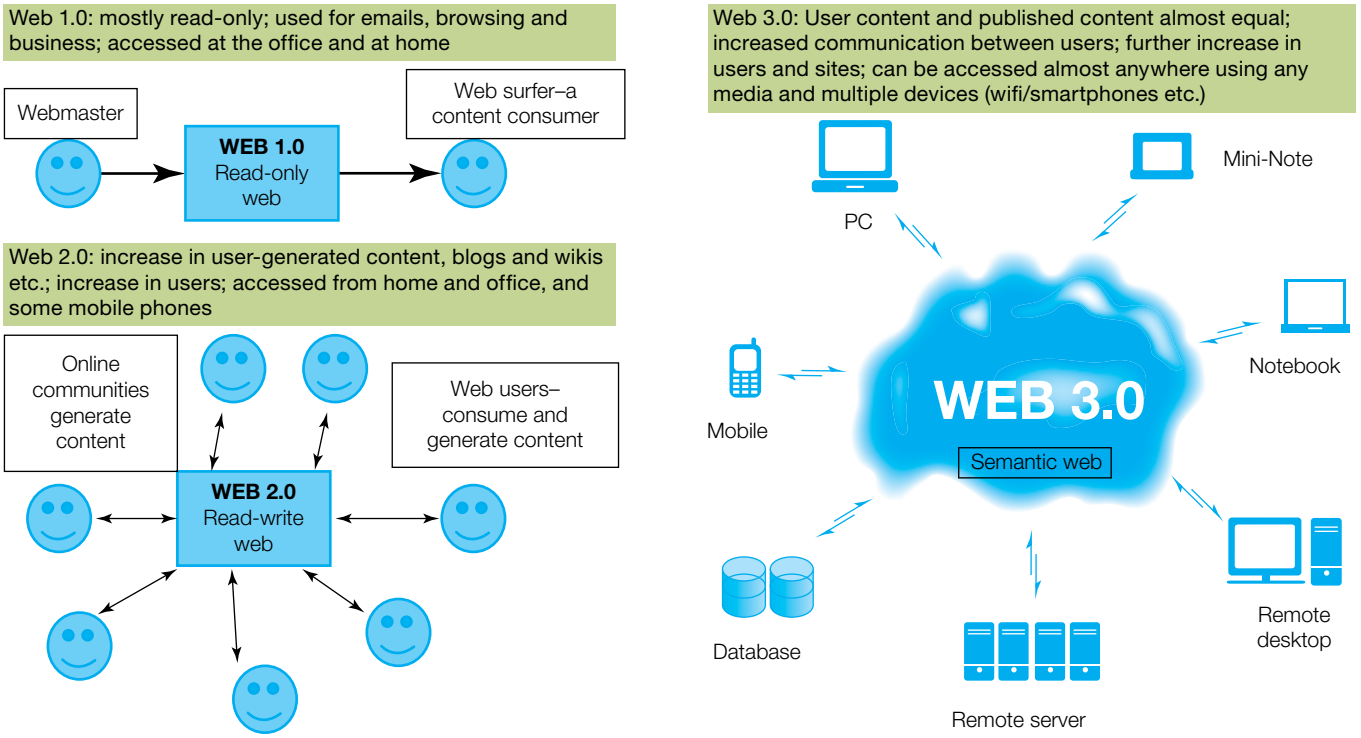
web 2.0 version of the web that allows the sharing of online information and ideas that anyone has created. It is the second generation of the World Wide Web that enables collaboration and exchanging of information online.

web 3.0 current version of the web. Focus is on connective intelligence; connecting data, concepts, applications and ultimately people.

18.7.3 Mobile phones

Mobile phones are a form of wireless communication that is transmitted via radio wave or satellite transmission. Smartphones are now a source of almost endless information. They are essentially pocket computers. Mobile phones bridge the domains of communication and information technology.

FIGURE 3 Web 1.0, 2.0 and 3.0

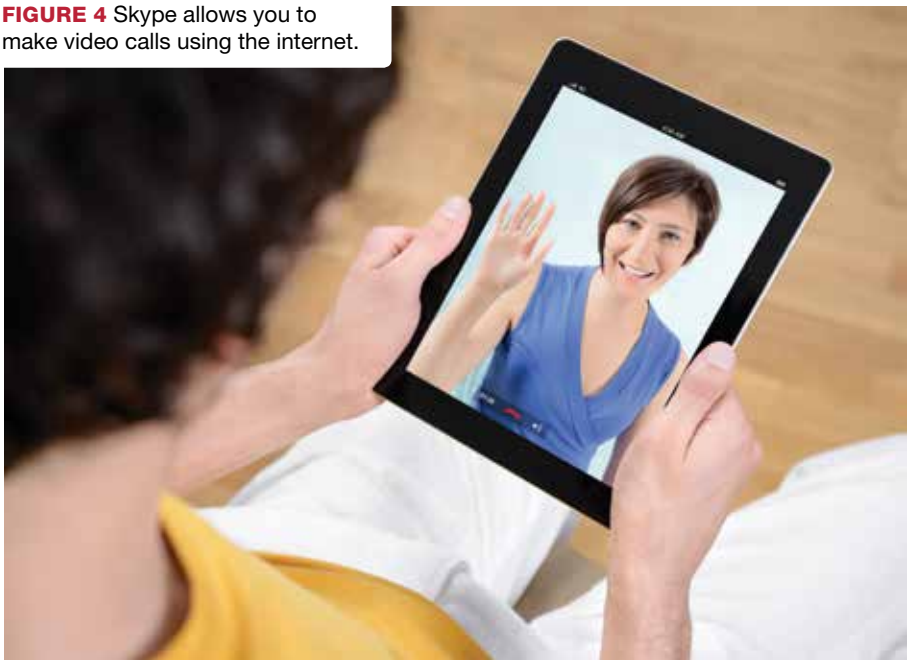


18.7.4 Information and communication technology

Information and communication technology is now used for a variety of purposes to make connections. We often do not realise how convenient our lives have been made by various forms of communication. Some of these include online and telephone banking, storing and sharing of medical records, online shopping and online games.

Skype is another example of an online communication medium — this service makes it possible for anyone with an internet connection to converse in the form of a video call with someone else anywhere in the world. Skype is also available as a mobile phone application, allowing users to have more interactive and cheaper communication. This simple form of communication technology improves the interconnectedness of places around the globe.

FIGURE 4 Skype allows you to make video calls using the internet.



eBook*plus*

Interactivity
www
Use this interactivity to learn more about how the web interconnects the world.
Searchlight ID: int-3341

ACTIVITIES

IDENTIFY

1 Refer to figure 1. How did the percentage of internet access change in households with children between 1998 and 2008?

2 Refer to figure 2. How does the number of submarine cables in Australia compare with the number in Japan?

EXPLAIN

3 Refer to figure 2. Explain the geographical pattern of underwater cables worldwide. Where are the greatest concentrations of cables? Which parts of the seas or oceans seem to lack cables? Why do you think this is?

INVESTIGATE

4 Refer to figure 3. Find out more about how web 1.0 differs from web 2.0 and web 3.0, and create a PowerPoint presentation to compare and contrast them.

PREDICT

5 Predict how the ***interconnectedness*** between Asia and Australia will ***change*** in the future. What do you think it will be based on?

6 Predict what you think will happen to low-income countries' access, quality and usage of information and communication technology.

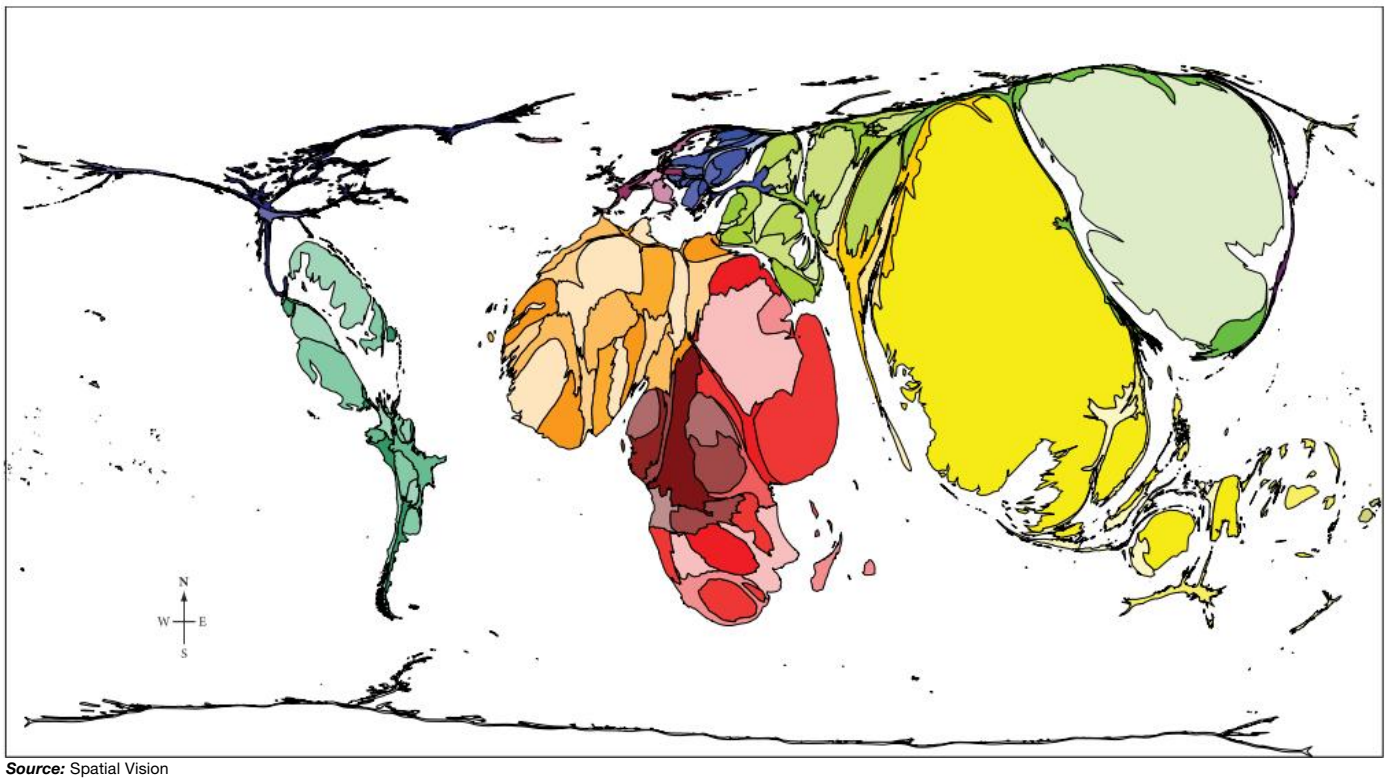
18.8 ICT and increased connection to services and information

18.8.1 Who owns mobile phones?

The growth of information and communication technology has had a significant impact on the way people are able to access online services. However, access to these services is not always equal between countries, let alone within them. Government spending on the infrastructure needed to access ICT has an influence on connecting people to services.

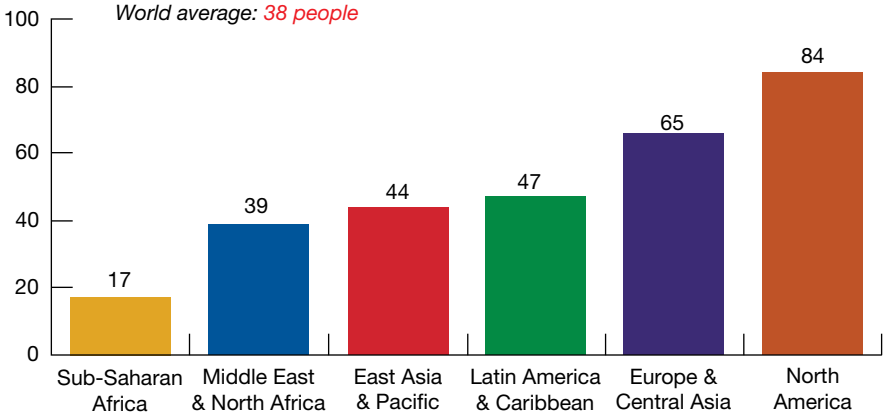
While factors such as way of life and financial situation impact on mobile phone use, there has been a global shift in mobile phone ownership (see figure 1). Many developing countries have bypassed building infrastructure to support landlines and have simply moved straight to mobile phones. It is estimated that over 70 per cent of the 5 billion mobile cellular telephone subscriptions reside in low- and middle-income countries.

FIGURE 1 Cartogram showing changing global mobile phone use



Source: Spatial Vision

FIGURE 2 Internet users by world region (per 100 people)



Mobile phone use worldwide varies considerably. Similarly, there are differences in numbers of internet users, by world region (see figure 2) or by country. North America has the greatest number of internet users. However, on a national basis, the numbers of internet users in China and India are growing rapidly.

18.8.2 The digital economy

The digital economy is the global network of economic activity that is enabled by information and communication technology. It is constantly evolving, offering a vast number of opportunities for innovation. In addition, it has the potential to improve access to services, such as education, and to improve environmental, health and social outcomes in rural and regional areas.

Shopping

Perhaps one of the biggest uses of new technology is the aid to shopping. Online shopping has been present for much of the internet's existence. As technology has improved many more businesses are ensuring that they have an online presences and the customers can have access to products 24 hours a day, seven days a week anywhere in the world (see figure 3).

FIGURE 3 Online shopping at Christmas time

Opportunities of new services

- **Business.** Using applications and services that rely on the internet has improved efficiencies and reduced costs. For instance, an online business owner does not need to lease a premises, which is a big saving. This has resulted in an expansion of markets, through greater interconnections in Australia and overseas. Businesses will have more choice of location, particularly in rural and remote places. It can also improve efficiency, and may reduce the need for a physical presence, for example clothes retailers who can sell their t-shirts online without the need for a shop.
  Improvements in infrastructure will lead to improved technologies, such as videoconferencing, allowing healthcare, for example, to reach remote areas and promote the sharing of knowledge.
- **Education.** Distance between student and teacher will no longer prevent access to specialist teachers across Australia and the world. It will improve collaborative learning practices between schools and higher education facilities, and promote the international exchange of ideas. In addition, ICT has improved access to online learning and collaboration beyond the walls of the classroom.
- **Environment.** Access to digital technology has demanded new ways of managing household consumption of resources. Smart energy grids can be installed to manage energy consumption, and changes can be made during peak energy demands. Farming systems can be improved by technologies that are accessible with the improved ICT, such as measuring soil moisture in relation to weather conditions.

ACTIVITIES

IDENTIFY

1 Define the term *digital divide* in your own words.
2 What are the reasons for the digital divide?
3 Refer to figures 1 and 2 and with the use of a world map identify a country in each the following categories: 30–39, 50–59 and 80–89 internet users per 100 people.

EXPLAIN

4 Why is there a greater demand for data than there was 10 years ago?
5 Refer to figure 3; why are there more visits occurring on Boxing Day?

APPLY

6 Create a table showing the differences for a day and a week in the number of purchases you conducted via technology versus face to face. What do you think the split will be? Do your results surprise you?

18.9 ICT and increased connection to people

18.9.1 Death of distance

When many of your parents and grandparents were at school they would have had a pen friend. This was another person, usually of a similar age, who lived on the other side of the state, country or even the world. Letters would be handwritten and posted, and could take weeks to arrive. Today, you can get in touch with people anywhere in the world with the click of a button.

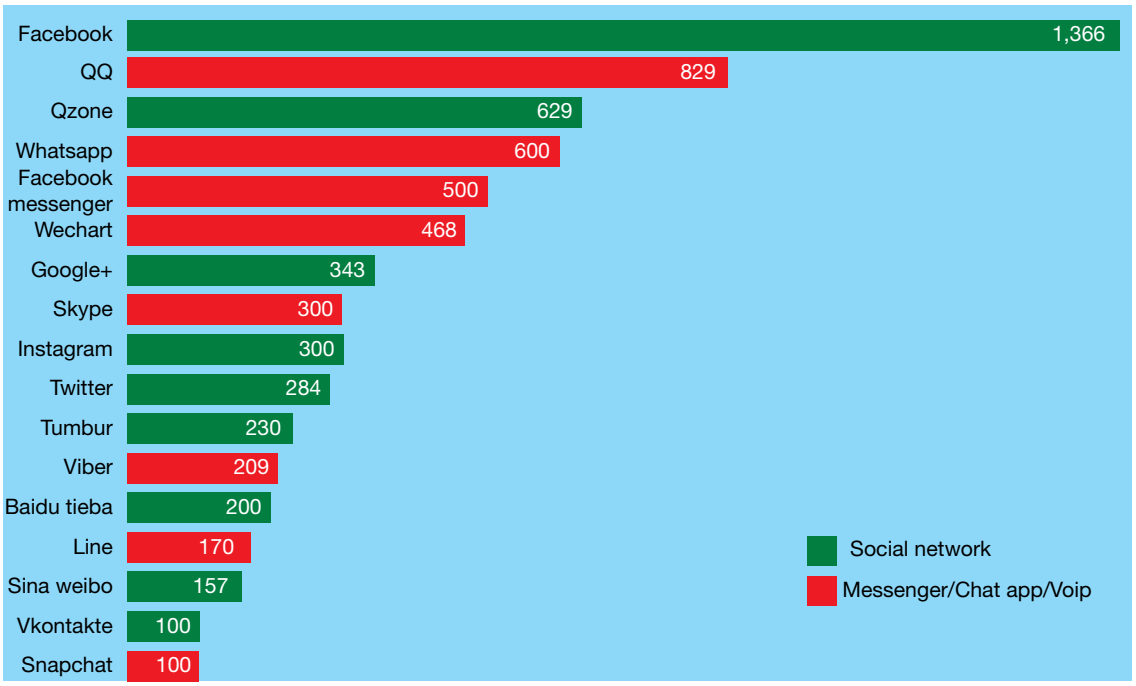
The term 'Death of distance' was coined at the end of last century and was used to explain how distance was no longer a limiting factor in people's ability to communicate.

> 'All distances in time and space are shrinking. Man now reaches overnight places which formerly took weeks and months of travel.'
>
> ***Source:*** German philosopher Martin Heidegger (1971).

18.9.2 Social media

Social networking sites were originally set up as a means of connecting people. Today, apps, such as Twitter, Instagram and Snapchat, allow people to connect and follow each other through text, photos and videos.

FIGURE 1 Most popular social media platforms



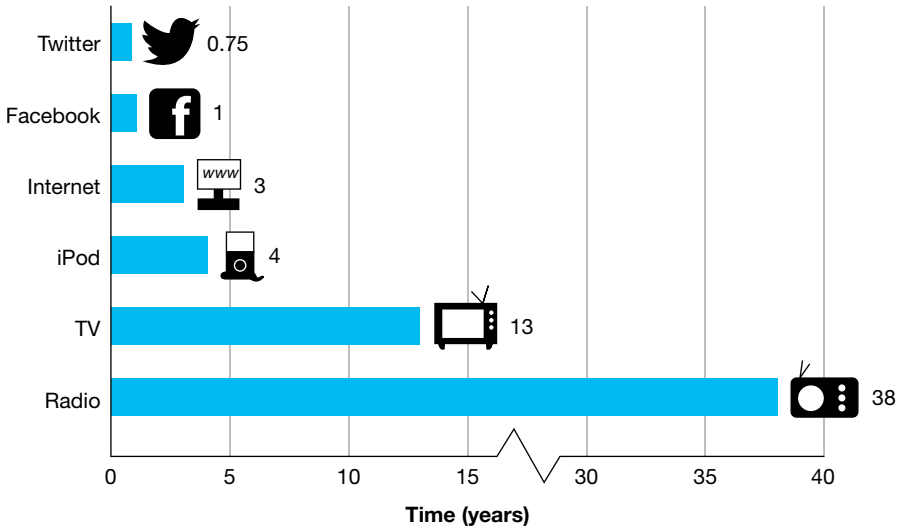
Every day there are over 1000 apps being submitted to the Apple app store. This means the ways in which we can connect to each other are evolving. Facebook was one of the first major social media websites and is still the most popular with over 1 366 000 000 users worldwide. Figure 1 shows the most popular sites worldwide. The rate at which people are adopting new technology is increasing, as is the speed of the connections. This is due to a range of factors including access, price and popularity. Figure 2 shows a comparison between the time taken for 50 million users worldwide to adopt different types of media.

18.9.3 Generations

Who uses the internet and social media, and how? The generation you belong to will affect the technology you choose to use. A 14-year-old is part of **Generation Z** and, unlike all

Generation Z those born after Generation Y, between 1995 and 2009

FIGURE 2 Time taken to reach 50 million users for different media



generations before them, they have never lived in a world without the internet. This varies greatly from their parents, **Generation X** and grandparents, the **Baby Boomers**. Along with **Generation Y**, who are those people aged 20 years and over, we can see how different platforms and apps appeal to different users (see table 1).

18.9.4 Trolls

One issue that can arise from these new technologies and forms of communications surrounds the issue of **anonymity**. Because communication is done online, rather than face to face, often people will type or post information and comments that they wouldn't say directly to a person. Internet trolls are people who deliberately intend to upset others by posting harmful or distressing messages. Sometimes they can set up accounts pretending to be someone else by using their name or identity. This can happen to celebrities and high-profile individuals but can also happen to anybody. These actions can often have extremely serious consequences.

Generation X those born after the baby boom, roughly between 1964 and 1980

Baby Boomers generally refers to those born during the post–World War II baby boom (1946–1964)

Generation Y those born after Generation X, between 1981 and 1994

anonymity where a person's details, such as their name, are unknown

TABLE 1 Demographics of different social media usage

Social networking sites used	Age (years)				
	18–29	30–39	40–49	50–64	65+
Facebook	97%	93%	95%	87%	88%
LinkedIn	23%	34%	29%	33%	12%
Instagram	54%	21%	17%	12%	2%
Google+	20%	29%	27%	20%	16%
Twitter	20%	28%	16%	10%	4%
Pinterest	22%	18%	18%	14%	8%
Snapchat	38%	7%	9%	3%	–
Tumblr	14%	2%	2%	4%	–

Source: https://www.sensis.com.au/assets/PDFdirectory/Sensis_Social_Media_Report_2015.pdf

FIGURE 3 A 'troll' is someone who deliberately, and usually anonymously, provokes arguments and upsets others online.

FOCUS ON FIELDWORK

Technology

Secondary data

We know that primary data is information that has been collected by you, whereas secondary data is that information that has been collected and interpreted by somebody else. The benefits of secondary data are that most of the work has already been completed with the questioning and collection of data already done. Copy and complete the table on the right regarding possible sources of secondary data and what may be positive and/or negative points for using the data.

Source of data	Positives	Negatives
e.g. Wikipedia	• Easy to access • Often contains current information	• Authors are unknown • Can be changed by anyone • Potentially unreliable

ACTIVITIES

IDENTIFY

1 How much longer did it take radio to get 50 million users than it took the internet?

APPLY

2 Why do you think that Twitter and Facebook managed to get so many users so quickly?

PREDICT

3 What do you think will be the next form of communication between people?

EXPLAIN

4 How many of the top 17 social platforms (see figure 1) do you use?
5 Have you heard of, or do you use, QQ? Why is this more popular than Twitter and Whatsapp combined?
6 What are your favourite apps? How do these differ from your parents' or teachers' favourite apps? Refer to figure 2.
7 Explain the differences in the popularity of some sites and apps between age groups.
8 What point do you think the cartoon in figure 3 is trying to make? Why is it likely to work?

18.10 Impacts of global connectivity on people and places

18.10.1 Connectivity

Global connectivity has been increasing rapidly over the past three decades. Many countries are in a race to develop their digital economies as they fear being left behind. We are moving towards a world in which personal mobile phone technology can connect every human being in every village in every country to knowledge, markets, services and communities.

This increased connectivity has affected people from villages and cities in all parts of the world in a range of ways, as well as having an impact on the natural environment (see figure 1).

FIGURE 1 Mobile phone use is increasing rapidly in Africa.

18.10.2 Positive impacts

Economic

The Global Connectivity Index (GCI) can be used to measure and predict a country's economic health. There is a strong link between GCI and a country's gross domestic product (GDP) — the higher a nation's GCI the higher the GDP. A 20 per cent increase in ICT investment will grow GDP by 1 per cent. Singapore has implemented a Smart Nation strategy, aimed at moving from natural resources and developing technological services. Greater connectivity and more integrated markets allow for new jobs and careers all over the world.

Social

The development of many countries can be enhanced with greater connectivity. A country's level of connectivity can be categorised using the terms *Leaders*, *Followers* or *Beginners*. By investing in older technologies such as 3G and mobiles, countries such as those in Africa and South America can enhance their levels of development much more rapidly, and therefore improve the standards of living for their citizens. It also allows for more connection between people from different cultures and backgrounds and hopefully greater understanding.

Environment

The climate change conference in Paris in 2015 (see figure 2) showed the benefits which can be achieved by an inclusive and connected approach to the environment. These talks involved **delegates** from 196 countries and culminated in the adoption of the United Nations resolution 'Transforming our world: the 2030 Agenda for Sustainable Development'.

delegate person sent or authorised to represent others, in particular an elected representative sent to a conference

FIGURE 2 The Eiffel Tower during the Paris Climate Change Conference

FIGURE 3 Some impacts of Western culture

18.10.3 Negative impacts

Economic

Poorer nations, or those unable to adapt to technological change as fast as other countries, may find themselves at a disadvantage. Whilst implementing new technology and infrastructure is important, if countries invest in the wrong areas they may have systems that become outdated or unable to handle the growing demands of its citizens.

Social

There is a risk of creating the 'haves' and 'have nots'. Those countries that are unable to keep pace with the Leaders may fall behind. Countries such as Portugal, Italy, Greece and Spain (the PIGS) are regarded as developed nations. However, they are now Followers when it comes to ICT. Beginner nations, such as those in Africa, are well behind the Leaders and will continue to remain there. There is also the possibility of 'westernisation' and loss of cultural identity.

Environment

With a greater push for ICT resources and infrastructure there will be continued pressure on the natural environment. The need for certain resources, such as copper, gold and nickel, will require continued mining and disruption to the natural landscape. The disposal and treatment of existing and outdated equipment is also an issue that needs addressing. E-waste is a growing global concern. However, many individuals, groups and governments have put in place plans to deal with this, such as Planet Ark which runs e-waste collection points at schools and nominated businesses.

FIGURE 4 e-waste

ACTIVITIES

IDENTIFY

1 What are considered older technologies?
2 Who invests in these technologies and why?

EXPLAIN

3 Why is there a link between GCI and GDP?
4 Why might Singapore have a greater need to develop 'digital fuel' rather than natural resources?
5 Refer to figure 3. What are the negative impacts that are portrayed in this cartoon?

INVESTIGATE

6 Use the internet to research some global campaigns that have support from people in many countries. What is the cause? Who is involved? How successful are they at achieving their aims? You could present your findings as a table or a poster.

APPLY

7 How much e-waste do you and your family produce in a year? How is old waste disposed of and could it be treated in a more environmentally friendly way?

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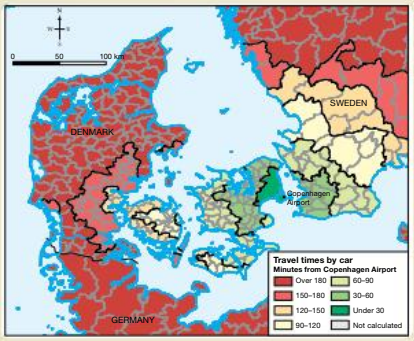
18.11 SkillBuilder: Constructing and describing isoline maps

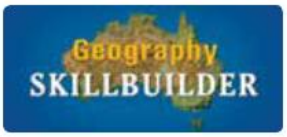
What is an isoline map?

An isoline map shows lines that join all the places with the same value. Isoline maps show gradual change in one type of data over a continuous area. Isolines show change in the trend of the data being mapped. Isoline maps are easy to understand, especially when coloured between the lines



eLesson

Watch this video to learn how to construct and describe an isoline map.



Searchlight ID: eles-1737

Interactivity

Try this interactivity to learn how to construct and describe an isoline map.

Searchlight ID: int-3355

18.12 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

Container terminals, Hong Kong, China

CHAPTER 19

Buy, swap, sell and give

19.1 Overview

19.1.1 Introduction

Trade, in the form of buying, swapping, selling and giving goods and services, is a driving force that interconnects people and places all over the world. Trade has gone on ever since human societies existed. In contrast, international aid is a modern phenomenon, although countries have always had internal programs to help those in need. Trade and aid can bring people together to share the Earth's resources, but there can be problems when those resources are limited and, potentially, have negative consequences for the environment. The big question is how to organise trade and aid so that it fosters social justice and is fair and sustainable.

Starter questions

1. What goods and services do you need to support your lifestyle? Think about your everyday life at home, at school, and in sport, recreation and hobbies.
2. Where do you access your goods and services? To what extent do you obtain goods and services online?
3. From what you know, do you think all trade that occurs in the world today is fair? How can fair trade and aid make the world a better ***place*** for all?

