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Geography for the Australian Curriculum 8



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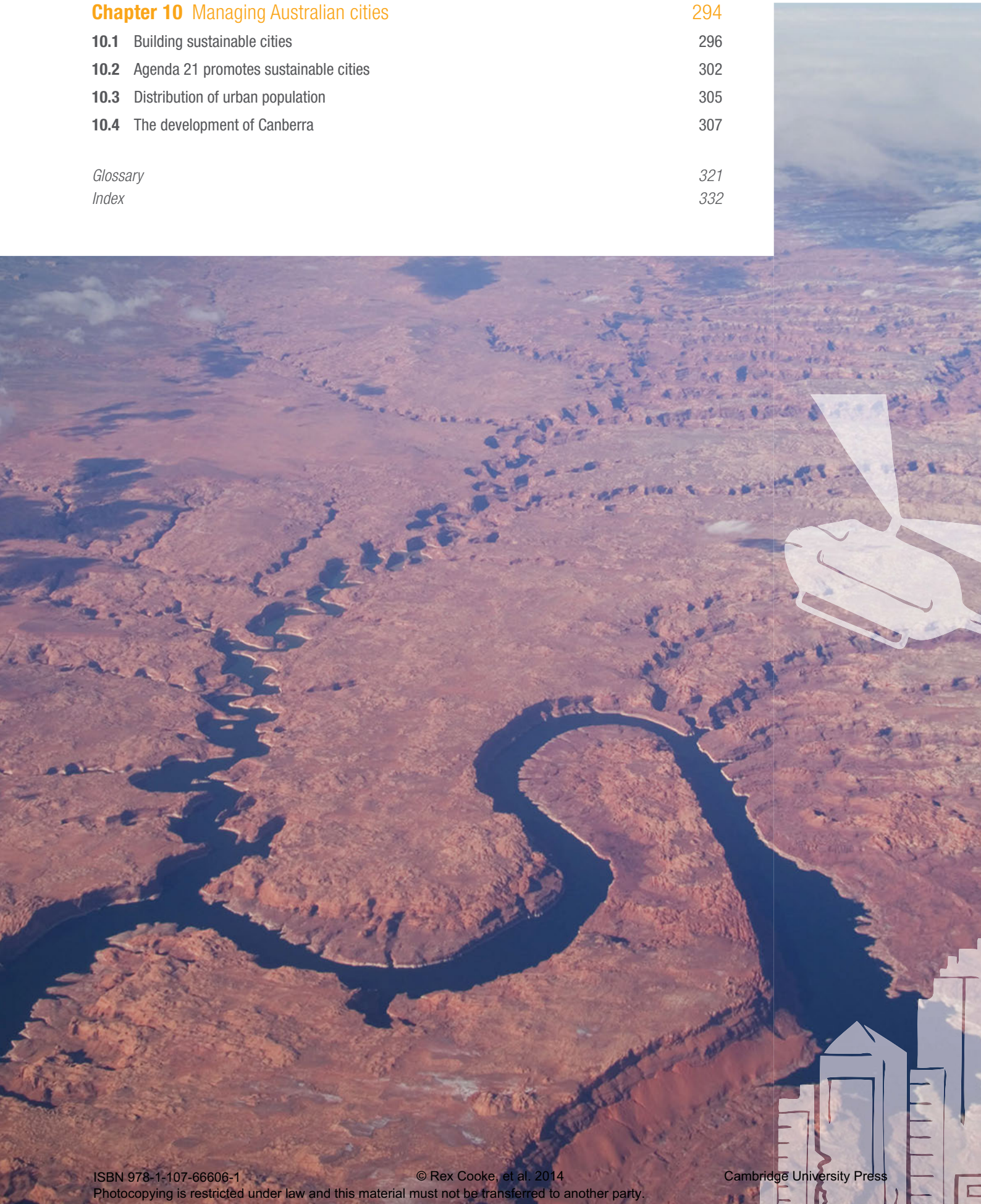
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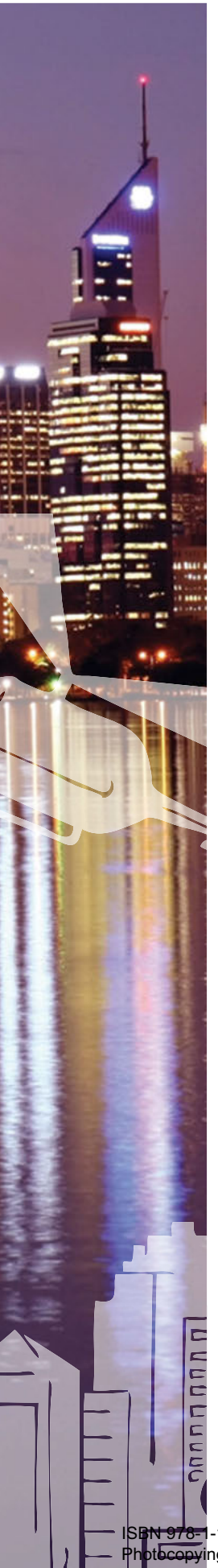
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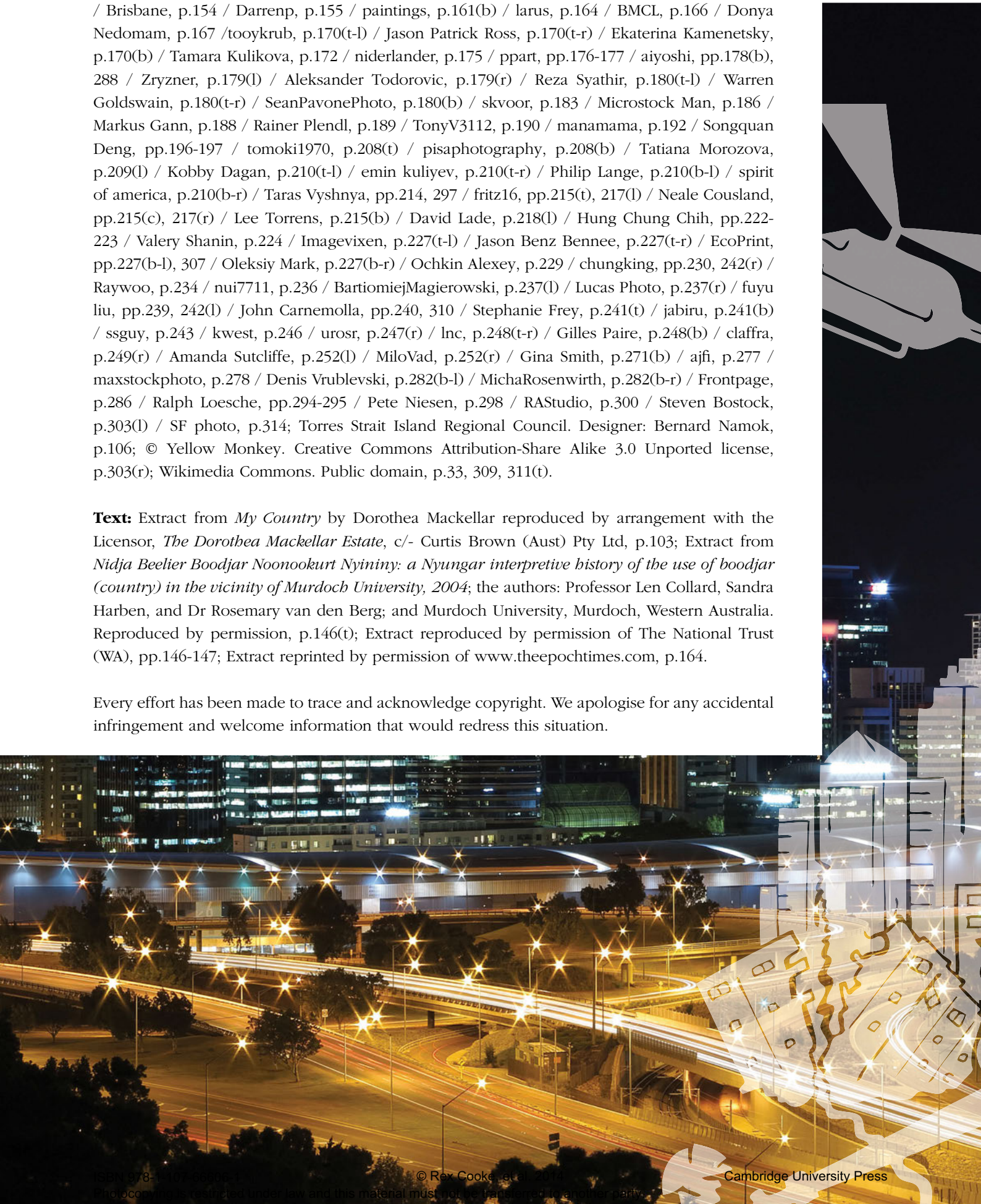
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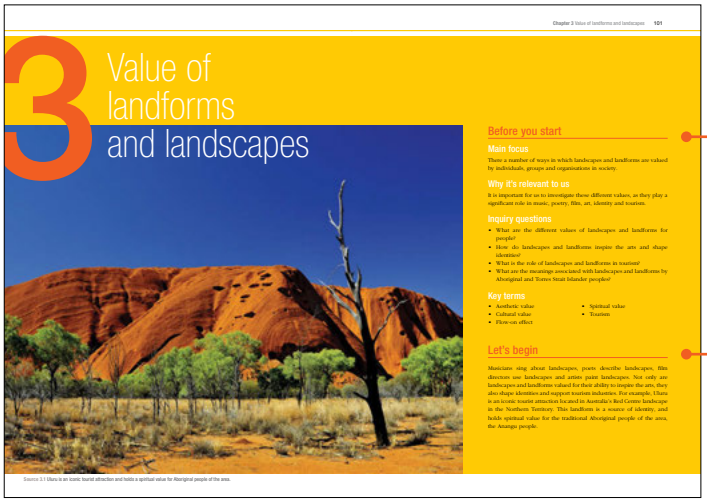
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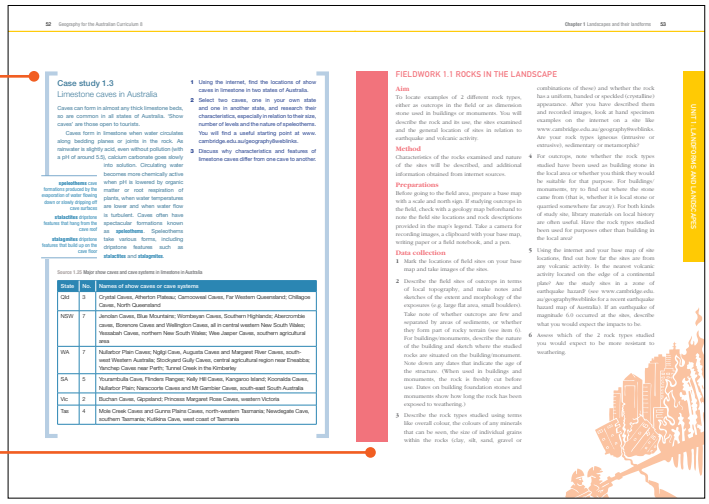
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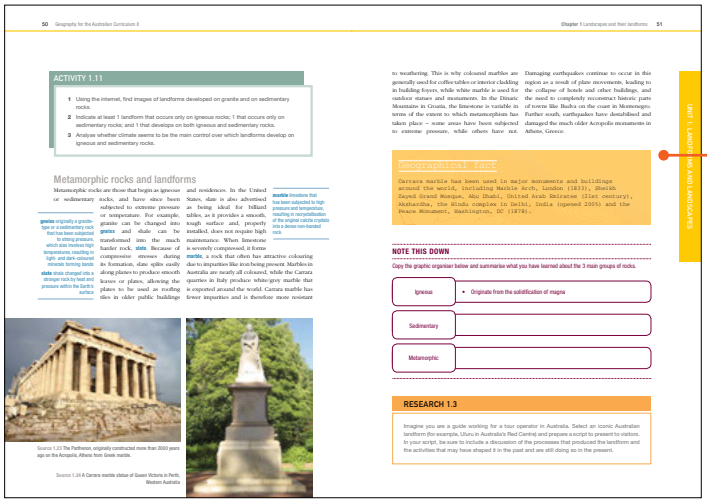
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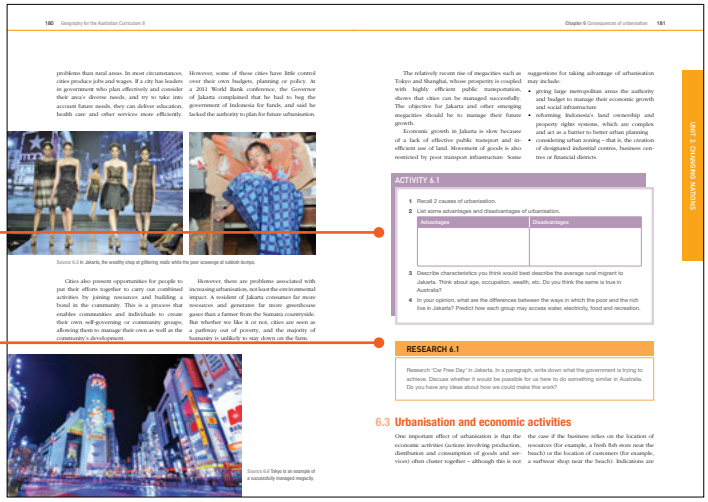




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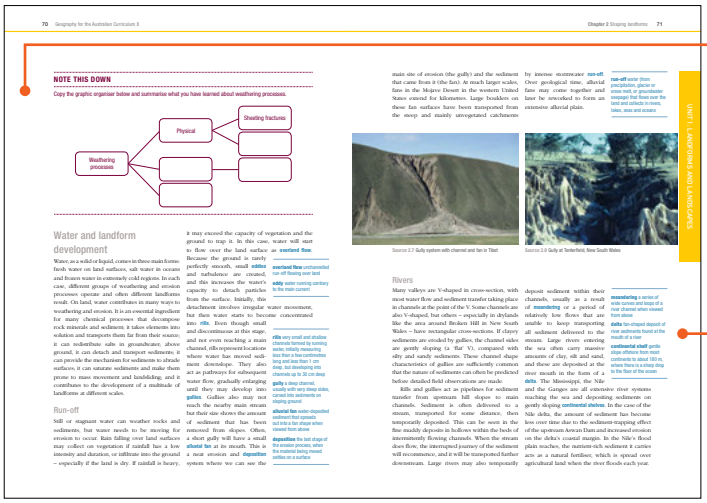
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A variety of **activities** and **research tasks** explore key concepts, develop skills and draw back to the general learning capabilities and cross-curriculum priorities.



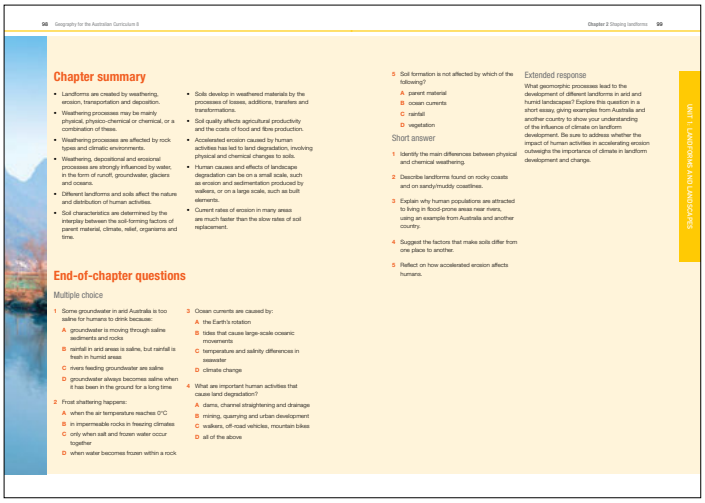
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Glossary terms are bolded in the text, defined in the margins and collated at the end of the textbook for easy reference.



Chapter summaries review the main ideas of the topic to consolidate what you have learned.

End-of-chapter questions include multiple choice, short answer and extended response to test your knowledge through the reinforcement of key concepts and application of skills.



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Geographical skills toolkit

0.1 Introduction

Geography is the study of the Earth, especially the surface: how it works and how humans interact with it. It involves describing, analysing and evaluating in order to understand and even predict how the elements that make up our world operate. It also includes the many ways in which people can affect and use their environments, from the individual or family unit to larger groups, companies and even governments. How we live on the Earth and how we change the environment today influences what the planet will be like in the future. This geographical skills toolkit explains the skills and concepts used in the study of geography. These tools will help you to think like a geographer as you explore landscapes and their landforms, and the changing human geography of countries.

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Source 0.1 The Grand Canyon is a famous landform in the United States, carved by the Colorado River.

0.2 Geographical inquiry and skills

What sets the geographer apart from others interested in the world is the methods we use to investigate. Geographers are not truly happy until they have collected data in the field, and developed a series of **hypotheses** to test their own work and investigation methods. Geographers enjoy working together in teams to share and discuss ideas. They know that the world is their laboratory, and that inquiry-based research is highly effective. As a geography student, you will be using the methods of the professional geographer, although on a smaller scale. You will follow an inquiry approach by working through a set of skills that represent a complete investigation:

hypothesis a proposition made on the basis of limited evidence, used as the starting point for further investigation

- observing, questioning and planning
- collecting, recording, evaluating and representing



Source 0.2 Geographers are involved in highly specialised work that helps us to live sustainably on the planet, minimising negative impact and supporting biodiversity in the environment as well as improving the lifestyles of people around the globe.

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- interpreting, analysing and concluding
- communicating
- reflecting and responding.

Depending on the type of inquiry, you may only need to focus on one particular skill. Your work becomes part of the complex web of data collected and analysed to ensure that our global footstep treads lightly on the planet, encouraging environmental sustainability and responsible human activities.

Observing, questioning and planning

Geography is a scientific study and it uses the same methods as other branches of science. The geographer begins planning an inquiry by observing issues or problems and developing geographically significant questions.

Develop geographically significant questions

Geographically significant questions are questions that are worth investigating. The inquiry questions at the beginning of each chapter form a model for geographical study, demonstrating the method used to construct a framework of questioning and learning. They prepare you for the learning to come, and allow you time and readiness to prepare for the material that lies ahead. However, they are not intended to limit your learning so that at the end of the chapter you are only able to respond to them; rather, they are a scaffold that supports you to build your learning a level at a time, adding your own inquiry questions as appropriate. These questions become the language of our study, moving us beyond the known and into discussions and debates where there may be no right or wrong answer, just many options and challenges to be explored as an integral part of our understanding.

Inquiry questions

- What are the different types of landscapes and landforms?
- What is the significance of plate movements for volcanic activity?
- What kinds of landforms develop from plate movements?
- Do different rocks produce different landforms?
- How do plate movements impact on people?

Source 0.3 The questions from Chapter 1, 'Landscapes and their landforms', make it clear in what direction the study will develop.

Collecting, recording, evaluating and representing

How do we collect and record information? How do we evaluate and represent this information? The geographer uses a range of tools to gather information, and needs to be aware of the source of that information in order to use it effectively.

Primary and secondary sources

Information gathered in the field or directly connected to our research is called a **primary source**. Primary sources are essential to valid scientific inquiry. They are targeted and specific to the task. We understand how the information has been collected,

primary source information that comes directly from the event or area we are studying. It is 'first hand', and is how we classify most of the data collected during fieldwork.

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the methodology used in the process and whether there were any elements that may have given unexpected results.

Information collected by others – perhaps people not directly involved in our research – is called a **secondary source**. Secondary sources can also be valuable, and can even reduce the work we need to do directly. For example, the Australian Bureau of Statistics (www.cambridge.edu.au/geography8weblinks) conducts the Census every 4 years, collecting demographic (population) information for the country. Where do people live? How far do they travel each day to work or school, and what transport do they use regularly? This is information that would be difficult for us to collect on our own on such a large scale, but it can be very useful.

secondary source information that is put together by someone else or someone not directly involved in the event or area that is being investigated

When collecting information, we also need to be aware of ethical protocols including confidentiality, informed consent, citation and integrity of data.

NOTE THIS DOWN

Copy the graphic organiser below and summarise what you have learned about primary and secondary sources.

Sources	Definition	Examples
Primary		Field notes
Secondary		Census data

Evaluating for reliability and usefulness

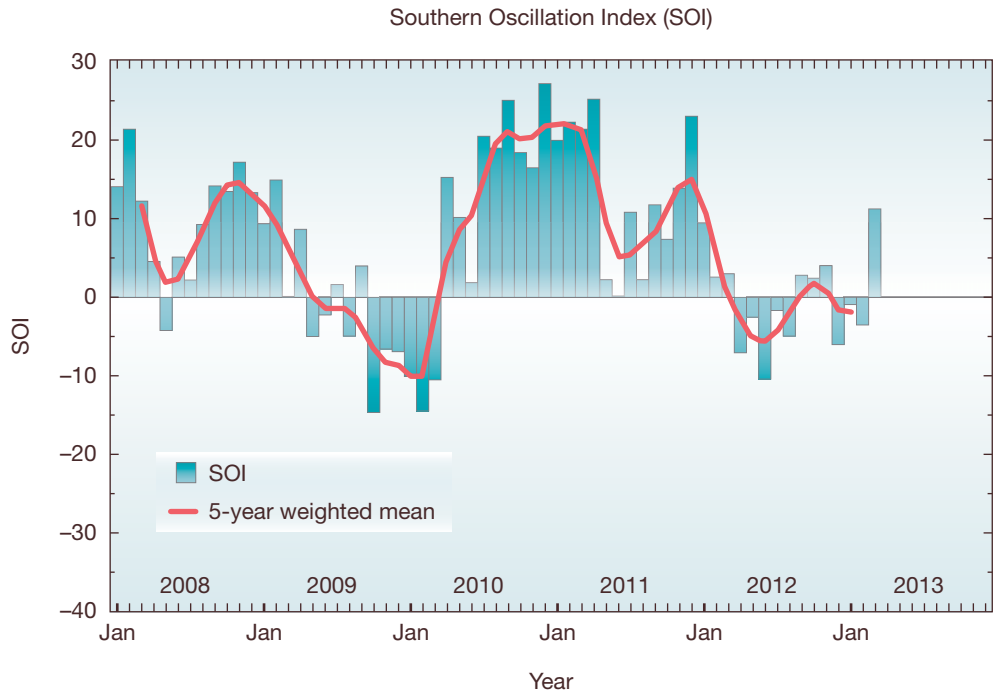
It is important to be able to trust the data we use in our research. We need to know that the ways in which they were collected were appropriate and consistent. It is important that the ways in which our data were gathered are reliable, but also that we are aware of any **bias** in the collection of the information that may make us review its value. If we are interviewing people in a town about using the water from a local river, we need to know whether they are relying on the water to irrigate their farm, enjoy fishing in the river or are interested in painting images of the river to depict the natural environment. Knowing this allows us to evaluate whether we can trust the information and how useful it will be in our work.

bias a particular interest or view that limits one's ability to make a fair judgement

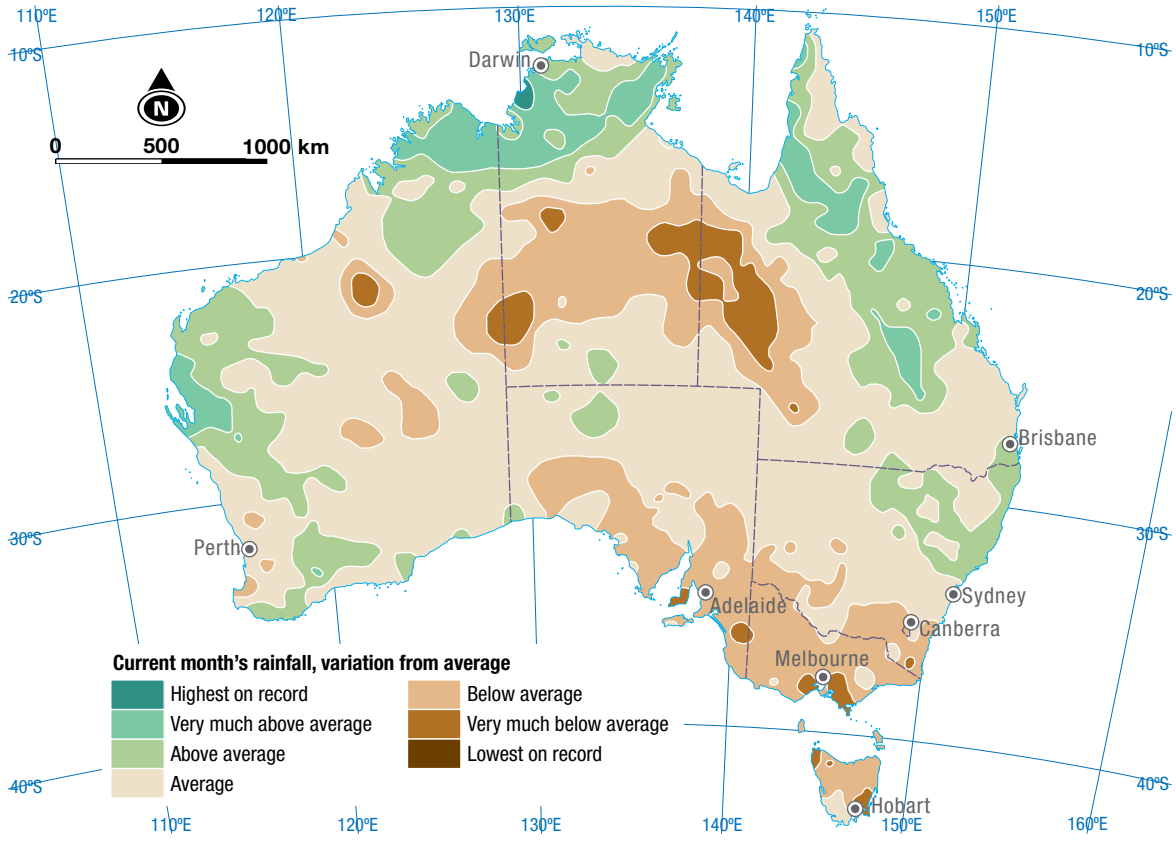
Representing data

Once we have collected our data, we need to present them in the most appropriate form. Some information easily fits into a written discussion, while numerical or quantitative data may work better in a visual representation, such as a graph or diagram. Other data can work well in an annotated photograph, a sketch or even a map. Geographers not only analyse the data they have, but also view them critically to decide what the best format will be for sharing that information.

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Source 0.4 Data can be represented in a range of appropriate forms including climate graphs, compound column graphs, population pyramids, tables, field sketches and annotated diagrams.



Source 0.5 Maps are probably the best-known geographic tool.

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Constructing maps

The same river can be viewed from different perspectives on a map, with information adding to our understanding of the system. We can see how steep the river valley is, the direction in which it flows and the type of landscape through which it flows. All of this information allows us to predict the impact of changes to the river if the surrounding environment changes.

Maps have various conventions that help us to construct and interpret them, including symbols, colour-coding, orientation and scale presentations. They allow us to present and analyse data in a visual format, giving us the ability to understand the information spatially, as separate parts of the environment.

Interpreting, analysing and concluding

Setting a series of inquiry questions and gathering information to try to answer those questions is important, but how you understand our information is vital to any geographic study. As a geography student, you need to be able to identify and propose explanations for spatial distributions, patterns and trends, and infer relationships. What is it that the data are showing? Do they point to further questions that require investigation in order for your work to be considered complete?

If the initial inquiry questions are clear and detailed, and if the research was appropriately targeted, then you have the information required to make informed conclusions. Let's take a closer look at what that means.

- Was your inquiry specific and measurable?
- Did your research include data collection?
- Did you also check your data with another research tool such as the internet?

If you can confidently answer 'yes' to all these questions, then you are ready to begin analysing your data and reaching logical conclusions. Start by answering your inquiry questions, not with a yes or no, but by explaining why/how you are sure of your response. What data back up your answer? Do the data clearly show that you have an answer, or is there a qualifying statement to be made? For example, 'The survey data from our visit to the city, where we took responses from 250 people over a 1-hour period, show that 83% of those people would prefer …' and 'from this, we can say that the local council should seriously consider … as a part of their management plan for the area.'

It is important not only to analyse your information, but also to decide what it is telling you. Are you able to make any reasonable and logical statements based on your data? Are some aspects of the data unclear? Sometimes, you need to be honest enough to say that your research may not have covered all angles, and you need to investigate further before you can really be sure about what is going on. Acknowledging a weakness in your initial inquiry or data collection shows your ability to reflect upon your work and identify areas or directions for further work.

Quantitative and qualitative methods

To assist with interpreting, analysing and developing conclusions, geographers use **quantitative** and **qualitative methods** to gather data. If we examine a nature reserve, we can talk to people who currently use the area so that we gain an understanding of how and when they use it, giving us qualitative methods for collecting information, while quantitative methods could include the numbers of animal populations sighted or the numbers of plant species found there. This information may be gathered using measures that give numerical results. Both types of methods are important for the geographer to be able to present a complete picture of the landscape.

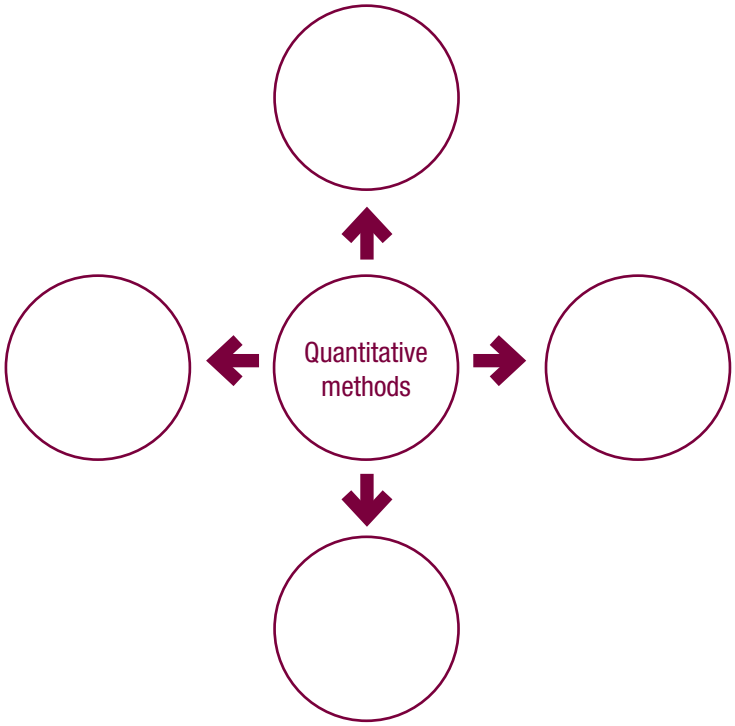
quantitative methods methods used to gather data that are expressed in numerical form

qualitative methods methods used to gather data that are expressed in non-numerical form (that can only be described)

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NOTE THIS DOWN

Copy the graphic organiser below and summarise some examples of quantitative methods. Use the same organiser to summarise examples of qualitative methods.



ACTIVITY 0.1

1. Discuss the importance of inquiry questions.
2. Identify some of the ethical protocols of which we need to be aware when collecting information.
3. Explain why it is important to use standard geographical conventions when creating a map.
4. If we research the viability of a local nature reserve, what qualitative and quantitative data can we use to support our conclusions?

Communicating

There are many ways to communicate the results of investigations. These include but are not limited to written, oral, graphical and visual methods. When deciding on which method to use to present findings, arguments and explanations, we need to consider the subject-matter, purpose and audience. It is also important to use relevant geographical terminology and digital technologies where appropriate.

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Communication forms

Written

The most common method to convey research results is the written report. Other methods include essays and extended responses. There is a need to ensure that written pieces are easy to understand, logically organised and fluent, and that they use the written conventions for spelling, punctuation and grammar. It is always a good idea to use a plan that keeps the work on track – especially if there is more than one writer.

Oral

It is just as important to have a plan when you make an oral presentation as it is when you produce a written report. The aim is to present your findings to an audience, so there is a need to make sure the audience can access your information. When using computer tools to create visual displays or presentations, be aware of the strengths and weaknesses of the program you are using. Make sure you use a font that is easy to read and a background that doesn't make it more difficult to see the information. Always keep the amount of text onscreen to a minimum, saving the space for visuals and allowing your presenter to reveal the information while speaking.

Graphical

Some data are better presented visually, through graphs and diagrams, rather than in words. If you are using a graph in a written report, always refer to it and discuss what it shows, ensuring that it is an important part of the report, not just a pretty image designed to fill some space. If it is worth using, it is showing something important and deserves to be discussed.

Visual

Other visual items add interest and understanding to your work, allowing your audience to clearly see what your work is about and how you have gone about your research. Make sure that all images are clearly labelled with a title and also have a purpose for being included in your work. Annotation (notes added to the picture) for field sketches you have taken or other images is useful in a report so you can easily highlight and refer to important sections. You should always acknowledge the source of an image if you did not take it yourself, in the same way as you list information sources in a bibliography.

Using geographical terminology

Any subject you study will have specific terminology for particular ideas and topics. These words form a vocabulary, which makes it easier to convey ideas and meaning in the subject area. Important vocabulary is listed at the beginning of each chapter, highlighted and listed separately in the margins of the pages, and collated in the glossary at the back of the textbook.

Key terms

- Convergent boundaries
- Divergent boundaries
- Hotspots
- Igneous rocks
- Landforms
- Lithosphere
- Metamorphic rocks
- Plate tectonics
- Sedimentary rocks
- Subduction boundaries
- Transform boundaries
- Volcanoes

Source 0.6 You should take the time to memorise and build your geographical vocabulary as it is introduced in each chapter.

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ACTIVITY 0.2

With a partner, spend 5 minutes memorising the words in the vocabulary list below. When you and your partner are confident that you know all the vocabulary, select some words and test each other to see who remembers more.

aesthetic value value placed on something due to its beauty

agriculture using the land to raise crops and livestock

aqueduct a human-made channel or passage for conveying water

climate change a long-term trend in the Earth's weather patterns, including a change in average weather conditions (such as increased atmospheric temperature) and/or in the distribution of weather around the average conditions (for example, more extreme weather events)

conservationists people who believe in the protection of the world's natural environment

continuous resources resources that are in no danger of being used in excess of their long-term availability

cultural value the emphasis placed on something for its importance and place in society, such as the inclusion of water in rituals, heritage and the Dreaming

demographic profile information used to create an image of the age/sex composition of a population

economic value a dollar amount placed on an asset to show how much it is worth

evaporation the part of the water cycle where water changes from liquid into a gas and escapes into the atmosphere

industrialisation the modernisation of a country, involving large-scale infrastructure development, economic growth and a movement towards more efficient, mechanised methods of production

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services, education systems, waste disposal systems, telecommunications

irrigation watering of crops

liveability living conditions in a place that make it easy or difficult to live there

meteorologists people who study weather and climate

recreational value the emphasis people place on something for its leisure purposes and enjoyment

renewable resources resources that can be replenished in a relatively short amount of time through reproduction or other biophysical processes

sanitation the provision of adequate facilities such as toilets, and services such as garbage collection, to promote community health and hygiene

sustainability wisely using resources so they are available indefinitely into the future; society, environment and economy must all be considered carefully

topography the layout of the land

urbanisation the process by which more and more people are coming to live in towns and cities

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Digital and spatial technologies

The use of digital and spatial technologies in geography is becoming increasingly important, both in geographic work and in the wider community. Not only is this an employment growth area, but also digital information has become a part of everyday life for many people. A range of digital communication technologies such as blogs and wikis, electronic surveys and social media applications can also be used effectively to gather data and share results. The trick is to make sure we use them when they are the best tools available for the specific task at hand.





Source 0.7 We easily view satellite maps and weather radar on smartphones from anywhere in the world without thinking about the technology that makes it all possible.

Reflecting and responding

As already mentioned, we should always reflect on the information we have, looking critically to understand what it shows and to see what work still needs to be done to make it more useful. This also applies to data, whether we collected them or whether they are being presented to us by others. Can the information be checked through another source, or do we trust it because of a known collection method? What is the information showing us? How can we respond to it? How can we use it? These are the crucial questions that must be asked if we are to make effective use of the information rather than allow the data to exist without analysis or response.

Thinking about the material allows us to absorb and bring together the key ideas, leading us to a point where we can put forward solutions to challenges in the world. When putting forward solutions, it is important that we take into account environmental, economic and social considerations. The purpose of our inquiry is to understand the current situation and to propose thoughtful options for the future.

A possible method for achieving this is through a Y chart as shown below.

Looks like
What does the landscape look like? Describe its key visual features.

Sounds like
What are the most obvious noises in the landscape? Can you link them to animals, people or activities?

Feels like
Does it feel relaxed? Busy? Safe? Happy? Can you identify the things that make it feel this way?

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Once our information is categorised into the Y chart, we can start to analyse it more efficiently. The Y chart helps us to organise our information and build a word picture of the place we are studying. It can help us to identify the key elements of the place and understand what makes the place important. The Y chart can also help to guide our research by highlighting key words for us to investigate in more detail.

If we are looking at an important local landform, such as a beach and the land around it, to assist local governments to plan resources for people to use, we can use the Y chart to build a picture of what the beach is like on a summer day. What does it look like? Who are the people using the beach and what types of facilities would they use? The Y chart can help us to focus our research on the key features of the beach.

Fieldwork

Fieldwork is at the heart of geographic inquiry. It is any activity conducted outside the classroom, whether in your local area or in a more distant location. It forms the framework for valid scientific research, and supports the development of inquiry questions that make sure we are able to consider a range of strategic solutions and management plans to maintain sustainable environments. In this textbook, you will find several fieldwork activities that provide step-by-step instructions on observing and recording information. There are a number of ways to communicate your observations and data, including in the form of a fieldwork report. This method is used in the textbook and explained below.

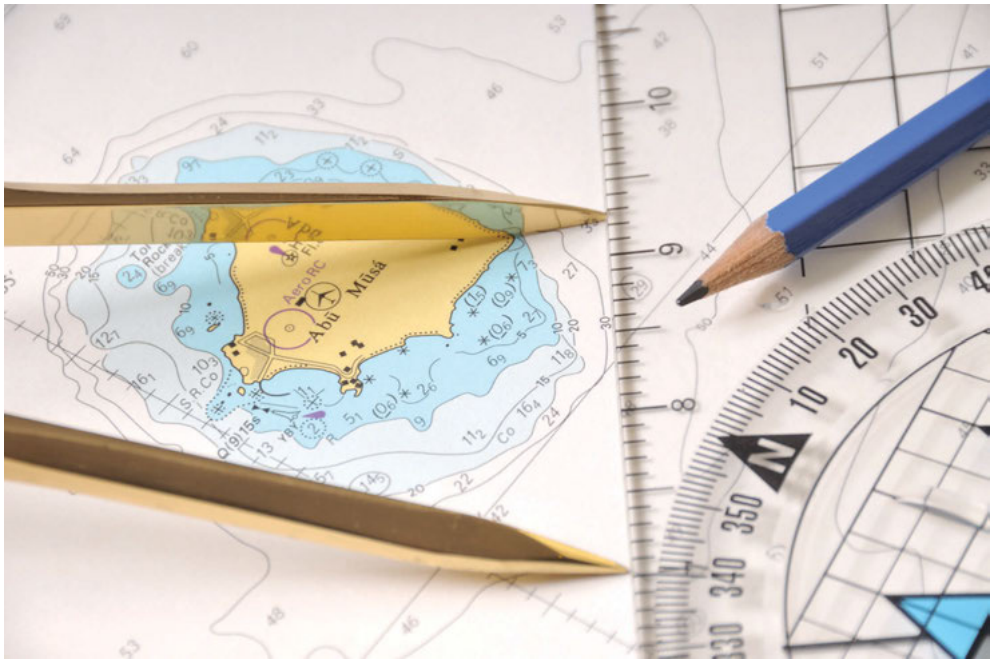
Fieldwork presentation layout

Front page	***Title and name*** Ensure you have your own name (or names of group members) clearly identified. The front page should also contain a clear title, indicating what your research was focused on.
Contents page	Do this last, as well as numbering pages.
Page 1	***Aims and methods*** What was your intention when you started the research? List your inquiry questions here and if you are able to predict what you may find, do that here too. Describe the way you collected the data to test your questions and hypothesis.
Page 2	***Location map*** One of the key tools for the geographer is mapping. Make sure your map is clear, is easy to read, follows the mapping conventions of BOLTSS and uses the recognised symbols and colours of maps, such as blue for water. ***BOLTSS*** • ***Border*** – the border should surround your map and everything that is a part of the map (title, scale, legend, etc.). It encloses the information and shows that it all relates to the map. • ***Orientation*** – show where north is by using 1 of the conventional symbols – for example, an arrow or full compass. • ***Legend*** – the legend or key shows what all the symbols and colours you have used on your map mean. • ***Title*** – make sure your map has an accurate title that explains what the map is showing; for example, 'Shopping Centre Traffic Flow, 1–3 pm, Thursday 26 December, 2013'. • ***Scale*** – the map's scale shows how big the area shown on the map is in the real world.

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	• ***Source*** – indicate where you obtained the information for the map. This could include your own measurements, a search engine, a GPS mapping system or the local council offices.
Page 3	***Introduction*** Give a brief description of the study sites and any noteworthy features.
Pages 4–5	***Description of uses and photos*** What is the area currently used for? A written description accompanied by photographic evidence is good practice.
Page 6	***Table of usage*** Effects of current use (positive or negative, short term or long term). A table is an excellent way to display this information. Keep your points simple and refer to any photographs or other data in your fieldwork report that support this information.
Pages 7–8	***Description of effects of use, sketches and/or photos*** This section needs to be quite detailed, and should show that you understand the area on which your fieldwork is based. Annotate any field sketches or photographs you use to highlight and explain the space.
Page 9	***Association between use and effects of use*** Make the links between how the space is used and the impact of those uses on the space. It may seem obvious, but you need to be explicit and openly state what is going on.
Page 10	***Table or written description of management strategies*** What are the current management strategies being used in this space? Depending on how many applicable strategies there are, you may choose to organise them in a chart or table to separate them and make it easier to discuss them later.
Page 11	***Photos or sketches of management strategies*** Do not underestimate the impact of images in your work. It is often easier to show how a management strategy is working than to explain it in words, and it could be more interesting for the reader. Make sure your photos or sketches are clearly labelled or annotated.
Page 12	***Evaluation of these strategies*** How well are the current management strategies working? Are there any parts of them that are supporting the space well? Perhaps other sections of the plan need rethinking? What would you change if you had the chance? Evaluate, don't just describe. Make sure you are giving clear and balanced feedback on the current strategies.
Page 13	***Appendix, bibliography, glossary*** An appendix is the section at the end of the book that provides additional information to support the main work. You should include an appendix to add meaning to your work. If you undertook a survey as part of your fieldwork, the results could be included here. The bibliography is an important piece of any research. Make sure you list all information sources, websites and people who informed your work. Here's 1 method: Author/s surname first, then initials (publication year in brackets). *Title in italics*. City location of publisher: publisher's name. A glossary is a mini-dictionary for your work. You should include any words in the glossary that your reader needs to know or understand your usage of them.

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Source 0.8 The geographer at work: marking points on a map

ACTIVITY 0.3

1. What are the considerations we need to take into account when reflecting on and responding to an issue or problem?
2. List 5 digital and spatial technologies and different ways you could use each in developing an inquiry research task.
3. Identify 2 other ways of communicating your observations and data when undertaking a fieldwork activity, other than in the form of a report.

0.3 Concepts for geographical understanding

It is useful to have a framework that supports and guides us in our geographic studies: a range of tools and ideas that will allow us to target our inquiry and support our learning. The concepts for geographical understanding (place, space, environment, interconnection, sustainability, scale and change) provide this, helping us to understand and build on the work of others in the same field of study. In addition, a framework makes it possible for us to confidently understand the work we do and its place as valid geographic research.

Place

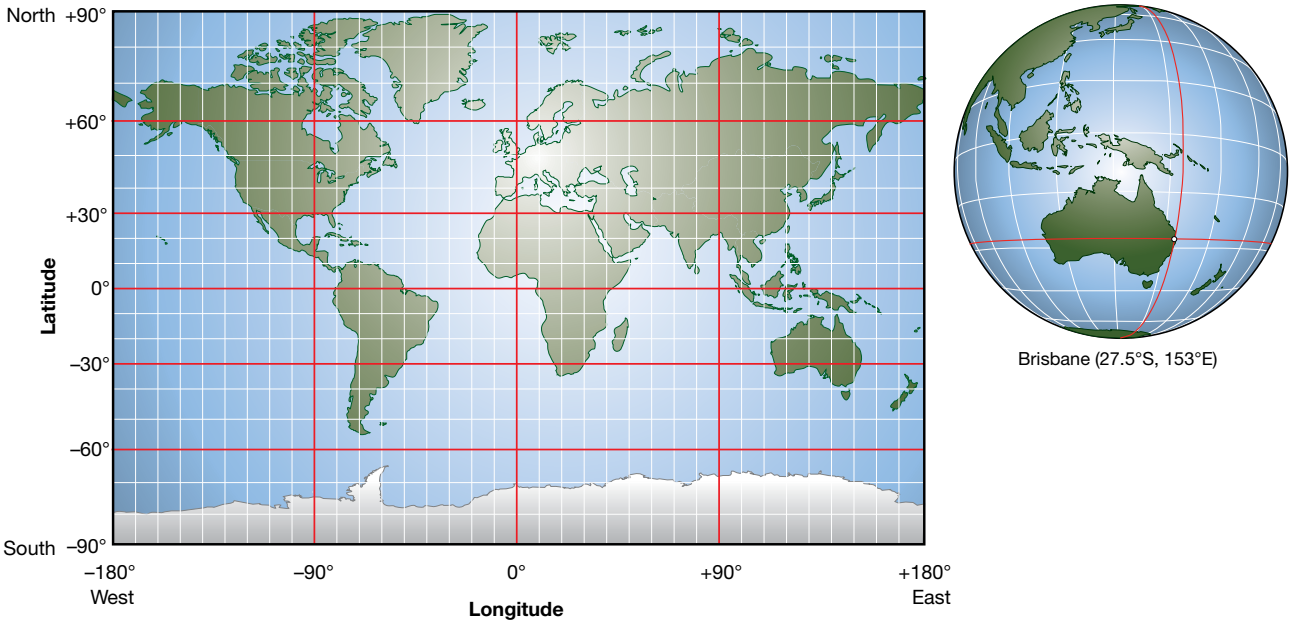
The world is made up of places that are given different meanings by people. For Aboriginal and Torres Strait Islander peoples, places can be given spiritual meaning and can shape their culture and identity. Places range in size from your classroom to a world region. Places are important locations for major events and social and human interaction, as well as areas that have importance in the natural environment.

Where something is – its location – is very important to our studies. We can use the coordinates on a map, called **latitude** and **longitude**, to show

latitude an imaginary line measured in degrees north and south of the Equator

longitude an imaginary line measured in degrees east and west of the Prime Meridian (or the Greenwich Meridian)

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Source 0.9 The best-known system for locating a place is latitude and longitude. This involves an imaginary grid that covers the Earth, allowing people all over the world to use and share consistent references.

others where something is. Latitude and longitude lines divide the world up into a grid, and when we use them, latitude is always stated first. You can see in Source 0.9 that the position of Brisbane is 27.5°S, 153°E.

Sometimes a description can help to show others where something is, or landmarks can help us to explain a place's location; for example, next door to the house with the red letterbox. Maps often have their own simple system of coordinates to help us find particular places easily. We can be directed to the north-east corner of the forest (for example, C4), allowing us to find the correct section of forest.

Space

In geographical terms, space is the distance between things and can involve spatial patterns. The space around us, rather than outer space, is the key. Space refers to the organisation of an area, where things are (location) and their distribution in it. It is about how the area is perceived, structured and managed. If we examine a town, we can see patterns in the street layout or the green spaces, how far apart services like schools, churches or shopping centres are and the pattern of major transport networks such as highways and railways. In the natural world, we can see mountains in a range, the web of streams and rivers in a catchment area or the frequency of lakes in a landscape. Space refers to the distribution of items as well as their frequency and helps us to describe the patterns we see.

Environment

The environment has an importance in our world. It is a term that is often used and rarely defined, so what do we mean by 'environment'? It refers to the external factors that exist within an area or region – for example, air, water, minerals, plants and animals – and how they work together to form a system. The term is often used to describe natural systems like forests and oceans, but it also applies to human-altered (**anthropogenic**) systems such as cities. Sometimes, environments are not as easy to classify, and we need to recognise the importance of both natural and human-altered elements (geologic/rock, atmospheric/air, hydrological/water, edaphic/soil, biotic/living and human). A natural water system such as the Murray–Darling Basin not only supports the

anthropogenic human-made

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plants and animals of the region, but the towns and human populations as well. The river is modified to provide year-round irrigation for farmers and drinking water for the city of Adelaide.

Interconnection

Interconnection is based on the concept that nothing can be viewed on its own; everything has a relationship to other things and systems. It recognises that, within an environment or space, there are real connections and influences that alter the way the space operates and is viewed. It analyses these connections and examines the level of influence to decide the level of impact and predict future patterns. It supports looking at geographic phenomena and features such as urbanisation, global warming or erosion as processes within real environments. Interconnections can be very detailed, and can lead us to look at spaces or environments as a whole system, rather than viewing each element separately.

Sustainability

Sustainability refers to the ability to achieve long-term balance, often in the environment, and refers to things that are not harmful, but are able to continue far into the future. Sometimes, sustainability is thought of as being a 'hippie' concept – something with which only **environmentalists** would concern themselves – but it is increasingly being used to describe any system (natural or human-made) that is in a healthy state of balance. It helps to direct people to accept their responsibility for their environment and to formulate plans to protect it for the future.

environmentalist a person who acts to preserve the quality of the natural environment

Scale

The main focus of this geographic concept is to see things at different levels, from the personal to the local, national and global. How we view an issue or the types of solutions we can put forward will change as we move through these different scales. Collecting water for personal use is at a low scale and very controllable, with variables such as chemicals and additives being our own responsibility. Water harvesting on a national or global scale is very different, with a supply chain that includes governments and supply on many levels.

We also need to understand that choices and management plans at one level can influence the situation at another level. This occurs when the federal government passes legislation that impacts



Source 0.10 The concept of sustainability helps us to question the current state of a space and to pose management solutions to issues and challenges that we are able to identify.

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Source 0.11 The Murray–Darling Basin Plan impacted on individual farmers, small towns and major cities, and was produced by the Australian federal government.

on how the individual is able to operate or changes processes on a local level – for example, the introduction of the Murray–Darling Basin Plan.

Change

Change refers to both space and time. It is a concept that covers the impact of movement and history, with human-altered and natural environments both being affected. When we look specifically at our local area, it is clear that it is dynamic. Homes are built, roads are upgraded, gardens are rejuvenated – and this is just the beginning. In fact, there is so much change over time in our local neighbourhoods that it would seem very unusual if it all stopped.

Change over space may initially seem more difficult. Think about what happens in your local area if a new shop opens. Consumers who were purchasing goods in another neighbourhood will begin to change their shopping patterns. As a result, traffic patterns and parking requirements may also change from one location to another. This is spatial change on a local scale.

ACTIVITY 0.4

1 In your own words, describe the concepts required for geographical understanding.
2 Explain how latitude and longitude are used by geographers. What is their link to world time zones?
3 Evaluate the long-term sustainability of your home. Develop a plan to improve its sustainability, including power supply, water and food production.

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UNIT 1
Landforms and landscapes

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1 Landscapes and their landforms



Source 1.1 Australia has many striking landscapes, including The Breakaways, Coober Pedy, South Australia.

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Before you start

Main focus

The Earth is made up of many different types of landscapes and their distinctive landform features. Large-scale plate tectonic movement of continents affects landforms at a variety of scales.

Why it's relevant today

Plate movements produce mountain-building, earthquakes, volcanic activity and tsunamis, which all impact directly and often adversely on people.

Inquiry questions

- What are the different types of landscapes and landforms?
- What is the significance of plate movements for volcanic activity?
- What kinds of landforms develop from plate movements?
- Do different rocks produce different landforms?
- How do plate movements impact on people?

Key terms

- Convergent boundaries
- Divergent boundaries
- Hotspots
- Igneous rocks
- Landforms
- Lithosphere
- Metamorphic rocks
- Plate tectonics
- Sedimentary rocks
- Subduction boundaries
- Transform boundaries
- Volcanoes

Let's begin

Some changes on the Earth's surface take place slowly over long periods of time as the result of continental movements, plate tectonics and erosive processes. Other events linked to plate tectonics, like earthquakes and volcanic activity, can happen quickly. In the process, these events cause major and dramatic changes to landforms. Different rock types in the lithosphere often have different landforms associated with them.

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1.1 Types of landscapes and landforms

landform a naturally formed feature on the Earth's surface, having a characteristic shape or form

landscape the visible features of an area including both the natural (mountains, forests, rivers etc) and human elements (roads, houses, bridges etc)

riverine associated with rivers

arid dry or parched, refers to regions such as deserts

karst limestone region where underground water is the main cause of distinctive landforms

Landforms of varying sizes and shapes, when taken together, are referred to as a **landscape**. There are many different types of landscapes, including but not limited to:

- coastal landscapes
- **riverine** landscapes
- **arid** landscapes
- mountain landscapes
- **karst** landscapes.

The landforms have relationships with each other, which means they form distinctive groupings in these different landscapes. In downstream riverine landscapes, for example, landforms will include a **channel**, possibly a **levee**, and a **flood plain** or **terrace**. Some landforms are extensive, like arid zone dunes that continue for many kilometres. When numerous dunes have formed, as in the Arabian Peninsula or Central Australia, they make up a dune field that can extend for hundreds of kilometres. Other landforms are small, such as individual pedestal rocks that may be shaped like an anvil or mushroom, and reach only a metre or so in height. Geographers and others try to explain these differences in size, shape and grouping of landforms.

channel the hollowed-out path formed by a river or stream

levee a sediment embankment bordering a channel

flood plain low-lying ground that is subject to flooding from a nearby river

terrace a 'platform' of fairly flat land, often a former flood plain that has become stranded by later down-cutting by the river



Source 1.2 Sand dunes near Liwa oasis, the Empty Quarter, Abu Dhabi, United Arab Emirates



Source 1.3 Ripples in sand preserved in rock at Kings Canyon, Northern Territory, Australia

The processes that produce landforms are both large and small in scale. At a large scale, the Earth's surface is influenced by forces that affect the distribution and nature of continents and oceans. The solid continents and sub-oceanic floors provide the raw materials for other kinds of processes to act on and change. The Earth's entire surface, whether exposed as landmasses or lying beneath the ocean, is affected by **erosion**, **deposition** and **weathering**. When considering landforms, we are viewing features that have evolved over time in response to different forces acting on them.

erosion the process of transferring rocks, sediment or solutions (transportation) from one place to another (deposition)

deposition the last stage of the erosion process, when the material being moved stops and settles on a surface

weathering the breakdown of rocks and sediments into smaller particles or a solution

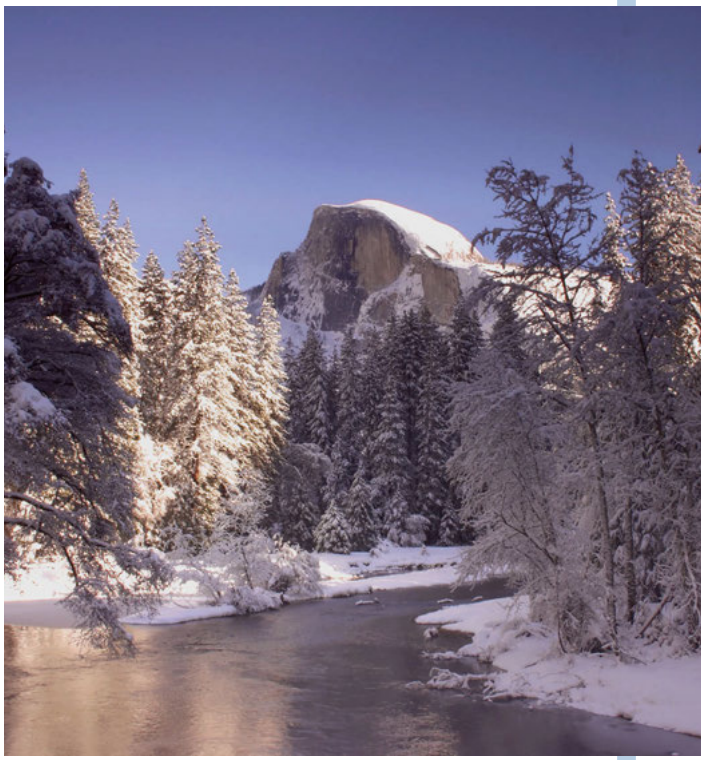
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Case study 1.1

Iconic landscapes in Australia and the world

Iconic landscapes are those that are most famous and popular. In some instances, a particular dominating feature within the landscape makes it 'iconic', like Uluru in the arid landscape of Central Australia or Half Dome in the glaciated landscape of Yosemite National Park in the United States. Other iconic landscapes cover larger areas, such as the Grand Canyon in the United States or the gorges along the Yangtze River in China.

1. Research some iconic landscapes and create a top 10 list.
2. Locate these landscapes on a virtual map. You will find a link to Google Earth at www.cambridge.edu.au/geography8weblinks and you can download the software if you do not already have it.
3. Describe what makes these landscapes iconic.



Source 1.4 Half Dome in the glaciated landscape of Yosemite National Park, United States

ACTIVITY 1.1

1. Describe the difference between a landform and a landscape.
2. List the types of landforms found in riverine landscapes.
3. Select another type of landscape (for example, a coastal or arid landscape) and list the types of landforms you may find.

RESEARCH 1.1

Research online illustrations showing different landforms to create a labelled 3D model or annotated sketch of a landscape that contains a number of different landforms. Materials you could use to make a model include paper, cardboard, sand, rocks, paint, toothpicks – be creative! Compare your model or sketch with the rest of the class and evaluate its accuracy.

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Studying landforms

Physical geographers examine the **lithosphere**, biosphere, atmosphere and hydrosphere. In relation to the lithosphere, the field of **geomorphology** concentrates on the surface features of the Earth, examining landforms and the processes that have produced them. Some of these visible features are formed rapidly while others develop only over long periods of time. A large river system like the Murray-Darling may have existed for millions of years, for example, but a smaller cut-off meander or billabong along the stream can form quickly during a flood.

lithosphere the solid upper zone of the Earth, including soil and underlying rocks to a depth varying between about 7 and 200 km

geomorphology the study of landscapes and landforms, and the processes that have made them the way they are

Rocks and weathered materials near the Earth's surface are often referred to by the general term **lithology** (*lithos* is the Greek word for rock). As landform development results from processes operating on both rocks and weathered materials, these lithologies influence how effective the processes can be and how long they take before particular landforms appear. Some ancient **sedimentary** and **metamorphic rocks** may be up to 4 billion years old, allowing for surface processes of change to have operated for a long time. Other rocks are forming today and have only been exposed to weathering processes for geologically short periods. For example, volcanoes are still creating rocks by producing lava that solidifies and, although some weathered sediments may be hundreds or tens of thousands of years old, current processes are contributing to their further breakdown. In some cases, weathering processes involve solutions that may be removed from the weathered rock or cause compaction (or lithification) of sediments.

lithology the general physical characteristics of rocks

sedimentary rocks rocks formed from sediments that have later been welded or pressed together

metamorphic rocks igneous or sedimentary rocks that have been subjected to extreme pressures or temperatures that have changed their original characteristics

Geologists examine the nature of rocks and sediments that have mainly formed over long time frames, and use laboratory tools to analyse field data and samples. These tools include scanning electron microscopes to interpret the nature and history of minerals in rocks; **uranium-thorium** and other dating techniques to determine rock and sediment ages; and computer models to analyse and visualise **plate tectonic movements** and to predict locations of economically important minerals and deposits.

uranium-thorium uranium is a radioactive element that decays to radioactive thorium at a known rate over time. The proportion of uranium to thorium thus allows people to date materials.

plate tectonic movement the movement of continental and oceanic plates of the Earth's crust

Sedimentologists interpret weathered materials in order to determine their **provenance**, the processes operating to produce or change sediments, and the sedimentary environments that led to the formation of sedimentary rocks. For example, old river channels can often be identified in sedimentary rocks, thereby providing information about the conditions under which the sediments were deposited before becoming compressed into rock. If streamflow is vigorous and swift, then large pebbles and boulders can be transported. Conversely, where streams are slow flowing and have low energy, mainly fine sediments like clays and silts will be deposited. Other sediments have been laid down on the ocean floor, and these often contain remnants of broken shells or marine organisms, which provide clues to the sediments' origins.

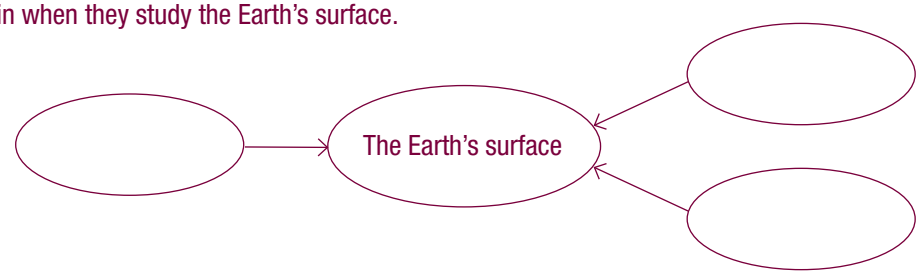
provenance the source rock or sediment of a weathered material

Physical geographers and sedimentologists are interested in the same object: the Earth's surface. In addition, geologists want to understand how the Earth itself formed and its history, especially in relation to rocks that comprise its solid components. Rocks and sediments both occur on the Earth's surface, contributing to the development of landforms. These materials act as a framework for the surface and near-surface processes of weathering, erosion and sedimentation. Combined, this broad framework and the processes acting on it produce landscapes and their landforms.

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NOTE THIS DOWN

Copy the graphic organiser below and summarise the groups of people interested in landforms. Describe the different interests of each group of people. Then provide an example of what the members of each group are interested in when they study the Earth's surface.



Landforms at different scales

Landforms comprise the landmass and submarine parts of the Earth's surface, and contribute to a sequence of features that can be viewed at different scales. Starting at the smallest scale, weathering environments such as arid, coastal or glacial will produce different patterns on the surfaces of **quartz** grains. These grains can be examined using an electron microscope to determine probable past environments that have affected them. At the next scale, weathering features like **honeycombing** may occur on cliffed shorelines or in saline arid environments, or a stream may contain rounded gravels. Individual quartz grains of less than 2 mm diameter will be classed as small scale, moving to a sequence of larger features like honeycomb weathering at several centimetres in size, to cliffs (landforms) that may be many metres in size, and then to groups of landforms (cliffs, beaches) that make up landscapes (e.g. coastal). Landforms can also be considered at a continental scale, at which point they will be referred to as **physiographic or geomorphic regions**. Some physiographic regions in Australia would in-clude mountain chains, shield (plateau) areas and dune fields. At this large scale, there are different landforms and landscapes that contribute to the nature of continental surfaces. At the even larger global scale, continents and oceans together make up the Earth's surface. We will now examine the Earth at this very large global scale, and show how changes at this scale affect landforms at smaller scales.

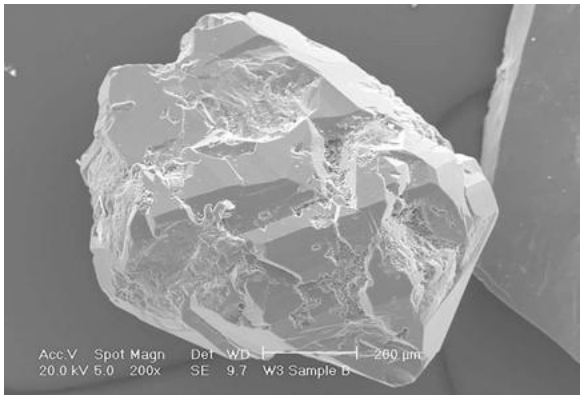
quartz rock composed of silicon dioxide; a hard mineral that resists weathering

honeycombing a network of pits several centimetres deep that looks as if bees have made a honeycomb in rock

physiographic or geomorphic region an area of the Earth's surface with similar landforms and topography



Source 1.5 Honeycombing in sandstone, Sydney region



Source 1.6 Scanning electron microscope image of a river-worked quartz grain from the Hawkesbury River, New South Wales

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ACTIVITY 1.2

1 The table below is a sequence of features at different geomorphic scales. Add in 2 examples at the landscape, landform and weathering feature scales.

Geomorphic feature	Example	Two additional examples
Continent	Australia	
Landscape	Coastal	
Landform	Dune	
Weathering feature	Honeycomb weathering	
Quartz grain	In coastal dunes	
Clay mineral	In weathered rock	

2 Create a list of the landforms and weathering features that you have seen. Then research online and locate topographic maps that show some of these different landforms. Compare your list and maps with those of others in the class.

3 Identify the landform and weathering features that appear in more than one landscape type. (For example, does honeycomb weathering occur only in coastal landscapes?) Discuss possible reasons why a landform or weathering feature may be present in more than one landscape type.

Starting at the large spatial scale of the Earth's framework, the distribution of continents and oceans needs to be viewed over long timespans (large temporal scales). Crystals that have been dated to more than 4000 million years old have been found in rocks younger than those in Western Australia. The oldest rock, also around 4000 million years old, has been identified in a relatively stable area in Canada. So why are some of these rocks, thought to be present at the time when the Earth came into being, so much older than many others on Earth? We know that in places where volcanoes are active today, lava can solidify into rock. Other rocks have formed at different stages throughout the long geological time of Earth's history. This suggests that environments have changed over time and that particular events like volcanism may be intermittent. Let us start by considering the Earth's mainly solid framework over large space and large time, before examining how this affects present-day global patterns of mountains and volcanoes.

The Earth's composition

Our knowledge of the Earth's composition has been gained mainly through studying earthquakes and the **seismic waves** they produce. Although the maximum depth at which an earthquake has been detected is about 800 km, energy waves from earthquakes extend out through the Earth. These waves and the rates at which they travel can be interpreted from multiple recording stations on the Earth's surface, allowing scientists to work out which zones are solid and which are fluid or plastic, and the probable types of minerals found in each zone.

seismic waves shock or energy waves caused by earth movements

The rocks and solid materials of the Earth's surface are together referred to as the lithosphere. The upper part of the lithosphere, the Earth's crust, extends down about 40 to 80 km under the continents, but thins to about 7 km under the oceans. The crust is referred to as **sial** because it

sial crust or outer part of the Earth, forming the continents, which are mainly made up of rocks containing **si**lica and **al**uminium

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asthenosphere the plastic mantle layer below the Earth's crust, composed mainly of sima

sima the lower part of the Earth's crust on which the continental plates float, made up of rocks which contain large amounts of **si**lica and **ma**gnesium

is made up of rocks containing large amounts of silica and aluminium. Beneath the crust lies the plastic **asthenosphere**. This layer is dominated by rocks containing silicon and magnesium, and is known as **sima**. Because the crust (sial) is less dense than the mantle (sima), the crust is sometimes thought of as 'floating' on the mantle. This means that the sial of which our continents form a part has the potential to be affected by what is happening in the underlying sima of the asthenosphere. This idea is important for understanding continental movements and plate tectonics. Beneath the asthenosphere, the Earth's upper mantle extends with a transition zone to a depth of about 700 km before reaching the lower mantle at a depth of nearly 3000 km. Here the Earth's materials have high strength. This layer then gives way to the fluid outer core, which has temperatures exceeding 5500°C. At a depth of about 5100 km, there is a sharp boundary with the solid inner core. Overall, there is a gradation of mineral densities from the densest (iron and nickel) in the centre of the Earth to increasingly greater proportions of less dense minerals above the core.

Geographical fact

In 1692, the mathematician and astronomer Edmond Halley FRS (Savilian Professor of Geometry at the University of Oxford from 1702) proposed that the Earth had a shell about 800 km thick, beneath which atmosphere separated 2 concentric shells and an inner core, with all shells having light and rotating at different speeds. His 'Hollow Earth' theory resulted from attempts to explain magnetic irregularities.

ACTIVITY 1.3

1 Draw a labelled diagram of the composition of the Earth, using information provided in the text.
2 Discuss how we know the Earth is not hollow.
3 Explain why continents are sometimes described as 'floating' across the Earth's surface.

1.2 Continental drift and plate tectonics

Large-scale events can have impacts on interpreting landforms at both the continental and local levels. For example, why is there a continuous line of mountain ranges along the western margins of North and South America (the Andes and the Rockies)? At a regional scale, why are the Himalayas gradually becoming higher? In Australia, why are mountains not as high as mountains on other continents? The answers to these questions are linked to the behaviour of the Earth's crust.

The most visible part of the Earth's crust is the surface of continents. When mapping the outlines of the continents of Africa and the Americas, a Portuguese **cartographer** in the 16th century

cartographer a person who constructs and draws maps

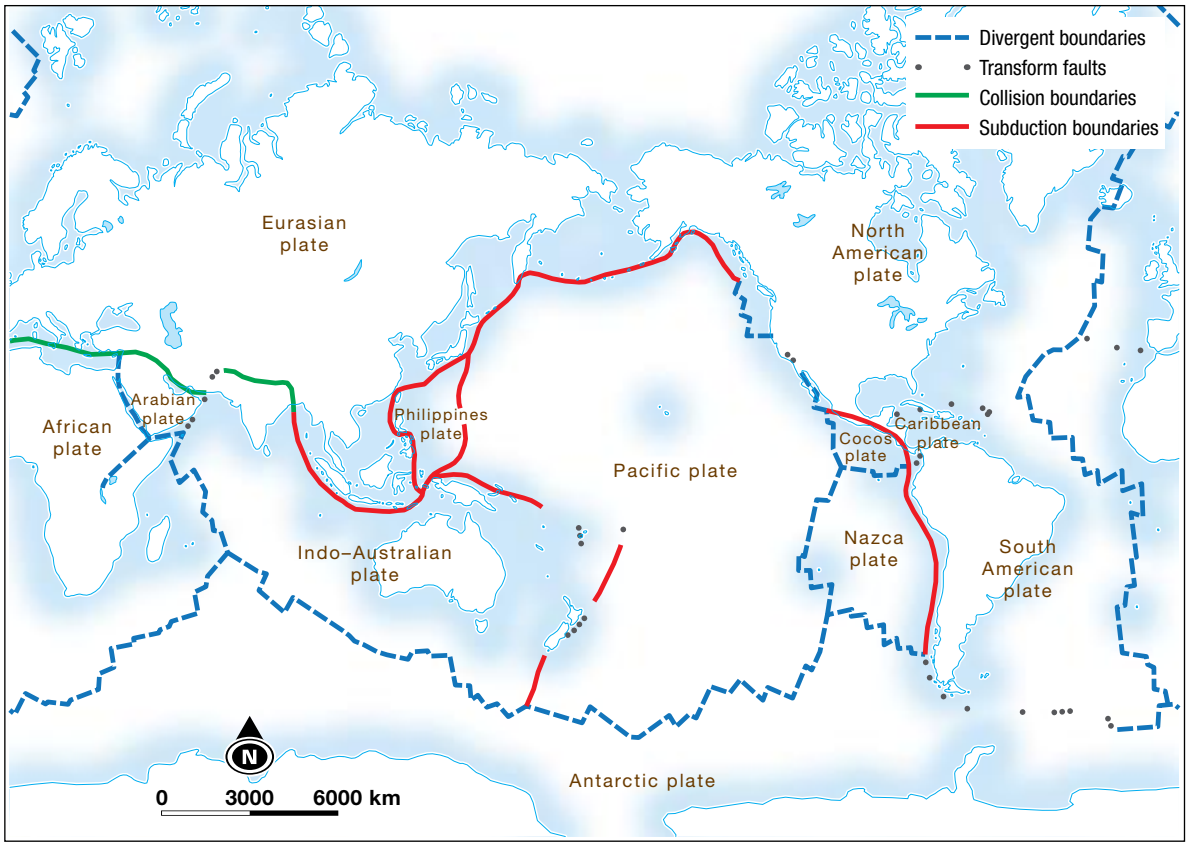
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noted the shapes of these continents, and suggested that they had previously formed a single landmass. In his map of 1527, Diogo Ribeiro pointed to the complementary outlines of the western coastline of Africa and the eastern coastline of South America, which looked as though the continents had been pulled apart. This idea was considered fanciful and was ignored at the time. It was not until the early 20th century that a German scientist, Professor Alfred Lothar Wegener, pursued scientific evidence that showed fossil species in eastern America and western Africa were the same. If the notion of drifting continents was to be rejected, then the only possible explanation of the fossil evidence was the parallel development of exactly the same species in different continents, an explanation that was discounted. Subsequently, Alexander du Toit in South Africa became a strong supporter of the **continental drift theory**, and in 1937 published *Our wandering continents*. He suggested that Wegener's 'parent' landmass, called Pangaea, had existed until about 250 million years ago, when it broke into two parts: Laurasia in the Northern Hemisphere and **Gondwanaland** in the Southern Hemisphere. Additional continents came into being when these 2 landmasses were further broken up, and du Toit found more evidence of geological links between Africa and South America. The continental drift theory answered questions about global-scale fossil distributions, climate changes and landmass shapes, but the theory raised another mystery: even though it happened over a long time, what mechanism could account for huge landmasses moving about across the Earth's crust?

continental drift theory the idea that major continents may have split from a common original landmass

Gondwanaland one of two super-continents believed to have existed 510 to 180 million years ago

Knowledge about links between the continents and what is happening beneath the Earth's surface has increased dramatically over the last 30 years. We now know that the Earth's core is extremely hot, and that heat from the outer Earth is lost



Source 1.7 Tectonic plates and their boundary conditions

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conduction the molecule-by-molecule transfer of energy through a substance

convection the current-like motion of fluids in response to an uneven distribution of heat

convection plume an accumulation of hot molten rock at the boundary between the Earth's core and mantle. The molten rock then rises in a plume through a thin or fractured zone of the mantle.

through **conduction** into space. Such energy transfer from the core to space can take place by conduction or **convection**. Energy transfer through conduction is neutral in relation to landmass movement. However, when **convection plumes** develop, the energy produced is sufficient to push continents and large landmasses slowly across the crust. In other places, this energy pulls plates and landmasses apart. Landmasses at the scale of continents are then referred to as being part of around 9 major tectonic plates – for example, North America covers a large part of the North American Plate. In the case of Australia, the situation is different, as our continent forms part of the Indo-Australian Plate, which also has large areas of ocean. The entire plate is moving steadily northwards, so that the Indian peninsula is colliding with part of the Southern Eurasian Plate. The Himalayas have been formed at the boundary between these two plates.

ACTIVITY 1.4

1. Using the internet, find a map or maps showing Pangaea, Laurasia and Gondwanaland. Do the outlines of present-day continents support the idea that Gondwanaland split up into different continents, including Australia? (For maps showing continental fit between Africa and South America, you could use Google and query 'continental fit between Africa and South America'.)
2. Describe the evidence proposed to support arguments for continental drift.
3. Explain why notions of continental drift were rejected for a long time before being accepted.

Plate movements

Tectonic plate movements occur both on continents and on ocean floors. By investigating patterns of volcanic activity and the absolute amount of continental movement over a number of years, scientists have proposed that plates are moving in different pathways and at different rates. Some plate boundary locations and movements are unclear, and these are referred to as plate boundary zones. Different landforms are associated with different kinds of plate boundary, giving clues to the way plates are behaving. The main plate boundary types are described as **divergent**, **collision**, **convergent (subduction)** or **transform**. These will be described along with their effects on landforms.

divergent plate boundaries the point where plates are pulled apart, allowing molten rock to emerge at the Earth's surface

collision plate boundary the point where two plates of similar strength or speed collide

convergent (subduction) plate boundary the point where two plates are moving towards each other and collide, with one plate being pushed beneath the other; the lower plate is the 'subducted' plate

transform plate boundary the point where 2 plates slide, grate or jerk past one another

Divergent plate boundaries

Here plates are being pulled apart and new rocks of volcanic origin are emerging in these spreading zones. It is thought that convection plumes exist below the spreading zones, generating both the energy for plate movement and the volcanic activity associated with it. Per-haps unexpectedly, plates that move apart do not always leave depressions or gaps in the Earth's crust. When plates diverge beneath oceans, the movement is referred to as **seafloor spreading**, and it allows for the release of molten magma,

seafloor spreading the separation of tectonic plates on the floor of the ocean which allows molten rock to emerge and form new ocean floors and mountains, such as the Mid-Atlantic Ridge

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which generates substantial submarine volcanic activity. It is the continued outpourings of lava and volcanic rocks that lead to the formation of major oceanic ridges like the Mid-Atlantic Ridge, which extends for thousands of kilometres. Although the rate of seafloor spreading in the Atlantic seems small – about 2.5 cm/year – over millions of years the plates have moved many kilometres. The Mid-Atlantic Ridge goes through Iceland, where the North American Plate and the Eurasian Plate are moving apart, and active volcanoes follow these plate boundaries, producing dramatic scenes of hot lava encountering ice. On land, major spreading has resulted in the development of the African Rift Valley, with its associated lines of volcanic activity. The Red Sea has also been formed by diverging plates.



Source 1.8 Volcanic ash cloud, Iceland, 2010 eruptions



Source 1.9 Volcanic fissure marked by volcanic cones, Iceland

Collision plate boundaries

These boundaries occur when plates are moving towards one another, resulting in the plates colliding. Even though plates are moving slowly, they often adjust quickly, causing earthquakes. If the plates have approximately the same rock density, the collision forces parts of the landmasses upwards. This has happened in the Himalayas, where the Indo-Australian Plate is moving northwards and the Eurasian Plate is moving southwards. Scientists believe that India has moved about 6400 km northwards over the last 80 million years, colliding with Asia between about 20 and 40 million years ago. This collision has caused the Indian landmass to slow down to about half its previous rate of movement, but the collision of continental plates moving head-on into each other has created large compression stresses in both landmasses. Although some stress was relieved by upward movement of the plate edges that formed the Himalayas, the remaining and continuously developing additional stresses continue to cause numerous earthquakes. The Himalayas are still rising at a rate of around 1 cm per year and its highest mountain, Mt Everest, currently reaches nearly 9 km (8854 m) above sea-level. At present rates of uplift, Mt Everest will gain another metre in height over the next century. The **strongly folded** European Alps mark the continental collision between the western boundary of the Eurasian Plate and the northern margins of the African Plate. Countries

strongly folded squeezed into sharp folds as a result of great horizontal pressure

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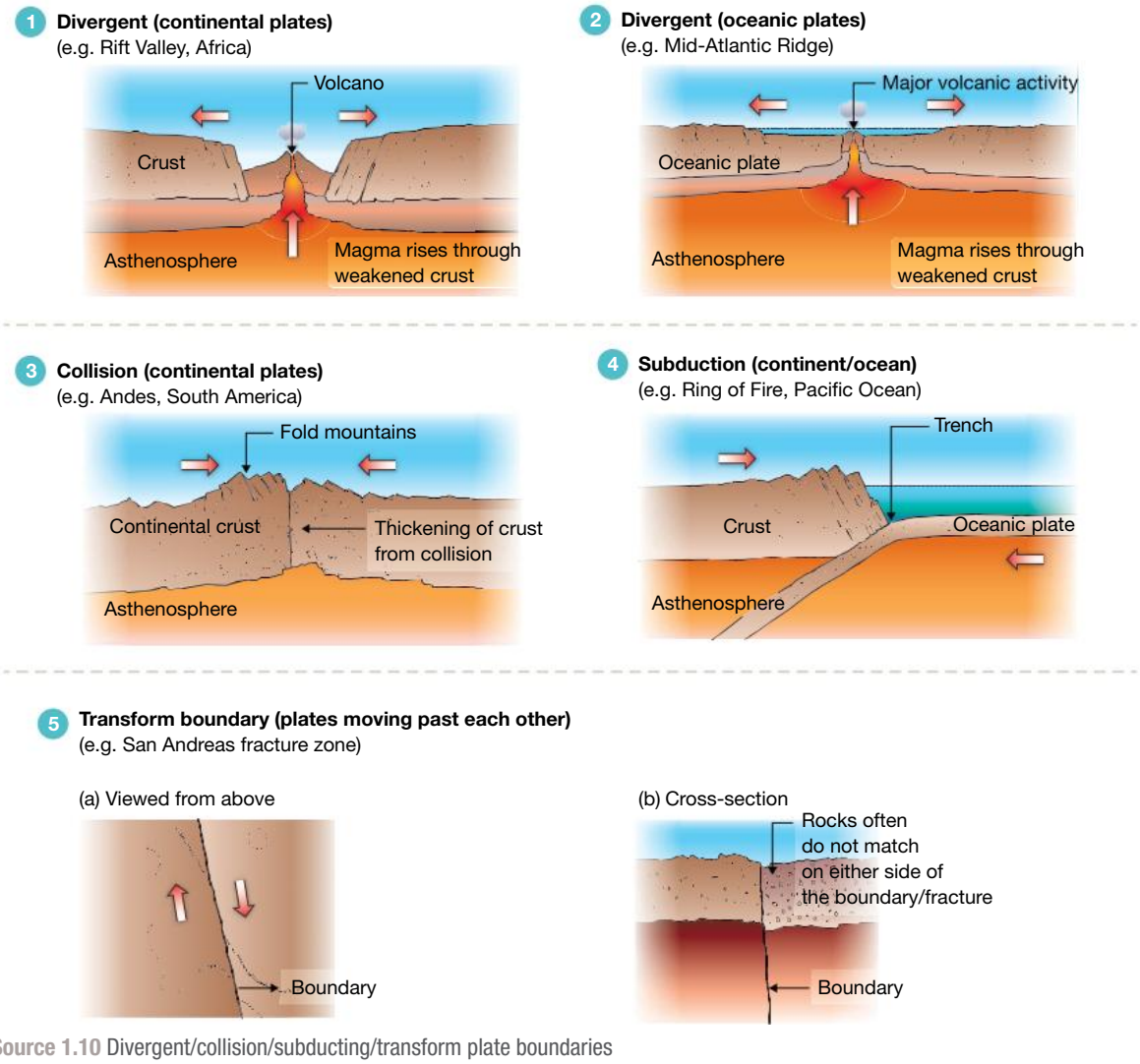
Geographical fact

People are not good at forecasting particular earthquakes, but toads may be able to assist. Five days before the L'Aquila earthquake in Italy in 2009, toads abandoned breeding sites and did not resume normal behaviour until several days after the earthquake.

around the Mediterranean thus experience earthquake activity. The ocean boundary between the Indo-Australian Plate and the Pacific Plate lies to the east of Australia, and here the Pacific Plate is moving at a rate of about 10.5 cm annually. In other places where plates are colliding beneath the ocean, deep trenches are formed as part of a subduction process.

Convergent (subduction) plate boundaries

Convergent boundaries occur when 2 plates move towards each other and one is forced beneath (or subducted under) the other. Convergent boundaries often behave differently from the collision responses of 2 land masses. Continental



Source 1.10 Divergent/collision/subducting/transform plate boundaries

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plates are less dense than oceanic plates; some oceanic plates may be denser than others; and plates may also be moving at different rates. Under these circumstances of plate differences, a process of subduction occurs in which one plate is pushed beneath the other. This can result in deep trenches being formed as the subducting plate is dragged beneath the stronger plate. Where the faster-moving oceanic Pacific Plate collides with the slower-moving oceanic Philippines Plate, the Marianas Trench reaches a depth of nearly 11 km.

The convergent boundary of the Eurasian Plate and the Indo-Australian Plate lies along an arc to the west of Java, and it was adjustment between plates along this subduction trench that resulted in the major earthquake and catastrophic Indian Ocean tsunami on Boxing Day 2004. Stresses that had been built up through continuing subduction were released suddenly by the rock moving along fractures, creating tsunamis that produced major loss of life in Indonesia, Thailand, Sri Lanka and India.

Geographical fact

Not all tsunamis are caused by earthquakes. In 563 CE, a tsunami wave between 3 m and 8 m high inundated the shores of Lake Geneva, Switzerland. Triggered by a massive rockfall, the tsunami pushed river sediments into the lake, resulting in a sudden rise in lake levels, flooding and loss of life. Currently, at least 1 million people live within the area flooded by the 563 CE tsunami.

Ocean–ocean convergence boundaries are often marked by lines of submarine volcanoes, which may eventually emerge from the ocean as islands. As the ages of volcanic rocks can be determined, the direction of movement of plates can be confirmed by the relative ages of the ocean's volcanic rocks. The oldest volcanoes represent the earliest positions of the plates, while the youngest volcanoes being those under which the plates have moved most recently.

ocean–ocean convergence boundary point where two oceanic plates move towards each other and one is pushed beneath the other

Subduction is common at continental–oceanic plate boundaries. The western boundary of the continental South American Plate (less dense) encounters the oceanic Nazca Plate (denser) and is being subducted under the landmass. In the process, the edge of the landmass is being lifted by the oceanic plate and the Andes have been formed. However, the edge of the oceanic Nazca Plate is not moving smoothly beneath the landmass, resulting in a buildup of stresses that cause earthquakes when the plates readjust.

Geographical fact

Earthquakes and tsunamis often destroy electricity grids, so how to recharge a mobile? Following the magnitude 9.0 earthquake and tsunami in Japan in 2011, the Japanese company TES NewEnergy invented a relatively low-cost saucepan-like device that allows people to boil water over a fire and recharge their mobiles at the same time.

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Transform plate boundaries

transform plate boundary the point where two plates slide, grate or jerk past one another

shear stresses stresses caused by two objects moving at an angle to each other

Transform plate boundaries are those where plates move horizontally past each other without colliding. However, plates do not glide past one another – their edges fracture and large-scale broken parts of the crust grate and grind against each other, generating large **shear stresses**. These boundaries have numerous faults or fracture zones; they often occur on the ocean floor and result in relatively shallow earthquakes compared with the deep earthquakes along collision boundaries. Of the transform fault boundaries found on landmasses, the San Andreas Fault zone in the western United States is probably the best known. It extends for more than 1000 km, and in places is tens of kilometres wide. At an average annual rate of movement of around 5 cm, the plates are moving relatively quickly past each other. The fault zone connects two divergent plate boundaries, one to the north and the other to the south. Because San Francisco is located on this extensive fault system, it suffered major collapse of buildings, loss of life and a huge fire in the early 20th century.

Geographical fact

In April 1906, a magnitude 8.3 earthquake struck along the San Andreas Fault zone. The rupture, which extended for nearly 480 km, moved at estimated speeds of about 2.7 km/s (or more than 9000 km/hr). Violent shaking for up to 1 minute had more severe effects in areas underlaid by sediments, like reclaimed parts of San Francisco Bay, than it did over bedrock. The San Francisco quake was associated with **offsets** of up to 6.4 m, which were shown by movement in fences, lines of trees, roads and rail lines. Vertical displacement reached up to 0.9 m. Both movements caused major disruption not only to buildings but also to water and gas pipelines, telegraph lines and power lines. When escaping gas ignited, water was not available to fight the fires, which raged for 3 days after the quake. Altogether around 28 000 buildings were destroyed, 87% of them wooden structures. The death toll is estimated to have been around 3000 in San Francisco itself, where 225 000 people of a total population of 400 000 were left homeless.

offsets horizontal displacements



Source 1.11 Damage to buildings in San Francisco after the 1906 earthquake

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Buildings on sediments are very susceptible to earthquake damage, as later confirmed in 1985 in Mexico City (built on lake-bed sediments) and in 1989 in Newcastle, New South Wales (built on river-deposited sediment). Photos of the San Francisco earthquake can be found at www.cambridge.edu.au/geography8weblinks.

Australia and plate tectonics

Unlike other continents, the Australian landmass has not been subjected to major collision or transform plate boundary conditions. This means that we do not have an equivalent of the Rockies, the Andes, the European Alps or the Himalayas, or high mountains like Mt Kilimanjaro in Africa (5895 m). The Tasman Sea between Australia and New Zealand formed after divergence of the 2 landmasses and later the Great Dividing Range was uplifted. Over geological time, the range has been eroded down to a maximum height of 2230 m at Mt Kosciuszko. The Great Dividing Range extends for about 3500 km along the east coast of Australia, and now acts as a watershed dividing the west-flowing rivers towards the inland from the shorter coastal rivers flowing to the east.

ACTIVITY 1.5

1. In your own words, describe the 4 main plate boundary types.
2. Explain why collision boundaries between 2 continental plates behave differently from convergence between 2 oceanic plates.
3. Identify the types of plate boundaries most often associated with earthquakes.

NOTE THIS DOWN

Copy the graphic organiser below and give an example of each boundary type and associated landforms.

Nature of plate boundary	Example (location)	Landform/s
Collision	Himalayas	High mountains
Divergent		
Convergent (subduction)		
Transform		

RESEARCH 1.2

In groups, select 1 of the major continental or oceanic plates and use the internet to gather information about the rate and direction of its movement. Assess what the likely outcomes of this movement will be over the next century, and share your results with the class in the form of a PowerPoint presentation.

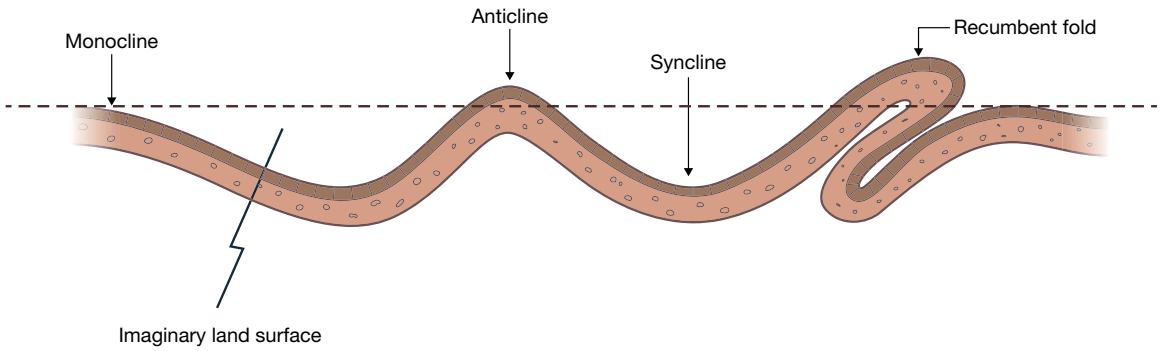
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Rocks responding to pressure

The Earth's surface is capable of being deformed or bent slightly (a process that is called plastic deformation, or rock elasticity) but relative to materials underlying the crust, it is rigid and brittle. This means that stresses can be applied in a particular place without the surface rock breaking immediately. However, if stresses continue to build up, they eventually will cause the crust to fracture and sometimes to bend. These large-scale outcomes of earth forces are referred to as tectonic landforms, and are produced by faulting and folding. Evidence for tectonic landforms is most obvious and lasts the longest when the affected rocks are very resistant to weathering and erosion.

Folding

When plates collide or converge, the edges of some continents are forced upwards and mountains are formed. This process usually causes large fractures in the crust and occasional rapid movements to release the built-up stresses. The readjustment of the stress load affects rocks at the surface. Any lateral or sideways pressure (compression) can result in rocks being squeezed and then responding to this stress by buckling. Rocks formed from sediments being deposited in layers or beds (sedimentary rocks) and layered rocks that have been subjected to extreme pressure following their formation (metamorphic rocks) can both respond by buckling or folding.



Source 1.12 Different fold types

The main kinds of folds are anticlines, synclines, monoclines and recumbent folds.

anticline the upward bulging of rocks caused by compression

syncline the downward squeezing of rocks caused by compression

Anticlines and **synclines** are often associated with one another. Anticlines are beds that have been forced upwards, producing an upward bulging of rocks and a convex upward shape at the surface. The syncline represents the nearby rocks that have been squeezed downwards (convex downward shape). Even though the rocks have been distorted, the oldest layer remains in the centre or lowest point of the anticline. Because the formation of an anticline involves stretching of rocks at the top of the bulge, additional cracks often appear usually at right angles to the bedding layers. This means that the higher parts of the anticline are the most fractured and vulnerable to weathering and erosion. In the field, younger fractured rocks on the former crest of an anticline may be eroded away, leaving younger rocks on the flanks and older underlying rocks remaining at the centre of the anticline.

The reverse of this is the syncline, which represents a convex downward fold. In the centre or lowest point of the syncline lies a zone of compressed rocks, which are more resistant to forces of weathering and erosion. Over long periods of time the fractured anticlinal bulges

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Source 1.13 Wilpena Pound, South Australia, an eroded syncline: the basin shape represents the centre of the syncline where rocks have been compressed.

will be weathered and eroded down, leaving the synclinal part of the fold system as the highest point in the landscape. Wilpena Pound in the Flinders Ranges of South Australia is an eroded syncline.

Sometimes folding results in only gentle buckling of terrain over extensive areas, as occurs in south-western Queensland and nearby parts of New South Wales and South Australia. Erosion of a gently folded ancient silcrete surface in these areas has left many remnants of ancient folds but no crests of anticlines.

Monoclines can be formed by fault movements at depth and may be gentle folds without steeply inclined layers. The Lapstone Monocline marks the eastern margin of the Blue Mountains near Sydney, and has numerous faults associated with it. This combination of folding and faulting is logical, as both structures require major forces for their development, and frequently the continental forces applied exceed rock strength, leading to buckling and/or fracture. In Western Australia, a major monocline now stands at about 850 m above the surrounding plain, approximately 860 km north of Perth. This large isolated outcrop, called Mt Augustus, extends for about 8 km and is made up of rocks that could be 1000 million years old. Beneath these ancient sediments is even older granite that probably solidified about 1650 million years ago.

Recumbent folds are those that have folded over themselves or overturned ('reclining'), so that initially the youngest rocks are on the surface. When the fold is eroded, older rocks beneath the

monocline a simple fold that occurs singly rather than as part of a series of anticlines and synclines

recumbent folds those that have folded over themselves or appear to have flopped over

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original upper layer become exposed. In this way, the sequence of rock ages is not the normal one of youngest at the top and oldest at the bottom, but a sequence of older–younger–older. Careful investigation of folded rocks is needed to ensure that the relative ages of landforms developed on them are not misinterpreted. In recumbent folds, the axial direction of the fold is approximately parallel to the bedding planes. Recumbent folds are frequent in strongly folded terrains like the European Alps.

Fold mountains

Folding is often accompanied by uplift, so that fold mountains are relatively common. Many mountain ranges have folded rocks, and this shows that they have been subjected to compression or shear pressure. All the folded mountain ranges in Australia also have **faults** present, and sometimes the ranges are marked by an **escarpment**. Compared with the high mountains making up the European Alps, the Himalayas, the Andes and the Rockies, Australia's fold mountains are much more subdued. To the east of Adelaide, the Mt Lofty Ranges – sometimes referred to in texts as 'a series of hills' – rise to a height of 727 m, and have been subjected to both folding and faulting. Folding is also present in metamorphosed and folded rocks around Brisbane, but the main range to the west is composed of a series of volcanic flows.

faults fractures in rocks or sediments where movement has occurred as a result of compression or shear stress

escarpment a sharp and continuous break in slope that may extend for hundreds of kilometres

ACTIVITY 1.6

1. Sketch an anticline, a syncline, a monocline and a recumbent fold.
2. Use the internet to find the locations of 2 examples of each type of fold.
3. Sediments are deposited over time, so the oldest sediments are laid down first and younger sediments are deposited on top. Explain how older beds can sometimes be exposed with younger strata beneath them.

Faulting

curvilinear in a curved line when viewed from above

Faults are linear or **curvilinear** fractures that may be approximately vertical, or be angled towards the surface, and often more than one fault is present. Where rocks have been subjected to compression, folding or uplift, or where shear stresses have developed, faults of diverse lengths may form to relieve the stress. In some cases, a series of fractures (faults) will occur within metres or kilometres of one another, as happens in the Mt Lofty Ranges. Other fault lines have eroded into major landforms, such as the Darling Fault to the east of Perth, which extends as a fault line escarpment for about 1000 km. Because the relatively uplifted side of any such fracture has been eroded over long periods of time, often faults may now be located at some distance from an escarpment, rather than at the junction between the higher and lower land surfaces.

Faults are not always associated with folding or compression. Where plates are diverging, large-scale fractures or faults develop. The Rift Valley in Africa has formed from plates diverging and the land between them becoming lower than that on either side. A string of active volcanoes has developed along the fault lines, marking the boundary between relative uplift and subsidence. This situation of fault lines separating higher from lower ground is referred to as a **block fault**, because the land in such areas tends to move as cohesive large chunks or blocks. At a much smaller scale, the Mt Lofty Ranges represent a block-faulted range, bounded by faults on both sides, with additional

block fault large area of land upthrust by earthquake activity

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Geographical fact

Faults or fracture lines can develop while people are watching. In 1968 at Meckering, 130 km east of Perth, a 6.9 magnitude earthquake created a rupture 37 km long. The **earthquake focus** was shallow – about 7 km, compared with about 30 km for the Japan earthquake in 2011. At Meckering, railway lines buckled, the ground moved visibly in waves or bumps, numerous fractures opened to about 5 cm and then closed, and sudden changes in land surface elevation were noted. Eyewitness accounts include that of a driver who saw 'immediately in front of him a 2.5 m high bump [rising] in the road where 2 seconds before none had existed'. Another observer, travelling in the opposite direction along the Great Eastern Highway, 'felt the shaking and saw the scarp rise, and crashed into a tree at the roadside, breaking an arm'. General vertical displacement along the new fault scarp was 1.5 m.

earthquake focus depth where rupture from an earthquake occurs

horst a chunk of fault-bounded land that is higher than the land on either side

graben a chunk of fault-bounded land that is lower than the land on either side

faults and associated 'blocks' between them. Where fault-bounded land is relatively uplifted rather than down-faulted (as in the Rift Valley), the uplifted block is referred to as a **horst**. A down-faulted block is called a **graben**. Spencer Gulf and Gulf St Vincent in South Australia are both submerged grabens.

In the western United States, an extensive area of faulting has produced alternately uplifted and down-dropped country. Probably more than 15 million years ago, the Basin and Range region of the Cordilleras started to form as a result of crustal stretching. The outcome is a series of roughly parallel uplifted (mountains) and down-dropped (valley) areas where the height difference (relief amplitude) between valleys and mountains can be more than 3000 m. Faults are angled so that peaks alternate with valleys. Volcanic activity has resulted from weaknesses created by crustal movements and fracturing. The geologist Clarence Dutton in



Source 1.14 Fault line forming an escarpment in the Rift Valley, Kenya, Africa



Source 1.15 Alluvial fan deposited in front of fault-bounded mountains, Death Valley, California

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alluvial fan water-deposited sediment that spreads out into a fan shape when viewed from above

ephemeral drainage drainage lines without permanent water flow

1886 described the Cordilleras as 'coming up through Mexico and crossing into United States territory … looking … like an army of caterpillars crawling northward' when reviewed on a map. Movement along the fault planes is continuing, and faults have cut through extensive **alluvial fans** deposited at the outlets of **ephemeral drainage** lines. Because the area is arid, with relatively low annual streamflow, and the uplifted country has blocked the rivers that do exist, the Great Basin area of more than 500 000 km^2 is a zone of interior drainage.

Faults can also occur in zones of plate convergence (subduction). The enormous stresses built up as a result of the Indo-Australian Plate moving north-east and overriding part of the Eurasian Plate near Sumatra were released extremely rapidly on Boxing Day 2004 by the creation of a 1300 km-long rupture, which is estimated to have travelled at speeds of about 2.8 km per second. Both horizontal (10 m) and vertical (3–4 m) movements occurred along the fault, resulting in severe earthquakes and the largest tsunami on record, in which wave heights of up to 30 m were registered.

ACTIVITY 1.7

1 Using the internet, locate an image of the Cordilleras in the western United States.
2 Describe how a feature like the Cordilleras has developed.
3 Evaluate whether the Cordilleras look like 'an army of caterpillars crawling northward', as described by the geologist Clarence Dutton.

Locating a fault

The idea of rocks fracturing under stress is easy to understand, but how would we go about finding a fault in the field? What kinds of evidence would we look for, and can the presence of a fault be inferred by assessing surface landforms?

Because faults are stress fractures and the stress may have originated from a number of directions, they can often be seen in quarries where a line of crushed and fractured rock, or **breccia**, appears. The fault zone may be seen as a single break or as a series of fractures in the quarry face and, if the rocks are layered, some of the layers will be offset by movement that occurred when the fracture formed. In other places, no quarry or cutting is available to determine the actual location of a fault line, even though sedimentary layers have been offset. These faults – the precise location of which is unclear – will be represented on geology maps as broken, rather than solid, lines and labelled as '**inferred faults**'.

breccia angular pieces of rock of various sizes that have been broken and fractured along a line as a result of fault movements

inferred fault a fault that is assumed to exist from field evidence, but that cannot be located precisely

Landforms on the Earth's surface often give clues to the presence and general location of faults. As faults represent broken or fractured rock, the zones where they occur are more susceptible to weathering and erosion than the adjacent rock. These weaker zones are often exploited by streams whose direction, when viewed from above (in plan) from maps, aerial photographs or remotely sensed imagery, will often follow fault lines. Any river with a suspiciously straight pattern needs further attention – is it following a line of weakness? Is the channel a human-constructed one, as many drainage channels are? In the Burrup Peninsula area of Western Australia, streams follow fault lines through rocky terrain, while in the south-east of South Australia numerous straight-line drainage channels have been constructed across a coastal plain.

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Larger-scale faults may involve relative uplift and associated subsidence of other land. When this happens, streams may be obstructed by land that has risen, and thus prevented from continuing on their normal path. Swampy and poorly drained ground is then created, as occurs along the Californian coast to the north of San Francisco. In this case, the disruption to drainage lines has been caused by the swarm of fractures along the San Andreas Fault belt. **Topography** there has been affected by both vertical and horizontal movements along different individual faults. When shear movement dominates along a fault line, drainage lines can be offset in the same way in which railway lines and roads develop 'kinks' if subjected to similar stress.

topography the layout of the land

Faults extend down into the earth and can affect subterranean features like **groundwater flow**. Following the Great San Francisco Earthquake, springs and artesian wells recorded changes in flow rates. Disruption to water tables in areas having saline groundwater can result in surface water becoming unexpectedly saline. In south-west Iran, a reservoir was constructed for hydroelectric power and downstream irrigation for agriculture. Water quality of the river downstream of the dam was seriously affected by salinity, which could not be explained by the nearby surface exposures of salt-bearing evaporites. As the salt-contaminated streamwater zones coincided with the fault zone, the saline surface water was attributed to the intrusion of **brackish** water through fault fractures. Other fault-like fractures can be caused by human activities. In the Blue Mountains in New South Wales, underground (longwall) coal mining creates tunnels up to 3 or 4 m high and 350 m wide, extending for several kilometres. When the overburden collapses, fractures are formed and these have major impacts on both surface watercourses and groundwater movement. Some creeks normally containing rock pools no longer carry water, which instead has drained into fractured rock. Other creeks only flow following heavy rainfall, rather than year round as before, and upland swamps have become dry. Reduction in surface flow and storage has meant a transfer of water underground, sometimes flooding existing or abandoned mines, and depriving water catchments of run-off that previously would have been collected in water reservoirs.

groundwater flow water that moves slowly below ground through sediments and cracks in rocks

brackish containing salt levels between those of fresh water and seawater

Geographical fact

Mt St Helens started forming about 40–50 000 years ago in a fault zone to the north of San Francisco. Including the 1980 eruption, 9 major events have occurred since its formation. On a broader scale, the Pacific Plate is being subducted offshore beneath the North American Plate at a rate of about 40 mm per year. This has created earthquakes, volcanoes and tsunamis. Mt St Helens had faults before the latest eruption and rising magma increased the number of splits, forming new fault lines and creating earthquakes. As well, the magma caused the crater floor to tilt outwards, causing movement along existing fractures.

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ACTIVITY 1.8

1 Make a list of 3 landform 'clues' that can be used in the field to recognise the presence of a fault.
2 Describe how each landform 'clue' has developed.
3 Assess whether the 'clues' could be explained by processes that do not involve faults.

Joints

Unlike faults, other planes of fracture in rocks may have a fairly regular pattern, which is sometimes restricted to particular types of rocks. Those rocks that solidify from magma or molten material are called igneous rocks, and their cooling can be associated with specific fractures or joint patterns. In basalt, for example, columnar jointing or vertically oriented rock columns form, contrasting with rectangular jointing (vertical and horizontal fractures) in rocks like granite. Even though joints exist in many rocks at this local scale, they are still subject to compressional and tensional forces that can produce faulting on a larger scale.



Source 1.16 Weathering along rectangular joints in granite produces large boulders, Devil's Marbles, Northern Territory.



Source 1.17 Columnar jointing develops in basalt as it cools: near the Giant's Causeway, Northern Ireland.

1.3 Volcanism

Volcanic activity occurs along collision, convergent and divergent plate boundaries both under the oceans and on landmasses, and along fault-bounded land or sea bodies. Transform plate boundaries, where plates move past each other, generally are not associated with volcanic activity. Much of the volcanism found along convergent plate boundaries is explosive, while most volcanic activity taking place along divergent boundaries involves non-explosive outpourings of lava. As many convergent plate boundaries are on or near landmasses, explosive volcanism is what people generally experience. The 'Ring of Fire' around the Pacific Ocean represents more than 1000 volcanoes that have appeared on convergent plate boundaries. Of those volcanoes that have erupted

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during historical time, the highest is in the Andes in northern Chile, at an elevation of nearly 7000 m. There is evidence of submarine volcanism having taken place over the last 150 years at depths of about 5300 m in the Mid-Atlantic Ridge (divergent plate boundary).

Volcanoes and hotspots

In addition to converging or diverging plate locations, volcanoes can be found where plates are considered to be relatively stable, such as in Australia. The Hawaiian Islands are also located thousands of kilometres from a plate boundary. So what causes volcanic activity? In general, where the movement of continental plates allows for a thinning or weakening of the crust, molten rock can emerge as a volcano at the surface. This happens whether the thinning or weakening of the crust occurs along a plate boundary or within it. In both cases, molten rock emerges at the Earth's surface, whether on a landmass or under the ocean. However, landmass thinning in locations far from plate boundaries is a complication to the plate tectonics mechanism. A general explanation for both plate boundaries and stable within-plate locations has been proposed: namely, that all volcanoes may be the result of **hotspot activity** (or high heat energy sites). Two interesting and incompletely answered questions arise from this. First, what causes the hotspots to form? The mechanism for hotspot formation remains unknown, but in seeking the answer researchers have suggested that differences in heat energy distribution within the Earth may result in the development of convection plumes. These would be capable of forcing molten rock through the crust, especially in places of pre-existing fracture (plate boundaries), but also where the lithosphere is thinner – whether this occurs under the oceans or in a mid-plate location. Second, do the hotspots remain fixed in the same place, or do they migrate over time? The initial hypothesis proposed that convection plumes remained at fixed points, with lithospheric plates moving slowly over them. If a string of volcanoes were present along a plate boundary or within a plate, then a 'fixed' convection plume/hotspot would produce a series of volcanoes of increasingly younger ages. There is evidence of this happening in the Hawaiian Island archipelago, which is not located on plate boundaries, and where the oldest volcanoes are in the north-west and the youngest in the south-west. However, hotspots (such as in Hawaii and Iceland) do not appear to be fixed in relation to one another, so there may be more than one mechanism to explain the patterns of volcanic ages.

hotspot activity current volcanic activity associated with convection plumes

ACTIVITY 1.9

1. Using the internet, locate 2 maps showing:
   - **a** the Pacific 'Ring of Fire'
   - **b** plate movements.
2. Note the types of plate boundaries around the Ring of Fire (collision, convergent (subduction), divergent or transform).
3. Consider whether particular types of plate boundaries have caused the Ring of Fire.



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Volcanoes: active, dormant or extinct?

Volcanoes are often described in terms of their activity. Even though it seems that these descriptions are obvious and useful, when considered in detail such categorisation is not a simple matter. For example, active volcanoes can be classified as those that have produced ash, lava, pumice or gases over **historical time**. Although this seems like a sensible definition, 'historical time' covers different timespans in different parts of the world, and probably encompasses a maximum period of only about 6000 years (which is geologically insignificant). Some classifications use the combined historical **Holocene** and late **Pleistocene** periods as representing 'active' volcanoes, because radiocarbon dating methods can reliably determine ages up to about 40 000 years before the present. Dormant volcanoes are those for which we have evidence of past activity during the historical period, but that are not active now. However, volcanic activity is not always a continuous process, and a particular volcano may be intermittently active over much longer time frames. The category that has led to the fewest number of unpleasant surprises over historical time is the 'extinct' volcano, but even these volcanoes can again become active. Humans have difficulty being precise about volcanic activity due to a mismatch in time frames. We consider a few thousand years to be a long time, but attempts are being made to assess landscape features operating over geological time frames of millions or tens of millions of years. There are bound to be some erroneous evaluations, even without the added short-term problem of trying to predict when a volcano known to be 'active' will next produce dangerously massive explosions, molten rock or poisonous gases.

historical time the period during which humans have recorded events

Holocene a geological epoch characterised by the growth and impact of the human species between the present and 10 000 years ago

Pleistocene a geological epoch characterised by the formation of widespread glaciers between 10 000 and 2 million years ago

Case study 1.2

The Tambora volcano, Indonesia, 1815

In 1815, the largest volcanic eruption during historical times took place in the Flores Sea near Lombok in Indonesia. Tambora had been considered an extinct volcano until then, when approximately 50 km^3 of dense rocks were ejected. Before the eruption, Tambora stood at about 4300 m but the summit exploded, leaving a **caldera** measuring 6 km wide and 1 kilometre deep. The new summit reached only 2850 m, a collapse of nearly 1.5 km. Apart from massive **pumice** flows, the volcano ejected an estimated 60 million tonnes of sulphur – more than 6 times the amount from Pinatubo (Philippines) in 1991 – and large amounts of fluorine, which is toxic to people and livestock. The violence of the eruption sent plumes of ash up to 43 km into the atmosphere, and explosions could be heard up to 2000 km away. During the worst few days of the eruption, many places within 600 km of the volcano remained 'pitch black', and air temperatures dropped dramatically. Global temperatures may have dropped by up to 3°C.

The after-effects of the volcanic eruption were severe. Immediately following the eruption and associated earthquakes, tsunamis reached a maximum height of 4 m and inundated low-lying coastal areas. Ash build-up caused buildings to collapse and people had difficulty breathing. At least 71 000 people are estimated to have died during the eruption or immediately afterwards, when no food or uncontaminated water was

caldera large basin-shaped depression caused when the summit of a volcano collapses into the magma chamber below or explosions destroy the summit

pumice a light-coloured rock with many holes (**vesicles**) due to gases mixing with rapidly solidifying lava and trapping multiple air bubbles. Pumice is light and floats on water.

vesicles holes, often round in shape, where air bubbles were trapped in lava

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available. Up to 3 years after the eruption, pumice and tree trunks formed sea-borne rafts up to 5 km across, and posed a major hazard for shipping.

The massive quantities of ash ejected into the atmosphere had climate impacts in the Northern Hemisphere. On the positive side, sunsets and twilights in places like London were spectacular. However, the year following the eruption – 1816 – was called the 'year without a summer' in north-east North America and Europe. That year, the weather was much wetter than usual and cold temperatures shortened the growing season. Grain crops failed, potatoes rotted in the wet ground and people suffered from major outbreaks of typhus.

1 Locate the Tambora volcano on a map.
2 Identify whether the Tambora volcano lies on or near a plate boundary.
3 Assess the importance of 5 impacts of the Tambora eruption on human populations.

Geographical fact

Pumice stones were used by clothing manufacturers to produce the original stone-washed jeans.

Volcanic activity and landforms

Volcanic activity is often associated with other events – especially earthquakes, tsunamis and topographic changes – along with the release of enormous amounts of sulphur dioxide and clouds of ash into the atmosphere. Volcanic activity is complicated and variable, producing an array of different landforms. Only some of the numerous and sometimes overlapping volcanic types and **morphologies** are described here, namely composite (stratovolcano), caldera and crater, fissure vents and shield volcanoes. Other landforms include the formation of islands such as the Hawaiian Islands. Much volcanic activity in regions of known volcanism has occurred at various times in the past, with evidence of sequences of lava flows or ash deposits of different geological ages, and the presence of calderas that represent collapsed or exploding former volcanoes. An active volcano is thus always at least partly a constructional feature, as molten rock is extruded at the Earth's surface, but explosive emissions involving gas and water may destroy the tops of existing volcanoes.

morphology form and structure of shape of landforms

Composite volcanoes are those from which a number of eruptions have deposited lava, rock debris and ash in layers. Many of these volcanoes are composed of a symmetrical cone with a single central vent. Others have a central vent and additional multiple vents on their flanks, resulting in complex layering of volcanic materials. In either case, ongoing deposition from volcanic activity has to be at a rate that outstrips erosion, as some volcanic sediments are easily eroded. Mayon volcano in the Philippines has relatively frequent eruptions, which allow it to maintain its exceptional symmetry.

When volcanic activity is accompanied or followed by explosive emissions, the summit of a volcano or group of volcanoes may be blasted away, leaving a large basin called a caldera. These depressions may be up to 100 km in size, and some calderas fill with water to form a lake. One of the largest water-filled calderas is Crater Lake in Oregon in the United States, which formed about 7000 years ago following major eruptions and the collapse of existing cones. The caldera is 8 km by 10 km in size, and about 1200 m deep. Although volcanologists classify calderas and the smaller craters (<1 km in size) separately because of different origins, the landform results are similar

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Source 1.18 Types of volcanoes

Volcano type	Vent	Emission	Size of emission	Examples/ characteristics
Flood/plateau	Fractures	Very liquid lava, flat-lying basalt	Very widespread	Deccan Traps, India – basalt >2 km thick covering >500 000 km^2
Shield	Central **vent**, large, up to 7 km in size	Liquid lava – series of slow flows	Large	Mauna Loa, Hawaii – ocean floor to peak >8500 m (4169 m ASL)
Cinder cone	Central vent, often with crater at top	Explosive liquid lava, breaking to cinders	Small	Parícutin, Mexico – 1943, cone to 366 m, ash covered about 260 km^2, then quiet lava flows
Composite/ stratovolcano	Central vent, cone-shaped, fissures on flanks solidify as dykes	**Viscous** and **pyroclastic**; moves at up to 200 m/s; 350ºC to >1000ºC	Large	Mt St Helens, USA; Mt Fuji, Japan; Mt Pinatubo, Philippines (erupted 1991, previously dormant for 600 years)
Volcanic/lava dome	Central vent, often in craters, or on flanks of composite	Very viscous, can be explosive, lava builds up near vent	Small	Mont Pelée, Martinique – pyroclastic; hot ash, gas and debris at >150 km/h killing about 30 000 people
Caldera	Central vent	Collapse after explosive emissions or after long erosion	Very large	Crater Lake, USA – also called a composite volcano; Mt Warning, NSW – erosion caldera, >1 km deep, >40 km wide, extinct for 20 million years

vent opening in a volcano through which molten rock, gas and water can escape

viscous with a thick consistency that allows for flow (neither completely liquid nor solid)

pyroclastic describes a superheated mixture of rock, ash, gases and water that moves rapidly downslope as a result of a volcanic eruption

except for the size difference. Craters are formed by explosive eruptions that do not involve collapse. In Chile, the Cotopaxi crater lies at a height of about 5900 m, and has a glacier-covered rim and a **drainage basin** with ice patches. This volcano has had several violent historical eruptions, including one in 1877 when **lahars** travelled more than 100 km to the Pacific Ocean.

drainage basin an area of land where surface water from rain and/or melting snow and ice joins at a single point at a lower elevation another water body such as a river, lake, dam, estuary, wetland, sea or ocean

lahar mixture of water and rock fragments flowing down the slopes of a volcano, usually following river valleys

Shield volcanoes are those producing low-angle slopes and resulting from numerous vents that have poured out vast quantities of lava and volcanic materials over extensive areas. In Australia, the Newer Volcanics Province includes western Victoria and the extreme south-east of South Australia. Nearly 400 small volcanoes have

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Source 1.19 A water-filled caldera forming the Blue Lake, Mt Gambier, South Australia

produced a shield area of around 50 000 km^2, with the most recent eruptions having taken place about 5000 years ago at Mt Schank and Mt Gambier (the location of the water-filled crater of Blue Lake) in South Australia. These 2 explosive eruptions in South Australia were the culmination of volcanic activity that had begun in the Tertiary period (commencing about 65 million years ago). In India, the Deccan Traps were formed about 60 to 68 million years ago by multiple layers of **extruded** shield and flood basalts, which exceed depths of 2000 m. Due to erosion and plate movements, the flood basalt province now covers only about 500 000 km^2; it was even more extensive in the geological past. Lava flows sometimes produce unusual features, like the Undara Lava Tubes in north Queensland. Here lava flowed down valleys, solidified at the surface and allowed molten lava to move out beneath the solidified surface. Once lava ceased flowing, the large underground gaps remained, creating the tubes that now form a bat habitat and attract many tourists.

extruded pushed out through a vent or fissure

Fissure vents are those where magma and gases escape through often lengthy fractures in the Earth's surface. Many of these fractures are associated with existing volcanoes, either because the magma is forcing the ground to fracture or because plate movements have ruptured the surface. In the 2 months before the 1991 eruption of Pinatubo in the Philippines, a 1.5 km long fissure was marked by steam, some ash emission and explosion craters. The fissure extended to the volcano's summit when the major eruption occurred in June of that year. Numerous fissures appear in Iceland, which is an above-sea-level part of the Mid-Atlantic Ridge, along the zone of seafloor spreading. Fissure vents in Iceland are thus probably created by divergent plate movements.

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ACTIVITY 1.10

1 Find images showing examples of 3 different types of volcanoes.
2 Indicate where the volcanoes are located and when they erupted last.
3 Discuss the impacts on human populations of the volcano types investigated.

Plate tectonics and landforms at different scales

Plate tectonics and volcanism help us to understand landform differences at the continental scale, but the results of these forces are also visible at regional and local scales. At a regional scale, basalt flows from volcanoes may extend over a subcontinent, as in India; a graben may be inundated by the ocean, as in Spencer Gulf in South Australia; or a series of volcanic islands may appear, as with the Hawaiian Islands. At the smaller local scale, swampy ground and changed river directions can result from fault movements; anticlines and synclines can be recognised in railway cuttings or other exposures; and volcanic craters of varying sizes can develop. Even smaller landform features are associated with each of the local or regional scale landforms – for example, fractures can be identified in crests of anticlines. When considering the processes at work to create landforms, each scale tends to overlap with others, so it is useful to think of possible explanations at various scales.

1.4 Rock types and landforms

Some landforms develop mainly on one rock type, like caverns in limestone. Other landforms, such as **inselbergs** (German for 'island mountains'), can occur on a variety of different rocks. Rocks and weathered rock (sediments) can be viewed as the raw material of landscape that is fashioned into different forms by weathering and erosion. We can illustrate this by taking examples from the 3 main groups of rocks: igneous, sedimentary and metamorphic.

inselberg an isolated steep-sided hill, often made of bare rock

Igneous rocks and landforms

Igneous rocks originate from the solidification of magma. Rocks that solidify at depth are referred to as intrusive rocks, while those formed at the surface are called extrusive rocks, but various gradations exist. When magma cools slowly at depth, most crystals grow to larger than about 1 mm across, and so can be seen with the naked eye. This is the case with minerals in granite. In contrast, extrusive rocks solidify from magma that has cooled quickly at the Earth's surface. Basalt, an extrusive rock, contains small crystals and often has vesicles.

Granite is more resistant to weathering and erosion than basalt because of the minerals it contains. When basalt outcrops in a wet climate, it eventually breaks down into a fertile soil. Granite, on the other hand, weathers more slowly into a gritty infertile soil due to the amount of quartz grains it contains. If relatively resistant granite is not strongly fractured by joints, it can form isolated high outcrops like Sugarloaf Mountain in Rio de Janeiro (Brazil), Wave Rock in Western Australia and the inselbergs on Eyre Peninsula in South Australia. These rock surfaces are relatively impermeable, and in Australia have been used as water collectors. Pits (gnammas) on the inselbergs often contain water after rain, and these natural supplies were used by Aboriginal people. Subsequently European settlers used some inselbergs as water-catchment areas for local dams.

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Source 1.20 Wave Rock, a granite inselberg at Hyden, Western Australia: a low stone wall on top of the outcrop captures rainwater for a dam on the far edge of the granite.

Geographical fact

The explorer Edward John Eyre, when on the dry west coast of South Australia, noted in his diary that he found

> a few drops of water trickling down a huge granite rock abutting on the sea-shore. This was the only approximation to running water which we had found since leaving Streaky Bay, and though it hardly deserved that name, yet it imparted to me as much hope, and almost as much satisfaction, as if I had found a river.

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Sedimentary rocks and landforms

sandstone a rock composed mainly of sand-sized grains (diameter of 0.2–2 mm), most often quartz grains, with the matrix between these grains being made up of clay-sized particles (<0.05 mm in diameter). The rock is welded together by a cement or binder, generally siliceous (silica) or sometimes calcareous (calcite).

limestone a rock made up of calcium carbonate ('lime'), originally deposited under the ocean and formed from broken-up shells, corals, animal skeletons and other carbonate materials

shale a rock composed of mostly clay-sized particles that have been compressed

Sedimentary rocks form from sediments deposited in layers (beds), which have later been compressed into solid rock. Many inselbergs in Australia are composed of granitic rocks, but such upstanding features in otherwise fairly flat areas can form on different rock types. Uluru, for example, is composed of a particular kind of **sandstone**, which is a sedimentary rock. Other sedimentary rocks include **limestone** and **shale**. Because all sedimentary rocks are deposited in layers, it is very easy to see whether the rock has been folded or faulted. If the beds have remained nearly flat-lying, plateaus can form, like those in the Blue Mountains in New South Wales. This area has mainly horizontally bedded sandstone, apart from the Lapstone Monocline on its eastern boundary. Most plateaus have been dissected by streams, but the crests between the valleys will all have approximately the same height, as in the Blue Mountains.

More usually, sedimentary strata have been folded or tilted; in the case of Uluru, beds have been tilted nearly vertically to an angle of 85°. Along the east coast of the Adriatic Sea in the Mediterranean, limestone beds of the Dinaric Mountains have been folded and tilted, and dramatic mountain scenery with deep gorges has resulted from rivers cutting canyons through the mountains in order to reach the sea. Other landforms associated with limestone are also present: disappearing streams, deep solution hollows, sharp-edged rock where fractures are close together and numerous caves.

Contrasting with sandstone and limestone is shale, which is readily weathered and often produces subdued landscapes with gentle slopes and hills. These landforms appear in the Sydney Basin. Where steep slopes develop on shale, dissection has often been rapid and the climate is fairly dry so that weathering and erosion are slowed down.



Source 1.21 Edges of steeply dipping sandstone beds form corrugations on the surface of Uluru, Northern Territory.



Source 1.22 Canyon of the Morača River in the Dinaric Mountains, Montenegro. A road tunnel has been constructed through the cliff on the left.

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ACTIVITY 1.11

1 Using the internet, find images of landforms developed on granite and on sedimentary rocks.

2 Indicate at least 1 landform that occurs only on igneous rocks; 1 that occurs only on sedimentary rocks; and 1 that develops on both igneous and sedimentary rocks.

3 Analyse whether climate seems to be the main control over which landforms develop on igneous and sedimentary rocks.

Metamorphic rocks and landforms

Metamorphic rocks are those that begin as igneous or sedimentary rocks, and have since been subjected to extreme pressure or temperature. For example, granite can be changed into **gneiss** and shale can be transformed into the much harder rock, **slate**. Because of compressive stresses during its formation, slate splits easily along planes to produce smooth leaves or plates, allowing the plates to be used as roofing tiles in older public buildings and residences. In the United States, slate is also advertised as being ideal for billiard tables, as it provides a smooth, tough surface and, properly installed, does not require high maintenance. When limestone is severely compressed, it forms **marble**, a rock that often has attractive colouring due to impurities like iron being present. Marbles in Australia are nearly all coloured, while the Carrara quarries in Italy produce white/grey marble that is exported around the world. Carrara marble has fewer impurities and is therefore more resistant

gneiss originally a granite-type or a sedimentary rock that has been subjected to strong pressure, which also involves high temperatures, resulting in light- and dark-coloured minerals forming bands

slate shale changed into a stronger rock by heat and pressure within the Earth's surface

marble limestone that has been subjected to high pressure and temperature, resulting in recrystallisation of the original calcite crystals into a dense non-banded rock



Source 1.23 The Parthenon, originally constructed more than 2000 years ago on the Acropolis, Athens from Greek marble.

Source 1.24 A Carrara marble statue of Queen Victoria in Perth, Western Australia



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to weathering. This is why coloured marbles are generally used for coffee tables or interior cladding in building foyers, while white marble is used for outdoor statues and monuments. In the Dinaric Mountains in Croatia, the limestone is variable in terms of the extent to which metamorphism has taken place – some areas have been subjected to extreme pressure, while others have not. Damaging earthquakes continue to occur in this region as a result of plate movements, leading to the collapse of hotels and other buildings, and the need to completely reconstruct historic parts of towns like Budva on the coast in Montenegro. Further south, earthquakes have destabilised and damaged the much older Acropolis monuments in Athens, Greece.

Geographical fact

Carrara marble has been used in major monuments and buildings around the world, including Marble Arch, London (1833), Sheikh Zayed Grand Mosque, Abu Dhabi, United Arab Emirates (21st century), Akshardha, the Hindu complex in Delhi, India (opened 2005) and the Peace Monument, Washington, DC (1878).

NOTE THIS DOWN

Copy the graphic organiser below and summarise what you have learned about the 3 main groups of rocks.

Igneous	• Originate from the solidification of magna
Sedimentary	
Metamorphic	

RESEARCH 1.3

Imagine you are a guide working for a tour operator in Australia. Select an iconic Australian landform (for example, Uluru in Australia's Red Centre) and prepare a script to present to visitors. In your script, be sure to include a discussion of the processes that produced the landform and the activities that may have shaped it in the past and are still doing so in the present.

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Case study 1.3

Limestone caves in Australia

Caves can form in almost any thick limestone beds, so are common in all states of Australia. 'Show caves' are those open to tourists.

Caves form in limestone when water circulates along bedding planes or joints in the rock. As rainwater is slightly acid, even without pollution (with a pH of around 5.5), calcium carbonate goes slowly into solution. Circulating water becomes more chemically active when pH is lowered by organic matter or root respiration of plants, when water temperatures are lower and when water flow is turbulent. Caves often have spectacular formations known as **speleothems**. Speleothems take various forms, including dripstone features such as **stalactites** and **stalagmites**.

speleothems cave formations produced by the evaporation of water flowing down or slowly dripping off cave surfaces

stalactites dripstone features that hang from the cave roof

stalagmites dripstone features that build up on the cave floor

1. Using the internet, find the locations of show caves in limestone in 2 states of Australia.
2. Select 2 caves, 1 in your own state and 1 in another state, and research their characteristics, especially in relation to their size, number of levels and the nature of speleothems. You will find a useful starting point at www.cambridge.edu.au/geography8weblinks.
3. Discuss why characteristics and features of limestone caves differ from one cave to another.

Source 1.25 Major show caves and cave systems in limestone in Australia

State	No.	Names of show caves or cave systems
Qld	3	Crystal Caves, Atherton Plateau; Camooweal Caves, Far Western Queensland; Chillagoe Caves, North Queensland
NSW	7	Jenolan Caves, Blue Mountains; Wombeyan Caves, Southern Highlands; Abercrombie caves, Borenore Caves and Wellington Caves, all in central western New South Wales; Yessabah Caves, northern New South Wales; Wee Jasper Caves, southern agricultural area
WA	7	Nullarbor Plain Caves; Ngilgi Cave, Augusta Caves and Margaret River Caves, south-west Western Australia; Stockyard Gully Caves, central agricultural region near Eneabba; Yanchep Caves near Perth; Tunnel Creek in the Kimberley
SA	5	Yourambulla Cave, Flinders Ranges; Kelly Hill Caves, Kangaroo Island; Koonalda Caves, Nullarbor Plain; Naracoorte Caves and Mt Gambier Caves, south-east South Australia
Vic	2	Buchan Caves, Gippsland; Princess Margaret Rose Caves, western Victoria
Tas	4	Mole Creek Caves and Gunns Plains Caves, north-western Tasmania; Newdegate Cave, southern Tasmania; Kutikina Cave, west coast of Tasmania

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FIELDWORK 1.1 ROCKS IN THE LANDSCAPE

Aim

To locate examples of 2 different rock types, either as outcrops in the field or as dimension stone used in buildings or monuments. You will describe the rock and its use, the sites examined and the general location of sites in relation to earthquake and volcanic activity.

Method

Characteristics of the rocks examined and nature of the sites will be described, and additional information obtained from internet sources.

Preparations

Before going to the field area, prepare a base map with a scale and north sign. If studying outcrops in the field, check with a geology map beforehand to note the field site locations and rock descriptions provided in the map's legend. Take a camera for recording images, a clipboard with your base map, writing paper or a field notebook, and a pen.

Data collection

1 Mark the locations of field sites on your base map and take images of the sites.

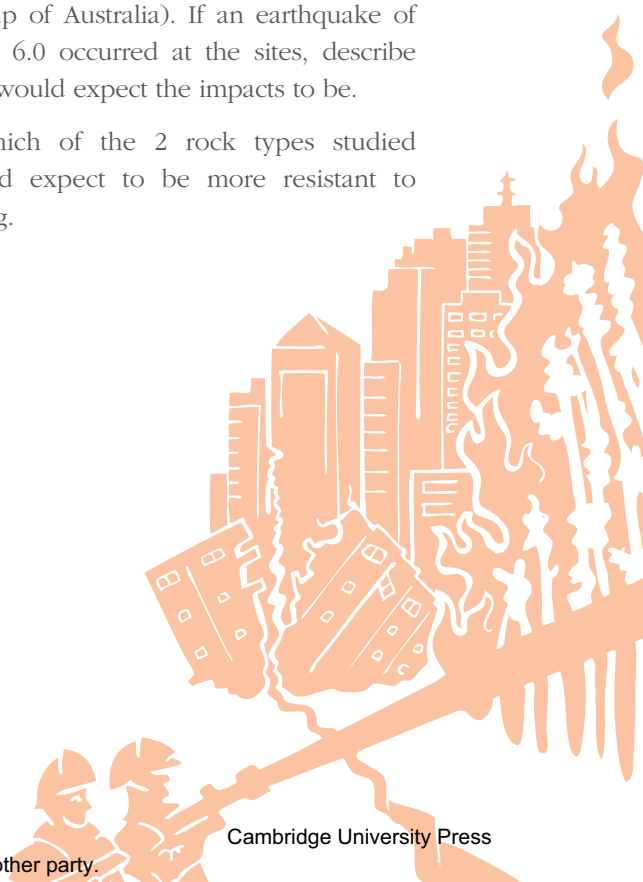
2 Describe the field sites of outcrops in terms of local topography, and make notes and sketches of the extent and morphology of the exposures (e.g. large flat area, small boulders). Take note of whether outcrops are few and separated by areas of sediments, or whether they form part of rocky terrain (see item 6). For buildings/monuments, describe the nature of the building and sketch where the studied rocks are situated on the building/monument. Note down any dates that indicate the age of the structure. (When used in buildings and monuments, the rock is freshly cut before use. Dates on building foundation stones and monuments show how long the rock has been exposed to weathering.)

3 Describe the rock types studied using terms like overall colour, the colours of any minerals that can be seen, the size of individual grains within the rocks (clay, silt, sand, gravel or combinations of these) and whether the rock has a uniform, banded or speckled (crystalline) appearance. After you have described them and recorded images, look at hand specimen examples on the internet on a site like www.cambridge.edu.au/geography8weblinks. Are your rock types igneous (intrusive or extrusive), sedimentary or metamorphic?

4 For outcrops, note whether the rock types studied have been used as building stone in the local area or whether you think they would be suitable for that purpose. For buildings/monuments, try to find out where the stone came from (that is, whether it is local stone or quarried somewhere far away). For both kinds of study site, library materials on local history are often useful. Have the rock types studied been used for purposes other than building in the local area?

5 Using the internet and your base map of site locations, find out how far the sites are from any volcanic activity. Is the nearest volcanic activity located on the edge of a continental plate? Are the study sites in a zone of earthquake hazard? (see www.cambridge.edu.au/geography8weblinks for a recent earthquake hazard map of Australia). If an earthquake of magnitude 6.0 occurred at the sites, describe what you would expect the impacts to be.

6 Assess which of the 2 rock types studied you would expect to be more resistant to weathering.



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Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map showing field sites (or building locations)
Pages 3–4	Description of the study sites, with sketches and/or images
Pages 5–6	Description of rock types, with images
Page 7	Uses of studied rock types in local area
Page 8	Description of study sites in relation to volcanic and earthquake activity
Page 9	Evaluation of possible effects of earthquakes on study sites
Page 10	Assessment of the comparative durability of the rock types studied
Page 11	Appendix, bibliography, glossary



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Chapter summary

- There are many different types of landscapes, including coastal, riverine, arid, mountain and karst.
- Landforms are naturally formed features on the Earth's surface. Physical geographers attempt to explain the differences in scale, morphologies and groupings of landforms.
- The Earth's crust has broken into about 9 major continental and oceanic plates, which are moving slowly at different rates and in different directions.
- Convergent, divergent, subduction and transform plate boundaries lead to different types of landforms.
- Rocks respond to compression and strain by folding and faulting, and in the process produce distinctive landforms.
- The frequency and timing of volcanic activity is unpredictable but the locations of volcanoes are associated with plate boundaries and hotspots.
- Igneous, sedimentary and metamorphic rocks may produce different or similar landforms, depending on the nature of the rocks, and their weathering and erosional environment and history.

End-of-chapter questions

Multiple choice

1 Sial is:

A an oceanic plate

B a type of volcano

C another name for limestone

D the composition of continents

2 Continental collision boundaries are characterised by:

A a wide continental shelf

B high mountains

C subduction of the slower-moving plate

D the formation of rift valleys

3 Folding occurs:

A in sedimentary rocks

B in igneous rocks

C only in oceanic plates

D below the crust

4 Volcanic activity happens because:

A the Earth is warming

B molten rock in the Earth's core is expanding

C weaknesses in the crust allow molten rock to erupt

D all rocks are produced by volcanoes

5 Some landforms on granite are different from those formed on limestone. This is because:

A granite is more resistant than limestone

B limestone is mainly present on subducted oceanic plates

C granite is made up of durable, compacted shell fragments

D limestone is a weak volcanic rock

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Short answer

1 Identify the difference between 2 kinds of landscapes, listing examples of both.

2 Describe 4 different types of volcanoes.

3 Explain why different landforms develop along divergent and subducted plate boundaries.

4 Discuss how the theory of plate tectonics developed.

5 Suggest why folds and faults develop in rocks.

Extended response

To what extent are landforms developed as a result of plate movements? Discuss this question in a short report by giving examples of both large-scale and small-scale landforms, showing your understanding of the role of plate movements in landform development. What other factors may affect landform formation?

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Source 1.26 Lake Cave, Margaret River, Western Australia

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2 Shaping landforms



Source 2.1 Tower karst landscape in Guilin, Guangxi, one of China's popular tourist destinations

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Before you start

Main focus

Geomorphic processes shape the Earth's landforms and soils, and influence our use of landscape resources.

Why it's relevant today

Sustainable human use of land resources depends on knowing how landscapes and soils develop and change.

Inquiry questions

- In what ways do weathering and erosion contribute to landform development?
- How important is water in shaping landforms?
- What is the significance for humans of differences in landforms and soils?
- What are the human causes and effects of landscape degradation?

Key terms

- Accelerated erosion
- Chemical weathering
- Coastal landforms
- Deposition
- Fluvial landforms
- Glacial landforms
- Land degradation
- Physical weathering
- Physico-chemical weathering
- Renewable resources
- Salinisation
- Soil quality

Let's begin

The Earth's surface is constantly being shaped by erosive and depositional processes. Weathering and erosion operate together – weathering produces sediment that can more readily be detached and transported by erosive forces acting on land surfaces, along coastlines and in submarine locations. Water in run-off and rivers is a major erosive force, along with water in glaciers and salt water in oceans. Weathering provides the raw materials for soil-forming processes on land surfaces. The distribution and nature of soils have important impacts on agricultural activities and productivity. Human use of soils has led to accelerated erosion, which may threaten soil as a renewable resource.

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2.1 Weathering and erosion

constructive forces those that build new landforms or add to those already there

destructive forces those that wear down and degrade landforms, infrastructure and property

weathering the breakdown of rocks and sediments into smaller particles or a solution

erosion the process of transferring rocks, sediment or solutions (transportation) from one place to another (deposition)

sediments fine particles of rock, including mud, sand or silt, and gravel

The Earth's surface is constantly being changed by a combination of **constructive** and **destructive forces** acting at different rates. Large-scale plate movements, tectonic uplift and volcanic eruptions contribute to new or higher areas of ground. At the same time, these surfaces are continuously being worn down by **weathering** and **erosion**, and the products of these processes accumulate as **sediments** in lower parts of continents and oceans. Both constructive and destructive forces are operating, but with different intensities and effectiveness at different times and in different places. As plate movements occur slowly over millions of years, many landforms that are visible now have to be considered as outcomes of very lengthy processes taking place over geological time. Human time frames are very short in comparison.

Weathering and erosion are closely linked, sometimes being so connected that it can be difficult to separate them. For example, the **transportation** of already-detached **quartz** grains by wind can cause these grains to then **abrade** against a rock and detach additional particles. On a windy day at the beach, sand grains will impact against bare legs and do the same to any rocks exposed nearby. Loose grains on rock surfaces will then be removed and transported by the wind. If local **topography** is sloping and water erosion is active, weathered materials will be transported away from their original site and moved further downslope. Sometimes sediments will be transferred directly into **drainage networks**, but more usually sediment transport on hill slopes is a 'stop–start' operation, with temporary storage points in small **depressions** or flatter areas. Sediment that enters drainage lines following heavy rainfall will make the water **turbid**; this water becomes visible in **estuaries** and in any rivers entering the sea.

transportation the carrying of sediment from one place to another

quartz rock composed of silicon dioxide; a hard mineral that resists weathering

abrade to wear down by rubbing against something

topography the layout of the land

drainage network pattern of gullies, streams, rivers and lakes in a drainage basin that allows water to flow to the lowest point

depressions sunken places or hollow surfaces

turbid cloudy or muddy

estuary a body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the seawater

ACTIVITY 2.1

1. Explain how weathering and erosion alter the Earth's surface.
2. List iconic landforms and landscapes that have been affected by weathering and erosion.
3. Identify areas in your local area that have been affected by weathering and erosion.

RESEARCH 2.1

Dams, channel straightening and drainage can contribute to the degradation of riverine and wetland landscapes. Complete online research and, in a short report, describe the effects of these human activities on the quality of these landscapes.

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Weathering processes

Erosive forces act on both rocks and sediments, but sediments are more vulnerable to being transported. Weathering thus provides the largest source of raw materials that can be made available for transport by erosion. As well as preparing rocks for transport, weathering is a process that continues to act on the resulting sediments. Weathering processes may be **physical** or **chemical** in nature, or a combination of both (**physico-chemical**). In addition, biological processes act through physical and chemical mechanisms. All weathering and erosion are affected directly or indirectly by climate, and processes operate with varying efficiencies both between different climates and in different rocks or sediments. Humans contribute to rock breakdown by constructing road and rail cuttings, **open-cut** and underground mines, and quarries. Sulphur dioxide pollution also increases weathering rates of many rocks, but especially limestone and marble.

physical (or mechanical) weathering processes that break up rocks into smaller pieces without chemical change

chemical weathering changes to the composition of the rock as a result of interaction between elements in the air or water

physico-chemical weathering a combination of physical (mechanical) and chemical weathering

open-cut mining (also known as open-pit or open-cast mining) extracting rocks from the earth from an open pit

RESEARCH 2.2

Mining, quarrying and urban development are human activities that impact on **landscape quality**. Select one of these types of human activity and examine its effects on landscapes by completing online research. Present your findings in the form of a PowerPoint presentation. Be sure to include photos and diagrams to illustrate your points.

landscape quality the human value placed on the condition and aesthetic appeal of a landscape

Geographical fact

Humans are effective geomorphic agents. In the United States, more than 400 000 tonnes of rock were blasted off Mt Rushmore to create giant sculptures of four presidents on the mountainside.



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Physical weathering

sheeting fractures large-, medium- and small-scale cracks that develop in rocks that have been subject to pressure and that do not have other existing fractures to allow for the release of pressure

insolation weathering heating of rocks by the sun, causing thermal expansion and fracturing with heating and cooling cycles

weathering by fire flaking or slabbing off in fire

abrasion rocks or sediment impacting against each other, usually when being transported by water, wind, ice or ocean waves

compressional caused by squeezing from the side

overburden material (usually rock) overlying a resource found close to the surface (often coal) which can be removed to access the resource

Physical or mechanical weathering refers to processes that fracture or break up rocks and sediments without chemical alteration being involved. The main physical weathering processes include **sheeting fractures**, **insolation weathering**, **weathering by fire** and **abrasion**.

Sheeting fractures

Pressures causing sheeting fractures may be **compressional**, from plate movements for example, or from the enormous weight of **overburden**. For rocks like granite, which crystallise slowly at depth, the overburden may well be several kilometres thick. Erosion at the Earth's surface can gradually remove the overlying sediments or rock, allowing previously compressed rock to expand. Although we tend to think of rocks as being strong and brittle, even rocks like granite are slightly **elastic** and can expand a small amount when pressure is removed. However, this elasticity is limited and the rock will eventually fracture. The number of fractures depends on rock strength and the amount of stress in the rock. Because the **morphology** of this kind of 'decompression' sheeting fracture is determined by the direction of pressure release (overburden removal), many of the fracture planes follow the approximate shape of the topography. Fracture frequency is greater near the surface where the greatest amount of pressure release has occurred, and cracks also become more open near the **outcrop surface** than at depth.

elastic able to expand without breaking

morphology form and structure of shape of landform

outcrop surface exposed rock surface

Granitic rocks at depth are dangerous for miners, as the pressure release created by mine tunnels will cause slabs of rock to explode off tunnel walls. These rock bursts are a particular problem in gold mines in South Africa that are more than 3 kilometres deep. In the thick sandstone beds near Sydney, cuttings for the F3 freeway allowed rock to expand towards the road and then fracture. Rock

Source 2.2 Sheeting on granite in Yosemite National Park, United States (scale is given by figure on the right)



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fragments fell into the guttering and on to the road, so heavy-gauge wire netting was installed to trap rock chunks at the bottom of the cutting. These examples show that sheeting fractures can develop in **cohesive** rocks of different types in any climate, and they have been described in many countries including Sweden, central, western and southern Australia, North America, tropical Brazil and India.

cohesive holding together strongly with few fractures or weak spots

ACTIVITY 2.2

Use the web to find two examples of sheeting fractures in rock outcrops. (Hint: look under 'sheeting fractures and exfoliation domes', and also under the names of individual inselbergs such as Stone Mountain.)

1. Note the location of each rock outcrop and its rock type.
2. Compare the number of sheeting fractures, or their size or spacing, in each of the outcrops.
3. Discuss the uses that humans are making of the rock outcrops.

Insolation weathering

Insolation weathering was originally proposed as a mechanism for physical breakdown of rocks in hot deserts, where daytime air temperatures can exceed 50°C. Rock is a poor conductor of heat, so rock surface temperatures can reach 80°C. Because temperatures within rocks respond slowly to daytime heating and night-time cooling, a layered pattern of rock expansion and contraction develops. Some geomorphologists believe that these temperature variations within a rock are sufficient to cause rupture in the form of fine fractures, including in temperate climates with much smaller daily temperature variations. Even if temperature changes do not directly produce rock fracturing, the overall expansion and contraction of rocks containing minerals that themselves expand at different rates are probably enough to slowly weaken the rock for other forms of weathering.

Weathering by fire

The extreme case of heat application is that of rock breakdown by fire, in which temperatures can exceed 600°C. The surfaces of cohesive rocks like granite will flake or slab off, as occurs in the Pilbara region in Western Australia, while sandstone in the Blue Mountains will flake off and also crumble. Fire is dependent on vegetation, climate and weather conditions, so weathering by fire can occur anywhere that fire does. The combination of extreme heat and sheeting fractures in rocks has been exploited in quarrying in India, where several fires are used to split rock in granite quarries. After a blunt chisel is driven about 10 cm into the rock, a small fire is lit over it and maintained for several hours. Heat from the fire travels to the base of the chisel and creates fractures, a system of rock splitting also used in Europe that pre-dates the use of dynamite. Very carefully controlled heat distribution and placing of fires are needed for this method to be successful.

Abrasion

In streams, gravels and large stones will eventually abrade and become rounded rather than angular in shape. Wind can readily transport sand-sized particles of quartz, usually within a metre of the surface. If the tool-laden wind impacts against softer rock like limestone, the rock will be undercut by this abrasive action. Glaciers drag fine sediment and boulder-sized material over rocks, creating abrasion grooves and smooth, **glacially polished** surfaces, even in granite. Similarly, if ocean

glacial polish smooth and sometimes shiny rock surfaces created by debris transported under moving glaciers

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waves carry along rocks or sediment, their powerful action can abrade rocky shores. Abrasion can also be seen at less dramatic scales – for example, flights of steps made of sandstone or marble are abraded by humans walking on them (look for the slight hollowing on steps), and glass becomes frosted if left close to the ground during a sandstorm.



Source 2.3 Fire weathering of sandstone in the Blue Mountains, New South Wales. Rock flakes have fallen to the ground, exposing pale sandstone patches.



Source 2.4 Glacial polish on granite in Yosemite National Park, United States

ACTIVITY 2.3

1. Suggest why the distribution of insolation weathering is strongly affected by climate.
2. Explain why weathering by abrasion can take place in a variety of climates.
3. Assess whether greater amounts of weathering are likely to be caused by fires or by abrasion.

RESEARCH 2.3

Erosion and sedimentation can be caused by various human activities. Analyse the effects produced by walkers, off-road vehicles and/or mountain bikes. How do these effects impact landscape quality? Prepare an oral presentation for your class.

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NOTE THIS DOWN

The physical weathering processes of insolation and rock breakdown by fire both involve temperature change, but abrasion does not. Copy the graphic organiser below and fill in the blanks with climatic environments and possible locations in which to find examples of each process.

	Insolation weathering	Weathering by fire	Abrasion
Kind of climate/s where found			
Possible location to find an example			

Physico-chemical weathering

frost shattering a process that occurs when water in cracks and crevices in rocks freezes and expands, causing the rock to shatter

salt weathering physical weathering of rock by the growth of salt crystals

In practice, physical disruption may be followed almost immed-iately by chemical alteration, or a chemical reaction may involve a volume change that fractures minerals or rocks. Several other processes that result in rupture of rocks or minerals involve water, so chemical alteration often accompanies physical weathering. These physico-chemical weathering processes include **frost shattering** and **salt weathering**.

Frost shattering

The process of frost shattering has two components: temperature variations and water. However, for the process to operate, the rock must be **permeable** and allow water to enter. Just having frozen water sitting on the surface of a rock will not cause it to fracture. When water freezes within a rock, it will occupy a larger volume than liquid water and create pressures. Ice is slightly plastic, but if water in a **pore space** or crack freezes first at the surface, then gradually into the space, the surface ice acts as a plug that forces within-rock ice to press against pore or crack boundaries. For water to become frozen within rock, surrounding temperatures of around –5°C are needed. Predict-ing the effectiveness of frost shattering by using air temperature records means that the number of frosts (that is, air temperatures of zero or less) is not a useful measure – these temperatures are not low enough to freeze water in rock. The duration of –5°C episodes is also important, so the process is complex. Geomorphologists have argued about whether the prolonged 'deep freeze' in Siberia and Antarctica is more effective in weathering than numerous freeze–thaw cycles each year, as occurs in cold temperate climates. Because frequent freeze–thaw cycles result in many applications and releases of stress, this situation is now generally thought to produce greater rock breakdown. Once water enters a rock, it will also react chemically with rock minerals.

permeable having interconnected pore spaces into which water can move

pore space tiny air space in weathered rock or sediment

Geographical fact

The average maximum daily temperature remains below 0°C for three months each year in Moscow, Russia, where the lowest minimum temperature of -42.2°C was recorded in 1940. In Siberia, two small towns have recorded minimum temperatures of below -67°C.

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Salt weathering

Salt weathering requires a salt source, water to take the salt into solution, permeable rocks and alternating wet and dry conditions that result in solution/crystallisation cycles. When salts are present in climates where frost shattering takes place, weathering is greater than if frost shattering is acting alone. This combined effect has been noted along some shorelines in Britain. As a salt crystal will occupy less space than the same salt crystal in solution, it may seem logical that salt crystallisation is not the reason for rocks and minerals fracturing. However, salt crystals grow in one direction and do not necessarily accommodate to the shape of the pore space in which they are formed. This means the salt crystals are exerting pressure within the rock as they grow. Salts can also cause chemical alteration of minerals.

In Australia, salt weathering occurs in arid and semi-arid regions, along the coastline and in places where **saline** groundwater emerges. Arid Australia has numerous **playa** lakes, and salts build up in these zones of interior drainage. Any rocks exposed around the playas are subject to breakdown by salts, and this occurs frequently in the granite shield areas of Western Australia. On rocky coasts, salts contribute to the development of cavernous weathering features, like those at Remarkable Rocks in South Australia, and smaller-scale **honeycombing** is common in sandstones and shales along coasts.

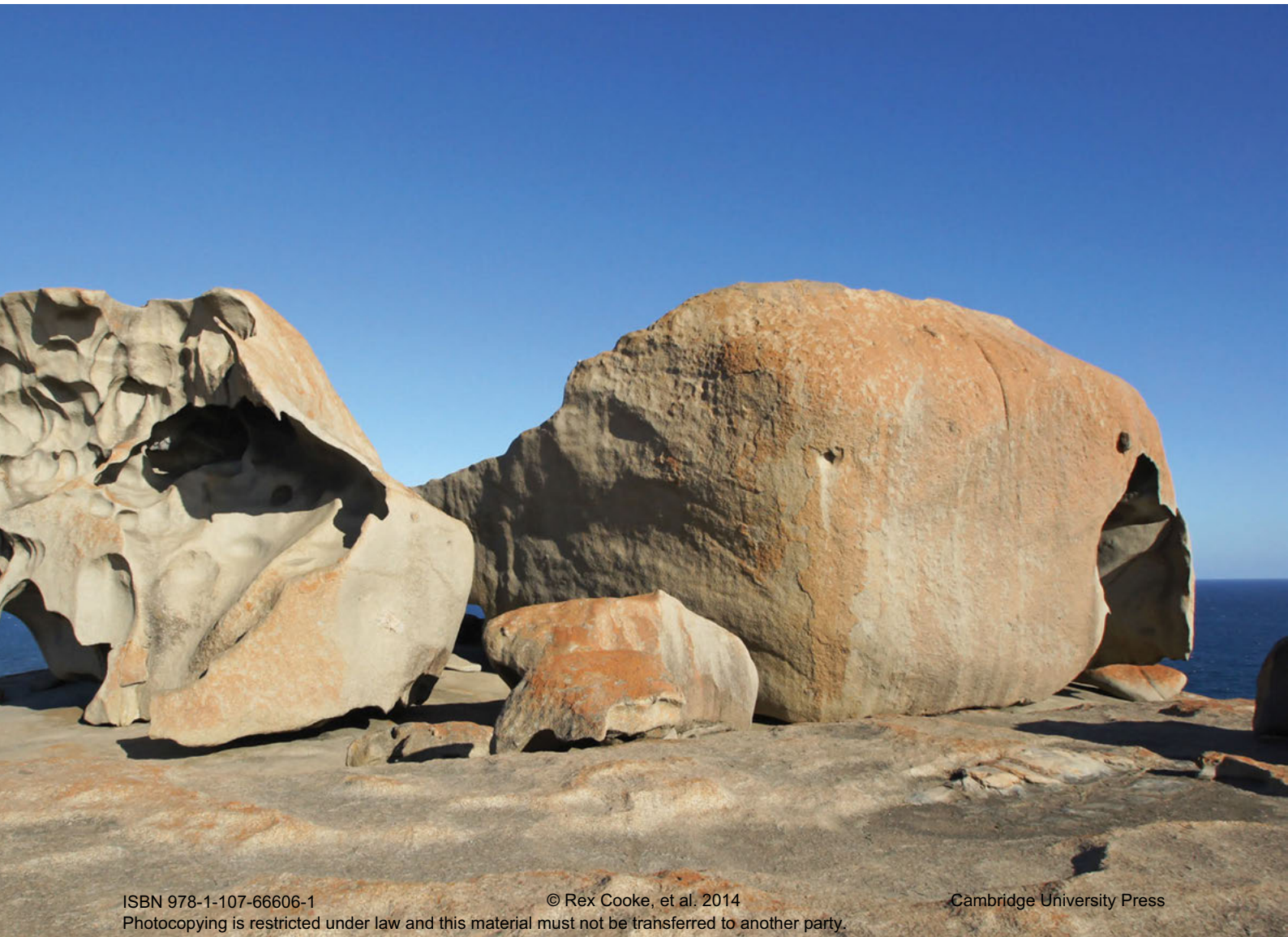
saline high in levels of salt

playa a lake, usually in an arid or semi-arid area, where local streams drain into a low-lying area that is often dry for long periods

honeycombing a network of pits several centimetres deep that looks as if bees have made a honeycomb in rock

sea walls rock or concrete walls erected to stop the sea from eroding a land area

Source 2.5 Cavernously weathered granite sheets at Remarkable Rocks, Kangaroo Island, South Australia



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Wherever **sea walls** have been erected, there will be evidence of salt weathering – usually in the form of honeycombing, small-scale pitting, flaking or crumbling. So-called 'rising damp' in houses often involves destructive salts, especially in heritage buildings where damp courses are either absent or have deteriorated. Such problems are common in Sydney, Adelaide and the Pilbara.