Inquiry sequence

		Syllabus outcomes
19.1 Overview		
19.2 How does trade connect us?		GE4-4
19.3 SkillBuilder: Constructing and describing a flow map	eBook plus ONLINE ONLY	GE4-8
19.4 How does trade connect Australia with the world?		GE4-4
19.5 How is food traded around the world?		GE4-4
19.6 SkillBuilder: Constructing multiple line and cumulative line graphs	eBook plus ONLINE ONLY	GE4-7
19.7 How are markets and factories linked?		GE4-4, GE4-5
19.8 Investigating topographic maps: How is Singapore linked to other places?		GE4-4
19.9 How has international automotive trade changed?		GE4-2, GE4-3, GE4- 4
19.10 Are global players altering the industrial landscape?		GE4-2, GE4-3, GE4-4,
19.11 Why is fair trade important?		GE4-4, GE4-5
19.12 Why does Australia give foreign aid?		GE4-4, GE4-5
19.13 Why is the illegal wildlife trade a cause for concern?	eBook plus ONLINE ONLY	GE4-4, GE4-5
19.14 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	

eBook*plus*

Watch this video
Trading places
Searchlight ID: eles-1724

19.2 How does trade connect us?

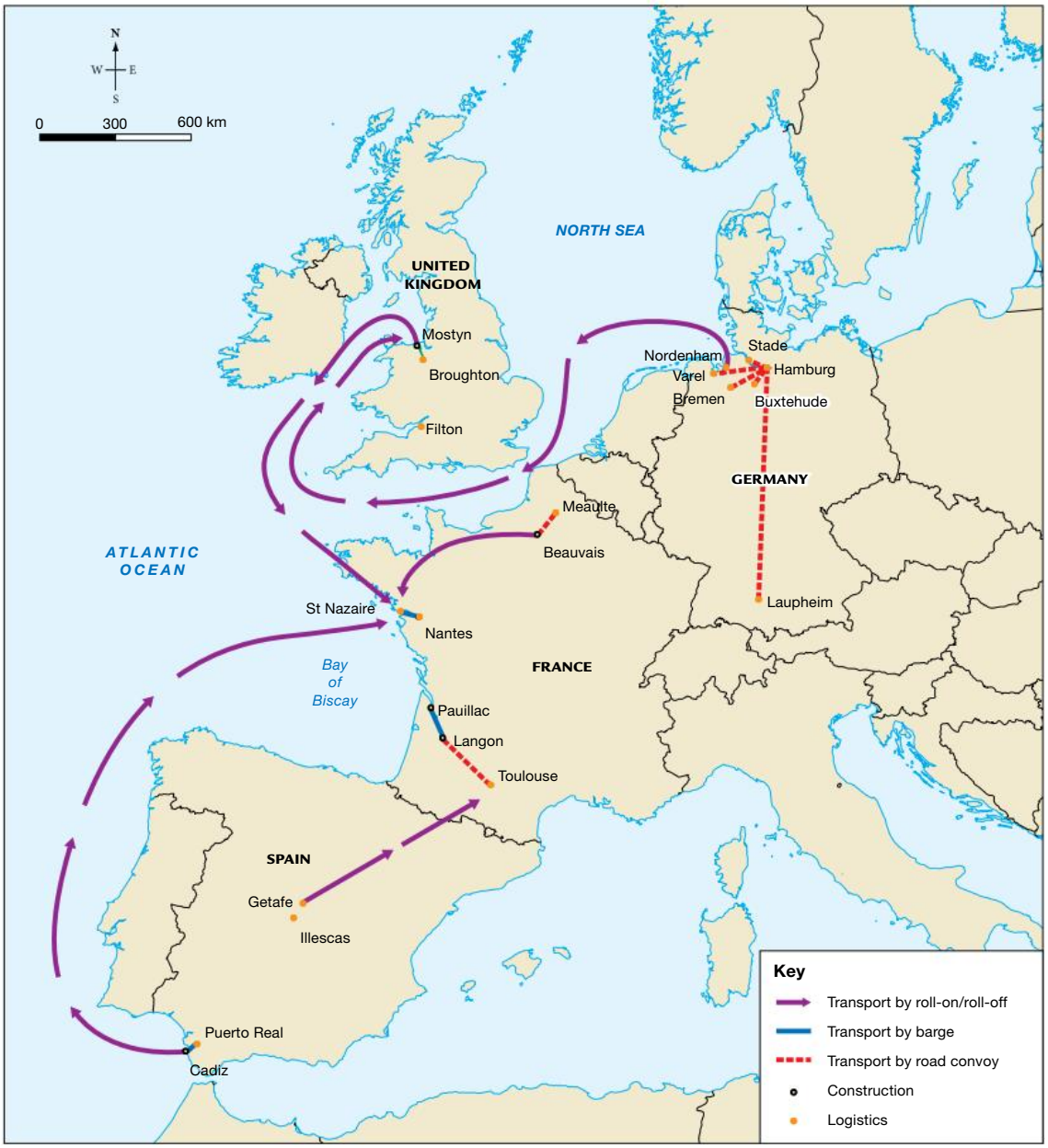
19.2.1 Trade in goods and services

eBookplus

Interactivity
Up, up and away
Use this interactivity to learn more about how the manufacturing of planes connects places.
Searchlight ID: int-3339

The system of trade has been around for a long time. Its earliest form was bartering at local markets. Merchants also used land and sea routes to access markets in foreign lands and exchanged goods for payment. Today we have a highly sophisticated, large-scale, global system of trade. A modern example of the interconnection of trade is the production of the Airbus A380. To construct this plane, component parts must be purchased from different countries and transported over land and sea to reach their final assembly place in Toulouse, France (see figure 1).

FIGURE 1 The component parts routes of the Airbus A380



Source: Data from Wikimedia Commons, User: Steff.

Trade connections in Australia

Throughout Australia and your local area, a system of trade and *interconnection* occurs. A visit to a local market will reveal a range of goods and services on offer from global, national, regional and local source areas, as shown in figures 2 and 3.

Goods and services, of which there are many, are generated by either processing Earth's resources or people doing things for each other. A good can be an item as simple as a loaf of bread or it can be as complex as a motor car. A service is not something you can hold in your hand; examples of services are education in a school or the advice a doctor gives a patient. What types of goods and services do you use to support your lifestyle?

As seen in figure 5, the processing of a resource into more complex goods can be a series of transitions, in which there is **value adding** at each level of industry (that is, its value increases). An important consideration in the production of goods and services is the impact on the environment.

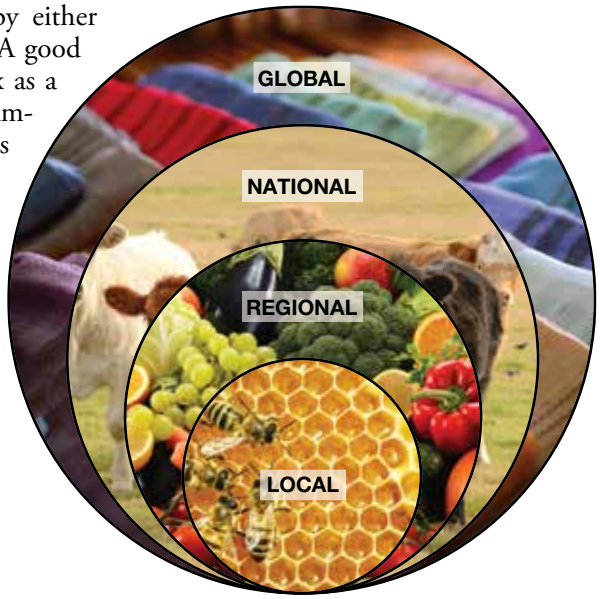


FIGURE 2 The scale of production found at a local market: global products (Fair Trade goods from Nepal); national products (beef and livestock from all states of Australia); regional products (fresh fruit and vegetables from the Hunter Valley); local products (honey from local bees)

value adding processing a material or product and thereby increasing its market value

FOCUS ON FIELDWORK

Fieldwork visit to a farmer's market

Aim

To investigate the interconnections between places and your local area

Task

Find out when and where markets, or the local show, take place in your town or suburb.

1. Investigate the source regions for the produce sold at the market. You can make a list of the locations by talking to the stall holders or taking photographs of the signs promoting the goods.
2. Are any of the products made using sustainable methods?
3. What are the advantages to customers from buying at this market?

On your return to school

4. List the produce that was local in origin; i.e. 0–50 kilometres away.
5. List the produce that was sourced from areas greater than 50 kilometres away from the market.
6. Select one product sold at the market that was sourced from a different environment. What is the environment like where this product comes from?

Farmers Market

- ✓ Where held?
- ✓ How often?

Observations

- ✓ Tally of produce for sale

Plants	Dairy	Fruit
IIII	I	IIIII III

- ✓ Source area of produce
- ✓ Customer numbers
- ✓ Photographs of:
  - Products being sold
  - Interesting scenes at the market

Interview

- ✓ Reason for seller attending this market
- ✓ Interesting points?

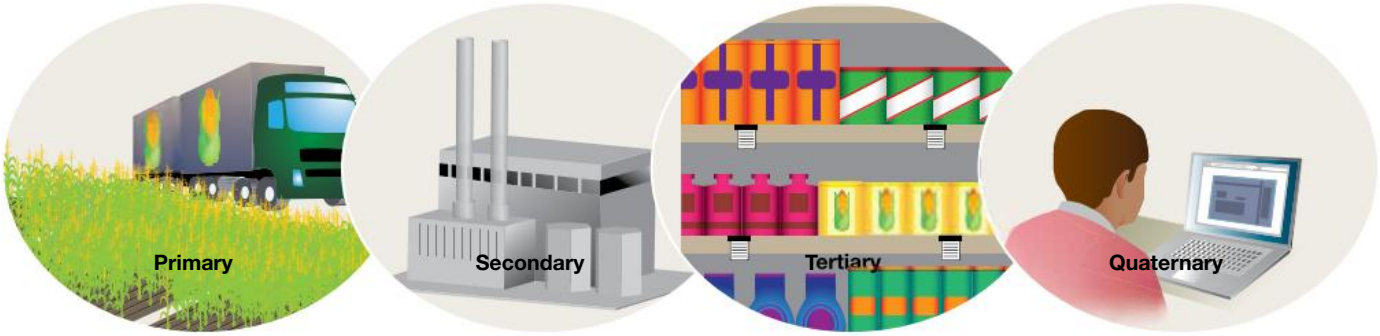
FIGURE 3 Regional produce at a city market

FIGURE 4 Selling rural equipment at the Henty field day

Interstate business

A heavy concentration of Australia's settlement in the south-east has led to a strong trade connection between major urban, regional and interstate places. Freight companies transport raw materials such as fresh agricultural produce (**primary industry**) to locations that process the raw materials into a more useful product (**secondary industry**). Manufactured goods are distributed to shops for sale (**tertiary industry**). Then the information that is gathered by companies is used for marketing purposes (**quaternary industry**).

FIGURE 5 Four levels of industry



primary industry the gathering of natural resources, such as iron ore and timber, or activities such as farming and fishing

secondary industry making raw materials into a more useful product; for example, making timber tables

tertiary industry selling goods and services; for example, a furniture business

quaternary industry gathering information about an industry; for example, marketing furniture

Freight is transported around Australia using rail, road, air and shipping. Major ports are used to link land-based (rail and road) and sea-based transport systems. Many global trade links are accessed through ports. When international shipping containers arrive in ports, they are transferred to road and rail transport for distribution within Australia.

FIGURE 6 Coal is a bulky product to transport.

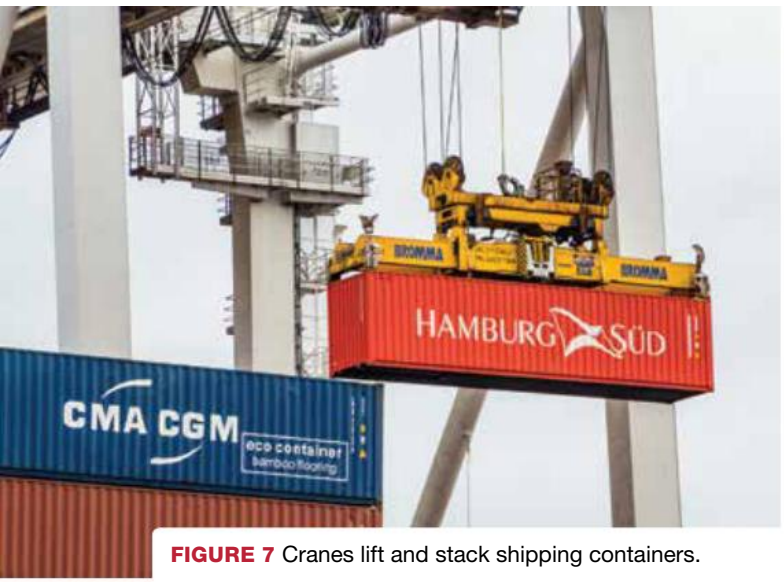


FIGURE 7 Cranes lift and stack shipping containers.

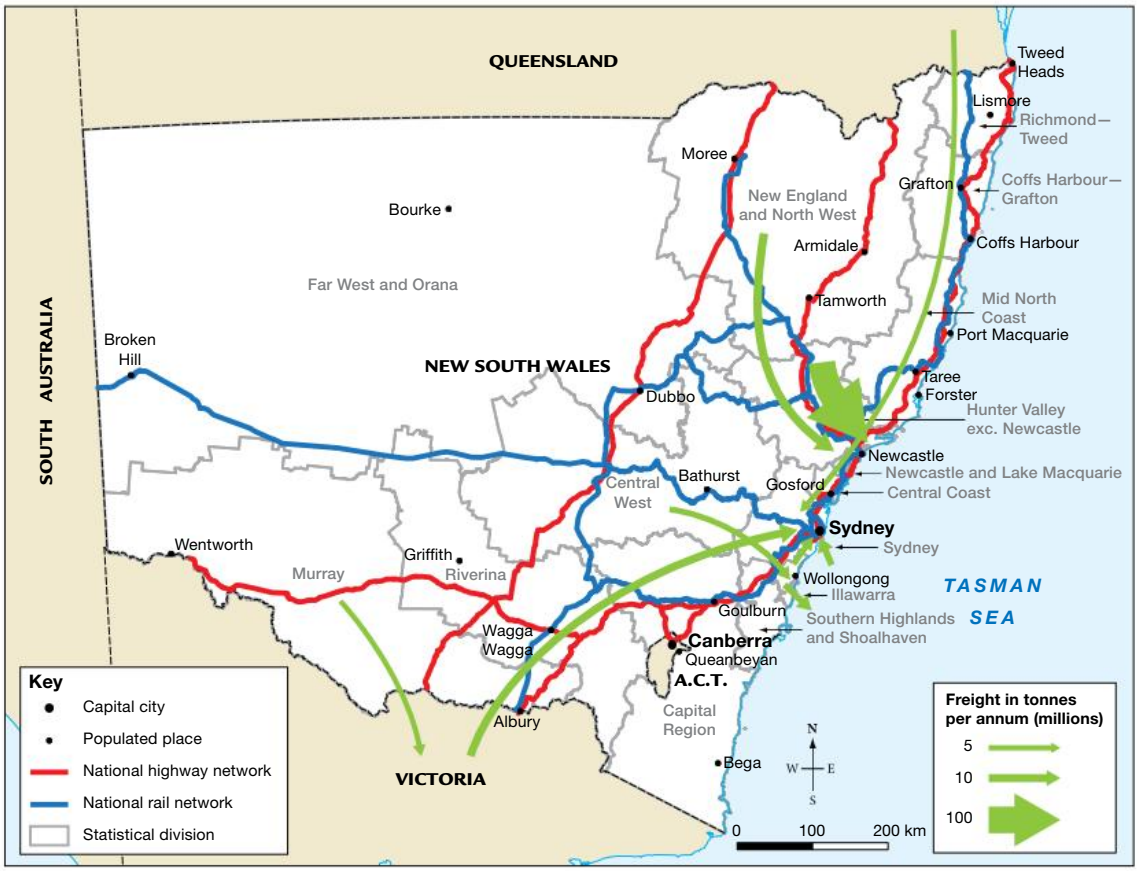
FIGURE 8 Road trains transport fuel.

GEOskills TOOLBOX

Flow maps

Flow maps show the movement and the volume of movement between places and environments. In figure 9, arrows indicate the direction of the freight flow between places. The arrow connecting the Hunter region and Newcastle is widest and indicates a large volume of traffic (100 million tonnes per year) between these two places. A flow map of student movements between school and each individual's home would reveal the locations that most students travel from and to each day.

FIGURE 9 Inter-regional freight flows for NSW during 2011



Source: Transport for New South Wales and Australian Bureau of Statistics.

ACTIVITIES

IDENTIFY

1 What reasons can you suggest as to why goods and services are traded?
2 Name the four levels of industry, and give an example of a good as it moves through the production process.

EXPLAIN

3 Suggest reasons why component parts of the Airbus A380 must come from different ***places*** (countries).
4 Explain what is meant by the term *value adding*, as a product moves through the four levels of industry. Choose a product such as wheat or timber.

APPLY

5 Suggest reasons customers are attracted to a local farmers market.
6 Prepare a poster to advertise a local farmers market and a farmers market at Port Moresby, in Papua New Guinea. What are the differences in the type of produce available?

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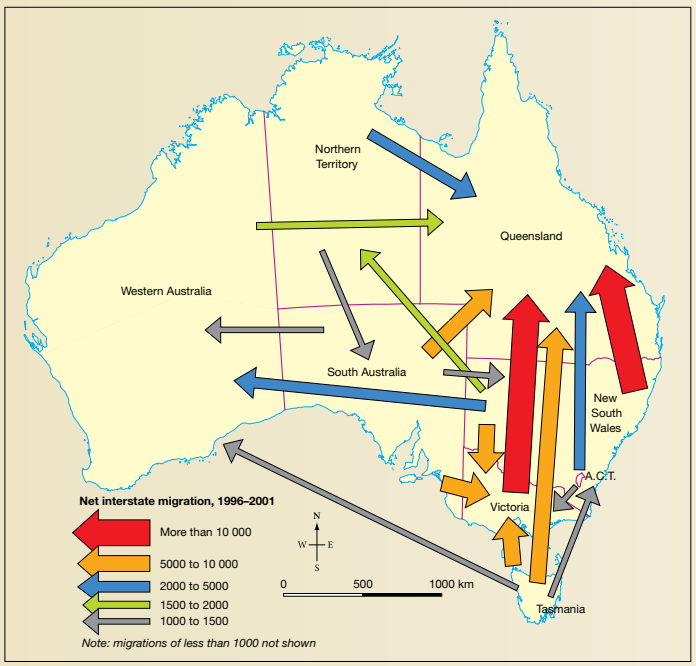
19.3 SkillBuilder: Constructing and describing a flow map

What is a flow map?

A flow map is a map that shows the movement of people or objects from one place to another. Arrows are drawn from the point of origin to the destination. Sometimes these lines are scaled to indicate how much of the feature is moving. Thicker lines show a larger amount; thinner lines show a smaller amount.



Source: MAPgraphics Pty Ltd, Brisane

eLesson
Watch this video to learn how to construct and describe a flow map.

Searchlight ID: eles-1741

Interactivity
Try this interactivity to learn how to construct and describe a flow map.

Searchlight ID: int-3359

19.4 How does trade connect Australia with the world?

19.4.1 Australia's trade organisation

Australia is one of the 164 members of the World Trade Organization (WTO), which covers 95 per cent of global trade. The organisation promotes free and fair trade between countries and, since 2001, its Doha Development Agenda has aimed to help the world's poor by slashing **trade barriers** such as tariffs, quotas and farm subsidies.

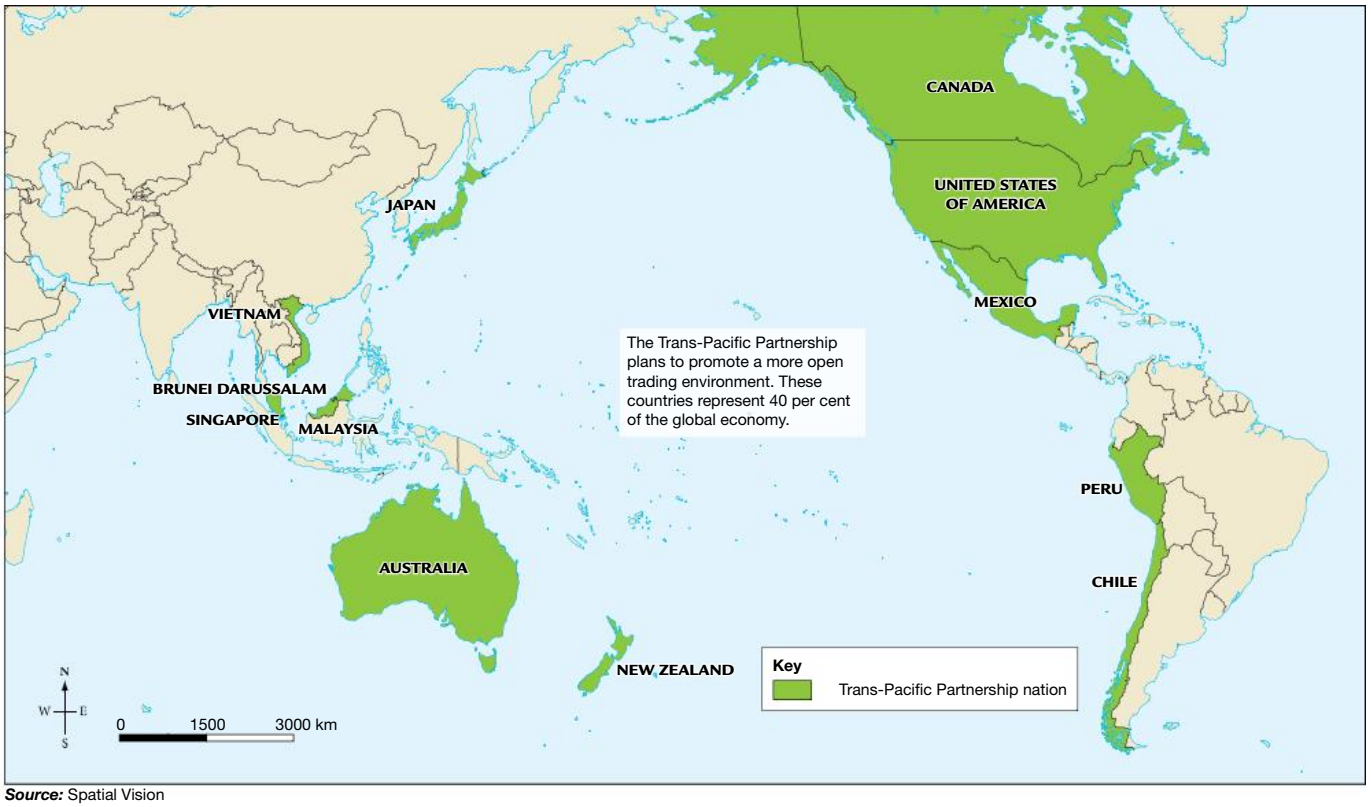
trade barriers government-imposed restriction (in the form of tariffs, quotas and subsidies) on the free international exchange of goods or services

The Australian Department of Foreign Affairs and Trade (DFAT) coordinates trade agreements on behalf of the Australian Government, and the Australian Trade Commission (Austrade) promotes the export of goods and services. About 70 per cent of Australia's trade is with the member countries of the Asia–Pacific Economic Cooperation (APEC) forum.

FIGURE 1 People involved with trade

Free Trade Agreements have been negotiated by Australia with a number of countries in the Asia-Pacific region. The Trans Pacific Partnership (TPP) also creates opportunity for trade.

FIGURE 2 The 12 nations taking part in the Trans-Pacific Partnership Agreement



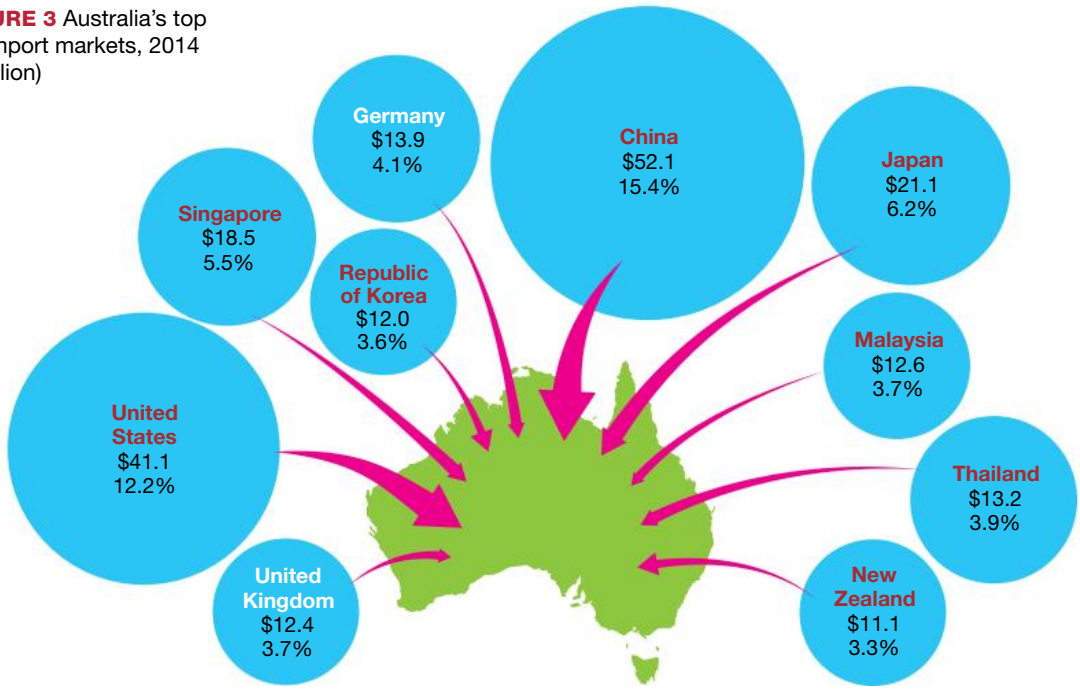
Source: Spatial Vision

19.4.2 Australia's trading partners

trading partner a participant, organisation or government body in a continuing trade relationship

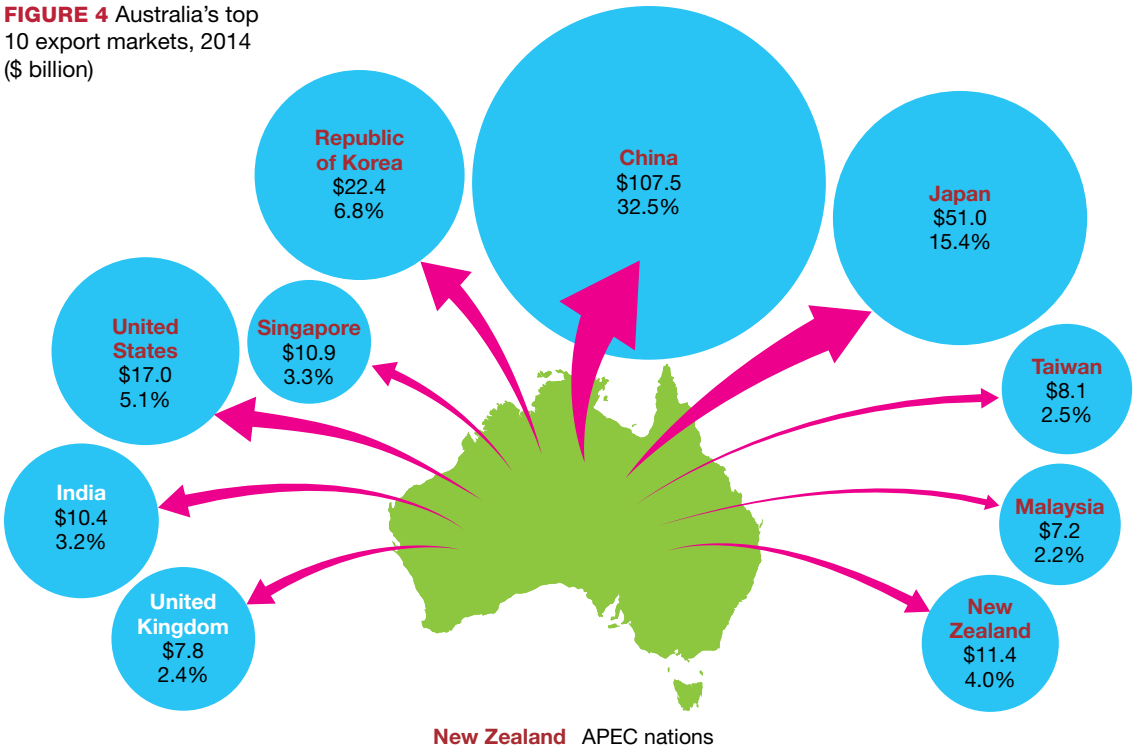
China, Japan and the United States were Australia's top three **trading partners** in 2014. Figures 3 and 4 show details of Australia's import and export trade.

FIGURE 3 Australia's top 10 import markets, 2014 ($ billion)



New Zealand APEC nations

FIGURE 4 Australia's top 10 export markets, 2014 ($ billion)



19.4.3 Australia's types of trade

Exports

Australia's export trade in 2014 was valued at $318 billion, and was dominated by the mineral products of iron ore, coal and petroleum. Recreational and educational travel, technical and other business services wereAustralia's leading services exports. Recent bilateral and multilateral trade agreements between Australia, the USA and a number of Asian economies have focused on removing tariffs on many products. These agreements will create new opportunity for strengthening demand in Australia's tourism, health services and agriculture into the future. However, the negative impacts of these agreements may include a loss of local jobs, loss of export income and a loss of control over product quality.

Imports

Like many countries, Australia is not self-sufficient in all goods and services. In 2014, Australia imported goods and services to a value of $338.6 million. Figure 6 shows the main aspects of this trade.