RESEARCH 2.4

Urban development, marinas and sea walls are built elements of the environment that affect coastal landscape quality. Investigate the effect of a built element on the quality of a landscape by completing online research. Present your findings in the form of a poster with photos and diagrams.

Geographical fact

Honeycomb weathering developed in less than 40 years in a dark-coloured variety of sandstone used to construct a sea wall in Victoria. Weathering was concentrated in the spray zone of frequent wetting and drying (crystallisation and solution of salts).

ACTIVITY 2.4

1 Copy the table below and identify the requirements for (a) frost shattering to be an effective weathering process, and (b) salt weathering to be effective in rock breakdown.

Requirements for effective frost shattering and salt weathering

Frost shattering	Salt weathering
1.	1.
2.	2.
3.	3.
4.	4.

2 Are there any similar requirements for both processes, which could mean that they act together under certain conditions?

3 Using a map of Australia, consider regional differences of climate, and discuss the probable distribution of frost shattering and salt weathering.

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Chemical weathering

Chemical weathering or decomposition processes include **solution**, **hydration**, **hydrolysis** and **chelation** (involving organisms). In all these processes, the presence of water is essential.

solution a reversible process of ions dissolving in water

hydration a reversible process of water combining with a mineral

hydrolysis an irreversible process of water combining with a mineral to form a new mineral

chelation chemical weathering process involving removal of ions from minerals by organic compounds

Solution involves the dissolving of minerals in water – common salt (the mineral halite, composed of sodium chloride) is a simple example of this. For rocks like limestone, which are susceptible to acid weathering, rainwater is an effective weathering agent. Carbon dioxide from the atmosphere is taken up by rainwater, giving it a pH of about 5.6. In the presence of acid pollutants like sulphur dioxide, the pH of rainwater can fall below 4, sharply increasing weathering rates.

Hydration involves the combining of water with a mineral in such a way that the only change is the addition of water. A simple example is that of anhydrite (anhydrous calcium sulphate $CaSO_4$), which becomes gypsum ($CaSO_4.2H_2O$) in the presence of water. In the field, both minerals are formed by evaporation and, if they occur in the same profile, anhydrite will be at the surface where most evaporation takes place and gypsum at lower depths. The hydration process is reversible.

Hydrolysis also involves the addition of water to a mineral, but a new mineral is formed as the water molecule does not persist. In weathering of granites and basalts, hydrolysis is the important process that produces **clay** minerals, which have a different chemical composition from that of the 'parent' mineral. Most clay minerals are formed from weathering of light-coloured **feldspars** or dark-coloured iron-bearing minerals, and have a complex layered structure when viewed in a scanning electron microscope. Clay minerals are too small to be seen by the naked eye, but their presence in weathered rocks can be observed by changes in mineral colour. Some minerals become dull; iron-bearing minerals that are black when fresh show a reddish tinge and feldspars will become a dull pale yellow. This can be observed in road metal, in cemeteries and in buildings where some fresh stones have replaced weathered ones.

clay small mineral particles with a diameter of less than about 0.005 mm

feldspars a widespread group of minerals in igneous rocks, possibly making up nearly half of the Earth's crust

Unlike stone that has recently been quarried, rocks that have been exposed for some time often have **lichens** growing on them. Lichens have both mechanical and chemical effects. When lichens are physically pulled from rocks, crystals are usually detached as well. In addition, lichen acids mobilise ions from within minerals in the rock, causing weathering. This chelation process is very effective in the early stages of weathering. Because lichen weathering raised concerns about deterioration of Aboriginal rock engravings, many years ago a program of chemical lichen removal was undertaken in Western Australia. This made the engravings more visible but probably led to other weathering processes taking over. At a larger scale, vegetation like grasses, trees and shrubs uses crevices to cling to rock surfaces. Minerals in contact with root systems are chemically altered, and the growth of tree roots can physically force apart joints in rock and heave up footpaths.

lichen a flat-lying symbiotic association of algae and fungi that adheres firmly to rocks and plants



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RESEARCH 2.5



Source 2.6 Statues or buildings (a) Taj Mahal (b) Angkor Wat (c) the Sphinx (d) Mt Rushmore

Divide the class into four groups and select one of the following statues or buildings:

- Taj Mahal (UNESCO World Heritage)
- Angkor Wat (UNESCO World Heritage)
- the Sphinx (of Giza)
- Mt Rushmore.

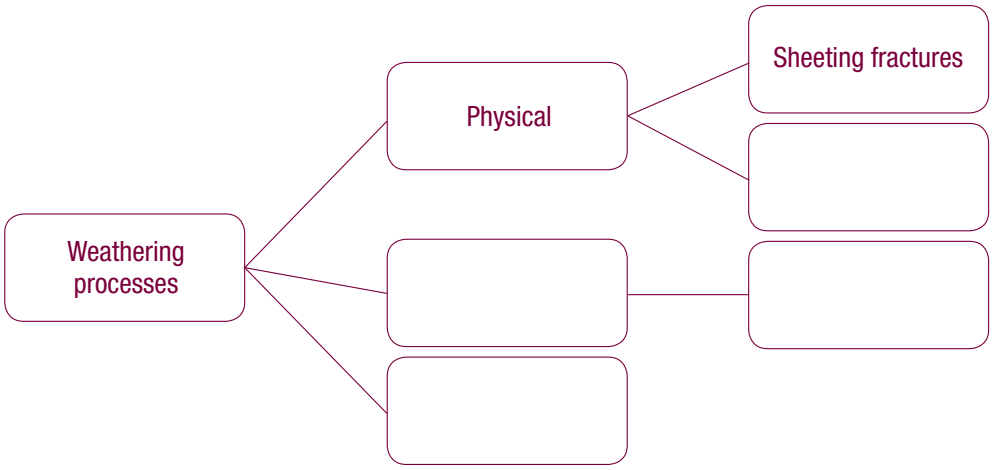
Answer the questions below by completing online research and present findings in a PowerPoint presentation to the rest of the class.

1 Find out where the statue or building is located.
2 Note the type of rock that was used to make the statue or building.
3 Identify the climatic environment of the statue or building.
4 Make a list of the 4 statues and buildings in order of 'most weathered' to 'least weathered'.
5 Describe the kinds of weathering processes likely to be operating on each of the statues or monuments.
6 Explain why some statues or buildings are more weathered than others.

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NOTE THIS DOWN

Copy the graphic organiser below and summarise what you have learned about weathering processes.



Water and landform development

Water, as a solid or liquid, comes in three main forms: fresh water on land surfaces, salt water in oceans and frozen water in extremely cold regions. In each case, different groups of weathering and erosion processes operate and often different landforms result. On land, water contributes in many ways to weathering and erosion. It is an essential ingredient for many chemical processes that decompose rock minerals and sediment; it takes elements into solution and transports them far from their source; it can redistribute salts in groundwater; above ground, it can detach and transport sediments; it can provide the mechanism for sediments to abrade surfaces; it can saturate sediments and make them prone to mass movement and landsliding; and it contributes to the development of a multitude of landforms at different scales.

Run-off

Still or stagnant water can weather rocks and sediments, but water needs to be moving for erosion to occur. Rain falling over land surfaces may collect on vegetation if rainfall has a low intensity and duration, or infiltrate into the ground – especially if the land is dry. If rainfall is heavy, it may exceed the capacity of vegetation and the ground to trap it. In this case, water will start to flow over the land surface as **overland flow**. Because the ground is rarely perfectly smooth, small **eddies** and turbulence are created, and this increases the water's capacity to detach particles from the surface. Initially, this detachment involves irregular water movement, but then water starts to become concentrated into **rills**. Even though small and discontinuous at this stage, and not even reaching a main channel, rills represent locations where water has moved sediment downslope. They also act as pathways for subsequent water flow, gradually enlarging until they may develop into **gullies**. Gullies also may not reach the nearby main stream but their size shows the amount of sediment that has been removed from slopes. Often, a short gully will have a small **alluvial fan** at its mouth. This is a neat erosion and **deposition** system where we can see the

overland flow unchannelled run-off flowing over land

eddy water running contrary to the main current

rills very small and shallow channels formed by running water, initially measuring less than a few centimetres long and less than 1 cm deep, but developing into channels up to 30 cm deep

gully a deep channel, usually with very steep sides, carved into sediments on sloping ground

alluvial fan water-deposited sediment that spreads out into a fan shape when viewed from above

deposition the last stage of the erosion process, when the material being moved settles on a surface

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main site of erosion (the gully) and the sediment that came from it (the fan). At much larger scales, fans in the Mojave Desert in the western United States extend for kilometres. Large boulders on these fan surfaces have been transported from the steep and mainly unvegetated catchments by intense stormwater **run-off**. Over geological time, alluvial fans may come together and later be reworked to form an extensive alluvial plain.

run-off water (from precipitation, glacier or snow melt, or groundwater seepage) that flows over the land and collects in rivers, lakes, seas and oceans



Source 2.7 Gully system with channel and fan in Tibet



Source 2.8 Gully at Tenterfield, New South Wales

Rivers

Many valleys are V-shaped in cross-section, with most water flow and sediment transfer taking place in channels at the point of the V. Some channels are also V-shaped, but others – especially in drylands like the area around Broken Hill in New South Wales – have rectangular cross-sections. If clayey sediments are eroded by gullies, the channel sides are gently sloping (a 'flat' V), compared with silty and sandy sediments. These channel shape characteristics of gullies are sufficiently common that the nature of sediments can often be predicted before detailed field observations are made.

Rills and gullies act as pipelines for sediment transfer from upstream hill slopes to main channels. Sediment is often delivered to a stream, transported for some distance, then temporarily deposited. This can be seen in the fine muddy deposits in hollows within the beds of intermittently flowing channels. When the stream does flow, the interrupted journey of the sediment will recommence, and it will be transported further downstream. Large rivers may also temporarily deposit sediment within their channels, usually as a result of **meandering** or a period of relatively low flows that are unable to keep transporting all sediment delivered to the stream. Large rivers entering the sea often carry massive amounts of clay, silt and sand, and these are deposited at the river mouth in the form of a **delta**. The Mississippi, the Nile and the Ganges are all extensive river systems reaching the sea and depositing sediments on gently sloping **continental shelves**. In the case of the Nile delta, the amount of sediment has become less over time due to the sediment-trapping effect of the upstream Aswan Dam and increased erosion on the delta's coastal margin. In the Nile's flood plain reaches, the nutrient-rich sediment it carries acts as a natural fertiliser, which is spread over agricultural land when the river floods each year.

meandering a series of wide curves and loops of a river channel when viewed from above

delta fan-shaped deposit of river sediments found at the mouth of a river

continental shelf gentle slope offshore from most continents to about 180 m, where there is a sharp drop to the floor of the ocean

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Geographical fact

The Huang He (Yellow) River in northern China is more than 5000 km long and carries enormous amounts of sediment – mainly silt from the **loess** regions upstream. Over a prolonged period, levee banks have built up naturally and the level of the stream bed has also risen due to sediment being deposited. The high-water level of the river currently flows at a height of between 9 and 11 m above the surrounding plain, a situation that causes massive flooding when the levees are breached. Due to the large population living near the river, major flooding and high tides may have killed more than 3.5 million people in 1931, and about one million in 1887. Flooding is a particular problem because of low to negligible riverbed slopes – for the last few hundred kilometres of its journey, the Huang He descends only 5 cm per kilometre. Because of the river's large sediment load, the delta at its mouth grew by more than 19 km in the century up to 1970 and covers more than 5000 km^2. Upstream, dam construction has now led to 'sediment starvation' and the delta is actively being eroded on its seaward margins.

loess extensive deposits of silty sediments, probably windblown, which develop almost vertical slopes when eroded by water

Source 2.9 The Huang He, called the Yellow River due to the colour of the sediment (loess) that it carries



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When rivers overflow their banks, they can deposit sediment near the channel. Over time, these deposits may become continuous for long distances and gradually increase in height. These **levee** bank deposits are often augmented by sandbagging in flood-prone locations in the hope of preventing floodwaters from reaching adjacent settlements or farmlands. Often the areas near rivers attract humans not only because of water supplies and navigation but also because of the presence of fertile soils, which have developed from **alluvial deposits** on **flood plains** or **terraces**. It is often difficult to determine in the field whether a feature is a flood plain (flooded often or intermittently) or a terrace (not flooded for a long time).

levee a sediment embankment bordering a channel

alluvial deposits sediments deposited by rivers

flood plain low-lying ground that is subject to flooding from a nearby river

terrace a 'platform' of fairly flat land, often a former flood plain that has become stranded by later down-cutting by the river

RESEARCH 2.6

This research task will involve using a small 'landscape' and adding 'rainfall' (water) in a series of three 'events' leading to 'high-intensity rainfall' (equivalent to a flooding situation). Work through the following instructions and present your findings in the form of a short report. Before starting, note the **texture** of the sediment to be used in the experiment (sandy, silty, clayey or **loamy**).

texture size of the individual mineral particles making up a sediment or soil. Particle sizes are: clay < about 0.005 mm; silt 0.005–0.02 mm; sand 0.02–2 mm. Particles with a diameter > 2 mm are classed as gravel.

loam a sediment with a texture that is a mixture of sand, silt and clay

Rainfall event 1

Using gently sloping bare ground (a safely located road cutting, or 'hills' created in a sandpit), gently sprinkle water ('rainfall') from a watering can over the highest point in your 'landscape' until you have created run-off.

1 Observe whether the water moves as overland flow and/or in tiny channels or rills.
2 Note the number and depth of any rills.

Rainfall event 2

1 Recommence the 'rainfall' event, noting any changes in the number and depth of rills.
2 Observe whether the rills form straight lines or have miniature meanders. (Meanders will only develop if water additions and slopes are gentle.)

Rainfall event 3

1 Recommence, adding a larger amount of water to represent a 'high-intensity' rainfall event.
2 Observe what happens to the size, number and shape of rills, and to the amount and destination of the sediment that has been moved.
3 Discuss the effects of 'rainfall' events on channel formation and sediment movement. Do you think the texture of the sediment used in the experiment influenced your results (for example, if sand was used, did 'rainfall' infiltrate at the beginning before overland flow started)?

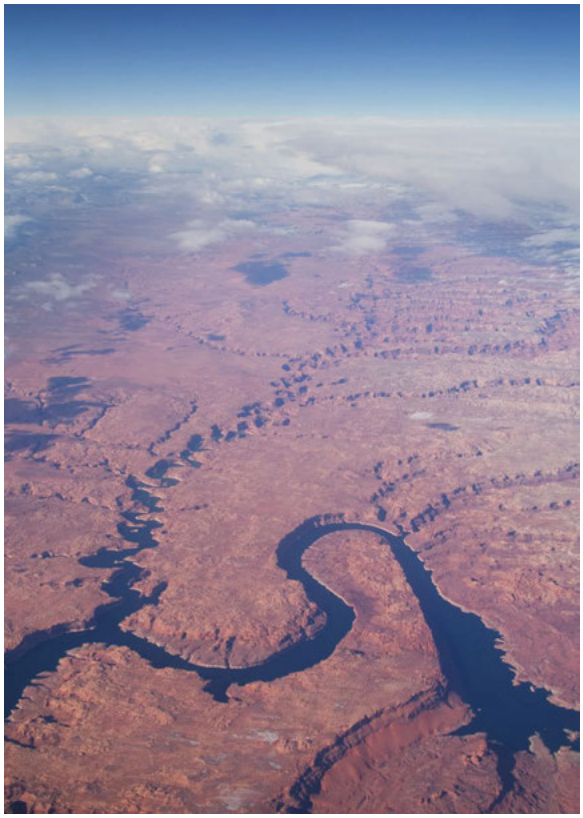
Rivers are agents of both deposition and erosion. The depositional features of fans, deltas, flood plains and levee banks are offset by the erosional features of gorges, waterfalls and V-shaped valleys. Most large-scale depositional features occur in the downstream or low-gradient reaches of rivers, while major erosional features tend to be concentrated in the upper reaches. At a smaller scale, river meanders are prominent in middle and lower river reaches, but they are not static entities, exhibiting both erosional and depositional features. The meandering process

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involves deposition of sediment on the inner sides of curves and erosion on the outer edges, and this takes place continuously unless flow patterns change. Although occurring only during extreme flows, floodwaters can temporarily 'straighten' the river's path by cutting across the necks of meanders to create **ox-bow lakes** or **billabongs**. As a result of this, the locations of individual meanders change over time. If a meandering river is flowing over land that is being uplifted, the existing meanders may become **entrenched** and their pattern may persist for hundreds of thousands of years. The Grand Canyon in the United States is an example of this.

ox-bow lake (billabong) an old looped river meander that has been cut off from the present channel

entrenched meanders those meanders eroded deeply into bedrock and thus unlikely to change their pattern over time



Source 2.10 An entrenched meander, the Grand Canyon, United States



Source 2.11 Wallaman Falls, Queensland, one of the highest waterfalls in Australia

Gorges and waterfalls are also linked to the kinds of rocks in the landscape. Gorges will form when river **downcutting** is vigorous and continues for a long time. As sediments are not as cohesive as rocks, they generally do not provide the deep and steep side-slopes generally associated with gorges. Often gorges are eroded along fault lines or other lines of weakness like **dykes**, as occurs at Katherine Gorge in the Northern Territory. This gorge is cut into horizontally bedded sandstone.

downcutting downward erosion of a river through its bed

dykes thin vertical intrusions into other rock types

Waterfalls can be spectacular landforms, like Niagara Falls in North America or the Victoria Falls in Africa. Less well known are the numerous waterfalls around the continental margins of Australia. Waterfalls are located where land surface elevations abruptly change – for example, at the edge of a plateau or where resistant rocks have prevented gradual downcutting of a riverbed. If relatively resistant rocks are horizontally bedded, streams flowing over the edge of eroded sections will create waterfalls. Rock barriers within the riverbed allow for the formation of rapids and both features attract tourists. Waterfalls often

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have a deep plunge pool at their base, and this turbulent water undercuts even stronger rocks above it, causing rock collapse. This is evident at Niagara Falls, where erosion of softer rocks at the waterfall's base leads to collapse of the flat-lying beds at the top of the waterfall. This process has resulted in average upstream waterfall migration of up to 1.5 m each year.

ACTIVITY 2.5

Copy and complete the table below by answering the following questions.

1. Select two large rivers, one in Australia and one in another country.
2. Using information in your table, make two lists of depositional landforms: (a) those associated with both rivers and (b) those present on only one of the rivers.
3. Make two lists of erosional landforms: (a) those associated with both rivers and (b) those present on only one of the rivers.

	River in Australia (name)	River in another country (name)
Rainfall distribution across the catchment (Heavier in some parts than others? The same everywhere? Approximate amounts?)		
Depositional landforms present 1. 2. 3.		
Erosional landforms present 1. 2. 3.		

4. Discuss the similarities and differences in depositional and erosional landforms associated with the two rivers selected.

Groundwater

When water infiltrates into the Earth's surface in sufficient quantities, it moves down to a zone of saturation, the upper limit of which is termed the water table. Groundwater moves more slowly than overland flow, as groundwater can only circulate through small interconnected pore spaces within rock or sediment, but it can still contribute to the formation of landforms. In limestone terrain, **bedding** and **joint planes** allow surface water to enter and take **calcite** into solution, thereby widening any existing weaknesses or fractures. Over time, this may lead to the development of underground streams, which emerge either as springs or as fully fledged rivers fed by underground water. Freshwater springs appear in the ocean off the coast of Montenegro in the Adriatic Sea, and offshore from Yucatán in the Gulf of Mexico.

bedding plane surface between layers of deposited materials or sandstone that make up sedimentary rocks

joint planes vertical, horizontal and angled patterns of cracks in rocks

calcite the main mineral in limestone and marble, composed of calcium carbonate

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karst limestone region where underground water is the main cause of distinctive landforms

karren small grooves or furrows in rock (usually limestone) formed by running water

Limestone regions and those with soluble rocks like gypsum have often developed distinctive **karst** topography due to the action of underground water. On the surface, small-scale features like **karren** are common. At a slightly larger scale, various other features appear: sinkholes, disappearing streams and springs. More extensive landforms, like limestone pavements, karst or flat-bottomed valleys and tropical-region **tower karst**, also occur. When dense, compacted limestone is uplifted, gorges can be cut through the rock. Because surface water tends to disappear quickly into limestone terrain through bedding planes and joints, and then enlarge them, limestone regions are also characterised by the development of extensive cave systems.

tower karst towers or pinnacles remaining after limestone has been weathered in tropical regions



Source 2.12 Karst valley or polje, part of the Zeta River valley in Montenegro



Source 2.13 Racing on salt lake surface at Lake Gairdner, South Australia

Geographical fact

A buried sinkhole in gypsum was discovered recently in Spain after two apartment blocks comprising 362 flats subsided suddenly. The buildings had to be demolished, with financial losses exceeding A$22 million.

Groundwater also affects landforms in non-limestone terrain. In arid and semi-arid Australia, some of the larger salt lakes like Lake Eyre and Lake Frome have very flat surfaces when dry and have been used for world speed attempts for two-wheeled and rocket-propelled vehicles. In 1996, a two-wheeled speed of 1029 kph was recorded at Lake Gairdner in South Australia. The flat surface represents the upper limit of the water table, where sediments below are wet and unable to be transported by wind. So the **morphologies** of these lake beds in dry areas, as for the smaller **lunettes** in semi-arid southern Australia, are mainly controlled by groundwater.

morphology form and structure of shape of landforms

lunette a crescent-shaped dune blown up on the down-wind side of an intermittently filled lake

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Geographical fact

The maximum recommended salt level in drinking water for humans is 1500 mg/L, with good-quality water having <500 mg/L. Beef cattle can tolerate up to around 5000 mg/L and adult sheep about 10 000 mg/L. Seawater has a **salinity** of 35 000 mg/L.

salinity the salt content of water

Groundwater or **artesian water** is important in the drier parts of Australia, where the often brackish water can be drunk by **livestock**. When artesian water is over-utilised, such as in the Great Artesian Basin where some water is up to a million years old, water flow may become **sub-artesian**. Elsewhere in Australia, safe drinking water for humans is found in sandy sediments in Perth, Western Australia and near Newcastle, New South Wales.

artesian underground water that flows freely when bores intersect the sediments in which it is found

livestock farm animals

sub-artesian referring to underground water that has to be pumped to the surface

ACTIVITY 2.6

1 List two landforms developed in limestone by groundwater, and two developed in non-limestone areas.
2 Explain why groundwater is so important to landform development in limestone terrain.
3 In what ways do humans make use of groundwater?

Glacial landforms

Glaciers are frozen 'rivers' of ice that produce landforms distinct from those sculpted by water. Instead of V-shaped valleys, glaciers fashion U-shaped valleys, which may have tributary **hanging valley** glaciers. Because tributary glaciers are smaller, they enter the main valley near the top of the glacier ice and are then left stranded when ice melts. The bulldozing action of glaciers pushes sediment and rocks down-valley or along each side of the glacier and, because of this debris and the weight of the ice, the glacier polishes and **striates** rock surfaces over which it moves. On melting, any rock and sediment it carries is deposited; **erratics** are left stranded far from their source. Glaciated landscapes have sharp ridges, often with **cirques** eroding back towards the summit. Only parts of Tasmania and small areas of south-eastern Australia were affected by the most recent glacial period during the **Pleistocene**. On a global scale, cold areas where surface zones are seasonally or intermittently frozen are referred to as **periglacial** regions. Here, **permafrost** often occurs at depth, and processes of **solifluction** take place at the surface.

Ice sheets or ice caps remain in the Arctic and Antarctic today, but these ice sheets were much more extensive during the Pleistocene. Nearly half of North America and much of Europe was covered

glacier a huge mass of ice slowly flowing over a landmass

hanging valley a tributary valley whose floor lies at a height well above that of the main valley; the junction may be marked by a waterfall

striations gouge-lines in rocks caused by the scraping of sharp debris transported under moving glaciers

erratics boulders carried in glaciers and then left behind when ice melts

cirque armchair-shaped semicircular hollow with a steep back wall and downslope lip found in glaciated areas

Pleistocene a geological epoch characterised by the formation of widespread glaciers between 10 000 and two million years ago

periglacial referring to an area, often near glaciers, where water freezes and melts every year

permafrost permanently frozen ground

solifluction slow soil flow caused by freeze–thaw activity in saturated surface sediments in periglacial areas

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Source 2.14 A hanging valley in Milford Sound, New Zealand

by ice. This left extensive areas of exposed bedrock in northern Canada, where ice pushed sediments out of its path. In the United States, glacier retreat left sediments metres deep over large areas. In many previously glaciated regions, ice retreat has allowed **fluvial processes** to rework glacial sediments and partly reshape valleys. Some glaciated valleys now have waterfalls cascading from hanging valleys and rivers incising V-shaped channels in the bottom of U-shaped valleys.

fluvial processes
processes associated with rivers and streams



Source 2.15 The edge of the ice sheet, Antarctica

Geographical fact

Warming temperatures in the Arctic have started to melt permafrost, which covers nearly a quarter of the Northern Hemisphere landmasses. When it melts, permafrost releases large amounts of carbon dioxide and methane. Estimates indicate that melting permafrost will release as much carbon dioxide as 40% of the emissions from human sources between now and 2100.

When glaciers melt and ice caps retreat, glacially sculpted features remain in the landscape. Cirques may now hold lakes, and areas of glacial polish may remain. Glacial striations on bedrock can persist when buried for millions of years, like the striations at Selwyn Rock in South Australia. Grooves on this rock formed during the Permian period (around 270 million years ago). First described by the Victorian Government Geologist ARC Selwyn in 1859, the exposure was later named Selwyn Rock. The site is now a scientific and tourist attraction.

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Landforms of varying sizes can persist over thousands or millions of years, if weathering and erosion have not been too severe since their formation and the landform itself is resistant. Some examples include large rivers with their waterfalls, gorges and entrenched meanders; cave systems in limestone terrain; groundwater-controlled playa bed morphology; and certain glacial landforms. Where major climatic change has taken place over geological time, erosion-resistant landforms can persist in places like arid Australia. During the **Miocene**, which ended about 5 million years ago, the climate in central Australia was wetter and warmer, allowing the development of hard, silica-rich deposits, which have partly survived to the present day.

Miocene a geological epoch characterised by the development of grasslands and grazing mammals

Geographical fact

Following the Japan earthquake and tsunami in 2011, scientists used satellite imagery to follow the breaking off of huge icebergs from the Antarctic ice shelf. This shelf section of ice-bound Antarctica had extended out over the ocean and already had some weaker points, so was vulnerable to changes in sea conditions. By the time the tsunami swell travelled for 18 hours over the 13 000 km from Japan to Antarctica, it probably only had a height of about 30 cm. However, in order to reach Antarctica the wave had hit various islands and its movement became chaotic, making it much more damaging than its 30 cm height would suggest. The 80 metre thick shelf ice was directly in the path of these erratic ocean movements, causing about 150 km^2 of new icebergs to be broken off.

ACTIVITY 2.7

1 Copy and summarise in the following table the characteristics of (a) glaciated landscapes and (b) landscapes eroded by rivers.

Characteristic	Glaciated landscapes	Landscapes eroded by rivers
Valley shape (in cross-section)		
Steepness and shape of hilltops/ ridges		
Erosional feature/s on hill slopes		
Tributary junctions (**accordant** or **discordant**)		
Depositional features in valleys? (yes/no)		

2 Suggest how we can recognise that a landscape has been glaciated in the past when there are no glaciers present now.

3 Explain why some landform features occur only in glaciated landscapes and are not present in landscapes eroded only by rivers.

accordant being in agreement or harmony (e.g. the same height)

discordant at different heights, as occurs with hanging valleys as can be seen in areas where glaciation has occurred in the past

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Coastal landforms

Landforms along the coast are formed by the same general processes that operate elsewhere, except that here the water involved is saline, and the water body is sufficiently large to generate additional internal movements (tides and currents) that impact on the land–ocean interface. As with all water bodies of any size or salinity, strong winds can cause waves to develop. During storms, ocean waves can impact with great force on rocky coastlines and beaches, leading to cliff retreat and beach erosion. The less frequent but highly destructive waves (tsunamis) caused by earthquakes transport large quantities of sediments and debris far inland, and so have both an erosive and a depositional action.

Geographical fact

When the ship *Pasha Bulker* ran aground following a storm at Newcastle, New South Wales in 2007, major salvage and re-floating efforts were made to move the ship to the open ocean. This operation was timed to coincide with high tides to make re-floating easier, but it still took three high-tide attempts before the ship could be towed out to sea.

Tides

Tides are caused mainly by the gravitational pull of the moon and secondarily by the sun. High tides occur when the moon and sun are aligned, and the largest tides during the year are recorded when the Earth is closest to the sun. At any one place there are usually two high tides and two low tides daily, with variations in tide height relating to new and full moon phases. Knowledge of tides is important for commercial and recreational fishers, for navigating ships in near-coastal waters, for constructing bridges or roads at safe heights and for estimating the distribution of pollutants in estuaries.

tidal range difference in height between low tide and high tide

The largest **tidal range** of 15 m occurs in the Bay of Fundy in Canada. When tidal ranges are very large, there are usually local topographic and seabed features that contribute. The continental shelf in north-west Western Australia is wide and gently sloping, so that waters are relatively shallow even at high tide. The town of Derby in King Sound experiences **macro-tides**: the tidal range can reach up to 11.8 m. At low tide, the ocean may be tens of kilometres from shore but when the tide turns, seawater is pushed from the deep ocean over the continental shelf. Due to the low gradient, this movement is rapid. When the ocean reaches King Sound, the rising tide of seawater is confined by the funnel-shaped topography. The tide will continue to rise regardless of obstacles, so the surface of the seawater is forced upwards.

macro-tide tide with a wide daily tidal range



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ACTIVITY 2.8

1 Select one place from each of the following two lists. Identify the location of your two selected places.

List 1 (select one)	Location (country and description)	Tidal range (m)	List 2 (select one)	Location (country and description)	Tidal range (m)
Broome			Newcastle		
Avonmouth			Athens		
Bay of Fundy			New Orleans		

2 Explain why tidal ranges are different at these two locations, using descriptions of the locations found on the internet.

3 Analyse why is it is important for humans to be aware of tidal ranges.

Ocean currents

Ocean currents are large-scale, continuous flows of seawater that follow a definite path. Currents can be either mainly at the surface or in ocean depths. At depths of less than 400 m, the so-called near-surface ocean currents are mainly driven by winds. These currents have a generally clockwise direction in the Northern Hemisphere and an anti-clockwise one in the Southern Hemisphere. In ocean depths, surface winds are not relevant and movement of seawater there is controlled by temperature and salinity differences. Deep ocean currents are thus referred to as **thermohaline currents**.

thermohaline currents ocean currents resulting from temperature and salinity differences that create density differences

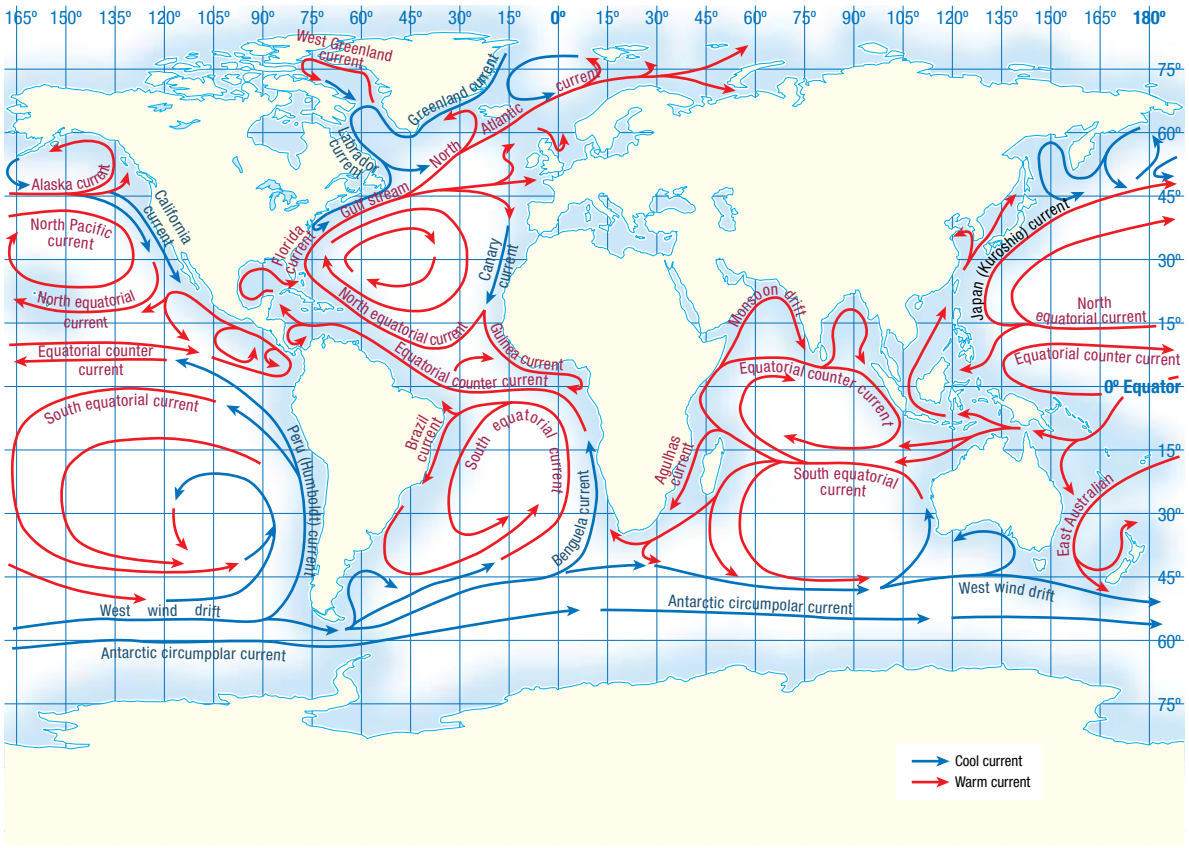
precipitation water that falls from clouds and may be in the form of rain, hail, snow or sleet

In high latitudes, colder surface water sinks to the ocean depths, creating a turnover of water. Reduced salinity can be caused by inflows of fresh water from large rivers, melting of freshwater ice and **precipitation**, while increased salinity results from high evaporation rates and the formation of sea ice. Because of the different nature of near-surface and deep-ocean currents, near-surface currents are dominated by wind-driven mainly horizontal movement, while deep-ocean currents allow for substantial vertical mixing of ocean waters.

The Gulf Stream and associated North Atlantic Drift in the Atlantic Ocean constitute one of the world's best known major ocean currents. It is driven by both wind and water-density differences, as the northern ocean waters have relatively low temperatures due to cold winds. This colder, denser surface water gravitates towards the deep ocean, where it continues moving towards the warmer equatorial waters, which are then pushed northwards. A large oceanic circulation is thus established, and this leads to annual temperatures in the United Kingdom and north-west Europe being probably 5°C warmer than expected for their latitude. In addition, warmer waters attract larger fish populations, so economic effects are also positive.

In contrast, the Humboldt current flowing from the cold region of Antarctica northwards along the coast of Chile brings colder conditions than would otherwise occur. Western Australia also has a north-flowing cold current originating in Antarctic waters, but eastern Australia is affected by south-flowing and warmer equatorial waters. Each of the major oceans has its own system of currents due to continents interrupting oceanic flows. As there are no continents to obstruct currents flowing around Antarctica, the west wind drift is the only uninterrupted global current.

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Source 2.16 World map of ocean currents

The shoreline

Weathering processes along the shoreline are the same as those operating on any land surface, with the exceptions that salt weathering is very pronounced and effective, and cliffs can be destabilised by the force of waves trapping air in fractures. This **hydraulic action** can loosen blocks of sandstone or other jointed rocks, which then tumble to the cliff base. Once detached, the rock and the intact cliff behind and above it can be abraded by gravel and sand caught up in the waves. Wave action is also turbulent, causing sand grains and pebbles to impact against each other, leading to fracturing for some and rounding for others. This same process of abrasion and wearing down of transported debris operates within stream channels. In addition, the ocean can be viewed as a saline solution, which accelerates some chemical and physico-chemical weathering – especially in the **intertidal** and **spray zones**.

hydraulic action the process of waves compressing air within gaps in the rock, and this air being explosively released when the waves retreat

For most people, the coast means the beach. Beaches can be composed of quartz sands, calcareous sands (broken pieces of shells), volcanic (black) sands or boulders (as at Anna Bay in New South Wales and in places along the Pilbara coastline in Western Australia). Bays are formed by rocky headlands marking the ends of beaches, and some beaches are many kilometres long – for example, the seaward side of the Coorong in South Australia, Ninety Mile Beach in Victoria and Cox's Bazar, which is a 125 km long sandy beach in Bangladesh. The material making up beaches comes from a combination of weathering of rocks along the coastline, wave action transferring sediments from the continental shelf to the beach and rivers depositing their load in the ocean. Sand or other

intertidal zone the area at the edge of a body of water (such as the ocean) that is exposed at low tide and under water at high tide

spray zone the area above the high tide line that is regularly splashed, but not submerged, by ocean water

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longshore drift the movement of sediment, usually sand, shingle or mud, along a coastline driven by the direction of the prevailing wind

groynes low barriers built from the beach into the sea, intended to reduce beach erosion

sediment can be moved along a coastline by ocean currents (**longshore drift**) and be shifted from one end of a beach to the other, or pile up behind obstacles like **groynes** or islands. When sand accumulates downdrift of islands or headlands, **spits** are formed. Erosion of sand from beaches occurs during stormy periods, and these sands often remain for some time on the continental shelf offshore. However, where beaches are important for tourism, as on the Gold Coast in Queensland, authorities will undertake beach nourishment programs that involve moving sand from elsewhere to add to the sand-depleted beach, rather than waiting for natural processes to return sand to the beach.

spit narrow, low-lying line of sand developed naturally by longshore drift and extending from the land into the sea

Geographical fact

Construction industries need more sand than cement for buildings. As sand is a bulky and relatively low-cost material, ideally it should be sourced from close to where it will be used. Many cities do not have large and accessible sand sources. In coastal cities like Sydney, companies have proposed that sand be mined from offshore to meet industry requirements. In late 2012, a Sydney-based mining company submitted an exploration licence to the New South Wales government, the permitting authority for offshore mining (to 3.3 km offshore; beyond that the Commonwealth government is responsible). Debate about offshore mining involves avoiding mining on high conservation value land areas, ecological impacts of offshore mining and the purposes of this mining. Some believe that the sand resource should remain for the present, so that beaches can be nourished when climate change is predicted to cause sea-level rise, increased beach erosion and declining beach sands over the next 50 years. This proposal would be expensive if all Sydney beaches were included in a nourishment program – an estimate of A$700 million for all beaches, but economic benefits for iconic beaches like Manly would far outweigh the costs.

Many beaches have one or more dunes on the landward side. Initially, the sand was transported and deposited by waves, but once a dune is formed, most erosion or reworking is done by wind. Older dunes are often fixed by vegetation, while others become destabilised by fire or human activities (roads or pathways) or have remained naturally unvegetated. Any loss of vegetation exposes the sand to potential movement, as sand is vulnerable to erosion by wind and run-off. Along the New South Wales coastline and in the south-east of South Australia, two or more shoreline dunes are separated from each other by **swales**, which may include swampy ground. Multiple dunes usually have very different ages.

swale low-lying land between two sand dunes

Along some coastlines, mud or mangrove flats replace sandy beaches. Mud can dominate where the continental shelf is wide and shallow, as in many parts of northern Australia. Mangrove-dominated coasts also appear in relatively sheltered and warmer environments, including in the headwaters of Spencer Gulf in South Australia, and in many areas in New South Wales and northern Australia.

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ACTIVITY 2.9

1 List 2 warm ocean currents and 2 cold ocean currents.
2 Explain why some ocean currents are warm and others cold.
3 Discuss the role of ocean currents in distributing sand and sediment along shorelines.

Coastlines may have cliffs, rock exposures and rocky shore platforms. In the Sydney region in New South Wales, horizontally bedded sandstone forms cliffed headlands in which weaker, often shaley beds are undercut, allowing the upper beds to overhang and eventually collapse into the sea. Other coastlines are fixed by exposures of tough rocks, as at Granite Island in South Australia and along the Pilbara coast in Western Australia. Some cliffed coastlines have **shore platforms**, which extend from the cliff out to sea for many metres. A notable example is Long Reef in Sydney, where low tide exposes 100 m of an irregular rock surface, which becomes submerged at high tide. On the cliffed landward edge of the platform, rocks at the base have been undercut to form a **notch**. Many platforms are intertidal and were thought to relate to sea-level changes. Whatever the ultimate cause, weathering on platform surfaces is continuing by a combination of **sub-aerial processes** (especially

shore platform fairly smooth, gently sloping rock surface lying between high and low tide

notch an indent at the base of a cliff caused by wave erosion

sub-aerial processes processes occurring on the Earth's surface

Source 2.17 The Twelve Apostles in Victoria



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chiton a type of hard-shelled mollusc, which moves slowly by strongly clinging to intertidal rock surfaces

molluscs a diverse group of invertebrate organisms

sea stack a pillar-shaped remnant of land that has been eroded by the sea

salt weathering and hydrolysis), wave processes (abrasion and removal of pre-weathered material exposing new surfaces for weathering) and scraping and burrowing organisms like **chitons** and other **molluscs**.

Rocks will always eventually weather, and in so doing may produce interesting morphologies. Along the Victorian coastline, for example, erosion of horizontally bedded limestone has produced a group of **sea stacks** up to 45 m high called the Twelve Apostles. The stacks were isolated from the nearby 70 m-high cliffs as a result of erosion, which formed arches; their tops then collapsed to leave the stacks. Stacks are more exposed to weathering and erosion than cliffs due to their smaller size and exposure on all sides, so only seven of the original 12 stacks are still standing. Tourists are often attracted to another feature of rocky coastlines, **blowholes**. These can develop where rocks have been weathered and eroded to create a vertical 'pipe' or opening. This can happen when rocks are cut by dykes or have especially closely spaced jointing in just one place. For a blowhole to send a jet of seawater into the air, waves must be able to wash into the lower end of the opening, the opening should not be too large, and the wave action or swell should be strong. Water builds up in a blowhole crevice and then a single powerful wave will force much of the water into the air.

blowhole a gap or hole in rock through which seawater is intermittently ejected

ACTIVITY 2.10

Choose 2 places on the coast in Australia, 1 in northern Australia and 1 in southern Australia.

1. Describe the coastal landforms in each area.
2. Identify any differences in landforms between the 2 areas.
3. Explain why coastal landforms may not all be the same in northern and southern Australia.
4. Discuss the ways in which humans have affected coastal landforms in the chosen locations.

2.2 Geomorphic processes and soil development

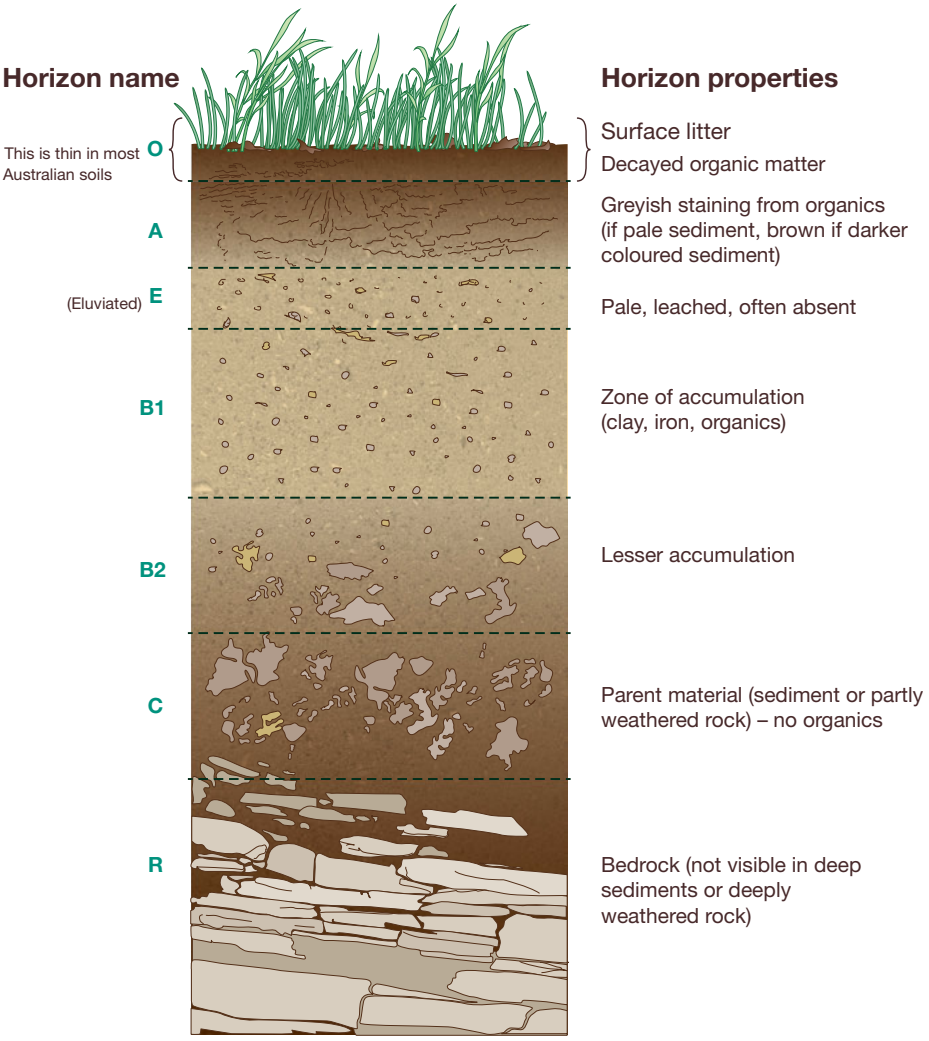
A key outcome of land-based weathering is the sediment produced, in which soils can form. Some researchers have long argued that civilisations rise and fall as a result of various economic, social and climatic factors – but that in all cases of social collapse there is also evidence of over-exploitation of the soil. This suggests that soil quality is an important part of a successful and long-lasting civilisation. David R Montgomery, Professor of Earth and Space Sciences at the University of Washington in Seattle, believes that 'Many factors may contribute to ending a civilisation, but an adequate supply of fertile soil is necessary to sustain one.' This idea now forms part of the concern about global food security. After considering the nature of soils and their quality, and human management and mismanagement of soils, you will be in a better position to decide whether or not soils do matter.

Soils are the layered mixture of materials that occur on the surface of the Earth, which have developed their characteristics as a result of **pedogenic** processes. In practice, it is sometimes difficult to distinguish between layers of sediment and **soil horizons**, as soils develop in sediments

pedogenic processes soil-forming processes

soil horizons soil layers with different physical and chemical properties

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Source 2.18 Soil horizons

suspension solid particles remaining dispersed through water

parent material original mineral material

deposited by wind or water as well as in weathered rock. The three main components of soil are mineral particles, organic matter and air spaces. Any interconnected air spaces allow for water to move through the soil, taking with it any mineral or organic material carried in solution or **suspension**. Because of the complex relationships between soil components, it takes time for horizons to develop within soils. Differences between soils are the result of variations in the **parent material**, climate, topography, biological characteristics (vegetation and organisms) and the length of time for which soil-forming processes have been operating.

Studying soil gives us important information about soil fertility for agriculture, soil suitability for growing particular crops or plants and what fertilisers need to be applied. Soil management is required in parks and recreation spaces, home gardens and farming enterprises. In all these situations, the potential for erosion, as well as the amount of erosion occurring or likely to occur over a given time period, is knowledge that allows for sensible judgements to be made and implemented. At a longer time scale of more than a century, the outcomes of land use changes can be reflected in **soil profiles**. Over much longer timespans of tens to hundreds of thousands of years, an old soil formed under a different environment may be buried by sediment and a younger soil formed on top. The buried soil is then referred to as a **paleosol**, and its characteristics provide clues about past environments.

soil profile the vertical sequence of horizons that make up the soil

paleosol ancient soil not formed under present-day conditions

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ACTIVITY 2.11

1 Suggest the ways in which soil is different from a pile of sediment tipped off a dump-truck.
2 Explain why soil is important to humans.
3 Evaluate whether soil mismanagement could eventually lead to a civilisation's collapse (including our own civilisation).

Soil formation

Agricultural land is often described in terms of soil quality – for example, people speak about 'rich alluvial soils' or 'poor sandy soils'. What makes some soils fertile and desirable for agricultural production, and others to be avoided where possible? Part of the answer lies in the ways in which soils form, especially the nature of the material in which they have developed (the parent material), environmental conditions (climate and biological life associated with it), the local landforms (topography) and how long pedogenic processes have been operating (age or time).

Once the soil-forming factors operate on sediments, several changes start taking place: some materials are added (additions), some are removed (losses), some are transformed (changed from one state to another) and others are translocated (moved within the sediment, either vertically or horizontally). Common additions to soils are **ions** in rainwater, plant litter or extra sediments deposited on the soil surface by dust storms, volcanoes, rivers or overland flow. Losses involve erosion of **topsoil** and movement of **soluble** elements to greater depths as a result of leaching. Important transformations include the weathering of rock to form clay minerals, the decomposition of plant litter into organic matter that contributes to soil fertility and the change in state of iron that is associated with drainage conditions. Although hydrated iron (yellow) can be inherited from a parent rock, poorly drained soils will have yellowish lower horizons while well-drained soils nearby have iron minerals of a reddish colour. Translocations refer to movement of materials mainly in suspension or solution from one part of the soil profile to another. In arid regions, the net movement of solutions may be upward due to capillary action, but most transfers in other climates take place in a downward direction. Clays can be translocated within sandy soils, with their large pore spaces, but not within a heavy-textured clayey soil. Other translocated materials include soluble salts (sodium chloride), lime (calcium carbonate) and iron. Organisms such as ants, earthworms and termites mix the soil with their burrowing, and may transfer soil particles from one horizon to another. Ant mounds often have a different colour from the surrounding ground, so you can see the nature of the subsoil without having to dig down.

ions atoms formed by the loss or gain of one or more electrons

topsoil surface soil, usually the A horizon

soluble able to be dissolved

Geographical fact

Termites build their mounds by moving fine subsoil sediments to the surface. As mounds can only be built in places where weathered sediments mask the bedrock, CSIRO researchers are currently investigating the use of termite mounds to save drilling costs for gold exploration.

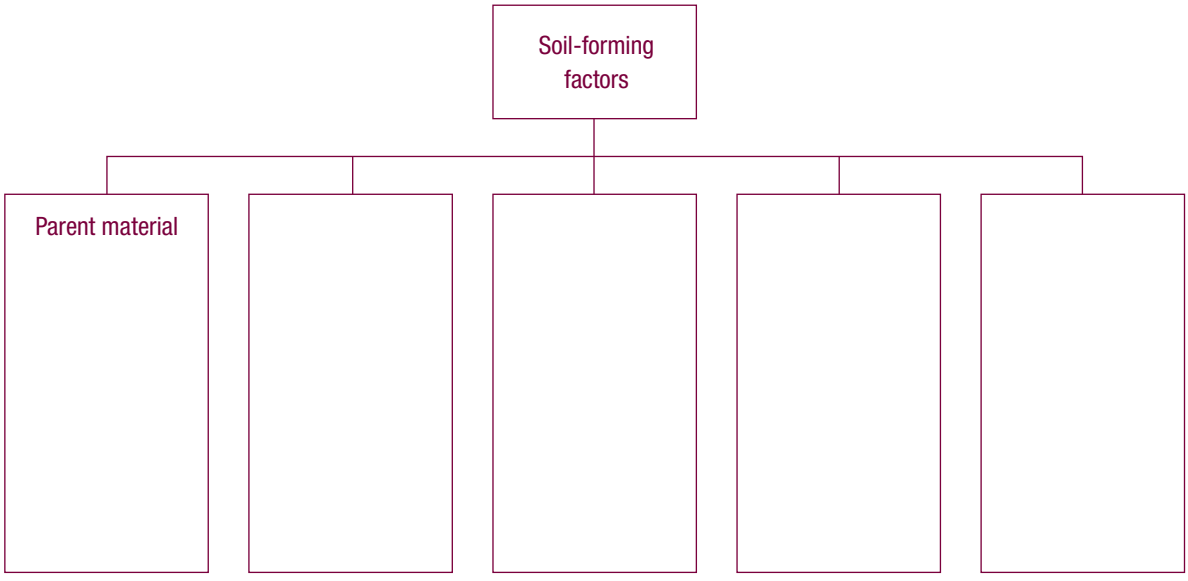
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Source 2.19 Termite mounds in Kakadu National Park, Northern Territory

NOTE THIS DOWN

Copy the graphic organiser below and summarise, in your own words, the soil-forming factors.



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ACTIVITY 2.12

1 Copy and complete the following table about the processes of soil formation.

2 Discuss which of these soil-forming processes seem to be occurring in your local soils.

Soil-forming process	Two examples of items involved in each process (example)	Operating in local soils (yes/no)
Additions	(Plant litter) 1. 2.	(Yes)
Losses	1. 2.	
Transfers	1. 2.	
Transformations	1. 2.	

Describing soils

Soils vary from place to place, but there are also similarities between some soils in different regions and continents. Because of this combination of local differences and broader-scale similarities, soil scientists have devised numerous soil-classification systems. These classifications all attempt in various ways to describe both differences and similarities between soils. In Australia, the Great Soil Group classification was followed by Northcote's Factual Key (or Principal Profile Form) for recognition of Australian soils, and currently the Australian Soil Classification includes a consideration of characteristic Australian landscapes before describing representative soils from the 14 Soil Orders. At the continental scale, the most widespread Soil Orders are Tenosols (slightly developed soils), Kandosols (strongly weathered earths with fairly uniform texture), Calcarosols (those dominated by carbonate), Vertosols (cracking clays), Rudosols (minimally developed soils) and Sodosols (alkaline and sodic soils with texture-contrast profiles). Many of the Orders contain a wide variety of soils with different textures and profile development. However, these names allow **pedologists** to use terms that have meaning internationally, as they describe particular characteristics that are deemed to dominate in specific groups of soils. The distribution of different soil types has special importance for agriculture, as well as home gardens and management of recreation spaces.

pedologists scientists who study soils

2.3 Distribution of soils and agricultural activities

In Australia, the continent-wide distribution of agricultural activities is strongly influenced by rainfall. Early settlement was clustered around safe harbours, a fresh water supply and soils capable of producing food crops. Although Sydney's initial settlement was on its harbour, farming

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activity soon moved to Parramatta, utilising the Parramatta River for transport and the alluvial flats for growing crops. This pattern of making first use of soils that were inherently more fertile occurred in all settlements. In the drier areas, livestock were grazed – not because the soils were particularly infertile, but because there was insufficient rainfall to sustain crops. Later, the use of **irrigation** allowed development of major agricultural districts in the drier parts of the Murray–Darling basin. Growth in agricultural production, where it can be undertaken, has relied increasingly on technological change, including:

irrigation watering of crops

- advances in fertilisers/trace elements and their application
- the invention of large machinery to undertake extensive cropping
- the development of transport networks to move agricultural products from farms to markets
- the breeding of new strains of livestock and crops to raise productivity and extend activities into otherwise marginal areas for particular enterprises
- the development of chemicals for weed control and preventing disease in livestock and crops.

These technical advances mean that much is possible – but often at a cost, either in terms of agricultural inputs (immediate cost of production issues) or environmental impacts (long-term decline in productivity). In both of these aspects, soil is a major player.

Soil quality

Soil quality is important in affecting plant growth, whether for food and fibre crops or for pastures grazed by livestock. If soils are not naturally fertile, soil amendments can be made, but such actions carry a financial cost. From the early 1900s, most farmers in the wheat-growing areas of Australia have applied superphosphate fertiliser to obtain satisfactory yields, as many soils are deficient in available phosphorus. In the South Australian **Mallee** region, wheat yields were low before superphosphate and trace elements became available, and farmers were advised to spend their spare time cultivating their sandy, phosphorus-deficient soils to increase yields. The problem was not a lack of cultivation, but nutrient-poor soils being over-cultivated (and producing dust storms instead of wheat). In recent years, concentrated ammonium sulphate fertilisers have reduced fertiliser transport costs; these fertilisers have the additional advantage of containing up to 20% nitrogen along with zinc as a trace element.

Mallee agricultural district where mallee vegetation was cleared for cropping

ACTIVITY 2.13

1. List 3 technological changes that have contributed to increased agricultural productivity in commercial agriculture.
2. Explain how these technological changes may lead humans to think that any activity can be undertaken anywhere, on any kind of soil.
3. Using the *Atlas of Australian resources* maps, assess whether soil quality affects the distribution of agricultural activities in Australia. The *Atlas* can be accessed by searching online for '*Atlas of Australian resources* third series'. All maps and commentaries are listed separately there under separate URLs (agriculture, soils and land use, vegetation, climate, geology, etc) and each has to be accessed individually.

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2.4 Accelerated soil erosion

The Earth's surface is always exposed to the forces of erosion, which can be viewed as the long-term rate of removal, transport and deposition of sediment and rock. This rate of erosion may be affected by catastrophic events like earthquakes, tsunamis and volcanoes, or prolonged events like glaciations or water erosion. As these sources of action on the Earth's surface are part of natural systems, even erosion that increases sharply after such events is sometimes referred to as 'natural erosion' to distinguish it from accelerated erosion, which is caused by human activities. Accelerated erosion is accompanied by a range of soil changes, or **land degradation**, involving a loss of fertility and its consequent impacts on ecosystems. These impacts affect relatively unaltered 'natural' or 'wilderness' areas, as well as deliberately modified agro-systems like cropping and grazing. Impacts on soils include loss of organic matter, decline in structural condition, acidification following vegetation removal and fertiliser application, development of acid sulphate soils following vegetation clearance, salinisation and removal of topsoil and nutrients by water and wind erosion. Indirect adverse effects of soil erosion include infilling of reservoirs with sediment.

land degradation
destruction of vegetation, soil, landforms and landscapes by human activity

Land degradation by erosion

Land degradation caused by erosion has important implications for agricultural production. Plant nutrients and organic matter present in topsoil are removed along with mineral soil when water or wind erosion transports sediment. Fertiliser application rates have to be increased to compensate for this nutrient loss. In the process of water erosion, gullies create barriers for vehicle and machinery movements on farms, as well as reducing the effective productive area. With wind erosion, dust storms in Australia have transported fine sediment

Source 2.20 Partly sediment-filled Umberumberka Dam, New South Wales during drought. The dam supplies Broken Hill with water. (Person in lower right-hand corner provides scale.)



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as far as the snow-covered mountains of New Zealand and beyond into the Pacific Ocean. Local problems from dust and sand storms include burial of fences, sand drift across roads and railway lines, interruptions to aircraft movements, respiratory difficulties for humans and sand accumulations on the sides of buildings or other barriers.

Case study 2.1
The Dust Bowl

In the Dust Bowl era of the 1930s, droughts in the High Plains of the western United States coincided with a period of low prices for agricultural products. This led to overcultivation and overgrazing on mainly tenanted farms, resulting in bankruptcies, occasional starvation and entire regions being subjected to massive out-migration. Following this economically and socially disruptive period, the US Soil Conservation Service was formed and large numbers of trees were planted as shelter belts to reduce wind erosion. Since the 1970s, many thousands of hectares of previously unploughed prairie lands have been cultivated and most of the shelter belts planted earlier to protect the land have been removed. This has been mainly in order to accommodate convoys of modern harvesters, which reap grain crops and require large open spaces to operate efficiently. Although dramatic dust storms like those during the 1930s have not recurred, dust monitoring in cities shows that dust levels are increasing. Soil erosion losses in the Dust Bowl region in the 1980s were more than double those during the catastrophic 1930s.

'Overcropping' and 'overgrazing' are terms used to describe overuse of the land, involving an imbalance between what the land can produce at a given time and the greater amounts that humans want it to produce. Overcropping and overgrazing can happen under adverse economic and climatic conditions. When agricultural prices are low, humans respond by trying to increase production to maintain their incomes. However, if financial pressures like the Great Depression in the 1930s coincide with major drought, serious land degradation can result. Similar but less severe problems to those in the United States also occurred in Australia in the 1930s, when drought hit in the marginal wheat-growing lands in southern





Source 2.21 The Dust Bowl, past and present (a) Part of the Great Plains Dust Bowl in 1936 (b) Cultivating in the Great Plains Dust Bowl area, 2007

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Australia and in the country's inland pastoral areas. The government response in Australia was to provide financial assistance for farmers to change the system of land use in vulnerable areas, and especially to reduce the reliance on cropping.

1 Using the internet, find a map that shows the location of the Dust Bowl area in the United States. Numerous maps and images of Dust Bowl conditions can also be found on the internet.

2 Discuss the effects of the Dust Bowl era on the people who lived there at that time.

3 Assess whether the environmental disaster of the Dust Bowl era could happen again. Information comparing the 1930s drought with dry periods in 2008, as well as a discussion of a possible return to Dust Bowl conditions, is available via www.cambridge.edu.au/geography8weblinks.

Apart from affecting the nutrient status of soils, water and wind erosion can remove topsoil and expose **heavy-textured subsoils** at the surface. Plant growth then becomes severely restricted due to the compact nature of the surface soil: root development becomes limited, water infiltration is reduced, the proportion of bare ground increases, the amount of plant litter returned to the soil is minimal, and water and wind erosion become worse. Much accelerated erosion has been triggered by vegetation loss, which reduces protection for the surface soil. In New South Wales, soil **conservationists** suggest a minimum vegetation cover of 70% to prevent major erosion. Soil erosion following the introduction of European agriculture is common in Australia, North America, South Africa and New Zealand, and overuse of lands surrounding the Mediterranean basin has had the same result. **Arroyo** development in semi-arid areas of the south-western United States became severe after heavy grazing by cattle coincided with an increase in storm intensity. In New Zealand, the introduction of sheep to steep pasture lands produced sharp increases in **landsliding** after heavy rains.

heavy-textured subsoils clayey B horizons

conservationists people who believe in the protection of the world's natural environment

arroyo dry creek or stream bed; gully

landsliding downslope movement of saturated soil and sediment by gravity

Salinisation

Salinisation is a major issue in Australia, affecting soils and water supplies. Part of our difficulty in addressing the salinity problem is that the natural amount of salt in our environment is high, and any disturbance to water relations in the soil will produce changes in salt distribution. Naturally saline areas are widespread around the low-lying parts of the coastline, and in arid and semi-arid areas. Following clearance of deep-rooted perennial native vegetation and its replacement with shallow-rooted crops and pastures in semi-arid and humid zones, the amount of rainfall percolating through to the groundwater increased. The level of the water table then rose. Where the water table intersected or came within about 1 m of the land surface, salt accumulated at the land surface as a result of **capillary movement** and evaporation. This was a slow process, and emerged as a problem about 30 to 40 years after vegetation clearance in the wheat belt areas of Western Australia. Although some small salt patches were present prior to the introduction of wheat growing in Western Australia, as well as South Australia, New South Wales and Victoria, these few patches enlarged and were joined by numerous new outbreaks. Wheat is not a salt-tolerant crop, and many salt

salinisation the build-up of salts at or near the soil surface, either by natural processes such as evaporation or by land clearing

capillary movement water movement, mainly upward and horizontal, in permeable materials (soil, sediment, rock, cement or bricks)

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Source 2.22 Dryland salinity on grazing land near Singleton, New South Wales



Source 2.23 Dryland salinity on a wheat farm, South Australia

patches are so saline that no other vegetation grows, so these areas have become small, unproductive 'salt deserts'. In irrigation districts, the water table has risen following major additions of water (irrigation), leading to waterlogging and salinisation at the surface, and the presence of a 'groundwater mound' beneath irrigated land. Various drainage, pumping and salt-removal techniques have been applied to keep irrigated land productive.

Supplies of fresh water are adversely affected by rising saline groundwater, either directly in terms of **base flow** within channels or from irrigation districts, or indirectly from groundwater moving slowly towards valleys. Many farm dams and small watercourses in wheat-growing areas in southern Australia have become increasingly saline, but the major issue relates to the Murray River. Because South Australia relies on the Murray for irrigation and fresh water supplies, salinity monitoring has been in place for many years. This shows that every day approximately 1000 tonnes of salt are carried by the river where it flows past the town of Morgan. This is a doubling of the estimated salt load that existed before irrigation and river regulation by **locks**. In South Australia, the main source of salt in the Murray is groundwater, followed by irrigation both upstream and within the state, and lastly vegetation clearance. The lag between commencement of irrigation and an increase in salt load is around 20 years, shorter than generally estimated for vegetation-clearance effects.

base flow low flow period in streams when water is not derived from run-off but from groundwater and slow lateral sub-surface movement

locks barriers in the form of large steel gates constructed to control the flow of water and allow boats to travel both up and down stream

Various attempts have been made to reduce salinity impacts, including interception schemes for irrigation districts in New South Wales, Victoria and South Australia. In the wheat belt, measures have included tree planting in salt-affected catchments, contour banks to divert water from directly entering small watercourses, contour ripping of salt patches, planting saltbush (Atriplex species) and other salt-tolerant plants on salt patches, and fencing off salt-affected areas from livestock. Responses to tree planting have been slow, as would be expected from the original lag time for salt to emerge. In addition, estimates of the proportion of a catchment that should be planted in order to remedy salt-affected areas is often too high to be economic for farmers – so severely reduced production in an area would be due to salt if nothing were done, and due to tree-planting if complete remedial action were taken. In practice, farmers often fence off the area and plant trees just inside this boundary, a measure that may prevent the patch from enlarging and possibly will reduce its size over the long term.

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ACTIVITY 2.14

Using the internet, find a map showing the distribution of some saline lands within Australia. Describe where areas of salinisation occur.

1 Explain why salinisation accelerates wind and water erosion.

2 Reflect on why salinisation has adverse impacts on humans.

2.5 Soil: a renewable resource?

A consideration of accelerated erosion suggests that soils will have to form quickly if they are going to keep up with recent losses. In the 1970s and 1980s, many resource economists considered that soil was a **renewable resource** but the time frames are important. Soil formation in humid Australia is estimated at 1–3 mm over 100 years, which describes its replacement rate. On basalt flows in north Queensland, dating of flat-lying layers of lava of different ages gave a weathering rate for soil formation of 1 mm per 3000 years. In river alluvium, a soil with a strong clay subsoil horizon (Chromosol) can develop over a period of 20 000 to 30 000 years. Generally, soil formation is faster in pre-weathered sediment than in rock, although soils can form rapidly on volcanic ash.

renewable resources resources that can be replenished in a relatively short amount of time through reproduction or other biophysical processes

Soil replacement rates

Before grappling with the problem of what is a tolerable level of soil erosion, it is worth looking more closely at soil formation and erosion rates. The replacement rate of 1–3 mm per 100 years noted above represents an average rate of 0.4 tonnes per hectare per year (t.ha.yr) of new soil. Untrained observers can generally recognise that erosion is happening when the average rate is 30 t.ha.yr (or a loss of 230 mm/100 yr). The *State of the environment* report for Australia in 2011 noted that: 'Current rates of soil erosion by water across much of Australia now exceed soil formation rates by a factor of at least several hundred and, in some areas, several thousand.' Advice on how to reduce erosion starts at a soil loss rate of 2 t.ha.yr in the Soiloss program, an Australian adaptation of the Revised Universal Soil Loss Equation (RUSLE), developed in the United States. In that country, where many soils have developed in deep glacial deposits, the acceptable range of erosion is 5–12 t.ha.yr. Because of local variations in soil-forming factors and agricultural practices, these numbers are generalisations. However, estimated losses of hundreds to thousands of times the replacement rate are not sustainable for long periods.

Can the current imbalance between soil formation and erosion be switched back in favour of soil growth? Soil-conservation activities on farming properties are more common now than they were in the past, and major efforts have been made by some farmers to turn things around. This involves well-known methods like infilling gullies, constructing roll-over contour banks and grassed waterways, controlling grazing pressures, and reducing the number of cultivations (the 'no tillage' system). A less well-known method is Natural Sequence Farming, which aims to raise biodiversity, store water naturally in the soil instead of in dams and increase land productivity. It involves reducing run-off by increasing infiltration and dispersing flow in existing channels, and increasing soil surface cover by using vegetation and plant litter.

Even though most humans would probably agree that soil-conservation measures increase productivity, practical difficulties remain. All conservation measures attract a short-term cost, either directly for earthworks or reduced stocking rates,

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or indirectly for decreased crop production while measures are being installed. Many improvements also take some time to show benefits, and short-term financial pressures on farmers may become too great for them to become involved. Others may decide that the results do not justify action on their part, thus allowing individual responses to play a significant role. Another factor influencing management responses is the existing level of soil degradation – if a prolonged period of heavy investment is needed for soil to be rehabilitated back to reasonable productivity levels, interest in undertaking sustainable practices will be limited. In places where soil deterioration has not been so severe, conservation may be more attractive.

Australians have fewer financial pressures than many humans in the world, and the climate change debate has directed their attention to time frames longer than one year. This has provided encouragement for the establishment of biodiversity corridors in partnership with governments. In relation to soils specifically, most soil-conservation sections within government departments have been disbanded through reorganisations and, in the absence of a major dust storm reaching capital cities or accelerated erosion reducing farm production to a level where food prices increase, soil erosion is only of passing interest to many urban dwellers who form the main voting public.

In conclusion, is soil a renewable resource? The answer may be that, under many current usage conditions, soil degradation will continue, threatening sustainability. Technically, soil is a renewable resource, but only if we want it to be and work towards that aim. What is your opinion?

FIELDWORK 2.1 FLUVIAL LANDFORMS AND HUMAN ACTIVITIES

Aim

To analyse landform features and geomorphic processes on a section of river or creek. You will also describe human use of the river or creek, and evaluate the effectiveness of management approaches in maintaining a healthy waterway and minimising erosion.

Method

Characteristics of the river or creek will be described, along with changes to the watercourse caused by human use of the area.

Preparations

Before going to the field area, prepare a base map with a scale and north sign. (Use Google Earth if no other map sources are available.) You should also collect information from library and internet sources about the history of possible changes in geomorphic features over the last two centuries, and background on human use and modifications in the area. You will need to take a camera for recording images, a clipboard with your base map, sheets of paper on the clipboard or a notebook for making field notes, and a pen.

Data collection

As you travel along the river or creek, stop at various sites and ensure that you collect the following information in preparation for your fieldwork report.

1. List all the ways in which the river or creek and nearby areas are used. Take images of these activities and mark their locations on your base map. Think of a key to describe each of these activities. If the river is used for human activities, what kinds of activities are they? How often would the river or creek be used for these activities? If there are boats on the river or creek, how many are there and are they commercial or recreational boats? If the field site is a creek, what is the land use near the creek? Is the area used for cropping or grazing, or is it in a national park? What types of vegetation are growing in the surrounding area? If there is vegetation on the banks or in the channel, what kind of vegetation is it?
2. In describing erosion, take into account the following questions. Is there any evidence of

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bank or bed erosion in the river or creek? Does the river or creek follow a straight or meandering path? If it is not straight, can erosion be seen on the outer curves of water flow and sediment deposition on the inner side of the curve? Is there any evidence of rills on banks, or of banks slumping into the river or creek? Are banks bare of vegetation, are they vegetated or has concrete or other reinforcement been used? Have any trees or shrubs been undercut by water action? Have humans or livestock made pathways down to the water and assisted erosion? If water is flowing, is it clear or turbid? If boats use the river or creek, are their wakes likely to erode channel banks? Note that bed erosion (hollows or pools) and deposition (finer sediment trapped in hollows) can only be seen when water is not flowing. Has a bridge, floodway or informal track been constructed across the river or creek? If so, has it caused sediment accumulation on the upstream side and erosion on the downstream side?

3 Describe the positive and negative impacts of human activities on the river or creek. For example, is there rubbish in the water (if present) or in the dry channel (if not flowing)? Is water in the river or creek being polluted from rubbish being left or washed down from further upstream? Are there any other adverse impacts of human use of the river or creek? Has vegetation been planted to stabilise the river or creek banks and, if so, what type of vegetation was used? Do aquatic weeds grow in the river or creek? Is there any algal growth or bloom evident in the water? If so, why is this? What kinds of birds did you notice while at the study sites?

4 Sketch two examples of the ways in which use of the area may have affected the watercourse, its vegetation or its bird life. Annotate your sketch with as much information as possible about the use and its impact.

5 Observe the human features surrounding the river or creek. Describe how these are used. How do you think the river or creek has influenced these developments? (In urban areas, consider the nature and number of buildings along the river or creek; in non-urban areas, note the number, types and approximate distances of buildings and roads from the water course.) Do these human features differ as you walk along the water course? If so, why?

6 List some of the management approaches that you observe, and assess whether the approaches are successful. Explain how you came to your conclusion, and suggest a way to improve managing the watercourse.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map – river or creek areas
Page 3	Introduction – brief description of the study sites
Pages 4–5	Description of uses and photos
Page 6	Table of usage: effects of use (positive or negative)
Pages 7–8	Description of effects of use, sketches and/or photos
Page 9	Association between use and effects of use
Page 10	Table or written description of management approaches
Page 11	Photos or sketches of management approaches
Page 12	Evaluation of these approaches
Page 13	Appendix, bibliography, glossary

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Chapter summary

- Landforms are created by weathering, erosion, transportation and deposition.
- Weathering processes may be mainly physical, physico-chemical or chemical, or a combination of these.
- Weathering processes are affected by rock types and climatic environments.
- Weathering, depositional and erosional processes are strongly influenced by water, in the form of runoff, groundwater, glaciers and oceans.
- Different landforms and soils affect the nature and distribution of human activities.
- Soil characteristics are determined by the interplay between the soil-forming factors of parent material, climate, relief, organisms and time.
- Soils develop in weathered materials by the processes of losses, additions, transfers and transformations.
- Soil quality affects agricultural productivity and the costs of food and fibre production.
- Accelerated erosion caused by human activities has led to land degradation, involving physical and chemical changes to soils.
- Human causes and effects of landscape degradation can be on a small scale, such as erosion and sedimentation produced by walkers, or on a large scale, such as built elements.
- Current rates of erosion in many areas are much faster than the slow rates of soil replacement.

End-of-chapter questions

Multiple choice

1 Some groundwater in arid Australia is too saline for humans to drink because:

- **A** groundwater is moving through saline sediments and rocks
- **B** rainfall in arid areas is saline, but rainfall is fresh in humid areas
- **C** rivers feeding groundwater are saline
- **D** groundwater always becomes saline when it has been in the ground for a long time

2 Frost shattering happens:

- **A** when the air temperature reaches 0°C
- **B** in impermeable rocks in freezing climates
- **C** only when salt and frozen water occur together
- **D** when water becomes frozen within a rock

3 Ocean currents are caused by:

- **A** the Earth's rotation
- **B** tides that cause large-scale oceanic movements
- **C** temperature and salinity differences in seawater
- **D** climate change

4 What are important human activities that cause land degradation?

- **A** dams, channel straightening and drainage
- **B** mining, quarrying and urban development
- **C** walkers, off-road vehicles, mountain bikes
- **D** all of the above

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5 Soil formation is not affected by which of the following?

- **A** parent material
- **B** ocean currents
- **C** rainfall
- **D** vegetation

Short answer

1 Identify the main differences between physical and chemical weathering.

2 Describe landforms found on rocky coasts and on sandy/muddy coastlines.

3 Explain why human populations are attracted to living in flood-prone areas near rivers, using an example from Australia and another country.

4 Suggest the factors that make soils differ from one place to another.

5 Reflect on how accelerated erosion affects humans.

Extended response

What geomorphic processes lead to the development of different landforms in arid and humid landscapes? Explore this question in a short essay, giving examples from Australia and another country to show your understanding of the influence of climate on landform development. Be sure to address whether the impact of human activities in accelerating erosion outweighs the importance of climate in landform development and change.

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3 Value of landforms and landscapes



Source 3.1 Uluru is an iconic tourist attraction and holds a spiritual value for Aboriginal people of the area.

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Before you start

Main focus

There a number of ways in which landscapes and landforms are valued by individuals, groups and organisations in society.

Why it's relevant to us

It is important for us to investigate these different values, as they play a significant role in music, poetry, film, art, identity and tourism.

Inquiry questions

- What are the different values of landscapes and landforms for people?
- How do landscapes and landforms inspire the arts and shape identities?
- What is the role of landscapes and landforms in tourism?
- What are the meanings associated with landscapes and landforms by Aboriginal and Torres Strait Islander peoples?

Key terms

- Aesthetic value
- Cultural value
- Flow-on effect
- Spiritual value
- Tourism

Let's begin

Musicians sing about landscapes, poets describe landscapes, film directors use landscapes and artists paint landscapes. Not only are landscapes and landforms valued for their ability to inspire the arts, they also shape identities and support tourism industries. For example, Uluru is an iconic tourist attraction located in Australia's Red Centre landscape in the Northern Territory. This landform is a source of identity, and holds spiritual value for the traditional Aboriginal people of the area, the Anangu people.

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3.1 Landscapes and landforms in the arts

aesthetic value value placed on something due to its beauty

cultural value the emphasis placed on something for its importance and place in society, such as the inclusion of water in rituals, heritage and the Dreaming

place an area that has a specific meaning or purpose

identity the way you see yourself and the way others perceive you

global scale a view that includes the entire Earth or a large part of it

People have always placed, and continue to place, **aesthetic**, **cultural** and **spiritual value** on landscapes and landforms. Landscapes inspire musicians, poets, artists and film directors. When people listen to a song, read a poem, admire a painting or watch a film, it evokes feelings, memories and associations. It can connect them to their sense of **place** and shape their **identity**.

Landscapes and landforms in music

Music can conjure up images of landscapes and landforms at local and **global scales**. 'From a distance' was a song by Bette Midler in the early 1990s. One interpretation of the meaning of the song is the idea that, if we look at the Earth as astronauts do from space, we don't see the imperfections. Check out the version of the song on YouTube, available at www.cambridge.edu.au/geography8weblinks.

Landscapes and landforms in poetry

Australian poet Dorothea Mackellar wrote of her passion for Australia in the poem 'My Country'. Here the focus has shifted from a global scale to a **national scale**. Similar images are brought to mind by the song 'Home Among the Gum Trees', written by Wally Johnson and Bob Brown. Both the poem and the song evoke images of Australia. You can find a link to the lyrics of the song at www.cambridge.edu.au/geography8weblinks

national scale point of view that focuses on an area the size of a nation



Source 3.2 The Earth from a distance

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!

Source 3.3 Extract from 'My Country' by Dorothea Mackellar

ACTIVITY 3.1

1. Identify the landscapes and/or landforms mentioned in the poem 'My Country'.
2. Can you think of other songs/poems that refer to landscapes and/or landforms? List them.
3. Construct your own song/poem about interactions with landscapes and/or landforms.

Landscapes and landforms in film

From the arid and dusty earth of the American Deep South to the dizzying snow-capped peaks of the Himalayas, landscapes and landforms have always played a crucial role in films. The film industry spends millions of dollars each year searching for the right location to shoot movies, whether it is a secluded, remote part of the planet or a bustling metropolitan city. These chosen locations not only allow the perfect setting and backdrop to the story, ideally they also become a part of the narrative and help develop important aspects of the film, such as characters and storylines.

ACTIVITY 3.2

1. List films you can think of in which landscapes and landforms have played a crucial role.
2. Select one film and describe the landscapes and landforms that appear in it.
3. Discuss how the landscapes and landforms can play an important part in a film's storyline.

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Geographical fact

The 2009 film *Avatar* was set on a distant moon called Pandora, a lush, green jungle inhabited by the Na'vi people. The director, James Cameron, began creating Pandora in 2006, and found inspiration in crafting this vast and mysterious moon from landforms such as the Huangshan mountain range in China.

RESEARCH 3.1

In groups of 2 or more, brainstorm the following question. How have modern media – digital photography, film and television – changed the way in which landscapes are viewed? Present your ideas in a poster using examples.

Landscapes and landforms in art

local scale point of view that focuses on the local area

Paintings of landscapes and landforms usually reflect the **local scale**, as they are a smaller scale than imagined in the music and poetry discussed in this chapter. Source 3.5 shows in great detail the coastal landscape of part of the Sunshine Coast, north of Brisbane. The major elements of the landscape are clearly evident – the **landforms**, the vegetation, the wave action and the weather.

landforms a naturally formed feature on the Earth's surface, having a characteristic shape or form

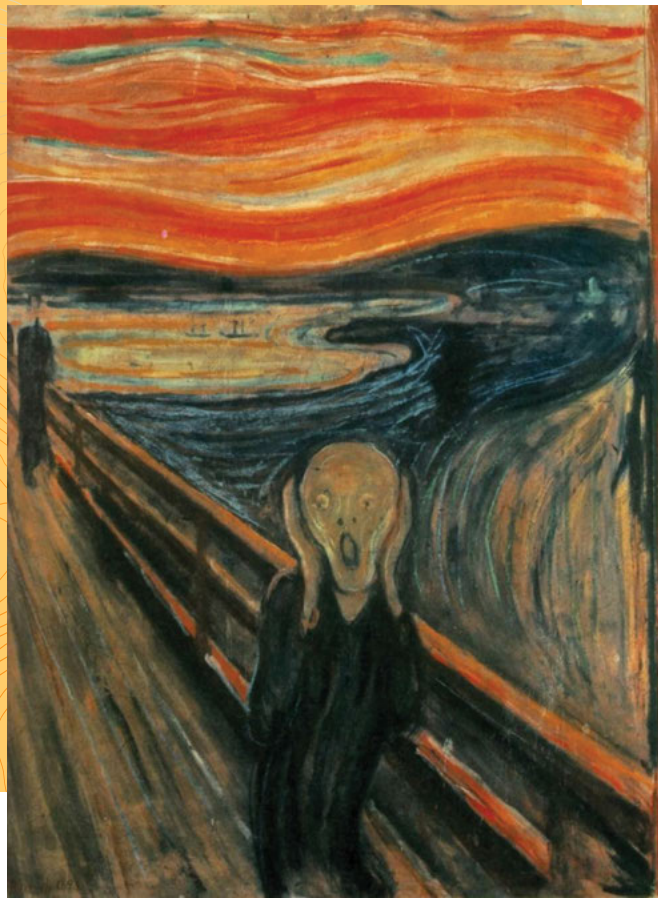


Source 3.4 *Seascape Point Cartwright* by Ken Wenzel shows the coastal landscape of the Sunshine Coast.

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Geographical fact

Source 3.5 might not usually be regarded as a landscape painting except that the original title of the painting was *The Scream of Nature*. Interpretations of *The Scream* – or *The Scream of Nature* (Der Schrei der Natur), as Edvard Munch entitled the painting in 1893 – have focused on the depiction of the person in the painting. But could Munch have placed the person in a landscape that reflected the skies seen over northern Europe following the 1883 eruption of Krakatoa? Certainly the spectacular evening skies that occurred over Europe following the eruption were the subject of the work of many artists, including William Ashcroft who painted the skies for 3 years following the eruption.



Source 3.5 *The Scream* – related to a volcanic eruption or not? Did Munch use the evening skies associated with the eruption of Krakatoa for his iconic painting?

Landscapes and landforms in Aboriginal and Torres Strait Islander peoples' art

Art is a significant and sacred part of Aboriginal and Torres Strait Islander culture. Much Aboriginal and Torres Strait Islander art conveys spiritual meaning, and many of these artworks are inspired by the stories from the **Dreaming**. This type of art shows a deep understanding of and connection to the land, with a heavy focus on the origin of landforms and landscapes. Often, specific features of landscapes and landmarks are represented in forms showing a spiritual and symbolic interpretation, using the legends and stories from the Dreaming.

Dreaming a central concept in Aboriginal culture that explains how the world works through creation stories

The most popular formats of Aboriginal and Torres Strait Islander artworks vary from dot painting, to rock painting and cave painting, to bark painting. Dot paintings usually represent an aerial view of the land below, and can be equated to a map, showing all the vast amounts of desert beneath. Artists use natural sediments mined from ochre pits to draw and paint, and use colours like red to represent the earth and white to represent the sky. Not only do Aboriginal and Torres Strait Islander artists draw upon the influence of the landscape and their surroundings, they also use them as the main tools by which to create their art.

Early Aboriginal artists such as Albert Namatjira were heavily influenced by the European style of art. However, despite this influence, Namatjira's art still focuses on Australian landscapes and landforms.

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Source 3.6 One of the pioneers of Aboriginal art was Albert Namatjira, who used the Australian landscape as inspiration for his artwork. This image shows one of his paintings, *Ghost Gum, Mt Sonder*, represented on an Australian stamp.

Geographical fact

As technology improves, computer games are becoming more immersive, and whole worlds provide the backdrop to absorbing and addictive narratives. Notable titles include Bethesda's *The Elder Scrolls IV: Skyrim*, *Dear Esther* developed by The Chinese Room and the *Mass Effect* trilogy from Bioware.

3.2 Landscapes and landforms as sources of identity

Landscapes and landforms not only represent the geographical makeup of a land, but also create a feeling of uniqueness when it comes to its inhabitants. A country such as Australia has a very strong sense of identity regarding its landscapes and landforms.

The personification of Australiana is represented in many ways by the media, and more recently by famous personalities like Steve Irwin, who invited the rest of the world to witness the different environments and beauty that Australia has to offer. From the desert landscape to the coast and the vastness of the Great Barrier Reef, Australia is represented as an exotic paradise, comprising all types of terrain. This in turn creates the representation of Australians as resilient and adventurous, with a deep connection to the land and all it has to offer. This idea of a deep connection to the land can be seen in Aboriginal and Torres Strait Islander culture. Aboriginal Dreaming stories and legends of Torres Strait explore the creation of people, animals and the land. Aboriginal and Torres Strait Islander people believe they are born out of the earth, the mountains and the sky, and therefore will always have a strong connection to it. This connection to the land has remained the central focus of Aboriginal and Torres Strait Islander culture to this day.

ACTIVITY 3.3

1. Define the term 'identity'.
2. Explain how landscapes and landforms shape identities.
3. Reflect on why landscapes and landforms are important in shaping the identities of Aboriginal and Torres Strait Islander peoples.

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3.3 Meanings associated with landscapes and landforms by Aboriginal and Torres Strait Islander peoples

> There is another dimension that invests land with meanings and significance – which transforms land and environment into landscape, and into 'country'. That other dimension is culture. Culture is what enables us to conceive of land and environment in terms that are different to conventional European notions. To us Indigenous peoples all landscapes are cultural … In fact, 'landscape' and 'environment' are human constructs – they are terms that are inherently shaped by the ways in which humans perceive, or think about the world around them.

Source 3.7 Quotation from Mick Dodson (1995)

Aboriginal and Torres Strait Islander peoples have cared for country on this island continent and on the islands for tens of thousands of years, and still tell cultural stories about its creation. They have evolved durable ways of living that have sustained them for countless generations.

The statement by Aboriginal scholar Mick Dodson in Source 3.7 highlights that 'nature' and 'culture' are not separate. Aboriginal and Torres Strait Islander peoples have lived in, walked over, managed and celebrated Australian landscapes and landforms for many years. These landscapes and landforms are in fact **anthropogenic**. There is no empty space and no wilderness. Rather, all landscapes and landforms are particular places with particular cultural meanings. These meanings are often reflected in place names and stories. In this way, landscape, landform, creation or Dreaming stories and place names are interconnected for Aboriginal and Torres Strait Islander peoples. For example, the south-west of Western Australia is the traditional country of the Nyungar people. Their word 'Manjar' means a place where a fair or trade occurs; where families of people gather for kinship and in-law making; where mothers, fathers and old people get together; and where young men and women who have 'come of age' meet future husbands and wives. There are several places, like Manjimup, Manjaree and Mandurah, whose names show their importance in Nyungar culture.

anthropogenic
human-made

NOTE THIS DOWN

What place names near you are Aboriginal and Torres Strait Islander words? Who are the traditional owners and what is their language? Investigate the possible meanings of these place names. Research online for lists of words that can help you in your quest. Copy the graphic organiser on the right and record your discoveries. An example is shown for 'Manjaree'.



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Geographical fact

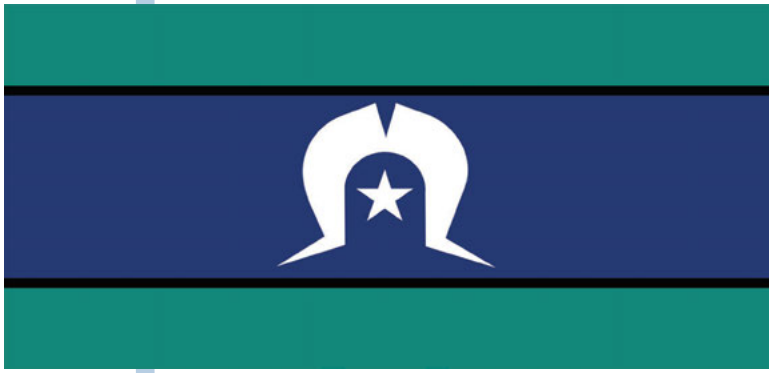
The Kari-oca Declaration asserts that ancestral and current family ties connect Aboriginal and Torres Strait Islander peoples to lands for which they are responsible. These cultural and ancestral connections have been the basis for land rights struggles. They also underpin struggles for self-determination, or the right of Aboriginal and Torres Strait Islander peoples to govern themselves and their lands.

We, the Indigenous peoples, walk to the future in the footprints of our ancestors. From the smallest to the largest living being, from the four directions, from the air, the land and the mountains. The creator has placed us the Indigenous peoples upon our Mother the Earth. The footprints of our ancestors are permanently etched upon the lands of our peoples. We, the Indigenous peoples, maintain our inherent rights to self-determination. We have always had the right to decide our own forms of government, to use our own laws, to raise and educate our children, to our own cultural identity without interference. We continue to maintain our rights as peoples despite centuries of deprivation, assimilation and genocide. We maintain our inalienable rights to our lands and territories, to all our resources – above and below – and to our waters. We assert our ongoing responsibility to pass these on to the future generations. We cannot be removed from our lands. We, the Indigenous peoples, are connected by the circle of life to our lands and environments. We, the Indigenous peoples, walk to the future in the footprints of our ancestors.

Source 3.8 The Kari-oca Declaration, signed at Kari-oca, Brazil on 30 May 1992

Case study 3.1

The symbolic meaning of the Torres Strait Islander flag



Source 3.9 The Torres Strait Islander flag

An understanding of the land is an important part of Torres Strait Islander culture and beliefs. This deep connection to the land and landforms is depicted in the Torres Strait Islander flag (see Source 3.9), which symbolises the relationship between the land, the sea and the people with a message of harmony and peace. The green panels at the top and bottom of the flag represent the lush green land, the blue represents the sea that surrounds the land, the thin black stripes and white **dhari** represent the people. Underneath the dhari is a white 5-pointed star, which represents peace

dhari a type of headdress

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and unity among the 5 island groups. This star is also used by Torres Strait Islander peoples for navigation.

1 Explain how the Torres Strait Islander flag reflects its people and their connection to landscapes and landforms.

2 Investigate why the star shown on the flag is representative of the types of navigation tools used by Torres Strait Islander peoples.

3 Suggest what aspects of the flag show that Torres Strait Islanders are a seafaring people. What is the importance of this to their culture and way of life?

FIELDWORK 3.1

Aim

To discover and understand the values placed on your capital city.

Method

1 Note the various methods of travelling into your capital city. Typically, most schools will choose to visit by bus or train.

2 Travel into the city. Note the commuters and other passengers/drivers heading into the city. What is the outbound (leaving the city) traffic like?

3 Break up into groups and 'stake out' as many tourist destinations as possible. Make sure to cover 1 or 2 places not typically viewed as tourist attractions.

4 Keep a tally of the types (race, culture, age, gender, etc) of people visiting each destination or attraction.

5 Conduct a survey (20–100 people) in each location to assess where these people have come from, and why they are visiting this place. How did they reach this location? Do they agree with the costs (if any)? Where did they hear of this place?

6 Break your tally/survey into separate parts of the day. Note the flow of traffic. Are there peak and off-peak times? How does the location adjust itself for this (for example, cheaper rates, different opening hours)?

7 Explore and research your location. What are its opening hours? What do attractions charge? What is their history? How do they attract visitors? Do they change throughout the year? Include any other questions you feel are relevant.

8 On the trip home, again assess the commuters and passengers/drivers leaving the city. What is the inbound (going into the city) traffic like?

9 Additionally, you could return if time is available throughout the week and complete the surveys on different days at different times.

10 Display the data collected in tables and charts to include in your presentation. What can you conclude from the data collected?

Preparation

- Research your local capital city and list various tourist (and non-tourist) locations. This can include attractions, parks, stores, restaurants, streets and so on.
- Organise your class into groups and cover as many of these locations as possible.
- Prepare tallies that are divided into the different times of the days (such as morning/afternoon, or 9 am, 10 am, 11 am and so on).
- Prepare questionnaires for visitors to each location.
- Prepare fact sheets on the intended locations.

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Data collection

Tally (to be taken based on all visitors)

Include:

- age group
- gender
- race/culture
- country of origin
- travel mode (where possible)
- any other factors you feel are relevant.

Survey (to be taken from a random sample of 20–100 visitors)

Include:

- all the items from the tally
- opinions of the location (i.e. cost, ability to find it)
- why the visitors chose this location
- how the visitors heard about this location
- any other questions you feel are relevant.

The commute

- Are these people mostly workers or visitors?
- Where are they coming from?
- Are there any stations/freeway entrances in which more people join the commute?
- What other relevant information is there?

The location

Include:

- cost
- opening hours
- attractions
- history
- any changes that occur through the year
- peak and off-peak times
- any other relevant information.

PowerPoint presentation layout

Front slide	Title and name Include your location
Contents slide	Do this last as well as numbering pages
Slide 1	Aims and methods
Slide 2	Location map and images
Slide 3	Location information
Slide 4– ??	Survey results Commute Tally Surveys
Final slide	Conclusion – what did the survey reveal?

3.4 The role of landscapes and landforms in tourism

The tourism industry employs thousands of people worldwide who depend on the regular arrival of tourists. Not every town is a tourist destination, but few towns are without either a billboard or a tourist centre identifying the attractions of their town.

Geographical fact

In the 12 months to March 2013, 6.2 million visitors came to Australia.



Source 3.10 Kimba's claim to fame – 'halfway across Australia'

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Kimba and Wudinna, South Australia

Kimba's claim to fame as a tourist destination is that it is halfway across Australia. Why do places need a 'claim to fame' or to advertise a particular feature? The answer is simple: when tourists stop, they spend money. This means that people providing goods and services are employed and supporting their families. This is a **flow-on effect** of tourism.

flow-on effect other changes that will follow if a change is made

The town of Wudinna in South Australia has a tourist information park adjacent to the highway. In it is located a series of panels about the interesting landforms in the surrounding area. If the town did not have this, tourists might not stop. The panels indicate an interesting geological history of the area, which has resulted in a current landscape that features some intriguing formations.



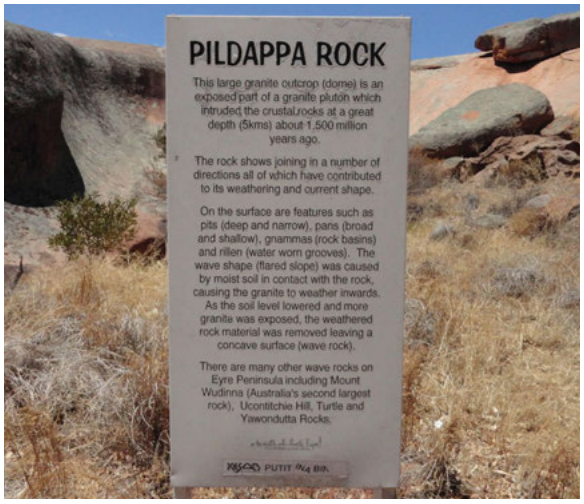
Source 3.11 Pildappa Rock from the connecting road

Geographical fact

Pildappa Rock is a granite outcrop. Granite is a volcanic rock formed underground. To be exposed on the surface, millions of years of weathering and erosion will have taken place to reduce the land surface to this level. But Pildappa Rock is no ordinary lump of granite exposed on the Earth's surface. Near the town of Hyden in Western Australia is a location known as 'Wave Rock'. The images on this page show you what a remarkable natural feature Pildappa Rock is.



Source 3.12 Pildappa Rock is a typical 'wave' rock formation.



Source 3.13 Information on Pildappa Rock

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Uluru, Northern Territory

Uluru is one of Australia's most iconic tourist attractions, recognised all around the world. It is a large sandstone monolith that is 348 m high and has a circumference of 9.4 km. In 1983, Prime Minister Bob Hawke announced the federal government's intention to hand ownership of Uluru back to its traditional owners, the Anangu people. However, the agreement required the traditional owners to lease the park to the Australian National Parks and Wildlife Service for a period of 99 years.

The park is recognised by UNESCO as a World Heritage Area for both its natural and its cultural values. An average of around 39 000 people visit Uluru annually, providing a large economic boost to the Anangu people. This tourism also allows them to educate visitors and demonstrate their traditional customs, beliefs and traditions. This has been facilitated by the construction of a cultural centre, where tourists can come to learn about the traditional law of the Anangu people and the foundation of Anangu culture.



Source 3.14 Anangu warden explains traditional hunting techniques to tourists.

Geographical fact

The Australia Tourism Commission introduced a campaign in the mid-1980s to promote Australia as the perfect holiday destination. Starring Paul Hogan, the 'Come and say G'day' campaign was riding on the success of the Australian film *Crocodile Dundee*, which also starred Hogan. The movie was received extremely well in the United States, and catapulted Hogan to stardom. The 'Come and say G'day' marketing initiative used a different approach by showing the accessibility of Australia to the rest of the world. Images of golden sands, impeccable beaches and a lazy attitude to life transformed Australia into an attractive vacation destination, rather than a strange, distant land with a seemingly treacherous terrain and wildlife. This campaign, which showed the 'gentler' side of the Australian landscape, promoted an awareness of an exotic and fascinating place, but also developed a sense of familiarity that appealed to all tourists.

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RESEARCH 3.2

Where are Australia's major tourist landscape and landform destinations?

1 Have your classmates list what they believe are Australia's top 10 tourist landscape and landform destinations.
2 Use these lists to make a top 10 list for your class.
3 Conduct a Google search of Australia's top 10 tourist landscape and landform destinations. Did your list match the Google search list?
4 Discuss why the two may be different.

Grand Canyon, United States

The Grand Canyon National Park attracts about 4 million tourists per year, and is one of the most visited tourist attractions in the United States. The park, established in 1919, is now part of the UNESCO World Heritage Site and makes just under $5 million per year through tourism, which has a huge impact on the economies of the state of Arizona and the United States generally. Tourist activities such as hiking and helicopter rides are among the popular activities the park offers to the public.

Geographical fact

One of the stranger activities offered by the Grand Canyon National Park is the Grand Canyon 24-hour Ultra Marathon, in which participants must race through 268 km of rough terrain, carrying with them all they will need to survive the extreme and varied climate and harsh environment of the Grand Canyon. Grand to Grand, which organises the annual race, donates a portion of its profits to charity each year.

RESEARCH 3.3

Divide your class into groups and select one of the following national parks:

- Yellowstone
- Grand Canyon
- Everglades
- Uluru
- the Wet Tropics
- the Great Barrier Reef.

Identify the positive and negative effects tourists have had on these parks. Present your findings to the class as a PowerPoint presentation.

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Why leave Australia?

With so much to see and do in Australia, it is a wonder that anyone would want to travel overseas for a holiday. Australia has the Gold and Sunshine Coasts, the Great Barrier Reef, the rainforests, the Blue Mountains, the Twelve Apostles, Bondi, Uluru, Darwin, Sydney and many other attractions. However, despite these attractions, Australians are holidaying abroad in increasing numbers. So what are Australians looking for overseas?

Different landscapes: the glaciers of the South Island of New Zealand attract tourists, as do the rice terraces of Bali.



Source 3.15 Fox Glacier, New Zealand



Source 3.16 Rice terraces near Ubud, Bali

Adventure: Australia's highest mountain does not represent a challenge for those who are interested in climbing, and climbing isn't the only route to adventure. More and more people are setting their sights on Antarctica as a tourist destination. Managing tourism in Antarctica has become a source of concern internationally.



Source 3.17 Tourists at the Argentinean base in Antarctica



Source 3.18 Accepting the Antarctic challenge of being immersed up to the neck in the waters of the crater of Deception Island volcano off the coast of Antarctica, where the water temperature is 3ºC

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Danger: for some, the idea of climbing a mountain peak provides a sense of adventure, just as careering through a white water stretch of a river on a rubber raft provides a sense of adventure for others. Both of these have a sense of danger attached, and danger can attract tourists. There are 2 locations easily accessible from eastern Australia where a tourist may feel a sense of danger. One is Mt Yasur on the island of Tanna in Vanuatu; the other is Anak Krakatau in Indonesia. Both are active volcanoes. Mt Yasur erupts on a regular basis about every 20 minutes. Anak Krakatau is less predictable, and may be far more violent when it erupts.



Source 3.19 View from the rim of Mt Yasur as eruption of ash and lava occurs



Source 3.20 Ash columns quickly being dispersed above Anak Krakatau

History: those who want to connect with history have a wealth of places to visit, including Borobudur temple in Java, Angkor Wat temple in Cambodia, the Pyramids in Egypt and Machu Picchu in South America.



Source 3.21 Angkor Wat, Cambodia



Source 3.22 The Great Pyramid of Giza, Egypt

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Biodiversity: whale watching and bird watching are popular tourist activities in Australia, as is experiencing a rainforest ecosystem. However, to see the annual migration of the wildebeest, the majesty of a herd of elephants crossing the savanna or just the savanna itself, it is necessary to go to Africa. Zoos can create some semblance of the original habitat, but can never provide the real-life and real-time experience of being there.

biodiversity the variety of life forms and the interaction between them in a given area

Source 3.23 Elephants leaving a waterhole, Africa

The culture of another country: this can include learning about different foods, clothing, customs, religion or language. Many of these cultural features are experiences you would never encounter in Australia.

Geographical fact

The first space tourist, Dennis Tito, a US engineer and multi-millionaire, paid an estimated $20 million for an 8-day visit to the International Space Station in mid-2001. This was not the start of a huge number of intergalactic tours, but it was the beginning. The trip was organised by a US company, Space Adventures Ltd, which offers packages including zero-gravity flights and orbital flights taking passengers beyond Earth's gravity and around the world. Virgin founder Sir Richard Branson has indicated that commercial space flights could begin as early as the end of 2014. So where to next? Mars? It is only a matter of time. The interesting thing is that someone who may be born while you are reading this text will probably have the opportunity to make this journey in the future.

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Chapter summary

- Different people place different values on landscapes and landforms, including aesthetic, cultural and spiritual values.
- Landscapes and landforms play a significant role in the arts (art, music, poetry, film, literature) and shaping identities.
- Aboriginal and Torres Strait Islander peoples place multi-layered meanings (material, cultural and spiritual) on landscapes and landforms.
- Iconic landscapes and landforms, such as Uluru and the Grand Canyon, attract tourists from all over the world.

End-of-chapter questions

Multiple choice

1 Landscapes and landforms in the arts refer to:

A landscapes and landforms in music

B landscapes and landforms in poetry

C landscapes and landforms in film

D all of the above

2 The aesthetic value of a landscape refers to its:

A geographical location

B beauty

C landmass

D climate

3 According to Aboriginal and Torres Strait Islander beliefs and culture, to what does 'the Dreaming' refer?

A the time in which Australia was discovered by the First Fleet

B the time in which the land was settled

C the time in which the land and the people were created

D none of the above

4 In the 12 months to March 2013, how many visitors came to Australia?

A 5.2 million

B 6.2 million

C 7 million

D 8 million

5 In what year was Uluru granted back to the Anangu people of the Northern Territory?

A 1981

B 1982

C 1983

D 1984

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Short answer

1 Describe the difference between aesthetic, cultural and spiritual values in relation to landscapes and landforms.

2 Discuss how landscapes and landforms influence the arts.

3 Suggest why the land is so important to Aboriginal and Torres Strait Islander traditions and culture.

4 Explain the role of landscapes and landforms in the tourism industry.

5 Analyse how the 'flow-on effect' of tourism impacts the local economy.

Extended response

Landscapes and landforms help to evoke a feeling of identity for their inhabitants. Different landscapes help shape people's identity and create a sense of belonging. Reflect on the different landscapes and landforms Australia and the world have to offer, and explain how they have formed the identities of local populations.

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Source 3.24 Horse Shoe Bend, Arizona, United States

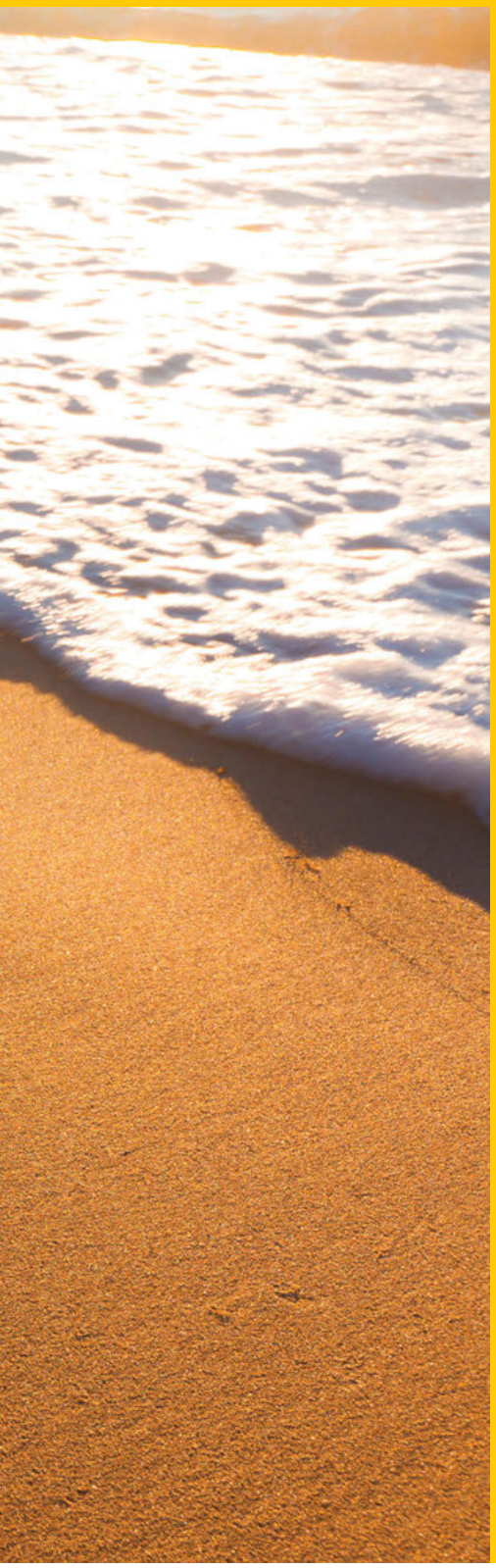
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4 Managing landscapes



Source 4.1 It is important to tread lightly on our landscapes and maintain sustainable lifestyles.

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Before you start

Main focus

It is important for the future of landscapes that we sustain biodiversity in order to meet the economic, ecological, socio-cultural and spiritual needs of humanity. There are different views about the value and protection of environments, including those of Aboriginal and Torres Strait Islander peoples.

Why it's relevant today

Modern lifestyles place many pressures on our landscapes, which can reduce their integrity and their capacity to support human society. We need to find ways of being that will support and promote sustainability.

Inquiry questions

- What are the different views about the value and protection of particular environments?
- How are landscapes threatened by human activities?
- What is the contribution of Aboriginal and Torres Strait Islander knowledge to the use and management of landforms and landscapes?
- What is being done to protect significant landscapes?

Key terms

- Climate change
- Landform
- Landscape
- Pressures on the coast
- Sustainability
- Value
- Views

Let's begin

Landscapes have changed dramatically over the course of history as a result of climate change and human activity. Aboriginal and Torres Strait Islander peoples learned to adapt to these changes, and also created some changes themselves. Since European settlement, however, human pressures and now climate change have become more intense. Our insights can help us achieve more sustainable lifestyles, and these can help to protect cultural landscapes and society.

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4.1 Different views about the value of environments

Australia is the world's largest island and smallest continent. It features a range of different landscapes, all used for different purposes and possessing different values. The landscape varies from cosmopolitan cities to dry deserts, from rich rainforests to long coastlines.

Australia is quite different from the rest of the world. Many Australian views and values come from a European heritage. However, Aboriginal and Torres Strait Islander peoples celebrate values based on of the land itself.

The typical calendar in Australia, featuring summer, autumn, winter and spring, was imported from the Northern Hemisphere. It does not always fit very well with the weather we actually experience in many parts of Australia. Traditionally, Indigenous people travelled around the country according to the seasons in their own landscapes. The seasons were defined not by calendar months, but by weather, such as the onset of the rains or winds coming from a certain direction, the availability of food and the need for social gatherings. For example, they might spend the warmer months on the coast and at coastal wetlands, fishing and collecting fruits, and the cooler months in the hinterland, sheltering from the storms and hunting for forest animals.

ACTIVITY 4.1

Design your own calendar, showing how you adjust your lifestyle to the weather and the landscape.

- Reflect on how the weather influences what you do in your landscape at different times of the year. How many 'seasons' are there in your life?
- Give the seasons new names and add photos to your calendar.
- Add or remove seasons as necessary.



Source 4.2 Graphic for describing the seasons of your life

Australians have many different worldviews and these affect how we see a landscape. To one Australian, a landscape may be full of spiritual and aesthetic values, while to another it may be a space for recreation and tourism. These different views depend on your background, your connection to the landscape, your lifestyle and your views of culture and the environment. The view of a particular environment possessed by a particular group will commonly be linked to their ideas about environmental sustainability. These worldviews can conflict with, relate to or complement one another.

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Source 4.3 Deserts are important national landscapes.

Commodity

A **commodity** view of the environment suggests that land can be owned and traded freely, and that such trade puts property to its greatest use. A commodity view is expressed through buying and selling land for financial reasons, where the focus is on properties for the purposes of investment. It promotes economic values.

commodity a product that can be bought and sold

Productivity

The **productivity** view of the environment is about putting environmental resources to use for the betterment of society and to enable profit to be generated by industry. The concept of productivity treats the environment as a standing stock of resources to be owned and used through technology. This view underpins the role of farming, fishing and mining in the economy. Like the commodity view, it promotes economic values.

productivity the total economic output compared with the input of resources

Spiritual

A spiritual view of the environment evokes awe, humility and wonder. It suggests a deep personal connection to the environment, a sense of place and a feeling of responsibility towards it. It supports cultural and some times ecological values.

Ecological

An ecological view of the environment places value on the **biodiversity** of genetic makeup, species and ecosystems, and on ecological processes and natural cycles. An ecological view is often expressed by conservation biologists and ecologists. It is usually scientific in basis, and therefore does not normally involve a spiritual, cultural or human dimension. The ecological view is an important rationale for the protection of nature in special nature reserves. It supports ecological values.

biodiversity the variety of life forms and the interaction between them in a given area

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Community

A community view emphasises public access to the environment and the right of everyone to enjoy it freely for social interaction and recreation. In this view, the community has a shared sense of belonging and ownership. It also maintains that the public should behave properly in relation to the environment, according to social norms of the day such as respecting the environment by not littering, and not interfering with others' enjoyment of the environment. A community view supports social values.

Landscape

The landscape view of the environment usually involves a **holistic** understanding of the visible features of an area of land, including physical landforms such as mountains, rivers and oceans; living elements such as vegetation; human elements such as heritage, buildings and land use; and the weather. Landscapes are often valued for their visual appeal to people, and they often have strong cultural elements. The landscape view supports a range of values.

holism a belief that complex environmental processes need to be understood as a whole, rather than seen simply as a collection of individual parts

Overlapping and conflicting views

The different views discussed above can overlap; for example, a landscape view and an ecological view have many elements in common, but differ in the emphasis placed on human activity and culture. Social conflict can occur when different views in society are in tension with each other. For example, in relation to mining, we often see conflicts among Indigenous, productivity, ecological and other views. Miners usually want to extract mineral resources for maximum productive value and profit. Conservationists usually want to protect the ecological values of the same area. Some Indigenous **traditional owners** may want to protect their traditional cultural values in an area, while others in the same area may want to embrace mining for its promise of job and wealth creation. Often, social, cultural or ecological values are traded off to create economic benefits.

traditional owner Indigenous person recognised as having primary spiritual responsibility for the land

Sustainability view

From a sustainability viewpoint, we seek to combine rather than trade off ecological, cultural, social and economic values. This entails creating technologies and livelihoods for people that also protect the environment, strengthen society and respect cultures.

The role of the whole community is very important in sustainability for several reasons. Involving the community in environmental management can bring in creative strategies and decisions that reflect the values and interests of the community, sometimes including spirituality. Sustainability is most likely to be achieved when the community has sound ecological knowledge and a strong sense of place and belonging. In working towards sustainability, community discussions about people's worldviews on the environment can help to develop a shared understanding of all values and how to combine them.

When we can successfully combine ecological, cultural, social and economic values, we are beginning to tread lightly on the Earth and move towards sustainability. For example, rather than locating industrial development, nature conservation, social activity and cultural heritage at different points on the landscape, we could make these activities more compatible so they could support each other and exist together in the landscape. Here are some examples of ways in which we are starting to do this:

- Miners can **rehabilitate** a mine site to restore its ecological value, and can also provide recreational **infrastructure** like a swimming pool for the local community.
- Farmers can plant a variety of native trees as windbreaks on their farms. The windbreaks can provide for plant and animal diversity but also increase the productivity of the farm by protecting the pasture and the livestock. The trees can also add visual appeal to the landscape.

rehabilitate to restore an ecosystem to health through, for example, tree-planting

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services, education systems, waste disposal systems, telecommunications

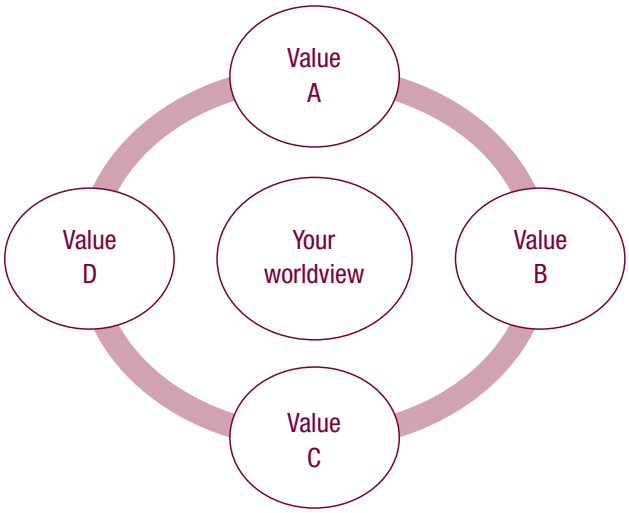
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- National parks can be managed jointly by a government conservation agency and traditional owners to support both ecological conservation and Indigenous cultural valies. Renewable energy and passive solar design can be used for the park facilities. Tourism can develop as a result of the joint management practice. Community education and the local economy can then also be enhanced.

empowerment the ability to make decisions, access resources and create change

NOTE THIS DOWN

What do you value most about your environment? Copy the graphic organiser below and summarise your main values. What do you conclude that your view may be? Write it down in the central circle.



4.2 Coastal landscapes and the threat of human activities

Australians are famous for their love of the outdoors and appreciation of the landscapes the country has to offer, particularly their passion for the coast. The interaction of sea, sky and land at the coast provides a powerful sense of place and identity for many Australians. Unfortunately, in many places our love creates pressure on the coast. **Climate change** is now recognised as an additional human impact that is likely to have serious implications for the coast in the coming decades.

climate change a long-term trend in the Earth's weather patterns, including a change in average weather conditions (such as increased atmospheric temperature) and/or in the distribution of weather around the average conditions (for example, more extreme weather events)

The ocean is the basis of life on Earth. It drives our weather systems. It is the nursery in the food chain. It provides us with plant and animal foods, pharmaceutical products and transport. It produces oxygen and absorbs carbon dioxide. The coast, where the ocean meets the sea, can also provide people with a beautiful place to live, work and play.

Australia has one of the longest and most ecologically diverse coastlines of any nation in the world. It has a long geological history. It has been shaped by many climates, and by the currents, waves and tides of our oceans. Our coastline has a wide variety of ecological habitats and important biodiversity.

In southern Australia, strong wave action has carved large cliff faces along the Great Ocean Road and along the Nullarbor coast. Massive deposits of marine sand have created extensive beaches and dunes, and often close off the mouths of estuaries such as the Coorong, where the Murray River

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Source 4.4 Beachgoers on a hot summer's day, South Beach, Western Australia

Source 4.5 Sea lions



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meets the sea. Off the coast, the temperate rocky reefs support kelp forests up to 30 m high, with unique species and extensive fisheries.

estuary an inlet at the lower end of a river where the waters of a river mix with the ocean or sea

Where large rivers reach the coast, we find landforms such as delta systems, coastal lagoons, tidal **estuaries** and large bays such as Sydney Harbour. The coasts are also fed by many smaller streams and creeks.

Australia has thousands of sandy beaches, from the highly popular Bondi Beach to the long stretches of remote beach in Western Australia. Our coast also has a diversity of islands, including large sand islands such as Fraser Island in Queensland, small coral rubble **cays** on the Great Barrier Reef, the windswept Recherche archipelago of ancient granite domes near Esperance in Western Australia, and limestone outcrops like Rottnest Island off Perth.

cay a small, low island on a coral reef formed of sand and/or coral pieces



Source 4.6 Pelicans fishing at the Goolwa Barrage, near the mouth of the Murray River, South Australia. The main purpose of the barrage is to maintain the freshness of the river by keeping out seawater.

Geographical fact

Australia's coastal biodiversity includes over 4000 fish species and about 43 different species of whales, porpoises and dolphins. The coasts and oceans support 100 seabird species, 76 of which breed and may spend their whole lives in the Australian region. Some 1100 species of seaweed also grow along our coast. Around 80–90% of species in our southern seas occur nowhere else in the world. Australian waters are home to 39 of the 68 mangrove species that occur worldwide, 6 of the 7 species of marine turtles and 34 of the world's 60 seagrass species. However, this biodiversity is under pressure: 58 native marine species are listed as threatened.

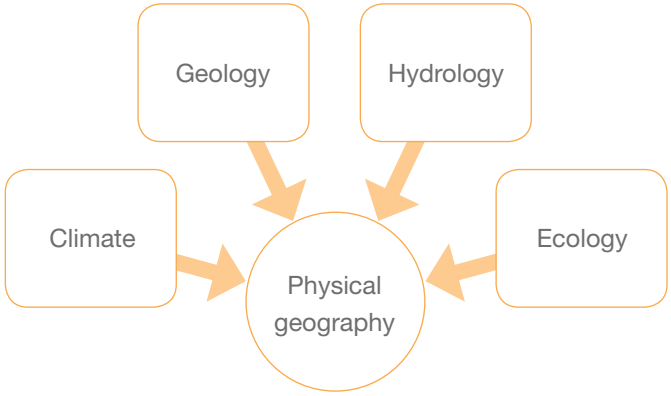
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Source 4.7 Observatory Island, Esperance, Western Australia

RESEARCH 4.1

Research the physical geography of a coast near you. Physical geography is the study of the natural environment, including those aspects set out below. Look on a map and find the stretch of coast nearest to you. Write a report that collates all of your research.



Answer the following questions in your report:

1 What is the name of the stretch of coast on which you are reporting? Provide a map showing its location. Give a brief description of the overall coastal form.

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2 What is meant by the following terms?
- climate
- geology
- hydrology
- ecology

3 For the coastal area nearest to you:
- **a** What is the climate like on the stretch of coast you are researching?
- **b** What are the main rock types here and how were they formed?
- **c** What sorts of wetlands, lakes, streams or rivers are close to the coast?
- **d** How do they connect with the sea?
- **e** What are the main habitat types above and below the sea, and what are some examples of key species of plants and animals in these habitats?

4 Provide photos or drawings to illustrate your answers.

Uses of the coast and their pressures

Australia's oceans and coasts are dynamic and uncertain, and provide many values and amenities. The uses of the coast discussed below bring great benefits to many people, but also place many harmful pressures on the environment. These can also harm people. The challenge of caring for our coasts and creating sustainability is to resolve the tension between our desire for a healthy environment in which we can play and reconnect with nature and our need for services, and residential and economic activity.

Building and development

Since European settlement, urban development on the coast has grown alongside port and supply infrastructure. As the human population has increased, **ribbon development** has occurred along the coast. Over 90% of Australia's population now lives on the coast, predominantly in capital cities or southern regional coastal towns.

ribbon development the spread of urban areas along transport routes, such as main roads, bus routes, railway lines

Source 4.8 Apartment buildings on Sydney Harbour's coastline

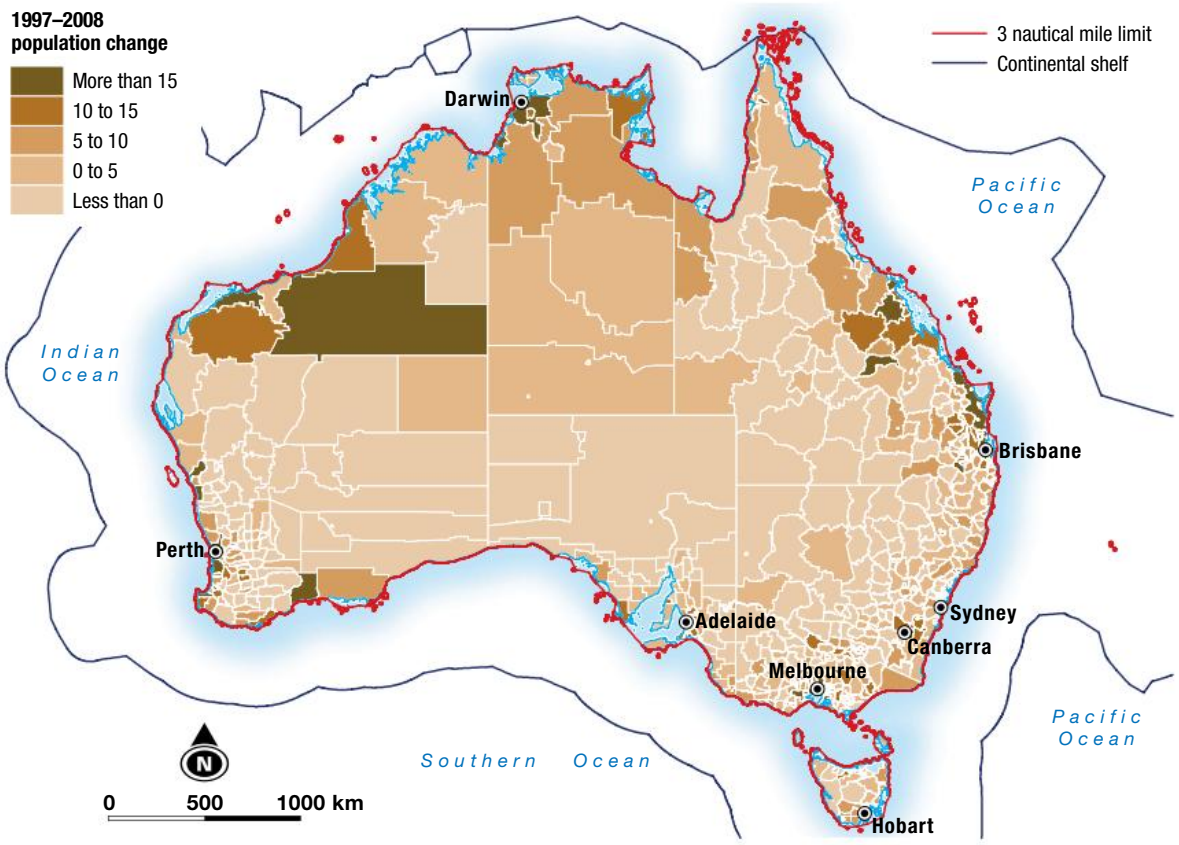


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Recent dramatic growth in regional coastal areas has been driven partly by city dwellers seeking a relaxed, scenic beachside lifestyle. This is known as the 'sea change phenomenon'. Population growth on the coast is higher than the national average, a trend that is expected to continue. In recent years, the south-east Queensland local government areas of the Sunshine Coast, the Gold Coast, and Townsville and Cairns in the north have experienced large population increases. In Western Australia, the south-west coastal local government areas of Capel and Busselton are among the fastest growing in Australia.

Pressures on the coast resulting from urban development include:

- stormwater run-off and sewage flow into rivers, sea and wetlands, polluting the coast so that recreation, human health and ecosystems are threatened
- pesticides, fertilisers and other chemicals released into stormwater or sewerage systems, increasing levels of pollution
- coastal native bush and habitat lost as city margins expand along the coast in a ribbon
- coastal wetlands destroyed, leading to a loss of nursery grounds for fisheries
- toxic waste released from old coastal industrial sites or rubbish dumps during redevelopment.



Source 4.9 Recent percentage changes of population in Australia – note the increases in coastal areas. (Source: CSIRO)

Recreation and tourism

Tourism has become a major industry in Australia over recent decades, especially in the marine and coastal environment. The Great Barrier Reef, Sydney's beaches, the Gold Coast, Phillip Island and Sea World are all highly popular destinations. Most international visitors rate beautiful scenery, vastness, cleanness, natural wonders and wildlife, and good beaches as reasons for visiting Australia. Tourism development often encroaches on land in its natural state, and creates a complex set of

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Source 4.10 Recreational fishers, Shark Bay, Western Australia



Source 4.11 Longboarder, South Cottesloe, Western Australia

demands on coastal resources. Recreational fishing, surfing, scuba diving and sailing are features of most Australians' lives.

Pressures on the coast due to recreation and tourism include:

- tourism and recreation facilities expanding on to natural environments and destroying them
- incorrect anchoring causing destruction of corals and seagrass beds
- waste disposal from boats causing a reduction in water quality
- trampling and off-road vehicles causing destruction of coastal vegetation and dune structures
- treated and untreated sewage from island resorts causing local pollution
- tourism and recreation activities destroying the very basis of their existence in Australia: a clean, beautiful natural environment
- mass tourism impacting on local communities and cultures, with or without bringing financial benefits
- recreational fishing impacting heavily on popular target species.

Source 4.12 Scuba diving in the Great Barrier Reef is a popular tourist attraction, but it comes at a cost to the environment.



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Aquaculture

Global production in aquaculture has been expanding. Molluscs and seaweeds are the main organisms farmed in seawater; however, marine finfish and crustaceans – for example, salmon and prawns – tend to be the more valuable species. In Australia, oysters, both edible and pearl, form the main part of mariculture production, with salmon, trout, abalone, marine finfish and giant clam production expanding quickly. They are usually grown on the coast and can have impacts on coastal ecology and use.

Pressures on the coast resulting from aquaculture, especially sea-cage mariculture, can include:

- **discharge** of untreated wastes from cages or pens
- mass escapes from sea cages
- diseases and parasites, which can spread to wild populations
- the use of toxic chemicals
- habitat damage through **siltation** and altered currents
- visual effects.

discharge release

siltation sand or earth being carried by running water and forming sediments in marine areas or water reservoirs

Fish feed is also a major consideration with finfish farming. Wild fish such as sardines are made into meal to feed farmed fish. This practice depletes the numbers of wild fish. From a social point of view, the need for high-quality protein to feed fish means that commercial fish farming tends to produce expensive products for the wealthy at the expense of cheap protein for poor people.

Agriculture

The high-rainfall coastal region of Australia includes much of the east coast, Tasmania and south-west Western Australia. This region features fertile flood plains, so it is highly productive for agriculture in many places. It also contains Australia's major cities, and in these areas agri-culture often competes for space with urban development. The **wheat-belt zone** lies largely between the coast and the dry interior, but it is also connected to the coast by waterways. The **pastoral zone** stretches throughout inland Australia across all states and territories; cattle and sheep are grazed at very low densities in this zone, and crops are not usually sown. The pastoral zone reaches the coast in the north, and even inland pastoral country is connected to the coast via waterways, so its sphere of influence can be large. The key point in terms of coastal impacts is that much of our agricultural land – even the hinterland – is connected to the coast by water.

wheat-belt zone agricultural area where wheat is grown

pastoral zone inland areas of Australia where the climate is too dry to sow pasture or crops but livestock can be grazed on native vegetation

The pressures on the **coastal zone** from agriculture include:

- the loss of coastal habitat and biodiversity due to land clearing
- pollutants in the form of fertilisers, pesticides and pathogenic organisms from animal manures carried down waterways to the sea
- nitrogen and phosphorus reaching estuaries and coastal waterways, causing **eutrophication**; this leads to algal blooms, 'cappuccino scum', anoxic and hypoxic events, fish kills and shellfish closures
- specific toxins poisoning marine organisms
- soil erosion in catchments generating high loads of fine suspended sediments, which can smother organisms on the coast.

coastal zone where the sea and the land meet

eutrophication a process whereby excess nutrients run off the land into lakes and rivers, causing unhealthy levels of plant growth

The impacts of agriculture on coastal waterways highlight the interconnected nature of catchments: actions taken by farmers several hundred kilometres inland can impact on coastal health. Declining water quality is a major threat to the ecosystem of the Great Barrier Reef, which is exposed to increased levels of sediments, nutrients and pesticides. These result in mangrove **die-back** and increased algae on coral reefs close to shore.

die-back a condition in a plant where the shoots or branches die from the tip

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Commercial fishing

Australia's commercial fisheries include prawns, rock lobster, abalone, scallops, oysters, fin-fish (including tuna, jack mackerel, pilchards, barramundi and snapper) and pearls. The value of Australia's fishing industry is around $800 million, of which around $700 million is in exports – mainly prawns, rock lobster and abalone – to Japan and the United States. Production in many fisheries has been declining from over-exploitation, despite developments in fisheries science and management. There has also been a trend towards larger companies, with some smaller fishers having to leave the industry.

Pressures on the coast resulting from commercial fishing include:

extinction disappearance of a species

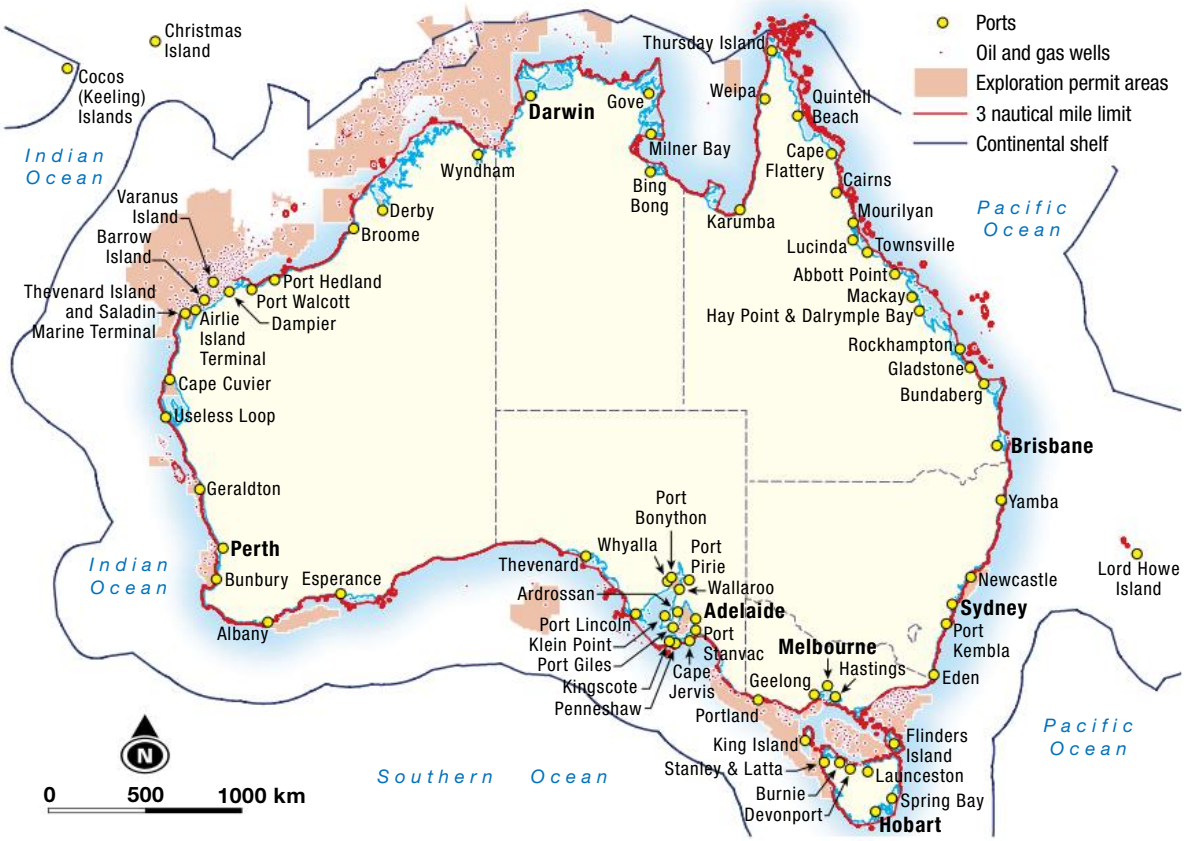
- widespread depletion of fishing stocks
- local **extinctions** of species
- wasted by-catch
- dolphins caught in tuna and other nets
- social disruption in fishers' lifestyles due to depleted stocks and changing regulations.



Source 4.13 Rock lobster pots, Abrolhos Islands, Western Australia

Coastal industries

Industries may locate themselves near the coast for ease of access to transport, for easy discharge and disposal of waste or because – like shipbuilding and ports – they are necessarily associated with the



Source 4.14 Locations of oil, gas and ports in Australia

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sea and the coast. The same is true of sandmining: many mineral sandmining operations are often near the coast because the minerals accumulate in the troughs of ancient dune systems.

A very high proportion of Australia's exports are transported by ship (241 million tonnes), although only around 4% (by weight) are exported by Australian ship. Around 23 million tonnes of goods are imported. A further 45 million tonnes of goods are carried around Australia by ship. Ports and waterfronts are obviously an important link in the import and export transportation. Ports have extensive storage facilities, and their location and contents often cause community concern.

Most of Australia's reserves of oil and gas are offshore. Bass Strait and Western Australia's North-West Shelf are the most significant. The offshore engineering industry that supports petroleum production is economically significant.

Pressures on the coast resulting from coastal industries include:

- land clearing, seabed reclamation and vegetation loss during construction and expansion of industry
- loss of sand to mining
- discharges of various substances, the worst of them including lead, copper, cadmium, mercury and zinc from industrial sources
- **ballast water** introducing foreign species such as Northern Pacific starfish, and **exotic** and toxic algae
- oil spills – the greatest threats from spills are during transportation from remote areas; in tropical areas, fields like Jabiru and the North-West Shelf are also vulnerable to cyclones, making accidents more likely
- visual effects.

ballast water water held in tanks and cargo holds of ships to increase stability and manoeuvrability while under way

exotic not native to an area, usually introduced from another ecosystem or country

RESEARCH 4.2

1 Choose one of the coastal uses discussed above: building and development; recreation and tourism; aquaculture; agriculture; commercial fishing; or coastal industries.

2 Identify and explain the benefits created by the use, and also the environmental pressures created by, that use.

3 Present your findings as a poster with photographs and diagrams.

Case study 4.1

The Great Barrier Reef: a landscape threatened by humans

One of the most famous national landscapes is the Great Barrier Reef, the largest coral reef system in the world, which is made up of 2900 coral reefs, over 900 islands and 300 coral cays. It is home to a rich ecosystem of different species of marine life and can even be seen from the moon. These qualities make the north Queensland location a popular spot for coastal industries, tourism and recreational activities.

This high level of human involvement has an increasing negative impact on the reef to the extent where the whole reef is now threatened. The corals and surrounding biodiversity are greatly affected by the pressure of human activity. One-fifth of the reefs have been destroyed and are showing no signs of recovery; a quarter are endangered; and another quarter of the reefs are facing the possibility of collapsing. The pollution caused by run-off from

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mining and farming is getting into rivers that lead into the ocean. This run-off damages ecosystems and causes massive amounts of algae growth, making it hard for the coral reefs to survive. Tourist boats dropping fuel into the ocean are also a major cause of pollution on the reef. Scuba diving, walking along the reefs and even swimming in large groups have had negative impacts on the strength of the area. As Queensland continues to grow, some industries are developing rapidly and major projects are increasing along the coast and on the islands adjacent to the Great Barrier Reef region. This also results in an increase in shipping.

Globally, overfishing is a serious problem. Fish are an important part of the ecosystem, and the Great Barrier Reef has experienced the effects of fishing. Fishing affects target species, non-target species and their habitats. It can cause ecological impacts on both the fished areas and the reef system as a whole. Fishing is banned on various parts of the Great Barrier Reef; however, illegal fishing still occurs and it is difficult to stop it completely. Tactics like zoning areas, creating marine parks and informing visitors of appropriate activities have been implemented in order to help protect the environment.

The Great Barrier Reef is protected under the *Environment Protection and Biodiversity Conservation Act 1999* (EPBC Act). Developments that have the potential to impact on matters of National Environmental Significance, which include the Great Barrier Reef World Heritage Area and Marine Park, must be referred under the EPBC Act to the Australian Environment Minister.

If a development's footprint is wholly or partly within the Great Barrier Reef Marine Park, the *Great Barrier Reef Marine Park Act 1975* also applies.

Along with protecting the ecosystem, human activity needs to be sensitive to the traditional owners of the Great Barrier Reef. Along the Queensland coast from the eastern Torres Strait Islands in the north to near Bundaberg in the south, over 70 Aboriginal and Torres Strait Islander traditional owner groups have a long-standing relationship with the Great Barrier Reef. The Marine Park Authority recognises these traditional owners and works with them alongside government organisations to protect the culture and heritage values held by tradition.

Sustaining the coral ecosystems is very important for the future of the landscape. Tourism is an important part of the economy, and without these reefs this would deteriorate drastically. More importantly, the oceanic ecosystem will be altered, killing marine life, polluting the water and damaging the shoreline. The loss of this landscape would also be devastating for the traditional owners, who value the cultural heritage of the reef.

1. Explain why tourism continues on the Great Barrier Reef, even though it has negative effects on the landscape.
2. Suggest why it is so difficult to stop overfishing completely.
3. Summarise the human activities that affect the reef.
4. Discuss why protecting the values of the traditional owners is important to the Great Barrier Reef.

Source 4.15 Boats dropping fuel into the Great Barrier Reef Marine Park are endangering the area.



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Climate change implications for the coast

In our atmosphere, concentrations of greenhouse gases such as carbon dioxide, methane and nitrous oxide are increasing due to human activities. For example, burning coal produces carbon dioxide. These greenhouse gases are causing our climate to warm and are creating more extreme events such as fires, storms and floods. New records have recently been set for serious bushfires, rainfall and floods. Climate change is also affecting the coast, and will damage coastal land values.

Ocean warming

Much of the heat accumulated in the Earth's system over the last 50 years has been taken up by the ocean. Ocean warming tends to be highest in coastal areas of poor circulation. The rate at which the oceans are warming is slower than for the atmosphere because of the greater thermal mass of the ocean. Sea surface temperatures may rise by as much as 2°C along the south coast of Australia and 2.5°C elsewhere by the end of the century. The decade ending in 2010 was the warmest on record for sea surface temperatures near Australia.

Atmospheric and oceanic warming will alter the abundance and distribution of coastal and marine life, as species respond to their changing environments. Some Australian species and ecosystems are already responding to warming. We are already seeing the decline of giant kelp forests off eastern Tasmania, coral bleaching, dwindling numbers of rock lobster larvae and local extinctions of abalone populations in Western Australia, and southward migration of tropical and temperate species. These trends are set to continue, and we will see further southward movements of tropical and sub-tropical species with local extinctions of coastal species in sub-tropical and temperate areas.



Source 4.16 King tide in Queensland

Sea-level rise

Increasing global temperatures are melting the ice in glaciers and the polar ice caps, and causing thermal expansion of the oceans. Both of these effects contribute to sea-level rise. Sea-levels around Australia rose approximately 17 cm between 1842 and 2002. According to the most recent **scientific consensus**, sea-levels will rise between 0.5 and 1 m by 2100 if we do not mitigate carbon dioxide emissions. We will see faster rates of change from the middle of the century onwards. However, there is a lot of regional variation in sea levels.

scientific consensus the agreed view of scientists about a particular topic, such as climate change

Sea-level rise will eventually cause permanent inundation of many urban and regional coastal areas. Significant losses and degradation of coastal ecosystems, public beaches, infrastructure, housing, land tenure, and commercial and recreational opportunities are anticipated. Coastal erosion and increased storm surges will force human settlement to retreat from the coast well before permanent inundation occurs.

Storm surges

As sea-levels rise, a small storm surge will travel as far up on to land as a large storm surge does now. Coastal communities will therefore experience an increasing number of storm-related high tides as a result of climate change.

In addition, the intensity of cyclones in tropical regions is likely to increase as a result of climate change. A recent example in Queensland is the impact of Cyclone Yasi on the coast around Cardwell, where there was massive destruction of

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Source 4.17 Coastal erosion at South Beach, Western Australia after a winter storm

property and ecosystems. Cyclones are also likely to travel further south.

The impacts of storm surges include more severe and frequent flooding, damage to sea defences and coastal erosion. These events may cause loss of life and major damage to coastal ecosystems and infrastructure.

Changes to ocean currents

Ocean currents are changing in response to global warming. Two of Australia's major ocean currents, the East Australian Current and the Leeuwin Current, influence the distribution of marine and coastal flora and fauna. These currents bring warm water to temperate latitudes, creating the conditions for tropical flora and fauna to flourish in southern Australian waters. The East Australian Current flows southward from the Coral Sea into the Tasman Sea. Long-term observations show that the East Australian Current has strengthened and extended further southward over the last 60 years.

Detrimental impacts are anticipated for cold temperate species and important fisheries such as abalone and rock lobster. The Leeuwin Current flows southward along the Western Australian coast, then eastward across the Great Australian Bight to the west of Tasmania. Changes to the



Source 4.18 Map of oceans and seas of Australia, and major currents (Source: CSIRO)

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Leeuwin Current are altering Western Australian coastal and marine ecosystems and fisheries.

Ocean acidification

Oceans absorb around a quarter of global carbon dioxide emissions. Increasing carbon dioxide levels in the atmosphere are also changing the chemistry of the oceans. Carbon dioxide dissolves in seawater, which causes it to become more acidic. The average acidity of seawater has increased by 30% since the beginning of the Industrial Revolution, and is projected to increase by 150% by 2050.

Ocean acidification decreases the amount of carbonate in seawater, which is a critical building block for the shells and skeletons of marine animals. These shells and skeletons will become thinner and weaker, making the animals more vulnerable.

Catchment flooding

Changing frequencies and severities of rain-bearing storms and cyclones have serious implications for dam design and flood prevention and management in coastal areas.

Following years of El Niño-related drought, parts of the east coast of Australia experienced flooding during an intense La Niña period in early 2011. As a result of this dramatic flooding of Brisbane, the design and management of the Wivenhoe Dam on the Brisbane River was examined closely.

In south-east Queensland, the increasing combined occurrence of heavy rainfall, storm surge and high tides will be made worse by sea-level rise.

Groundwater changes

aquifer a layer of soil or rock that contains groundwater

Groundwater, found in underground **aquifers**, is an important source of fresh water for consumption, irrigation and ecosystem health. As sea-levels rise, aquifers may become contaminated by seawater. When coastal aquifers are contaminated by seawater by as little as 5%, they can no longer be used for drinking water, irrigation, parks and gardens, or for sustaining ecosystems.

Implications for sustainable coastal and marine management

We can summarise the above issues in sustainable coastal and marine management as follows:

- loss of productive rural land to urban and semi-urban development
- increased pressure for the use of coastal recreational resources
- loss and degradation of habitats and environmental resources through development and overuse
- liquid and solid waste management, particularly in fragile coastal environments

NOTE THIS DOWN

Copy the graphic organiser below and summarise 4 of the types of climate change impacts and what they will mean for people and the environment.

Type of climate change impact on the coast	What it will mean to social or environmental values

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- heavier demands on coastal resources such as fish stocks, prime development locations and quarry materials
- increased management costs for local and state governments
- gradual and incremental degradation of coastal environments – beaches, dune systems, wetlands, tree-covered areas, cliffs and headlands, estuaries and waterways
- competition with other activities – for example, tourism and mariculture – for access to coastal resources
- loss of coastal values due to the many impacts of climate change on the coast.



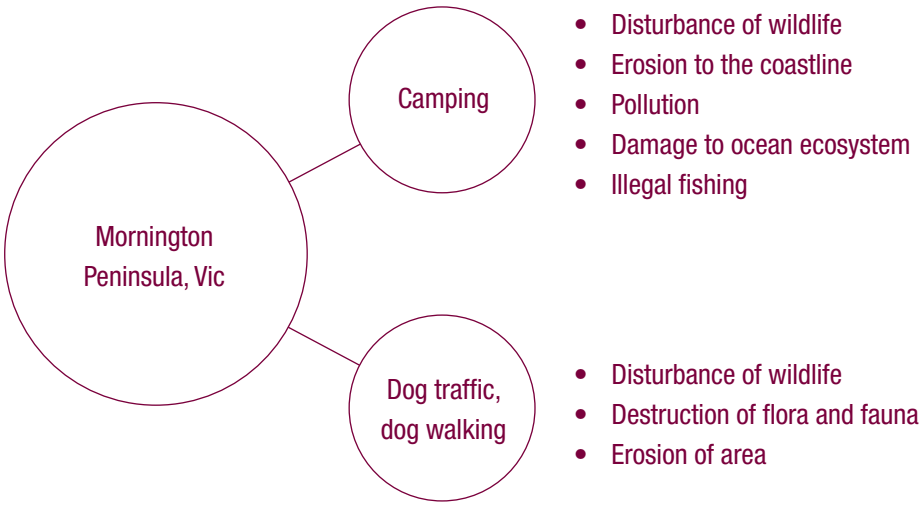
Source 4.19 Overfishing is a serious issue that has dramatic effects on the ocean.

ACTIVITY 4.2

1 Identify and list the nearest coast to you.
2 Describe the main human activities that occur there.
3 Analyse the impacts of these activities.

NOTE THIS DOWN

Copy the graphic organiser below and use your findings from Activity 4.2 to complete it. An example has been completed for you.



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Case study 4.2

Big Bonanza Coast: developing a proposal for a landscape threatened by humans

The impacts of humans on the coast are many and varied. Below is a situation of coastal conflict, which – although hypothetical – is common in many places along the Australian coast. This hypothetical region is called Big Bonanza Coast.

Coastal conflict

Typically, the coast of Australia attracts a range of residents and visitors. Over the past 20 years, urban development has increased at a rapid rate. Big Bonanza Coast is no different. There is a surf beach with a reef break, which is popular with local and interstate surfers. The beach is backed by dunes. A river flows down and meets the sea at an estuary next to the surf beach. On one side of the estuary, there is a woodland behind the primary dunes that features a rare and highly localised species of eucalypt. This area is part of a national park, which protects the dune ecosystem, eucalypt woodland and a rare species of wallaby.

The sea is famous for its clear turquoise water and abundant fish, such as snapper, bream, tailor, drummer and luderick, which can be angled from the beach – although numbers are declining. The estuary contains a commercial and recreational crab fishery. A popular safe swimming beach is located close to the town. Around the estuary and on the dunes, there is tourism and residential development. An airport and hospital also exist close to the estuary. The main road runs very close to the sea and crosses the estuary at a low bridge. Inland from the estuary, there are wineries and farms.

Because of its many values, the coast has attracted sea-changers, retirees, scientists, fishers, surfers, conservationists, holiday-makers, artists, tourist operators, land developers, gourmet food and drink producers, shop-owners and many other businesses.

Indigenous folk have also valued the area for thousands of years for its abundant food sources and excellent campsites. There are several significant men's sites and women's sites on the dunes and around the estuary.

Because of its varied land uses, this location is highly prized and under extreme pressure for development. The region has become divided over land-use issues, with diverse interests in the use and protection of the dunes, estuary and seashore.

Source 4.20 The hypothetical Big Bonanza Coast is home to a popular swimming beach close to town.



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There are also divisions between the older residents, who fondly remember the quiet little town to which they first moved, and the newcomers, who are part of the development boom.

The area straddles 2 local government areas that lie on either side of the estuary.

The coast has been eroding for a long time. However, erosion of beaches and sand dunes is now accelerating. Each winter, erosion eats further into the dunes, where the national park and housing developments are located.

With climate change, these impacts will be made worse by:

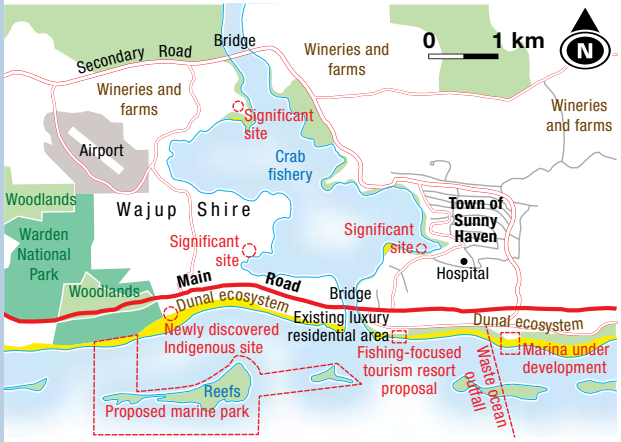
- changing patterns of long-shore and on-shore sand movement
- faster erosion due to sea-level rise
- much more frequent coastal inundation from storm surges
- increased catchment flooding from heavy rainfalls
- unpredictable effects on marine ecology and fish stocks produced by changing sea temperatures and currents.

Impacts of these changes will include the loss of many amenities: houses, coastal ecosystems, beaches, beach quality and facilities (e.g. sport and recreation), infrastructure and economic value.

However, because of the strong demand for residential and tourism development, both local governments are under constant pressure to approve requests for development and increase infrastructure provision, but also to protect vulnerable ecosystems, land and properties. This has come to a head with several controversial new developments in place and others being proposed vigorously by real estate and tourist developers:

- A large marina is under construction, including island and canal developments aimed at building 1000 dwellings, hotels and boardwalk retail developments, as well as beaches and seawalls. This would provide employment for 1000 people during construction and 500 once it is established. The developer has provided scientific evidence that the marina will create minimal impact on the coast, but this has been disputed by NGO groups, which have scientific evidence to show that there will be serious ecological, social and cultural implications.
- A luxury residential development already exists on the primary dune system, which would have access to the marina facilities.
- A tourist resort has just opened, aiming to concentrate on recreational fishing, both big game offshore and angling onshore. The owner is asking for support from council and state government to provide more jetties, fishing amenities, seating and fish-cleaning areas.
- The local conservation group, backed by several national and international NGOs, is calling for the creation of a marine protected area, as it is a site for several iconic but threatened marine species. Commercial fishing interests dispute the science of the NGO proposal, claiming the area is not as unique as is being suggested.
- In the past, wastewater was deposited in the **swales** between the sand dunes but now all wastewater is discharged via an ocean outfall. However, changing currents and beach formations are now causing sewage to wash back towards the beach in some storms.
- An Indigenous burial site in the dunes has recently been exposed in the face of the eroding dune, which reveals that Indigenous

swale low-lying land between two sand dunes



Source 4.21 Map of Big Bonanza Coast

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folk were occupying this site for much longer than had previously been believed. Unique tools and artefacts have also been found.