FIGURE 5 Australia's top 10 exports of goods and services, 2014–15 ($ million)

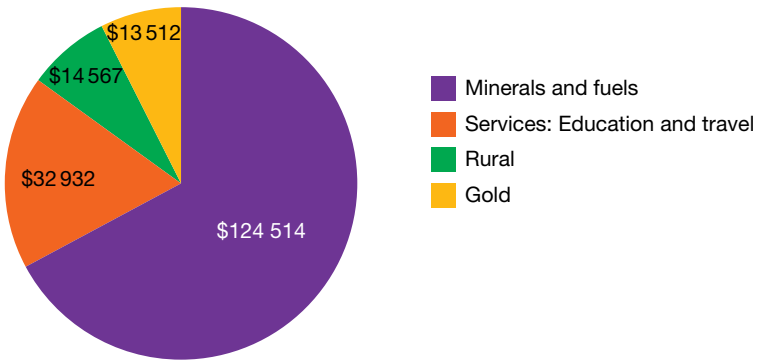
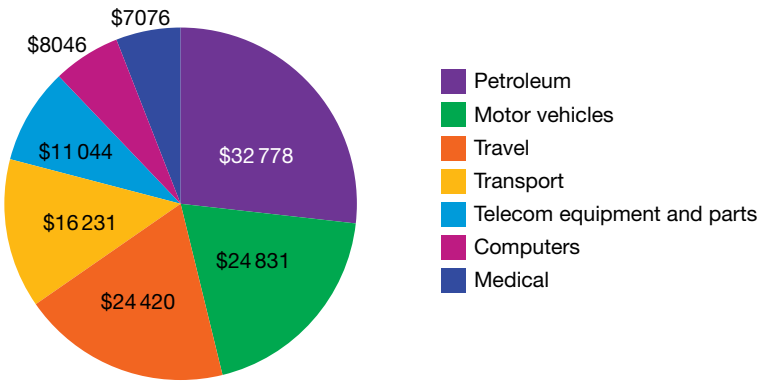


FIGURE 6 Australia's top 10 imports of goods and services, 2014–15 ($ million)



Regional trade opportunity

Australia's strategic location within the Asia–Pacific region has led to tourism, study and sport interconnections with our neighbours. In 2014, a category of 'educational travel services' was ranked our number three export and was valued at $15.7 billion. With 543123 international students studying in Australia, education is now very important for our economy. In effect, it is a service export, in that students are paying for knowledge that they will take back to their home country.

FIGURE 7
International students studying in Australia, 2015

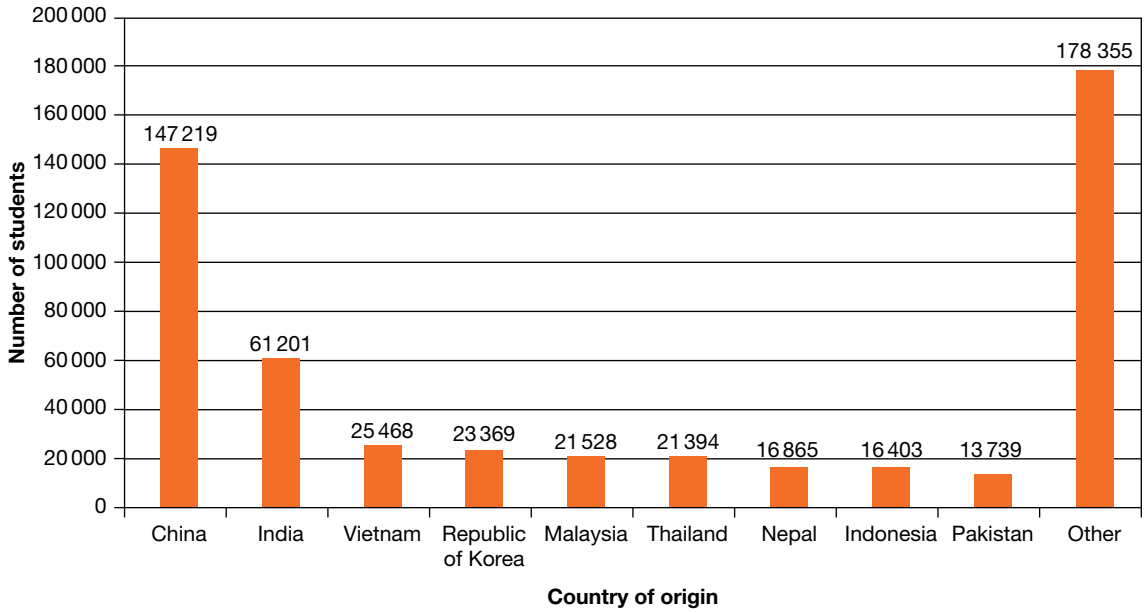
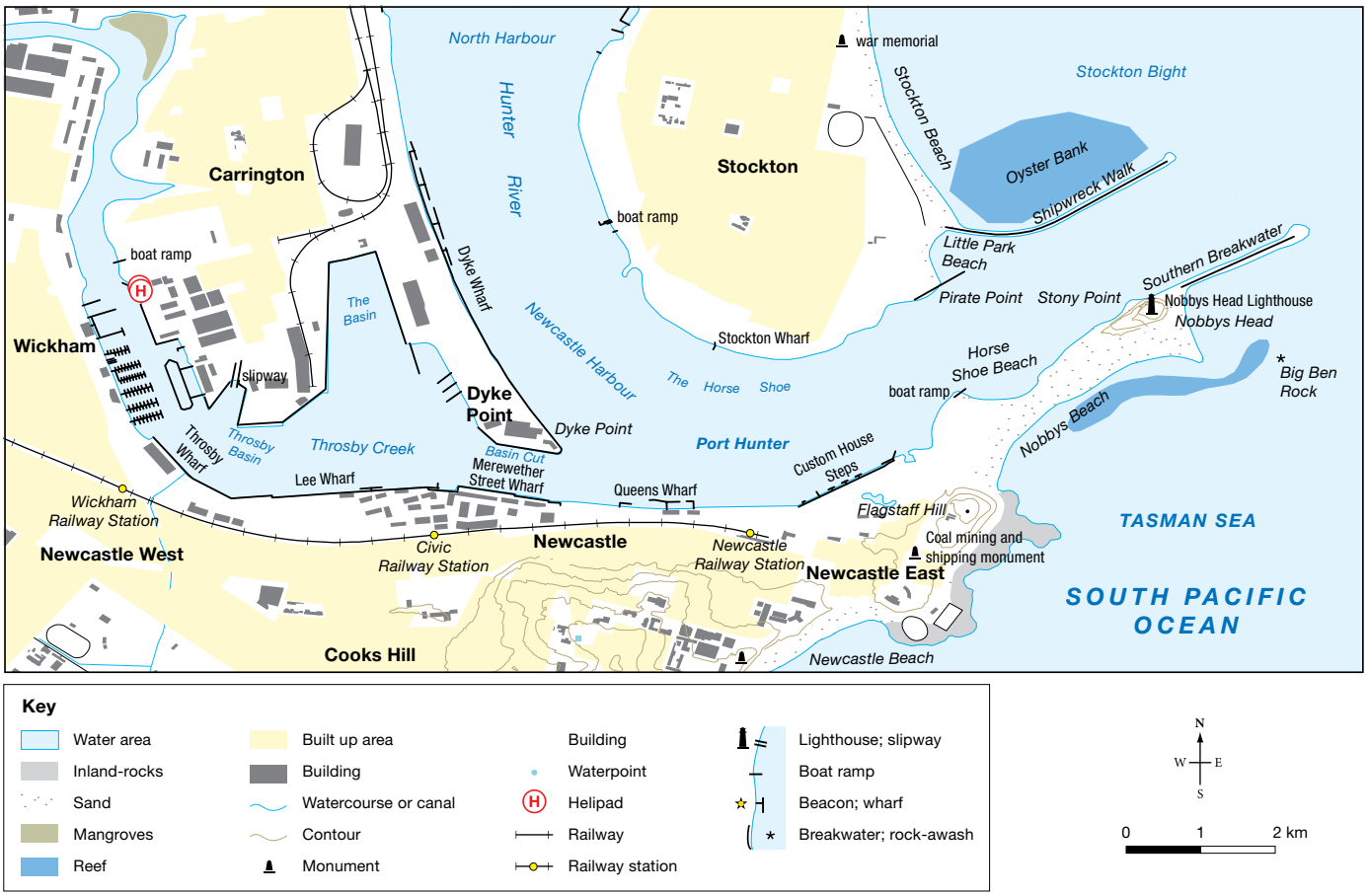


FIGURE 8 The Port of Newcastle is the largest bulk shipping port on the east coast of Australia.



Source: Land and Property Information, NSW.

ACTIVITIES

IDENTIFY
1 What is the ***interconnection*** between the World Trade Organization and Australia's trade?
2 What are Australia's three most important exports and imports?
3 Refer to figure 8. Identify three features of Newcastle Harbour that make it ideal for a shipping port.

EXPLAIN
4 Refer to figures 3 and 4. Compare Australia's imports and exports with those of Asian countries. Use data in your response.
5 Despite having a relatively small population, Australia has many goods and services to trade. Explain why this might be so.
6 Using the **Australian trade partners** weblink in your eBookPlus, describe the trade connection that exists between Australia and one other trading partner.

APPLY
7 How might a ***change*** in the growth of Australia's population affect the country's agricultural exports?
8 Look at the list of goods that Australia imports shown in figure 6. What factors could lead to a ***change*** in the types of goods imported by the year 2050?

INVESTIGATE
9 a What evidence is there in this section to confirm the fact that Australia is regarded as mostly a primary industry exporter?
b Research the way in which an opportunity to trade with Australia is promoted overseas.
c Prepare a brochure for students from a country of your choice that promotes study in Australia.

eBookplus

Interactivity
Trading partners
Use this interactivity to further your understanding of the interconnection between Australia and its trading partners.
Searchlight ID: int-3338
Weblink
Australian trade partners

myWorldAtlas Deepen your understanding of this topic with related case studies and questions. **› Aid, migration and trade**

19.5 How is food traded around the world?

19.5.1 Trade in food

The world's population is unevenly distributed across space, as is the quantity of food produced. Some places, such as Australia, produce an abundance of food, while others struggle to produce enough to maintain food security.

Traditionally, food production consisted of hunting and gathering or cropping and herding. Excess food was consumed locally or sent to nearby markets for **barter** or cash. While up to 41 per cent of the world's population is still directly tied to subsistence agriculture, many of the world's highly developed economies produce large surpluses of food specifically for international trade. For instance, Australia's food production is estimated to be worth $163.4 billion annually, and of that, $35.8 billion-worth is exported.

barter to trade goods in return for other goods or services rather than money

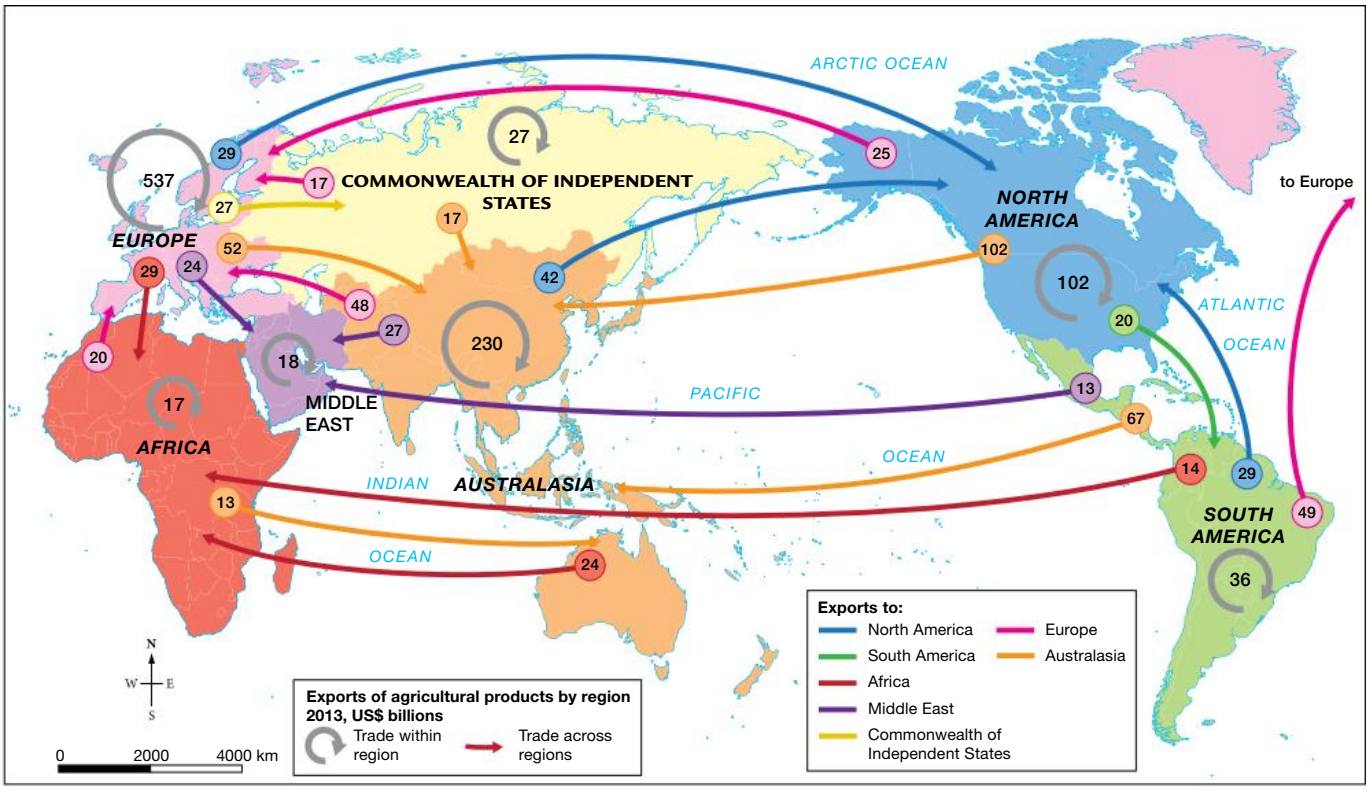
The flow of food trade

Much of the flow of food trade is controlled by powerful nations, such the United States, the European Union and China, and by international food trade agreements. The World Trade Organization (WTO) and G20 (a group of 20 highly developed and powerful nations) have a significant say in the flow of food products around the world, particularly with respect to tariffs and **fair trade** rules.

Food trade is a complicated business, as can be seen in figures 1 and 2. It is estimated that for developing countries, three-quarters of exports are agricultural produce. While developed countries may need to import tropical foods, many actually export as much as they import in agricultural produce. For instance, the United States, Canada and Australia use large farms to produce wheat, and they control 75 per cent of the global export trade in cereals.

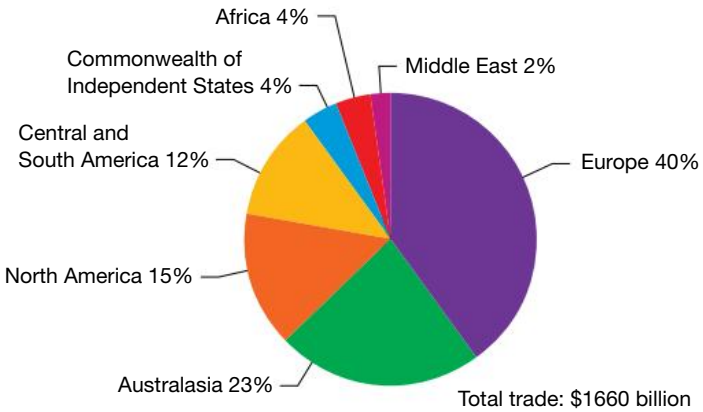
fair trade a consumer-driven movement to promote fair prices and reasonable conditions for producers in developing regions. Fairtrade International is a group of 25 organisations trying to ensure a better deal for producers.

FIGURE 1 World trade flows — exports of agricultural products by region, US$ billion



Source: Spatial Vision

FIGURE 2 Agricultural exports, share by region, 2013



Trade in animals

World trade in animals as food is estimated at close to 50 million animals — pigs, cattle and sheep. Using modern shipping methods, many animals are transported over long distances, and questions have been asked about potential cruelty in the operation of this trade (see figure 3).

The livestock import policies that our trading partners introduce may have an impact on the volume of Australian livestock exports. The aim of exporting live animals is that they are slaughtered according to **halal** religious customs in the country of import.

halal describes food that is prepared under Islamic dietary guidelines

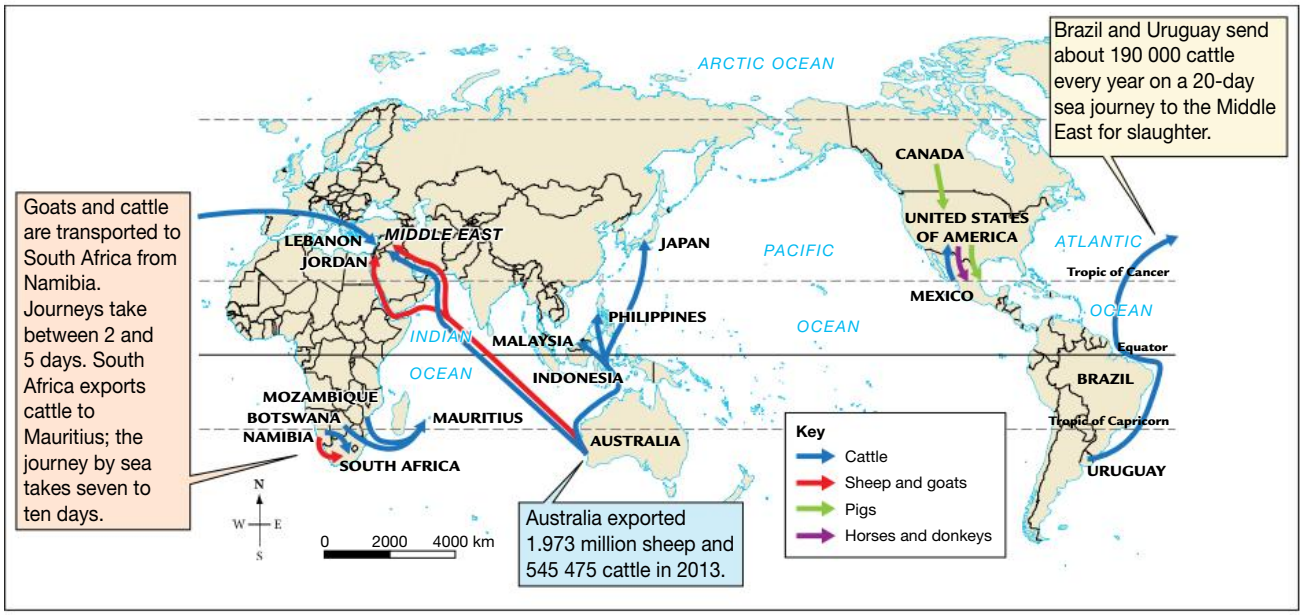
Due to the extensive nature of farming cattle and sheep in Australia, these animals must often travel very large distances to reach ports. They then travel by ship to distant markets.

Where does my food come from?

As a result of the global trade of fresh and processed foods, it may be difficult to determine where your food has come from. For example, a packet of sultanas bought at a local supermarket and labelled 'Made in Australia' may be made entirely of ingredients that have been imported from another country, such as Turkey. The packaging may be stamped with a 'Made in Australia' label because the contents have been processed and packaged in an Australian factory.

New food labelling laws in Australia are designed to protect shoppers by listing the place of origin of food they are about to buy and eat. Customers can then make an informed choice about buying ingredients and produce grown or prepared locally or in other countries.

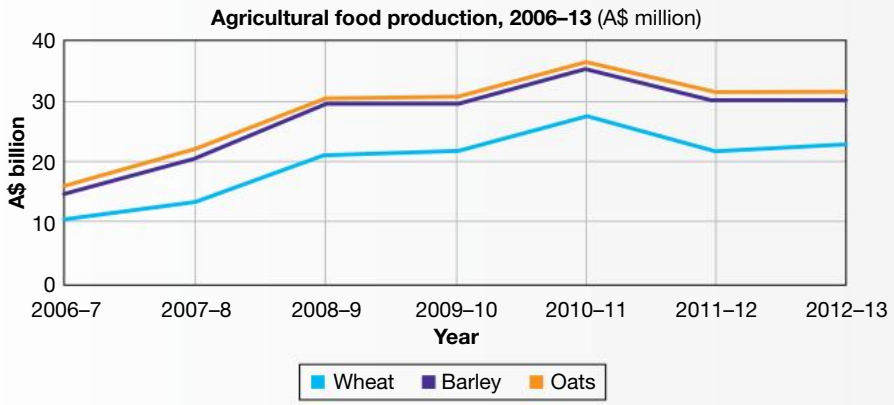
FIGURE 3 Live animal transport around the world



Source: Spatial Vision

GEOskills TOOLBOX

Cumulative line and bar graphs allow you to display and compare factors on the same graph over a period of time. The following graph shows the amounts of wheat, barley and oats produced in Australia between 2006 and 2013. This graph shows an increase in wheat and barley production, while oats production has remained stable between 2006 and 2013.



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Weblink
Trade

ACTIVITIES

IDENTIFY

1 What is the value of Australia's food exports?
2 Suggest why highly developed economies are able to produce food surpluses.
3 Refer to figure 1.
  a What is the value of food trade from Australasia to Europe?
  b What is the value of food trade from Europe to Australasia?
  c Is there a balance in this food trade based on your calculations in (a) and (b)?
  d Place the regions of the world in decreasing order by volume of food trade.

EXPLAIN

4 Refer to figure 2.
  a Explain why Africa has such a low level of food trade.
  b What reasons can you suggest as to why Europe dominates world food trade with a value of 40 per cent?
  c Why do you think Oceania is not represented?

APPLY

5 Why do countries in ***places*** such as the Middle East and Asia have a preference for live animal imports?
6 Use the **Trade** weblink in your eBookPLUS to help you prepare a 200-word statement about the types of agricultural produce Australia exports and the nations to which we export. Also state what agricultural produce Australia imports.
7 a Investigate the issue of live animal exports from Australia.
  b How might a ban on live animal exports from Australia affect farmers?

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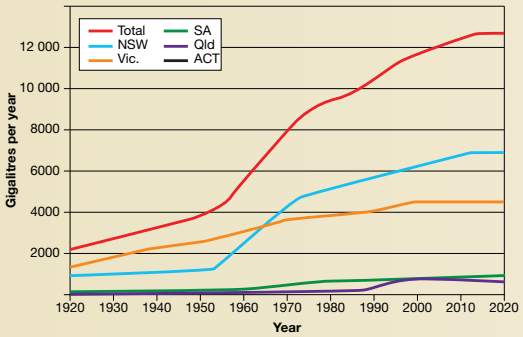
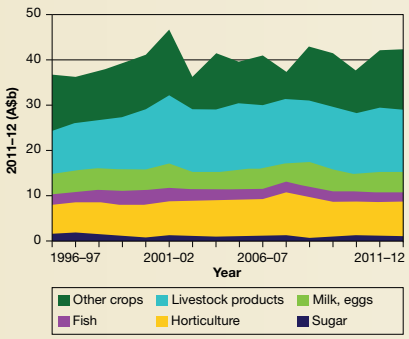
19.6 SkillBuilder: Constructing multiple line and cumulative line graphs

What are multiple line graphs and cumulative line graphs?

Multiple line graphs consist of a number of separate lines drawn on a single graph. Cumulative line graphs are more complex to read, because each set of data is added to the previous line graph. Both formats show change over time and show trends effectively. They are both useful when comparing the change in one set of data with changes in other sets of data, and are easier to read than a table of statistics.





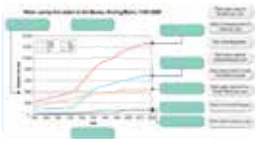
eLesson

Watch this video to learn how to construct multiple line and cumulative line graphs.

Searchlight ID: eles-1740

Interactivity

Try this interactivity to learn how to construct multiple line and cumulative line graphs.



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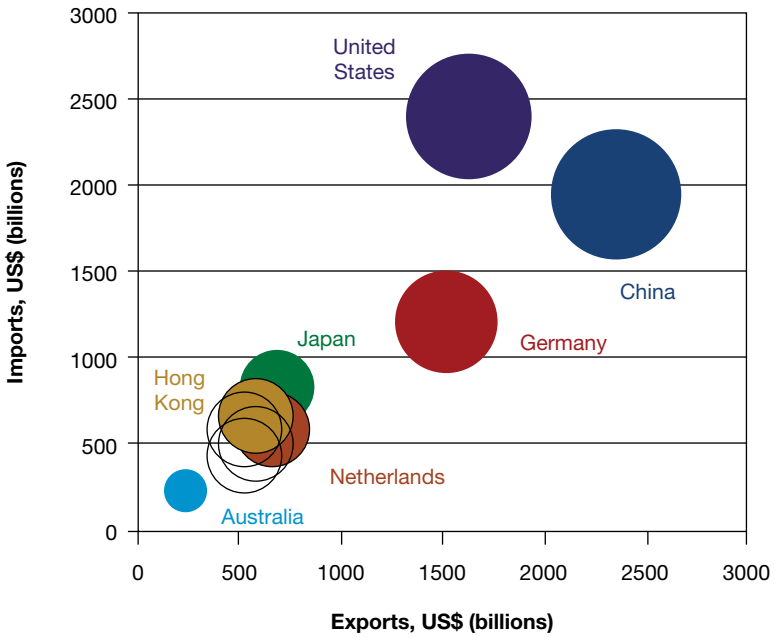
19.7 How are markets and factories linked?

FIGURE 1 A scattergram of the world's leading merchandise traders, 2014



19.7.1 How trade moves around the world

Global trade of resources, manufactured goods and services connects people and places around the world. Information technology enables environments with a competitive advantage in the production of a good or service to connect with destinations that have a need. Transport technology provides an efficient interconnection between source areas, markets and businesses on a global and a local scale.

China is the world's largest exporter of goods, accounting for more than 12 per cent of total exports. The United States is the largest importer, with a share of almost 13 per cent. Growth in world trade patterns continues and global trade is dominated by movements between these strong trading nations. Figures 1 and 2 show the main aspects of this trend.

Global shipping routes

International trade involves the exchange of goods and services between countries. A port is a place for ships to dock on a coastline to load and unload their cargo. A growing global population and the development of an efficient form of goods transport, such as containers, have led to strong shipping links between countries, as shown in figure 2. These interconnections have led to greater choice and more competitive prices for consumers. Economies are boosted and jobs are created worldwide.

FIGURE 2 Global shipping routes

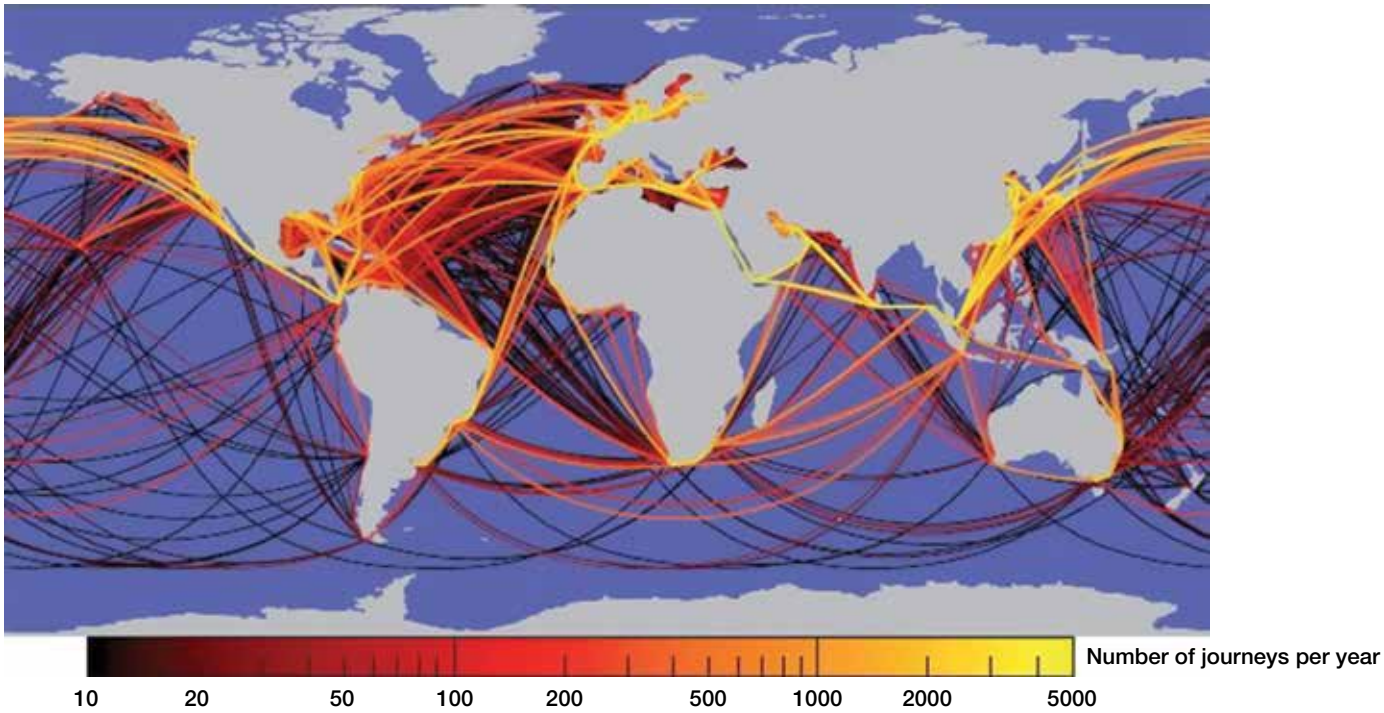


FIGURE 3 The carrying capacity of container ships has increased 1200 per cent since 1968.