Coastal sustainability and adaptation principles

Below are some principles for coastal sustainability and adaptation to climate change impacts to guide your proposal to resolve the conflict at Big Bonanza Coast.

1. Think long term about strategy and resilience. Climate change operates over a much longer time scale than political cycles, and the sea will continue to rise for several millennia beyond 2100. Future generations may live in a world that is also politically, economically and socially different. A long-term plan is needed to cope with a retreating coastline. The plan has to be flexible enough to deal with new information as it presents itself. The plan should include a transition zone that identifies the areas of the coast likely to be impacted by climate change. The plan should aim to build resilience so that coastal communities – both human and ecological – can return to a healthy condition even after a major cyclone or flood. Resilience can be built by strengthening the community's sense of place and belonging, as well as its skills and confidence. Ecosystems need to be kept healthy. Sewerage and transport infrastructure needs to be able to cope with increased coastal and catchment flooding. The plan should incorporate the coastal adaptation ladder below.
2. Use the coastal adaptation ladder. The coastal adaptation ladder suggests actions that can be taken. In order from highest to lowest priority, they are as follows:
   - **a** Avoid creating future problems. Direct new development away from the coast. Allow generous buffers between the sea and buildings in the form of native vegetation and public open space.
   - **b** Protect and enhance natural buffer systems. Coasts have their own buffer systems, such as dunes and wetlands. These can be strengthened by planting native vegetation and preventing habitat destruction by development. Natural buffers can slow the erosion of coastlines.
   - **c** Roll back existing development. Move existing coastal development to safer ground, or plan for its complete removal. This process will need careful planning, and close community and stakeholder engagement. Specific local strategies will need to be developed.
   - **d** Accommodate floods and sea-level rise. Some development can be allowed to remain longer in a transition zone if it is resilient to occasional inundation or flooding. This includes some sports and recreation facilities or parkland. Some development can be made more resilient to flooding or inundation through building retrofits or design.
   - **e** Defend highly valuable assets with coastal engineering structures. This option is attractive to many stakeholders, but also presents problems in the form of conflicts around prioritisation; expense of construction; false perceptions of long-term risk-reduction; increased future liability for maintenance; transfer of risk along the coast; and loss of beach.
3. Consider the 4 aspects of coastal sustainability and adaptation. Coastal sustainability is about finding positive interactions among economic, ecological, social and cultural aspects of our coastal lives. We have to consider climate impacts on all of these aspects.
   - **a** The cultural aspect relates to how we make and share meaning. It may include heritage and Indigenous sites, art galleries, music venues, museums and our lifestyle.
   - **b** The social aspect relates to how we organise ourselves to provide for our needs. It may include hospitals, libraries, schools, the police station, cafés and clubs.
   - **c** The economic aspect relates to how we generate livelihoods and the resources required to meet our needs and wants. It may include water, energy and waste-disposal

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infrastructure, ports, airports, tourist sites, shops, mines, farms and factories.

d The ecological aspect relates to the natural world. It may include beaches, sea, estuaries, bushland and processes such as water and nutrient cycles.

4 Engage the whole community to develop learning, literacy and capacity. Sustainability and climate change affect whole communities, and the costs of adaptation may affect whole states and countries. We have to learn and adapt continuously, using the best information available at the time. Discussions among society, government and scientists will help to establish learning and literacy about sustainability and coastal adaptation. Knowledge comes not only from scientists but also from government and society, including Indigenous people. As people learn and develop their understanding about climate change and coastal sustainability, the community will be able to have fairer and more constructive conversations about how to go forward. This is called 'building capacity'. Community art projects can help develop a sense of place and understanding about coastal sustainability and adaptation.

5 Listen to Indigenous stories. Some coastal Indigenous peoples have cultural stories about the last ice age, when they lived on coastal plains that are now seabeds, and how the sea levels rose at the end of the ice age to drown those coastal plains and change the shape of the coastline dramatically. So our current society is not the first to have experienced the need for coastal adaptation. It is important to record and learn from the experiences of first peoples, and how they achieved sustainability in the face of a changing coastal climate.

6 Develop partnerships at the scale of 'coastal compartments'. Partnerships have become a useful means of sharing information and resources for coastal adaptation. Local governments and their communities can work together, calling on state and federal governments for funding and advice where needed. The best scale for a coastal adaptation partnership is likely to be a 'regional coastal compartment' – a natural landform such as a large embayment. Governments working at the scale of a coastal compartment will likely share similar issues.

7 Mitigate to adapt. The fewer greenhouse gases we emit, the less we will have to adapt in the future. Mitigation is still the best form of adaptation.

Coastal sustainability strategy for Big Bonanza Coast

As a result of the above pressures, the Big Bonanza Coast region has become very conflicted about its future development. Hence the Commonwealth, state and local governments concerned have decided to appoint a broad-based taskforce on coastal sustainability for the region. You are members of this taskforce and your role is to create a brief proposing a strategy to resolve the conflict at Big Bonanza Coast. Your proposal needs to consider as wide a range of community interests as possible, and to think in the short and long term. Within your brief, address the following questions:

1 Identify and list the main stakeholders.

2 Summarise their values and views.

3 Investigate the region's assets and opportunities for sustainability.

4 Explain the threats to sustainability in the region.

5 For each of the principles in the list above, develop 1 or more specific goals and actions that could help create a sustainable future for Big Bonanza Coast.



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4.3 Aboriginal and Torres Strait Islander knowledge about use and management of landscapes

Geographical fact

The Australian landscape has probably been more strongly influenced by climate change than by Aboriginal land use over Indigenous peoples' 60 000+ years of occupation of this land. There have been 4 major advances of glacier ice during the last 70 000 years. The coldest part of the last ice age was between 20 000 and 22 000 years ago, and only lasted a few thousand years. During the last ice age, the climate was much colder and drier, and the coastline was tens of kilometres seaward of its current position. Some landforms that are now islands were at that time connected to the mainland. Indigenous people occupied many of these islands.

Aboriginal and Torres Strait Islander peoples have experienced and managed land in very different ways from non-Indigenous Australians. Tribes and clans also vary in their cultural practices, so there is no single Aboriginal and Torres Strait Islander perspective on the land. However, there are some common features in how Aboriginal and Torres Strait Islander peoples view landscape:

- Landscapes and culture are inseparable; the term '**country**' expresses this idea of a fully cultural landscape.
- Land, sea, waterways and sky are interconnected.
- Cultural stories describe features of country, and some place names and sacred sites reflect these stories.
- Clan identity is closely related to country.
- Clans use resources for **subsistence**, culture and exchange.

country the Aboriginal concept of place, which includes all aspects of the environment including life

subsistence collection or production of food for oneself and one's family, but not for sale

Clans traditionally managed their estates through cultural ceremonies such as song and dance, and many do so to this day. They restricted access to the landscapes according to season, status of clan member, **totem** and presence of sacred sites. Dreaming stories also affect management practices. For instance, Nyungars in the south-west of Western Australia do not push beached whales out to sea, as they are viewed as bringing human spirits ashore.

totem an object representing an animal or plant that is of special significance to a particular group, family or tribe

Indigenous peoples of various cultures farmed or managed ecosystems to various extents. Aboriginal peoples of Australia and the Australian landscape evolved together as a result of management practices such as **burning**. In some cases, burning was done on a large scale; in other cases, a 'mosaic' landscape of small patches was produced through strategic small-scale burning. Burning off is traditionally done by people who have a detailed knowledge of the country, of where and how to light fires, and of the likely movement of the winds. It is a very specialist skill that has been used for many generations. The act of burning managed landscapes benefited travel, hunting, communication and horticulture. It also resulted in the development of a unique growth process of vegetation that provided food and habitats to people and animals.

burning ritual practice of setting fire to areas of bushland for environmental purposes and to attract wildlife to the new growth

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Source 4.22 Traditional burning in the Red Centre, Australia

Geographical fact

Life would have been very hard for Aboriginal people living in the southern parts of Australia during the last ice age, because temperatures in Canberra, for example, would have been around 9°C colder than they are now. Terrestrial, coastal and marine ecosystems were certainly very different, as they were adapted to colder conditions.

ACTIVITY 4.3

1. Discuss whether Aboriginal and Torres Strait Islander land management is traditionally done by individuals or groups.
2. Evaluate the advantages of this approach. What challenges could there be in this approach?
3. Explain what Aboriginal and Torres Strait Islander peoples mean by the term 'country'.

Geographical fact

In the north-west of Australia, the Martu people burn spinifex to reveal the hiding places of their prey – for example, goanna burrows. Women who hunt for goanna can spot burrows and tracks better in burnt country than in thick spinifex. Burning off spinifex and other grasses also encourages the growth of a wide range of plants and the animals that rely on those plants. The Martu burn country in patches of about 22 ha to create a patchwork quilt of recently burnt earth and recovering vegetation. These patches are much smaller than those left by lightning wildfires, which cover around 800 ha.

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self-determination freedom to live as one chooses

freehold a form of land ownership, which is inherited or held for life

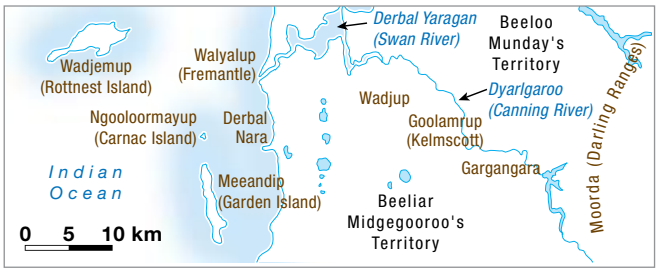
Current land use by Aboriginal groups in Australia varies. Many believe that **self-determination** and secure title (whether **freehold** or native) over land is an important aspect of their cultural sustainability. Current uses of Aboriginal land include tourism, foraging and hunting, herding of animals, horticulture, national parks (with various degrees of joint control) and residential land.

Exciting partnership projects for land management are also starting to appear. One of these is a project operated by the North Australian Indigenous Land and Sea Management Alliance (NAILSMA), which aims to have traditional owners across the top of Australia manage the northern marine turtle and dugong populations, including hunting them for subsistence purposes. Although the project has been very successful, there have been public concerns about Indigenous management of animals that results in the hunting of species that are rare or iconic. However, it is worth noting that it was not Indigenous practices that endangered these marine species in the first place and, overall, Indigenous coastal **stewardship** is more likely to benefit than endanger such species.

stewardship the responsible planning and management of resources

Protecting landforms of significance to Aboriginal and Torres Strait Islander peoples

Along the coast of Perth in Western Australia is Derbal Nara, the Nyungar people's name for the area of Cockburn Sound. 'Derbal Nara' means 'estruary of salmon'. It includes the water of Derbal Nara, the islands of Derbal Nara (Wadjemup (Rottnest), Ngooloormayaup (Carnac) and Meeandip (Garden) Islands), the dunes and coastal plains, and the freshwater lakes and waterways.



Source 4.23 Map showing Nyungar names for key places within Whadjuk country (after Neville Green)

Nyungar oral histories recount how these islands were once connected to the mainland, during the last ice age when sea levels were much lower (see Source 4.24).

> My grandmother used to live along the river right down there and she reckon they [ancients] used to walk right out to Rottnest Island; that it was all sandbanks way back. And they used to walk across there and because Rottnest Island is a hill and it stood out when there was no water there … those olden days, things were a lot different.

Source 4.24 Traditional owner and Nyungar Elder Dorothy Winmar narrates one story that was told to her.

When sea levels rose as the last ice age ended some 12 000 to 7000 years ago, the islands became separated from the mainland by sea.

> The Walyalup (Fremantle) Dreaming story tells of Yondock, an ancestral crocodile that travelled down from the north, causing floods and disturbances, creating Wadjemup (Rottnest Island, Ngooloormayaup (Carnac Island), Derbal Nara (Cockburn Sound), and flooding the Derbal Yaragan (Swan River) with salt water. The Waagle or Rainbow Serpent, guardian of the fresh water, smells the salt and travels down Derbal Yaragan to see what's happening. With advice from Woorriji (a lizard) from the Waagle cave in North Fremantle and strength gained from a freshwater spring at the East Street Jetty, he fights the crocodile, bites off his tail and places the tail across the mouth of the river to prevent salt water coming upstream. The tail is secured with hair from the armpits

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of the Waagle on the southern side of the river, and with toenails from the crocodile on the north side of the river. The rest of the crocodile's body remains as Meeandip (Garden Island) and dingoes watch from Cantonment Hill to make sure the spirit of the crocodile is not reunited with its tail. The rock bar at the mouth of the river was a crossing place for Aboriginal men. In the 1890s, with CY O'Connor's plans to create the Fremantle Harbour, the rock bar was blasted to make a deepwater port. Part of the tail remains and is visible from the Maritime Museum.

Source 4.25 Traditional owner Trevor Walley tells how Derbal Nara was formed through a fight between the Waugal and the Spirit Crocodile.



Source 4.26 The island known as Meeandip looks like a crocodile.

Some Nyungar recognise the above story as describing the rising of the sea-levels at the end of the last ice age. These accounts show that Aboriginal stories are still relevant to today's communities. By understanding and protecting landforms of significance to Aboriginal people, we preserve the whole cultural significance and history of an area. We can understand the connection between country, Dreaming story and place names as a holistic cultural account. Stories like the one above also help to record and link human experience to dramatic changes in geography and climate over the long haul of our history.

Preserving values of a landscape

Traditional owners, local governments and academics have worked together on a project that aims to record the Whadjuk Nyungar history of Derbal Nera (or Cockburn Sound). The project makes a major contribution to the representation

Source 4.27 Derbal Nera, or Cockburn Sound



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of Nyungar coastal and marine values. The City project partners have created a resource available online to educate others about the Aboriginal history of the area. It describes creation stories, the features of the land, and trade and exchange. To view the complete resource, visit www.cambridge.edu.au/geography8weblinks.

RESEARCH 4.3

Using online resources, research 1 of the Nyungar Dreamtime narratives and prepare a presentation on it for the rest of your class. Identify any impacts the story has on the cultural and environmental practices of the Nyungar people. Suggest any ideas that might be applied to current conservation efforts in the Nyungar region or beyond.

FIELDWORK 4.1 HEALTHY ENVIRONMENTS

Aim

To gain an understanding of the environments in your area. You will also analyse the role of the environment and describe the effects of human activity on the landscape.

Method

Select an area nearby – this may be a national park, reserve, lake or coastal area. Visit the area. Bring your camera-phones or cameras.

Preparation

Find a map of the selected area, and indicate the sections that will be visited and studied. You will also need to take a camera, the list of questions based on the 'data collection' section below, paper (on a clipboard) and pen.



Source 4.28 What animals are living in your local area?

Data collection

Take photos of plants, animals or scenes that you think are interesting, striking or beautiful in some way. Select 3 of your favourite photos. Use these images and your notes to research answers to the following questions about the plant, animal or scene.

1. List the specific names of the area/objects/animals in your photographs.
2. Explain what role this environment plays. Consider the traditional owners, the surroundings and the ecosystem. Is the area used for recreation, industry or spiritual purposes?
3. To what extent does the location influence the types of activities that occur there?
4. Describe the positive and negative, and short-term and long-term, impacts of these activities on the area.
5. Analyse how healthy the area was at the time you visited.
6. Discuss what you or others could do to help sustain this environment and its inhabitants.

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Fieldwork presentation layout

Front page	Tile and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map
Page 3	Introduction – brief description of the study sites
Pages 4–5	Description of uses and photos including the specific names of the items in your photographs
Page 6	Explanations of the role this environment plays in your local area
Page 7	Table of usage: effects of use (positive or negative, short term or long term)
Pages 7–8	Description of effects of use, sketches and/or photos
Page 9	Association between use and effects of use
Page 10	Analysis of the health of the landscape
Page 11	Suggestions for sustainable strategies
Page 12	Conclusion summarising what you learned about the area in this fieldwork activity.
Page 13	Appendix, Bibliography, Glossary



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Chapter summary

- Indigenous societies traditionally understand the environment as a cultural landscape or 'country', to which nature and culture are integral; they care for country accordingly.
- Modern lifestyles place many pressures on the environment, which can reduce its health and its capacity to support us.
- Our views or belief systems influence how lightly we tread on the landscape.
- Some 90% of the population of Australia lives in coastal areas. This has caused a number of environmental challenges in these areas.
- The impacts of climate change on coastal areas will be severe, and will require a concerted effort by governments and individuals to avoid its most harmful effects.
- Sustainability requires a long-term, inclusive and flexible mind-set in order to confront future challenges.

End-of-chapter questions

Multiple choice

1 What does 'ribbon development' mean?

A the act of building very narrow roads

B the act of growing crops following main roads

C the act of building houses in a continuous row, following main roads and transport routes

D the act of building houses down winding roads

2 Why do some Aboriginal communities burn the country?

A to make hunting animals easier

B to benefit travel and communication

C to kick-start the vegetation growth in the landscape

D all of the above

3 When the last ice age ended, what happened to sea-levels?

A The sea-levels rose and land separated.

B The sea-levels decreased.

C The sea became fresh water.

D The salt levels in the ocean increased dramatically.

4 Why is tourism having a negative effect on the Great Barrier Reef?

A Tourists are frightening all the marine life.

B Human activity such as reef walks, boats in the ocean and fishing are damaging the fragile reefs and marine life.

C Resorts are littering in the ocean.

D The destination is becoming too popular and it is too hard to get accommodation in the area.

5 The value of Australia's fishing industry is around:

A $800 million

B $200 million

C $1 billion

D $80 million

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Short answer

1 Suggest how the different seasons affect the way we live.

2 Describe 4 different views and the values they support.

3 Outline an example of how sustainability can be enhanced in the landscape.

4 Discuss the pressures that humans currently place on our coasts.

5 Identify the stakeholders that need to come together to create a coastal sustainability strategy.

Extended response

Evaluate what you think is meant by the phrase 'treading lightly on our landscape'. Identify and explain ways in which we can tread more lightly on our landscape.

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5 Landscape hazards



Source 5.1 Geomorphological hazards are a concern all around the world, and it is important for us to explore causes and impacts of, and responses to, these hazards.

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Before you start

Main focus

Most of the world's population live in an area where one or more types of natural hazard are likely to occur. People learn to live with these hazards.

Why it's relevant today

We need to be able to identify the hazards likely to affect us where we live, work and holiday, and know how to react if a hazard turns into a disaster.

Inquiry questions

- What are geomorphological hazards?
- What are the natural causes of geomorphological hazards?
- To what extent have human alterations to the environment contributed to the occurrences of geomorphological hazards?
- How should people prepare for a particular hazard?

Key terms

- Bushfire
- Cyclone
- Drought
- Earthquake
- Flood
- Landslide
- Natural disaster
- Natural hazard
- Prevention
- Storm surge
- Tsunami
- Volcanic eruption

Let's begin

Most Australians live in an area where the prospect of drought, bushfire or cyclone is possible. Few Australians are aware that they also live in areas where earthquakes, tsunamis and storm surges may occur. Geomorphological hazards are common around the world, due to natural causes and even human alteration of environments. Responding to hazards and working towards prevention are difficult but necessary practices, especially for people living in an area that is prone to geomorphological hazards.

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5.1 Natural causes and spatial distribution of geomorphological hazards

geomorphology the study of landscapes and landforms, and the processes that have made them the way they are

hazard a known feature of an area that may cause loss of life, injury and/or property damage

natural disaster the occurrence of an expected natural event that adversely affects the environment and people in the area

flood the flow of water through an area that normally is dry, such as when a river breaks its banks

hydrological hazard a natural hazard , such as a flood, whereby water may cause loss of life, injuries and/or property damage

Geomorphology refers to the study of landscapes and the processes that have made them the way they are. A geomorphological **hazard** is a danger that occurs as a result of changes to a landform, affecting the stability of the site and resulting in devastating effects on the area and those living there. These **natural disasters** include floods, earthquakes, volcanic eruptions, landslides and tsunamis.

Floods

Floods can be considered **hydrological hazards**, but they are also geomorphological, as they cause a large amount of destruction and erosion to landscapes and carry large amounts of sediment. The main causes of flooding are overflowing rivers and other bodies of water, melting snow or heavy rainfall. **Cyclones** can also be a cause, as they draw in moisture from the surrounding ocean. Most of this moisture is dumped along the coast, where flooding may quickly occur in coastal river systems; however, if the path of the cyclone continues inland, it is likely to bring enough moisture from the ocean to create widespread flooding to inland areas.

cyclone an atmospheric system characterised by the rapid inward circulation of air masses about a low-pressure centre, usually accompanied by stormy, often destructive weather

Geographical fact

Floodwaters contain a variety of dangers beyond drowning. They can hide debris and dead animals, and contain bacteria and sewage that can make a person ill or cause injury (or both). Victims of floods are encouraged to not swim in floodwaters due to the dangers.

Source 5.2 An aerial view of the Brisbane River flood in 2011



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ACTIVITY 5.1

1 Contrast and compare geomorphological and hydrological hazards.
2 Explain why floods can be both geomorphological and hydrological hazards.
3 Summarise the process of how cyclones can cause floods.

Earthquakes

tectonic plates layers of the Earth's crust that move and float

earthquake the result of the Earth's tectonic plates moving against each other

The outer layer of the Earth is broken up into **tectonic plates**. When these plates move in a way that is stressful to the Earth's layers, rocks are broken and caused to move, resulting in an **earthquake**. Earthquakes commonly occur on the boundaries of the plates: one plate will be forced under another, causing the geomorphological hazard. Plates may move away from each other, causing the land to subside between the two plates – for example, the Rift Valley in Africa. Plates can also grind past each other, causing major damage when movement occurs – for example, the Southern Alps of New Zealand.

landslide the failure or collapse of a slope, resulting in the movement of debris downslope under the influence of gravity

avalanche the failure or collapse of a snow-covered slope, resulting in the movement of snow and debris downslope

The movement of earthquakes can trigger a **landslide** or an **avalanche**. An earthquake can also trigger a **volcanic eruption**, which in turn can trigger an avalanche or a landslide, depending on the location where it occurs.

volcanic eruption the process of lava (originally magma from the Earth's core) spilling from fissues or vents in the Earth's crust

Geographical fact

A lot of people believe that standing in a doorway is the best method to survive an earthquake. However, modern homes in Australia aren't built like older homes, and doorways aren't as strong as they once were. Instead, a person is better off sheltering beneath a sturdy table or bench, as falling objects are the biggest risk to safety.

Source 5.3 Damage from the Christchurch, New Zealand earthquake in 2011



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Case study 5.1
The Meckering earthquake

Richter Scale the scale developed by Charles Richter and Beno Gutenberg to measure the severity of earthquakes. The scale was based on a logarithmic progression so that an earthquake of magnitude 5 was 10 times stronger than a quake of magnitude 4.

Severe earthquakes are rare but not unknown events in Australia. One significant earthquake occurred in and around the small wheatfield town of Meckering in Western Australia on 14 October 1968. The quake measured magnitude 6.9 on the **Richter Scale** and occurred at 10.58 am on what fortunately was a public holiday. There were no deaths, even though the town suffered significant damage with the collapse of most major buildings. Twenty people required hospital treatment. It was the first recorded evidence of an earthquake in Australia producing a **scarp**. The activity caused one part of the plate to ride up over the other. Eyewitness accounts of the earthquake were recorded.

scarp a cliff or sloping surface caused by earthquake activity

Miss Glenys Nichol was alone in the general store when it started to collapse around her. She escaped through the front door and ran across the street to the parking area. As she ran, numerous ground cracks in the parking area were opening as much as 5 cm and shutting again, and she felt a slight burning sensation on the skin and there was a slightly nauseous smell reminiscent of carbide. She experienced a similar smell following one of the major aftershocks.

The local butcher, Mr Vic Edwards, lived on the north side of the railway, about 750 m north-east of the town centre. At the time of the earthquake, he was in his backyard with his family. All suddenly experienced the sensation of being thrown into the air. Mr Edwards got to his feet but was knocked to the ground twice more and there seemed to be coincidental explosions. He saw cracks in the ground opening as much as 3.5 cm with spurts of white vapour or dust rising about 2.5 m high as the cracks shut. Most of the cracks in the ground around the ruined house settled down and were not visible a week later, but two large openings about 75 cm deep and 7.5 cm wide remained in the alluvial soil.

At the time of the earthquake, Mr TH Morrell and his son were driving in the farm truck on the outskirts of Meckering, close to the cemetery. They heard a loud noise that seemed to be moving north, and the truck suddenly thumped up and down with a sensation akin to a flat tyre. Looking to the side of the road, they saw laterite pebbles jumping and bouncing as much as 50 cm from the ground.

Mr L Solomon was sitting in his truck in Meckering at 10.59 am when the heavy vehicle seemed to be thrown into the air, then dumped down. Simultaneously there was a large explosion, and immediately in front of him the front wall of the general store crashed down on an unoccupied utility van. Joined by his son, he ran across the road to the parking area where, amid loud noise, two distinct groundwaves were seen to move easterly across the main street. The rolls were travelling at about 12 km/h, and the ground appeared to rise sharply and fall away slowly with about a 2-second interval between the crests. Both men were brought to their knees by the ground movement. In the parking area, the railway water tank was swaying alarmingly and two tie-rods parted audibly. The Solomons immediately left town, and as they drove up the main street observed the chimneys on the two-storeyed bank building falling northward, and on recoil,

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the south wall fall outward. Eight hundred metres further along the Goomalling Road, mud bricks were still falling from a house as they passed by. About 2 km further along the road, when the truck was travelling at about 100 km/h, they reached the scarp of the **Meckering Fault**. On crossing the 1.8 m high fault scarp, the vehicle was airborne until it landed with such force that the front bumper hit the ground. Driving on, Mr Solomon came to a second, smaller fault scarp 0.3 m high, adjacent to his ruined home.

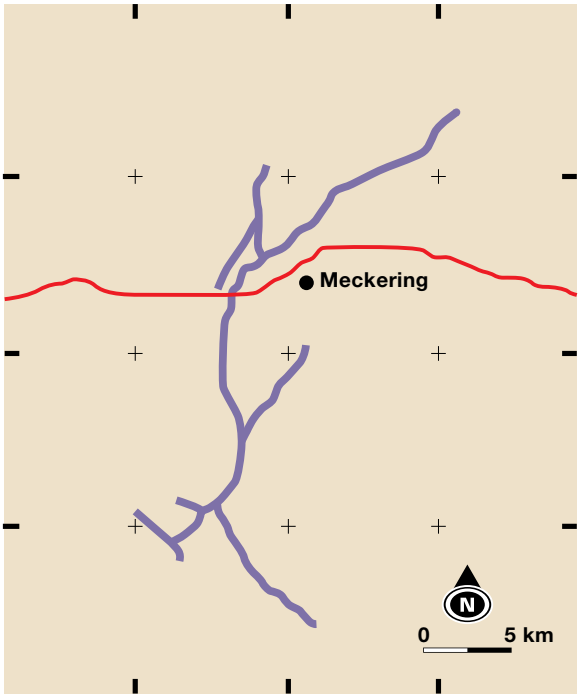
The observer closest to the Meckering Fault at the time of formation was Mr LA Sheehan of Cunderdin, who was driving eastwards towards Meckering, about 6.5 km away. The trees along the roadside, already agitated by wind and rain, started to whip violently and at the same time the car rocked as if a tyre had blown out. The driver at first thought he was involved in a **cockeyed bob**, but then immediately in front of him a 2.5 m high bump rose in the road where 2 seconds before none had existed. Another observer, travelling in the opposite direction along the Great Eastern Highway, felt the shaking and saw the scarp rise, and crashed into a tree at the roadside, breaking an arm.

Meckering Fault the displacement of rock layers as a result of earthquake activity in and around Meckering, Western Australia in October 1968

cockeyed bob a Western Australian name for a small but violent cyclonic disturbance, particularly one that causes localised wind damage

Source 5.4 Eyewitness accounts of the Meckering earthquake

The fault scarp that confronted the drivers on roads in the Meckering area was almost 40 km long (see Sources 5.5, 5.6 and 5.9). The area has returned to producing wheat, and erosion and bulldozers have removed all traces of the scarp. A small section has been preserved and, while little remains of



Source 5.5 Map of the fault line



Source 5.6 Aerial view of the fault

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the original town, the locations of different places have been recorded and the owner of the Big Camera, a photography museum in town, has a great collection of photos recording the event, as does the owner of the HCT Rural Agencies General Store.

1 As a class, discuss whether you have ever experienced an earthquake in Australia.
2 Examine the infrastructure (building) in which you are located. Identify the safety measures you could take if a severe earthquake were to occur.
3 One safety recommendation during an earthquake is to stand in a doorway. Explain why this may no longer be a good idea.
4 Explain what you think it meant when the case study mentions 'the roll' in the Earth's surface.



Source 5.7 Railway lines showing vertical and horizontal displacement



Source 5.8 Remains of Salisbury homestead, built in 1904 – but not built to earthquake standards



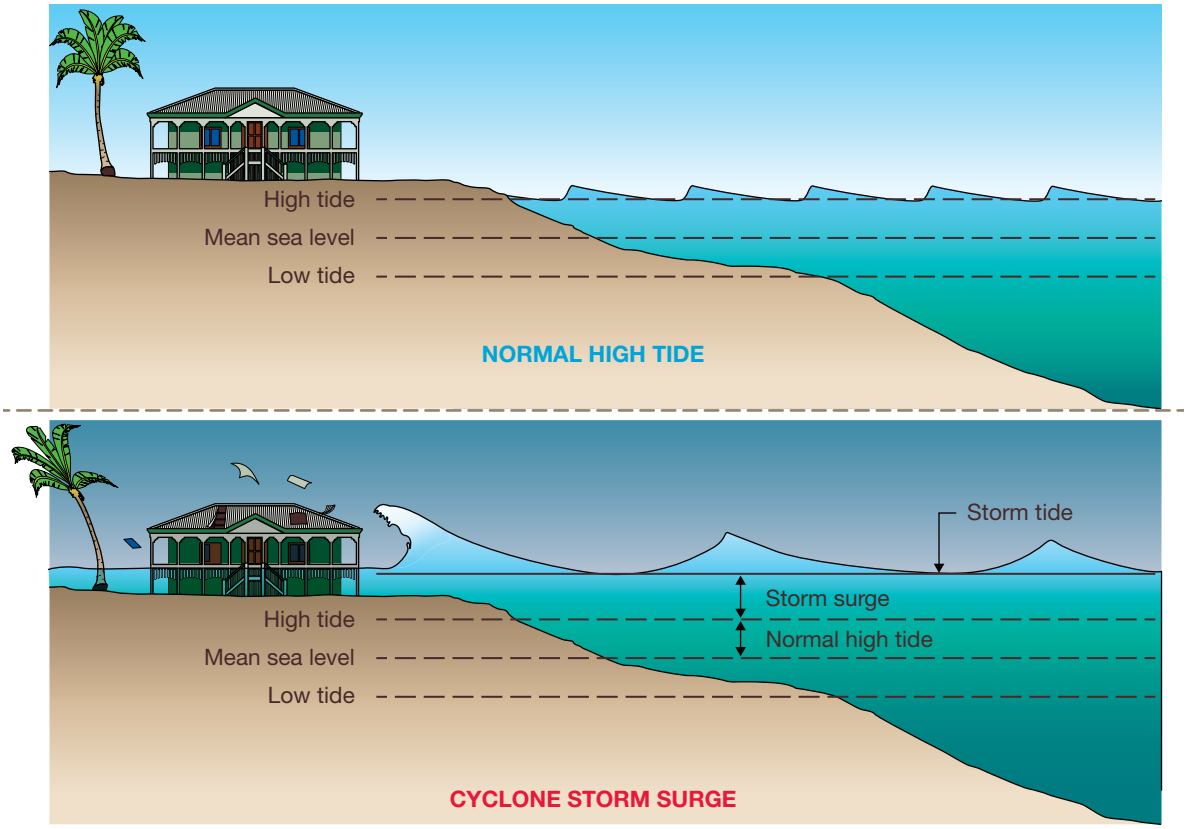
Source 5.9 Meckering fault scarp in 2013

Storm surges and tsunamis

People living along the coast are particularly vulnerable to storm surges. This is because waves are created by wind. The stronger the wind, the larger the wave. Cyclones often occur out in the ocean and have very strong winds, creating very large waves. Waves like these erode beaches, causing damage to private and public property. The winds associated with cyclones push the surface of the water up to such a degree that the normal levels of a high tide are exceeded. This creates a much higher tide, which is known as a **storm surge**. Some areas along the coast have significant differences between low tide and high tide, and storm surges are particularly destructive to these areas, as the high tide can make the storm surge even more aggressive. Storm surges have been known to wipe out infrastructure and take lives.

storm surge an increase in the height of coastal waters as a result of onshore winds, usually associated with a cyclone

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Source 5.10 The difference between a normal high tide and a storm surge

Storm surges are destructive, but not as destructive as **tsunamis**. Unlike regular sea waves, tsunamis have an extremely long wavelength. Generally, tsunamis resemble a rising tide and consist of a series of wave periods. Tsunamis are a result of the displacement of a large volume of water, usually caused by earthquakes, volcanic eruptions or landslides. The smashing force of the walls of water has a destructive effect on both the land and infrastructure. After the waves have covered the land, the area is flooded and the water begins to drain back out, carrying debris and people with it.

tsunami a series of ocean or lake waves with enormous destructive potential, usually created by an undersea earthquake

Source 5.11 The aftermath of the 2004 Indian Ocean tsunami off the coast of Sumatra



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RESEARCH 5.1

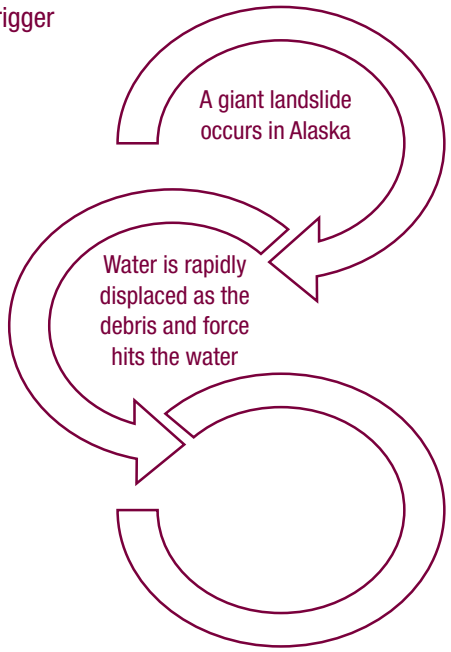
Using the internet, research the 2004 Indian Ocean tsunami. Select 1 of the countries affected by the tsunami:

- Indonesia
- Sri Lanka
- India
- Thailand
- the Maldives.

Construct a timeline of events for your chosen country that summarises what happened during the tsunami and how the area was damaged.

NOTE THIS DOWN

Copy the graphic organiser and explain how one natural disaster can trigger another. One common example is an earthquake causing a tsunami, or storm surges causing flooding. One example has been started for you. Add or remove circles as needed.



Droughts

drought an extended period of time when there is an absence of sufficient amounts of water

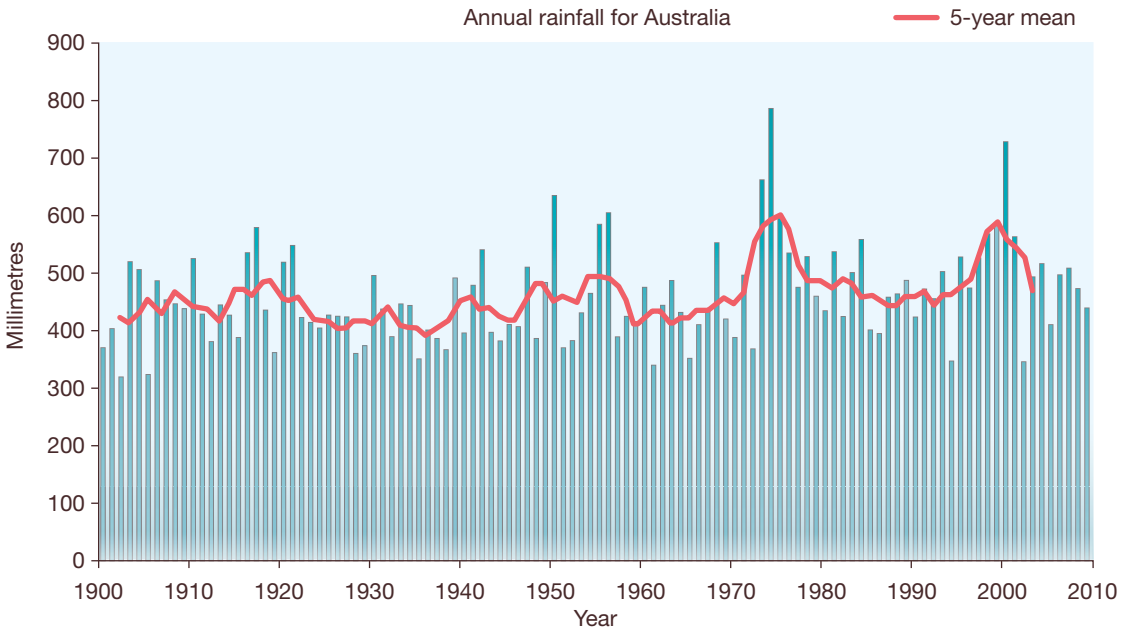
precipitation water that falls from clouds and may be in the form of rain, hail, snow or sleet

Droughts dry out areas and can cause famine, diminished crop growth, death of animals and livestock, loss of habitats and mass migration. The absence of sufficient amounts of rain (**precipitation**) creates a dry and damaged landscape.

In some years, Australia has either too much rainfall or too little. Climate records have been used to show how serious this problem can be. The issue is how variable Australia's rainfall totals can be from one year to the next. Source 5.12 shows a recent scenario.

The graph in Source 5.12 shows an interesting picture. Up until about 1970, the fluctuations of

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Source 5.12 Annual rainfall in Australia

the 3-year mean were no more than 100 mm. Since then, the fluctuations have been more extreme, reaching almost 200 mm. This graph is very general, as it covers the whole of the Australian continent. Australia is such a large continent that, while some areas may be experiencing drought, other areas may be experiencing excess rainfall. Source 5.13 shows the impact of the Brisbane floods in January 2011.

Another way to explain the situation is to examine a map showing rainfall **variability** Australia-wide. Source 5.14, on the next page, shows the situation based on information from 1900 to 2003.

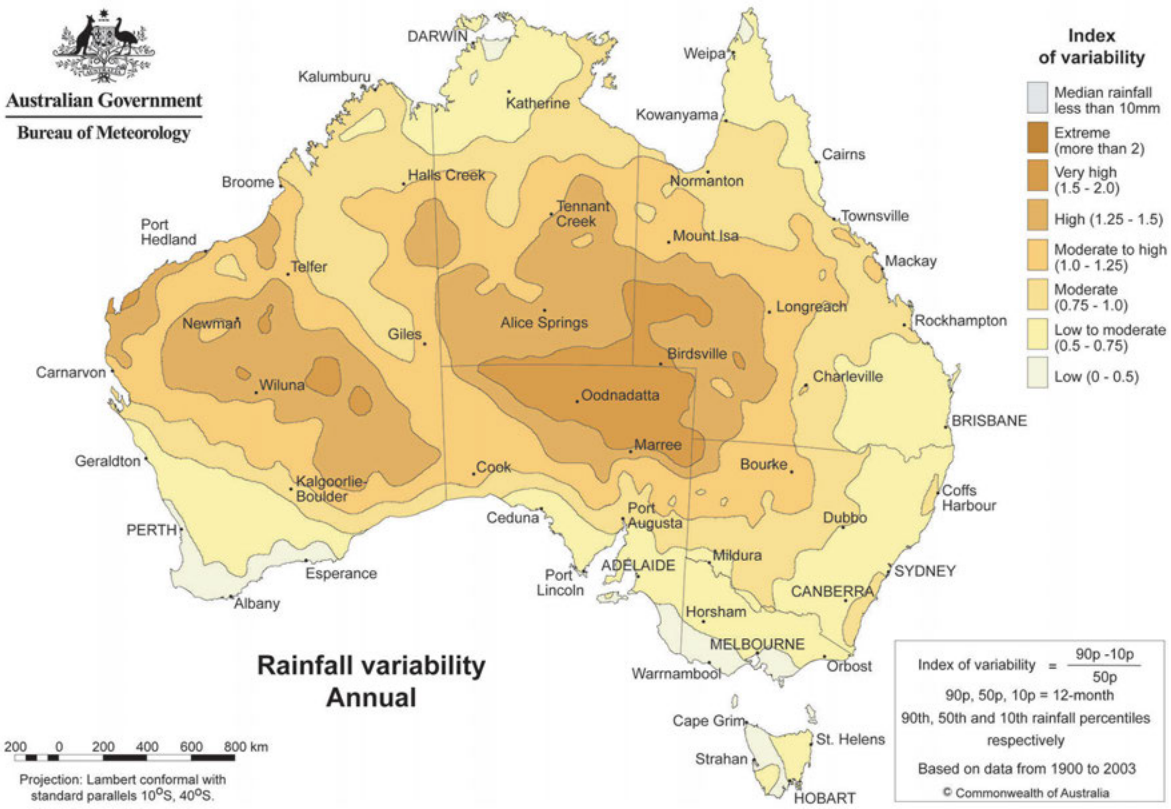
variability refers to differences – in this case, the different measured amounts of rainfall

One final source to examine on rainfall variability, Source 5.15 (next page), shows the rainfall variability for Australia in 2008.

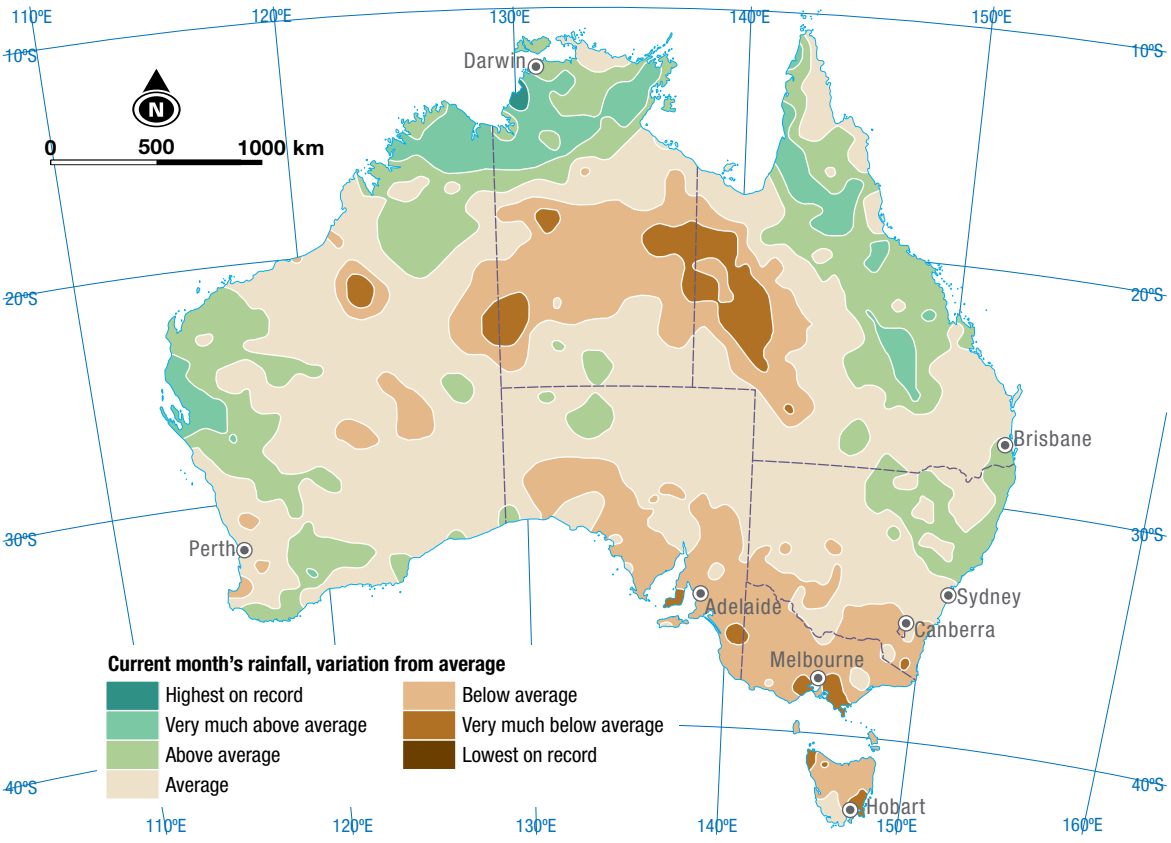
Source 5.13 Brisbane floods, January 2011



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Source 5.14 Rainfall variability based on 1900–2003 data



Source 5.15 Variation from historic rainfall totals in 2008

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The situation shown in Source 5.15 is similar to that in Queensland. Parts of Australia – the south-east and a large part of the Northern Territory and western Queensland – are experiencing drought conditions, while areas less than 2 days' drive away are experiencing flooding.



Source 5.16 A dried-up area in South Australia during the 2007–08 drought

RESEARCH 5.2

Drought has affected every Australian state. Between 1850 and 1995, the Bureau of Meteorology has identified 10 major drought periods. Divide your class into 7 groups and allocate 1 of the 6 states and the Northern Territory to each group.

The task is to identify and describe how each area was affected by the 10 events and research what measures were put in place to protect the area from future droughts. Present your findings to the class in a PowerPoint presentation.

5.2 Human alteration of environments

Geomorphological hazards are both a natural occurrence and a devastating consequence of the changes in our landforms. However, landforms are not changed solely by natural causes; human alterations have increased the risk of geomorphological hazards around the world.

Landslides often result from natural factors such as floods, earthquakes or storm surges, but clearing vegetation, over-steepening the base of a slope for development and allowing water to penetrate sub-surface layers can encourage the change to the landscape that will cause a landslide. Avalanches often result from natural factors such as earthquakes or heavy snowfall or rainfall, but can also be caused by human recreational activities such as skiing or snowboarding.

In 2005, a flood brought on by the glaciers melting caught loose sediment and caused over 555 million euros' worth of damage to Austria. This flooding was believed to have been caused by rising temperatures in the Alps. This temperature rise – almost twice the global average – is believed to be the result of human-induced global warming.

Droughts are often caused by unwise agricultural practices and deforestation affecting the amount of water vapour in the atmosphere and leading to increased desertification.



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Source 5.17 A sign warning of the danger in the mountains

Case study 5.2
Desertification in China

Four years of droughts in south and north-west China have resulted in severe desertification, poor harvests and water shortages, affecting the lives of 400 million people, according to a Chinese NGO.

The China Green Foundation says a total of 2.6 million km^2 of land has turned into desert, amounting to 27.4% of China's land. On average, 2460 km^2 of land becomes desert each year, but the drought is hastening the process.

On 18 March, the Chinese regime's mouthpiece, *The People's Daily*, reported that 12 provinces were affected, including Hubei, Guizhou, Yunnan and Sichuan.

Ms Chen from Wangjiazhai in Guizhou Province told *The Epoch Times* that people are waiting for it to rain so they can plant crops. 'We haven't seen any rain for a few months, maybe half a year already … The land is dry and hard, and cannot be cultivated; even corn does not grow here.'

In Laohekou City, Hubei Province, a thick layer of sand up to 50 cm deep has been deposited along the banks of the Hanjiang River, and the entire area within a radius of 2 km from the river is covered in sand.

A female resident told *The Epoch Times* that there has been no rain since September: 'Crops have dried up, and life is very hard. Areas near the river are full of sand that is spreading every day. No matter how hard we dig, there is sand still everywhere.'

The desertification problem that China faces is among the most severe in the world, and could seriously hamper the country's economic development.

Source 5.18 The desertification problem in China

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Source 5.19
Desertification is increasing at an alarming rate in China as a result of human alterations to the environment.

1 Summarise who in particular is most affected by the desertification.
2 What problem is desertification causing for farmers?
3 How may desertification hamper China's economic development?

Demand for resources as the population increases puts a large amount of unnatural strain on landscapes around the world. Landforms already change naturally, but as humans progress they also change the land to progress with them. Mining, pollution, deforestation, agriculture, modern technology and war are just some of the human activities that cause alterations to the land and bring on geomorphological hazards. Yet we still continue to carry out these alterations, despite knowing the cost. Some areas have seen the risks increase more than others, and people still continue to live and work in these areas. The effects of these hazards go further than changes to the environment: they can also affect how others live, levels of poverty, infrastructure and lifestyles.

5.3 The effects of geomorphological hazards

There is no doubt that geomorphological hazards have a strong effect on our landscapes. Land erodes and shifts, and vegetation can increase or decrease after a hazard has hit a certain area. These hazards also have an effect on social, cultural and economic factors. Think of the areas around Melbourne, Sydney and Brisbane, which are quite congested. Houses are built densely in and around the main cities and lining the coast. However, if you explore Australia further you can see some of its 9 official deserts, where you will not see any houses for long stretches. People do live in and near these deserts, but they do so very differently from those who live in the coastal areas of Australia.

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Source 5.20 A solar home with its own rainwater catchment system, built to adapt to the Australian desert

Houses are often bigger and less expensive in the drier states and territories of Australia. They are likely to be a long distance away from any stores and facilities. These areas are very vulnerable to drought and increasing desertification. This means that agriculture in the area suffers greatly, and that soil erosion and loss of vegetation are common. Rural Australia is important to the economy, and declining productivity there has a stressful impact on Australia.

RESEARCH 5.3

Select 1 of the areas below to research:

- Albany in Western Australia
- Oodnadatta in South Australia
- Darwin in the Northern Territory
- Mackay in Queensland.

Put yourself in the position of someone living in your chosen place. Using the internet for research, answer the following questions:

1 How reliable is the rainfall in each of these places?
2 What other places experience similar rainfall variability?
3 What agriculture is popular in the area?
4 Is this area more vulnerable to floods or droughts?
5 How would drought affect people living in this location? Present your findings in a short report.

The congested areas of Australia are also vulnerable to geomorphological hazards, and the people in these areas are influenced by their effects. In Queensland, the warm climate and varied weather allow for an increased vulnerability to flooding. With many houses built on flood plains, flood-proof homes have been around since the 1840s. These houses are built higher and of strong materials that can withstand floodwaters. This idea of a stilt house is popular in Asian countries like Vietnam

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Source 5.21 Comparing the impacts of geomorphological hazards

Developed countries	Developing countries
Suffer higher short-term economic losses	Cause setbacks to long-term economic and social development of the country
Have mechanisms in place to avoid or reduce loss of life – for example, early warning systems and building regulations to ensure development in high-risk areas is designed to withstand forces	Lack of resources for early warning systems; unplanned squatter developments are not designed to withstand natural forces
Have immediate emergency and medical relief infrastructure available, which reduces casualties	Inflict massive casualties due to lack of relief infrastructure and resources
Insurance against property and infrastructure losses	Forced to divert funds from development programs to emergency relief and recovery



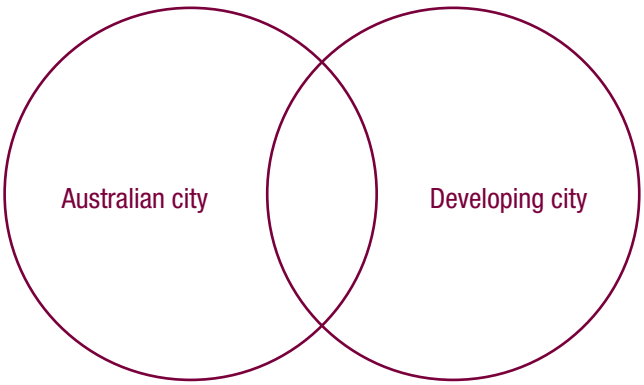
Source 5.22 Stilt houses in Cambodia

and Cambodia, as protection against flooding and to prevent vermin entering the home. However, these areas are developing countries, without the resources and funds to protect them further.

Poverty can result from hazards, and also means increased vulnerability. People living in poverty are often not warned of the hazards approaching, as they are marginalised socially, politically and geographically. They lack the resources to help them to prepare for, predict and minimise the risks.

NOTE THIS DOWN

Copy the graphic organiser below and select a geomorphological hazard of your choice. Compare what would happen in the event of a specific geomorphological disaster occurring in your city or town with what might occur if a similar event affected a city in a developing country.



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Why do people continue to live there?

Why do people continue to live in areas of poverty where the risk of a hazard is high? Why do people build houses on flood plains or live in the desert? The answers to these questions are interesting.

1 People may come to the area because of the employment opportunities available in the rebuilding operation. They will stay as they settle into the area. For example, people move to rural Western Australia for the mining industry and will remain there for the rest of their lives.
2 They will stay because of their economic and other ties to the area – mortgages, employment, family ties.
3 They will stay because they believe 'that was the big one', and nothing like it will occur for another 50 years.
4 They may come to the area without knowing its natural hazard history.
5 The economic situation may prevent them from moving. In developing countries, the home a family has may be the only one they can afford, so they will remain there.

ACTIVITY 5.2

1 Summarise how rural Australia is influenced by its landscapes.
2 Describe the features of a flood-proof house.
3 Explain why developing countries are more vulnerable to hazards.
4 Suggest how you could make your house less vulnerable to hazards in your local area.

5.4 Minimising the harmful effects

As we can see in rural Australia, the flood plains of Brisbane and developing countries around the world, the choices of how homes are built, how people live their lives and the nature of their economy are influenced by geomorphological hazards. A lot can be done to prevent these hazards from causing extensive damage. The ability to predict hazards and the time to take safety measures are important in minimising harmful effects.

Predicting drought

Because Australia does not have a long history of climate records, as some parts of the world do, it has been difficult to accurately predict a drought event. It is all too evident from the drying landscape and dying animals when Australia is in a drought period. Australian **climatologists** owe much to the work of Sir Gilbert Thomas Walker, who worked in India studying the variations in the monsoons that have such a major impact on life in that region. In the course of his mathematical studies, he noticed that there were periodic changes in air pressure between the Indian and Pacific Oceans, and that these were related to changes in temperature and pressure in the same areas. What is now known as the **Southern Oscillation Index (SOI)** is the result of his early work.

climatologists people who study the climate of an area (long-term changes in the weather)

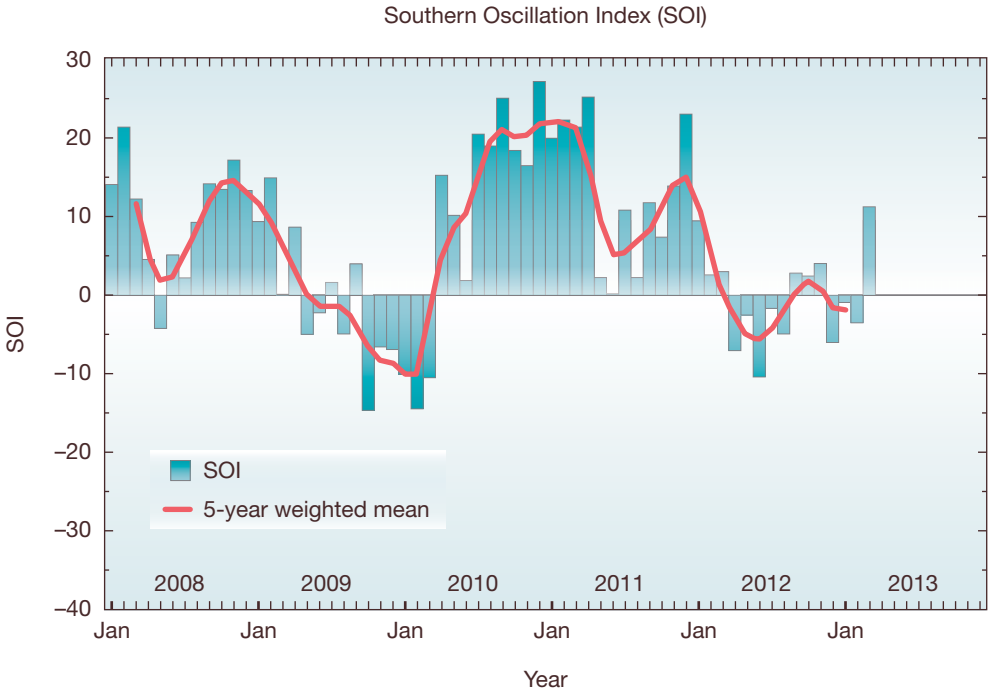
Southern Oscillation Index (SOI) a figure calculated on the air pressure differences between Tahiti and Darwin

The SOI varies from positive to negative. A positive reading in Australia means good weather conditions and a very positive reading means that there may be too much rainfall. A negative reading – especially less than –8.0 – is a prediction of drought (see Source 5.23).

Wheat farmers place a great deal of weight on the reliability of the SOI, but it is only a figure.

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It provides an indication of what might happen in the coming months. People in drought-affected areas will be hopeful that the figure is returning to the positive side of the line.



Source 5.23 Variations in the SOI, 2008–13

ACTIVITY 5.3

Bushfires are a frequent summer hazard across Australia in the drier months.

1 Examine posters and advertising on how to protect a property in bushfire season.

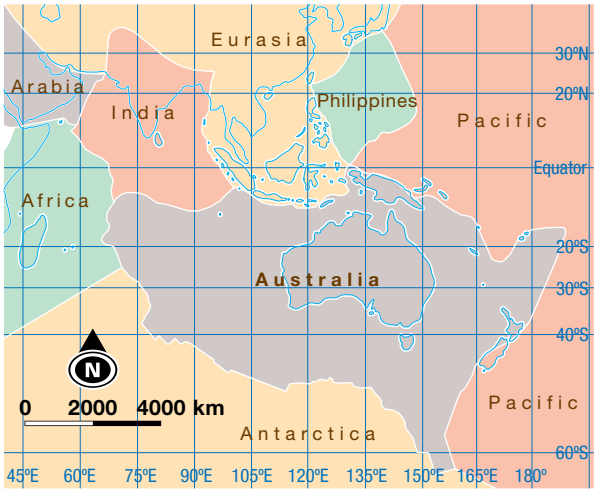
2 Create a poster that warns of the signs of bushfire hazards in the local area.

bushfires uncontrolled fires that destroy the environment and property but can be necessary for the regeneration of plant species

Earthquake potential

State and local governments across Australia prepare for natural hazards. Very few would be preparing for earthquakes. This is simply because earthquakes are more likely to occur along plate boundaries. As Source 5.24 shows, the Australian continent is a long way from any plate boundaries.

Japan, however, is an earthquake-prone country. Because of this, new infrastructure is built to be flexible and tall. When an earthquake occurs, rather than break and crumble, Japan's buildings will sway and move with the earthquake.



Source 5.24 The boundaries of Australia's continental plate are far from the Australian mainland.

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Source 5.25 The Skytree Tower of Japan, said to be earthquake proof



Source 5.26 Layers of ash and cinders show evidence of multiple eruptions at Tower Hill volcano, which last erupted around 25 000 years ago.



Source 5.27 Blue Lake at Mt Gambier – last eruption 4500 years ago

Potential for volcanic activity

There would not be a single state or local government authority designing hazard management plans for volcanic activity anywhere on the Australian mainland or in Tasmania. Again the reason is simple: there are no plate boundaries where volcanic activity occurs close to the Australian mainland.

There is plenty of evidence of volcanic activity occurring in Australia's past, however. Much of Australia's prime agricultural areas are founded on soils derived from the weathering and erosion of volcanic rocks. Queensland's sugar cane farms and the Darling Downs are based on the breakdown of basalt. The wineries and stone fruit orchards of the Granite Belt in southern Queensland are based on the breakdown of a volcanic rock – granite.

Indigenous Australians were living in Australia when volcanoes were last active on the Australian mainland. Tower Hill volcano in western Victoria last erupted 25 000 years ago. Mt Gambier erupted

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as recently as 4500 years ago. Even Lakes Eacham and Barrine on the Atherton Tableland erupted more recently than Tower Hill – both around 12 000 years ago (see Sources 5.26 and 5.27).

People living in areas with active volcanoes have to take very specific safety measures. Evacuation routes are planned and emergency kits with goggles and masks are kept in homes to reduce the risk of damage to health and fatalities. Volcanic eruptions are among the most destructive hazards on Earth. It is almost impossible to minimise the effects of an eruption. The key is detection and early evacuation.

Geographical fact

While Australia itself does not have any current active volcanoes, it does have two active volcanoes in territories it controls in the southern Indian Ocean. These are on the Heard and McDonald Islands. This area is one of the most remote locations on Earth.

ACTIVITY 5.4

Use the internet to answer the following questions:

1. Using a blank map of Australia, identify and mark the locations of the following volcanoes:
   - Mt Beerburrum, Queensland
   - Mt Warning, New South Wales
   - Mt Porndon, Victoria
   - Tower Hill, Victoria.
2. List the ages of these volcanoes. There is a distinct trend from older to younger. Looking at this map, people who study volcanoes would suggest that Australia was travelling over a 'hotspot' in the Earth's crust, which managed to break through every so often. What extra information would support or disprove this idea?
3. Suggest why evacuation plans and other safety measures in relation to volcanic activity are not required in these areas.

FIELDWORK 5.1 THE IMPACT OF GEOMORPHOLOGICAL HAZARDS ON AUSTRALIA'S COAST

Aim

To analyse the impact of geomorphological hazards on the current and potential sea-levels on the coast of Australia, and evaluate the effectiveness of strategies that could be used to protect them.

Method

Select an area of Australia's coast to analyse. Preferably, the stretch of coast will feature cliff faces. Note that the best time to explore the area is during low tide.

Preparations

Find a map of the coastline you plan to study. Indicate the areas with cliff faces that you can investigate. You will also need to take a camera, a list of questions based on the 'data-collection' section below, paper (on a clipboard) and a pen.

Data collection

As you travel along the suggested path on this fieldwork trip, stop at various sites and ensure that you collect the following information in preparation for your fieldwork report:

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1 Mark each area that you study on your map and take photos with your camera. If you have a GPS unit or app, mark each location with your GPS.

2 List all the evidence of erosion that you can see. This may include:
- rock formations
- tunnels, bridges, columns and pillars made from rock
- collapsed sections of cliffs
- patterns in the rocks
- smooth surfaces where it looks as if the surface should be rough.

3 Describe the extent to which the location has suffered from erosion.

4 Predict the geomorphological hazards that caused erosion to the cliffs.

5 Suggest what geomorphological hazards could occur due to erosion in the area.

6 List some of the management strategies to minimise the risks that you observe. Determine whether you think the strategy is working, explaining your reasoning. Suggest a new strategy to prevent one of the geomorphological hazards listed in Question 5.



Source 5.28 Coastal erosion can be an effect of, and lead to, geomorphological hazards.

7 Once you have returned to your classroom, research the history of the area:
- **a** Does the area have a history of geomorphological hazards?
- **b** Is there any evidence that erosion is occurring at higher levels than usual in this area?
- **c** Has the erosion caused any hazards?
- **d** Do your observations match the history of the area?

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map
Page 3	Introduction – brief description of the study site
Pages 4–5	Description and photos of evidence of erosion
Page 6	Table of erosion prevention methods: effects of methods (positive or negative, short-term or long-term)
Page 7	Evaluation of these strategies. Selection of one strategy to recommend.
Pages 7–8	Description of possible causes of erosion
Page 9	Association between geomorphological hazards and erosion of the area
Page 10	Comparison between observations made and actual history of the area
Page 13	Bibliography, appendix, glossary

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Chapter summary

- Geomorphological hazards are dangers that occur as a result of changes to a landform, affecting the stability of the site and resulting in devastating effects on the area and those who live there.
- Floods, earthquakes, storm surges, tsunamis, volcanic eruptions, landslides and avalanches are all geomorphological hazards.
- Human activities may increase the likelihood of a disaster and create change within an environment that may in turn lead to a hazard.
- Geomorphological hazards can occur in many landscapes and have drastic effects on the land.
- Land erodes and shifts, and vegetation can increase or decrease, after a hazard has hit a certain area. Geomorphological hazards also have social, cultural and economic effects.
- Most people are aware of the hazards in the area in which they live, thanks to technology, knowledge of weather patterns and an understanding of their environment.
- Geomorphological hazards can be managed by building infrastructure in certain ways, planning evacuations and taking safety measures to limit the effects of a disaster.
- It is almost impossible to minimise the effects of a volcanic eruption due to its highly destructive nature.

End-of-chapter questions

Multiple choice

1 Which of the following is not a geomorphological hazard?

A landslide
B earthquake
C tsunami
D the sudden collapse of an old building

2 Which geomorphological hazard does not regularly occur in Australia anymore?

A volcanic eruption
B bushfire
C earthquake
D flood

3 In which state is Meckering the site of one of Australia's major earthquakes?

A Western Australia
B Queensland
C New South Wales
D Tasmania

4 In which state are flood-proof houses becoming popular?

A Western Australia
B Queensland
C Canberra
D New South Wales

5 Which of the following can be both a hydrological and a geomorphological hazard?

A earthquake
B flood
C avalanche
D all of the above

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Short answer

1 Identify the differences between a 'natural hazard' and a 'natural disaster'.

2 Explain the difference between a storm surge and a tsunami.

3 Suggest where and when floods would be expected in Queensland.

4 Discuss why Australia has so few earthquakes.

5 Describe the measures a country may take to decrease the effects of earthquakes.

Extended response

Australia has many areas that are vulnerable to geomorphological hazards. Storm surges, floods and bushfires occur regularly. For some people, the regular occurrence is too much and they pack up and leave, while others are resilient, pick themselves up and rebuild. In a short report, debate the question 'How often should people be allowed to rebuild in areas where a known natural disaster occurs regularly?'

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UNIT 2
Changing nations

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6 Consequences of urbanisation



Source 6.1 Cityscape of Jakarta, Indonesia's capital

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Before you start

Main focus

Some young people who live in rural areas may consider moving to the city when they get older. There is more choice of universities and jobs, as well as a larger variety of social activities. Others consider moving away from the city, but the greatest internal migration figures suggest that there are more people who move to the city. This is known as urbanisation.

Why it's relevant to us

As the world becomes increasingly interconnected, the effects of changes or actions in one place are increasingly likely to affect other places. Australia's position as a major economic partner of China and other countries makes this extremely relevant to our lives.

Inquiry questions

- What is urbanisation and what affect does this have on an area?
- How do economic activities cluster and why?
- How is economic growth in regions in Australia and China affecting other regions?
- What is the relationship between the economies of Australia and China?
- How does urbanisation affect carbon emissions and water consumption?

Key terms

- Archipelago
- Industrialisation
- Recession
- Bilateral
- Demographic factors
- River basin

Let's begin

In the last century, Australia looked to far-away Europe and the United Kingdom for its economic ties. However, with the populations and wealth of Asian countries growing quickly, Australia is poised to take advantage of economic prospects much closer to home. The global 'centre of gravity' is shifting to Asia. Economists forecast that, within a few years, the Asian region will be the world's largest producer of goods and services, and the biggest consumer of them. Asia is already the most densely inhabited region in the world. In the future, it will also be home to the majority of the world's middle class. That is why Australia sometimes refers to the 21st century as the 'Asian Century'. Australia wants to take advantage of the economic opportunities that the rise of Asia presents. To do so properly, we must know and understand our neighbours.

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6.1 Indonesia: our nearest neighbour



Source 6.2 Map of the Indonesian **archipelago**

archipelago a group of islands

Indonesia is a country of more than 17 000 islands, with an area of 2 million km² over a 5000 km span. It has a population of just under 247 million – more than 10 times the population of Australia. More than half of Indonesia's people live in cities, and the capital, Jakarta, is home to over 10 million people.

Indonesia has the fourth largest population in the world, after China, India and the United States, and is Australia's closest neighbour. It comprises 33 provinces, 497 districts, 6651 sub-districts and



Source 6.3 In 2011, Jakarta's population was 10 187 595, and 51% of the population lived in urban areas.

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77 126 villages. Of its over 17 000 islands, fewer than 9000 have been named, and according to the Government of Indonesia, just 922 of them are inhabited.

Jakarta: megacity

Jakarta, the capital of Indonesia, is one of the world's 'megacities' – vast cities with huge populations, often defined as having over 10 million people, that are challenging the way we deal with population growth. The 19th and 20th centuries saw the rise of cities as centres of industry and population in Europe and North America. This pattern of urbanisation – populations moving to cities in search of work – shifted to the developing world, including Asia, from the second half of the 20th century.

Whereas the world's older megacities like New York or London have, over time, become richer and developed better services and infrastructure, some of Asia's biggest cities, like Jakarta, have a different feel. They are poorer, are less well planned and have less developed public transport.





Source 6.4 As in many megacities, housing in Jakarta varies from slums to high-rise apartments to detached housing.

6.2 Urbanisation as a shift in where and how people live

Urbanisation is a process whereby a society becomes more focused on its urban areas, due to increased internal migration to cities and their increased economic importance compared with that of rural areas. So we look at why more people move to cities and why this then means that sometimes cities have more money than the country areas.

While megacities have captured much public attention, most of the new growth will occur in smaller towns and cities, which have fewer resources to respond to the scale of the change. In Asia, the population is rapidly shifting from the countryside to the bigger cities at a rate of 45 million people each year. Many people in the developing world move to cities to try to escape poverty – just as people did in Europe during the Industrial Revolution that began in the 18th century. The world is now experiencing the biggest trend in urban growth ever. In 2010, for the first time in history, more than half of the world's population were living in towns and cities. It is predicted that, by 2050, 7 out of 10 people will live in an urban area, with urban growth concentrated in Africa and Asia.

However, in Asia only 40% of the population lives in cities, which may mean that much of Asia's urbanisation is still to come. As young people have better access to education, they are likely to seek professional rather than rural careers.

In theory, cities offer a more encouraging setting for the solution to social and environmental problems than rural areas. In most circumstances,

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cities produce jobs and wages. If a city has leaders in government who plan effectively and consider their area's diverse needs, and try to take into account future needs, they can deliver education, health care and other services more efficiently. However, some of these cities have little control over their own budgets, planning or policy. At a 2011 World Bank conference, the Governor of Jakarta complained that he had to beg the government of Indonesia for funds, and said he lacked the authority to plan for future urbanisation.



Source 6.5 In Jakarta, the wealthy shop at glittering malls while the poor scavenge at rubbish dumps.

Cities also present opportunities for people to put their efforts together to carry out combined activities by joining resources and building a bond in the community. This is a process that enables communities and individuals to create their own self-governing or community groups, allowing them to manage their own as well as the community's development.

However, there are problems associated with increasing urbanisation, not least the environmental impact. A resident of Jakarta consumes far more resources and generates far more greenhouse gases than a farmer from the Sumatra countryside. But whether we like it or not, cities are seen as a pathway out of poverty, and the majority of humanity is unlikely to stay down on the farm.



Source 6.6 Tokyo is an example of a successfully managed megacity.

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The relatively recent rise of megacities such as Tokyo and Shanghai, whose prosperity is coupled with highly efficient public transportation, shows that cities can be managed successfully. The objective for Jakarta and other emerging megacities should be to manage their future growth.

Economic growth in Jakarta is slow because of a lack of effective public transport and inefficient use of land. Movement of goods is also restricted by poor transport infrastructure. Some suggestions for taking advantage of urbanisation may include:

- giving large metropolitan areas the authority and budget to manage their economic growth and social infrastructure
- reforming Indonesia's land ownership and property rights systems, which are complex and act as a barrier to better urban planning
- considering urban zoning – that is, the creation of designated industrial centres, business centres or financial districts.

ACTIVITY 6.1

1 Recall 2 causes of urbanisation.

2 List some advantages and disadvantages of urbanisation.

Advantages	Disadvantages

3 Describe characteristics you think would best describe the average rural migrant to Jakarta. Think about age, occupation, wealth, etc. Do you think the same is true in Australia?

4 In your opinion, what are the differences between the ways in which the poor and the rich live in Jakarta? Predict how each group may access water, electricity, food and recreation.

RESEARCH 6.1

Research 'Car Free Day' in Jakarta. In a paragraph, write down what the government is trying to achieve. Discuss whether it would be possible for us here to do something similar in Australia. Do you have any ideas about how we could make this work?

6.3 Urbanisation and economic activities

One important effect of urbanisation is that the economic activities (actions involving production, distribution and consumption of goods and services) often cluster together – although this is not the case if the business relies on the location of resources (for example, a fresh fish store near the beach) or the location of customers (for example, a surfwear shop near the beach). Indications are

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that there are now a lot of people and economic activity in large cities, and many similar and related firms and industries are located near each other. Transportation and business costs may be cut as a result of improved contact between suppliers and customers located nearby. It also makes 'business sense' because customers can compare and have a choice while not having to waste time travelling or finding similar businesses. Production costs may also be decreased for the companies themselves through the possibility of sharing resources. This may help improve business performance. Another reason why cities have greater potential for a cluster of economic activities is because, with a higher and more varied population, there is an opportunity for companies to make use of people's diverse skills. Often internal and external communication is better, which enhances performance. So, regardless of whether or not firms in the city are directly engaged in collaboration and/or competition within a particular industry, the mixed nature of the circumstances and contact will assist with the success of a firm.

ACTIVITY 6.2

1. Define the term 'economic activities'.
2. Discuss some ways in which transportation costs could be reduced for businesses.
3. Analyse why a higher and more varied population of people may be a positive for a business.

Case study 6.1

Cambridge University Press

Cambridge University Press is the company that published the textbook you are reading. This publishing business is located in the city of Melbourne. There are other educational publishers located in Melbourne, many of which are within a few kilometres of each other, close to the suburb of Port Melbourne. This suburb is the location where a lot of tankers deliver shipments of products from overseas. Being located close to where the books come into Australia on a ship means that the publishing companies cut down on transport costs from the ship to their warehouses. Some of these publishing businesses are around the corner from each other, although they are competitors. They each believe that schools and students should use their textbooks, yet they are clustered together. Some of the reasons for staying in the same location include the following:

- Printing businesses are nearby (not all of their books are printed overseas).
- IT specialists who work on digital books are located nearby.
- There are more people who live in the city, so companies have more choice about whom to employ.
- There are more schools located in the city, and as school teachers write the books there are more authors from whom to choose.
- There are more bookstores in the city.

Now answer the following questions:

1. Recall why being located close to where the books come into Australia on a ship cuts costs.
2. Discuss why there are more schools located in or near a city.
3. Pose a reason why publishing companies print some books overseas and some in Australia.

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How do global economic connections shape a country's geography?

As economic connections between countries become ever more important, they inevitably shape the geography of countries. This may be through processes such as **industrialisation**, via shifts in levels of development or through migration of workers changing the culture of a city or town.

industrialisation the modernisation of a country, involving large-scale infrastructure development, economic growth and a movement towards more efficient, mechanised methods of production

This is not a new concept. Since European settlement, Australia's geography – particularly in terms of economic development – has been linked closely with other countries by the possibility of sharing resources. Throughout the 19th century, paddle boats used to rush wool and other products down the Murray River and out to clippers to export them back to England and around the Commonwealth. Prospectors from all around the world also arrived in Australia in the 1800s to make their fortunes in the gold rush.

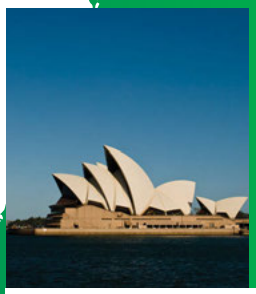
Today, these economic connections are even more complex and have influenced practically every area of the country. These relationships may involve services and property as well as the exportation of goods. Some examples of how these relationships are shaping places are shown in Source 6.7.



Mining: Australian and foreign-owned mines have attracted huge amounts of investment in regional areas. Almost $190 billion worth of mined resources is sent overseas each year.



Tourism and property development: The ability to invest and develop property overseas has also shaped places. Much of the property on the Gold Coast has been developed as a result of finances from Japan and other nations.



International business: Many companies have offices or regional headquarters in Australian cities. Sydney's CBD is home to many of the world's biggest companies' Asia-Pacific headquarters, bringing in money and workers from overseas.



Education: Foreign students are vital to the economy of Australia, with many coming from India and China to study. Almost 100 000 international students live in Melbourne, adding cultural diversity and economic value to the city.

Source 6.7 The influence of economic relationships

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What does Australia export and import?

All countries import and export a range of goods and services. Imports are goods that are bought into the country and exports are goods or services that are sold to other countries. The quantity and value of these goods is a major contributor to the wealth of a country. These products can be defined by using the following terms:

- *primary goods:* products that are extracted or grown in the ground or water – for example, wheat, iron ore, fish
- *manufactured goods:* products that are made or refined from primary goods – for example, furniture, petrol, televisions
- *services:* services or activities purchased by people from another country – for example, overseas students, tourism.