Source: Allianz Global Corporate & Specialty Safety and Shipping Review, 2016

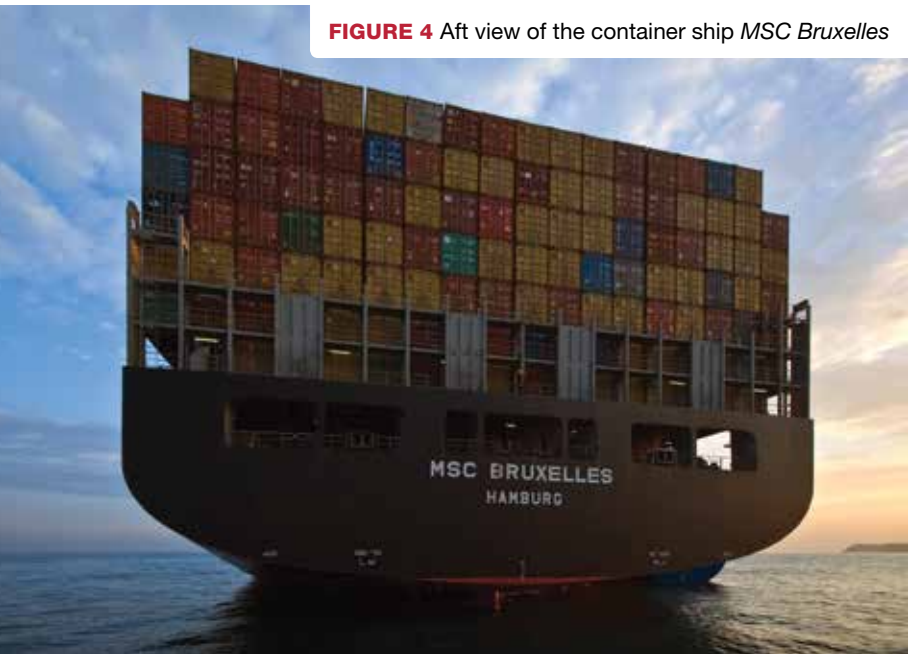


FIGURE 4 Aft view of the container ship *MSC Bruxelles*

The development of the shipping container has created an efficient method of transporting resources and goods from place to place. The introduction of a standardised measure for shipping containers (TEU, which stands for Twenty Foot Equivalent) has shaped the design of cargo ships, port handling facilities and trade routes around the world. Ships are able to carry increasing loads efficiently and more cheaply. For instance, the *MSC Oscar* (figure 3) is able to carry 19 244 containers.

What are port areas like?

Ports are commercial areas where water and land transportation links meet. Efficient handling of the transport of resources and goods will ensure that road and rail networks link the source areas within a country to international air and shipping. These interconnections create employment opportunities in transport and distribution industries. Global Logistics companies manage the movement of trade.

On a global scale, large ports such as Singapore operate 24 hours a day and 365 days a year to load and distribute goods. Raw materials and manufactured goods are distributed to global markets.

FIGURE 5 Inter-modal points manage the transfer of goods.

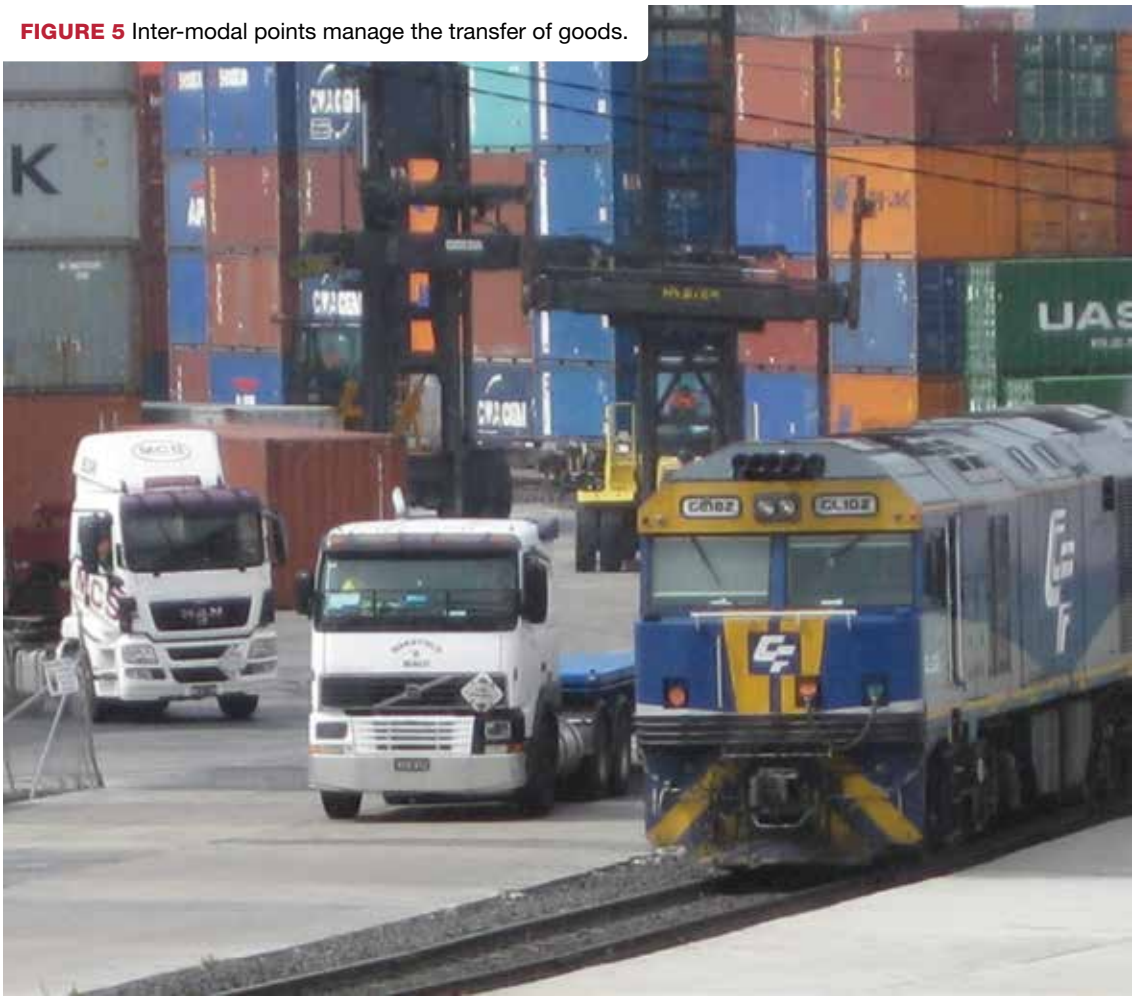
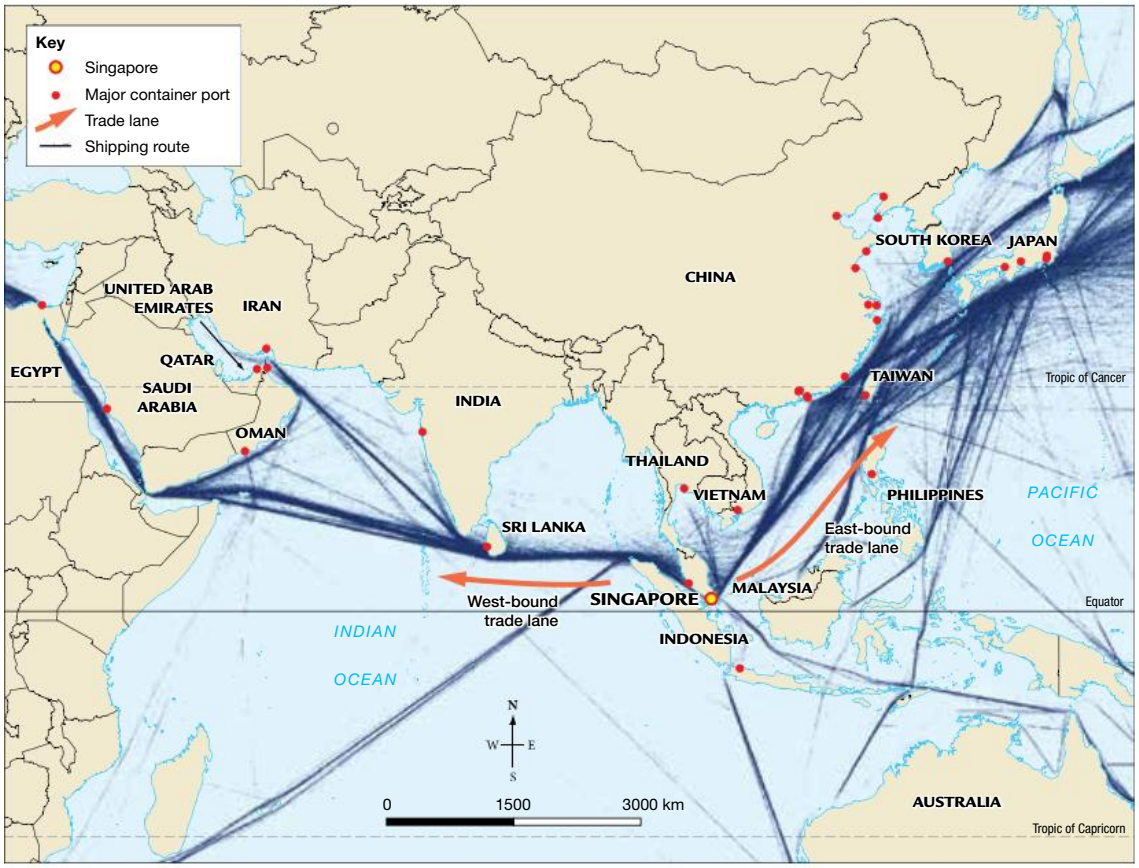


FIGURE 6 Port of Singapore

FIGURE 7 Singapore is strategically located where the west-bound and the east-bound trade links pass.



Source: Spatial Vision

How sustainable is shipping?

The capacity of the environment to continue to support our lives and the lives of other living creatures into the future is known as sustainability. Shipping interconnects places around the world through trade. The use of containers makes the process efficient and more reliable, but what are the environmental costs of this industry?

FIGURE 8 Some impacts of the widespread use of containers

Reuse of container to supply housing

Marine debris from shipping accident

Port congestion

Pollution from shipping

Increased influence of globalisation: loss of local jobs, loss of cultural identity

Migration patterns of North Atlantic Right whale disrupted

Damage to World Heritage Areas as a result of increased shipping

Containers used to support earthquake-damaged structures in Christchurch

FOCUS ON FIELDWORK

How is your location connected to larger areas?

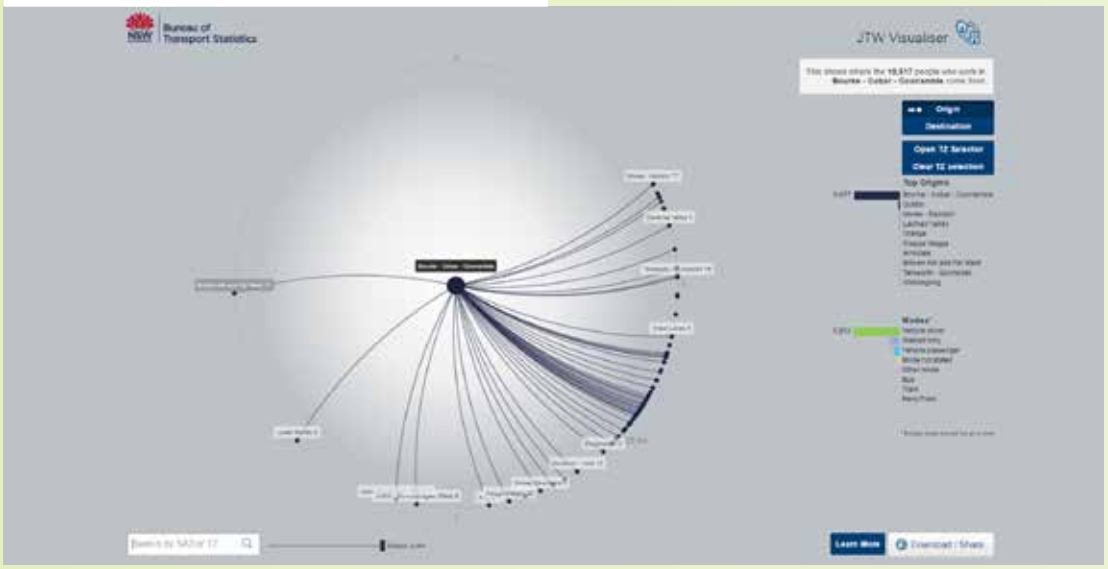
Visit a locality that is well connected by transport to areas outside of your location. For example, a local supermarket or shopping centre may be found along a highway or major transport link, or your school may be supported by a range of bus services.

Record your observations. The following questions are a guide.

1 What are the source areas and the destinations of the transport observed?
2 How are passengers or goods moved through the loading dock or interchange area?
3 In what ways do large transport centres have an impact on the environment? Note any strategies that are used to make the flow of people or goods more efficient. This may involve ticket collection and the use of exits for passenger movement. It may involve special lanes for trucks, buses and trains.
4 What are the public transport links that are available for your location? (You can identify these by using the **My public transport links** weblink in your eBookPLUS.)

FIGURE 9 A road and rail transport interchange

FIGURE 10 Pattern of public transport for Bourke



ACTIVITIES

IDENTIFY

1 Which country exports the greatest amount of goods?
2 Which country imports the greatest amount of goods?
3 Refer to figure 1 to rank the top 5 exporting countries in US$ billion.
4 Refer to figure 1 to rank the top 5 importing countries in US$ billion.
5 Refer to figure 2 to describe the shipping routes that have the greatest number of shipping journeys.

EXPLAIN

6 What role does a port play in the movement of global trade?
7 What are the advantages to trading companies of using ships able to carry large container loads?
8 What natural features would a port need to process large volumes of ships each day?

APPLY

9 Prepare arguments for a debate on the topic 'Shipping is a sustainable option for international trade'. Explore the positive and negative points on this topic and suggest strategies to reduce some of the impacts presented in figure 8.

INVESTIGATE

10 Use the **Ports** weblink in your eBookPLUS. Select one of the ports to investigate. Visit the GIS image of your chosen port and capture a screenshot. Use this image to annotate the key areas of the port. Where do the ships enter the port? What types of goods are traded through the port? What volume of traffic passes through this port?

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Weblinks
- My public transport links
- Ports

19.8 How is Singapore linked to other places?

19.8.1 Singapore's strategic location

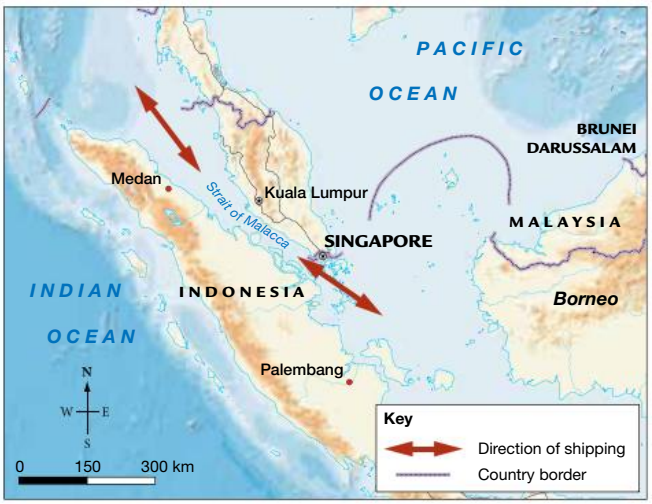
Singapore plays an important role in connecting places around the world. It has a very strategic location in the heart of South-East Asia, and is an important trade and transport hub. Singapore is an island that borders Indonesia and Malaysia by sea, and its export-oriented economic policy encourages flows of trade and investment.

Singapore is a major transport node. Annually over 55 million passengers pass through Changi International Airport and more than 140 000 vessels pass through the Port of Singapore. The airport is the sixth busiest for international traffic, providing connectivity to over 300 cities worldwide. There are over 27 000 aircraft movements occurring every month (see figure 1) and almost one flight every 90 seconds.

Figure 2 shows Singapore's strategic location at the southern end of the Strait of Malacca, the shortest shipping route between the Indian Ocean and the Pacific Ocean. This stretch of water is the biggest oil corridor in the world and accounts for 25 per cent of all traded goods. At one point the Strait narrows to only 2.8 kilometres, creating shipping congestion and an increased risk of piracy. The Port of Singapore handles a wide range of cargo including containers, motor vehicles and crude oil, which is refined into petrochemical products.

FIGURE 1 Changi airport and port facilities connect Singapore to over 300 countries.

FIGURE 2 The Strait of Malacca links the Pacific Ocean and the Indian Ocean.



Source: Spatial Vision

FIGURE 3 The Causeway Link buses connect Singapore with the mainland.

Singapore consists of 63 islands and is linked to neighbouring mainland Malaysia by road and rail connections. The Causeway Link buses shown in figure 3 enable day workers from Malaysia to commute to Singapore. Singapore is also a popular tourist destination and, in 2015, the Singapore Tourism Board reported that more than 15.2 million people visited the nation.

Interconnections exist between Singapore and its multicultural population. Chinese groups comprise over 74 per cent of the population, with Malay and Indian groups forming over 20 per cent combined. As a former British colony, a member of the Commonwealth of Nations and a founding nation of Association of South-East Asian Nations (ASEAN), Singapore has many links to cultures and economies around the world.

FIGURE 4 Topographic map extract of Singapore

Key

- International boundary
- National capital
- Railroad
- Expressway
- Trunk road
- Primary road
- Ferry
- Port
- Airport
- Park
- 163 m + Spot height

Source: © OpenStreetMap contributors

ACTIVITIES

IDENTIFY

1. Which country is Singapore's closest neighbour?
2. Name the body of water that separates Singapore from its closest neighbour.
3. Identify the country that is found at the following area reference locations.
   a AR2447 **b** AR2544 **c** AR 2345
4. What is the area reference for Changi International Airport?
5. What is the direction of Batam from Singapore?
6. What is the direction of Johor Bahru from Singapore?

EXPLAIN

7. Describe the location of ports within Singapore Island as shown on the map.
8. Suggest two advantages of road and rail access to Malaysia for residents of Singapore.

APPLY

9. Use the line scale for the map of Singapore to measure (a) the length and (b) the width of Singapore.
10. Estimate the land area (in square kilometres) of Singapore.
11. What is the distance between Singapore and Batam along the ferry route shown?
12. Research the current population of Singapore. Then calculate the population density of the country using the formula below:
    The population density of a place is: total number of people / area km² = number of people per km².

19.9 How has international automotive trade changed?

19.9.1 The rise of the Asian car industry

Trade is one of the strongest interconnections between people and places on the planet, as goods are transported all over the world. Worldwide earnings from car exports make up 5.3 per cent of earnings from all international exports. Two countries with the largest share of the car export market are Japan in north-east Asia and Germany in Europe. Together, they have 61 per cent of the world's net profits on international car exports. Other countries with significant car exports include China and South Korea in Asia.

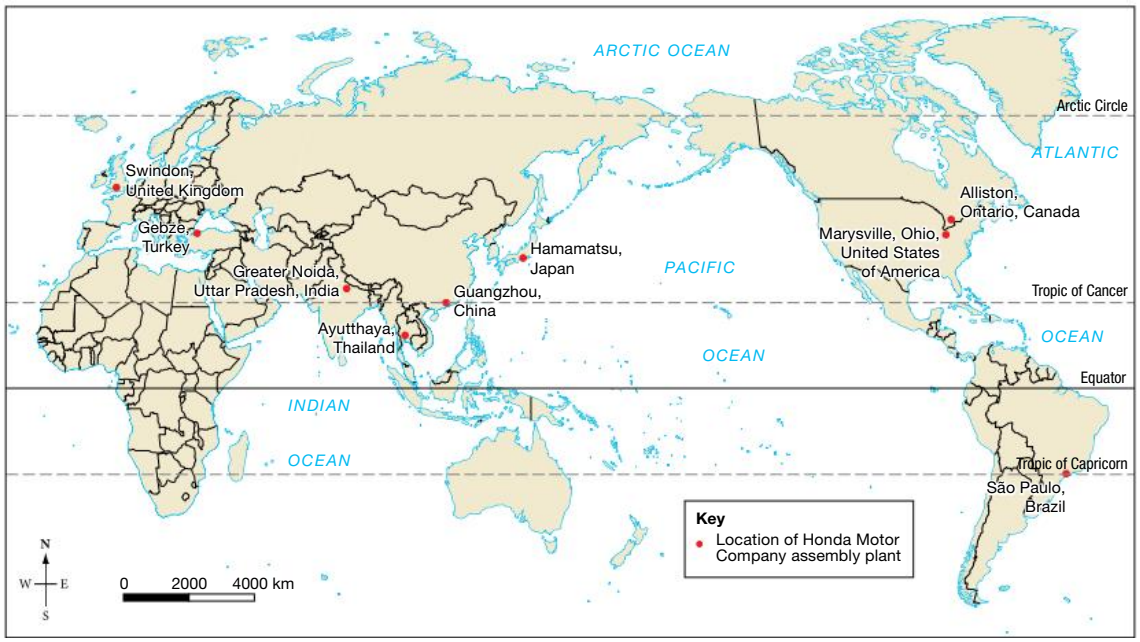
TABLE 1 The world's ten leading car manufacturers, 2015

Rank	Manufacturing company	Headquarters
1	Toyota	Japan
2	Volkswagen	Germany
3	Daimler	Germany
4	BMW	Germany
5	Honda Motor Company	Japan
6	General Motors	US
7	Ford	US
8	Nissan	Japan
9	Hyundai	South Korea
10	SAIC	China

The world's ten leading car manufacturers, according to 2015 data, are found in Asia, Europe and North America. As seen in table 1, Toyota is the world's leading car manufacturer based on revenue, and has assembly and manufacturing plants located around the globe.

Honda Motor Company is a successful Japanese multinational corporation operating plants worldwide. North America is the company's largest market and part of their success is due to car assembly and design taking place in the United States (see figure 1). Honda develops different vehicles to cater to the specific needs of each market. Its vehicles vary by country and may feature models exclusive to one region.

FIGURE 1 The Honda Motor Company operates plants worldwide for the manufacture of their products.



Source: Spatial Vision

19.9.2 The decline of the American car industry

Detroit is the largest city in the state of Michigan, in the United States, and was long known as the world's automotive centre. Detroit and the surrounding region constitute a major centre of commerce and global trade, most notably as home to America's 'Big Three' automotive companies: General Motors, Ford and Chrysler.

These three car manufacturers were, for a while, the largest in the world. Ford had held the position of second-ranked car maker for 56 years, but was relegated to third in North American sales after being overtaken by Toyota in 2007.

The United States car industry is suffering from increased overseas competition and from the 2008–2012 global recession. Car dealerships across the United States are struggling, and many are closing. The Big Three manufacturers have suffered from perceived inferior quality and reliability compared to their Japanese counterparts. They have also been slow to bring new vehicles to the market, whereas the Japanese are considered leaders in producing smaller, more fuel-efficient cars.

FIGURE 2 Sustainable technology will be important for future car sales.

As a consequence, a rise in automated manufacturing using robotic technology (figure 5) has created related industries in Detroit. Inexpensive labour in other parts of the world and increased competition have led to a steady change in certain types of manufacturing jobs in the region. For example, the Detroit area has gained new lithium ion battery plants. As well, the Detroit car makers and local manufacturers have restructured in response to competition. General Motors has invested heavily in fuel-cell-equipped vehicles, while Chrysler has researched and developed biodiesel.

FIGURE 3 Car industry redistribution in the United States

Source: Spatial Vision

Changes to Australia's car industry

Trade enables Australian consumers to access 64 car brands, making Australia one of the most competitive new car markets in the world. Until recently, Holden, Mitsubishi, Toyota and Ford manufactured cars in Australia. A number of factors have contributed to a decision by all four car manufacturing companies to move car production offshore. Australia's relatively high wage costs, withdrawal

FIGURE 4 Australian car imports

of government assistance, the high value of the Australian dollar, and a move by car buyers to smaller cars made it unsustainable for companies to continue producing cars. Australia will continue to provide design, engineering and testing expertise to these companies; however, high levels of unemployment are expected in areas of Victoria and South Australia where car-making plants were concentrated.

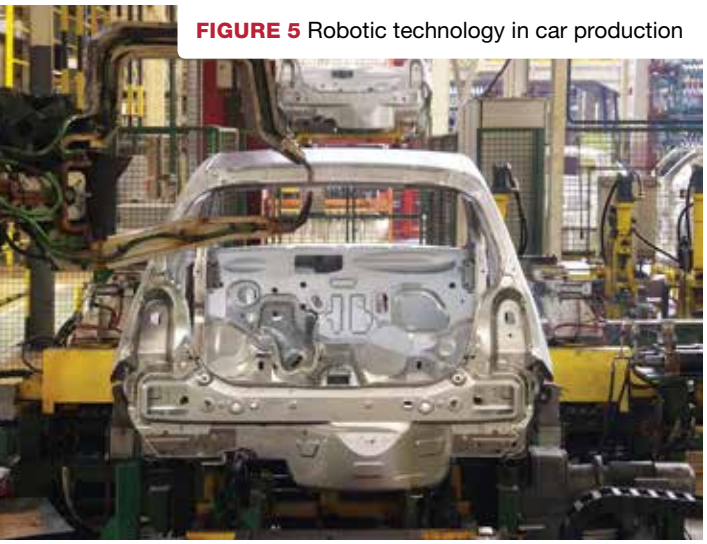


FIGURE 5 Robotic technology in car production

FIGURE 6 The decline of the US car industry has changed employment in Detroit.

ACTIVITIES

IDENTIFY

1 Refer to figure 1. Honda cars are manufactured in many ***places*** around the world. Where is Honda's manufacturing centre for the Australian market?

EXPLAIN

2 Explain the advantages of the Big Three US car manufacturers being located in the same ***place***.

3 Why has the Japanese automotive industry become a world leader in international exports?

4 What ***changes*** have Detroit's industries made in response to the decline of the car industry?

5 Look at figure 3. Describe the location of foreign and domestic automotive plants.

INVESTIGATE

6 Research the effects of the decline of the US car industry on Detroit and surrounding towns and businesses.

7 New Zealand used to have a Honda assembly plant. Find out when it opened, when it closed, and the reason for its closing.

19.10 Are global players altering the industrial landscape?

19.10.1 Changing trends

Until recently, designer clothing came from Italy, and jeans came from the United States. Today, that Italian suit might be designed in Milan, but it is woven from New Zealand wool and stitched together in China. **Globalisation** has brought global marketing, encouraging consumers everywhere to buy goods without a thought to where they come from.

globalisation the process that enables markets and companies to operate internationally, and products and ideas to be freely exchanged

The clothing industry has faced several tough years. Since the global recession (or global financial crisis) in 2008, consumer spending patterns have changed and retailers have experienced a decline in sales. Further changes have occurred due to the growth of online shopping and the signing of Free Trade Agreements.

The Australian clothing manufacturing industry has produced some very recognisable brand names and distinctive products. One challenge facing this industry is international competition, especially from developing countries that can afford to mass-produce clothing more cheaply than Australian companies can. Australian clothing manufacturers tend to focus on high-end, high-quality products rather than attempting to compete with lower-cost producers.

Many multi-national firms have moved production away from the relatively expensive location of Australia, 'off shore' to a relatively cheaper location such as China. These cheaper places offer low labour costs, no labour unions, a stable political system and government incentives designed to attract investment.

FIGURE 1 This symbol signifies that a product has been manufactured in Australia by an Australian-owned company.

Bonds latest brand to head offshore

While iconic Australian clothing brands Bonds, King Gee and Hard Yakka will now be manufactured offshore, the company that owns them insists the heart of the business remains Australian.

However, the decision by Pacific Brands to move its entire clothing manufacturing workforce to Asia means labels like Bonds will be the latest in a long line of Australian brands hoisted overseas.

The trend goes back to the 1920s, when the Vegemite trademark was acquired by United States giant Kraft.

More recently, Arnott's Biscuit Company was bought by US-based Campbell Soup Company in 1997, and Aeroplane Jelly was acquired by Jelly McCormick Goods two years earlier . . .

Cereal company Uncle Toby's was bought by Swiss Nestlé in 2006, and . . . swimwear company Speedo was bought by the United Kingdom–based Pentland Group in 1990.

But [the] Pacific Brands chief executive . . . is adamant that while Bonds singlets and undies will now be made in countries like China, the ideas will continue to come out of Australia . . .

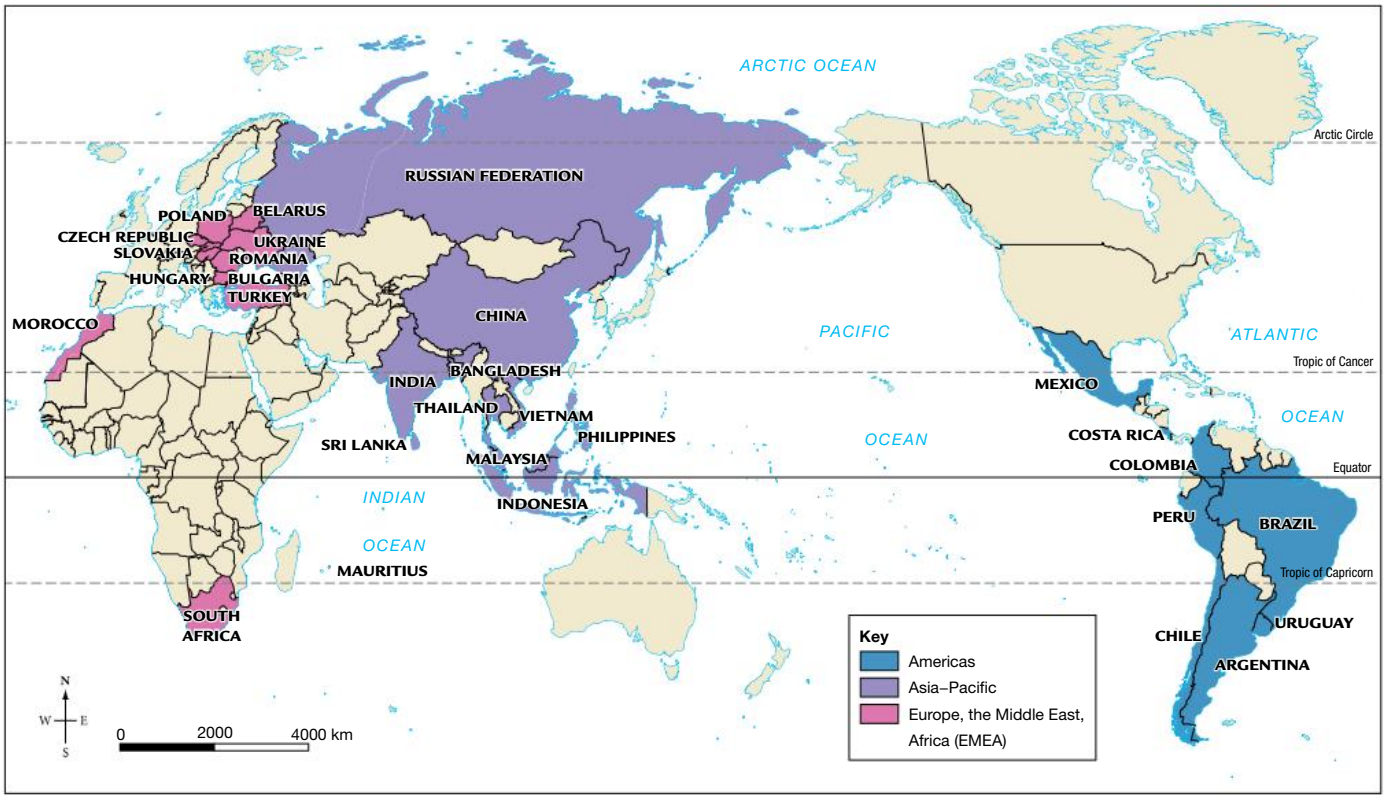
Source: *The Age*, 25 February 2009. © 2009 AAP. See full notice on acknowledgements page.

19.10.2 Foreign companies in China

In 1979, there were 100 foreign-owned enterprises in China. In 1998, there were 280 000, and by 2010 there were 300 000. Since 2007, foreign companies employed 25 million people in China. Foreign companies that operate in China include Coca-Cola, Pepsi, Nike, Citibank, General Motors, Philips, Ikea, Microsoft and Samsung.

FIGURE 2 Ikea products have been redesigned with Chinese customers in mind; for example, making bowls deeper for eating rice-based meals.

FIGURE 3 Top 30 locations for offshore companies in 2014, by region



Source: Spatial Vision

19.10.3 Are your clothes made in sweatshops?

If you buy the brands Puma, Nike, Adidas, Mizuno, New Balance, Bonds or Just Jeans, then you may be wearing clothing or footwear that was made in a sweatshop.

A sweatshop is any working environment in which the workers experience long hours, low wages and poor working conditions. Typically, they are workshops that manufacture goods such as clothing. Sweatshops are common in **developing countries**, where labour laws are less strict or are not enforced at all. Workers have to use dangerous machinery in cramped conditions and can even be exposed to toxic substances. Child labour may be used.

developing country nation with a low living standard, undeveloped industrial base, and low human development index relative to other countries

Despite the fact that sweatshop workers receive wages, many of them continue to live in poverty. Most are young women aged 17 to 24.

FIGURE 4 Bangladesh sweatshop

FIGURE 5 Activists in New York raise awareness of Bangladesh's Rana Plaza garment factory deaths.

ACTIVITIES

IDENTIFY

1 Why have many countries moved their production to offshore ***places***?
2 What are sweatshops?

EXPLAIN

3 What ***change*** do you think online shopping will make to the Australian retail industry?
4 What do you think would happen to the price of clothing if sweatshops were to close down?

APPLY

5 Look at figure 3. Give reasons why most offshore manufacturing companies are located in the Asia-Pacific region.
6 What impact does moving production offshore have on the Australian economy and its people?
7 If clothing carries the Ethical Clothing Australia (ECA) label, it means the garment was manufactured in Australia and the manufacturer has ensured that all people involved in its production received the legally stated wage rates and conditions — known in Australia as award wages and conditions. Find out which Australian-made garments you can purchase to support fair working conditions.
8 How might internet shopping affect ***places*** such as shopping centres?
9 Are sweatshops ethical or ***sustainable***? Explain your answer.

19.11 Why is fair trade important?

19.11.1 Social justice and problems of trade

The benefits of international trade are not evenly distributed around the world, and trade often favours large, developed countries rather than small developing countries. It is the role of governments, organisations and agencies to regulate this trade so that economic benefits are more evenly distributed.

Australians benefit economically, culturally and politically from international trade, but **social justice** problems can arise from this trade. For example, when we import blood diamonds from Africa or carpets made by child labour from Nepal, we are supporting unethical industries.

social justice the aim to create a society that is based on equality, that values human rights, and that recognises the dignity of every human being

In addition, some countries can make it difficult for other countries to compete fairly, on a 'level playing field'. They do this by:

- imposing tariffs — taxes on imports
- imposing quotas — limits on the quantity of a good that can be imported
- providing subsidies — cash or tax benefits for local farmers or manufacturers.

19.11.2 Fair trade

The fair trade movement aims to improve the lives of small producers in developing nations by paying a fair price to artisans (craftspeople) and farmers who export goods such as handicrafts, coffee, cocoa, sugar, tea, bananas, cotton, wine and fruit (figure 1). The movement operates through various national and international organisations such as the World Fair Trade Organization and Fairtrade International (see figure 2).

The fair trade labelling system is operated by Fairtrade International, of which Australia is a participating member. This system works to ensure that income from the sale of products goes back directly to farmers, artisans and their communities. Fairtrade International is present in 74 countries worldwide and has a total of 1210 producer groups (see figure 3). The number of farmers and workers participating in Fairtrade is estimated to be 1.5 million, with 27 per cent of this number being women.

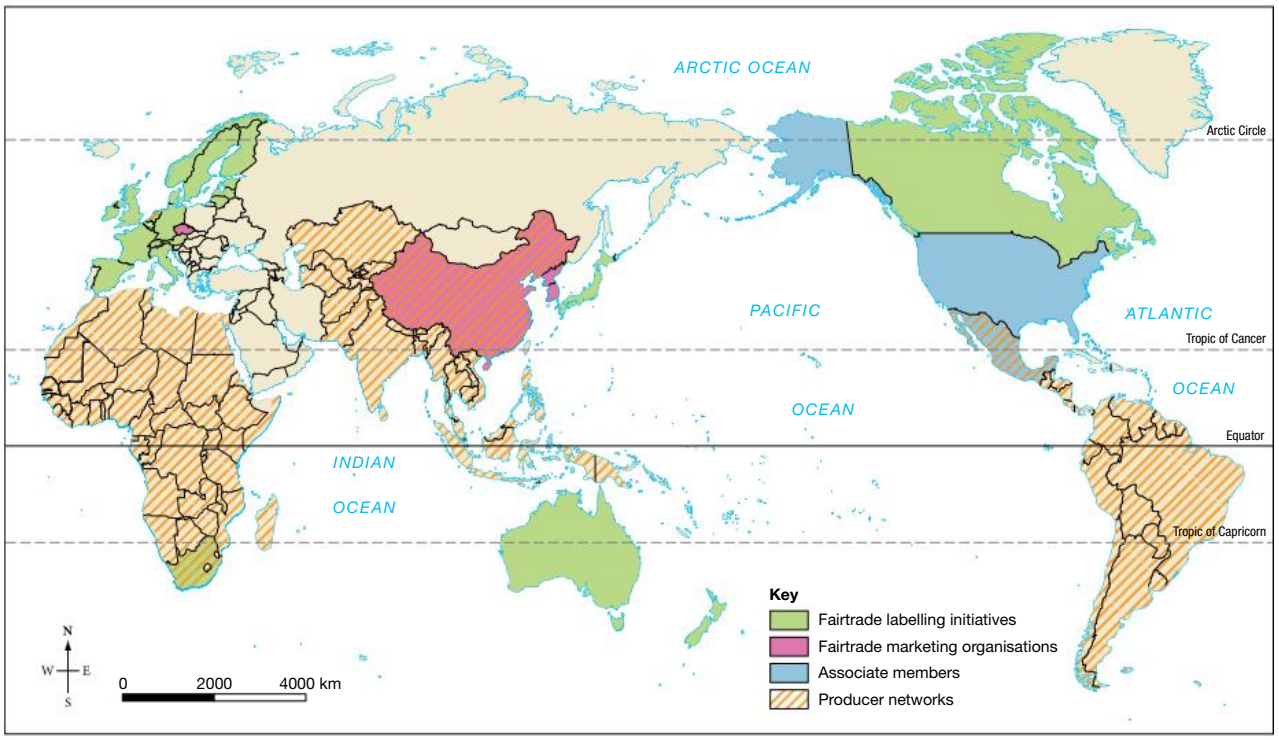
Fairtrade food items currently include sugar, chocolate, coffee, tea, wine and rice. Other products include soaps, candles, clothing, jewellery, bags, rugs, carpets, ceramics, wooden handicrafts, toys and beauty products.

In 2014, Australia and New Zealand had a combined retail sales total of A$ 259 million in Fairtrade Certificate products. Coffee accounted for 75 per cent of sales, followed by chocolate, tea and sports balls. On a global scale, eight million producers and their families have benefited from Fairtrade-funded infrastructure and community development projects.

FIGURE 1 Fair trade organisations promote fair labour practices.

FIGURE 2 Goods produced by workers for the World Fair Trade Organization mission

FIGURE 3 Fairtrade International member countries



Source: Spatial Vision

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

Non-government organisations and fair trade

Non-government organisations (NGOs) such as Oxfam and World Vision also support fair trade, and oppose socially unjust trade agreements. They oppose attempts by developed countries to:

- block agricultural imports from developing countries
- subsidise their own farmers while demanding that poor countries keep their agricultural markets open.

ACTIVITIES

IDENTIFY
1 What are the main principles of fair trade?

EXPLAIN
2 Explain the role of NGOs such as Oxfam in relation to trade.
3 Why can trade be unfavourable to poorer countries?

APPLY
4 Find out more about Fairtrade labelling of products sold in ***places*** such as Australia.
5 What types of goods do Oxfam and World Vision sell in Australia?
6 Find out what Oxfam does to promote fair trade by using the internet to search for their programs.

INVESTIGATE
7 Use the **Ethical choices** weblink in your eBookPLUS to discover ethical shopping for clothing. Prepare a wallet-sized checklist for shoppers to inform them of ethical shopping for clothing tips.
8 Online ordering of goods has become a feature of the internet age. Make a list of the advantages and disadvantages of online ordering for workers in the Australian retail industry (such as those who work in department stores).
9 In theory, every country, rich or poor, should have the opportunity to benefit from international trade. However, the reality is very different. Discuss.
10 Australia has made stronger regional trade ***interconnections*** with its neighbours by lowering its tariffs on imported textiles, clothing and footwear. How has Australian trade benefited from this?

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Weblink
Ethical choices

19.12 Why does Australia give foreign aid?

19.12.1 Foreign aid aims

Countries give aid to other countries in order to help people overcome poverty or humanitarian crises. This often helps the donor country by promoting stability and prosperity in the region. Foreign aid may be delivered in a number of ways such as emergency shelter, water, medical expertise, education and training, building programs, financial assistance as well as law enforcement.

Over one billion people in the world live in poverty and do not have easy access to education and health care. When disasters strike, they lack the resources to get back on their feet. Poverty needs to be addressed by the international community, because it can:

- breed instability and **extremism**
- cause people to flee violence and hardship, thus swelling the number of refugees.

Australia takes the stance that helping people who are less fortunate is a vital way of supporting **humanitarian principles** and social justice. Apart from showing we care, it is in the interests of our **national security**. It also increases our status throughout the world and creates political and economic interconnections with our Asia–Pacific neighbours.

Australia is a member country of the Organisation for Economic Co-operation and Development (OECD). One form of foreign aid contributed by Australia is Official Development Assistance (ODA). In 1970, the United Nations set the international community a target of 0.7% of a country's national income for foreign aid spending. The contributions made by OECD members, including Australia, are displayed in figure 1.

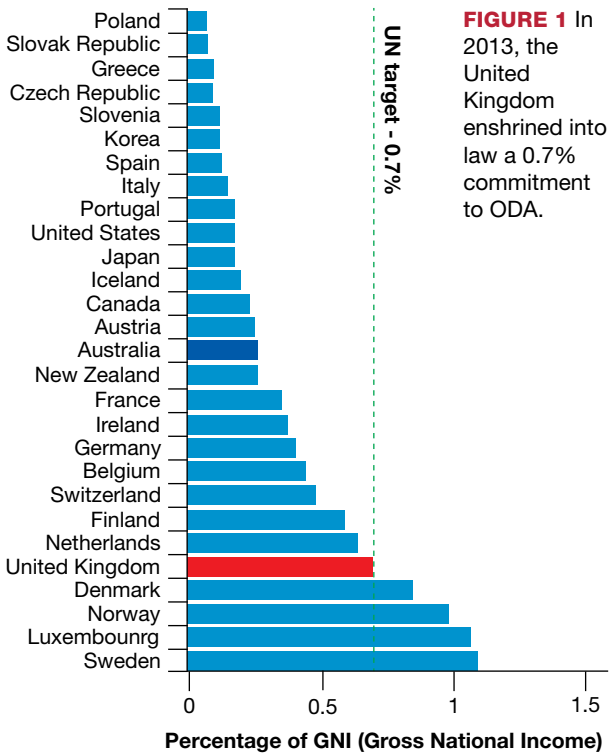


FIGURE 1 In 2013, the United Kingdom enshrined into law a 0.7% commitment to ODA.

extremism extreme political or religious views or extreme actions taken on the basis of those views

humanitarian principles the principles governing our response to natural disasters, such as tsunamis and earthquakes, or human-induced disasters, such as armed conflicts — the main aim being to save lives and alleviate suffering

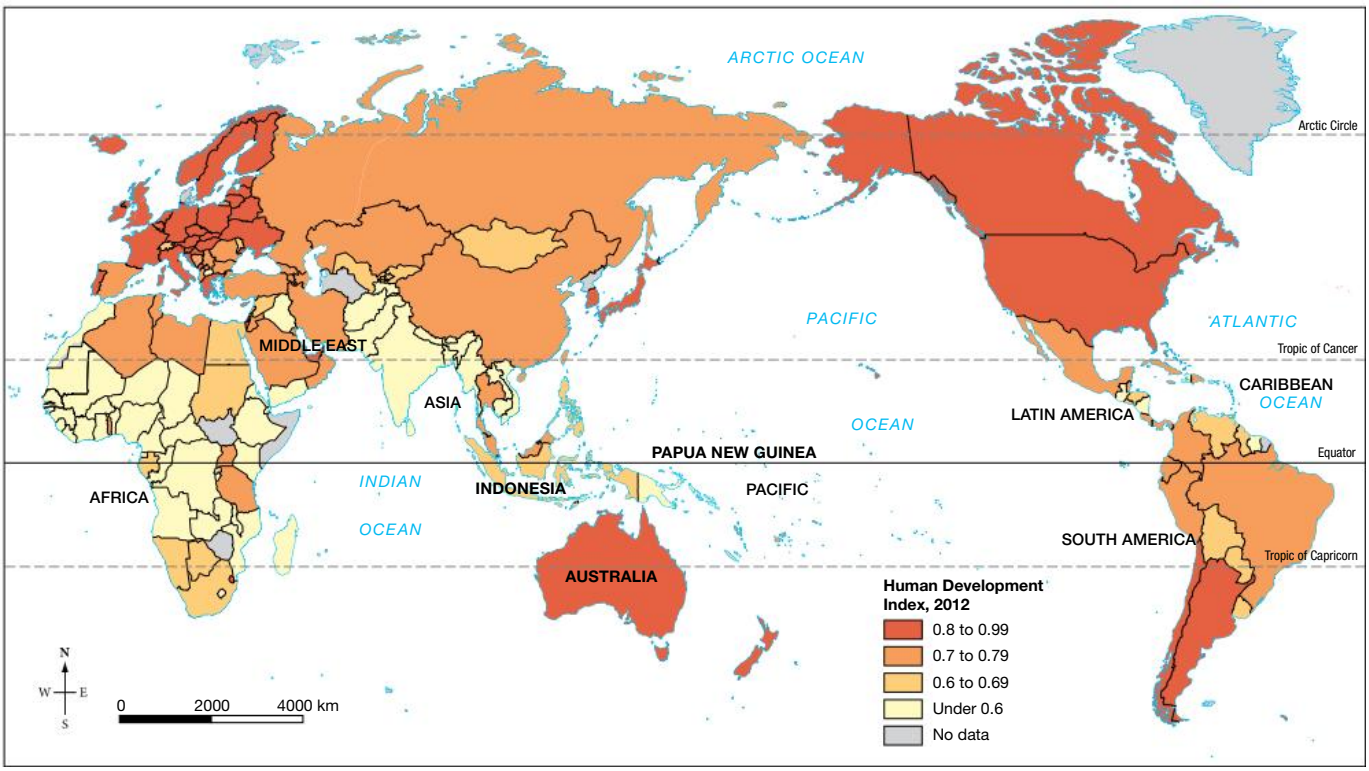
national security the protection of a nation's citizens, natural resources, economy, money, energy, environment, military, government and energy

FIGURE 2 Sustainable Development Goals

Sustainable Development Goals

The aim of Australia's foreign aid program has become more focused on promoting sustainable economic growth in developing countries and to create opportunity for communities in poverty. This new approach to foreign aid has coincided with the adoption by the United Nations of 17 Sustainable Development Goals (SDGs) as seen in figure 2. The SDGs replace the Millennium Development Goals (MDGs) which helped lift 700 million people out of extreme poverty. By 2030, 62 per cent of people around the world are projected to live in extreme poverty, especially in places facing conflict. To ensure that funds reach the needy, DFAT works with Australian businesses, non-government organisations such as CARE Australia, and international agencies such as the United Nations (UN) and the World Bank.

FIGURE 3 The Human Development Index (HDI) ranks a country according to life expectancy at birth, adult literacy, school enrolments and income.



Source: Spatial Vision

Sustainability is the careful use of natural resources, such as water, forests, minerals and soil, in such a way that enables future generations to meet their needs. Farming practices that return nutrients to the soil, limiting the size of fish catches to ensure fish stocks can regenerate, and selectively cutting trees for timber are all examples of the ways we can practise sustainability. The United Nation's SDGs promote sustainable development.

The global Human Development Index rankings are shown in figure 3. The countries that have the lowest rankings need ongoing support and assistance to achieve sustainable development.

FIGURE 4 Australia's aid is more focused on the Asia-Pacific and Indian Ocean regions.

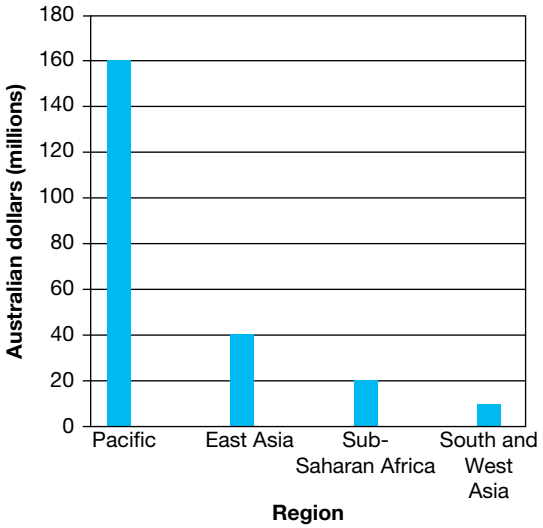


FIGURE 5 Emergency supplies of food and water assist communities severely affected by natural hazards.

FIGURE 6 Australian aid in the Pacific region

FIGURE 7 Bulk quantities of aid are delivered by the Australian defence force.

ACTIVITIES

IDENTIFY

1 What forms of foreign aid are donated by countries?
2 What regions of the world receive most of Australia's aid funding and why do you think this is so?

EXPLAIN

3 What reasons can you put forward to explain why Australia's foreign aid programs are worthwhile in terms of Australia's ***interconnections*** with its neighbours?
4 Is there a case that could be argued for cutting aid budgets? Explain your reasons.

INVESTIGATE

5 Conduct internet research to find out how the Sustainable Development Goals guide Australia's foreign aid program.
6 **a** Why is the Pacific region such an important ***place*** for the distribution of Australian aid?
b Why does South and West Asia receive little foreign aid from Australia?

APPLY

7 If Australia were to stop donations of aid, what ***changes*** do you think this would have on Australia's reputation in the international community?
8 What elements of Australia's aid do you think will have the greatest impact on the lives of people in the Pacific region? Give reasons for your selection.
9 Can you suggest a better way of distributing the budget dollars of the Australia's aid program in order to improve the lives of people in the Asia-Pacific region?
10 If Australia's economic prosperity were to decline in the next 50 years, what elements of Australia's aid program do you believe would not be ***sustainable***?

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19.13 Why is the illegal wildlife trade a cause for concern?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

eBookplus ONLINE ONLY

19.14 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.

e-waste at Agbogbloshie dump, in Accra, Ghana — a dumping ground for electronic waste from all over the developed world

CHAPTER 20

For better or worse?

20.1 Overview

20.1.1 Introduction

The development of technology and communication around the world has both positive and negative effects. One positive outcome is that advances in technology have made people's lives more interconnected. On the other hand, drawbacks include a widening gap between the 'haves' and the 'have-nots', and some negative effects on the environment. Therefore, it is essential to ask whether we are better off or worse off with ever-improving technology and communication.

Starter questions

1. What percentage of students in your class have a mobile phone? How many times a day do you use your mobile phone?
2. If you wanted to discard your outdated mobile phone, do you know how to do so responsibly? Do you think about where your e-waste goes?
3. Have you ever considered how many people in developing countries have access to the internet?
4. When did you last 'Google' the answer to a question?

Inquiry sequence

		Syllabus outcomes
20.1 Overview		
20.2 Who has access to technology?		GE4-2, GE4-3
20.3 SkillBuilder: Constructing a table of data for a GIS	eBook plus ONLINE ONLY	GE4-7
20.4 What are the consequences of unequal access?		GE4-4
20.5 How has technology improved lives in developing countries?		GE4-4
20.6 How has technology improved in Australia?		GE4-3, GE4-4
20.7 How are e-wastes managed?		GE4- 5
20.8 How does e-cycling work?	eBook plus ONLINE ONLY	GE4-4, GE4-5
20.9 How can you reduce your consumption?		GE4-4, GE4-5
20.10 Investigating topographic maps: Can waste be managed more sustainably?		GE4-4, GE4-5
20.11 SkillBuilder: Using advanced survey techniques — interviews	eBook plus ONLINE ONLY	GE4-4, GE4-5
20.12 Review	eBook plus ONLINE ONLY	
Key terms	eBook plus ONLINE ONLY	

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20.2 Who has access to technology?

20.2.1 Who owns mobile phones

When we think of using the internet and mobile phones, we often forget about those who do not have access. Access is not equal across the world, let alone within Australia.

Today it seems that mobile phones have become the most important form of communication. However, it is interesting to note that not everyone in Australia owns one, and Tasmania actually has the highest proportion of mobile phone ownership (see figure 2).

Mobile phone use across the globe is also uneven. This could be due to a variety of factors, such as access, financial situation and way of life. Some countries, such as Saudi Arabia, have 128–209 mobile phones per 100 individuals, indicating that some people own two devices. Bangladesh is very different, where 1–39 mobile phones are owned per 100 individuals.

expenditure the amount of money spent

infrastructure the features that are built by humans to allow other activities to occur, for example roads, electricity networks and water supply pipes

gross domestic product (GDP) the value of all the goods and services produced within a country in a given period of time. It is often used as an indicator of a country's wealth.

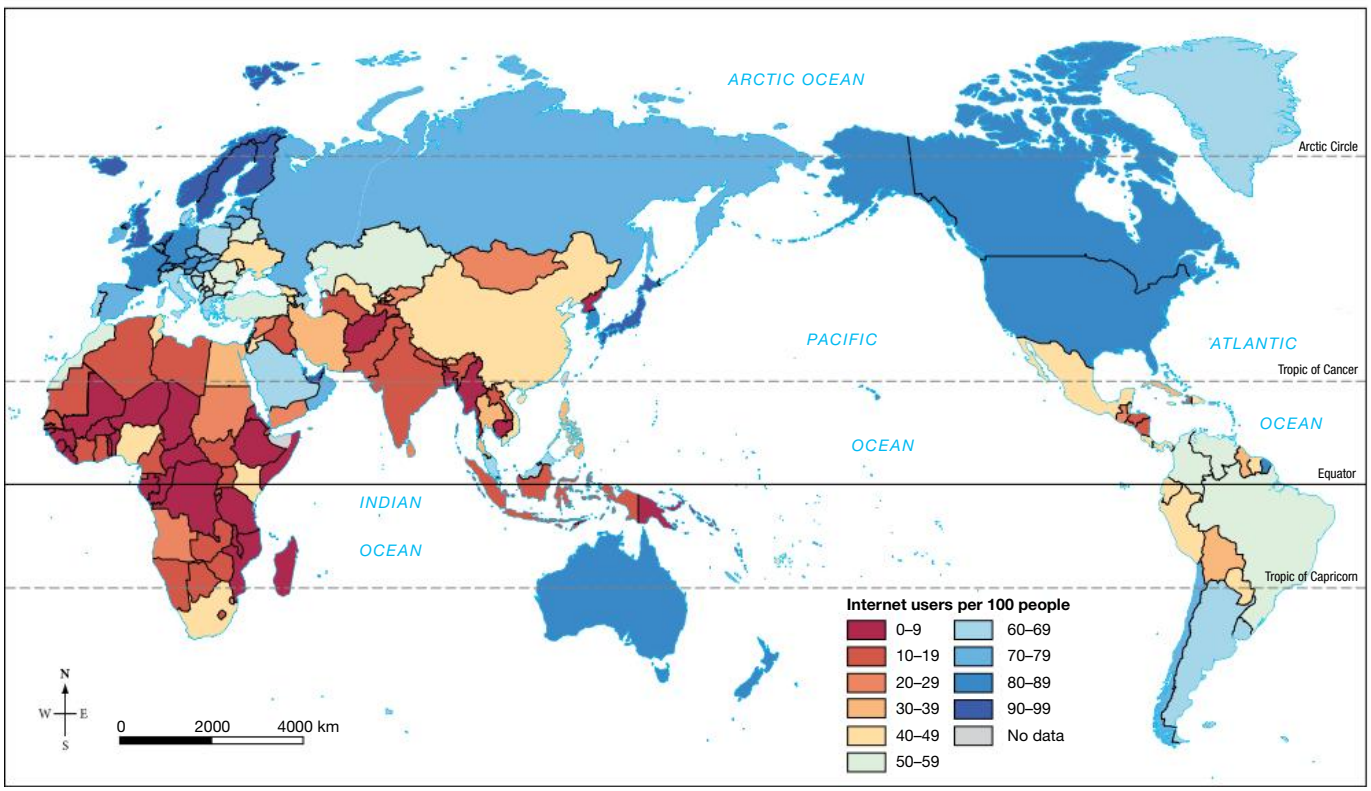
20.2.2 Internet access

Some of us take for granted the fact that we can access the internet almost everywhere we go, whether we are at home, school, at the shops, or even walking down the street. While this might not be the case for everyone in Australia, it is definitely not the case for everyone in the world (see figure 1).

20.2.3 ICT expenditure

It is important to note that the amount of money spent by individual countries on information and communication **infrastructure** can play a vital role in consumer access and uptake. Figure 3 indicates **expenditure** on information and communication technology (ICT) as a percentage of **gross domestic product (GDP)**. This map shows that expenditure across the globe is uneven and there is no set pattern. It is difficult to correlate access to ICT with country expenditure; for example, Australia

FIGURE 1 Internet users (per 100 people) in 2015



Source: Spatial Vision

spends between 3 and 6 per cent of its GDP, but access is relatively high. In contrast, a developing nation such as Bangladesh spends 9 to 12 per cent of its GDP, yet access is limited.

It is interesting to note that Estonia, a small country in Europe, sets a worldwide benchmark by providing free wireless internet access almost everywhere. A group of volunteers successfully lobbied Estonian cafés, hotels, hospitals, local governments and small business owners to provide this free access, which has been made available in a country with a GDP per capita of around $US 16 000; considerably lower than that of Australia, which has a GDP per capita of around $US 67 000. As a result, Estonian society has become reliant almost entirely on information in electronic form — doctors issue only electronic prescriptions, voting is conducted online, and government cabinet meetings are now paperless. Not only has free wifi helped the environment, it has also led to a better-educated society.