While most exports are sent overseas, services such as education and tourism that occur in Australia, but are purchased by people from other countries, are still considered exports.

Australia's 12 biggest exports and imports are shown in Source 6.8.

Geographical fact

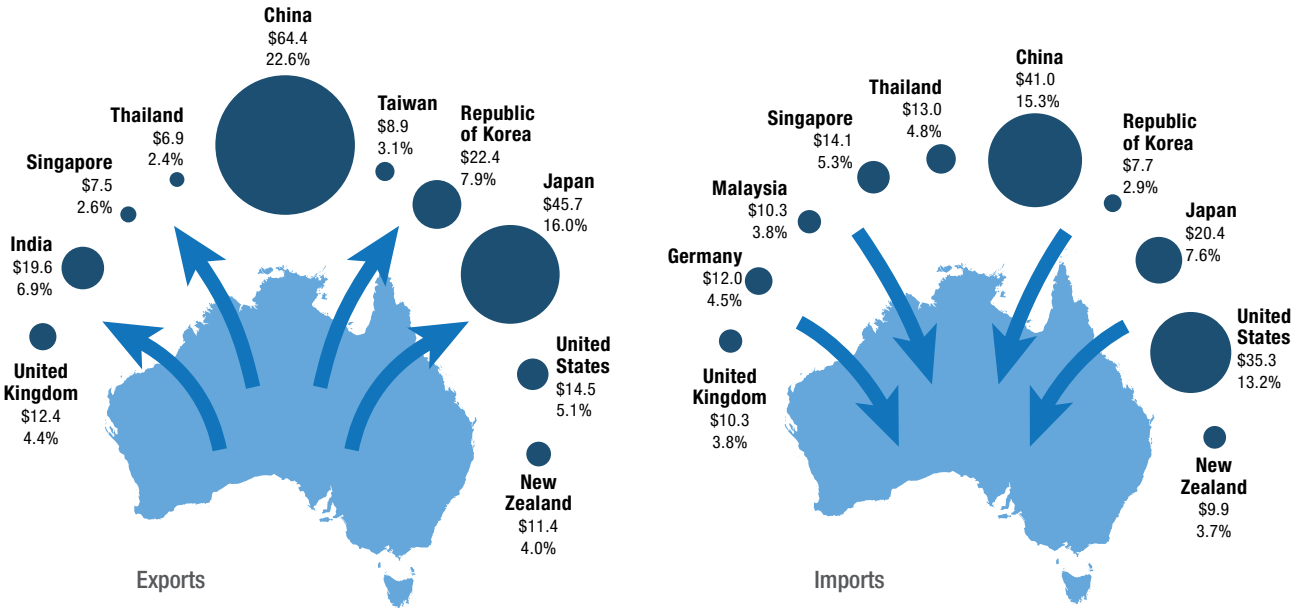
In 2010, Australia exported over $16 billion more of goods and services than it imported. This is called a trade surplus.

Source 6.8 Australia's biggest exports and imports

Export	Value (billions)	Import	Value (billions)
Iron ore	$49.4	Crude oil	$16.2
Coal	$43.0	Passenger vehicles	$15.9
Education	$17.7	Petrol	$10.0
Gold	$15.0	Medicines and medical supplies	$7.9
Travel services	$12.2	Telecommunication equipment	$7.5
Crude oil	$10.5	Computers	$6.5
Natural gas	$9.4	Goods vehicles	$6.0
Aluminium ore	$5.3	Civil engineering equipment and parts	$3.0
Copper	$5.0	Televisions	$2.8
Aluminium (refined)	$4.4	Furniture, mattresses and cushions	$2.6
Beef	$4.4	Measuring and analysing instruments	$2.6
Wheat	$4.2	Vehicle parts	$2.6

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Where do our goods go and where do they come from?



Totals are in A$ billion and percentage figures represent the share of the total market.

Source 6.9 Australia's main export and import markets

ACTIVITY 6.3

1. Classify the following possible exports as primary goods, manufactured goods or services:
   - **a** potatoes
   - **b** accounting services
   - **c** T-shirts
   - **d** coal.
2. Using the table, calculate how many billions of dollars Australia's exports are worth in the 3 categories of primary goods, manufactured goods and services. Calculate the figure for imports as well.
3. Now draw a bar graph (or use a spreadsheet to create the graph) of the information found in your answer to Question 2, comparing exports and imports for Australia in the 3 categories. Describe the trends shown in 2 sentences.
4. Locate Australia's main partners for imports and exports on a blank world map, and apply 3 colours to mark the countries on the map: one colour for importers, one for exporters and one for countries that are both main exporters and importers. Organise a title and key for your map.
5. Describe where most of our import and export partners are located, and explain why you think this is.

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What Australia's economy does and why

As discussed, the economy is made up of various exports and imports. But why does Australia import some products and export others? This is mainly due to the fact that certain products can be produced more easily and cheaply in Australia, and others may be cheaper and easier to get from overseas. The ability to produce a particular good or product more cheaply than in another economy is known as a **comparative advantage.**

comparative advantage in economic terms, the ability of one country over another to provide goods at a cheaper price

Australia does produce a varied range of products and services, but there are certain key areas where Australia holds a comparative advantage over other economies. These include:

- primary production
- provision of services
- low-scale specialised production.

Primary production

Much of Australia's economy is based around primary production. This includes mining, farming and forestry. Mining is one of Australia's most important industries. Its comparative advantage lies in the vast array of deposits of minerals found in this country. As a developed country, Australia also has the technology to exploit these resources.

Farming is another extremely important industry for Australia. As Source 6.11 shows, most of Australia's land is farmed. The huge areas available to farmers, and the excellent conditions for growing of crops such as wheat and the raising of livestock, give Australia a comparative advantage over other nations.

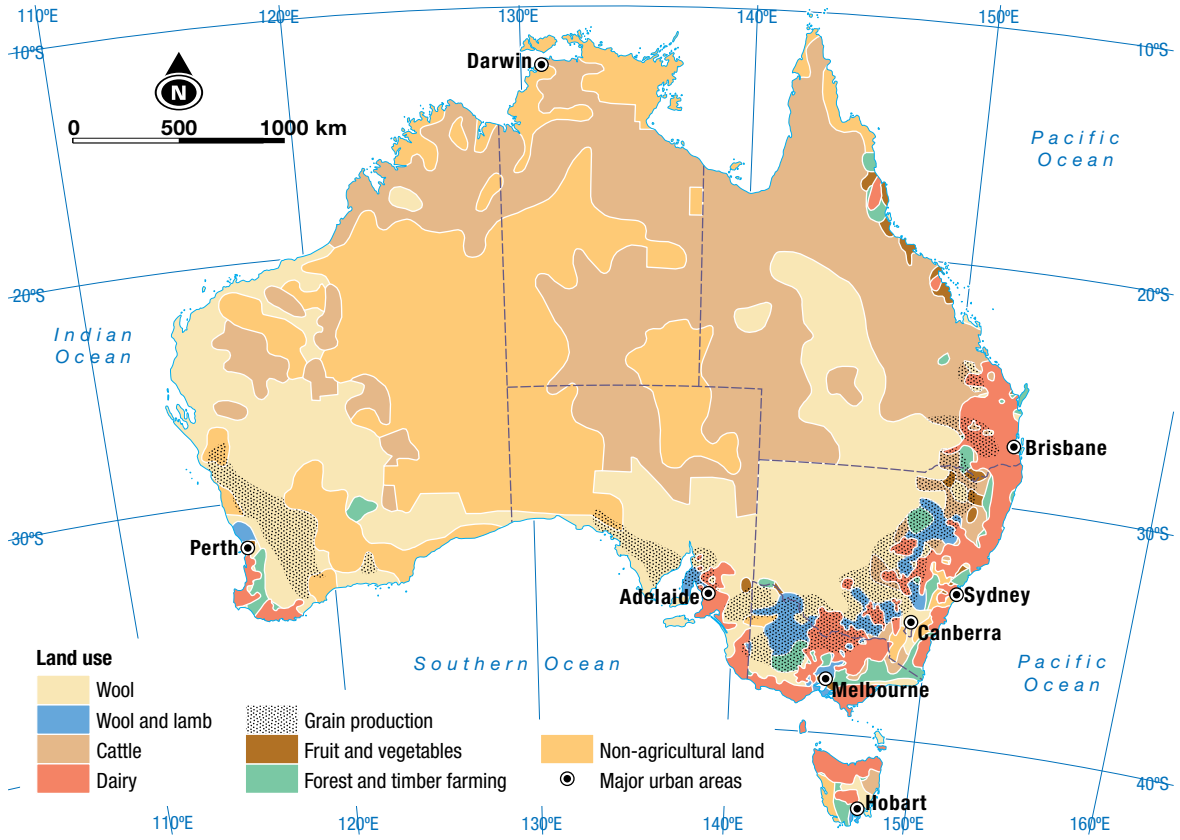
Provision of services

Service industries are even more important to Australia than primary production, providing 4 out of every 5 jobs. The biggest service sectors providing a comparative advantage to Australia are education and tourism.



Source 6.10 An open-cut mine at Cobar in New South Wales. Australia is one of the world's biggest coal-mining nations.

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Source 6.11 Map of main farming land use in Australia

Education is particularly significant in the area of overseas students studying in Australia. Overseas students are attracted to Australia because it is an English-speaking country – English is an extremely important language globally, and particularly in Asia, where it is often used to conduct business. The relatively close proximity of Australia to the large Asian populations that study overseas, compared with the United States and Europe, also gives it a comparative advantage. Furthermore, Australia is considered a safe destination, and its language schools and universities are well established.

Tourism is also a very significant service industry for Australia. Along with factors such as the country's safety and short travelling time from Asia, Australia's comparative advantage in this industry lies in its attractive climate, rich and varied landscapes, and unique animals and habitats. This is evident in tourism attractions such as the Great Barrier Reef, Uluru and Kangaroo Island, which are not found anywhere else.

NOTE THIS DOWN

Copy and complete the table below on Australia's comparative advantage in education and tourism, using the information in the paragraph above.

Education	Tourism
English-speaking	Safe destination

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Specialised manufacturing

While Australia does import many of its manufactured products, low-scale, specialised manufacturing still occurs here. For these industries to have a comparative advantage, they usually have to be making something that can only be manufactured here, or is only likely to be wanted here in Australia. Examples include technical mining equipment, or heavy products like bull-bars for 4-wheel-drive vehicles that would be too expensive to ship from overseas.



Source 6.12 Mining equipment, such as trays for dump trucks and surveying equipment, is still produced in Australia.

ACTIVITY 6.4

1 Explain what the term 'comparative advantage' means.
2 Outline why Australia is an attractive area to farm.
3 Suggest when manufacturing may be at a comparative advantage in Australia.

6.4 Economic trends in Australia

Australia's economy has been extremely successful over the last 20 years. Unemployment has typically been low, and the nation has been affected less by global **recessions** than almost any other developed nation. Its Gross Domestic Product (GDP), which measures how big the economy is, has grown consistently over this period. This has been largely due to the mining boom and investment from many overseas companies in Australia. However, these two factors also mean that much of the control of Australia's economy is now in the hands of large companies based in other countries.

recession period when the economy shrinks

The automotive industry in Australia

Car manufacturing is extremely important to many areas of Australia, with the industry employing thousands of people in Melbourne, Adelaide and Geelong. However, these factories are controlled by companies such as Toyota in Japan and General Motors and Ford in the United States. As these companies look to maximise profits, car manufacturing in Australia is under threat, as cars can be made more cheaply overseas. This can put jobs at risk in the factory owned by the company as well as the factories that supply car parts.

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Source 6.13 Jobs in the car industry are in the hands of overseas parent companies.

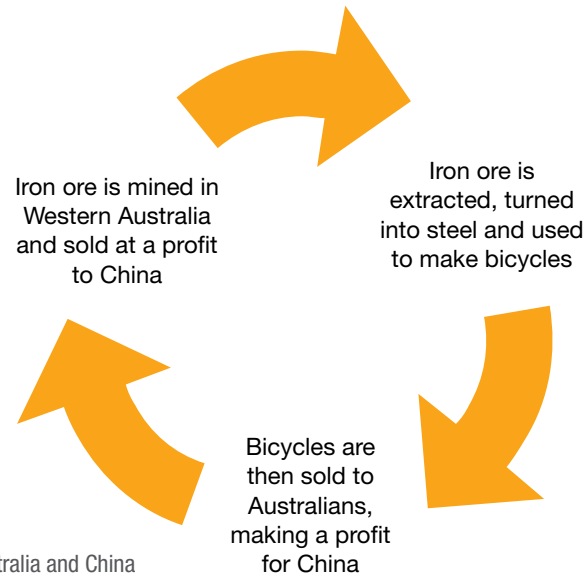
The mining industry in Australia

To some extent, Australian mines are also controlled from overseas. While most mines in Australia are owned by Australian companies, they are reliant on supplying companies and economies in other countries. If those countries were to suffer from a recession, they would be likely to stop buying Australian raw materials as demand decreased. If the price of minerals drops – this is set internationally – many mining companies simply shut down the mine until prices rise again. A number of major mining projects have been delayed or cancelled as a result of the recent Global Financial Crisis (GFC).

6.5 Bilateral trade: how China's and Australia's economies are interconnected

bilateral between two nations

Economies of different nations have different comparative advantages. Trade allows nations to take advantage of these differences in economies to supply and receive goods. **Bilateral** trade between Australia and China allows both economies to work successfully (see Source 6.14).



Source 6.14 Bilateral trade between Australia and China

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Who benefits from this interconnection in Australia?

The bilateral trade between China and Australia has led to considerable benefits for a number of different parties within Australia:

- *Mining companies and their shareholders*. The resource boom has meant Australian mining companies such as BHP Billiton and Rio Tinto have become highly profitable. This benefits shareholders, but also leads to more employment and investment in areas where mines are located, as the companies look to continue to increase their profits. Without the demand for their minerals in China, this boom would not exist.
- *Areas where mining is occurring*. With mining occurring in many regional areas, money is being spent on new facilities, roads and other infrastructure, which also benefits local populations. As demand from China continues to increase, more and more regional areas are being explored for mineral growth.
- *Governments*. Through mining royalties and taxes of both companies and workers, mining is providing a profitable revenue stream for governments at the national and state levels. This money is then spent on providing services such as health, education and defence. Chinese companies are also investing in mining projects around Australia, which are taxed by the government.

6.6 How urbanisation can affect carbon emissions and water consumption

Carbon emissions

Carbon emission is the release of carbon into the atmosphere. Carbon emissions/greenhouse gas emissions are a component of climate change. Greenhouse gas emissions are known as carbon emissions when we talk about global warming or the Greenhouse Effect. Since the Industrial Revolution, the burning of fossil fuels has increased, which directly relates to the rise of carbon dioxide levels in our atmosphere and speeds up global warming. China faces increasing



Source 6.15 China has surpassed the United States as the world's largest emitter of carbon dioxide, pumping out 6200 million tonnes annually.

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international pressure to reduce carbon emissions, due to its size and growing urban population. How to organise energy use, carbon emissions and economic growth has become an important issue for a carbon economy. With the population moving from rural to urban, urbanisation – as discussed previously – has a direct effect on many factors, including carbon emissions.

Demographic factors not only impact greenhouse gas emissions and have important implications for climate change, but also bring about serious outcomes. These factors help us to analyse and understand how population is a driving force of carbon emissions due to the process of urbanisation. Carbon emissions caused by changes to a population's industry structure, economic growth, urbanisation level and carbon intensity are all measures of urbanisation factors that affect climate change.

demographic factors factors of a population expressed statistically, such as age, sex, education level, income level, marital status, occupation, religion, birth rate, death rate, average size of a family and average age at marriage

It is important to ensure that all parties benefit in some way by reaching a compromise between urbanisation and climate change easing. Carbon intensity and GDP per capita are the main factors influencing carbon emissions, followed by population size, urbanisation level and industrial structure. The main factors leading to global warning are population growth and human activities. These include, but are not limited to, consumption (carbon emissions per person) and family pattern (per household carbon emissions), changes to production (industrial structure changing lifestyle) and transportation (carbon intensity).

Though reducing carbon emissions needs to be a major goal for a country like China, it is a difficult task, as the economic and population growth rates are both rapid, as are rates of urbanisation and industrialisation.

Water consumption

Water security is under threat in urban areas. Urbanisation adds to concerns associated with water due to factors like population growth, poor city planning, pollution, poverty and opposing demands for water. Climate change is predicted to cause vast changes in rainfall patterns, which will affect the accessibility of water and cause water-related disasters. Urban water use is likely to double by 2025. From the viewpoint of technical operations, cost-effectiveness, social fairness and environmental sustainability, the current models of urban planning and water management have failed in China and other rapid developing Asian countries. More should be done than simply improving the function and ability of a water system. A water-management plan is needed to provide a framework for interventions over the entire water cycle and a review of how water is used (and reused). Addressing matters such as water use in households, ecosystems, agriculture and industry should be a priority. Many more governments these days recognise the importance of addressing the challenges of cities by taking a united approach to urban water resources management. They are beginning to recognise the mutual benefits associated with land use, management of water resources and energy.

In Indonesia, the problems with water management continue with the battle to improve both access to and the quality of water. Many Indonesian homes rely on low-quality drinking

ACTIVITY 6.5

1 Recall why demographic factors affect greenhouse gas emissions.
2 Discuss some examples of how changes in rainfall patterns can affect the accessibility of water and cause water-related disasters. Perhaps use an example that has recently been in the news.
3 List some concerns with water that can be created by urbanisation.

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water, with a high percentage of the country's good-quality drinking water available only in urban areas, coming from bottled water that has to be purchased. This exploitation of drinking water for financial gain adds to household spending and worsens conditions for the poor. Many households in Indonesia spend two-thirds of their income on food, so having to buy drinking water puts more pressure on poorer households. Critically, there has been a decline of the Indonesian **river basins** over the past 40 years. The bulk of main rivers in Indonesia fall into the seriously polluted category. Indonesia does have an action plan, which is to extend and improve their water pipe networks; however, if the river basins are in decline then this plan is not going to work.

river basin the area of land drained by a river and its tributaries



Source 6.16 Water management in Indonesia

FIELDWORK 6.1 JAKARTA: THE BIRTH OF A MEGACITY

In this fieldwork task, we will explore the development of Jakarta into the megacity it is today, and investigate some of the challenges and opportunities that will be faced by the city into the future.

Aim

To understand how Jakarta developed into a megacity, and the problems that this process of rapid urbanisation has caused.

Method

To research data and information using a variety of sources, including the internet, the State Library, the atlas and your local or school library to produce a presentation and report on urbanisation in Jakarta.

Preparations

Locate a map of Jakarta today, as well as maps of the city at 4 historical points. We suggest finding maps from the years 1800, 1900, 1950 and 1990.

1 On these maps, mark and compare:
   - physical features such as rivers, nearby mountains and the ocean
   - the urban boundaries.

2 Use an overlay (tracing paper is good for this) to show the major road and rail transport networks.

3 Use a separate overlay to show the suburbs as they were in 1800, 1900, 1950 and 1990.

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4 Can you see areas of Jakarta that have changed purpose (for example, from farmland to residential zoning, from residential to industrial zoning) over time?

Data collection

Use Google Earth, Google Maps (using Street View) or an interactive e-atlas to explore Jakarta and travel through the main streets. How you manage the data collection will depend on the method you use. Where the instruction tells you to walk down the main street, you will move the cursor on the screen to move the view of the street. Where it says to take a photograph, you may be taking a screenshot or saving an image.

1 Before you 'visit' Jakarta, do some background research. List information such as: how and when your city began; the governments it has been governed by, and when; its changing ethnic and cultural makeup; and its changing industrial base.

2 Record the population of the city in 1800, 1900, 1950, 1990 and 2010 to see the rate of urbanisation over time. Also research the total population of Indonesia at these times. What percentage of Indonesia's total population lived in Jakarta at these times?

3 You could present these data in the form of graphs.

4 Use Google Earth or another source to look at a main street in Jakarta. What do you notice about the traffic? Use the internet to find statistics about the use of motorbikes in Jakarta.

5 Use the internet to obtain anecdotal or statistical information about commute times in Jakarta. What does this suggest about the availability of public transport in Jakarta? Compare public and private transport, and investigate which form of transport is most efficient for moving people to their workplaces and other destinations. What other factors do people in Jakarta consider when making their transportation choice? Search the internet for public transport timetables.

6 Use Google Earth to compare a street in the centre of Jakarta with a street in the suburbs or on the outskirts of the city. Can you notice any differences? List the building types that the two areas have in common. List the building types that only occur in the suburbs. What condition are these buildings in? Do they reflect a rapid, unplanned expansion of the suburbs?

7 Investigate some prominent environmental problems (such as air pollution) that are occurring in Jakarta. Explain how rapid urbanisation causes these problems. In a table, identify and investigate solutions to these problems that have been proposed. Do you think that these ideas could work? Explain your answer.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map – Jakarta over time
Page 3	Introduction – brief description of Jakarta street scene
Pages 4–5	Description and analysis of graphs and photos
Page 6	Background information on the city
Pages 7–8	Description of Jakarta's transport network
Page 9	Additional data such as train timetable screenshots/samples
Page 10	Analysis of environmental problems in Jakarta
Page 11	Table or written description of proposed management strategies
Page 12	Evaluation of these proposed strategies
Page 13	Appendix, Bibliography, Glossary

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Chapter summary

- Indonesia has a population of just under 247 million.
- More than half of Indonesia's people live in cities.
- Jakarta, the capital of Indonesia, is one of the world's megacities.
- Urbanisation is a process whereby a society becomes more focused on its urban areas.
- If a city has leaders in government, they can deliver services more efficiently.
- At a 2011 World Bank conference, the Governor of Jakarta complained that he had to beg the government of Indonesia for funds, and said he lacked the authority to plan for future urbanisation.
- Megacities such as Tokyo and Shanghai show that cities can be managed successfully.
- An effect of urbanisation is that the economic activities often cluster together.
- Cities have greater potential for a cluster of economic activities.
- Imports are goods that are brought into the country.
- Exports are goods or services that are sold to other countries.
- Much of Australia's economy is based around primary production.
- Service industries are even more important to Australia than primary production.
- The biggest service sectors providing a comparative advantage to Australia are education and tourism.
- While Australia does import many of its manufactured products, manufacturing does still occur in Australia.
- Australia's economy has been extremely successful over the last 20 years.
- The bilateral trade between China and Australia has led to considerable benefits.
- Carbon emission is the release of carbon into the atmosphere.
- Carbon emissions/greenhouse gas emissions are a component of climate change.
- Demographic factors have important implications for climate change.
- Urbanisation adds to concerns associated with water, due to a variety of factors.
- Climate change is predicted to cause vast changes in rainfall patterns.
- Many Indonesian homes rely on low-quality drinking water.

End-of-chapter questions

Multiple choice

1 Indonesia has the fourth largest population in the world. What are the other 3 countries with the highest populations?

A China, India and the United States

B China, the United Kingdom and the United States

C China, Australia and Africa

D China, India and Russia

2 By 2050, what proportion of the world's population is predicted to be living in urban areas?

A 5 out of 10 people

B 6 out of 10 people

C 7 out of 10 people

D 8 out of 10 people

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3 What is Australia's largest export business and what is its largest import business?

- **A** beef (export) and televisions (import)
- **B** iron ore (export) and crude oil (import)
- **C** coal (export) and passenger vehicles (import)
- **D** copper (export) and computers (import)

4 In an urbanised environment, economic activities (such as production of goods) tend to be:

- **A** spaced as far apart as possible
- **B** distributed evenly across the city
- **C** clustered together in one area
- **D** none of the above

5 What are the main factors influencing carbon emission levels?

- **A** population size and carbon intensity
- **B** population size and industrial structure
- **C** carbon intensity and GDP per capita
- **D** GDP per capita and urbanisation level

Short answer

1 Describe 3 effects rapid urbanisation has on water supply and infrastructure.

2 Explain the bilateral trade process between China and Australia, giving examples of what products and services may be involved.

3 Justify why megacities require effective public transport systems.

4 Outline 3 major threats to Australia's car manufacturing industry.

5 Identify the major industry in your town or suburb. Evaluate 3 ways in which the needs of that industry have affected the local geography.

Extended response

The mining industry has been an incredibly important element of Australia's economy over the past decade. What may happen when the global demand for our mining exports decreases?

- List at least 3 possibilities in your response.
- Write a paragraph for each of the possibilities and try to include statistical or economic data to support each paragraph.
- Predict what arguments could be developed against your thoughts and provide counter-arguments to them in your report.

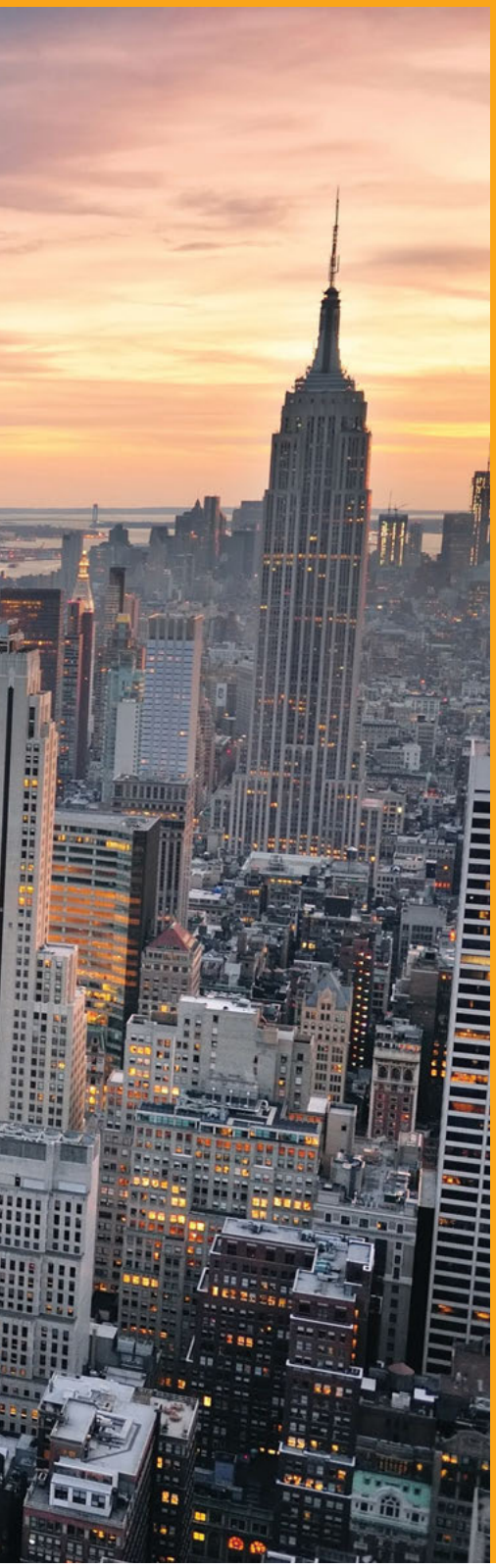
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7 Urban settlement patterns



Source 7.1 New York City, Manhattan aerial view skyline

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Before you start

Main focus

This chapter will discuss urban concentration and settlement patterns in Australia and the United States. Cities are complex places, with economic, social and environmental forces interacting in constantly changing ways.

Why it's relevant to us

It is important to study our cities today, as they have a major impact on the way in which we live. A large majority of Australian and United States citizens live in cities, making them diverse and fascinating places in which to live and work. However, the future of these cities will depend on whether or not they are environmentally sustainable.

Inquiry questions

- Why does Australia have areas of urban concentration?
- Why does the United States have areas of urban concentration?
- What is the history of European settlement and migration?
- What is the relationship between population density and proximity to urban centres?
- What is the shape of our transportation network?

Key terms

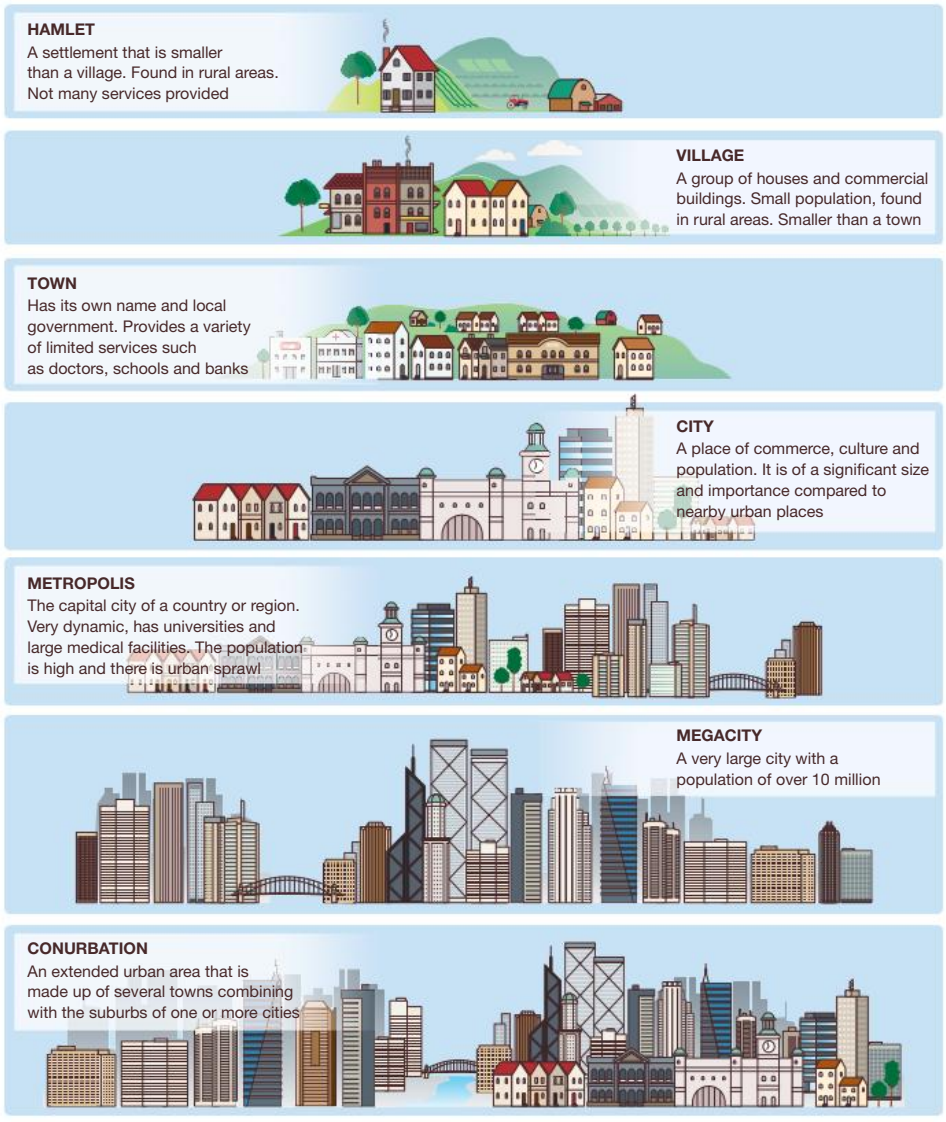
- Agriculture
- Manufacturing
- Satellite city
- Indentured servant
- Recreation
- Urban settlements
- Emigrants

Let's begin

Cities have been important places for much of human history. This goes back to ancient times and the civilisations of Ancient Egypt and Rome, where communities developed close to fertile river plains and valleys. It is a natural phenomenon for people to want to live close to services such as employment, education and medical care. In Australia, some of the early colonial settlements determined the location of our metropolitan areas. Our cities are linked by a complex transport system that connects each of them to their surrounding suburbs. Cities can also be linked by waterways and bridges. People in cities need power supplies, drains and sewerage, and access to fresh water and waste disposal, often on a large scale. It is important to maintain our cities so that they can be sustainable into the future. Both citizens and governments need to take responsibility for the ecological footprint of our cities.

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7.1 What are urban settlements?



Source 7.2 There are a variety of urban settlements.

In ancient times, cities were important places that protected people. Dubrovnik's Old Town in Croatia is completely surrounded by enormous stone walls that date back to the 10th century. Dubrovnik's ancient city walls were built to protect the city and deter would-be invaders. People create urban settlements to suit the environment – for example, Coober Pedy in South Australia has underground houses.

Geographical fact

According to the Australian Bureau of Statistics (ABS), the percentage of people living in major cities in Australia increased from 54% in 1947 to 70% in 1971 and to 89% in 2012. This makes Australia the fifteenth most urbanised country in the world. Qatar is ranked first, with 100% of the population living in urban settlements!

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Urban settlements are distinct areas where people live and work. At any one time, a huge variety of activities are taking place in an urban settlement. People work in factories, shops, offices, warehouses and banks; they visit schools, stadiums, cinemas and places of worship. Urban concentration can vary in size from a small town to a large metropolis with millions of inhabitants. An urban settlement can be defined by how many people do not depend on **agriculture** for a living. Other definitions of an urban settlement rely simply on its population size. Different countries have different thresholds, ranging between 2500 and 20 000 people.

urban settlements distinct areas where people live and work

agriculture use of the land to raise crops or livestock

The growth of urban settlements

Urban settlements grow for two reasons. One, because of general population increase, and two, because of the resettlement of people from rural areas. The proportion of the total global population living in urban areas has grown rapidly since the Industrial Revolution.

Source 7.3 Growth of urban settlements around the world

Year	% of population in urban settlements
1800	3
1900	14
1950	30
2050	70 (est.)

Source: Information from Population Reference Bureau (USA).

Global distribution of urban concentration

Why are urban settlements growing?

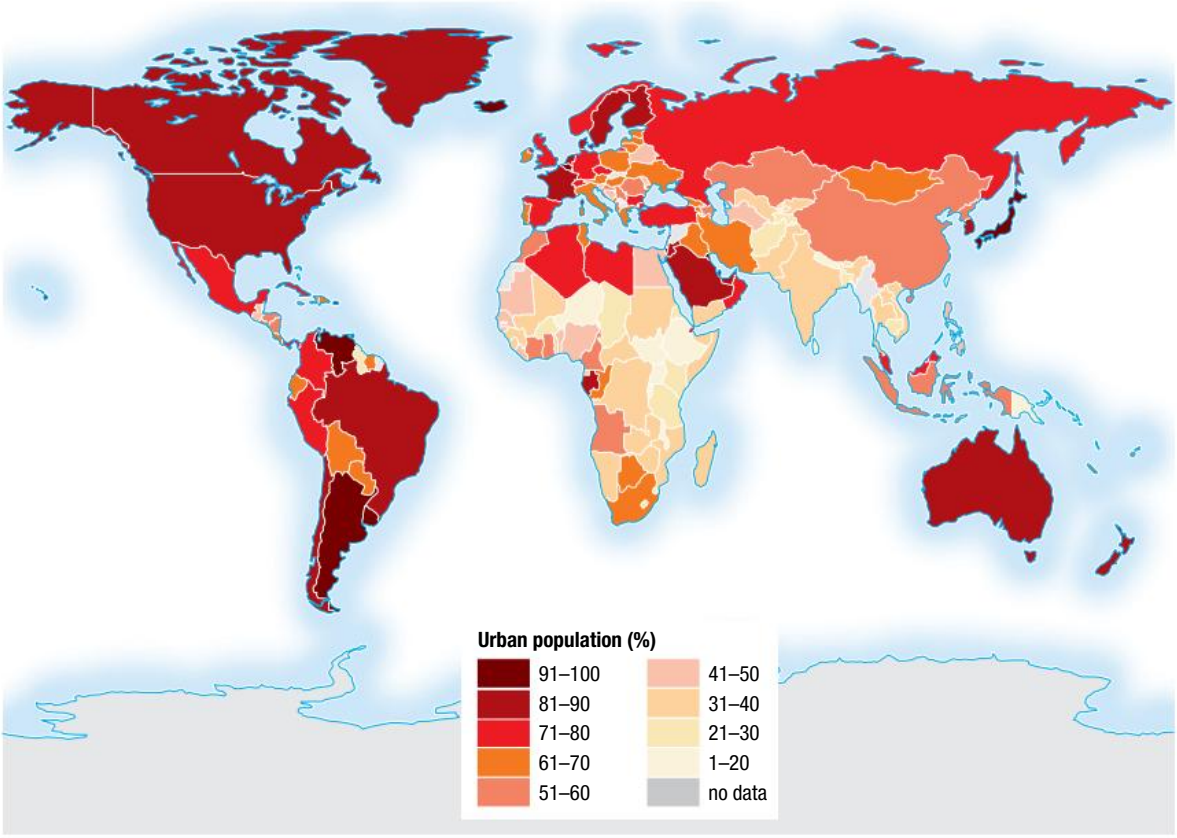
There are many reasons why urban settlements are increasing in size. The first is that there is a natural increase due to the rise in population. This has been caused by advances in medicine and better living conditions for many. Because of better medicine and immunisation programs, more children are surviving to adulthood than ever before, and people are living longer. This means that there are more children being born than people dying. The second major reason why urban concentration is increasing is push–pull factors, which drive migration from rural areas to urban settlements. For example, historically speaking, after the World War II years, for European migrants who were looking for a better life than their war-devastated countries could provide – this was the 'push' factor. Australia actively controlled who came by targeting specific skilled cohorts. Australia also enticed prospective emigrants by 'selling a dream'. At information evenings and via posters, billboards and fliers, prospective **emigrants** were told of the attractive lifestyle they would have in Australia, which included a level of materialism unheard of in post-war Britain and Europe. This propaganda also promised them a home of their own, white goods (electrical goods) and a vehicle – this was the 'pull' factor. An additional pull factor was passage assistance, to which both governments (of the relinquishing and receiving countries) contributed.

emigrants people who leave their country to permanently live in another

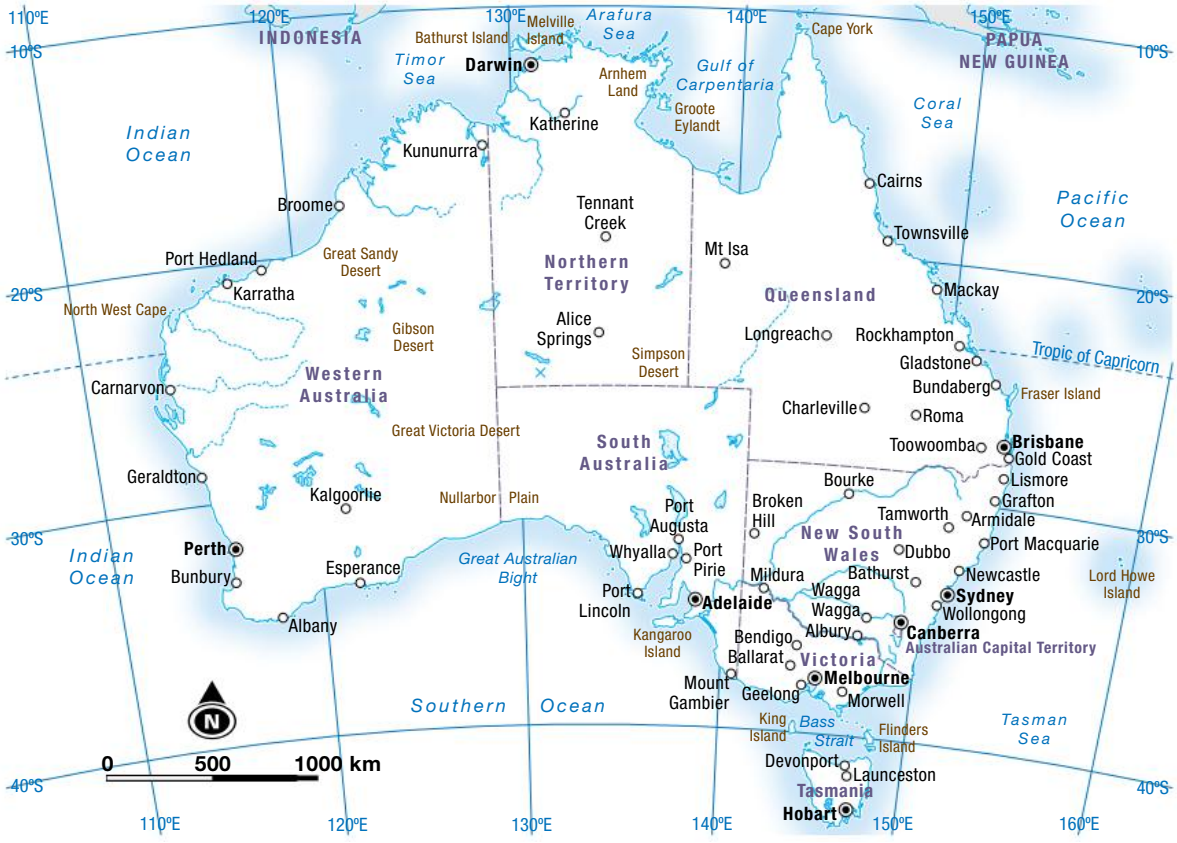
Geographical fact

The World Bank reported in 2012 that over 90% of urban growth was occurring in the developing world, adding an estimated 70 million new residents to urban areas each year. During the next 2 decades, the urban populations of 2 of the world's poorest regions – South Asia and Sub-Saharan Africa – are expected to double.

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Source 7.4 World urban population map, 2012



Source 7.5 Urban places in Australia vary in size and distribution.

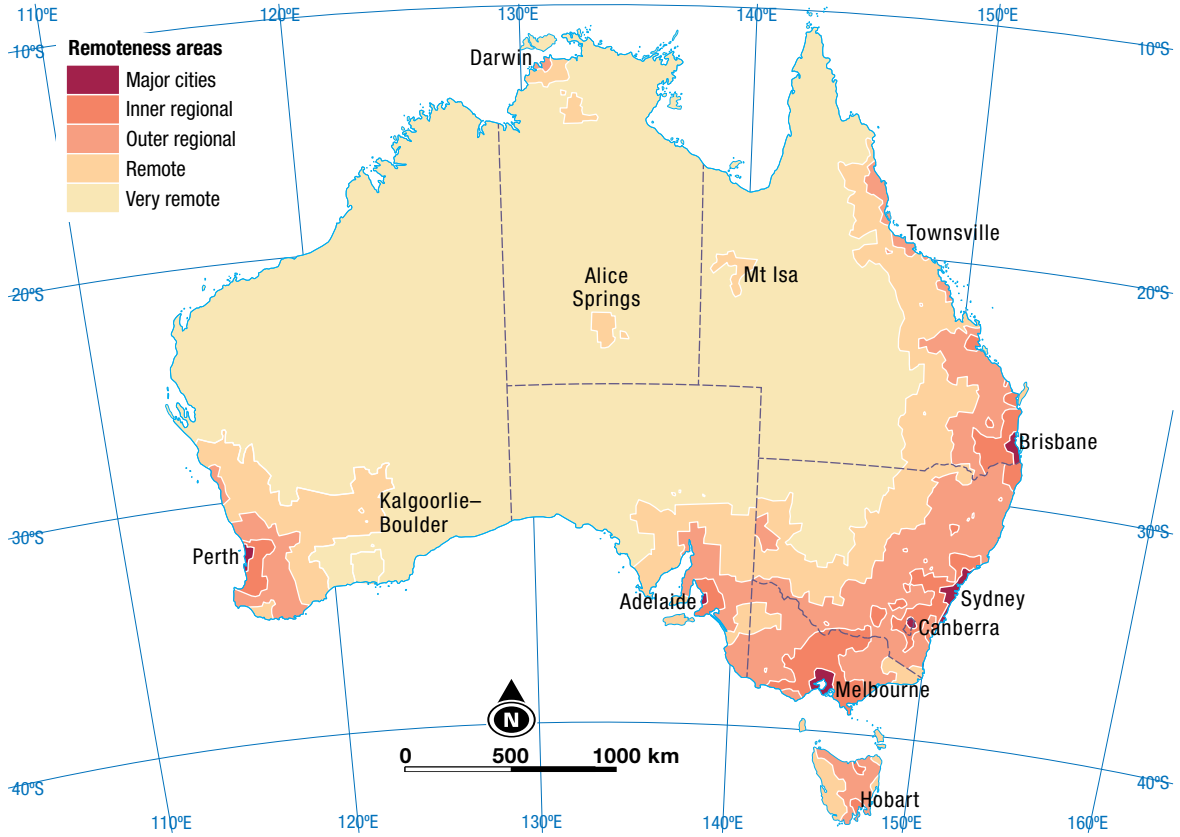
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Often people move from rural areas in search of a better life, especially to find work and improved educational opportunities. Advances in technology mean that fewer people are needed to cultivate farming land today. Source 7.4 shows the urban concentrations on a global scale.

Geographical fact

Did you know that 1 in 5 people living in New York City lives in poverty? This means 1.6 million people live below the poverty line (*New York Times*, 22 September 2011).

7.2 Urban concentration and settlement in Australia



Source 7.6 The types of urban settlements vary from state to state in Australia.

Australia is one of the most heavily urbanised countries in the world, with nearly 90% of the population living in urban areas, compared with around 80% for the United Kingdom and the United States, 70% for Italy and Germany, and 50% for China. The two maps in Sources 7.5 and Source 7.6 show the distribution of the main urban settlements and population density in Australia. Source 7.7 shows how each city has grown between 2005 and 2010.

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Source 7.7 Growth of capital cities, Australia, 2005–10

Estimated resident population by major region				
	June 2005	June 2010	Change 2005–10	
	no.	no.	no.	%
Capital city statistical division				
Sydney	4 245 045	4 575 532	330 487	1.5
Melbourne	3 680 609	4 077 036	396 427	2.1
Brisbane	1 822 074	2 043 185	221 111	2.3
Perth	1 485 823	1 696 065	210 242	2.7
Adelaide	1 134 513	1 203 186	68 673	1.2
Canberra	329 865	358 222	28 357	1.7
Greater Hobart	203 467	214 705	11 238	1.1
Darwin	111 258	127 532	16 274	2.8

Source: Information from ABS (2010)

RESEARCH 7.1

In groups, research an urban concentration. Your example can be from within Australia or from another country in the world. For your chosen urban settlement, create a poster of your findings in response to the following questions. Remember to include statistics and images to support your findings.

1. Locate your urban settlement on either a world map or a map of Australia. Include the latitude and longitude.
2. Describe any important geographical features or features of the population of the urban settlement you have chosen.
3. Describe the changes to the natural and human environment that have occurred from the beginnings of the urban settlement until today.
4. List the population total and the average population density.
5. Explain the push and pull factors that would impact on your chosen urban settlement.
6. Demonstrate how your urban settlement is linked to others – for example, there may be a waterway linking them, or perhaps they are linked by transport and roads.

Historical factors in Australia's development

Indigenous Australian people did not have a large network of permanent settlement when the European settlers first came to the continent. James Cook made notes about possible settlement locations, and those following him were able to gather more information about the sites and make informed decisions about where to locate each town. Cook had recommended Botany Bay as the location for the first settlement, but this was moved further along the coast to Port Jackson by Captain Arthur Phillip because of its water supply

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and naturally deep harbour, which made it easier for ships to deliver necessary goods. When John Batman sailed to the Port Phillip district of what became Victoria, he declared that the area where Melbourne now stands looked like 'the place for a village' because of the richness of the surrounding land and its potential for agriculture.

In each colony of what eventually federated into the nation of Australia, there was a similar story. Towns were established to serve the new settlers and to ensure that the colony flourished and grew. Australia is not the only nation that began its white settlement as a colony of a major European country; there are many, including Canada, New Zealand and the United States.

ACTIVITY 7.1

1 Using the internet, find out who Colonel William Light was and what role he played in the foundation of Adelaide.

2 Contrast Adelaide's beginnings to the beginnings of other state capital cities.

3 Adelaide is also known as the 'City of Churches'. Do an internet search and list as many of the churches in the main city as you can. Decide whether you think the city deserves that title.

Advantages and disadvantages of living in large cities in Australia

Different groups of people have conflicting views about the advantages and disadvantages of living in cities. These advantages can be classified as economic, social and environmental.

ACTIVITY 7.2

1 From the diagram in Source 7.8 (on the next page), classify the points of view into the following groups. Place your answer in the table below:

Social, economic and environmental advantages and disadvantages of living in cities

	Social	Economic	Environmental
Advantages			
Disadvantages			

2 In pairs, discuss the following statement: 'There are more advantages than disadvantages in living in large cities'. Summarise your conclusion.

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CITY LIVING: DISADVANTAGES

Police officers
- High crime rate
- Graffiti
- Drug use
- Problems associated with population-dense areas, such as the potential for rioting and drunk and disorderly behaviour in 'nightclub districts'



Young parents
- High price of housing
- Limited 'green' areas for children to play in, for sport or recreation
- Competition for education facilities



Aged persons
- Noise and traffic
- Isolation
- Lack of community



Ambulance officers
- Higher rates of accidents
- Higher rates of drug-related emergencies
- Traffic congestion can be a problem in emergencies



Government
- Problems associated with increased waste
- Pressure from growing populations to find suitable housing
- Pressure from growing populations to build suitable infrastructure, especially public transport



Social workers
- Growing inequality between rich and poor
- Isolation of those living in outer suburbs without reliable public transport system



Environmentalists
- Cities cause many sustainability issues
- Cities create strains on flora and fauna



Traditional cultures
- Urbanisation may create distance from traditional customs of Aboriginal and Torres Strait Islander peoples
- Can be challenging to sustain cultural heritage



CITY LIVING: ADVANTAGES

Migrants
- Access to resources to help settle in a new country
- Often chain migration means that new migrants will already people in an area
- Easier access to facilities (e.g. government departments, banks)
- More opportunities for employment



People aged in their twenties
- More job opportunities
- Selection of entertainment
- Greater opportunity for social activities in all forms
- More opportunities for employment



Doctors
- Wide range of medical facilities
- Opportunities to specialise in a variety of fields
- Variety of emergency services



Tourists
- Variety of cultural precincts and sites
- Access to public transport
- Variety of restaurants, cafes, bars and entertainment
- Greater diversity



Teachers
- Greater choice of schools and universities to teach at
- More opportunities to network with other teachers/academics
- Often more resources available



Business people
- Bigger market in which to develop business ideas
- More choice for consumers
- Greater access to a potential workforce and more variation of experience in the workforce

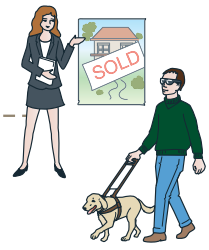


Youth
- Sport and entertainment facilities
- Greater access to public transport
- More opportunities for employment
- Greater opportunity for social activities in all forms



Real estate agents
- Population density drives up housing prices
- Greater assortment in choices of housing

People with disabilities
- More support available
- Accessibility to more services



Source 7.8 Advantages and disadvantages of living in cities

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7.3 Australia's population distribution

Most of Australia's population is concentrated in 2 widely separated coastal regions – the south-east and east, and the south-west. Of the 2 regions, the south-east and east is by far the largest in area and population. The population within these regions is concentrated in urban centres, particularly the capital cities.

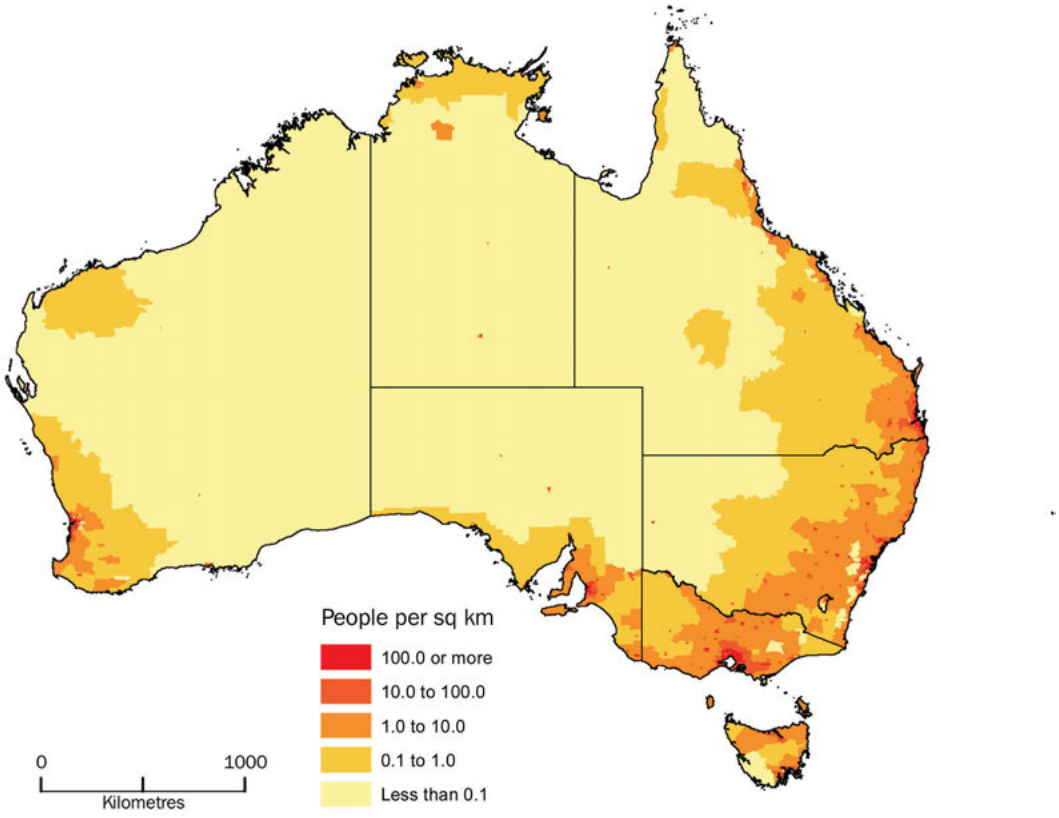
Australian cities have always been places where a large number of Australians have lived. More than 123 years ago, author Adna Weber, in his book *The growth of cities in the nineteenth century*, stated that 'the most remarkable concentration, or rather centralisation, of population occurs in that newest product of civilisation, Australia, where nearly one third of the population is settled in and around capital cities'.

Why has this pattern of settlement occurred?

The location of many of our early colonial settlements determined where our cities would develop. Safe sea ports located near rivers were needed for trade, so the coastline or a large stretch of river near the ocean became the natural choice for the location of a major city. Then the trade and **manufacturing** of the last part of the 19th century strengthened this pattern of settlement. The rail networks that were centred in capital cities increased their importance and connectivity within each state.

manufacturing the production of goods, often on a large scale and for sale to others.

By 1911, almost half the populations of New South Wales and Victoria lived in Sydney and Melbourne respectively. Adelaide and Perth



Source 7.9 The distribution of Australia's population, 2010

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accounted for 40% of the population of their states. Today, these cities, along with Brisbane, contain 60% of Australia's total population.

The end of World War II saw the need to reconstruct the nation, and large-scale immigration was needed to supplement the workforce. The combination of population and economic growth led to major urban expansion. At this time, the percentage of people living in cities grew from 54% in 1947 to 70% in 1971 (ABS 2008).

Since 1971, the growth of our major cities has continued, but at a slower rate. The ABS stated in 2010 that the populations of regional or **satellite cities**, such as Newcastle, Wollongong, Geelong and the Gold Coast, are also increasing.

satellite city a smaller metropolitan area that is located near a major city, which may be economically and politically independent

State or territory	Name of regional city	Satellite city of
South Australia	Gawler	Adelaide
Queensland	Ipswich	Brisbane
New South Wales	Gosford	Sydney
Victoria	Melton	Melbourne
Western Australia	Mandurah	Perth
Northern Territory	Palmerston	Darwin
Australian Capital Territory	Tuggeranong	Canberra
Tasmania	Kingston	Hobart

People from many nations and backgrounds have settled in Australia and made their mark on the land. Mt Kosciuzko, Australia's highest mountain, it is named after the Polish general Thaddeus Kosciuszko. Tasmania is named after the Dutch explorer Abel Tasman, and our capital city of Canberra was designed by Walter Burleigh Griffin, an American. Our history has been strongly influenced by people from many lands, and our nation has reminders of them everywhere we look.

Our settlements, regardless of size, have been established for a variety of reasons. Many, including our state and territory capitals, were ports with natural advantages for large ships to dock and unload their cargo or passengers. Other inland settlements began as 'staging posts', a day's journey from the major city or the previous post. These towns would often include a hotel that provided meals and accommodation to the human travellers and stables for horses. Berwick in Victoria is one such town – a full day's ride from Melbourne and halfway between Melbourne and central Gippsland.

Some towns sprang up to service the local population with general stores, or as trading posts for farmers to sell their goods and purchase other items they needed. Other towns were founded around an industry such as mining or whaling. There were many reasons why a town would be founded and a range of conditions under which it would flourish and grow.



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NOTE THIS DOWN

Using the internet, fill in the table below with the names and foundation years of Australian settlements.

Reasons for settlement's establishment	Name of settlement	Establishment year and any other interesting information about the settlement
Penal colony	Sydney Cove	1788. The city of Sydney went on to become Australia's largest city.
Sea port		
River transport		
Rail transport		
Road transport		
Mining		
Pearling		
Whaling		
Agriculture		
Tourism		

ACTIVITY 7.3

1. Locate maps of your local area and identify the natural features that would have been desirable as the town was beginning.
2. List any fresh water and available transport, as well as the reason for the establishment of the town.
3. Identify any notable people who were involved in the foundation and development of your town.
4. Using your findings, design a brochure promoting the town to attract more residents to move to it.

Environmental factors in Australia's development

There have been many attempts to explain why people live where they do. In simple terms, people need to feel safe and have access to shelter, food and fresh water. It is important to have these elements for the survival of each individual and family. These needs are increased with larger populations. Added to this is the need to be able to dispose of waste effectively.

Australia is a land that has limited fresh water and fragile land that needs to be managed and nurtured carefully if long-term settlement is to be successful. With so much of the Australian continent being semi-arid or even desert, it is not surprising that the new settlers stayed close to the coastal fringe. The coast generally has higher and

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more reliable rainfall, more fertile land and more immediate access to transport, especially by sea. In order to future-proof the growth of some cities and the need for fresh water, desalination plants like the one found in Kurnell New South Wales were built. Many new Australians never returned to their country of origin, especially in the first century of settlement, but it remained important to them to stay near the links that could take them back if the opportunity ever arose. The wetter, greener coastal area also reminded them of the cooler environment they had left behind in Europe, and allowed them to feel 'at home' more quickly.

Source 7.10 Kuranda Scenic Train, north Queensland

Geographical fact

Australia's most recognisable urban building, the Sydney Opera House, was designed by Joern Utzon from Denmark. In 2013 it celebrated its 40th birthday!



Source 7.11 Sydney Opera House

7.4 Urban concentration and settlement in the United States

The United States is a nation made up of international migrants who came from a variety of distant places looking for a new life. That search may have been for political freedom, refuge, employment and economic opportunity, religious freedom or family. One of the most recognisable symbols in the United States is the Statue of Liberty. The Statue of Liberty Enlightening the World was a gift of friendship from the people of France to the people of the United States, and is a universal symbol of freedom and democracy.

There have been multiple waves of international migration to the United States. Each one has had a different impact on the nation's cities and way of life.

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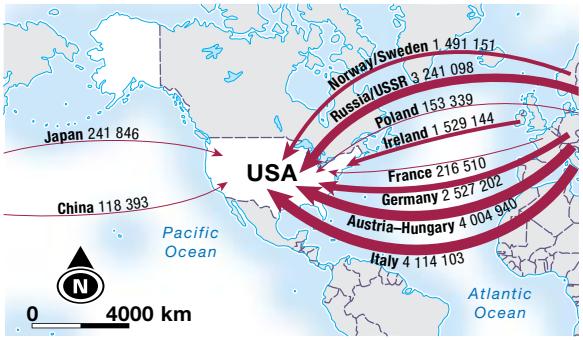
Give me your tired, your poor, your huddled masses yearning to breathe free, the wretched refuse of your teeming shore. Send these, the homeless, tempest-tossed, to me: I lift my lamp beside the golden door. (Emma Lazarus, 1883)

Source 7.12 The Statue of Liberty, New York

The first wave

The first wave of immigration to the United States began in the colonial period during the 17th and 18th centuries. During this period, most people came from northern Europe, especially England, Germany and Ireland. Over half of these European immigrants arrived as **indentured labourers** – young workers who were provided with food and training, who then worked to pay off their travel costs. Africans also came to the United States by force through the slave trade.

indentured labourer a worker, typically a labourer or tradesperson under contract for a fixed period of time in return for payment of travel expenses and accommodation



Source 7.13 Migration to the United States, 1880–1920

The second wave

The second wave of mass migration, in the mid-19th century, saw another great influx of people from Europe, in particular from Germany, Italy, Poland, Russia and Hungary. The advent of steam-powered ships made the journey across the Atlantic Ocean faster and more economically viable for families. This period was the most multicultural in United States history, with 15% of the population in 1890 being born in another country.

The third wave

The early part of the 20th century saw a further wave of immigration from Europe, particularly southern and eastern Europe. It was during this period that the United States experienced its peak year of European immigration, 1907, when 1 285 349 people entered the country. This decreased greatly in the following decades: World War I, the Great Depression, restrictive immigration laws that targeted Asia and southern and eastern European countries, and World War II combined to bring this immigration boom to an end.

The fourth wave

It wasn't until the *Immigration and Nationality Act* of 1965 that the United States sought to change the fundamentals of its immigration system, opening its doors to migrants from non-European nations. This changed the fundamental ethnic make-up of the nation. Today, international migrants primarily come from Latin America, Asia and the Caribbean. This shift has been caused by the need

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to find employment and make a new life. A large proportion of these immigrants are unauthorised; sources suggest that, of the 38 million international migrants, nearly one-third are in the country without legal permission.

How are the new migrants different from those of the past?

Geographic distribution is the key here. Until recent times, migrants settled in the traditional 'gateway states' such as California, New York, Texas, Florida and Illinois – all situated at the geographical edges of the country. In 1980, changes to laws made it easier to settle further inland, in the Midwest and South, which led people to settle in large numbers in areas that had not had international migrants before. In 1990, 66% of immigrants lived in gateway states and 34% lived in other states. By 2005, the proportion living in gateway states had decreased to 60% while 40% were living inland.



Source 7.14 The impact of migration on American cities

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Geographical fact

The *Titanic* was a British passenger liner that sank in the North Atlantic Ocean on 15 April 1912 after colliding with an iceberg during her maiden voyage from Southampton in the United Kingdom to New York City. A total of 1502 people died, including hundreds of emigrants from Great Britain, Ireland, Scandinavia and elsewhere throughout Europe seeking a new life in America.

7.5 Comparing Australia and the United States

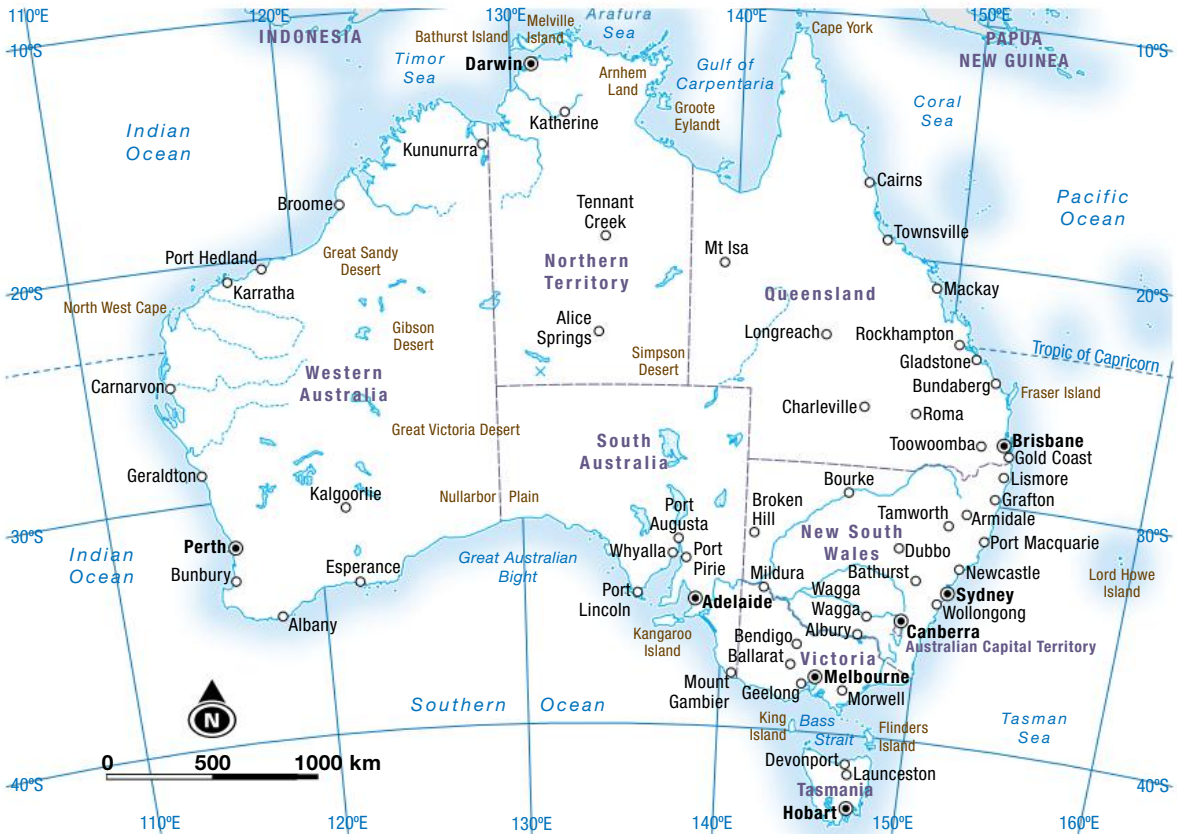
A comparison of the development of settlements in Australia and the United States reveals both similaritites and differences. We need to understand these, and to analyse the reasons for the differences to predict future patterns of development. We should first recognise that both nations were already settled by native peoples who had been living on the land in harmony with the environment for long periods of time. In both cases, their lifestyle and sovereignty were not valued by the new colonists, and were often seen to conflict with the goals of the new settlers. A further similarity is that the free settlers who came to both countries were often looking for a better life for themselves and their families. They rarely had very much in the way of property or money, but were willing to work hard to achieve their dreams.

There are many historical factors that are common to both countries. It was the American

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Source 7.15 Map of the United States



Source 7.16 Map of Australia

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Civil War that saw the end of transportation of convicts. This directly led to England searching for a new destination for prisoners and deciding that Australia was a suitable replacement. The discovery of gold in California drew immigrants from across the globe, including some who later travelled to Australia and found gold in Victoria and New South Wales. The discovery of gold in the Australian colonies directly led to the end of transportation, as it was felt that sending prisoners to a gold mine was not really an effective punishment.

A key difference is that colonists who settled in America found that the environment was similar to the lands they had left behind. There was a plentiful water supply, and they were eager to push the frontier or settlement boundaries further west in their quest for a better life. The map of the United States in Source 7.15 clearly shows the regular distribution pattern of cities and towns across the nation, providing a network that supported the development of utilities and services such as transport and communication for the population.

The main exception to this is the state of Alaska, where the harsh climate limited the number of people who chose to live and work there. Despite being much colder, Alaska shares the harshness of its environment with the hot, dry Australian outback, producing a similar pattern of settlement with increased population centres along the coastline, and large interior regions with smaller and fewer towns.

Source 7.17 Comparison of Australia and the United States

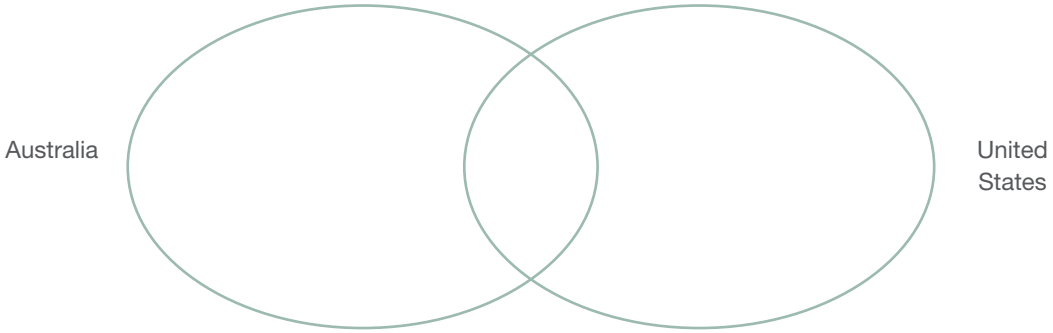
Settlement factor	Australia	United States
Colonised by England	First Fleet arrived 1788.	Began in the early 1600s.
Free settlers and convicts	Mostly convicts before the discovery of gold in New South Wales and Victoria in 1851.	More free settlers than convicts. Penal transportation ended in 1776 with the Civil War. Discovery of gold in California in 1848.
Settlement pattern	Settlers came from Britain and other areas of Europe. Convicts featured as the major source of labour to build infrastructure in settlement locations decided upon by the British. There was also the forced migration of Melanesian workers to support agriculture.	Settlers came from Europe directly across the Atlantic Ocean, looking for land similar to the homelands they had left behind. They settled the eastern areas first, gradually moving west. The major exception to this was the forced migration of slaves from Africa and the Caribbean.
Environmental factors	Arid land with nutrient-poor soils through much of the inland; fertile soils with more reliable rainfall and access to fresh water supplies along the coastal fringe, especially the eastern and southern coasts.	Desert areas, but generally a more even climate with predictable precipitation in many areas, supporting more locations for settlements and agriculture.
2011 population	21 507 717 (21 million)	311 800 000 (311 million)
Land size	7 617 930 km^2	9 158 960 km^2

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ACTIVITY 7.4

1 Calculate the population density of Australia and the United States (land ÷ population = the average number of people per square kilometre)

2 Using a Venn diagram (as below), categorise each settlement factor in Source 7.17 into Australia or the United States, or allocate it as a shared factor.



7.6 Transport and urban settlements

We have already identified many factors that are important in the selection of a site for a permanent settlement. Another very important one is transportation, especially as regards how easy it is to bring goods such as food into the town and to take any produce of the area out to the markets. Good transport options can make a town thrive and prosper, while issues with transport can even cause a town to collapse. Throughout Australia's history, the importance of towns has changed according to the efficiency and reliability of transport.

Source 7.18 Many Australians use transport today.



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Source 7.19 Paddle steamer on the Murray River near Echuca



Source 7.20 Road train in the Northern Territory, Australia

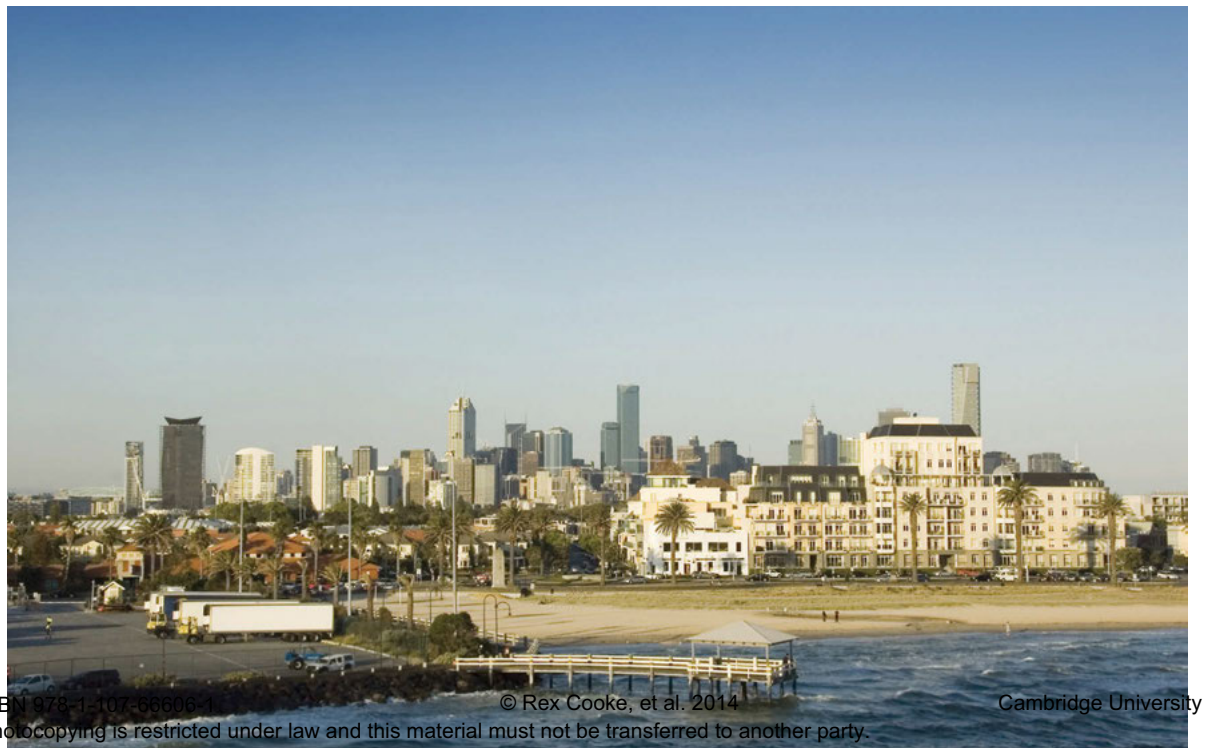
When Australia was first colonised, water transport was the primary method of moving large quantities of goods around, both from England to the colonies and inland on rivers. It was slow, but there were very few other options. As roads began to be built, horses and bullocks pulling loads on carts were also used, but they still did not compete with the water for large haulage. This led to the development and expansion of river ports such as Echuca on the Murray River, which provided a regional 'depot' for the area surrounding it. Goods could be brought to Echuca for transport to the larger cities or taken from Echuca back to the farmhouse.

As better overland transport options such as rail opened up in the second half of the 1900s, river ports began to decline in importance and size. River transport could not compete with the speed and cost of rail transport for large amounts of freight. The rail system was not restricted to the rivers, and could take goods to areas that had been difficult to access.

Transportation today

The development of roads and the invention of cars and trucks continued to improve the ability to move goods around the country, while the development of road trains made it even easier. These trucks, with their massive engines, are able

Source 7.21 Melbourne from the bay, showing industry and recreation activities side by side



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to pull several loads at once across the continent. They can carry goods from place to place, but can also replace trains in carrying freight to ports for movement to international destinations. Many ports around the country, such as Fremantle and the Port of Melbourne, have been revived by the increased efficiency of the road transport network in Australia. They are also benefiting from an influx of new residents, who are 'cashed up' and wanting to live in an historic area. These new residents are changing the areas from being primarily industrial to having a more diversified economic base that includes tourism, hospitality and **recreation**.

recreation activities for the purpose of relaxation during leisure time

NOTE THIS DOWN

Using the graphic organiser below, summarise what you have learned about environmental resources and how they impact on the development of urban places.

	Plus factors/advantages	Minus factors/disadvantages	Interesting facts
Sea transport	Can move large amounts of cargo between major cities quickly and cheaply	Can't move into shallow water or take cargo inland	Australia was the first country to use refrigerated shipping to transport dairy products to England
River transport			
Rail transport			
Road transport			

Communication

Until very recently, newspapers were a major source of information for people. They were the chief way people found out what was going on in the world, as well as in their local community. With improved communication services, there has been a steady decline in the number of newspapers being produced. Some papers have vanished altogether, while others have merged or reduced the number of editions produced each week. Television news services are also suffering a decline, with more people now using the internet and their smartphones or tablets to stay informed. News can be updated quickly and downloaded to where it is wanted in a matter of seconds. If this technology had been available to the first European settlers as they arrived in Australia, the pattern of settlement would have been very different. Towns that were based on providing telegraph communications, like Alice Springs, might not have existed at all, while others might have had a completely different focus.

If communities had been able to access the global communication and information services that we can today, there may have been an even stronger concentration of settlements along the coastal edge of the country, without the need to move nearer to families and friends. Improved transport links and options would have further changed settlement patterns, allowing easier movement around the country. Perhaps towns that are now virtually 'ghost towns', like Walhalla and Charters Towers, would have remained viable settlements, with residents being able to maintain connections to the outside world instead of being physically isolated.

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Adapting to the environment

Over the past 75–100 years, technology has played an ever-increasing role in the Australian landscape. It has supported change to the agricultural and manufacturing systems we use, made us re-evaluate how we get our information and shown us new ways to stay in touch with our friends and family, as well as changing how we move around the country.