FIGURE 2 Mobile phone ownership by Australian state and territory

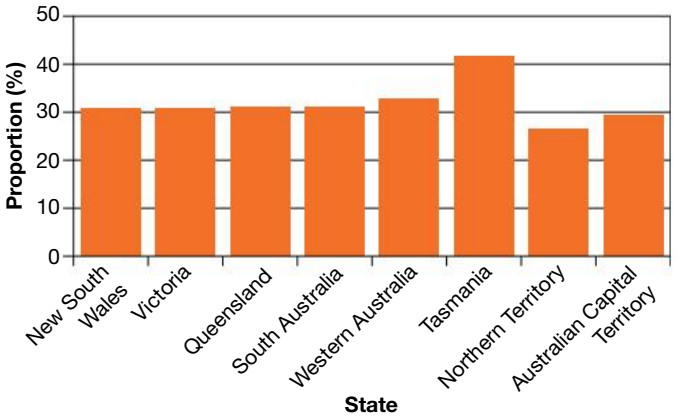
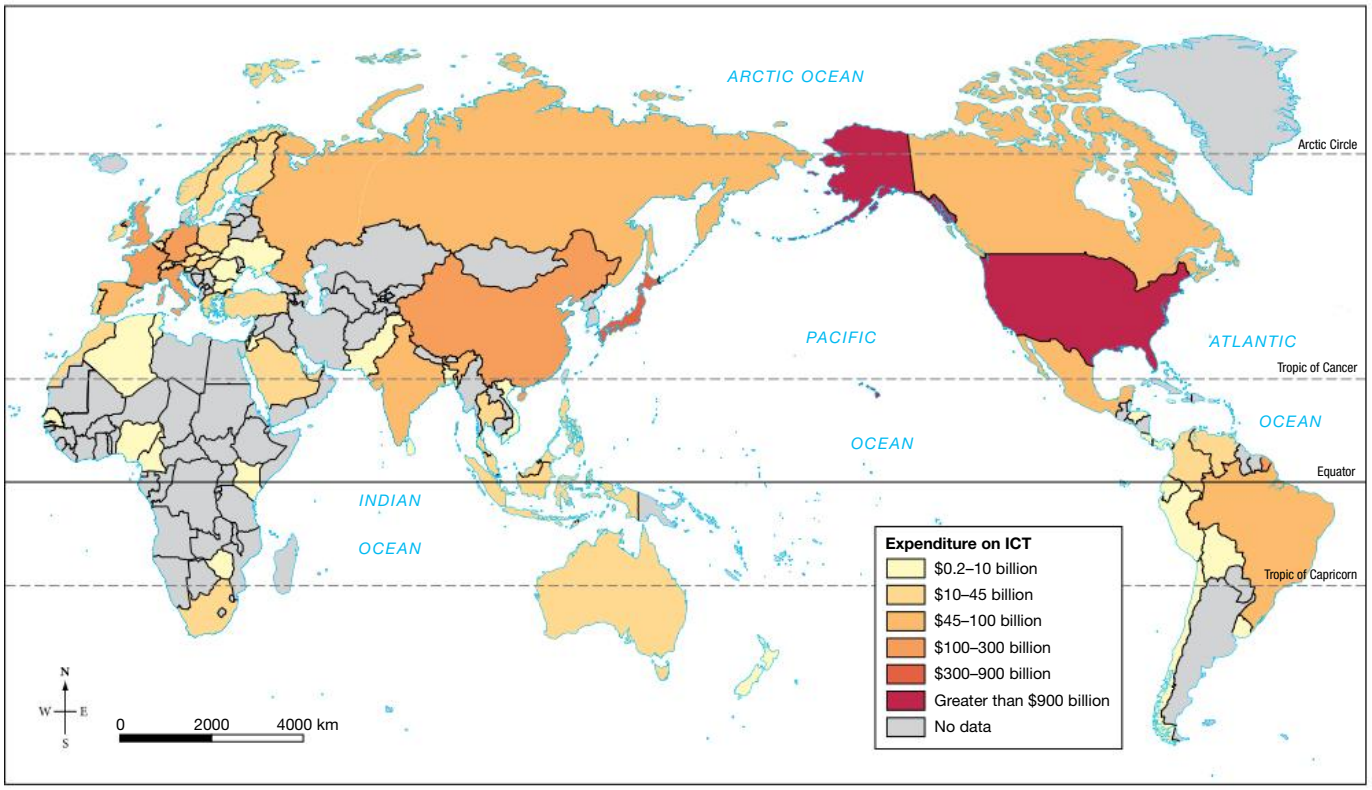


FIGURE 3 Expenditure on information and communication technologies by country, 2015



Source: Spatial Vision

ACTIVITIES

IDENTIFY

1 Refer to figure 2. Which state has the lowest percentage of mobile phone ownership?

INVESTIGATE

2 Research the reasons for Senegal and Morocco having a high expenditure on ICT.

3 Using figure 1 and the **Mobile phone subscriptions** weblink in your eBookPLUS, explain how global internet users and mobile phone subscribers are spatially ***interconnected***. What are the similarities and differences?

APPLY

4 Refer to figure 1. What factors do you think affect the pattern of internet use throughout the world?

PREDICT

5 Refer to figure 3. Where in the world do you predict there will be an increase in infrastructure expenditure in the next 10 years? Explain.

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Weblink
Mobile phone subscriptions

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20.3 SkillBuilder: Constructing a table of data for a GIS

Why are there tables within GIS?

GIS, or geographical information systems, use tables to organise and store information about points, lines and polygons (vector data). These tables have rows and columns, called fields. The GIS software links the rows in the table to the points, lines or polygons on a map. Setting up the structure for a table helps us to understand how information may be stored digitally.

In a GIS, each row in the table is linked to a polygon on the map

Sample	Address	No_home	No_mobiles
1	42 Jacob Street	2	4
2	27 Jacob Street	3	3
3	36 Adele Avenue	4	3
4	34 Flint Street	4	1
5	35 Flint Street	5	3
6	25 Flint Street	4	2
7	12 Jess Court	4	2
8	2 Jess Court	4	4
9	12 Flint Street	5	3
10	52 Jacob Street	6	2

eLesson
Watch this video to learn how to construct a table of data for a GIS.

Searchlight ID: eles-1743

Interactivity
Try this interactivity to learn how to construct a table of data for a GIS.

Searchlight ID: int-3361

20.4 What are the consequences of unequal access?

20.4.1 What is the digital divide?

Unequal access to information technology creates a division between people with access and people without. Such divisions can have implications for economic growth and social equity. How often do you consider access to the internet as a necessity, not a luxury item?

digital divide a type of inequality between groups in their access to and knowledge of information and communication technology

There is a growth in internet access worldwide, but the gap between those able to access information technology and those who are not able to access information technology is widening. This is known as the **digital divide**. The divide is primarily based on internet access, but it includes all forms of information.

It is also evident within countries that some people have access to high-speed internet, while others only have access to dial-up internet.

Factors contributing to the digital divide are shown in figure 1.

The digital divide changes as the structure and characteristics of the population shift. Digital disadvantage is a dimension of poverty, which leaves people with a sense of powerlessness. If your ability to connect to information and communication technology is limited, this can affect what you are able to do with your life.

Globally, the average level of access to information and communications technologies (ICT) was 42 per cent in 2015. As figure 2 shows, the regions of South Asia (19 per cent) and the continent of Africa (26 per cent) have the lowest levels of connectivity. Internet access is only one aspect of the challenges faced by regions, as specific areas within a country may face disadvantage in terms of the factors displayed in figure 1. For example, regional areas of Australia may have difficulty accessing information technology. Nine out of ten people living in rural Africa don't have access to electricity. This unequal access may restrict the ability of communities to access information, communication and ideas that will enable them to overcome poverty and disadvantage.

FIGURE 1 A range of factors contribute to the digital divide.

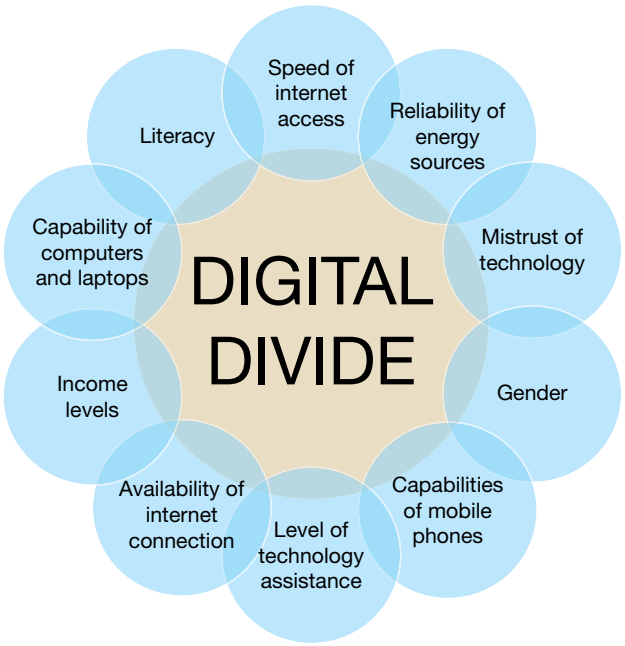
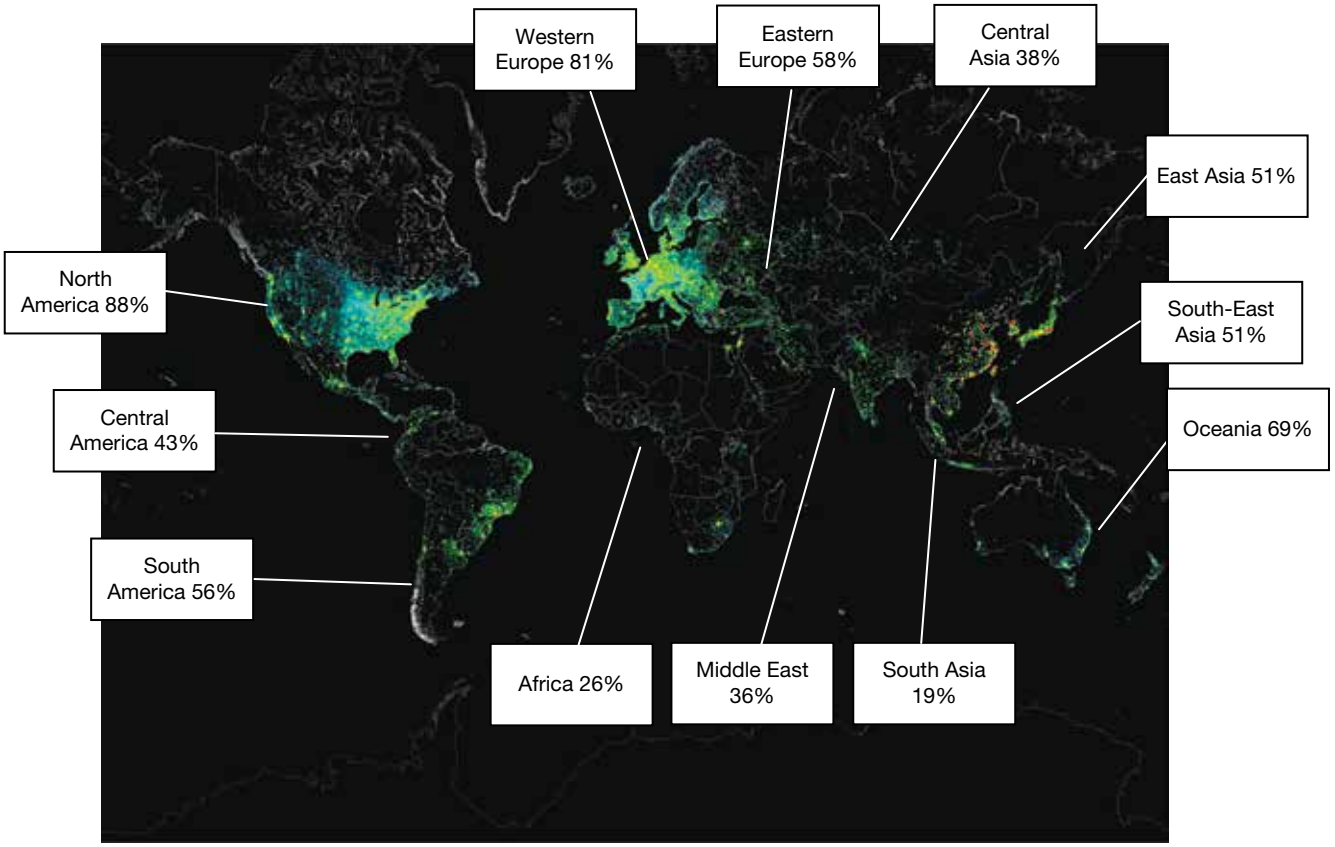


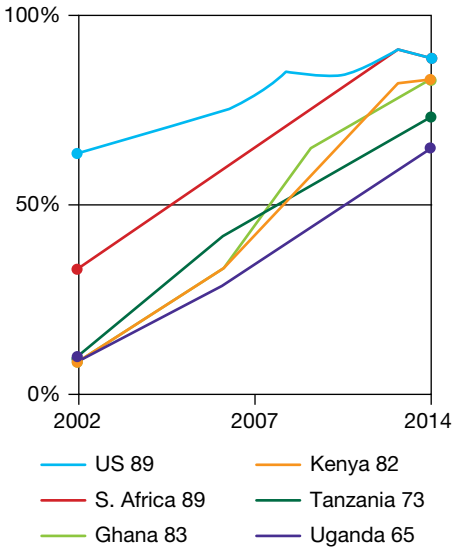
FIGURE 2 Regional differences in internet connection



20.4.2 Mobile phones and the internet

Mobile phone technology is transforming the way people are accessing ICT. Fewer people are subscribing to landline connections in favour of owning a mobile phone. Smartphone technology is allowing people to connect to mobile internet services and information. In Africa a large percentage of people (76 per cent) use mobile phones, but only a small percentage (7 per cent) are online.

FIGURE 3 Percentage of adults in the US and selected African countries who own a mobile phone



20.4.3 Sustainable Development Goals

United Nations Sustainable Development Goals were adopted in 2015 and support efforts to promote greater global connectivity. Improved global internet access is expected to provide the tools and knowledge needed to increase education and health opportunity, to create jobs, fight injustice and lift communities out of poverty.

Why bridging the gap is important

- *Economic equality*. Some social welfare services are administered electronically, so access to a telephone and the internet is important. The telephone also provides security, and can be used in emergency situations. In addition, access to the internet can be important for career development and accessing civic information.
- *Social mobility*. Computers play an important role in learning and education. The digital divide is unfair for children in lower socio-economic groups. The higher the qualification held by an individual, the more likely they are to have internet access at home.
- *Democracy.* Some people think that access to the internet creates a healthier democracy. It is thought that it increases public participation in elections and decision-making processes.
- *Economic growth.* Information and communication infrastructure and active use could stimulate economic growth, particularly for less developed nations. Economic changes and improvements tend to be associated with information technology. Certain industries can give a country's economy a competitive advantage.

FOCUS ON FIELDWORK

How connected are you right now?

At different times during our day, we are more connected to places, information and people than at other times.

1 Select three times of a day to review your level of connectivity; for instance, on the way to school, during your Geography class and then in the evening at home.
2 Record the level of connectivity at each time of the day by answering questions such as: What technologies am I relying on? Do I have internet access? Is it free? What internet access issues am I facing? Do I have a landline? What apps do I use to keep connected? What are the benefits of internet to my day?
3 Use your data to create a table and present this information as a graph that uses a different colour for each time of the day. What does the information display about your level of internet connectivity?
4 Were there any factors that may make this information unreliable? Why?

eBook*plus*

Interactivity
The digital divide
Use this interactivity to further your understanding of the extent and consequences of the digital divide.
Searchlight ID: int-3342

ACTIVITIES

IDENTIFY

1 Define the term *digital divide* in your own words.
2 Refer to figure 2. Using the statistics given, rank the internet connectivity of these regions from the most connected to the least connected.

EXPLAIN

3 Refer to figure 1. Describe how any three of the factors shown contribute to a digital divide.
4 Refer to figure 3. Compare the level of mobile phone ownership for the US with that of one of the African countries listed over the period 2002 to 2014.

INVESTIGATE

5 Refer to figure 2. Research the names of the countries found in South Asia. How do you account for low connectivity levels in these countries?
6 Propose an initiative to improve the level of connectivity currently found in one community. What challenges need to be overcome? What change will it introduce to the community?

20.5 How has technology improved lives in developing countries?

20.5.1 The situation in Kenya

While there is a difference between the developed and developing world, it is important to note that access to the internet and mobile phone networks is improving. This is largely thanks to non-government agencies and to service providers. The people of Kenya, for example, no longer need to take long journeys into town or to wait in long queues just to transfer money. Instead, they can type in a couple of numbers, hit a button, and pay for anything they want within seconds via mobile phone.

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

Most people in Kenya live in rural and remote places in the countryside. Landline access is very limited, and it is also considered costly to install, owing to the vast distances. This can leave families disconnected from one another, as the primary earner in the family often has to work in a distant township in order to provide money for the family. Those left in the rural villages are often self-employed farmers or tradespeople. Without communication, families are often disconnected.

Improving access

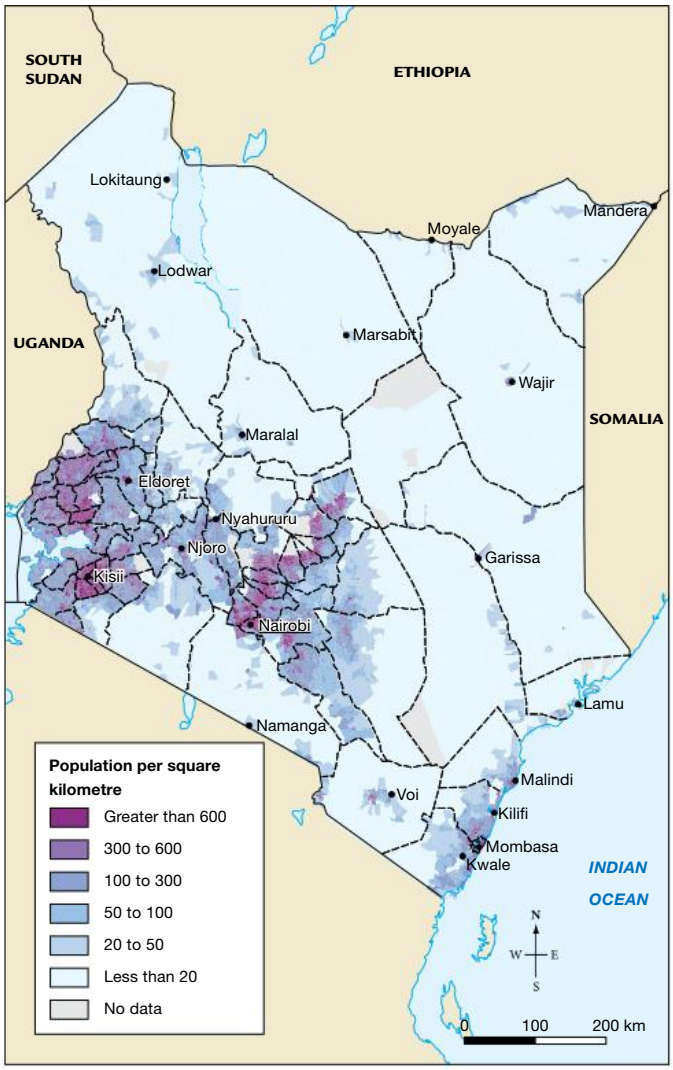
Mobile phone coverage and access has been significantly improved in Kenya, which has dramatically improved people's lives. The UK-based **non-government organisation (NGO)** called Financial Deepening Challenge Fund (FDCF) has worked with Vodafone to set up M-Pesa, meaning 'mobile money'. A customer can go to an M-Pesa agent, such as a supermarket, and:

- deposit and withdraw money
- transfer money to other users and non-users
- pay bills
- purchase phone credit
- transfer money between the service and a bank account (see figure 1).

People do not need a bank account or even a permanent address to use M-Pesa. They receive a text message to confirm a transaction, and the money can then be stored on the phone or it can be forwarded to someone else. At any time, the money can be transferred back to cash through an M-Pesa agent or an ATM. Figures 2 and 3 show mobile phone coverage and population, indicating the coverage is significant in highly populated areas.

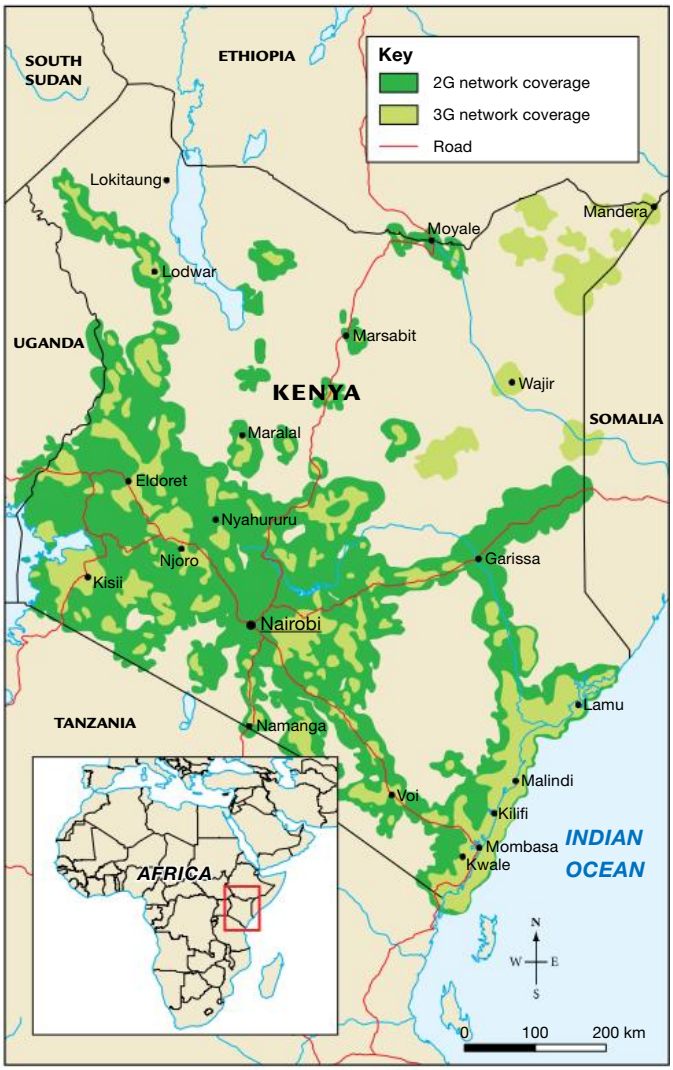
FIGURE 1 Customers at an M-Pesa agent in Kenya

FIGURE 2 Kenya, population density



Source: Spatial Vision

FIGURE 3 Kenya, mobile phone coverage



Source: Safaricom

FIGURE 4 A local market in Kenya

How successful has it been?

Today there are around 25 million subscribers and over 40 000 M-Pesa agents in Kenya. These agents include petrol stations, supermarkets and other retail outlets. By 2014, over 70 per cent of Kenya's population was using M-Pesa.

Taxi drivers have benefited, too. They no longer need to drive around with a lot of cash in their cars, because their passengers are able to pay using M-Pesa. It has also been seen as an improvement in personal safety, because it is a secure and easy way to transfer money.

Access to mobile phones for small business operators has meant they are now able to advertise to a larger audience, and are no longer dependent on word-of-mouth advertising. Clients can now contact business operators with ease. For those working away from home, it is a safe and easy way to send

money back to families in the countryside. This has enabled **Maasai** herdsmen to go to the markets and make purchases by using their mobile phones. M-Pesa has eliminated the need to carry large sums of cash to markets, and has reduced the number of thefts.

M-Pesa demonstrates how dreaming big but thinking locally can have a significant effect on the economic and social structure of a place, just through the use of a mobile phone.

Maasai ethnic group of semi-nomadic people in Kenya and Tanzania, whose way of life depends on their cattle

ACTIVITIES

IDENTIFY

1 How successful has M-Pesa been in Kenya? Ensure you use specific examples in your answer.
2 What ***interconnections*** can now occur between people because of M-Pesa?

EXPLAIN

3 Why would safety be a concern to people in Kenya? How does safety relate to information and communication technology in Kenya?
4 What ***places*** in Kenya are well serviced by the mobile phone network?
5 Which ***places*** are not well serviced by the mobile phone network? Suggest reasons for this.

APPLY

6 Using the internet, research how another developing country has improved its information and communication technology. Create a multi-modal presentation on your findings.

INVESTIGATE

7 What services in Australia serve a similar purpose to M-Pesa? Explain what they are and how they operate.

20.6 How has technology improved in Australia?

20.6.1 The digital economy

In a bid to make internet access faster and more accessible in Australia, the federal government is developing the National Broadband Network (NBN). This revolution in Australia's infrastructure aims to connect more people, in an affordable way. It is yet to reach all homes in Australia but, when it does, it will vastly improve the digital economy.

When you use your debit card to buy a movie ticket, send a text to a friend on your mobile, or use a web browser to check your phone balance, you are participating in the **digital economy**. Participation in this economy can improve productivity, social wellbeing and competitiveness. In addition, it has the potential to improve access to services such as education, and to improve environmental, health and social outcomes in rural and regional Australia.

digital economy the network of economic and social activities that are supported by information and communication technology, such as the internet and mobile and sensor networks

20.6.2 What is the NBN?

The NBN is the infrastructure that will improve and enlarge Australia's digital economy in the future. It is a revolution in telecommunication technology, involving three main technologies: fibre optic cable, fixed wireless and satellite (see figure 2).

The plan is to ensure that all Australians can connect to this new high-speed broadband network (see table 1).

TABLE 1 Future NBN access in Australia

Who?	How much?	Access via	Speed
Homes, school and businesses	93%	Fibre optic	1 gigabit per second
Premises	7%	Fixed wireless and satellite	12 megabits per second

20.6.3 How does Australia compare?

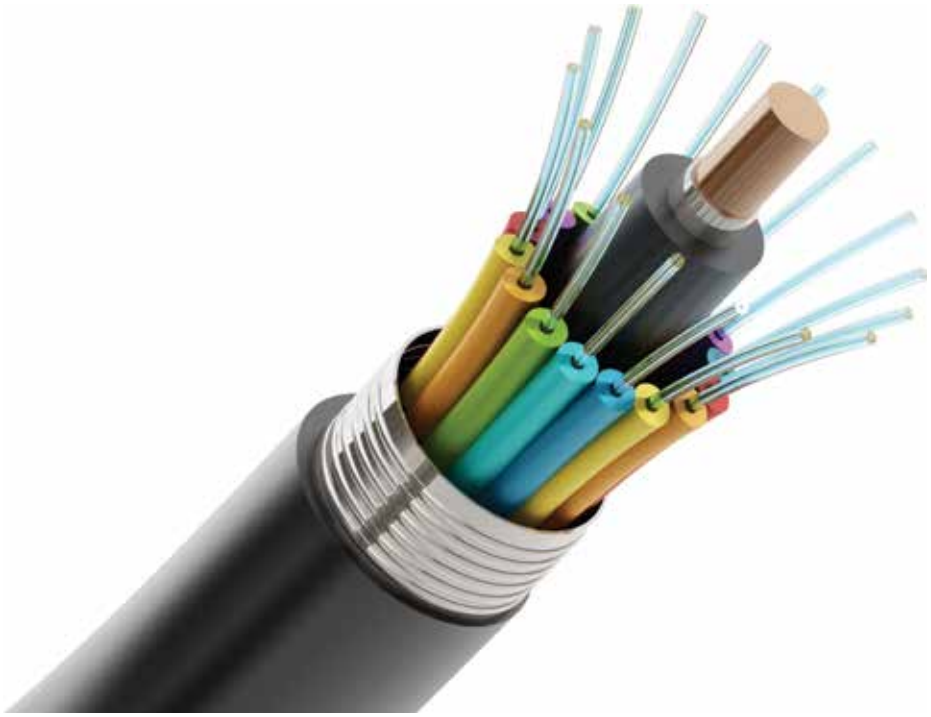
OECD Organisation for Economic Co-operation and Development, which has 34 member countries and promotes policies that improve economic and social wellbeing

In terms of broadband infrastructure, Australia was falling behind the 34 **OECD** countries, so it was felt that action needed to be taken. It was also noted, in 2015, that Australia is one of the most expensive countries for broadband.

Rural and remote communities

Data indicate that the number of people who have never used the internet in Australia is highest in rural and remote communities. For example, between 2008 and 2009, 23 per cent of people living in major cities who were over the age of 15 did not use the internet. In comparison, 31 per cent of people in regional and remote Australia did not use the internet. It is also noted that, of all businesses located outside capital cities, only 29.7 per cent had a web presence, while 39.5 per cent of capital city businesses did. Therefore, the government regards it as a priority to roll out the NBN in rural and remote communities in order to ensure greater involvement in the digital economy.

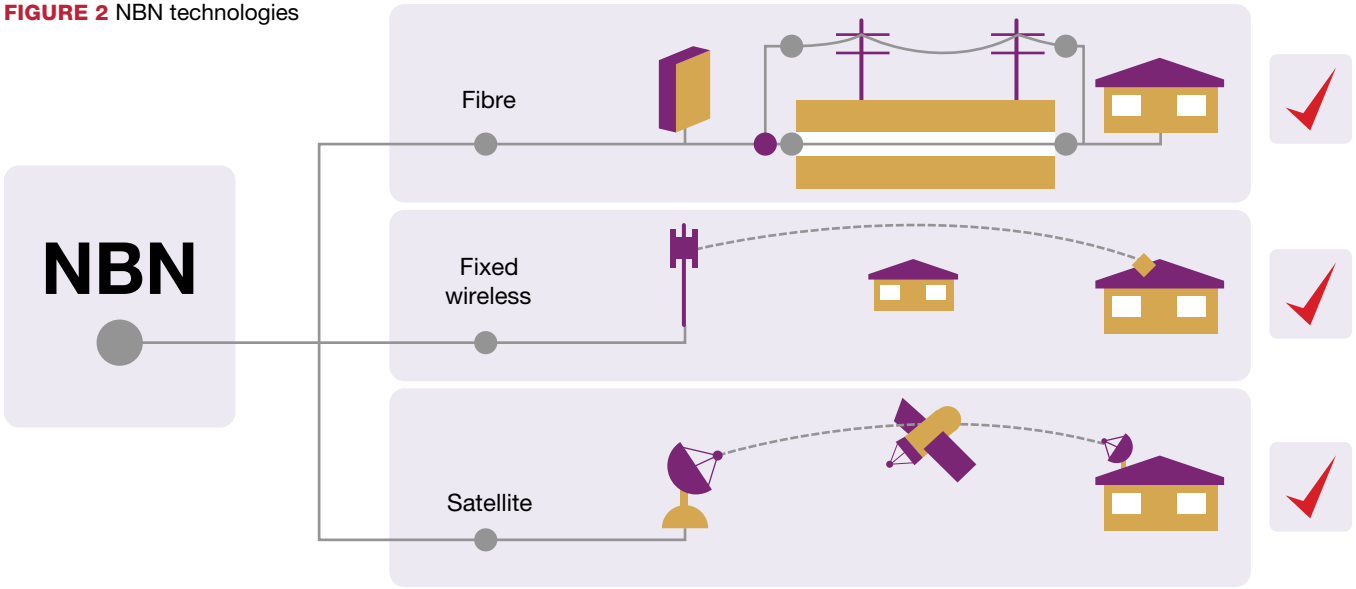
FIGURE 1 Fibre optic cable



20.6.4 Opportunities of the NBN

- *Business.* Using applications and services that rely on the NBN will improve efficiencies and reduce costs. The NBN could result in an expansion of markets, through greater interconnections in Australia and overseas. Businesses will have more choice of location, particularly in rural and remote places. It could also improve efficiency, and may reduce the need for a physical presence. Improvements in infrastructure will lead to improved technologies, such as videoconferencing, allowing healthcare, for example, to reach remote Australia and promote the sharing of knowledge.
- *Education.* Distance between student and teacher will no longer prevent access to specialist teachers across Australia. It will improve collaborative learning practices between schools and higher education facilities, and promote the international exchange of ideas. In addition, the NBN will improve access to online learning and collaboration beyond the walls of the classroom.
- *Environment.* Access to digital technology has demanded new ways of managing household consumption of resources. Smart energy grids can be installed to manage energy consumption, and changes can be made during peak energy demands. Farming systems can be improved by technologies that are accessible with the NBN, such as measuring soil moisture in relation to weather conditions.

FIGURE 2 NBN technologies



20.6.5 When will I get the NBN?

The NBN is being rolled out over the next few years, with the latest phase expected to be completed by mid 2020 connecting 4.9 million homes and businesses. Each year a new plan will be released, indicating the targeted areas. Once an area has been declared NBN-ready, it can take up to three or four weeks for providers to be able to supply customers with a connection.

20.6.6 Downloads

Most of us are familiar with exceeding our download limit; we never feel we have enough. The average volume of downloaded data per Australian subscriber is 58 GB per month. This is a significant increase from an average of less than 6 GB per month per household in 2006. In 2013, the average download volume for a household connected to the NBN was 46 GB per month, indicating that connection to the NBN is resulting in an increase in data downloads. It is predicted that data consumption is set to increase up to four-fold in the next five years as the roll-out of the NBN continues.

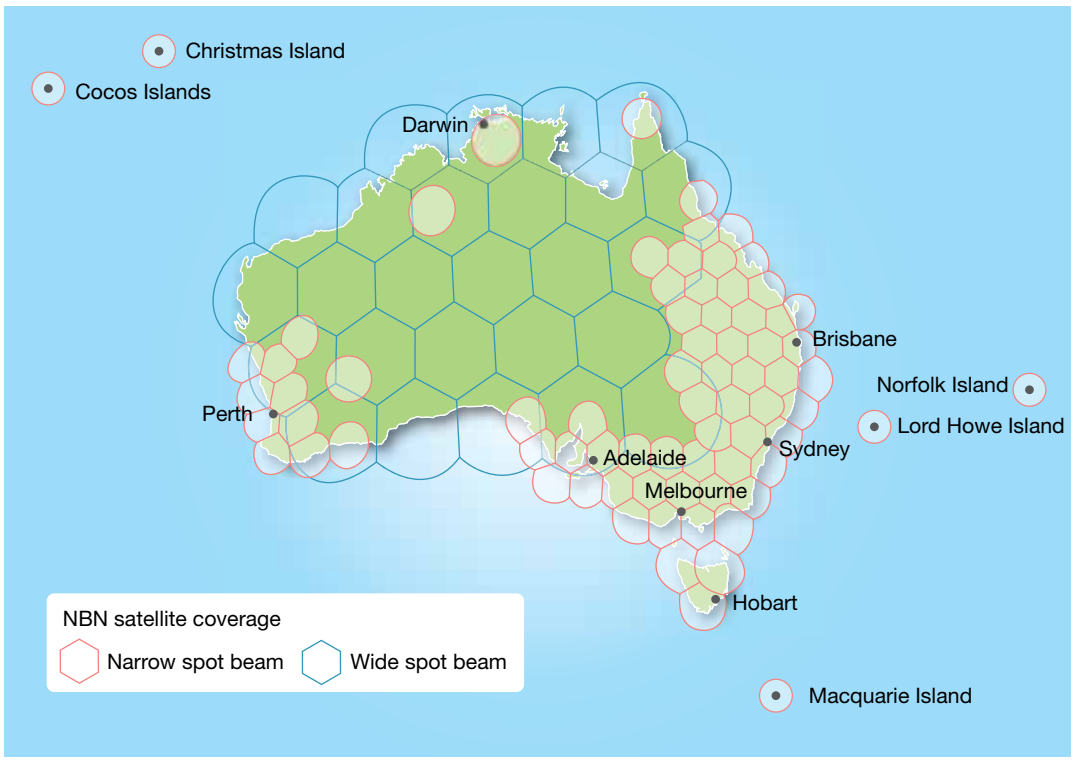


FIGURE 3 The Sky Muster satellite was launched in 2015 to improve connectivity for remote Australia.

Recent trends show video and app-based mobile use is dominating data traffic. In 2014, video accounted for 45 per cent of all mobile data traffic. It is expected that, by 2020, video will account for 60 per cent of data traffic, as video streaming companies enter the Australian market.

ACTIVITIES

IDENTIFY

1 What is the digital economy?
2 What are the three forms of NBN technologies?

EXPLAIN

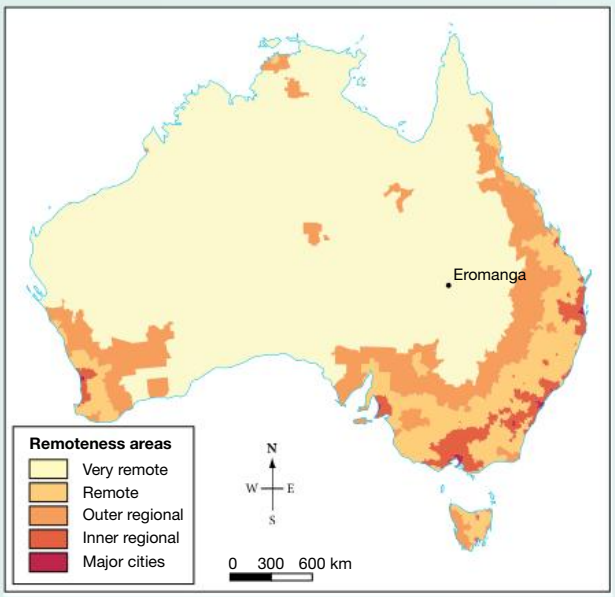
3 Why is it crucial that Australia builds the NBN?

APPLY

4 Using the **NBN** weblink in your eBookPLUS, describe the geographical pattern of the NBN and the types of technologies that are being used in different regions.

INVESTIGATE

5 Imagine what life would be like without the internet and mobile phones. Write a letter to a friend about your life without such technology.
6 Imagine this scenario. You have just been selected to 'live remotely' for two weeks with a partner of your choice in the remote Queensland town of Eromanga. Use the **Connect** weblink in your eBookPLUS to justify your choice of phone company to provide the best connectivity for you during your stay.



Source: Spatial Vision

eBookplus

Weblinks
- NBN
- Connect

20.7 How are e-wastes managed?

20.7.1 What is e-waste?

Litter in the schoolyard is only minor waste compared with that produced by technology and communication: **e-waste**. A controversial issue is how to dispose of it. The disposal and trade of e-waste is seen by developed nations as a solution and by many developing countries as a money maker. How e-waste is dealt with has serious economic, environmental and social consequences.

e-waste any old electrical equipment that includes computers, toasters, mobile phones and iPods that no longer work or are no longer required

e-waste is any old electrical equipment, such as computers, toasters, mobile phones, iPods and televisions that are broken, obsolete or no longer wanted. Given our technology-based lifestyle, our e-waste pile is growing at an alarming rate — faster than we know what to do with. There are five main places where e-waste usually ends up (see figure 1).

20.7.2 What are the impacts of e-waste?

Many of us do not think about where our rubbish goes. We just put it in a bin, and then it is out of sight, out of mind. However, e-waste is now a part of the global economy, and is sold, shipped and dumped worldwide.

Nevertheless, we must think about the ramifications of such actions. Computers are made up of many toxic chemicals and metals; when dumped, these can cause significant environmental and health problems (see figure 3).

FIGURE 1 Where does e-waste end up?

Health impacts

In the slums of Delhi, computers, keyboards and monitors are pulled to pieces and then placed in acid baths or melted, to extract metals. This practice should only ever occur in proper recycling facilities, where safety precautions can take place. Consequently, there has been a rise in Delhi in **mercury poisoning** and other side effects of dealing with cadmium, plastic, PVC, barium, beryllium, and carcinogens such as carbon black and heavy metals (see figure 2).

FIGURE 2 Composition of a computer

What is in a computer

Ferrous metal	Plastic	Non-ferrous metal	Glass	Electric boards
32%	23%	18% Lead Cadmium Antimony Beryllium Mercury	15%	12% Gold Palladium Silver Platinum

A report by India's Department of Scientific and Industrial Research showed that e-waste being sent to India is increasing by 10 per cent each year. Slum dwellers are unsafely disassembling the e-waste, and toxins are damaging the health of an enormous number of people.

Exposure to mercury, even in tiny amounts, can lead to health problems and threaten child development. It damages the nervous, digestive and immune systems, and harms the lungs and kidneys. It is corrosive to the eyes and skin and to the gastrointestinal tract if swallowed. Neurological and behavioural disorders have also been observed, which can lead to insomnia, memory loss and motor dysfunction. A large number of women and children in India now expose themselves daily to mercury while working in makeshift e-waste recycling facilities in slums.

mercury poisoning a toxic condition caused by the ingestion or inhalation of mercury or a mercury compound. It has various symptoms, including vomiting, nausea, insomnia and fevers.

Environmental impacts

As we have seen, thousands of tonnes of e-waste are being dumped in developing countries. There, the e-waste is burned in informal recycling stations in slums. In the slums, there is nowhere to dispose of byproducts such as acid and cyanide, and they are simply dumped in the local waterways or onto the soil. This contaminates aquifers and destroys vital freshwater resources, making the land too toxic to farm.

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Interactivity
e-wasted
Use this interactivity to further your understanding of the impacts of e-waste.
Searchlight ID: int-3343

The issue is that the e-waste can be of great value to the citizens of developing nations, such as China and India, because it is a fairly easy way to make money. However, the chemical composition of products such as mobile phones leaves a deadly trace in the environment.

The burning of plastic leads to an increase in air pollution, resulting in above-standard emissions. The air is often left with the stench of acid, paint and plastic, which impairs people's quality of life. Contamination of agricultural soils may occur, affecting local farms, which are often the main form of income in developing countries.

Waste acids recovered from the burning process, which are of no value or use, are often dumped in rivers and streams, damaging the ecosystem. Often this leaves waterways black and pungent, and leads to contamination of drinking water. In Guiyu, China, the water is so toxic it can disintegrate a coin within a few hours.

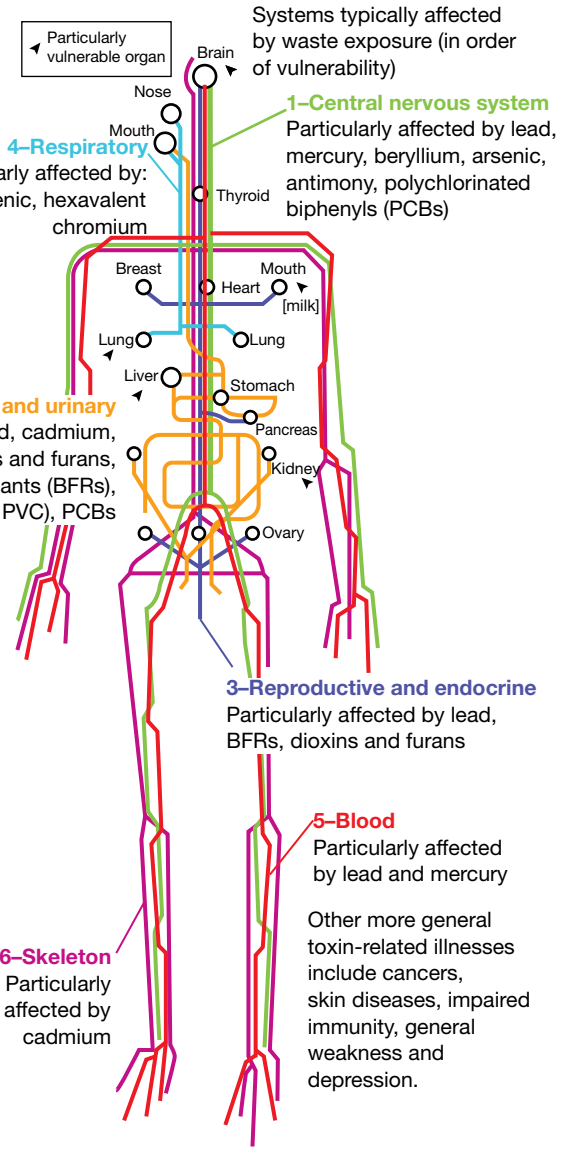

FIGURE 3 Health impacts of e-waste on waste workers and people who live near landfills or incinerators

20.7.3 International management of e-waste

By the start of this century, many countries could not deal with either the quantity or toxicity of the e-waste they were generating. One solution was to export it to developing nations that did not have laws in place to protect workers or the environment. It is also significantly cheaper to recycle waste in developing nations.

Concerns in Europe regarding the export of e-waste led to the Basel Convention in 1989. This was adopted by the European Community in 1994, which banned the exports of hazardous waste to countries other than OECD countries, which were mostly developed countries. Waste had to be collected and recycled according to European Union (EU) environmental standards. The EU has reluctantly admitted that its rules are only somewhat effective, as bans on exporting e-waste are being ignored or avoided. Scrapyards in Asia are able to extract valuable substances from the waste.

Rotterdam is Europe's busiest port, with more than nine million shipping containers passing through each year. Despite every effort, only three per cent of all containers in Rotterdam are checked; consequently only about one illegal shipment of e-waste is caught each week. Inevitably, containers of e-waste slip through. One of the difficulties that customs officers face is the fact that it is not illegal to export goods to be re-used and sold as secondhand goods.

The United Kingdom's Environment Agency, which is in charge of regulating hazardous waste in England and Wales, has set up international cooperation and intelligence with over 40 countries. This is being done in order to combat the illegal smuggling of e-waste, and companies are fined if they are caught. The United States has not ratified the Basel Convention, and they are seen as lagging behind Europe. Almost 80 per cent of their e-waste goes to China via Hong Kong (see figure 5).

FIGURE 4 Goats being herded through e-waste smoke around the Agbogbloshie dump in Ghana. When e-waste ends up in landfill, the toxins, carcinogens and heavy metals in it can leach into the environment. These substances then contaminate the groundwater and soil and enter the food chain.

Until we find a cheap alternative to dumping waste overseas, it is going to be difficult to compete with this process in developed countries. More research needs to be done on how to make recycling safer in developing countries, and how to enable it to take place in proper factories instead of unsafe makeshift plants.

20.7.4 Local e-waste management

According to the Australian Bureau of Statistics, almost all Australian households were involved in some form of recycling in the last 12 months. However, in 2009, nearly a quarter of electronic equipment and half of household appliances were placed with non-recycling garbage.

Locally, most waste transfer stations in metropolitan areas now have e-waste facilities. A visit to the tip is no longer a matter of putting everything into landfill; it involves a more complex system of organisation. On arrival at your local waste transfer station, you are directed to various stations to dispose of your waste. Such stations include green waste, white goods, oils, gas bottles, petrol cans, copper and e-waste. This sorting of waste not only reduces the need for landfill, but also encourages and enables more recycling to take place.

FIGURE 5 Who gets the trash?

Source: Spatial Vision

FIGURE 6 e-waste facility at a refuse station

ACTIVITIES

IDENTIFY

1 Define the term *e-waste*. Compile a list of potential e-waste either in the classroom or in your home.

2 Why is it difficult to prevent the illegal trade in e-waste?

EXPLAIN

3 Using figure 5, explain the geographical pattern to illegal dumping of e-waste. Ensure you make specific reference to ***places*** in Asia on the map.

APPLY

4 Discover the difference between ferrous and non-ferrous metals. Which is more harmful to humans and the ***environment***?

5 Research the metals listed in figure 3, and explain what makes them harmful to humans and what ***environmental*** effects they can have.

INVESTIGATE

6 Create a presentation on how e-waste is managed at your school. Suggest strategies for making the current management techniques more ***sustainable***.

7 Why are international agreements on e-waste difficult to manage?

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20.8 How does e-cycling work?

To access this subtopic, go to your eBookPLUS at **www.jacPLUS.com.au**.

20.9 How can you reduce your consumption?

20.9.1 Recycling your e-waste

On a global scale, entrepreneurs are tackling the waste problem society is creating. We live in a part of the world where consumption of information and communication technology is high. However, some global solutions have now been set up to ensure that individuals can easily find out online about what is recyclable, and can then undertake recycling from their own home. Society is now being encouraged to act locally, while thinking globally. This is an important concept when it comes to reducing and managing one's own consumption.

Electronic waste, or e-waste, is defined as any device with a cord or a battery. An estimated 16 per cent of global e-waste is being recycled and reused.

According to the Australian Bureau of Statistics (ABS), when people were surveyed about their e-waste disposal, most stated that they did not recycle because they did not generate enough materials to warrant the use of e-waste services or facilities. Perhaps if everyone knew more about the hazardous nature and environmental impacts of e-waste, the idea of recycling would be embraced.

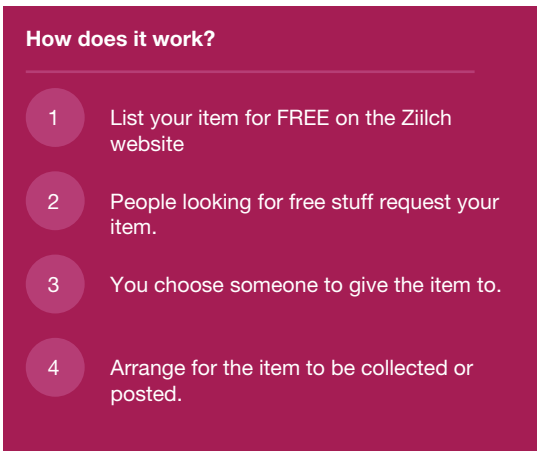
Below are some innovative ways of dealing with waste.

Ziilch

Most of us have an old computer we no longer use, or an old charger for a device we no longer have. We may even have books, furniture or clothing that could be recycled. The website Ziilch has come up with an easy solution to de-clutter, find new items and save on disposal costs. It is as easy as a click of a button (see figure 1).

This online company connects people in different places, and the platform enables you to exchange goods for free. This promotes the idea of recycling, which reduces consumption and hopefully leads to a more sustainable future.

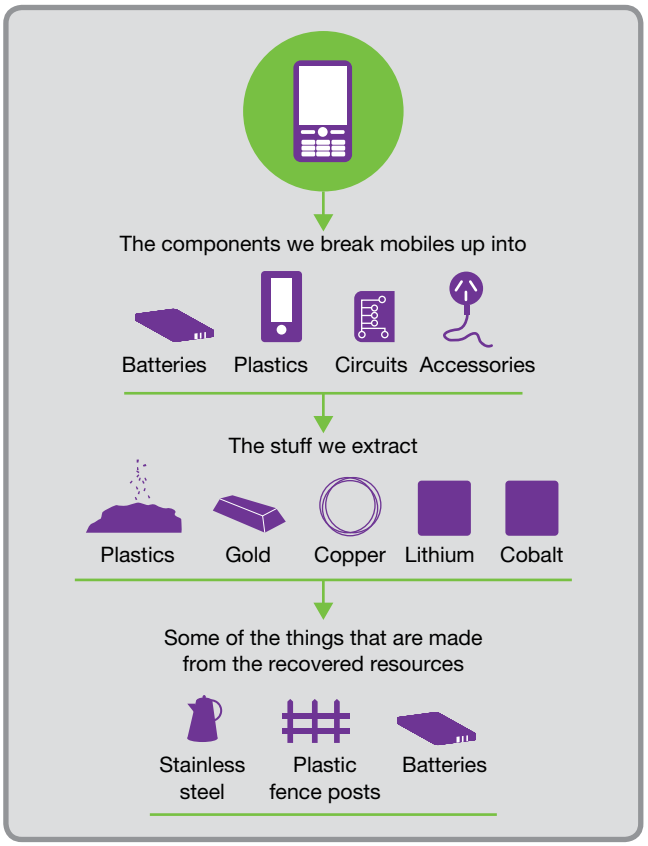
FIGURE 1 How Ziilch works



MobileMuster

MobileMuster is a simple, easy way to dispose of old mobile phones, batteries and accessories. MobileMuster is voluntarily funded and managed by distributors, network carriers, service providers and manufacturers. It is a free service where you can send your mobile phone or find your nearest drop-off point, of which there are over 4500 in Australia. This ensures that mobiles are recycled correctly rather than dumped in **landfill**. Over 90 per cent of materials in mobile phones can be recycled (see figure 2).

FIGURE 2 The mobile phone recycling process



landfill a method of solid-waste disposal, in which refuse is buried between layers of soil

By using a certified recycling program, you can ensure that your e-waste is not being illegally exported, and the environment is not being contaminated by the metals and minerals in the products.

carbon emissions carbon dioxide that is released into the atmosphere by natural processes or by burning gas, coal or oil, for example; the latter emissions are contributing to climate change

Reduce energy consumption

It is not only important to be involved in recycling, but also vital to reduce your **carbon emissions**, which is another byproduct of information and communication technology. Some strategies include:

- turning off your PC overnight, on weekends and during holiday periods
- ensuring printers and other equipment are switched off when not in use
- refraining from printing emails whenever possible
- removing active screensavers
- only charging your mobile phone when it is flat.

FIGURE 3 A local council advertising e-waste collection

National Television and Computer Recycling Scheme

The National Television and Computer Recycling Scheme will provide households and small businesses with free recycling services for televisions and computers. While it is governed by Commonwealth legislation, *Product Stewardship Act 2011*, state and territory governments retain responsibility for regulating waste.

The scheme commenced in 2011 and has been able to provide residents with a more coordinated approach to local e-waste disposal. The first drop-off points were rolled out in 2012 in metropolitan areas, and expanded into rural and remote areas in 2013. The scheme will accept all televisions, computers, and computer accessories such as keyboards and hard drives.

It is hoped that by 2021–22, recycling of computers and televisions will have reached 80 per cent, compared to the 17 per cent that are recycled today.

FIGURE 4 Electronic devices and accessories are collected for recycling by local councils.

FOCUS ON FIELDWORK

Conducting a class survey

In a group, conduct a class survey in which you interview students and teachers about their recycling habits.

Decide on the types of questions you wish to ask and how you will record responses. If you wish to do this online, use the **Survey Monkey** weblink in your eBookPLUS.

After you have conducted your surveys, collate and present your findings in graphic form.

Analyse your graphs and write a summary of your findings, ensuring you cover the following questions.

- Are students more environmentally conscious than teachers?
- Does age make a difference?

Prepare a recycling plan for your school.

eBook*plus*

Weblink
Survey Monkey

ACTIVITIES

IDENTIFY

1 a What do you understand by the term *e-waste*?

b According to the ABS, what is the main excuse that people give for not recycling?

2 Refer to figure 2. Name three byproducts extracted from mobile phones and two products that can be made from recovered resources in mobile phones.

APPLY

3 Have you ever participated in a national or global recycling scheme? If so, explain what it was and what you recycled. If not, suggest what you could recycle and how to do so.

4 Create a mind map to display the things you can do daily to reduce your energy consumption.

INVESTIGATE

5 Find out where your nearest National Television and Computer Recycling Scheme drop-off point is. Describe this ***place*** in relation to where you live. Is it realistic for you to take your recyclables there?

20.10 Can waste be managed more sustainably?

20.10.1 Woodlawn Eco Precinct

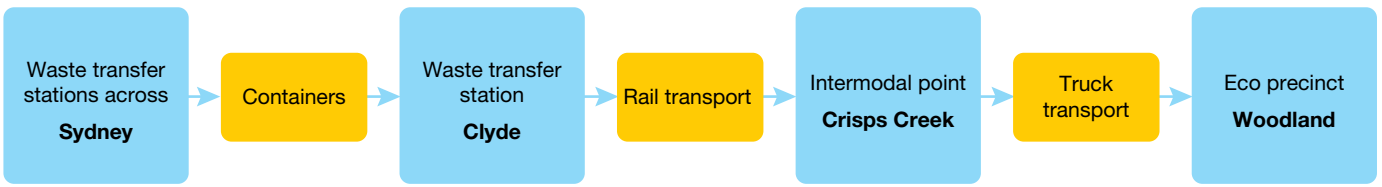
Woodlawn Eco Precinct is a former mine site being used as a waste management facility. The waste management facility is located near the settlement of Tarago, New South Wales, 250 kilometres south of Sydney. Here, compost is created from containerised organic and household waste that is delivered to the site by freight train and trucks. The compost is used as landfill to rehabilitate the former open-cut mine site shown in figure 1.

More recently, bioreactors are being used to extract organic matter from waste. Sustainable technologies such as wind farms generate enough energy to power over 4000 homes. Fish farming and horticulture are also being practised at the site. Figure 3 shows the movement of the waste between Sydney and the tip.

FIGURE 1 Former mine site at Tarago, New South Wales

FIGURE 2 Rubbish from Sydney is being transported to Woodlawn.

FIGURE 3 Many forms of transport are used to move 20 per cent of Sydney's waste to Woodland.



ACTIVITIES

IDENTIFY

1. Give the location of the Woodlawn mine open pit using at least two area references (AR).
2. What is the direction of Tarago railway station from the Woodland open-cut mine?
3. Using the scale of the map, calculate the width of the Woodlawn open-cut mine.
4. Suggest the direction of water flow in Crisps Creek.

APPLY

5. Use the **Woodlawn MBT Facility** weblink in your eBookPLUS to find out more about the Woodlawn mechanical biological treatment operations.
6. Examine the topographic map of Woodlawn in figure 4 and suggest reasons why this site was chosen as a waste dump.
7. Use evidence from the map (for example, AR or GR) to suggest two environmental problems that could occur at this site, if it is poorly managed.
8. Woodlawn waste management facility is using aquaculture, wind farming and agricultural practices at the Tarago site. Using AR and GR locations, suggest an appropriate location for each of these activities. Give reasons for your answer.