When Europeans first came to Australia, they did not understand the new land in the way that Indigenous Australians did. The local Aboriginal groups had been living with and from the land for thousands of years, maintaining balance in the environment. The Europeans brought with them farming methods that did not properly look after the land, and ultimately were unable to continue to be efficient in food production. The Australian environment had less fertile soil and less reliable rainfall than the settlers were used to. The obvious answer was to fertilise and irrigate the land to reproduce the conditions they were accustomed to, but this created other problems, especially salination of the land and conflict over water supply. Fortunately, scientific research has shown farmers how to better manage their land, while developments in technology have provided more efficient machinery for the industry.

Other manufacturing industries also benefit from similar processes. We have seen advances in robotics and assembly line practices, computerisation and, most importantly, human safety in the workplace. Distribution and transport network improvements have supported advances in manufacturing, as well as assisting in the tourism and hospitality sectors. When goods can be moved around the country more quickly and cheaply, the profits of the manufacturer increase. Consumers also benefit from cheaper prices for products and greater choice in the range of products available.

FIELDWORK 7.1 EXPLORING OUR CAPITAL CITIES

In this fieldwork, we will explore your state or territory's capital city. Where possible, a visit to the city centre would benefit your understanding of the city and help you to analyse the city structure.

Aim

To understand how the capital city in your local state or territory began and how it changed into the city it is today.

Method

To research data and information using a variety of sources, including the internet, the State Library and the Australian Bureau of Statistics in addition to the atlas and local or school library to produce a presentation and report on the city.



Source 7.22 Adelaide's Victoria Square fountain, designed to represent the rivers from which Adelaide receives its water



Source 7.23 The Perth skyline from the Swan River at night

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Preparations

1 Locate a map of your city and mark on it the following:
   - physical features such as rivers, nearby mountains and the ocean
   - the place where settlement first began.

2 Use an overlay (tracing paper is good for this) to show the major road and rail transport networks.

3 Use a separate overlay to show the suburbs as they were in 1800, 1850, 1900 and 1950.



Source 7.24 Suburban houses, Hobart



Source 7.25 The Rocks and Sydney Cove, c.1800

Data collection

If you are able to do so, making a visit to the city you are investigating is the best way to learn about it. If that is not possible, there are alternatives that give excellent results. You could use a program like Google Earth or an interactive e-atlas to 'see' the features of the town and travel through the main streets. How you manage the data collection will depend on the method you use. Where the instruction says to walk down the main street, you will move the cursor on the screen to move the view of the street. Where it says to take a photograph, you may be taking a screenshot or saving an image.

1 Before you visit your capital city, do some background research. List information such as: how and when your city began; what major industries were there at the beginning and what are there now; who were the most important people in the development of the city.

2 Record the population of the city in 1800, 1850, 1900 and 1950 to see the rate of change over time.

3 You could present these data in the form of graphs or a series of chloropleth maps (if you are able to find the data across local government Areas (LGAs)).

4 Travel along the main street, noticing what types of building (age, height, style) there are. Photograph or sketch a section of a building and annotate it with the building's details.

5 Analyse the public transport available in this part of the city. Investigate whether it is efficient in moving people to their workplaces and other destinations. You may need to look at the internet for public transport timetables.

6 Identify any buildings or features in the main street that stand out. It could be that they don't seem to fit with the rest of the streetscape, or perhaps they are unusual and add to the attractiveness of the overall view. Include images of these and explain why you have included them.

7 Identify any issues with human movement through the main street, such as pedestrian obstacles (signs, narrowing of footpaths, uneven footpath, public art, etc) and suggest ways in which these issues could be solved.

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Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map – your capital city
Page 3	Introduction – brief description of the street sites
Pages 4–5	Description and analysis of graphs and photos
Page 6	Background information on the city
Pages 7–8	Description of streetscape, sketches and/or photos
Page 9	Additional data such as train timetable screenshots/samples
Page 10	Analysis of issues with the streetscape
Page 11	Table or written description of proposed management strategies
Page 12	Evaluation of these proposed strategies
Page 13	Appendix, Bibliography, Glossary



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Chapter summary

- Urban settlements are distinct areas where people live and work.
- Urban settlements have grown over time because of increasing populations.
- Australia is one of the most heavily urbanised countries in the world.
- Most of Australia's population is concentrated in 2 widely separated coastal regions.
- Australia is a land that has limited fresh water and fragile land that needs to be managed carefully.
- The United States is a nation made up of international migrants.
- Australia and the United States have many similarities in their colonisation and history, as well as geographically.
- Technologies – particularly in the transport and communication fields – have changed the way we can operate in our landscape.

End-of-chapter questions

Multiple choice

1 A settlement is:

A a town
B a city
C a farm
D all of the above

2 The following is not necessary for a settlement:

A defence
B a reliable food source
C good shopping
D clean drinking water

3 In Australia, the coast is a more desirable area in which to live than the interior because:

A it has more reliable rainfall
B there are good red soils
C it is greener
D all of the above

4 The main reason why urban settlements have become larger is:

A deforestation
B better medicine
C population increase
D population decrease

5 Alice Springs was once an important:

A transport centre
B agricultural centre
C industrial centre
D telegraphic centre

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Short answer

1 Compare the United States and Australia, and articulate the most important differences and the most interesting similarities. Justify your choices in a paragraph format.

2 How comfortable people feel in an environment is very important. Taking this into account, suggest why more migrants moved to the United States than to Australia.

3 Interpret the importance of transport routes when living in a vast country such as Australia. Construct an email that supports the transport industry, highlighting its importance to this country, which could be sent to your local member of parliament to encourage them to reduce fuel costs for the industry.

4 Via the internet, research photographs of Australia's capital cities. Select 2 and write a brief 'promo' for each of them – that is, why someone should choose them to live in.

5 List 3 social, economic and environmental advantages of living in your local town or city, and then list 2 disadvantages of each type.

Extended response

What if …

Predict what the settlement pattern would have been in Australia if we still relied on sea travel and horseback.

- List at least 3 reasons for your response.
- Organise a paragraph for each of the reasons and try to include data, a map or an image (photograph or sketch) to support each paragraph.
- Predict what arguments could be developed against your thoughts and provide counter-arguments to them in your report.
- Construct your response in the form of a report that could be presented to an Australian student conference based on the theme 'What if …'

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8 Internal migration in Australia and China



Source 8.1 Shanghai is China's largest city.

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Before you start

Main focus

To understand the effects of internal migration and how it redistributes a nation's population.

Why it's relevant to us

Where we choose to live and why we want to live there have an impact on everything about our lives, from the size of our community to the services available to us, to our daily communication with people in other communities. In one way or another, decisions about where we want to live, and when each person makes that decision, have an enormous collective impact on our community, nation and world.

Inquiry questions

- What do the 4 main migration terms mean?
- What are the 2 main factors associated with internal migration?
- Are fly-in fly-out (FIFO) workers a modern example of the internal migration of people within a country?
- Does Australia's economic advantage lie in primary production, service provision, tourism or highly specialised manufacturing?
- Has the mining boom in Australia resulted in a large movement of people to areas in Western Australia and Queensland?
- Has the manufacturing boom in China resulted in a large internal migration from central areas to coastal cities such as Shanghai?
- Are Aboriginal and Torres Strait Islander peoples the custodians of one of the world's oldest continuing cultural heritage traditions and sustainable environmental practices?

Key terms

- Migration
- Push factors
- Pull factors
- Displacement
- Intrastate migration
- Interstate migration
- Negative internal migration
- Biodiversity
- Urban sprawl
- Open-cut mining
- Engineer
- Geologist
- Displaced persons
- Customary
- Sovereignty
- Conquest
- *Native Title Act*
- *Terra nullius*
- *Mabo*
- *Wik*
- Stolen Generations

Let's begin

This chapter looks at the effects of internal migration on the redistribution of populations, focusing primarily on Australia and China. It looks at the concentration of Australia's population on the east coast, and the emergence and dominance of major economic activities – especially mining in the central and western areas of the continent. It identifies the changes that have occurred in both Australia and China as a result of internal movement of people, and explains the economic, environmental and social effects of this movement. Aboriginal and Torres Strait Islander peoples' attachment to a number of places through family, country/place, dispossession, relocation and employment is discussed.

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8.1 What is migration?

Migration is the movement of people from one place to another to take up permanent or semi-permanent residence. It allows people to move from town to town, city to city or country to country. There are various forms of migration:

- internal migration: migration within a country
- seasonal migration: migration to an area for employment based on a season
- international migration: migration to another country
- rural-to-urban migration: movement from the countryside to the city.

Global trends in migration

A number of global trends exist in terms of migration, but the most common – and the one that has the most impact on population distributions in many countries around the world – is rural-to-urban migration. Rural-to-urban migration is defined as the movement of people from the countryside to the city. A unique feature of rural-to-urban migration is the fact that it is not confined to certain areas of the world; it is evident across all continents (except Antarctica), and exists in both developed and **developing countries**. Rural-to-urban migration is having the most impact in the developing countries of the world, especially in Asia and Africa.

developing country a country with a low standard of living and a developing industry base and/or economy

Push and pull factors

A range of factors contribute to the movement of people as a result of rural-to-urban migration. These factors are split into 2 key groups: **push factors** and **pull factors**. Push factors force people to leave their place of residence in search of a new place in which to live.

push factors reasons that force a person to leave their place of residence

pull factors reasons why a person would want to move to a particular area



Source 8.2 A rural house in southern Laos. This is the type of area from that people leave to move to the larger cities.

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displacement the situation of people forced to leave their home and community, either because others have made them leave, or because life in the community has become intolerable or unliveable

These factors can range from poverty and **displacement** to war, environmental hazards and famines.

Pull factors are forces that attract or entice a person to relocate to a new area or location. These factors generate optimism and hope for the residents that they will receive better conditions than in their current situation. These factors range from better employment opportunities to access to medical and health services.

Source 8.3 Push and pull factors associated with rural-to-urban migration

Push factors	Pull factors
Being forced off the land by owner of the land	Perception of better employment opportunities in cities
War and civil unrest	Promise of better access to essential services
Failure of subsistence farmers' crops	Better health facilities
Extremes of weather (floods or droughts) that destroy crops	Greater opportunities for an education
Rapid increases in populations	More access to entertainment and recreation activities
Lower standards of living in rural areas	
Boredom with rural life	
Increased mechanisation of farming, leading to loss of employment	

ACTIVITY 8.1

1. Imagine that you are a rural Chinese person moving to Shanghai. List what push factors and pull factors would bring you to the city.
2. Suggest which push factors and pull factors would make you most likely to migrate in any circumstance.
3. After conducting a survey in class, list how many class members have experienced internal migration.

RESEARCH 8.1

Use the internet to gather information about how rural-to-urban migration is having an impact on a specific country. In groups or as individuals, research a specific country and identify examples of push and pull factors that are operating within that country. Organise your results and present them to the class in a wiki or PowerPoint presentation.

(continued)

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A good starting point for your research is the Population Division of the Department of Economic and Social Affairs of the United Nations, and a link is available via www.cambridge.edu.au/geography8weblinks.

Countries you could research include:

- Thailand
- Vietnam
- Nigeria
- Bangladesh
- India
- Mexico
- Brazil
- Egypt.

Make sure you incorporate the following features in your presentation:

- maps
- photos
- statistics.

8.2 Australia's population

According to the Australian Bureau of Statistics (ABS), Australia's population in 2012 reached 22.8 million. This ranked Australia as the 53rd most populated country in the world. In comparison, Australia has a land area of 7 682 300 km^2, which ranks Australia as the 6th largest country in the world in terms of area. Only Russia, Canada, the United States, China and Brazil have greater land areas than Australia. To identify the population density of a country, we divide the land area by the population. This gives the number of people on average per square kilometre. Australia's population density is one of the lowest in the world, with 2.9 people per square kilometre. This can be compared with places like Monaco, which has 17 703 people per square kilometre, Singapore, which has 7252 people per square kilometre; and Hong Kong; which has 6782 people per square kilometre.

Economic growth in Australia

primary resources (also known as natural resources) products from the Earth that can be used to produce or run human-made inventions

Australia has relied heavily on the production of **primary resources** for economic benefits. From the early establishment of Australia as a country, it relied on the wool industry as a main source of economic growth; now the mining industry is one of the biggest contributors to the economic prosperity of the country. According to the Mineral Council of Australia, in 2010–11 the total mineral exports that Australia generated (excluding oil and gas) reached $154 billion, about 52% of Australia's exports.

Case study 8.1
Western Australia

The greatest concentration of economic growth over the past few years in Australia has been from the mining industry in Western Australia. In 2011, the value of the mining industry was $107 billion, an increase of 16% from 2010. Also during 2011, the total value of Australia's merchandise exports was $263 billion. Western Australia accounted for 46%, followed by Queensland with 20%, New South Wales with 15% and Victoria with 8%. This clearly illustrates the economic dominance that Western Australia has over the other states in the export sector.

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Source 8.4 An open-cut mine at Kalgoorlie in Western Australia



Source 8.5 A processing plant at Galaxy Lithium mine at Ravensthorpe, Western Australia

Western Australia has a wide variety of mineral and petroleum resources. These include iron ore, gold, petroleum, liquefied natural gas (LNG), crude oil, alumina, nickel, natural gas, copper, lead, zinc, diamonds, coal and cobalt. However, the 3 main sectors that account for the greatest percentage of the industry are iron ore, petroleum and gold. The total value of these 3 sectors is $95 billion, or 89% of the overall value of the industry.

1. Explain why Western Australia's export market is so much larger than those of other states.
2. Suggest what effect these economic factors would have on migration to Western Australia, taking into account push and pull factors.
3. Using your own research on the internet, analyse why Western Australia's export sector has increased so much in recent years.



Source 8.6 A large open-cut iron ore mine in Western Australia



Source 8.7 Gold is mined and turned into gold bullion.

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8.3 Internal migration in Australia

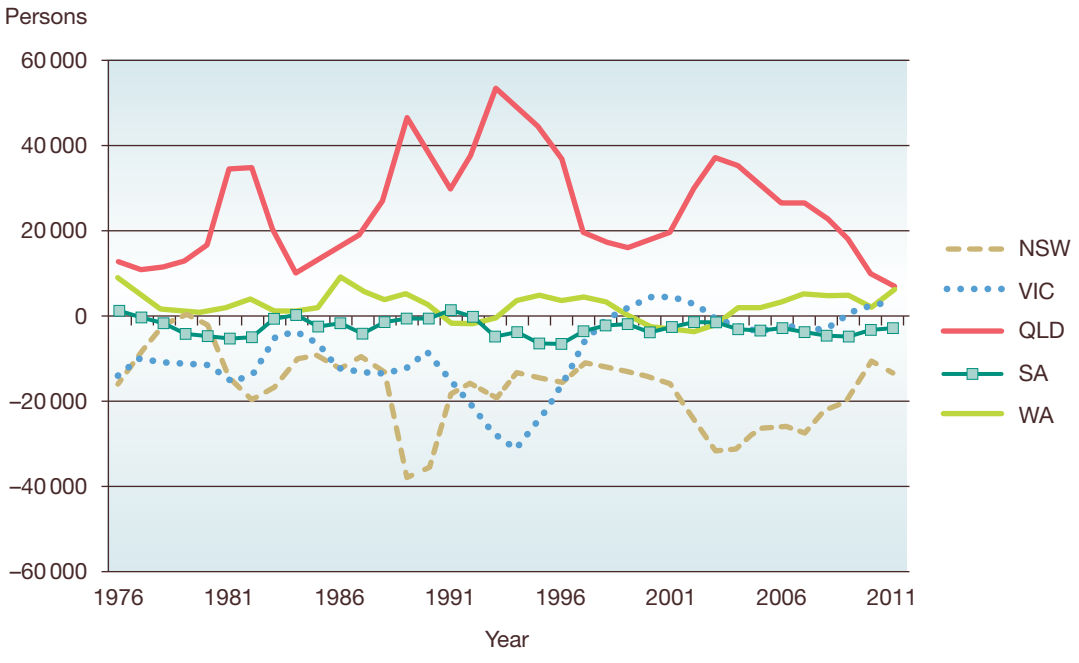
intrastate migration movement of a person within their own state

interstate migration movement of a person to another state

Internal migration that occurs in Australia can be classified into 2 key types. There is **intrastate migration**, whereby people move within their current state of residence – for example, from Brisbane to Townsville. The other is **interstate migration**, where people move from their current place of residence to another state – for example, from Melbourne to Perth. A very distinct pattern has emerged over the past 35 years in the internal migration of Australians. Queensland consistently has received the greatest number of internal migrants; however, that trend has dropped to the point where it is at its lowest in the last 35 years. There are a number of key factors why Queensland has received the most internal migrants in Australia. First, Queensland has a warm temperate to tropical climate, which makes it very attractive to people who are looking for a climate that gives them a unique lifestyle opportunity. Second, Queensland is very attractive to people who are looking to retire to a warmer climate to enjoy benefits such as beaches and recreational activities such as golf or tennis.

negative internal migration a situation in which more people leave a state than arrive as newcomers

There are some other key trends that have occurred over the past 35 years. New South Wales has had fluctuating rates of **negative internal migration**. This means that there are more people leaving New South Wales than migrating into the state. This negative internal migration peaked in the late 1980s, when New South Wales lost a net total of 40 000 migrants. However, since then it has gradually decreased to a point in 2011 where 9000 more people migrated to New South Wales than left the state. Victoria has experienced a trend similar to that of New South Wales. Its lowest point was in 1994, with 30 000 people leaving; however, it has now reversed this trend and had a positive figure of 3000 people in 2011. This is because of better employment opportunities and the growth of Melbourne and Sydney as global cities with increased links into the global economy. Western Australia has seen a net increase in its internal migration over the period 1998–2011. Some 2000 people left the state in 1998, but by 2011 that trend had reversed, with 8000 people migrating to Western Australia. This has a direct correlation with



Source 8.8 Net internal migration in Australia, 1976–2011

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the mining and resources boom, which has seen a rapid rate of development in Western Australia. With attractive salaries to be earned in the mining and resources sector, many workers have relocated themselves to this state to take advantage of the high salaries offered by resource companies.

Over time, there has been a general trend of internal migration in Australia to become a movement towards the cities. Whether it is intra-state or interstate, the main part of the migration has involved people moving to the major urban centres. This has developed to a point where Australia has now become one of the most **urbanised** countries in the world.

urbanisation the process by which more and more people are coming to live in towns and cities

ACTIVITY 8.2

1. Taking Source 8.8 into account, predict the order for those 5 states in 2020, from highest net internal migration to lowest.
2. Victoria's negative internal migration was reversed in 2011. Explain why this was so.
3. Describe a major pull factor for each of the following states: Queensland, Western Australia, Victoria.

8.4 Internal migration in China

The movement of people internally through China has changed over time. The rise in economic development of China over the past 30 years has had a major impact on the movement of people throughout the country. This economic development has drawn the rural Chinese to the cities in search of higher paid work than is available in the agricultural sector. According to China's National Bureau of Statistics, the movement of rural Chinese to the major urban areas increased from around 30 million in 1989 to more than 140 million people in 2008. Another estimate puts the total movement of rural people to urban centres in China at 278 million people between 1979 and 2003.

Source 8.9 Square inside the Forbidden City, Beijing



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Source 8.10 A village and rice terraces in Guangxi province, China

A number of key factors help explain why this large movement of people has occurred:

- **A lack of employment in rural areas** – in rural areas, it is difficult to maintain a constant income with variables such as drought and other natural disasters restricting employment prospects. Therefore, people are seeking more stable and higher incomes in urban areas.
- **Income gain** – people are moving to urban areas to find employment that will give them a higher wage. In 2011, the average net income of a rural worker was 6977 yuan (A$1073), while the average net income for an urban worker was 23 979 yuan (A$3643).
- **Working conditions and employment** – jobs in rural areas tend to involve manual labour, working outside in all seasons. These are very tough working conditions, whereas work in urban areas tends to be in service or manufacturing occupations, which usually involve less physical strain.
- **Access to services** – this is an important factor, especially for parents with children, who want to be able to give their children better access to educational institutions such as schools and universities.

Where is the internal migration in China occurring?

China is a large country with a large area, divided into **provinces**, as shown in Source 8.11.

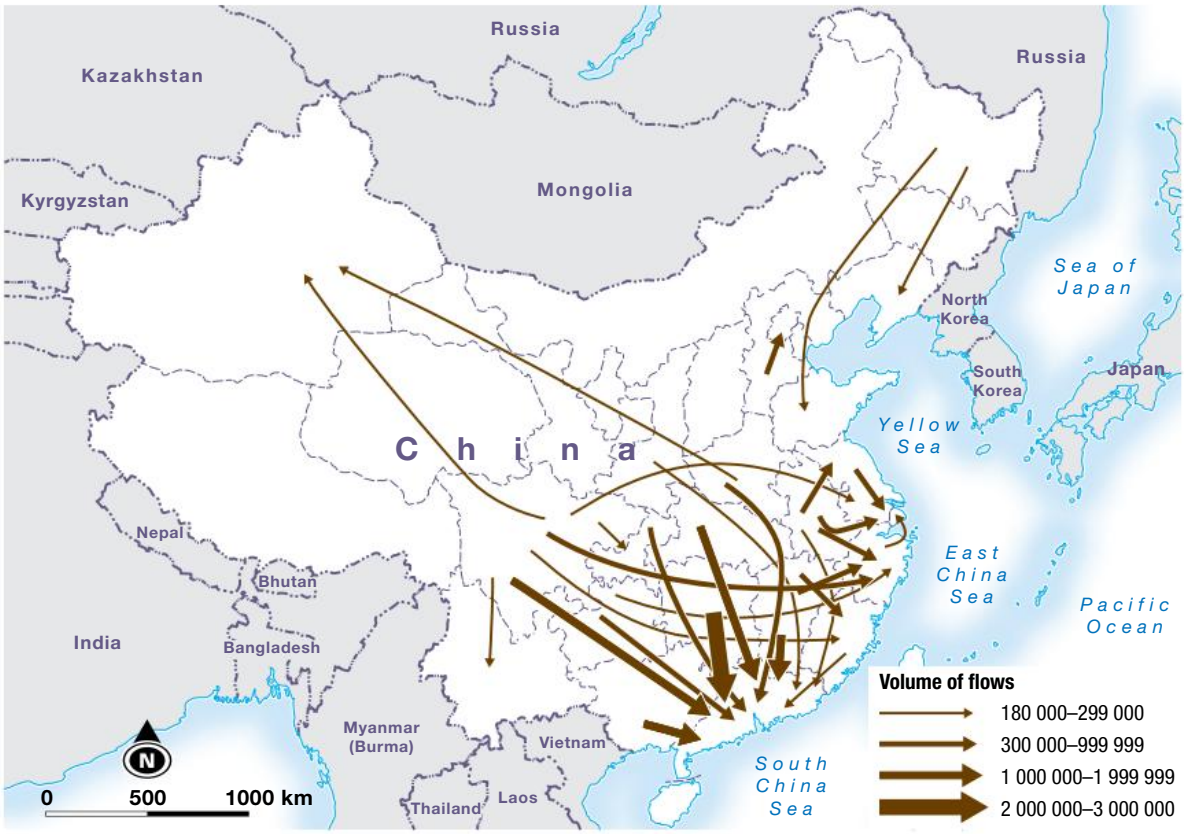
province an area within a country or state

Most of the internal migration that occurs in China is based around a large movement of people from the central areas of China towards the coastal areas, especially in the south-east of the country. This is illustrated in Sources 8.12 and 8.13, which indicate the internal migration flows in 1995–2000 and 2000–2005.

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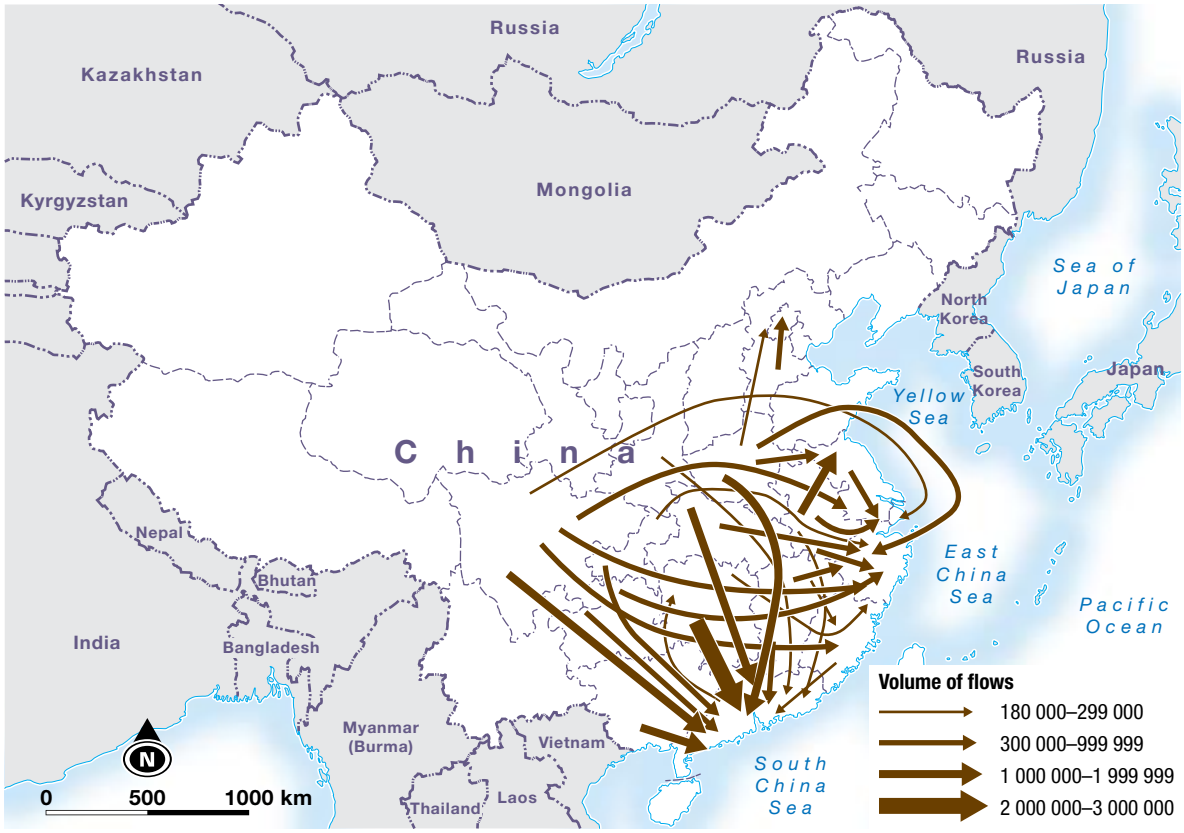


Source 8.11 China's many provinces



Source 8.12 Chinese internal migration, 1995–2000

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Source 8.13 Chinese internal migration, 2000–2005

These figures clearly show that the largest numbers of people moving within China over this period are from the Henan, Hubei, Hunan and Sichuan provinces. The destination for these internal migrants has been Guangdong province.

ACTIVITY 8.3

1. Imagine you are a young parent with an infant child who has moved to the Guangdong province from rural China. In a paragraph, explain the reasons why you moved.
2. Taking into account Sources 8.12 and 8.13, try to construct a similar migration map for Australia using Source 8.11 and other information in the chapter.
3. Discuss briefly how drought and other natural disasters restrict employment prospects in rural areas.

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Case study 8.2

China and its ethnic minorities: a brief overview

ethnic group a collection of people sharing the same nationality, religion, culture or language

minority a smaller section of the population, sometimes experiencing discrimination

China is a country of many different landscapes, climates and people. It is a nation of 56 **ethnic groups** that, while very different, largely get along. Like many places in the world, China is faced with the challenge of deciding its national borders while still recognising where people of different ethnic backgrounds traditionally have lived. Most Chinese people are from the Han ethnic group. They account for 91.6% of China's 1.35 billion people, and can be found in every region of the country. China's other 55 ethnic groups generally are referred to as the national **minorities**. The smallest group, the Hezhen, with fewer than 2000 people, lives in the far north-east. At the National People's Congress (NPC) in March 2013, the governing Communist Party emphasised how China's 55 ethnic minorities and the Han majority live in harmony.

According to the 5th national census in 2000, the national minorities that have a population of over 1 million include the Zhuang, Manchu, Hui, Miao, Uygur, Yi, Tujia, Mongolian, Tibetan, Bouyei, Dong, Yao, Korean, Bai, Hani, Li, Kazak and Dai, totalling 18 ethnic groups. The Zhuang ethnic group has the biggest population of 16.179 million. There are 17 ethnic groups with a population of between 100 000 and 1 million, including the She, Lisu, Gelo, Lahu, Dongxiang, Va, Shui, Naxi, Qiang, Tu, Xibe, Mulam, Kirgiz, Daur, Jingpo, Salar and Maonan. Another 20 ethnic groups have a population of between 10 000 and 100 000:



Source 8.14 Yunnan is China's most ethnically diverse region.

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the Blang, Tajik, Pumi, Achang, Nu, Ewenki, Jing, Jino, Deang, Ozbek, Russian, Yugur, Bonan, Moinba, Oroqen, Drung, Tatar, Hezhen, Gaoshan (excluding the population of the Gaoshan ethnic group in Taiwan) and Lhoba. The Lhoba ethnic group has the smallest population at just 2965 people.

The national minorities live all over China and can be found in approximately 64.3% of the country, mainly distributed in the border areas of the north-east, north, north-west and south-west.

Yunnan province, home to more than 20 ethnic groups, has the greatest diversity of ethnic groups in China. This has taken place over China's long history. The Chinese philosophy is to have different ethnic groups 'living together in one area, while still living in individual compact communities in special areas'. This idea continues to help the Han and the various minority groups make political, economic and cultural decisions, including the management of the **regional** ethnic **autonomy** system. However, the reality is sometimes very different. More than 100 ethnic Tibetans have set themselves on fire – many fatally – since 2009 to protest state policies and request the return of the exiled spiritual leader, the Dalai Lama.

regional relating to a particular geographic region, for example the Asian region, comprising East Asia, Southeast Asia, South Asia, etc

autonomy independence or freedom

The main religions in China are Buddhism, Taoism, Islam, Catholicism and Protestantism. Officially, the people of China may freely choose and practise their religions. Statistics suggest that there are over 100 million followers of different religions, more than 85 000 sites for religious activities, some 300 000 clergy and over 3000 religious organisations throughout China. There are also 74 religious schools and colleges run by religious organisations for training clerical personnel.

The ABS classifies Chinese people as a single group. However, those in Australia come from many different nations, such as Mainland China, Hong Kong, Macau, Taiwan, Indonesia, Malaysia and Singapore. The latter 3 countries are recipients of the Chinese **diaspora** in Asia.

diaspora people of a particular nationality who live outside their country of origin

1. Compare the cultural diversity in Yunnan province, China with Australia's cultural diversity.
2. Research and write about the religion, customs and traditions of the Hmong or another ethnic group from Yunnan, some of whose members have made Australia home.
3. Recall how many ethnic groups live within the nation of China.

Source 8.15 Village on the red field in Dongchuan district, Kunming city, Yunnan province, China



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How global economic connections are shaping China's geography

While China historically has been a great **trading nation**, communist China was relatively isolated from the rest of the world until the late 1970s, when **special economic zones** were created in many coastal cities to encourage trade and manufacturing. These zones allowed foreign investment, and their coastal locations made trade with other countries convenient. Within 30 years, China's economy grew to the point where it was the largest **manufacturer** in the world in 2010, responsible for almost 20% of all goods produced globally. This transformation has had a wide range of impacts on the geography of the country.

trading nation a nation with an economy that greatly benefits from the export of goods to other countries

special economic zone region that has conditions designed to ensure competitive trade between countries

manufacturer maker of goods

Increase in standards of living

As the economy of China has grown, so has the standard of living. Average **wages** have increased to 10 times those of 1978. Life expectancy has also increased, and the Chinese health system is comparable to those of many more developed nations. It has also led to the emergence of the 'super-rich' in China, a class of people whose wealth far exceeds that of the average population.

wages payment to employees for work

Geographical fact

Shanghai has around 123 000 millionaires – more than any other city in the world.



Source 8.16 In 20 years, this small coastal town has developed into a city of more than 1.1 million people.

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Mass urbanisation

air pollution substances in the air that affect the health of humans and the environment

vegetation trees, shrubs and other plants

In 1950 only around 15% of China's population lived in cities. As more and more people from rural areas migrate to cities, especially in special economic zones, that figure is predicted to be 90% by 2030.

The rapid growth of cities in China is causing considerable concern to environmentalists, as issues such as **air pollution**, rubbish disposal and a lack of **vegetation** impact on the quality of life of residents.

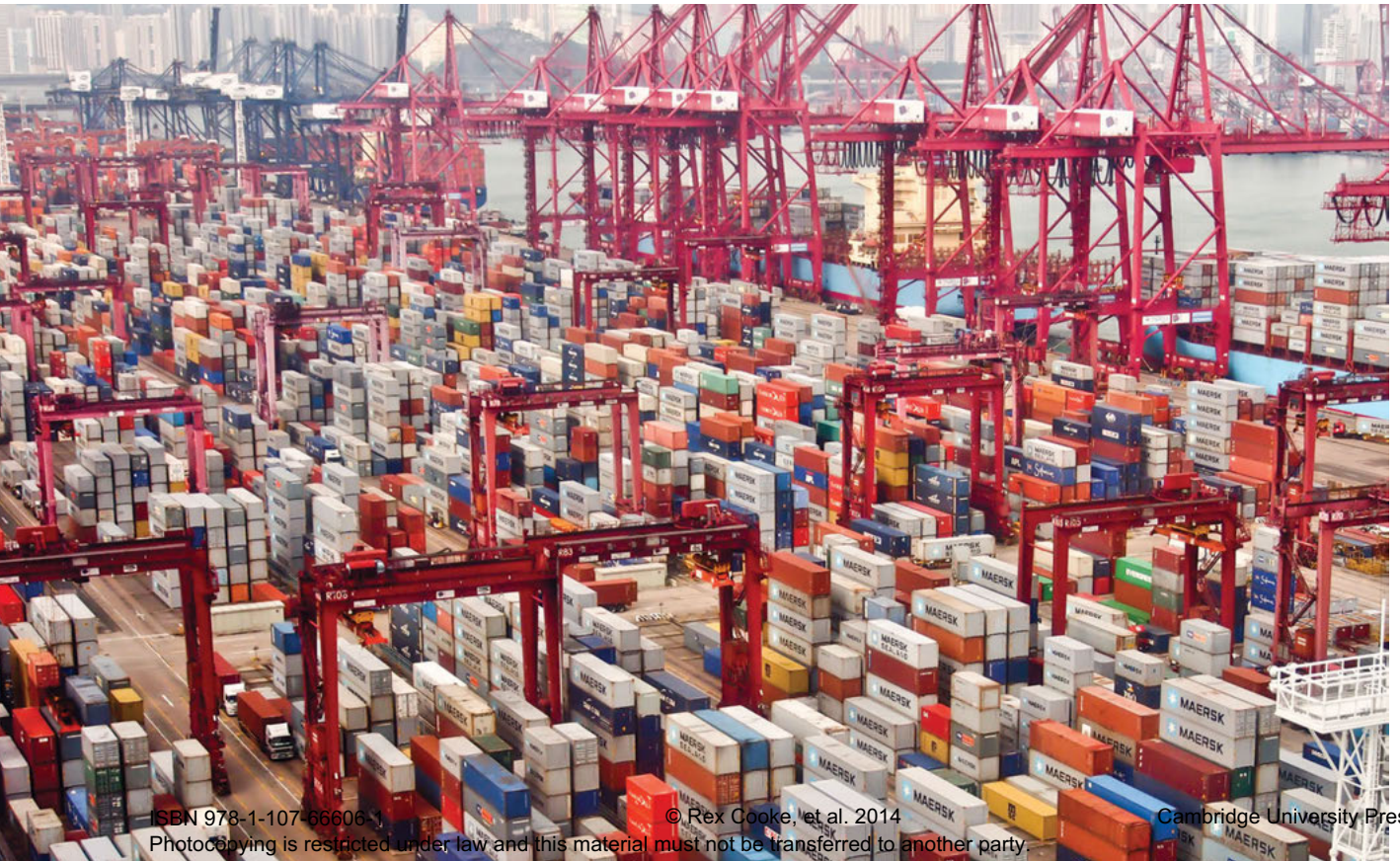
Development of global hubs of trade and transport

As a result of China's huge export market, ports such as Hong Kong have become vital hubs in the transport of goods. Hong Kong has the world's busiest cargo airport, and its sea port is the third busiest in the world. Six of the world's 10 busiest ports are located in China.

ACTIVITY 8.4

1. Describe 1 way in which both China and Australia are shaped by their global connections.
2. Evaluate whether the ways in which places are shaped by these connections are always positive. Provide evidence from the text to support your answer.
3. List the goods in your home and at school that are manufactured in China, and outline what types of products they are.

Source 8.17 Hong Kong's busy port links China's factories to the world.



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8.5 What China's economy does and why

China's economy is very different from Australia's. It is largely focused on manufacturing goods (although it does have a growing services sector). For a long time, these goods were basic items such as clothing or plastics that did not require much technology, but now China has thousands of factories producing high-technology goods such as computers, mobile phones and planes.



Source 8.18 An earphone factory in Shenzhen, China



Source 8.19 Technology fair, 2012, Shenzhen, China

Why does China enjoy a comparative advantage in manufacturing?

comparative advantage in economic terms, the strength of one country over another to provide goods at a cheaper price

China is the world's largest manufacturer of products. There are a number of reasons why the nation maintains a **comparative advantage** in this area (see also Source 8.20 on the next page):

- low wages
- a large domestic market
- factories being subcontracted by western companies
- less strict rules and regulations in worker welfare and health and safety.

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Low wages
The average minimum wage in China is about $2000 per year. This compares to the minimum wage in Australia at just over $20 000. This allows Chinese factories to spend far less on wages, which enables them to charge less for their products, giving them a massive comparative advantage. As China continues to develop, wages will rise, reducing the impacts of this advantage.

Large domestic market
China's huge population of about 2 billion provides a large market to sell products to. This allows factories to produce on a larger scale, making them more efficient and cheaper. As the population of China gets richer this advantage will become even more important, as they will be able to buy more products.



China's comparative advantage

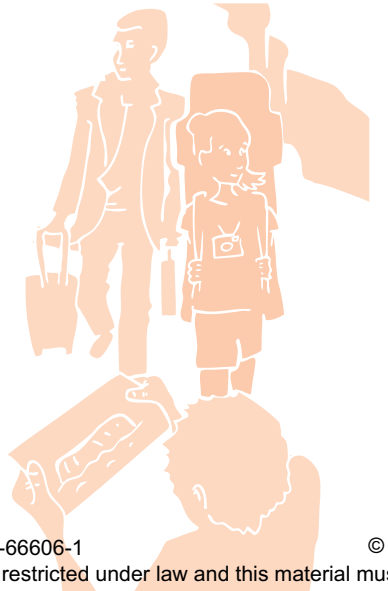
Factories being subcontracted by western companies
Many of the factories in China are not owned by the companies whose products they make. For example, a Chinese bicycle factory may make bikes for several of the big western bike companies. This means they can concentrate their activities on manufacturing and not on more expensive design and innovation. This also give manufacturers greater flexibility.

Less strict rules and regulations in worker welfare and health and safety
Chinese industrial areas do not have the same strict rules as many developed countries in areas such as workplace safety and environmental regulations. This means money is not always spent on reducing pollution or training workers in safe practices. This makes their products cheaper than in places where these rules exist.

Source 8.20 Comparative advantages of China

8.6 How has manufacturing led to regional growth in China?

In the same way as Australia's population has increased in areas where mining occurs, China has also seen dramatic growth in regions where manufacturing is focused. Much of this growth is from rural-to-urban migration, where people are leaving farming areas to work in cities – especially in the special economic zone.



What are the negative impacts of this interconnection with China?

While it is clear that China's demand for natural resources has brought economic benefits to many regions in Australia, there are aspects of the economy and the environment that have suffered as a result.

As we have seen, the Chinese economy has a huge comparative advantage in terms of wages and working conditions. This has caused many Australian manufacturing companies to either close down or move their manufacturing overseas. Areas of cities based around manufacturing have seen increased unemployment as a result. Pacific Brands, the company that makes Bonds underwear, has moved its manufacturing to China in recent years, costing Australia 1800 jobs.

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Damage to the environment

Despite strict environmental controls, as the number of mines grows – often in remote, pristine areas – the environmental damage that occurs inevitably increases. Mining is also an activity that uses high levels of water and produces large amounts of carbon dioxide.



Source 8.21 A uranium mine in the middle of Kakadu National Park, Northern Territory

RESEARCH 8.2

Divide the class into groups of 3 students. The groups will take part in a role-play radio debate about the state of Australia's economy and the role of foreign-owned businesses and the bilateral trade relationship with China. All 3 students in the group must work together to complete additional research and statistics that build on the content in this book to provide a strong argument for both sides of the debate.

- One student is representing the Australian government, and is to argue that these relationships have been good for the economy.
- Another student will take on the role of a workers' representative in an area where unemployment has occurred as a result of these relationships, and is concerned about the power of overseas interests.
- The final member is the radio host, responsible for asking appropriate questions and linking the debate together.

The debates should be recorded and marks awarded for good communication, appropriate questions and understanding of the main issues.

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Case study 8.3

Regional growth in Guangdong province

Guangdong province is located in the south of China, close to the island of Hong Kong. Its main city, Shenzhen, has grown dramatically since the region became a special economic zone in 1979, with its population rising from 200 000 to around 11 million people today, making it one of the world's largest cities.

The city has received over $30 billion in foreign investment over that period, with companies setting up hi-tech manufacturing factories to take advantage of cheap labour and low taxes. Some 140 of the 500 biggest companies in the world have offices or factories in the region. As China's domestic companies grow in size and wealth, many are choosing to relocate to Shenzhen.

To export the vast array of products manufactured in Guangdong province, the port at Shenzhen is now the 4th busiest in the world. Goods from the region are transported all around the world, including to Australia.

1. Explain why foreign companies have been attracted to locate to Guangdong province.
2. Suggest what problems the rapid population growth in this city may have caused for the region.
3. Recall how busy the port of Shenzhen in Guangdong province is.

Source 8.22 The city of Shenzhen



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8.7 Economic, environmental and social effects of internal migration

Internal migration has many varied effects on countries. Positive effects include increased employment, population growth and economic development. However, there are negative effects of internal migration, such as environmental destruction, overly rapid population growth and exploitation of workers.

Economic effects

The internal migration and movement of people has a range of economic effects. With people moving from one location to another, a number of economic transactions take place that create a flow of goods and services. For example, the most common form of internal migration in Australia is rural-to-urban migration. When someone moves from a rural location, a range of economic transactions takes place, with the sale of houses and goods, a loss of skills, and the loss of spending by that person in the rural area. Therefore, the economic impact on rural areas can be very detrimental as more and more people leave, shrinking the local economy. The more people who leave an area, the greater the economic impact on the rural area – and with decreased services in rural areas, it is very hard to attract new families to replace the people who have left, thereby creating further economic stress on rural areas.



Source 8.23 Buying and selling houses is an economic effect of internal migration.

Rural-to-urban migration has a positive impact on the urban areas to which the internal migrants move. These migrants will need to buy or rent accommodation, they will need to purchase

Source 8.24 Large numbers of internal migrants move to the Gold Coast each year, so the government has to ensure that it has sufficient infrastructure to cope with the demand.



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government services fundamental services provided by the government, such as law enforcement, education and health care, considered to be necessary for the functioning of society

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services, education systems, waste disposal systems, telecommunications

goods and services and, most importantly, they will need employment. All these factors create an economic gain for the urban area, which allows it to provide more services for the population.

Another economic effect of internal migration is the allocation of **government services** and **infrastructure**. With greater movement of people towards major urban areas, governments have to redirect the funding that they allocate to these areas to ensure they can meet the needs of the redistributed population. This can be detrimental to rural areas because people moving away means less funding from governments, and this can ultimately lead to cutting back of services to those areas.

Environmental effects

Internal migration of people also raises some major environmental issues. Shanghai, China's largest city, has experienced rapid population growth, which has raised a number of environmental concerns. Shanghai's population has grown from 10.8 million people in 1975 to 23.47 million people in 2011, which is a 12.67 million increase in 36 years. Additionally, the land area of Shanghai has increased dramatically to accommodate the growth of in the population. In 1975, the urban area covered 159 ha^2; by 2011, this had expanded to 6340 km^2. However, this rapid increase in population and associated expansion in land area, which has been driven by internal migration to the city, has created a **degradation** of air and water quality, changes in **biodiversity** and local climate changes.

degradation a loss of quality

biodiversity the variety of life forms and the interaction between them in a given area

The degradation of air in Shanghai has been attributed to the burning of coal for electricity production and the exhaust fumes from the many additional private motor vehicles within the city – in 2011, there were about 1.95 million private cars in Shanghai. In an effort to control the number of cars in Shanghai, the government has placed a **quota** on the release of number plates every month. The loss of biodiversity has been associated primarily with the urban expansion of the city and increased human activities. The number of native plant species has declined as a result of the **urban sprawl** of the city. For example, in the Sheshan area of Shanghai there has been a

quota a specific number that must be achieved or not exceeded

urban sprawl the gradual spread of cities into previously rural areas due to population growth



Source 8.25 Aerial view of Shanghai, China's largest city



Source 8.26 Traffic congestion in Shanghai is a major cause of environmental damage

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Source 8.27 The vast urban area of Shanghai has created a number of issues with the biodiversity of plants and animals.

50% decrease in the number of native species. Additionally, there has been a dramatic increase in the introduction of non-native plants; this has had a major impact on the biodiversity of the area. In response, the government has established nature reserves and forested parks in an attempt to preserve and maintain the biodiversity of the region.

Social effects

Social effects of internal migration have a range of influences across sectors of the community. This movement of people affects the population structure of a town. Most people who migrate are in the younger age groups (the 18–40 age bracket), which leaves the areas from which migrants are drawn with a much older average population. The large numbers of people moving puts pressure on businesses and services because they find it hard to get people to fill employment positions in smaller towns or cities.

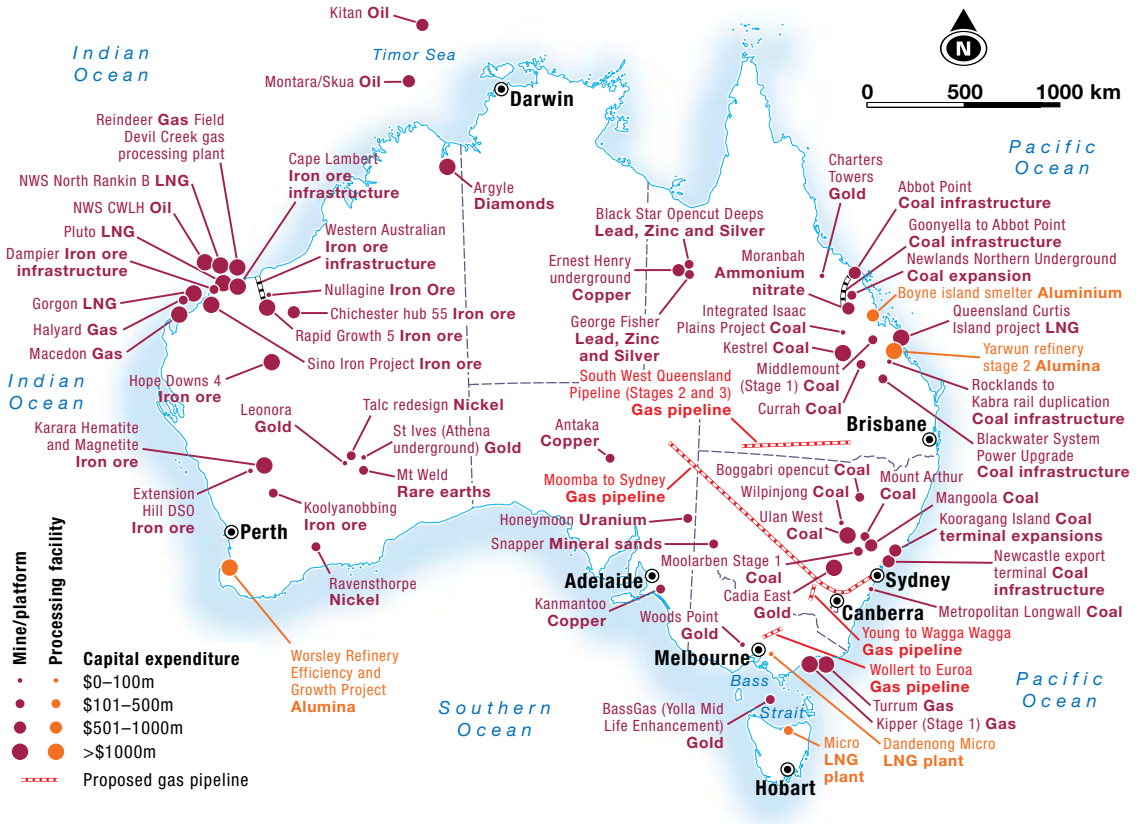
ACTIVITY 8.5

1. Summarise what you think are the most positive effect and the most negative effect of internal migration for the city that receives the internal migrants.
2. Explain why the government in Shanghai placed a quota on the release of number plates every month.
3. Suggest ways in which your city could lessen the negative impact of internal migrants and could improve the positive impacts.

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8.8 How has mining led to regional growth in Australia?

In Australia, most growth has occurred near the large cities as people have moved from rural areas and overseas to these areas for work, education or services. However, the mining boom has reversed this trend in some areas of regional Australia, as jobs are created at or close to mining sites. Most of Australia's recent mining sites and infrastructure projects are located in regional areas that are many hundreds of kilometres from Australia's largest cities. This has led to regional growth in these areas.



Source 8.28 Map of Australia's recent mining projects

How agriculture, mining and tourism activities have positive effects in both regions of production and cities in Australia

Mining occurs more often in regional areas of Australia, often well away from cities. Agriculture and mining are both activities vital to our economy that occur in rural regions. Despite this, these industries also bring a wide range of benefits to cities.

Agriculture

Agriculture covers a wider area of Australia than any other industry. Livestock, dairy, wheat production and **viticulture** are all significant contributors to the local economy. These industries often sustain small rural towns and cities, and provide a range of manufacturing and service jobs. For example, in many regions where livestock farming occurs, the local town may be home to **abattoirs** and meat-processing

viticulture the practice of growing grapes

abattoir place where animals are killed for human meat consumption

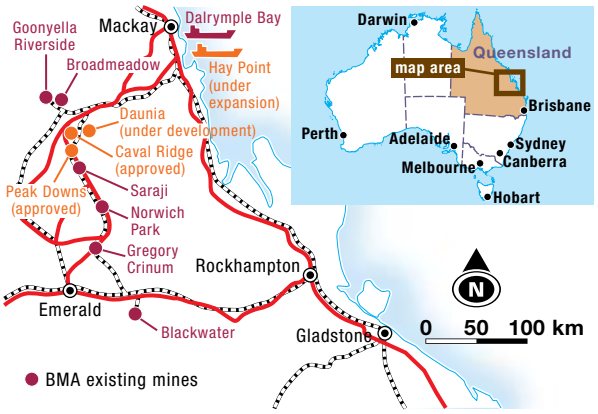
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Case study 8.4

Regional growth in central Queensland

Central Queensland is one of Australia's most important mining regions, with 47 coal mines located in the Bowen Basin alone. Gas has also been discovered in the area, and is being extracted in large quantities. The port city of Gladstone exports 50 million tonnes of coal each year, and is home to the world's largest alumina refinery. Upgrades to road and rail networks have also occurred.

As these mining areas were created, the population of these areas grew dramatically. Most of this was through interstate migration, as people looked for employment in the mining industry. Growth in this area has been around 1700 people a year over the last 10 years. While this may not seem a large number of people, this growth is more than double the average for Australia. To accommodate these workers, a large number of new homes have been built, which brings more money into the local economy.



Source 8.29 Map of mining area in central Queensland

1 Describe 3 sources of employment in central Queensland.

2 Identify where most of these workers have come from.

3 List 2 benefits to the existing population of this region as a result of the mining boom.



Source 8.30 Coal being loaded on to ships in the port of Gladstone

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factories. Other businesses in these towns may provide services that assist farmers, such as repairs to machinery or veterinary services.

These benefits are also passed on to cities. Supermarkets, butchers and food companies will employ large numbers of people, selling the goods that originated in that local area.

Case study 8.5

Viticulture in the Barossa Valley, South Australia

Viticulture is the growing of grapes to make wine. The Barossa Valley is Australia's most famous wine region, and is known internationally for the quality of its product. Nearly 100 000 tonnes of grapes are grown in this region each year, and around 1000 people are employed in grape growing. However, this industry also provides a wide range of other opportunities for work in the area, with a large number of grape-processing plants and wineries located in the region. Another 520 000 tonnes of grapes and other fruit are imported into the region and processed in the local plants. These plants and wineries employ about 2000 people.

Tourism is also very important to the area, as visitors visit wineries, eat in restaurants and stay in local accommodation. They are estimated to spend over $100 million per year on these activities, significantly benefiting the local economy.

Adelaide, located around 60 km south of the Barossa Valley, also benefits as a result of its wine industry. Many international and domestic tourists fly into Adelaide, boosting the local economy because many choose to also spend time in the city. Adelaide is also home to bottling plants and exporters of wine, which operate through ports in the city.

1. List the ways in which viticulture in the Barossa Valley benefits the local region.
2. Deduce how the city of Adelaide benefits from viticulture in the Barossa Valley.
3. The Barossa Valley is Australia's most famous wine region, and is known internationally for the quality of its product. Recall how many tonnes of grapes are grown in the Barossa Valley each year.

Source 8.31 Vineyard in the Barossa Valley



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Mining

This chapter has already explored in some depth the ways in which mining has led to regional growth, which in turn benefits local economies. This increase in the number of workers in areas that are often sparsely populated can bring large injections of money to local businesses. Mining services, such as transport companies and surveyors, are also likely to benefit regions where mining is occurring. Specialised manufacturing of highly technical or bulky equipment may also take place in these regions.



Source 8.32 The headquarters of mining companies in Perth

The benefits of mining also flow through to large cities located in the states where mining occurs. The 270 mines that operate in Western Australia have had a major impact on Perth. Mining royalties paid to the state government have improved infrastructure and the building industry has boomed, as many miners who live temporarily in mining areas build homes in Perth. Mining companies have also set up headquarters in the city, providing employment for a range of workers.

Tourism

Tourism is often a vital aspect of economies in regional areas. Locations such as Alice Springs, north Queensland and the east coast of Tasmania rely on tourism to bring money into the region and provide employment. Tourism can also benefit manufacturing and primary production in these areas. Tourists often want to buy goods manufactured locally, and eat produce grown in the region. Cities also benefit from tourists heading to these regional destinations. Hotels and tourism businesses purchase supplies from manufacturers in cities, and many tourists (particularly international visitors) fly in via these cities to visit the regions.

Alice Springs

Alice Springs in central Australia attracts about 600 000 tourists every year. Many of them are international tourists, who are flying in to experience the unique cultural attractions and to visit Uluru. Tourists visiting Alice Springs are likely to spend money on Indigenous artworks and souvenirs, benefiting local manufacturing in these areas.

Mined precious stones, such as opal and other gems, are also sold in the city, helping locals, while local produce is served in many restaurants and cafés. The area has improved its infrastructure partly as a result of tourism, including a major airport, **recreational facilities** and a range of cultural centres.

recreational facilities programs and structures, such as libraries and parks, that provide enjoyment for communities



Source 8.33 Camel riding tours are a favourite tourist attraction in Alice Springs.

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RESEARCH 8.3

Explore a tourism region in your state and write a short report highlighting the main ways in which tourism benefits the area. Collect secondary research findings on visitor numbers and trends from the Tourism Australia website and look for other articles on tourism in the area. Interview locals employed in tourism in the region and find out where the visitors come from, how long they stay and what they spend their money on. Then identify 1 negative impact of tourism in the area.

8.9 Areas changing as a result of resource extraction

The introduction of mining to an area can lead to a range of economic, environmental and social impacts. While many of these impacts are positive, there are a range of negative impacts in areas where mining for resources occurs.



Infrastructure
As well as roads, electricity and water supplies, mining companies often invest in local recreational facilities, while increased taxes at a local level can provide a range of services not always found in regional areas.

Source 8.34 Golf course in the desert: revenue from the Olympic Dam site allows Roxby Downs to have its own irrigated golf course.

Jobs
Employment is provided to areas where mining occurs, both in the mine and in the businesses that support the mining industry. This may keep people from leaving rural areas. Salaries in mining are also high, with some truck drivers earning over $100 000 a year.



Source 8.35 Mining provides a range of jobs.

HOW MINING CAN BENEFIT AN AREA

Money entering the economy
Mining companies may need to use local suppliers to provide a diverse range of products and services in areas where mining is being carried out. Well-paid workers may also spend their wages in local businesses, benefiting the local economy.



Source 8.36 A hotel in Kalgoorlie. Western Australia benefits from miners spending money in the town.

Increased house prices
House prices in mining towns can increase dramatically when mining occurs, as there are often very few houses and mine workers can afford to pay high prices. However, while this may be good for home-owners, who can make a profit, it may be bad for those from the area trying to buy a first home or rent a property.

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Ecological impacts

open-cut mining (also known as open-pit or open-cast mining) extracting rocks from the earth from an open pit

strip mining the removal of resources (usually coal) found close to the Earth's surface by the removal of overburden along a long line and then mining by open-pit operations

The nature of mining means that flora and fauna are destroyed. **Open-cut mining** and **strip mining**, whereby large areas are mined on the surface, can cause severe loss of habitats. Many mining companies set up revegetation programs to counter this issue. Dust and water pollution can also occur if mining sites are not managed carefully.



Source 8.37 Natural environments damaged as a result of copper mining in Tasmania

HOW MINING CAN HAVE A NEGATIVE EFFECT ON AN AREA

Changes to population structure in mining areas

Mining can change the structure of a population in a region. Although more women are working in the industry, more males are still employed in mining, which can lead to situations where there is a gender imbalance.



Source 8.38 Gender imbalance in mining

The short-term nature of a mine

Mines are usually planned and designed to last for periods of about 20 to 30 years. This means that any investment in a town and its facilities is likely to exist only for a relatively short period of time. What happens after the resources have gone is a concern for many who live in mining regions.

RESEARCH 8.4

Locate a mining project in your state and use newspapers, books and the internet to research the impacts of the mine. Draw a poster examining the positive and negative impacts and use the terms 'social', 'environmental' and 'economic'.



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8.10 What happens when the resources run out?

As we have seen, mining is a relatively short-term form of economic activity, with many mines only planned to last between 15 and 30 years. So what happens to communities when the resources run out?

Case study 8.6

Wittenoom, Western Australia

From 1940 to 1960, Wittenoom in north-western Australia was home to Australia's only blue asbestos mine. At the height of its popularity, over 150 people lived in the town and it was the biggest in the region. Despite this, the mine was never very profitable and when the losses from the mine increased, along with health concerns about asbestos, the mine was closed down in 1966. Wittenoom lost its town status in 2006 and now only 6 people live in the area.

The area still has a campsite and a gem store for tourists but, as a result of the dangers associated with asbestos and the remote location of the site, very few people have heard of, let alone visited, the former town of Wittenoom.

Many are concerned that, as the mines constructed during the recent mining boom close down, many rural communities will face a similar fate to Wittenoom. Other settlements, where farming was carried out, are concerned about their traditional economies disappearing, with skills being lost and families not being able to continue farming their land into the future. It is clear that, for many of these rural areas where mining is occurring, a diverse economy – with agriculture and tourism as well as mining – is required for long-term sustainability.

1. Articulate why Wittenoom's mine closed down.
2. List 2 reasons why the town declined after the removal of mining.
3. Recall what the years were during which Wittenoom was home to Australia's only blue asbestos mine.



Source 8.39 What remains of the petrol station at Wittenoom

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Case study 8.7
Fly-in fly-out (FIFO) workers

Fly-in fly-out (FIFO) is a way of placing employees into a remote area. Often there aren't communities in the region where workers can live, or the communities aren't of sufficient quality to attract families to live locally.

Many mining companies have decided it is cheaper to fly workers in for a shift of 2 weeks or so, and then fly them out again at the end of the shift. During their time at the mine, workers live in on-site accommodation. This means workers do not buy or rent property, and are less likely to spend money in the local economy, limiting the benefits of mining in the area.

Who employs fly-in fly-out workers?

There are currently about 200 000 people employed as fly-in fly-out workers in the mining industry in Australia. The mining industry operates in some very remote and isolated areas of Australia, where there are very few established settlements, towns or cities, and therefore no available local workers for the mines. The mines then bring in the workers, many of whom work up to 4 weeks away from home, for pay rates that are usually at least double those in the major cities.

With the increasing demand for Australia's mineral exports, there is a growing need for workers to fill new jobs being created by the development of new mines in rural and remote areas. According to the Australian Mines and Metals Association (AMMA), about 80% of mining workers are employed on a fly-in fly-out basis, and the workforce of 200 000 will only increase. Additionally, AMMA believes that there will be a demand for another 100 000 workers to fill skill shortage areas within the mining industry, particularly **engineers** and **geologists**.

The only way for these workers to reach such remote locations is for them to fly. This has created issues for governments, because they have had to upgrade a large number of regional airports to cater for the increased flights and the people who now use them as a result of the mining in the area. According to the federal Department of Infrastructure and Transport, from 2001 to 2011 flights from Brisbane to mining towns jumped 582%, and from Perth they grew by 713%.

engineer a professional employed to develop systems, buildings and materials

geologist a scientist who studies the composition of the Earth's surface and interior; its rocks and fluids, how they were formed and how they may be useful to people

Source 8.40 A fly-in-fly out mining compound at a coal mine in Queensland – note the runway next to the mine to the north.



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Source 8.41 Coal miners are often employed as fly-in fly-out workers.



Source 8.42 Mine workers are employed on a range of shifts, and often have to work throughout the night.

Effects of fly-in fly-out workers

Fly-in fly-out workers make a number of impacts – both socially and economically. A positive economic effect is that a fly-in fly-out workforce will prevent an oversupply of houses and infrastructure in the mining town when the boom or the mine finishes. An example of this is in the Pilbara in Western Australia and the Bowen Basin in Queensland, which have a much greater proportion of fly-in fly-out workers and a much smaller share of permanent residents. About 30% of all the people in these areas were fly-in fly-out workers in 2011, compared with 15% in 2006 and 4–5% for other towns.

However, a negative economic effect for the mining town is that, by using fly-in fly-out workers, the towns receive little financial benefit from the nearby mining projects because the workers don't live in the town, and therefore spend little money in the town. The Mt Isa City Council is opposed to the use of fly-in fly-out workers, believing that regional towns across Queensland are emptying out because of the growing trend for miners to travel to work while their families live on the coast. They want the government to implement tax breaks to encourage workers to live in mining towns.

A negative social impact is the strain that fly-in fly-out work puts on families and relationships. There is a high turnover in workers who work as fly-in fly-out workers, with 1 in 3 mine workers not lasting 12 months in the job. The main issue is the separation of the workers and their partners and families. The absence of workers for up to 4 weeks from their families and partners places a lot of stress on families and partners who have to run a household and family on their own for extended periods of time.

1 Explain why a company would choose to employ fly-in fly-out workers.
2 Explain why a worker in the mining industry would choose to be a fly-in fly-out worker rather than be permanently based near their work.
3 Imagine you are the mayor of a community that receives a lot of fly-in fly-out workers. Construct a plan to share with your class of how you would attract the workers to stay in your community permanently, using what you have learned about push and pull factors.

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8.11 Aboriginal and Torres Strait Islander peoples' population mobility

millennia thousands of years

marooned abandoned on an isolated island with little hope of rescue or escape

convict a person found guilty of a criminal offence and serving a sentence of imprisonment

indentured labourer a worker, typically a labourer or tradesperson, under contract for a fixed period of time in return for payment of travel expenses and accommodation

displaced person someone forced to leave their home country because of war, persecution or a natural disaster – a refugee

Aboriginal Australia is a product of a unique blend of established traditions and new influences. The country's original inhabitants, the Aboriginal and Torres Strait Islander peoples, are the First Nations custodians of one of the world's oldest continuing cultural traditions. These peoples have been here for **millennia**. On the other hand, migrants – both voluntary and forced (**marooned** seafarers and the slaves they had on board, **convicts**, **indentured labourer**, **displaced persons** and **refugees**, including **boat people**) – only began making Australia home by chance from 1629, and as 'official' settlers from 1788.

On 8 March 2013, the resident population of Australia stood at 22 941 155 people. Australia's inhabitants comprise two distinct categories: Aboriginal and Torres Strait Islanders; and forced and voluntary migrants (and their descendants) from source countries around the world. Many are **naturalised Australians**.

refugee a person who has left their own country because of fear for their safety and wellbeing

boat people refugees arriving by boat

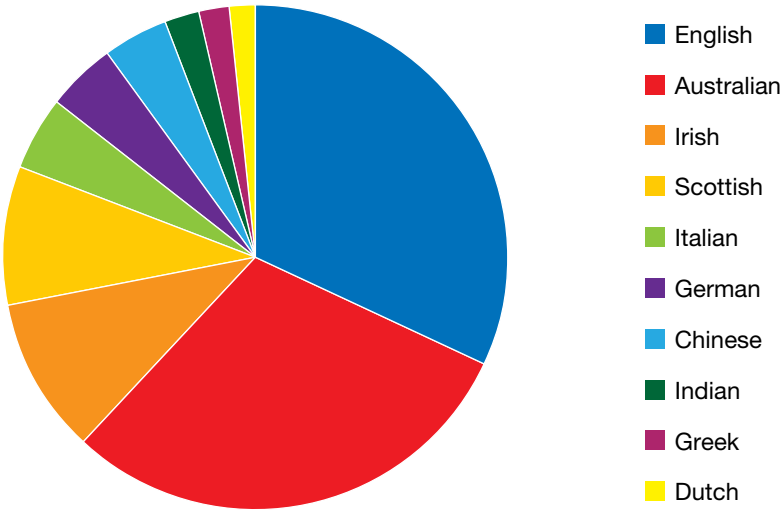
naturalised Australians individuals born outside Australia who have become Australian citizens

Australia's descendants from the colonised population since 1770 and settlers from 1788, along with today's migrant populations, collectively speak about 400 different languages and identify with about 300 ancestries. More than a quarter of the population were born in one of over 210 overseas countries. Two out of every 5 people have at least one parent born overseas (see Source 8.43).

Source 8.43 Selected characteristics of ancestry groups

Ancestry	Generations in Australia					
	Persons	Proportion of total population	First generation	Second generation	Third-plus generation	Also stated another ancestry
	000	%	%	%	%	%
English	7238.5	36.1	18.5	20.1	61.4	53.5
Australian	7098.5	35.4	2.0	18.3	79.6	38.5
Irish	2087.8	10.4	12.9	13.9	73.2	80.4
Scottish	1792.6	8.9	17.1	19.1	63.8	78.3
Italian	916.1	4.6	24.1	41.0	34.9	44.3
German	898.7	4.5	17.3	19.8	62.9	75.4
Chinese	866.2	4.3	74.3	21.3	4.4	16.2
Indian	390.9	2.0	79.8	18.6	1.6	12.9
Greek	378.3	1.9	30.9	44.8	24.3	26.2
Dutch	335.5	1.7	32.5	43.3	24.2	55.1

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Source 8.44 Percentage of the population claiming a specific heritage

Geographical fact

In 2011, the ABS counted 548 400 people who identified themselves as being of Aboriginal and Torres Strait Islander origin. New South Wales had the highest count (172 600, or 32% of the national total), followed by Queensland (155 800, or 28%) and Western Australia (69 700, or 13%). The Northern Territory had the highest proportion of the population counted as being of Aboriginal and Torres Strait Islander origin (27%), and Victoria the lowest at less than 1% of the state total. The numbers of Aboriginal and Torres Strait Islanders – albeit still small – are increasing.

Two systems of information

pre-contact refers to the period before the arrival of Europeans in a particular area

linguistic relating to language

Pre-contact, Aboriginal people lived on the mainland and, until 1863, Torres Strait Islanders lived on the islands between Australia and Papua New Guinea, in what is now called the Torres Strait. We draw on the findings of two knowledge systems – western scientific, and Aboriginal oral history and **linguistic** traditions – to explore Aboriginal and Torres Strait Islander history. Combined, they provide us with opportunities to expand our knowledge and understanding.

dispossessed deprived of property and possessions

marginalised treated or thought of as less important

The government of Australia has a very poor record when it comes to treatment of its Indigenous citizens. Aboriginal and Torres Strait Islander people were **dispossessed** of their land, despised for their culture and **marginalised**, abused and murdered. British colonial settlers believed Aboriginal peoples were destined to die out.

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Pre-contact

Gondwanaland one of two supercontinents believed to have existed 510 to 180 million years ago

radiocarbon dating a technique that uses the decay of Carbon-14 to measure the age of organic material, such as leather or wood

Scientists maintain that the first Australians must have arrived by sea. Australia became an island continent when it separated from the southern super-continent of **Gondwanaland** some 80 million years before the emergence of humanity. The increasingly superior **radiocarbon dating** since the 1950s now has the earliest known occupation of Australia standing between 60 000 and 120 000 years. From that time, the antiquity of Australia exceeded the colonisation of the American continent by at least 20 millennia.

Aboriginal and Torres Strait Islander cultures developed narratives to explain the emergence of the landscape (see Case study 8.8). The information about these places was passed down by Aboriginal **oral history** and through art, song, dance, and secret and sacred traditions. Moreover, modern scientific research has proven that many of these narratives are, in fact, fairly accurate historic records. One such series of narratives explains that the Australian coastline was once near the edge of the Great Barrier Reef, which is now dozens – even hundreds in some places – of metres from the shore. Geologists have proven that this story is accurate. During the last glacial period, when sea levels were lower, Australia's coastline did extend kilometres into what is now the ocean. As sea-levels rose and we became an island continent, we lost much of the evidence of the adaptive measures of the early Aboriginal way of life, which was now covered by oceans.

oral history information about important events, traditions and individuals passed on in families and communities through spoken stories

Case study 8.8
The Dreaming

Dreaming a central concept in Aboriginal culture that explains how the world works through creation stories

The **Dreaming** is that remote time in history when creator ancestors travelled across the great southern land of Bandaiyan (Australia), creating and naming as they went. Reverence for the land and a belief in the Dreaming are central to Indigenous Australians' spiritual values and oral traditions. There were many different groups, each with its own individual culture, belief structure and language. These cultures came to overlap to a greater or lesser extent as they evolved over time. However, the Rainbow Serpent is a major ancestral being for Aboriginal people across Australia. The Yowie and Bunyip are also well-known ancestral beings. Dingo dreaming is a significant ancestor in the interior regions of Bandaiyan. The Dingo formed the songlines that cross the continent from north to south and east to west.

Today, the Dreaming refers to both the ancient time of creation and the present-day reality. The Dreaming is a complex network of faith, knowledge and ritual that dominates all spiritual and practical aspects of Aboriginal life. It laid down the structures of society, and the rules, cultural values, social behaviour and ceremonies to sustain and increase the land's fertility. Spirituality was based on a philosophy of oneness with the natural environment. Both men and women were involved in the spiritual life of the group. Complex and sophisticated **kinship systems** placed each person in relationship to every other person in the group, and determined the behaviour of an individual to every other person.

kinship system the system of social relationships that constitute kinship in a particular culture

Songlines

The Dreaming – including the regard for the land – is depicted in **songlines**, a long sequence of short verses that form a sung map of an ancestral being's creative journey. Song cycles have many verses that must be sung in the correct order. Each verse records the events of a particular

songline a sequence of short verses that form a sung map of an ancestral being's creative journey, providing a mental map of country

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site and is repeated several times. Aboriginal elders travelled along songlines with their young people, telling the stories and singing the songs of the sites, so that children acquired a mental map of their country. There are songlines that record the end of the ice age, when rising temperatures dried up the lakes of inland Australia, while rising seas drowned vast areas around the coasts. Oral traditions account for the evaporation of inland lakes and the formation of huge saltpans, and they tell of the time when all the waters of the Earth were fresh but then became salty.

Sacred rituals and sacred sites

Aboriginal **sacred sites** are areas or places in Australia of significance to Aboriginal Australians within the localised belief system. Most are somehow related to Aboriginal Dreaming. Once the ancestor spirits had created the world, they changed into trees, stars, rocks, waterholes or other objects. The 'sacred sites' of Aboriginal culture have special properties. As the ancestors did not disappear at the end of the Dreaming, but remained in these sacred sites, the Dreaming is never-ending, linking the past and the present, the people and the land.

sacred sites areas or places with cultural significant meaning to particular people, e.g. Indigenous Australians

For example, when Imberombera, the great ancestress of the Gagadju people, came across the sea to Arnhem Land, her womb was filled with children and from her head were suspended woven grass fibre bags called dillybags in which she carried yams, bulbs and tubers. She travelled far and wide, creating hills, creeks, plants and animals, and left behind her many spirit children, giving a different language to each group. In central Australia, Kuniya, the carpet snake, camped by a waterhole on a large flat sandhill that turned to stone and became Uluru. Wilkuda, the hunter, threw down the skin of a giant kangaroo he had killed and it became Lake Eyre. In his canoe, powerful Ngurunderi chased the great codfish down the Murray River, where it swished its tail, creating wide bends. When Ngurunderi at last caught the cod in the Lake Alexandrina, he sliced it into pieces and tossed them back into the lake, where they became new species of fish.

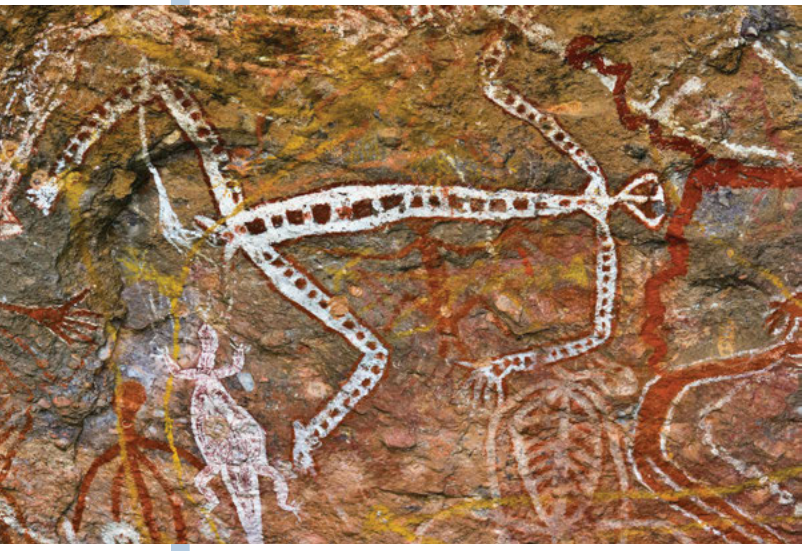
For Aboriginal people, all that is sacred is in the land. Knowledge of sacred sites is learned through a process of **initiation** and by gaining an understanding of **Aboriginal law**. Uluru is perhaps one of the best-known sacred sites. The caves inside the rock are covered with Aboriginal paintings. In 1985, the Commonwealth government returned Uluru to its traditional owners, the Pitjantjatjara and Yankunytjatjara people (also known as the Anangu).

initiation a rite of passage symbolising the acceptance of an individual into a group or into adulthood

Aboriginal law beliefs and expectations recognised by Indigenous peoples

sacred rituals traditions and practices of cultural significance to particular groups of people

Sacred rituals also often involved dot painting on the body, a process that was translated to western-style art canvases in the 1970s through the Papunya art movement. Such pieces reveal a map of circles, spirals, lines, dashes and dots, the traditional visual language of the Western Desert Aboriginal peoples. The Papunya Tula artists originally used a process that reflected traditional spiritual ceremonies. In preparation for an actual ritual, the soil would be cleared and smoothed over in readiness for the inscription of sacred designs, replicating movements of ancestral beings upon the Earth. These Dreaming designs were outlined with dancing circles and often surrounded with a mass of dots. At the end of the ritual, the secret–sacred designs were cleared off both the earth canvas and the bodies of ritual participants.



Source 8.45 In Aboriginal mythology, the Wandjina (or Wondjina) were cloud and rain gods who, during the Dreaming, created or influenced the landscape and its inhabitants. When they found the place where they would die, they painted their images on cave walls and entered a nearby waterhole.

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ACTIVITY 8.6

1. Research an Aboriginal sacred site that has been returned to its original owners, and uncover its Dreaming stories.
2. Compare and contrast the belief systems of Aboriginal Australians, Torres Strait Islander people and Muslim or Christian Australians about how the world was created.
3. Analyse an Aboriginal dot painting. Find out and discuss what the author is conveying.