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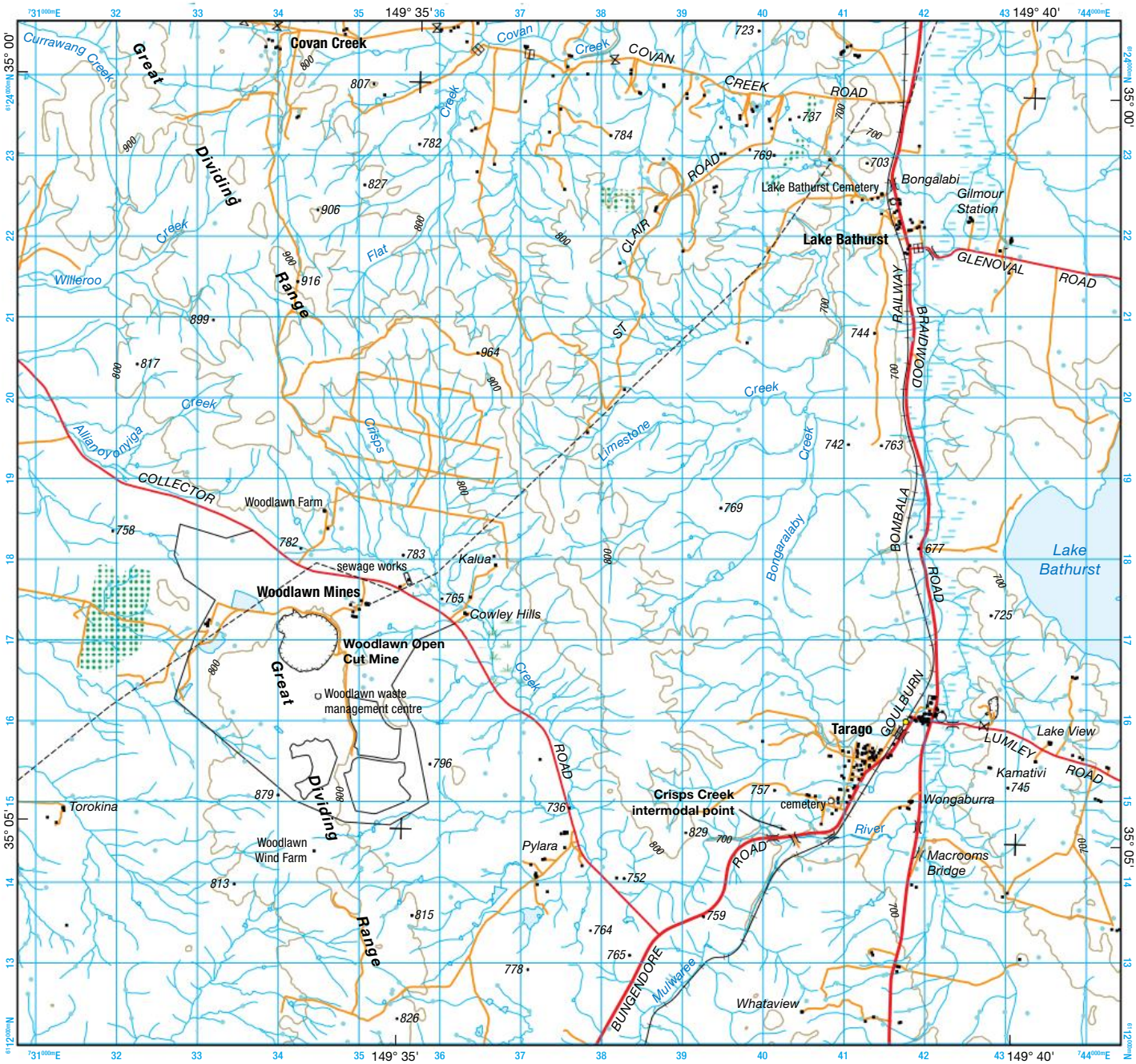
Weblink
Woodlawn MBT Facility

FIGURE 4 Topographic map of Woodlawn



Key

- Water area
- Swamp - wet
- Land subject to inundation
- Orchard or plantation
- Open-cut mine
- Land use boundary
- Watercourse or canal
- Contour with height (metres)
- Spot height (metres)
- Building point
- Water point
- Landmark point
- Highway sealed
- Secondary road sealed
- Minor road unsealed
- Railway; railway station
- Transmission line
- Cattle grid
- Gate
- Bridge

N, W, E, S

0 1 2 km

Source: Land and Property Information, NSW.

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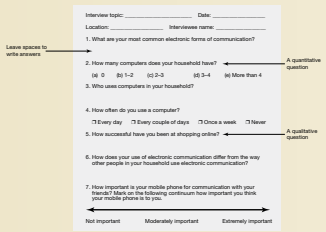
20.11 SkillBuilder: Using advanced survey techniques — interviews

What are interviews that survey people's opinions?

Conducting a survey means asking questions, recording and collecting responses, and collating the number of responses. Interviews are particularly useful for gathering information on attitudes and values. An interview, which is an advanced survey technique, allows you to explore attitudes and values without being restricted by survey categories.


Interview topic: _____ Date: _____

Location: _____ Interviewee name: _____

1. What are your most common electronic forms of communication?

Leave spaces to write answers

2. How many computers does your household have? ← A quantitative question

(a) 0 (b) 1–2 (c) 2–3 (d) 3–4 (e) More than 4

3. Who uses computers in your household?

4. How often do you use a computer?

❒ Every day ❒ Every couple of days ❒ Once a week ❒ Never

5. How successful have you been at shopping online? ← A qualitative question

6. How does your use of electronic communication differ from the way other people in your household use electronic communication?

7. How important is your mobile phone for communication with your friends? Mark on the following continuum how important you think your mobile phone is to you.

Not important Moderately important Extremely important

eLesson

Watch this video to learn how to use advanced survey techniques.

Searchlight ID: eles-1742

Interactivity

Try this interactivity to learn how to use advanced survey techniques.

Searchlight ID: int-3360

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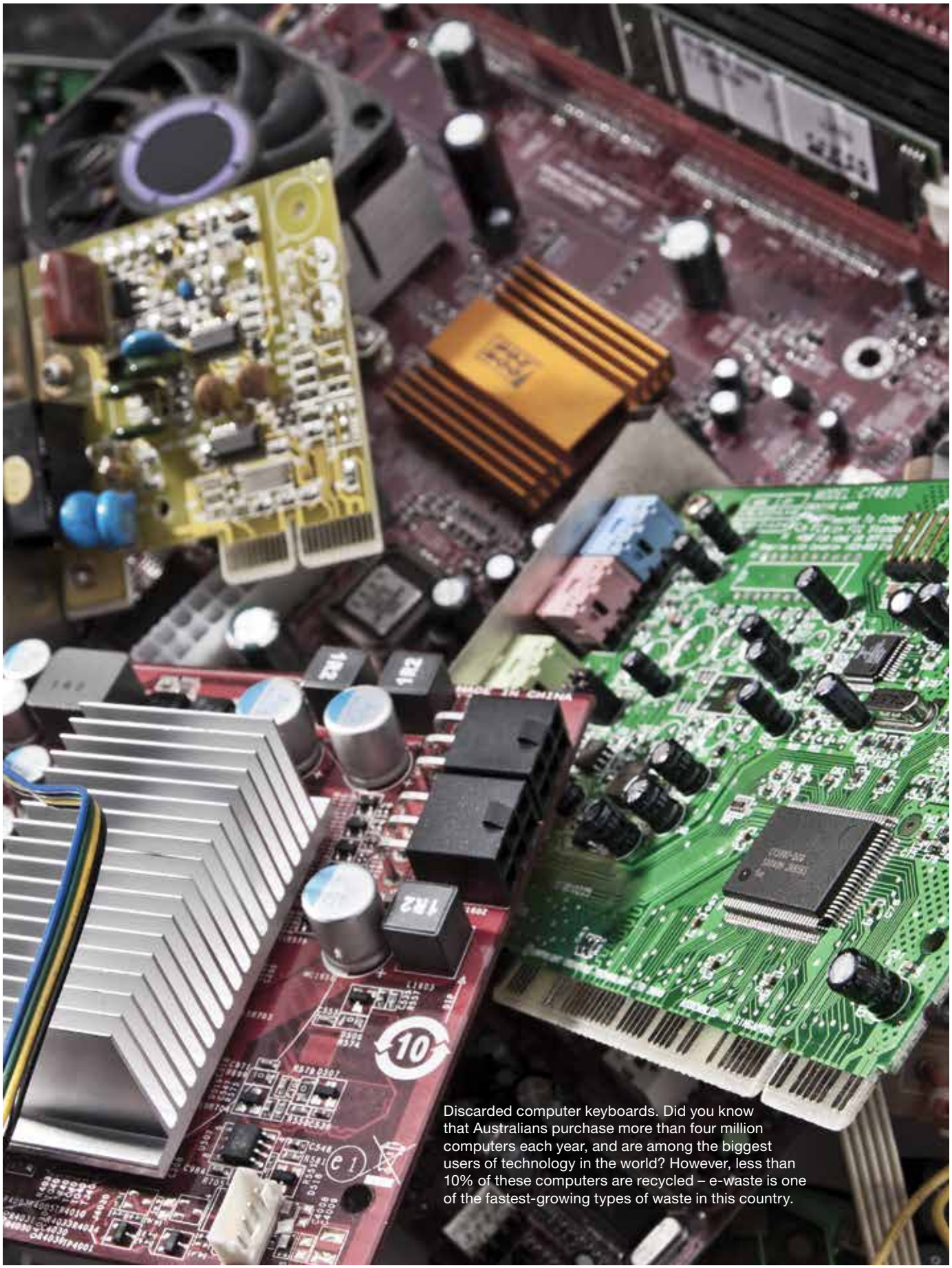
20.12 Review

To access this resource, go to your eBookPLUS at **www.jacPLUS.com.au**.



Discarded computer keyboards. Did you know that Australians purchase more than four million computers each year, and are among the biggest users of technology in the world? However, less than 10% of these computers are recycled – e-waste is one of the fastest-growing types of waste in this country.

CHAPTER 21

Fieldwork inquiry: What are the effects of travel in the local community?

21.1 Overview

21.1.1 Scenario and task

Task: Produce a report about the impacts of travel movements around a local school or traffic hotspot, and devise a plan to better manage traffic and pedestrian movement.

People travel for many reasons at the local scale — for example, they may travel to work, to shops, to visit friends and to local sporting venues. Often there are times when traffic congestion occurs, creating danger areas for motorists and pedestrians. Examples of places where such congestion occurs are schools and shopping centres. Undertaking fieldwork allows you to observe and collect original data first-hand.

Your task

Your team has been commissioned by the local council to compile a report evaluating the impacts of travel movements around a local school or traffic hotspot. You will need to collect, process and analyse suitable data and then devise a plan to better manage future traffic and pedestrian movement in the area.

21.2 Inquiry process

21.2.1 Process

Open the ProjectsPLUS application for this chapter located in your eBookPLUS. Watch the introductory video lesson and then click the 'Start Project' button and set up your project group. You can complete this project individually or invite members of your class to form a group. Save your settings and the project will be launched.

- **Planning:** Navigate to your Research Forum. Research topics have been loaded into the system to provide a framework for your research. You can also add your own new topics.
- As part of a class discussion, determine a suitable location for your fieldwork study. This might be your own or a local school, or a nearby shopping centre. Talk about some of the issues related to your fieldwork site and then devise a key inquiry question — for example: *What are the effects of . . . ?* or *How can we reduce the impact of . . . ?* This will be the focus of your fieldwork. You then need to establish the following:
  - **What** sort of data and information will you need to study the travel issue at your site?
  - **How** will you collect this information?
  - **Where** would be the best locations to obtain data?
  - **When** would be the best times of the day or day(s) of the week to obtain data?
  - **How** will you record the information you are collecting?

If you wish to collect people's views on the issue, or suggestions for improvements, you will need to plan and write suitable survey questions.

21.2.2 Collecting and recording data

As a class, plan the field trip by identifying and allocating tasks and possible sites to groups or pairs. It is often easier to share data collection. Once everything has been planned, you will need to perform your allocated tasks on the day.

In class, invite your school principal or a member of your local council to be a guest speaker discussing your fieldwork site. They may be able to assist with background information that you may not be able to gain elsewhere. They can also provide a different perception of the effects of travel at your

site. Plan a series of questions you would like to ask and be prepared to take notes that you can use in your report.

After the field trip, it may be necessary to collate everyone's data and summarise surveys so that everyone has access to the shared information.

21.2.3 Processing and analysing your information and data

Look at your completed graphs and maps. What trends, patterns and relationships can you see emerging? Within your fieldwork area, are there some places that have a bigger issue with cars and pedestrians than other areas? Is there an interconnection between traffic congestion and time of the day, or day of the week? What have your surveys revealed? What are the major effects of travel at your fieldwork site? How do people perceive the travel issues in this place? Go back to your key inquiry question. To what extent have you been able to answer it? Write your observations up as a fieldwork report using subheadings such as:

- Background and key inquiry question
- Conducting the fieldwork [planning and collecting data]
- Findings [results of data analysis].

Visit your Media Centre and download the report template to help you complete this project. Use the report template to create your report.

21.2.4 Communicating your findings

Now that you have identified a traffic problem and collected and analysed data, it is time to try to solve it. Your completed map and supporting data will form part of your management plan for the future. What have been the main issues that have emerged from your fieldwork research? How can you best manage these issues? Using your base map, create an overlay or annotated map to show possible options for reducing the traffic problem. You will need to support each proposal with data that you have gained from your fieldwork. Possible ideas could include:

- changing parking restrictions
- staggering times of drop-off and pick-up
- introduction of traffic wardens to guide traffic
- creation of a one-way system.

Your teacher may arrange for your completed report to be presented to your school or local council. Considering your audience, what is the best way to present your findings? You might like to produce a PowerPoint presentation or an annotated visual display.

21.3 Review

21.3.1 Reflecting on your work

Think back over how well organised and prepared you were for the fieldwork, the data you collected and how you processed the data for your report. Download and complete the reflection template from your Media Centre.

Print out your Research Report from ProjectsPLUS and hand it in with your fieldwork report and reflection notes.

Your ProjectsPLUS application is available in this chapter's Resources tab in your eBookPLUS. Visit **www.jacplus.com.au** to locate your digital resources.

Suggested software

- ProjectsPLUS
- Microsoft Word or any other word processing tool
- PowerPoint or any other presentation tool

Media Centre

Your Media Centre contains:

- a sample traffic count data sheet
- a sample survey question sheet
- a report template
- an assessment rubric.

GLOSSARY

activity hub a centre for business activities that may or may not be the central business district

aerial view an image taken from above an object; also known as a bird's-eye view

aesthetic relating to something beautiful and pleasing to look at

alluvium the loose material brought down by a river and deposited on its bed, or on the floodplain or delta

altitude height above sea level

anonymity where a person's details, such as their name, are unknown

Anthropocene a period of time to describe the time when humans made significant changes to the Earth's environments

appropriate technology technology designed specifically for the place and the people who will use it. It is affordable and can be repaired locally.

aquifer a body of permeable rock below the Earth's surface which contains water, known as groundwater. Water can move along an aquifer.

artesian aquifer an aquifer confined between impermeable layers of rock. The water in it is under pressure and will flow upward through a well or bore.

Baby Boomers generally refers to those born during the post–World War II baby boom (1946–1964)

barter to trade goods in return for other goods or services rather than money

biodiversity the rich variety of all life forms on Earth, including plants and animals

bucket list a list of things a person wants to do before they die or 'kick the bucket'

built environment a place that has been constructed or created by people

carbon emissions carbon dioxide that is released into the atmosphere by natural processes or by burning gas, coal or oil, for example; the latter emissions are contributing to climate change

catchment area the area of land that contributes water to a river and its tributaries

census an official count or survey of a population, which often seeks and records other information about people. The Australian Bureau of Statistics conducts a national census every five years.

clearfelling a forestry practice in which most or all trees and forested areas are cut down

climate long-term weather patterns in an area

climate change a change in the world's climate. This can be very long term or short term, and is caused by human activity.

collate to organise the findings of fieldwork

community a group of people living in a particular region

commute to regularly make a journey such as from home to work

compost a mixture of various types of decaying organic matter such as dung and dead leaves

contour line a line joining places of equal height above sea level

convection current a current created when a fluid is heated, making it less dense, and causing it to rise through surrounding fluid and to sink if it is cooled. A steady source of heat can start a continuous current flow.

convectional rainfall heavy rainfall as a result of thunderstorms, caused by rapid evaporation of water by the sun's rays

converging plate a tectonic boundary where two plates are moving towards each other

cultural relating to the ideas, customs, and social behaviour of a society

cyclone intense low pressure system producing sustained wind speeds in excess of 65 km/h. It develops over tropical waters where surface water temperature is at least 27 °C.

degradation a decline in quality caused by time or improper use

delegate person sent or authorised to represent others, in particular an elected representative sent to a conference

delta a landform at the mouth of the river where a river splits into smaller streams and sediment is deposited to create an arch of land reaching out into the sea

deposition the laying down of material carried by rivers, wind, ice and ocean currents or waves

desertification the process by which an area becomes a desert

developed describes countries with a highly developed industrial sector, a high standard of living, and a large proportion of people living in urban areas

developing country nation with a low living standard, undeveloped industrial base, and low human development index relative to other countries

digital divide a type of inequality between groups in their access to and knowledge of information and communication technology

digital economy the network of economic and social activities that are supported by information and communication technology, such as the internet and mobile and sensor networks

discharge the volume of water that flows through a river in a given time

distribution the way things are spread across an area

divergent plate a tectonic boundary where two plates are moving away from each other and new continental crust is forming from magma that rises to the Earth's surface between the two

domesticate to tame a wild animal or plant so it can live with or be looked after by people

drainage basin the entire area of land that contributes water to a river and its tributaries; the whole area of land drained by a river and its tributaries

Dreaming in Aboriginal culture, the time when the Earth took on its present form, and cycles of life and nature began; also known as The Dreamtime. Dreaming Stories pass on important knowledge, laws and beliefs.

economic a system made up of producing, buying and selling goods and services

ecosystem an interconnected community of plants and animals in a particular environment

ecotourism tourism that interprets the natural and cultural environment for visitors, and manages the environment in a way that is ecologically sustainable

ecotourist a tourist who travels to threatened ecosystems in order to help preserve them

epicentre the point on the Earth's surface vertically above the focus

equatorial near the equator, the line of latitude around the Earth that creates the boundary between the northern and southern hemispheres

erosion the picking up, transport and depositing of weathered material; the wearing away and removal of soil and rock by natural elements, such as wind, waves, rivers or ice, and by human activity

ethnic minority a group that has different national or cultural traditions from the main population

evaporate to change liquid, such as water, into a vapour (gas) through heat

evaporation the process by which water is converted from a liquid to a gas and thereby moves from land and surface water into the atmosphere

evapotranspiration the process by which water is transferred to the atmosphere from surfaces such as the soil and plants

e-waste any old electrical equipment that includes computers, toasters, mobile phones and iPods that no longer work or are no longer required

expenditure the amount of money spent

extremism extreme political or religious views, or extreme actions taken on the basis of those views

fair trade a consumer-driven movement to promote fair prices and reasonable conditions for producers in developing regions. Fairtrade International is a group of 25 organisations trying to ensure a better deal for producers.

fault an area on the Earth's surface that has a fracture, along which the rocks have been displaced

field sketch a diagram with geographical features labelled or annotated

fissure a long, narrow crack or opening in the face of a rock

flood inundation by water, usually when a river overflows its banks and covers surrounding land

floodplain the area of land next to the river, usually reaching to the base of the mountains surrounding the catchment. It experiences flooding during peak rainfall periods.

fly in, fly out (FIFO) describes workers who fly to work in remote places, work 4-, 8- or 12-day shifts and then fly home

focus the point where the sudden movement of an earthquake begins

fossil fuels fuels that come from the breakdown of living materials, and which are formed in the ground over millions of years. Examples include coal, oil and natural gas.

gale force winds winds with speeds of over 62 kilometres per hour

Generation X those born after the baby boom, roughly between 1963 and 1980

Generation Y those born after Generation X, between 1981 and 1994

Generation Z those born after Generation Y, between 1995 and 2009

geomorphic describes a process that occurs in the lithosphere

geostationary satellites satellites that orbit with the Earth's rotation and appear to be stationary in the sky making locating features on the Earth's surface more accurate with GPS

geothermal energy energy derived from heat in the Earth's interior

glacier a large body of ice, formed by an accumulation of snow, which flows downhill under the pressure of its own weight

global citizen someone who is aware of the wider world, tries to understand the values of others, and tries to make the world a better place

globalisation the process that enables markets and companies to operate internationally, and products and ideas to be freely exchanged

gorge narrow valley with steep rocky walls

green building building that requires fewer resources when being built, and uses power and water efficiently

greenbelts plantations of trees for the purpose of conservation

gross domestic product (GDP) the value of all the goods and services produced within a country in a given period of time. It is often used as an indicator of a country's wealth.

groundwater recharge a process in which water moves down from the Earth's surface into the groundwater

habitat the total environment where an animal lives, including shelter, access to food and water, and all of the right conditions for breeding

halal describes food that is prepared under Islamic dietary guidelines

hard sport tourism tourism in which someone travels to either actively participate in or watch a competitive sport as the main reason for their travel

host an organism that supports another organism

hotspot an area on the Earth's surface where the crust is quite thin, and volcanic activity can sometimes occur, even though it is not at a plate margin

human features structures built by people

humanitarian principles the principles governing our response to natural disasters, such as tsunamis and earthquakes, or human-induced disasters, such as armed conflicts — the main aim being to save lives and alleviate suffering

humidity the amount of water vapour in the atmosphere

Hummer a type of car originally built for use by the US army; they are now often used in cities as stretched limousines

hydroelectric dam a dam that harnesses the energy of falling or flowing water to generate electricity

hydrologic cycle another term for the water cycle

ice age a geological period during which the Earth is colder, glaciers and ice sheets expand and sea levels fall. The last ice age was approximately 13 000 years ago.

improved drinking water water that is safe for human consumption

indigenous peoples the descendants of those who inhabited a country or region before people of different cultures or ethnic origins arrived

industry the production of goods and services

informal sector jobs that are not officially recognised by the government as official occupations and that are not counted in government statistics

infrastructure the facilities, services and installations needed for a society to function, such as transportation and communications systems, water and power lines; the features that are built by humans to allow other

activities to occur, for example roads, electricity networks and water supply

inselberg an isolated hill, knob, ridge, outcrop or small mountain that rises abruptly from the surrounding landscape

intensify to become stronger

intermittent creek a creek that flows for only part of the year following rainfall

landfill a method of solid-waste disposal, in which refuse is buried between layers of soil

landslide a movement of rock, debris or earth down a steep slope (for example a mountain or cliff)

leaching a process that occurs where water runs through the soil, dissolving minerals and carrying them into the subsoil

levee also known as an embankment, it is a built-up part of the river bank

liquefaction a process whereby the shaking of an earthquake reduces or converts soil to liquid

literacy rate the proportion of the population aged over 15 who can read and write

lithosphere the Earth's crust, including landforms, rocks and soil

liveable city an informal name given to cities if they rank highly on a reputable annual survey of living conditions; a city that people want to live in, which is safe, well planned and prosperous, and has a healthy environment

location where a point on the Earth's surface is to be found

mantle the layer of the Earth between the crust and the core

Maasai ethnic group of semi-nomadic people in Kenya and Tanzania, whose way of life depends on their cattle

mass market the market for goods that are produced in large quantities

mass movements large areas of earth that move

mature-aged describes individuals aged over 55

meander a curve in a river caused by fast-flowing water eroding the bank of one side of the river and slow-flowing water depositing sediment on the other side of the river

mental map a drawing or map that contains our memory of the layout and distribution of features in a place

mercury poisoning a toxic condition caused by the ingestion or inhalation of mercury or a mercury compound. It has various symptoms, including vomiting, nausea, insomnia and fevers.

microclimate specific atmospheric conditions within a small area

mobility the ability to move or be moved freely and easily

monsoon the rainy season in the Indian subcontinent and South-East Asia

mound springs mound formation with water at its centre, which is formed by minerals and sediments brought up by water from artesian basins

national park a park or reserve set aside for conservation purposes

national security the protection of a nation's citizens, natural resources, economy, money, energy, environment, military, government and energy

natural disaster an extreme event that is the result of natural processes and causes serious material damage or loss of life

natural environment elements such as wind, soil, flowing water, plants and animals that influence the characteristics of an area

natural hazard an extreme event that is the result of natural processes and has the potential to cause serious material damage and loss of life

new moon the phase of the moon when it is closest to the sun and is not normally visible

nomadic describes a group or tribes that move from place to place depending on the food supply

nomadic lifestyle describes a lifestyle in which people do not live in one fixed spot but move according to the seasons from place to place in search of food, water and grazing land

non-government organisation (NGO) non-profit group run by people (often volunteers) who have a common interest and perform a variety of humanitarian tasks at a local, national or international level

nutrient an essential element that feeds living things to help them function and grow

OECD Organisation for Economic Co-operation and Development, which has 34 member countries and promotes policies that improve economic and social wellbeing

Pangaea the name given to all the landmass of the Earth before it split into Laurasia and Gondwana

patron a customer, especially a regular one

permafrost a layer beneath the surface of the soil where the ground is permanently frozen

pictorial map a map using illustrations to represent information

place specific part of the Earth's surface that has been identified and given meaning by people

plateau an extensive area of flat land that is higher than the land around it. Plateaus are sometimes referred to as tablelands.

population density the number of people living in a square kilometre

precipitation the form of water falling from the sky, such as rain, snow or hail

primary data information that you have collected where the researcher uses fieldwork techniques

primary industry industry involved in the gathering of natural resources, such as iron ore and timber, or activities such as farming and fishing

pull factors positive aspects of a place; reasons that attract people to come and live in a place

push factors reasons that encourage people to leave a place and go somewhere else

quaternary industry gathering information about an industry; for example, marketing furniture

rain shadow the drier side of a mountain range, cut off from rain-bearing winds

rainfall variability the change from year to year in the amount of rainfall in a given location

region any area of varying size that has one or more characteristics in common

regional centre the main town in a region

relative humidity the amount of moisture in the air

remote describes a place that is distant from major population centres

sea change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small coastal town

secondary data information that has been collected by another person. This could include websites, books or pamphlets.

secondary industry making raw materials into a more useful product; for example, making timber tables

sediment material carried by water

seismic waves waves of energy that travel through the Earth as a result

of an earthquake, explosion, or a volcanic eruption

selective logging a forestry practice in which only selected trees are cut down

settlement place where humans live together, e.g. houses, villages, towns and cities

shanty towns slum settlements housing the poor on the outskirts of major cities in developing nations. They lack basic services such as clean water, sanitation and electricity.

shifting agriculture process of moving gardens or crops every couple of years because the soils are too poor to support repeated sowing

sketch map a simple labelled drawing of an area using a bird's-eye view

soak place where groundwater moves up to the surface

social justice the aim to create a society that is based on equality, that values human rights, and that recognises the dignity of every human being

soft sport tourism tourism in which someone participates in recreational and leisure activities, such as skiing, fishing and hiking, as an incidental part of their travel

soluble able to be dissolved in water

sparse thinly scattered or unevenly distributed; often used when referring to population density

sparsely populated describes a region in which few people live

species a biological group of individuals having the same common characteristics and able to breed with each other

spot height a point on the map which shows the exact height above sea level at that place

stalactite a feature made of minerals, which forms from the ceiling of limestone caves, like an icicle. They are formed when water containing dissolved limestone drips from the roof of a cave, leaving a small amount of calcium carbonate behind.

stalagmite a feature made of minerals found on the floor of limestone caves. They are formed when water containing dissolved limestone deposits on the cave floor and builds up.

storm shelter underground shelter where people can take refuge from a tornado

storm surge a sudden increase in sea level as a result of storm activity and strong winds. Low-lying land may be flooded.

street view an image of a building taken from the road or footpath, at street level

subsistence producing only enough crops and raising only enough animals to feed yourself and your family or community

subsistence farming a form of agriculture that provides food for the needs of only the farmer's family, leaving little or none to sell

sustainable to use the environment now in such a way that it continues to support our lives and the lives of other living creatures into the future

sustainable development economic development that causes a minimum of environmental damage, thereby protecting the interest of future generations

tectonic plate one of the slow-moving plates that make up the Earth's crust. Volcanoes and earthquakes often occur at the edges of plates.

temperate describes the relatively mild climate experienced in the zones between the tropics and the polar circles

ten pound Pom the name given to British migrants who migrated to Australia after World War II. The fare to Australia was subsidised by the Australian government and cost only £10.

tertiary industry selling goods and services; for example, a furniture business

tertiary study the educational level following the completion of high school, e.g. university

Tornado Alley a region of the central United States, across which tornadoes are most likely to form. The core states are Texas, Oklahoma, Kansas, Nebraska, eastern South Dakota, and the Colorado Eastern Plains.

torrential rain heavy rain often associated with storms, which can result in flash flooding

trade barriers government-imposed restriction (in the form of tariffs, quotas and subsidies) on the free international exchange of goods or services

trading partner a participant, organisation or government body in a continuing trade relationship

transportation the movement of eroded materials to a new location by elements such as wind and water

tree change the act of leaving a fast-paced urban life for a more relaxing lifestyle in a small country town, in the bush, or on the land as a farmer

typhoon the name given to cyclones in the Asian region

UNICEF United Nations Children's Fund: a UN program that provides humanitarian and developmental assistance to children and mothers in developing countries

uranium radioactive metal used as a fuel in nuclear reactors

value adding processing a material or product and thereby increasing its market value

virtual water all the water used to produce goods and services. Food production uses more water than any other production.

volcanic loam nutrient-rich soil derived from volcanic ash deposits

vulnerable the state of being without protection and open to harm

water footprint the total volume of fresh water that is used to produce the goods and services consumed by an individual or country

water scarcity a situation that occurs when the demand for water is greater than the supply available; when annual water supplies drop below 1000 cubic metres per person. *Absolute water scarcity* describes the situation when annual water supplies drop below 500 cubic metres per person.

water stress a situation that occurs when annual water supplies drop below 1700 cubic metres of renewable fresh water per person

water vapour water in its gaseous form, formed as a result of evaporation

weathering the breaking down of rock through the action of wind and water and the effects of climate, mainly by water freezing and cooling as a result of temperature change

web 1.0 read-only version of the web. It enabled users only to search and read information.

web 2.0 version of the web that allows the sharing of online information and ideas that anyone has created. It is the second generation of the World

Wide Web that enables collaboration and exchanging of information online.

web 3.0 current version of the web. Focus is on connective intelligence; connects data, concepts, applications and ultimately people.

weir a barrier across a river, similar to a dam, which causes water to pool behind it. Water is still able to flow over the top of the weir.

wilderness a natural place that has been almost untouched or unchanged by the actions of people

winter solstice the shortest day of the year, when the sun reaches its lowest point in relation to the equator

World Heritage List a list of human and natural sites that have been approved by UNESCO as meeting the criteria of being a World Heritage site

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