Kinship

anthropologist an expert who studies humankind

nomadic having no fixed home; moving according to the seasons and availability of food and shelter

bloodline line of descent of an individual

Anthropologists note that mainland Aboriginal people generally lived in small family groups and were semi-**nomadic**. They lived mostly in lightly constructed shelters or rock shelters, which they visited regularly. Aboriginal people value and emphasise relationships with family, group and country. Membership of a family or language group is by birthright through **bloodline**. Complex and sophisticated kinship systems place each person in a relationship with every other person in the group, and determine the behaviour of an individual towards every other person. For example, traditionally a man's role involved skills in hunting as well as cultural obligations that were important to the cohesion of the group.

The men hunted the large animals such as kangaroos, emus and turtles and the women and children hunted smaller animals and collected fruits, berries and other plants. On the coast, people caught fish and collected many types of shellfish, including mussels and oysters. Women were also responsible for early child-rearing and, like the men, had their own separate cultural obligations.

Each family group lived in a defined area. A family would move across its territory methodically, following seasonal changes. At certain times, family groups would gather to engage in social activities (marriage alliances) and other ceremonial events and trade. Such ceremonies could see up to 500 people gathering at the one time.

Relationship to 'country'

'Country' is fundamental to the wellbeing of Aboriginal people. It is a richly symbolic and

Geographical fact

To maintain the fragile environment, and because of seasonal variations, people would stay in one area only for a limited time. This helped to ensure that they did not deplete the stocks of fish and other resources. They used every part of the animals they hunted and the plants they gathered for **sustenance** or to make clothing, baskets, tools or weapons. Sharing and **reciprocity** were central to Aboriginal society's survival, and these values continue to define Aboriginal people today.

sustenance something that maintains life, such as food or water

reciprocity relationship involving mutual exchange

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spiritual landscape rather than merely a physical environment. Land is not just soil or rocks or minerals, but a whole environment that sustains and is sustained by people and culture. Indigenous beliefs are based on a philosophy of oneness with the natural environment.

Aboriginal peoples' greatest emphasis is on social, cultural and spiritual activities, because they believe the environment is controlled by spiritual rather than physical means, and their beliefs are deeply tied to country (see case study on the Dreaming on pages 255–6). The relationship Indigenous people have to their country is a deeply spiritual connection that is different from the relationship to the land of non-Aboriginal Australians. They believe that a person belongs to the land – land is not owned. Aboriginal peoples' relationship to land has been deeply misunderstood over the past 200 years or so, and remains central to all issues that are important to Indigenous people today.

When Australia was colonised in the 18th century, the recognised ways of acquiring legal **sovereignty** (control) were considered to be by **conquest**, **cession** or occupation of the land, which was 'ownerless'. In 1770, Australia was regarded as 'common land', occupied only by wandering tribes. For this reason, the British declared Australia ***terra nullius*** – or 'land belonging to no-one'. This perception of the landmass of Australia held by British settlers is responsible for the continuing battle over **land title**.

sovereignty independent power over a one's own place

conquest the victory of one party over another (e.g. through battle or voting)

cession the transfer of land from one individual or group to another

terra nullius land belonging to no-one

land title an official record of who owns a piece of land

customary according to the practices of a particular group or place

Native Title Act an Australian law recognising the ownership of traditional Indigenous land

Mabo a case fought and won by Indigenous Australian Eddie Mabo that first recognised native title

Wik a case which decided that pastoral leases did not extinguish native title

In contemporary times, Aboriginal groups' traditional lands have been recognised by the national legislature as **customary** land title. Customary land title is a recognition that ownership of traditional tribal land will remain with the Indigenous community. Under the current ***Native Title Act***, which was passed after the ***Mabo*** and ***Wik*** cases and subsequent decisions by the **High Court of Australia**, Aboriginal and Torres Strait Islander groups are required to prove their connection to and use of the land they claim as their customary country. Aboriginal and Torres Strait Islander groups regularly work with the government and private companies to harvest the resources on tribal land. Conflicts over land use and resource rights continue to occur between Aboriginal and Torres Strait Islander groups, the government and corporations.

High Court of Australia the highest court in Australia

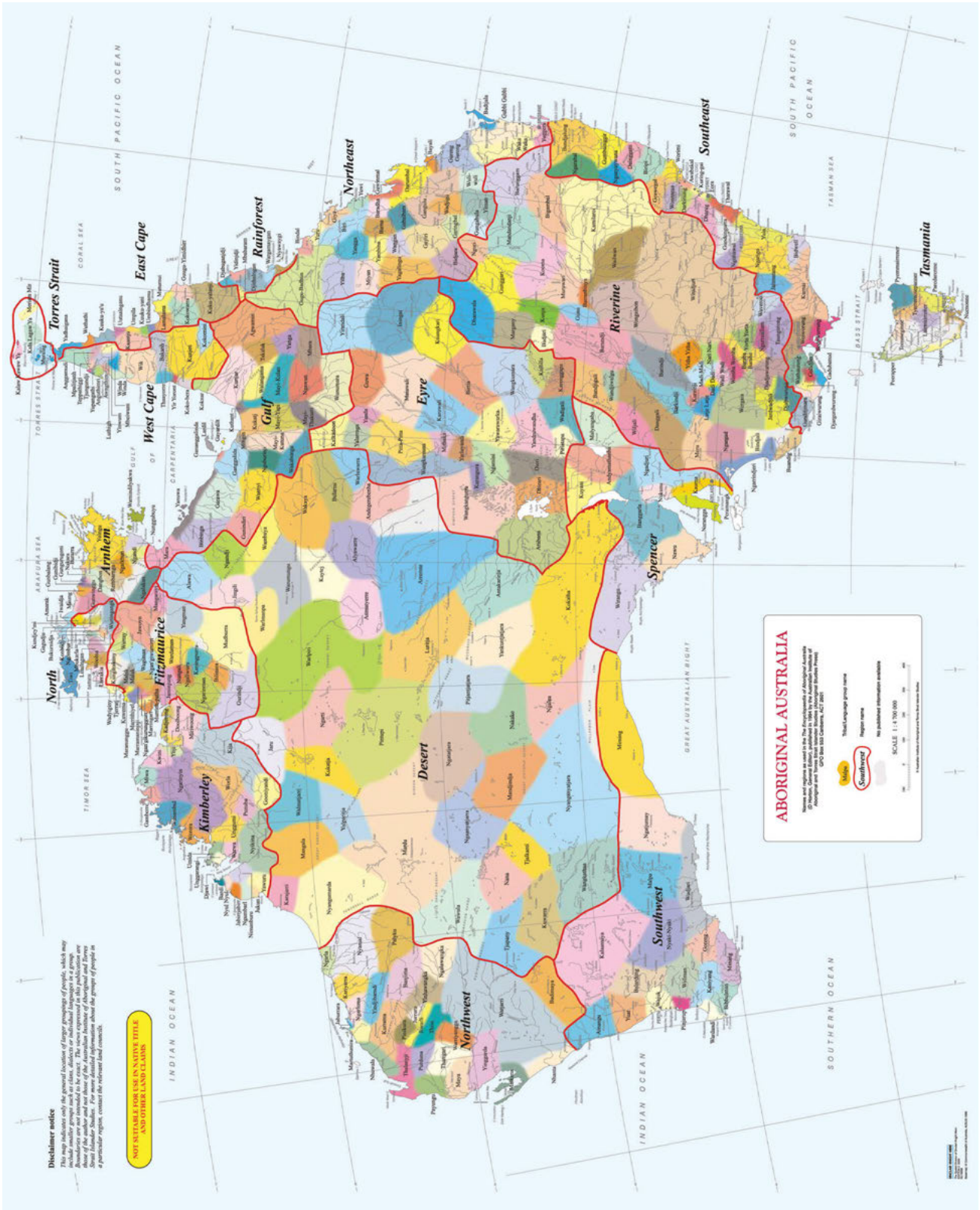
Language systems

Language is vitally important for understanding Aboriginal and Torres Strait Islander heritage, as much Indigenous history is oral. Hundreds of languages and dialects existed (although many are now extinct), and both language meaning and geographic location are used today to identify different groups. Think of the Kimberley region of Western Australia. Cultural anthropologists note that if you travel through the Kimberley, with its large Aboriginal population, it is like travelling through Europe, with its changing cultures and languages. Many English concepts and words have made their way into modern Aboriginal and Torres Strait Islander languages. 'Kangaroo' – or 'kanguru' – was adopted from local Aboriginal people in 1770 by Captain James Cook when the *Endeavour* was forced to stop in the region for repairs.

One of the reasons Aboriginal culture has survived for so long is Aboriginal peoples' ability to adapt and change over time. Their affinity with their surroundings has enabled Indigenous Australians to survive for millennia. Aboriginal people take great pride in their personal and group identity.



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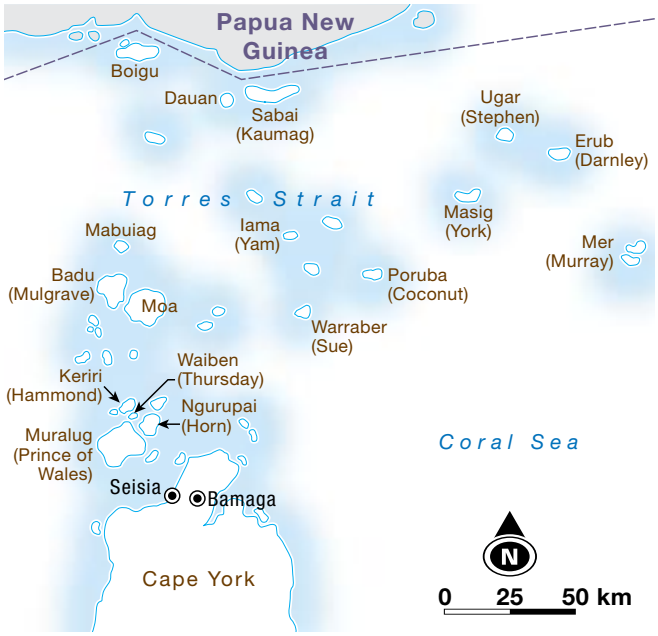
Source 8.46 Map of Aboriginal Australia's diverse groups and the boundaries of country

This map is just one representation of many other map sources that are available for Aboriginal Australia. Using published resources available between 1988–1998, this map attempts to represent all the language or tribal or nation groups of the Indigenous people of Australia. It indicates only the general location of larger groupings of people which may include smaller groups such as clans, dialects or individual languages in a group. Boundaries are not intended to be exact. This map is NOT SUITABLE FOR USE IN NATIVE TITLE AND OTHER LAND CLAIMS. David R Horton, creator, ©Aboriginal Studies Press, AIATSIS and Auslig/Sinclair, Knight, Merz, 1996. No reproduction allowed without permission.

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The cultural landscape of Torres Strait Islanders

Torres Strait Islanders, the other group of Indigenous Australians, represent a minority within a minority. They reside on the islands of the Torres Strait, situated between the northernmost tip of Australia and the coast of Papua New Guinea. The Strait was named after the Spanish navigator Luis Vaez de Torres, who sailed through and named the region in 1606. Hundreds of islands, islets, cays, reefs and sandbanks are situated in the waters of the Strait, where the Coral and Arafura Seas meet. It is also considered one of the most fragile and intricate waterways in the world. Its islands are found dotted all along its 150 km stretch. The population of approximately 8000 comprises around 6000 Torres Strait Islanders, including some Aboriginal people.



Source 8.47 Map of the Torres Strait

Source 8.48 Torres Strait Islands: traditional and English names

Traditional name	English name
Badu	Mulgrave Island
Boigu	Talbot
Dauan	Mt Cornwallis Island
Erub	Darnley
Keriri	Hammond Island
Mabuiag	Jervis
Masig	Yorke Island
Mer	Murray
Moa	Banks Island (There are 2 communities on Moa – Kubin and St Paul's Community.)
Muralag	Prince of Wales Island
Ngarupai	Horn Island
Puruma	Coconut
Saibai	Saibai Island
Ugar	Stephens
Waiben	Thursday Island
Waraber	Sue Island
Yam	Turtle-Backed Island

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Geographical fact

All the islands have traditional as well as contemporary names, and all are owned and used collectively. No two islands are identical, each of them being shaped by its unique landscape, stories and history. In the past, many more islands were inhabited. Today, Torres Strait Islanders live predominantly in 18 permanent communities on 17 islands. Concurrently, they continue to visit their traditionally owned islands for fishing, gardening, food collecting, camping and picnicking. The population of each community varies between 70 and 750 people. Two traditional languages are spoken in the Torres Strait: Kalaw Lagaw Ya, which is similar to Aboriginal languages, is spoken on the Western, Central and Northern Islands; Meriam Mir, the language spoken on the Eastern Islands (including Mer), is derived from Papuan languages. Individual dialects are also found on each of the islands. The third language that developed over time, Torres Strait creole (or Yumiplatok), is a mixture of the 2 traditional languages.

Two-thirds of all Torres Strait Islanders now live on the Australian mainland. The majority of these people live in Townsville, Cairns and Darwin. Eddie 'Koiki' Mabo's family members live in Townsville and also in Robina, Brisbane and Rockhampton. Torres Strait Islanders maintain a strong cultural identity. This is also the case for those who live on mainland Australia. Islanders have forged a separate identity from that of Aboriginal peoples, which finds expression in their flag. Designed by the late Bernard Namok, the flag's symbols relate to the unity and identity of all Torres Strait Islanders. (See Source 3.19, page 108)

Torres Strait Islanders are not mainland Aboriginal people who inhabit the islands of the Torres Strait. They are a separate people in origin, history and culture. Nineteenth-century Europeans considered them to be 'superior' to mainland Aboriginal people because, as well as fishing and hunting, they gardened. Although they formed part of a broad culture area and were linked by warfare, trade and ceremonial exchange with the coastal peoples of New Guinea and Cape York, each group considered itself separate from its neighbours. Torres Strait Islanders were also described as fearless defenders of their territories.

The Torres Strait Islanders have managed their own communities for over a century. Their efforts and experiences – especially through Eddie 'Koiki' Mabo's case – helped to overturn Australian laws regarding Aboriginal and Torres Strait Islander land tenure, and the Torres Strait Islands are currently on course to achieve regional autonomy.

The islands are now legally part of Queensland. Those within 60 nautical miles (97 km) of the coast were **annexed** in 1872, and the remainder in 1879. At annexation, the Islanders became **British subjects** and their islands became **crown lands** – although at **Federation** (in 1901) they became Australian citizens in name only, not in benefits, which came much later. Torres Strait Islanders represent less than 10% of the Aboriginal and Torres Strait Islander population. They have been relatively neglected by government authorities, opinion-makers, the media and academia. Even so, these Islanders were the first Indigenous Australians to be granted forms of local self-government. Moreover, it was

annexed taken possession of

British subjects British citizens under British rule and laws

crown land land owned by the government – originally by the British monarch

Federation the creation of the Australian union of states

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Geographical fact

Torres Strait Islanders have maintained separate cultural and linguistic traditions that, in contrast to those of mainland Australian Aborigines, have evolved in small island environments. Pre-contact, Torres Strait Islanders were not a single **homogeneous** or unified group. In fact, it was not until recently that they began to think of themselves as one people. Although they formed part of a broad culture area and were linked by warfare, trade and ceremonial exchange with the coastal peoples of New Guinea and Cape York, each group considered itself separate from its neighbours and maintained its own cultural and linguistic differences.

homogeneous all the same or all together

their efforts that saw Australian laws regarding Aboriginal and Torres Strait Islander land tenure overturned.

The late Eddie Koiki Mabo is perhaps the most famous Torres Strait Islander. Born on Murray Island between Australia and Papua New Guinea, he is well known for his role in campaigning for Indigenous land rights and the landmark decision of the High Court of Australia that overturned the legal doctrine of *terra nullius*, which characterised Australian law with regard to land title. Captain James Cook declared Australia to be *terra nullius* when he sailed into Botany Bay on 28 April 1770, so that he could claim Australia for Britain. This **proclamation** ignored the fact that hundreds of different groups of Aboriginal and Torres Strait Islander people occupied the land.

proclamation a public announcement or declaration

Today, Aboriginal and Torres Strait Islander communities keep their cultural heritage alive by passing their knowledge, arts, rituals and performances from one generation to another; speaking and teaching languages; and protecting cultural materials, sacred and significant sites and objects. Aboriginal and Torres Strait Islanders are active in all aspects of Australian society, including the arts, academia, business and government. Cultural practices – especially in sports and the arts – unite Aboriginal and Torres Strait Islanders. Despite this, Aboriginal and Torres Strait Islander peoples can be defined as a marginalised population. Aboriginal peoples suffer from disproportionately high rates of disease, imprisonment and unemployment. The average life expectancy of Aboriginal people is about 18 to 19 years less than that of non-Indigenous people. The government of Australia is working to resolve these issues. In 2010, Ken Wyatt became the first Aboriginal Australian elected to the Australian House of Representatives. In 2008, Prime Minister Kevin Rudd issued a public apology to members of the **Stolen Generations** (Aboriginal children taken from their families and raised under European supervision in group homes or orphanages). This policy began in 1869 and officially ended in 1969.

Stolen Generations a term that refers to the Aboriginal children removed from their families and institutionalised in western orphanages or sent to foster homes



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Geographical fact

Native title is a form of land title that recognises the unique ties some Aboriginal groups have with land. Australian law recognises that native title exists where Aboriginal people have maintained a traditional connection to their land and waters since sovereignty, and where acts of government have not removed it. Native title was first accepted by the High Court of Australia in 1992 in the *Mabo* decision, which recognised for the first time that Aboriginal and Torres Strait Islanders may continue to hold native title and to be uniquely connected to the land. Aboriginal and Torres Strait Islander peoples can apply to the courts to have their native title rights recognised under Australian law. Native title-holders have the right to be **compensated** if governments acquire their land or waters for future developments.

compensated paid for or reimbursed

RESEARCH 8.5

1. Uncover the similarities and differences in culture between Aboriginal and Torres Strait Islanders: type TROVE into Google to read National Library of Australia (NLA) newspaper articles, and see pictures and documents relating to this topic. Check your school library catalogue for relevant books and encyclopedias.
2. Watch Kevin Rudd's 'sorry' speech, apologising to the Stolen Generations. A link is available at www.cambridge.edu.au/geography8weblinks. Why do you think this apology took so long to happen?
3. Find out more about Torres Strait Islander Eddie Mabo from the film *Mabo*, made about his life. Evaluate the film. What did you think about it? Did it change your views about anything? Explain why.

8.12 How have Indigenous Australians been advantaged and disadvantaged by mining?

Because such a large amount of Australia's valuable minerals is located in isolated rural areas, mining often occurs in places owned and occupied by Indigenous Australians. Mining in these areas is often controversial, given the special connections many of the communities have with their local areas, and there is considerable debate about whether mining advantages or disadvantages Indigenous Australians.

How mining can benefit Indigenous Australians

Leasing land

Indigenous communities possessing land ownership rights can grant **leases** to mining companies. This can provide a significant source of income, which can be spent

lease contract allowing temporary management or use

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on infrastructure and raising standards of living. These agreements often include undertakings to not damage sacred sites and environmental controls. However, once consent to mine has been given, Indigenous groups can do little to control it.

Providing employment and training

Some leases include agreements to train and employ members of the Indigenous community in the field of mining. Some Indigenous elders claim mining is directly employing 3000 Indigenous people in the Western Australian region of the Pilbara.

In remote communities where unemployment can be as high as 35%, this is a significant advantage to some. **TAFE** quali-fications have also become available at several mining sites. In Port Hedland, BHP Billiton set up an after-school project for Indigenous children who show academic promise, providing study and computer facilities. This initiative has led to increased school attendance for those taking part.

TAFE Technical and Further Education training college



Source 8.49 BHP has employed a number of local Indigenous Australians at Port Hedland.

Providing facilities and infrastructure to remote communities

One of the biggest issues for remote Indigenous communities is a lack of infrastructure due to their distance from urban centres. Mining towns and sites can bring health care, mains electricity and even recreational facilities closer to Indigenous populations. Airstrips and bitumen roads may also be built, providing links to capital cities that may not have existed before.

How mining can disadvantage Indigenous Australians

The short-term nature of mining

Indigenous communities and their ancestors have strong historic links with their land, often stretching back over thousands of years. While mining can bring benefits as described above, these benefits are only going to last as long as mining does, which can be for periods of as little as 15 years. Many argue that the short-term nature of mining makes its benefits for Indigenous populations **unsustainable**.

unsustainable impossible to maintain

High levels of poverty in areas being mined

While some argue that the financial benefits of mining have been recognised in many communities, others point out that Indigenous communities in mining regions are often just as poor and disadvantaged as those living in communities without mining.

Tensions caused by mining agreements

Many Indigenous communities have found it hard to decide whether to agree to mining on their land. For example, many of the votes about whether to allow mining may be split, with significant numbers opposed to the mine. This can cause conflict and divisions in the community.

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Damage to the environment and traditional ways of life

Many Indigenous Australians object to the ways in which mining companies have assumed that their communities want employment in mining and closer links to urban centres, and object to the idea of mining as a 'solution' for inequalities within their areas. Others are concerned about environmental damage that will scar the landscape for hundreds of years.



Source 8.50 Some local Indigenous people have expressed concern about environmental damage from bauxite mining in Arnhem Land.



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Chapter summary

- Migration is the movement of people from one place to another to take up permanent or semi-permanent residence.
- There are 4 main types of migration: internal, seasonal, international and rural-to-urban migration.
- There are 2 main factors associated with internal migration: push and pull factors.
- Fly-in fly-out (FIFO) workers are a modern example of the internal migration of people within a country.
- The geography of both Australia and China is shaped to a large extent by global connections.
- Australia's economy will be reliant on importing and exporting a vast range of goods to many different countries if it is to continue being successful.
- Australia's economic advantage lies in primary production, service provision, tourism and highly specialised manufacturing, while China's lies in large-scale production of goods.
- Australia's and China's economies are closely intertwined through the provision of raw materials from Australia and the provision of manufactured products from China. This provides both benefits and disadvantages to Australia.
- Mining and manufacturing have led to regional growth in both Australia and China, although China's regional growth has occurred on a much larger scale, with huge increases in population in these areas.
- Resource extraction can lead to radical changes to the areas in which it occurs, with both negative and positive impacts for Indigenous Australians and others living in those regions.
- The mining boom in Australia has resulted in a large movement of people to areas in Western Australia and Queensland.
- The manufacturing boom in China has resulted in large internal migration from central areas to coastal cities such as Shanghai.
- Internal migration has a range of negative economic, environmental and social effects, such as air pollution, population decline, loss of biodiversity and loss of government services.
- Australia's original First Nations inhabitants, the Aboriginal and Torres Strait Islander peoples, are the custodians of one of the world's oldest continuing cultural heritage traditions and sustainable environmental practices.

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End-of-chapter questions

Multiple choice

1 Migration is defined as:
- **A** the movement of people from one place to another to take up a permanent or semi-permanent residence
- **B** the movement of people for a holiday
- **C** the temporary movement of people for recreation
- **D** the forced movement of people due to conflict such as war

2 Australia's population in 2012 was:
- **A** 20.7 million
- **B** 21.4 million
- **C** 22.8 million
- **D** 25.7 million

3 The Australian state that generates the largest amount of revenue from mining is:
- **A** New South Wales
- **B** Tasmania
- **C** South Australia
- **D** Western Australia

4 In 2008, the number of Chinese people moving from rural areas to major urban areas was:
- **A** 100 million
- **B** 120 million
- **C** 140 million
- **D** 160 million

5 Unlike people of other cultures, Aboriginal peoples did not build permanent structures or clear the earth and cultivate the land. Their spiritual beliefs and way of life were bound to the land, the sky and the sea. They took from the Earth only what they needed. What did their art represent?
- **A** Dreaming stories
- **B** the conceptual relationships that influence the way the landscape is seen and understood
- **C** an economic means of making money for the Aboriginal artist and art galleries
- **D** a substitute for monuments, cathedrals, synagogues and mosques

Short answer

1 Contrast the 4 types of migration.

2 Explain the characteristics of both push and pull factors.

3 Describe the impact the rapid growth of Shanghai has had on the physical and built environment.

4 Discuss the benefits of fly-in fly-out (FIFO) workers

5 Explain why Eddie 'Koiki' Mabo is so well known.

Extended response

Evaluate whether internal migration has had a positive impact on the redistribution of people in Australia and China. In your answer, you need to refer to:

- environmental factors
- economic factors
- social factors.

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9 International migration in Australia



Source 9.1 Seeking greener pastures – fears, hopes and expectations

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Before you start

Main focus

To understand how international migration has changed cities and urban lifestyles.

Why it's relevant to us

It is important to know about international migration because it helps us to understand the foundations of our nation and the characteristics that make Australian cities unique.

Inquiry questions

- What is international/internal migration?
- Where have international migrants come from to live in Australia?
- How have migrant communities in Australian cities changed over time?
- Why do migrants want to live in Australia, and what impact has this had on Australian communities?

Key terms

- Migrant
- International migration
- Voluntary migration
- Persecution
- Forced migration
- Mass migration
- Immigration
- Chain migration
- Seasonal migration
- Visa
- Demographer
- Refugee
- Asylum seeker
- Cultural integration
- Genocide

Let's begin

International migration has shaped many nations, including Australia. Australia has a long history of migration that begins with the migration of Aboriginal and Torres Strait Islander peoples. A key theory is that, when the first humans left Africa, they followed the coastline. They moved across the Middle East, into southern Asia, and eventually to Australia. This migration dates back approximately 60 000 years, when the first Aboriginal and Torres Strait Islander peoples migrated from islands of present-day Malaysia and parts of Indonesia. Convicts were later forced to migrate from countries such as Ireland and England between 1788 and 1868. The gold rush era also attracted many new migrants to Australia. After World War II, there was mass migration from Europe. In more recent times, there has been a pattern of migration from the Middle East, Africa and Asia. International migration occurs for many reasons, including those of economics, family, employment, education and freedom. International migration includes those seeking asylum and refugees. Generally, people who migrate are seeking a better future.

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9.1 International migration

international migration the movement of people from one country to another

voluntary migration when people move somewhere else by their own choice

migrant an individual who has moved from one country to another

International migration is the movement of people from one part of the world to another. People migrate to live somewhere else. They can migrate because they want to, seeking brighter opportunities for work and family – this is known as **voluntary migration**. Alternatively, they can migrate because they are forced to do so, through political instability in their country, or the threat of war or **persecution** – this is known as **forced migration**. Migration has occurred throughout history, beginning from the movement of the first humans in East Africa to their current position in the world. Migration happens on a variety of scales – from the **mass migration** after World War II to individual migration.

persecution unfair or cruel treatment over a long period of time because of race, religion or political beliefs

forced migration movement of people somewhere else because they have to leave

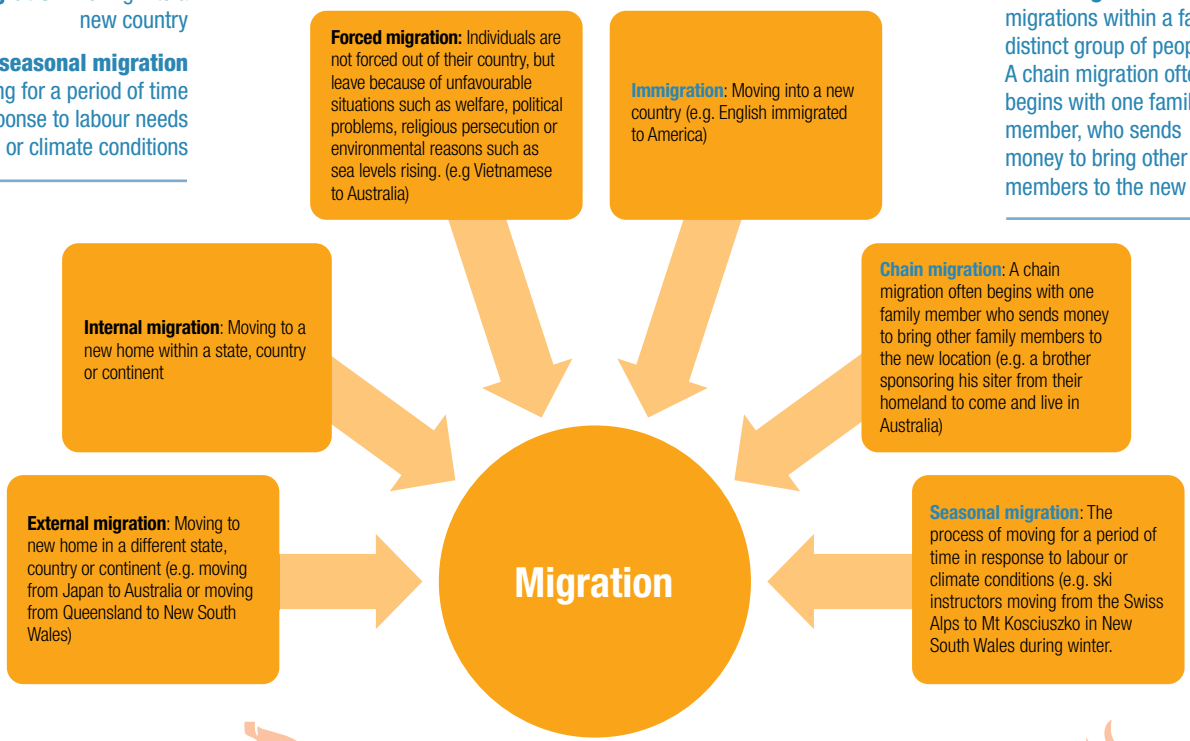
mass migration large numbers of people moving somewhere else for similar reasons

What are the types of migration?

immigration moving into a new country

seasonal migration moving for a period of time in response to labour needs or climate conditions

chain migration a series of migrations within a family or distinct group of people. A chain migration often begins with one family member, who sends money to bring other family members to the new location





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(a) Rosario Messina



(b) Natale Messina, Maria Amenta



(c) Maria Amenta, Graziella Messina



(d) Natale Messina

Source 9.2 An example of chain migration: Natale Messina was sponsored by his brother (Rosario Messina) to move to Australia where he settled and started a family.

9.2 Sources of international migrants to Australia

According to the Department of Immigration and Citizenship, Australia's migration program is open to anyone from any country, regardless of their nationality, ethnic origin, gender or colour. In 2010–11, people from 185 different countries migrated to Australia. China was Australia's largest source of permanent migrants, accounting for 29 547 places, or 17.5% of the total migration program, up from 24 768 or 19.3% in 2009–10.

Source 9.3 Chinese New Year celebrations in Australia

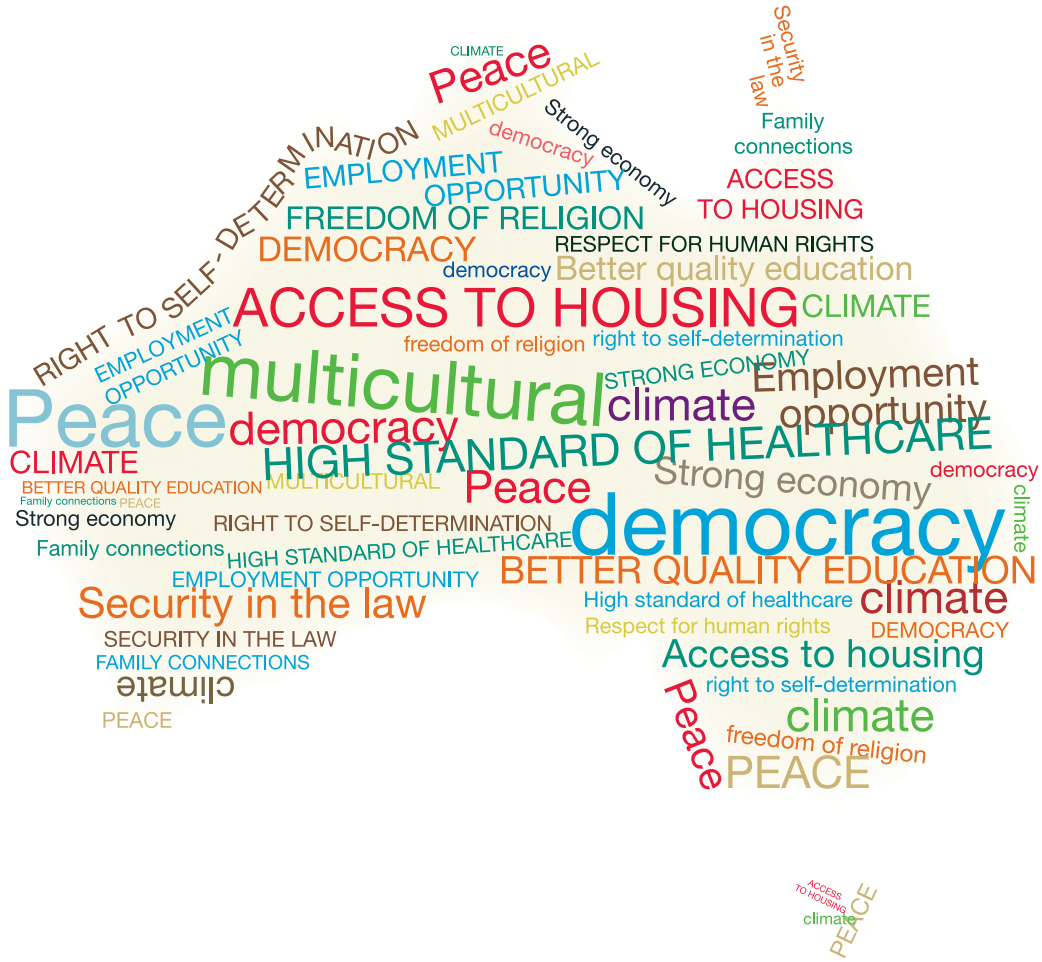


Geographical fact

Of the 6 million-plus migrants living in Australia, over a million people were born in the United Kingdom.

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Why do international migrants want to live in Australia?



Source 9.4 Why migrants choose to live in Australia

People choose to live in Australia for many reasons, including:

- the freedoms we have – such as freedom of religion and the right to self-determination
- our democracy
- the climate
- our **multiculturalism** society
- higher-quality education
- employment opportunities
- a high standard of health care
- respect for human rights
- access to housing
- security in the law
- a strong economy
- peace
- family connections.

multiculturalism an idealogy that different cultures can coexist successfully within a country (rather than conform to one national culture)

What is the impact of international migration on Australia?

There are many advantages to international migration. The Human Rights Commission identifies the following economic and cultural advantages:

- filling skill and labour shortages
- creating demand for goods and services
- investing in the Australian economy.

Migrants can also foster Australia's international trade through:

- business networks
- speaking a language other than English
- knowledge of overseas markets and cultural practices.

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Employment

Migrants are better able to participate in the local workforce the longer they live in Australia. Research suggests that the success with which new migrants find jobs is related to their proficiency in English, age, skill level and qualifications. Over one-third of migrants (36%) struggle to gain employment. This may be due to discrimination, or to a lack of Australian work experience.

The Australian government encourages international migration for a variety of reasons in addition to population growth. For example, the government has a variety of State-Specific and Regional Migration (SSRM) proposals with the aim of assisting state and territory governments to:

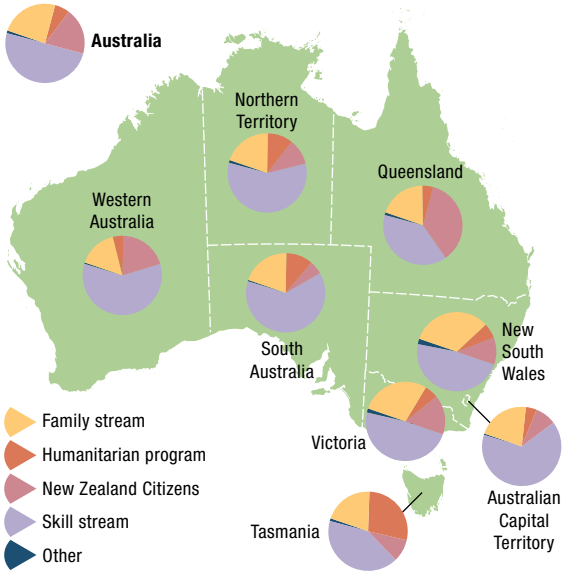
- attend to skill deficiencies that may exist in their area
- attract overseas business people to establish new or joint ventures in their area
- support a more balanced settlement of Australia's skilled migrant intake.

These proposals include flexible criteria that recognise the unique conditions of rural and regional areas. The goal is to entice young, skilled, English-speaking migrants to move to areas in need. Skilled migration **visas**, which are sponsored by regional employers or state and territory governments, receive priority handling. This helps state and territory governments and regional employers to influence the amount and type of skilled migrants settling in their areas, in line with the skills required and the expansion goals of the area in question.

visa a document allowing a person to enter and stay in a particular country for a specified time period

Where do migrants want to live in Australia?

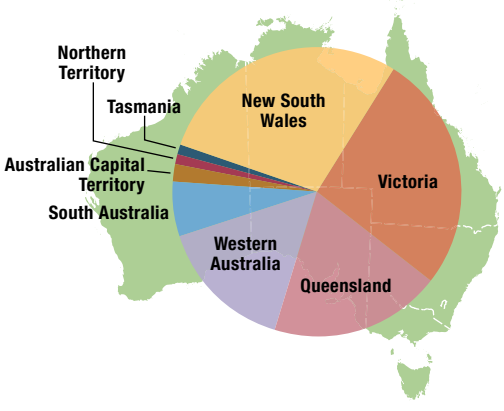
According to research and statistics, most migrants choose to live in large cities or suburbs where there are family and friends from the same cultural heritage. Quite often, this will depend on the reasons for their migration to Australia – for example, the map in Source 9.5 shows that 33.35% of migrants coming to live in New South Wales did so to join existing family members. They are also in search of work, and in 2009–10 62.05% settled in Western Australia due to the minerals boom. The map in Source 9.6 reveals a distinct preference for living in New South Wales.



Source 9.5 Map showing the distribution of Australia's migrant population

Geographical fact

According to the Department of Immigration and Citizenship, almost 7 million people have migrated to Australia since 1945. There are over 260 languages spoken.



Source 9.6 The proportion of migrants in each state and territory

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ACTIVITY 9.1

1. Define 'international migration' in your own words – include an example.
2. Identify 3 reasons why people may migrate to other countries.
3. Identify the top 5 countries of origin for migrants who came to live in Australia in 2010–11.
4. Describe the composition of Australia's population in 1947 and 1997. Identify any notable changes.
5. Using Source 9.5, identify which state has the largest proportion of its permanent residents coming for family stream. Justify one reason for this pattern.
7. Using Source 9.6, explain why there are such a high proportion of new migrants in New South Wales.
8. *Class discussion:* Imagine that Australia did not accept immigrants from other countries. What would Australia be like?

Geographical fact

Demography is a science that studies populations. A **demographer** is someone who works with the statistics. According to the Australian Social Science Data Archive, the first population count was taken in 1788 and was known as a 'muster'. The first official Census was taken in New South Wales in 1828.

demographer a person who works with statistics to examine populations

RESEARCH 9.1

Imagine you are a demographer. Your job is to present a series of graphs that summarise your findings based on the following class survey. Your aim is to find out what migrant heritage exists in your class.

Survey questions

1. Where were you born?
2. Where was your mother born?
3. If your mother was born overseas, how old was she when she came to Australia?
4. Where was your father born?
5. If your father was born overseas, how old was he when he came to Australia?
6. Where was your grandmother born (maternal)?
7. Where was your grandfather born (paternal)?
8. What languages do you or your family members speak?
9. What were the reasons for migrating to Australia?
10. Why did they settle in their chosen suburb or town?

Organise the data you have collected into a series of graphs (pie charts, bar graphs, etc) that show and present this information to the class.

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Extension task

List the cultural origins of all members of your class. On a large map of the world, draw the paths of immigration from these countries to Australia. For each country, indicate the number of students who share this cultural origin (for example, 9 from the United Kingdom, 5 from Greece).

1 Identify any patterns that emerge.
2 Discuss the contributions each of these cultures has made to Australia.

Geographical fact

The United Nations estimated that there were 43.7 million refugees worldwide in 2012.

Case study 9.1
Refugees

refugee a person who has left their own country because of fear for their safety and wellbeing

The issue of **refugees** is one of the most difficult problems currently facing the world. Every year, millions of refugees from around the world seek a new homeland. According to the Australian Human Rights Commission, about 13 000 of these people are permitted to make new lives in Australia. Of these, about 6000 are chosen by the government from the world's refugee camps, and a further 7000 arrive on humanitarian visas, often sponsored by family and friends.

All have met the United Nations definition qualifying them as refugees. The United Nations defines a refugee as follows:

> A person who, owing to a well-founded fear of being persecuted for reasons of race, religion, nationality, membership of a particular social group or political opinion, is outside the country of his nationality and is unable or, owing to such fear, is unwilling to avail himself of the protection of that country; or who, not having a nationality and being outside the country of his former habitual residence as a result of such events, is unable or, owing to such fear, is unwilling to return to it.

It is reported that 80% of refugees are women and children. This includes Najeeba, an Afghani refugee. Her story began after the family decided to look for a better life. Their country, Afghanistan, was war-torn, and its citizens had few political freedoms. She does not remember her childhood, as there was much fear due to the discrimination against her and her family by those in power. Of her experiences, Najeeba says: 'Asylum seekers carry sorrow and distress and depend on human sympathy. An asylum seeker is a kneeling person; kneeling in front of the captain of the ship to ask for a reduced escape price; kneeling in front of the aid agency asking to be saved.' Her journey on the boat that took her to Australia is one she will never forget, nor will she forget the fear of drowning or

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starving. You can read more about Najeeba's story on the Amnesty International website via www.cambridge.edu.au/geography8weblinks.

1 For how long has Afghanistan been in a state of war?
2 According to Najeeba, what do politicians claim is the best way to minimise the number of boat arrivals? Identify some of her arguments against this.
3 How many **UNHCR** refugees did Australia take from Indonesia in the first 3 months of 2012?
4 In groups, discuss what you would do if you were faced with the same decision Najeeba and her family had to make.
5 Using the same website, compare Najeeba's story with those of 2 others. What do the stories have in common?

UNHCR United Nations refugee agency (United Nations High Commission for Refugees)

9.3 What is the difference between a refugee and an asylum seeker?

asylum seeker a person whose claim for refugee status has not yet been approved

An **asylum seeker** is a person who has sought protection as a refugee, but whose claim for refugee status has not yet been approved. Every refugee has at some point been an asylum seeker. Those asylum seekers who are found to be refugees are entitled to international protection and assistance. Those who are found not to be refugees, or not in need of any other form of international protection, can be sent back to their country of origin.

Asylum seekers are not illegal immigrants.

- Asylum seekers are people seeking international protection, whose claims for 'refugee status' have not yet been determined. They are not 'illegal immigrants' because under both international and domestic laws they have a legal right to enter Australia to seek asylum.

Asylum seekers and refugees do not receive more favourable treatment or higher benefits.

- Claims that refugees in Australia have higher benefits than other social security recipients are not correct. Everybody arriving by either air or boat must go through the same process. Non-government organisations and churches often provide great support for refugees.

Boat people are not 'queue jumpers'.

- There is no queue for asylum seekers to join. Only a small amount of people are registered with the UNHCR, and of these only 1% are resettled.

Other countries have far greater numbers of refugees than Australia.

- Australia, with 22 548 refugees, ranks 47th in the world. This compares with Pakistan (1 740 711), Iran (1 070 488), Syria (1 054 466), Germany (593 799), Jordan (450 756), Kenya (358 928), Chad (338 495), China (300 989), the United States (275 461) and the United Kingdom (269 363). On a per capita basis, Australia is far behind poorer countries such as Jordan and Syria.

Source 9.7 Dispelling myths about refugees

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ACTIVITY 9.2

1. Define the term 'refugee'. How is this different from the term 'migrant'?
2. Outline Australia's responsibility to refugees, according to Article 1 of the Convention Relating to the Status of Refugees (1951).
3. Explain why people seek refugee status in countries like Australia.
4. World Refugee Day is 20 June. Visit the World Refugee Day website via the following link and write a brief report about the importance of the United Nations acknowledging this day: www.cambridge.edu.au/geography8weblinks.
5. Visit the Edmund Rice Centre for Justice and Community Education website via www.cambridge.edu.au/geography8weblinks and make your own fact sheet about refugees. Use an ICT application such as Microsoft Publisher to create your document.



Source 9.8 World Refugee Day is an international day that acknowledges the plight of refugees

9.4 The emergence of a multicultural policy

Australia prides itself on the fact that, accord-ing to recent statistics published by the Australian Bureau of Statistics (ABS), 1 in 4 of its citizens has a migrant heritage. Some 44% were born overseas, and 4 million speak a language other than English. **Cultural integration** occurs when ethnic communities and governments work together to create communities. The Australian Department of Immigration and Citizenship defines 'multicultural' as a term that describes the cultural and linguistic diversity of Australian society. Multiculturalism is all about ethnic communities being recognised and strengthened, and has been the official government policy since 1970. In 2010, the Australian government released its most recent multicultural policy. It is based on 4 main ideas, shown in Source 9.9. This policy indicates the strong government support that exists for multiculturalism.

cultural integration the process of drawing together various elements of a cultural system, such as ethnic groups into a wider community.

It is a system of unity that encourages respect and celebrates our cultural diversity. Every Australian benefits from this inclusiveness. All Australians have the right to be active and free participants in society by maintaining their cultural traditions and encouraging others to celebrate this.



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Principle 1
The Australian government celebrates and values the benefits of cultural diversity for all Australians.

Principle 2
The Australian government is committed to a society where everyone can participate in the opportunities that Australia offers and where government services can provide services to meet the needs of Australians from different cultures.



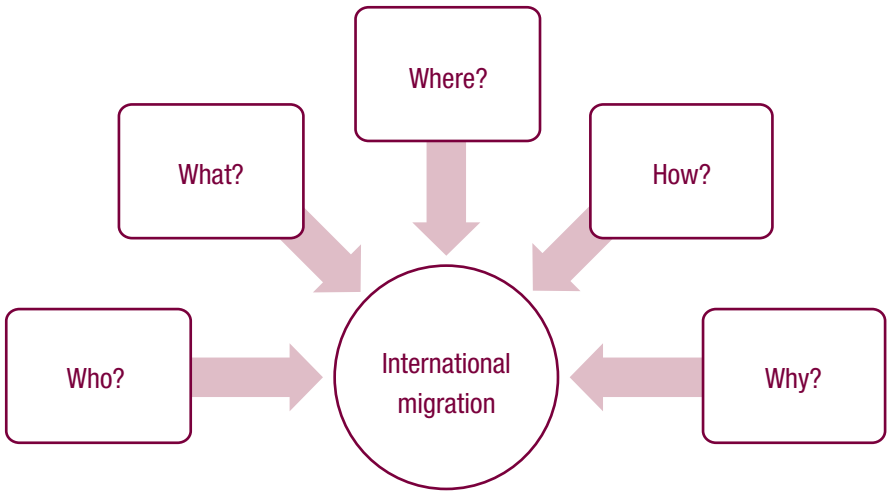
Principle 3
The Australian government encourages the economic, trade and investment benefits that come from our multicultural nation.

Principle 4
The Australian government promotes understanding and acceptance, and discourages discrimination. If this occurs, the law will be there to provide support.

Source 9.9 Australia's multicultural policy is built on 4 principles.

NOTE THIS DOWN

Using the graphic organiser below, summarise what you have learned about international migration.



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First Australians: Sources suggest Torres Strait Islanders and Aboriginal societies had some 700 different cultural groups and 250 different languages.

1606 First documented European contact with Aboriginal people: Willem Janssen, skipper of the *Duyfken*, a vessel of the Dutch East India Company.

1770 Captain Cook arrives and claims the east coast for Britain.

1788 The First Fleet arrives in Sydney with 60 nationalities on board.

1790 Aboriginal people are killed as they resist the European colonisation.

1830s Assisted migration from Britain, labourers from Asia and the South Sea Islands, Germans settle in South Australia.

1840s People from Greece, China, Italy, Hungary and Spain arrive, as do Irish convicts.

1850s Chinese come for the gold rushes. There are also a great number of Irish settlers after the potato famine.

1860s First Afghan camel drivers arrive. South Sea Islanders are kidnapped for labour in north Queensland.

1870s Irish migration peaks.

1880s Laws introduced to restrict immigration.

1890s A dictation test is introduced to exclude non-European migrants.

1900 The White Australia Policy is introduced.

1910s World War I: immigration stops.

1920s Immigration starts up again with British and northern Europeans arriving.

1930s Anti-immigration feeling during the Depression. Assimilation of Indigenous people adopted as national policy. Jewish refugees are granted permission to come to Australia.

1940s Post-World War II 'populate or perish' policy. The Adult Migrant Education Scheme begins.

1950s Dictation test abolished and assisted migration from some countries such as Italy introduced.

1960s Referendum for Aboriginal rights passed and policy of integration for migrants.

1970s Aboriginal flag flown for the first time. Department of Aboriginal Affairs set up.

1980s SBS television begins transmission.

1990s Temporary protection provided for those from Kosovo and East Timor.

2000s Australians march in support of Reconciliation.

2008 Prime Minister Kevin Rudd says 'sorry' to the Stolen Generations.

2010 New multicultural policy introduced by the federal government.

2012 Labor government discusses whether to recognise Indigenous peoples in the Australian Constitution and what this recognition will be.

Source 9.10 Some key dates in the history of Australian multiculturalism

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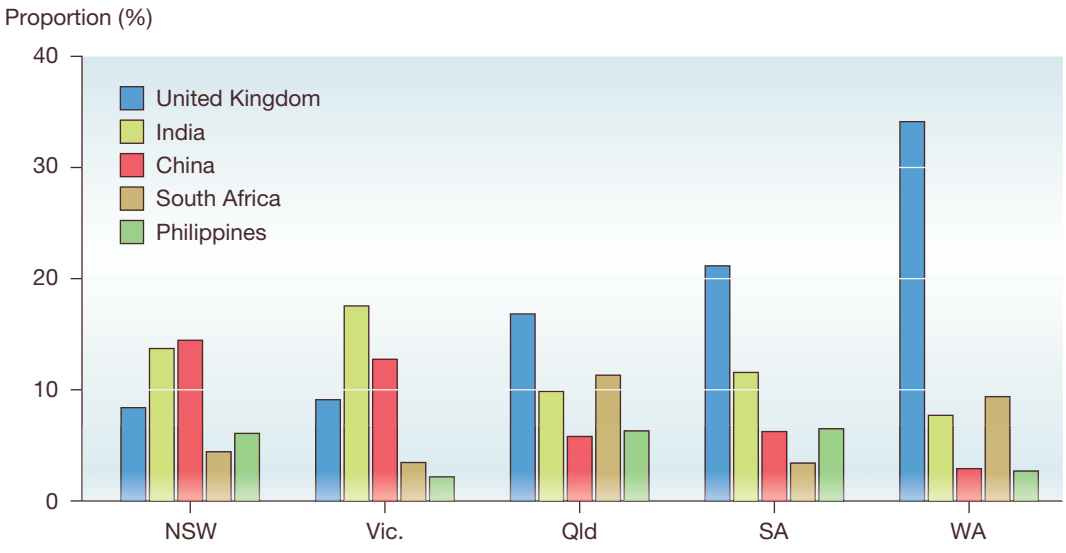
ACTIVITY 9.3

1. Identify the main types of migration and provide 1 example of each.
2. Discuss some reasons why migrants may choose to live in the capital cities of Australia.
3. Refer to the timeline in Source 9.10 on the previous page. Reflect on 1 of the historical events. Explain how it helped or hindered multiculturalism – for example, the White Australia Policy or the dictation test.
4. Refer to the 'Living in Australia' website via www.cambridge.edu.au/geography8weblinks. Using Publisher, create a brochure that gives advice about coming to live in Australia for someone wanting to migrate.

9.5 The importance of community: the migrant experience

A community is a group of people with something in common. In the case of international migration – whether voluntary or forced – communities are important for human survival. When migrants first arrive, they face natural barriers. One of the most difficult of these is the language barrier: the ability for them to communicate with the people of their adopted country. This is often very difficult or impossible for some migrants, so they rely heavily on their children and others in the migrant community for help. Communities are formed for a number of reasons: these include the need to belong, common **heritage**, common experience and common religious celebrations. The urge to builds community data back to ancient civilisations. Having a group of people with similar

heritage monuments, physical objects or customs and traditions inherited from previous generations



Source: *Characteristics of Recent Migrants*, Australia, Nov 2010 (cat. no. 6250.0)

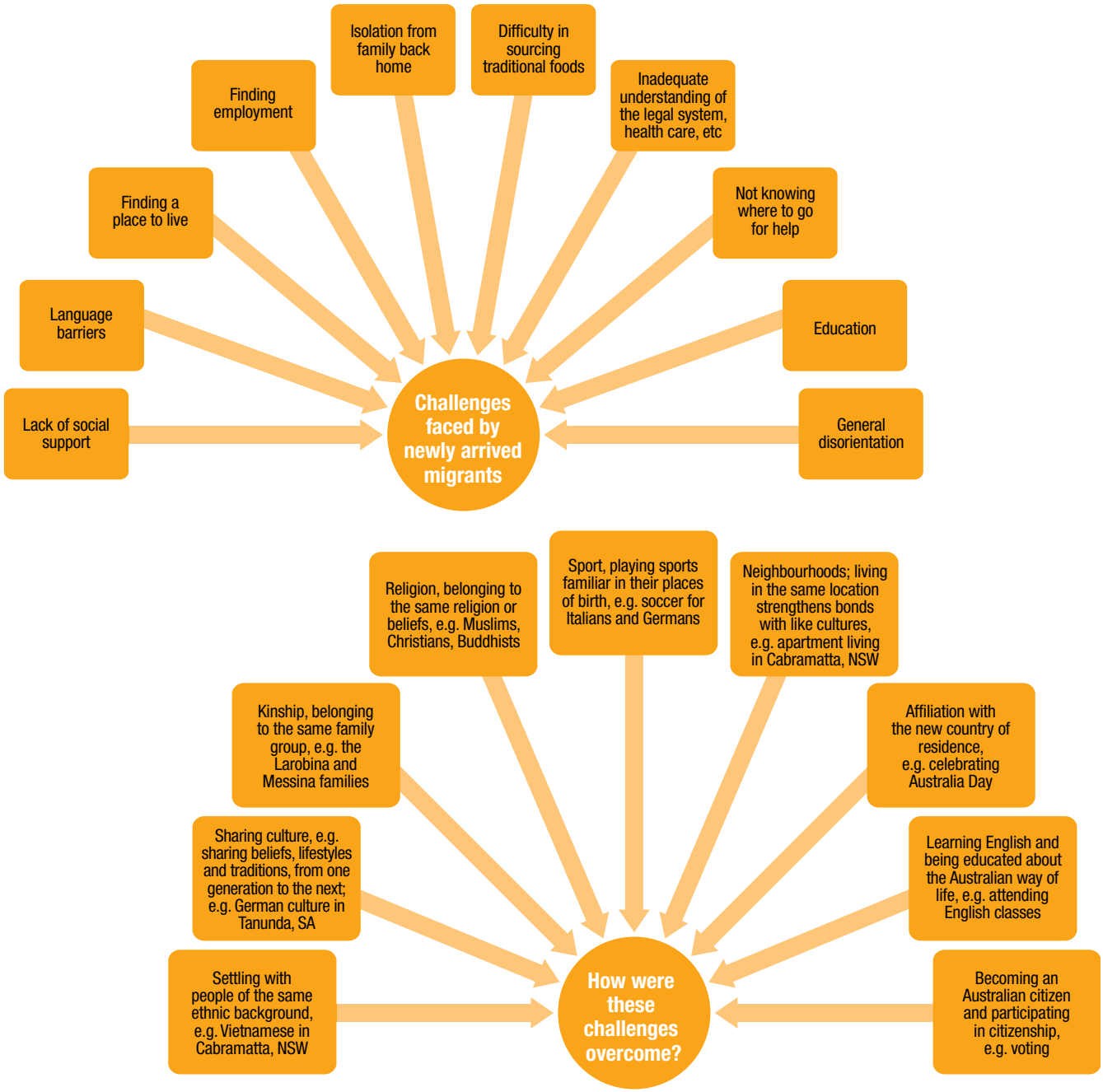
Source 9.11 Distribution of migrants creating communities in Australia, by birth and usual state of residence, November 2010

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cultural backgrounds is the key to the survival of new migrants. The celebrations, clothing, food, sport, music and religious practices are a way of remembering their previous lives and celebrating their new life here in Australia. As the social face of Australia has changed, so migrant groups have needed to change as they have forged a new life in this country.

Challenges faced by migrants

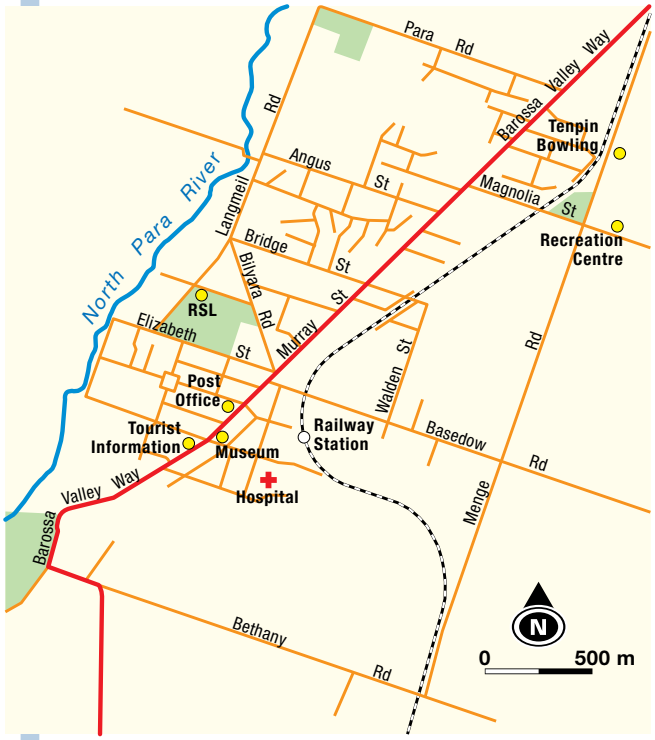
Migrants arriving in Australia have faced a wide range of challenges, from learning a new language and finding somewhere to live to obtaining employment and negotiating new social rules and structures. Source 9.12 outlines some of these challenges and how they were overcome. The case studies that follow are practical examples of how people have overcome the challenges listed in Source 9.12.



Source 9.12 Challenges faced by newly arrived migrants and how they were overcome

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Case study 9.2
Germans in Tanunda, South Australia



Source 9.13 Street map of Tanunda, South Australia

German settlement in South Australia dates back to 1838. Germans have formed a significant part of the population of South Australia almost since the state's foundation. This has been estimated at between 7 and 10% until the outbreak of World War I in 1914. By 1855, Germans and their children made up over 8% of the population of South Australia. The first German settlers had come because they were suffering religious persecution in their homeland. Later German immigrants came to enjoy the freedom and economic prosperity of the new colony. Many came because they had friends or relatives already living in South Australia.

The 1850s were important years for the German settlers. Two German newspapers were launched, *Die Deutsche Post* (The German Post) and *Deutsche Zeitung für Südaustralien* (German Newspaper for South Australia) and a German Hospital was opened. The Liedertafel choir started, as did the famous Brunswick Brass Band. *Der Deutsche Club* (the German Club) began in 1854 and was to flourish as a centre of German culture and learning until 1907. German miners from the Harz Mountains were active in the colony's copper fields, while German smelters brought their knowledge of how to smelt with timber to the Glen Osmond and Burra mines. In the 1850s, numerous German silversmiths and goldsmiths arrived in the colony to settle in Adelaide, as did cabinet makers and piano makers.

Located 70 km from Adelaide, Tanunda (an Aboriginal word that means either 'watering hole' or 'many birds on a creek') is the focal point of the





Source 9.14 German immigrants have contributed to the food and wine industry in South Australia.

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Source 9.15 Ancestries in Tanunda

Ancestry, top responses	Tanunda	%	South Australia	%	Australia	%
Australian	1729	27.8	551 097	26.5	7 098 486	25.4
English	1656	26.6	608 346	29.3	7 238,533	25.9
German	1482	23.8	124 625	6.0	898 674	3.2
Scottish	390	6.3	128 042	6.2	1 792 622	6.4
Irish	317	5.1	121 248	5.8	2 087 758	7.5

Barossa Valley. It is a large rural settlement with leafy streets that is surrounded by vineyards.

Before European settlement, a small number of Aboriginal people were well established in the district. They lived on a diet of grass seeds (made into a kind of damper), kangaroos, wallabies, possums, lizards and fish, and protected themselves against the winter cold with possum-skin rugs. Their life was perfectly in tune with the climate, flora and fauna of the region.

Soon after the arrival of colonists in South Australia in July 1836, expeditions were sent out to explore the hinterland. By 1839 Colonel Light, the Surveyor General of South Australia, was selling off large areas of land in the valley. German settlers arrived in Langmeil (the town has since changed its name to Tanunda) in 1842 as a result of the work of Pastor Augustus Kavel, who had contracted for the land on 30 June 1839. He was also responsible for some of the German emigration to South Australia. Today the town continues to have a distinctly German feel, with sausage shops, German bread shops, German-style restaurants and lots of wine.

People: cultural and language diversity

The most common ancestries in Tanunda were Australian 27.8%, English 26.6%, German 23.8%, Scottish 6.3% and Irish 5.1%.

1. Identify the German products in Tanunda still present today.
2. Explain why the early German migrants created a community in Tanunda.
3. Using the above table, draw a column graph that shows the cultural diversity in Tanunda.

Case study 9.3

The Italians in Leichhardt, Sydney, New South Wales

The 1840s saw the end of convict migration from Britain and the opening of free immigration. The Italians began migrating to Sydney in 1861, but the period following World War II saw the greatest migration from Italy to Australia. This led to the creation of many businesses and cultural activities. The 1947 Census registered 33 632 first-generation Italians residing in Australia, while that of 1971 accounted for a peak number of 289 476. Sydney's Italian population increased accordingly, to the point that, by 1971, over 5000 Italians lived in Leichhardt.

Decline

From 1971, the Italian community in Sydney suffered a steady decline in numbers, mainly due to the **gentrification** of the suburb, which triggered an end to Italian immigration in the area. The younger generation moved to Sydney's outer suburbs, where

gentrification the renovation and growth in social and economic status of previously run-down areas

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Source 9.16 Italian festival in Leichhardt, Sydney, 2012

larger and more affordable housing blocks were available. For example, the suburb of Leichhardt in Sydney's inner west had 5000 Italians in 1971, 3922 in 1976 and 1872 in 1991. This case study shows how the suburb of Leichhardt has changed over time with the decline of the Italian population, but emphasises that it is still a community that celebrates the contributions of Italians. Some aspects of Italian heritage clearly present in Leichhardt are recognisable in the names of local businesses and the frequent use of the colours of the Italian flag. There is also a CoAsIt Bilingual School for 2nd- and 3rd-generation Italian speakers.

According to the 2011 ABS Census, the population of Leichhardt is 13 520. The country of birth of people living in Leichhardt is 5.1% England, 3.8% Italy, 0.9% Ireland, 0.8% China and 3.2% New Zealand. Some 73.8% of people speak English as their first language, 0.9% speak Cantonese, 6.1% speak Italian, 1.8% speak Spanish, 1.6% speak Greek and 0.8% speak Mandarin. From

Source 9.17 Origins of people in Leichhardt

Country of birth	Leichhardt	%	New South Wales	%	Australia	%
Australia	34 098	65.3	4 747 372	68.6	15 017 847	69.8
Other top responses						
England	3 818	7.3	227 524	3.3	911 593	4.2
New Zealand	1 696	3.2	114 232	1.7	483 398	2.2
Italy	919	1.8	51 626	0.7	185 402	0.9
Ireland	537	1.0	21 919	0.3	67 318	0.3
United States	497	1.0	26 530	0.4	77 009	0.4

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these statistics, it is clear that the community has undergone demographic change.

What was Leichhardt like during the period of peak Italian population?

Italian settlement in Leichhardt dates back more than a century. However, the most important time in terms of building a community was from 1940 to 1970, when a sizeable Italian-born community settled in Leichhardt and adjacent suburbs. Today, Leichhardt is close to other suburbs and municipalities in which there are concentrations of Italian-born people, as well as their second- and third-generation descendants.

From the 1940s, the Italian-born community of Leichhardt was supported by a growing number of Italian-run businesses, such as the many restaurants and cafés that are still found in its main street, Norton Street. In the post-war period, there were also social, sporting, religious, and educational and welfare clubs and associations. The Italian-language media – newspaper *La Fiamma* and TV station RETE Itali – are based in the suburb of Leichhardt. The Italian-born community was also assisted by Italian-speaking Capuchin friars at the church of St Fiacre's in Catherine Street, Leichhardt. In 1954, the Associazione Polisportiva Italo-Australiana, the APIA Club, opened in Norton Street, Leichhardt, and moved to Fraser Street in 1962; it has since become a function centre. Many of the Italians in Leichhardt had occupations such as dressmakers, fruit and vegetable store owners and furniture manufacturers.

Despite its demographic decline, the importance of this suburb to Sydney's Italian community and its influence on the city's life remain strong. Italian celebrations, including the following, are very popular:

- Italian National Day is celebrated annually. It is part of wider community celebrations that occur during the Sydney Italian Festival. The day is marked by a range of activities, including networking functions, a ceremony to acknowledge Italian war experiences and a large, free event featuring entertainment and a fireworks display.
- The Sydney Italian Festival promotes and showcases Italian culture, bringing to Australia a focus on the innovations and uniqueness of Italian lifestyle and design, film and arts, as well as Italian foods and wines.
- The Italian Film Festival, held at Norton Street, Leichhardt, remains a key cultural event.
- The Italian Forum in Leichhardt, designed by Romaldo Giurgola (also designer of Parliament House in Canberra) is a feature of the suburb.

1 Identify how free migration opened the way for Italian migrants to come to Australia.

2 Explain what has happened to the number of Italians living in Leichhardt since 1971.

3 Account for the declining numbers of Italians living in Leichhardt.

4 Using Source 9.17, deduce the impact of Italian culture in Leichhardt.

5 Investigate why Italians still gather in Leichhardt for celebrations like the Sydney Italian Festival, despite the fact that many no longer live there.

6 Critically analyse Source 9.17. What do these figures show about Italians living in Leichhardt?

7 'The Italians have been successful in creating a community in Leichhardt.' Do you agree or disagree? Justify your answer.

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Case study 9.4

The Sudanese in Moorooka, Brisbane, Queensland

A recent documentary, *I'll Call Australia Home* (2008), states that in the 1990s, 2 million Sudanese died in the civil war and an estimated 4 million were displaced as towns and villages were destroyed and communication was lost between families. Many spent as long as 10 years in a refugee camp, usually in squalid conditions and with poor security and medical care. A recent study by the Centre for Displacement Studies says that children across the Sudan have faced 'extensive threats and abuses, including killing, maiming, and other forms of violence, abduction, lack of humanitarian assistance, forced labour, trafficking, and recruitment by armed forces and groups'.

Some Sudanese have found it difficult to settle into the Australian way of life, often because they have experienced such extreme events; they are often the survivors of torture, massacres and other atrocities. They have needed a lot of support and resources to keep their families together and to properly engage with the wider community. The Australian government has been active in the resettlement of citizens of South Sudan, where ethnic warfare and the threat of **genocide** have made many Sudanese fear for their safety. In 2007, the Sudanese community was one of the fastest growing groups of settlers in Australia. Between 1997 and 2007, the number of newly arrived immigrants born in Sudan increased by approximately 34% each year, primarily due to humanitarian programs from 2001. Between 2001 and 2006, Sudanese-born new immigrants settled mainly in Victoria (36%), New South Wales (24%) and to a lesser extent Queensland (14%), largely in the capital cities. Only 10% reside in regional Australia, and many are located in cities such as Toowoomba, which already had an established Sudanese community.

genocide the deliberate killing of a large group of people, especially those of a particular ethnic group or nation

There are an estimated 5000 African refugees in Queensland; the Sudanese constitute the largest national group. The Sudanese in Moorooka have found strength and resilience in their new lives. Moorooka is 12 minutes away from Brisbane's central business district. The Sudanese have established businesses and united with other African communities from Ethiopia, Somalia, Sierra Leone, Kenya, Tanzania, Eritrea and most recently Burundi. The area along the central street of Moorooka is Beaudesert Road, which is often referred to as 'Little Africa'.



Source 9.18 A good way to share culture is to serve food from your homeland.

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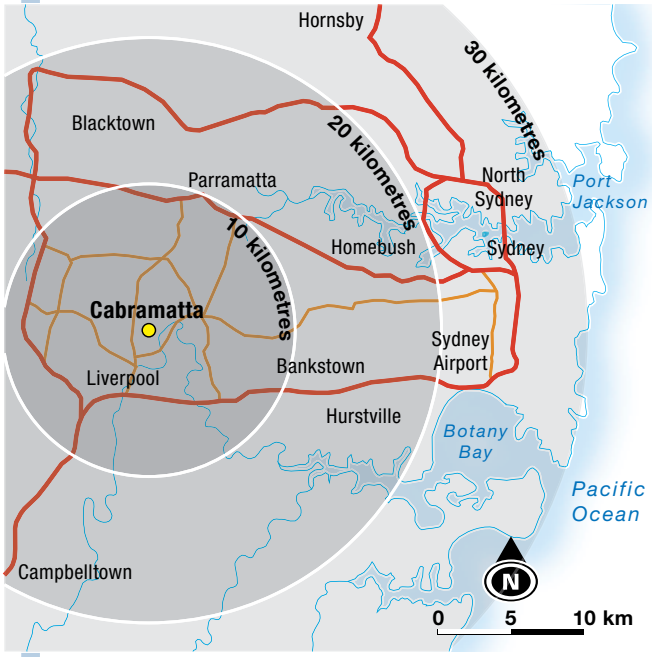
There are an estimated 394 African refugees in Moorooka. Having refugee settlement accommodation in the area has encouraged this community to grow. In the streets, there are colourful fabric stores, restaurants and Halal butchers. Stores such as Onan Global Goods sell special flour, beans and spices. Within this young community, there is a strong sense of resilience and success. For example, on 29 October 2006, the Brisbane *Courier-Mail* published a story about a refugee from the Sudan who spent 4 years in Port Hedland Detention Centre, Western Australia. He then worked for 2 years in a chicken processing plant and saved enough money to open up his own Umdorman Cafe serving Sudanese food, where he employs 2 people to help him.

The founder of another restaurant, called the Mu'ooz restaurant, has 22 women working for her. These women have been encouraged by the Eritrean Women and Family Support Network to work and be involved in the community. This has provided a way of sharing their culture by serving the food of their homeland.

1 Outline the reasons why the Sudanese left their country.
2 Explain why the Australian government has supported the refugees' resettlement in Australia.
3 Describe how the Sudanese refugees have created a community in Moorooka.
4 Describe the impact of the Sudanese on the suburb of Moorooka.

Case study 9.5

The Vietnamese in Cabramatta, Sydney, New South Wales



Source 9.19 The location of Cabramatta, the largest Vietnamese community in Australia

Australians of Vietnamese origin comprise one of the largest migrant communities in Sydney. Following the fall of Saigon to communist forces in 1975, the Vietnamese were the first large group of Asian immigrants to settle in Australia subsequent to the end of the White Australia Policy. According to the *Dictionary of Sydney*, before 1975 there were already around 500 Vietnamese in Australia, mostly Colombo Plan students. Vietnamese refugees did not begin to arrive in Australia in their thousands until 1978, when 5400 were settled. Arrivals continued strongly through the early 1980s, with

Geographical fact

Vietnamese is the 5th most commonly spoken language in Sydney, other than English.

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Source 9.20 Origins of people in Cabramatta

Country of birth	Cabramatta	%	New South Wales	%	Australia	%
Australia	6106	29.4	4 747 372	68.6	15 017 847	69.8
Other top responses						
Vietnam	6 769	32.6	71 840	1.0	185 039	0.9
Cambodia	1 944	9.4	11 147	0.2	28 329	0.1
China (excludes SARs and Taiwan)	1 081	5.2	156 035	2.3	318 969	1.5
Laos	337	1.6	5 101	0.1	9 932	0.0
Thailand	306	1.5	17 539	0.3	45 464	0.2

12 915 people arriving in 1980. Today, Vietnamese migration to Australia has entered a post-refugee phase in which the new immigrants are students and migrant workers.

Cabramatta today

In Cabramatta, 29.4% of people were born in Australia. The most common countries of birth were Vietnam 32.6%, Cambodia 9.4%, China (excluding SARs and Taiwan) 5.2%, Laos 1.6% and Thailand 1.5%.

The main reason Vietnamese Australians settled in Cabramatta is that most arrivals were initially housed in hostels in the area. The biggest of these hostels was the Cabramatta Migrant Hostel. Cabramatta has a history as a migrant 'transition zone', and has had many post-World War II arrivals, including British, German, Greek, Italian and Yugoslav migrants. The evidence of these cultures is still present today, and can be seen in the clubs, housing styles and places of worship established by these communities. Many of the Vietnamese were traumatised by the war in Vietnam, and wanted to build a strong community. Today, the distinct character of the strong community that grew up here can be seen in the food, sounds, shop signs, buildings and languages spoken on the streets of Cabramatta. Almost every bank has an interpreter service to support the Vietnamese. The main street, John Street, is dominated by the Pailau Chinese gateway, which has Chinese symbols and words in Chinese, Vietnamese and English: 'The world is for us to share and respect' – a reminder that all people should treasure freedom and democracy, no matter what our origins. The Freedom Plaza is a community meeting place that unites the various Indo-Chinese cultural groups, including Vietnamese, Lao and Thai people. The places of worship help to create a sense of community, as they allow people a place to celebrate their common faith or beliefs. These form an important part of the identity of the migrants in Cabramatta. The streetscape has many shops trading beyond their boundaries out on to the

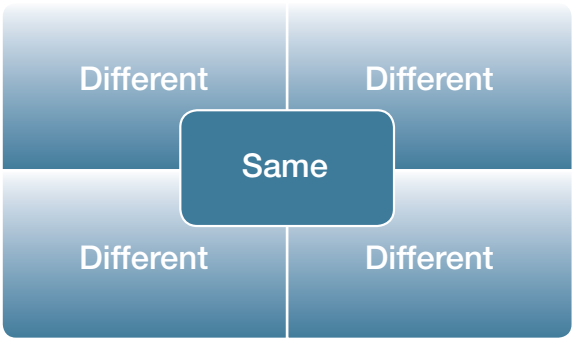


Source 9.21 Participants in a recent Cabramatta Moon Festival

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footpath. This gives the main street a market-style feel and look. Street lighting is provided in the shape of Chinese lanterns. Red and gold trim is also used on many shops. Today there are many traditional celebrations, including the Moon Festival and the Lunar New Year. Together these festivals unite the community and display cultural diversity. Every year, over 50 000 people attend each festival.

1 List the ethnic groups found in Cabramatta.
2 Identify why there are so many different cultures found in Cabramatta.
3 Explain why the Vietnamese have settled in Cabramatta.
4 Describe why Cabramatta is seen as a multicultural community.
5 Using the statistics in Source 9.20, construct a pie graph showing the cultural diversity in Cabramatta.
6 Copy the graphic organiser below into your exercise book, then use it to compare and contrast any 4 of the case studies presented in this chapter.



The most ambitious phase of Australia's migration program followed the end of World War II, which had displaced millions of people from their homelands. Australia negotiated agreements to encourage newcomers from the United Kingdom, and Western and Southern Europe as well as Displaced Persons (DPs – refugees) from Eastern and Central Europe and the Baltic states. Australia needed migrant labour in order to boost the economy, overturn the flagging birth rate and ensure defence was maintained. Intending emigrants were enticed to Western Australia with images of booming industry, boundless opportunity, full employment, good working conditions and a level of materialism that was unheard of in post-war Europe. Passage assistance was offered by the Commonwealth government to prospective emigrants if they met the health, security and age criteria and agreed to remain in the employment for which they were selected for a period of 2 years, or to repay their fare.

A policy of **assimilation** ruled in the 1940s to the 1960s. 'New Australians' were expected to learn the Australian language and to adopt the traditions and customs of their new country. Cultural heritage and language had to be discarded, as migrants were told that the past was irrelevant to the new life they were about to forge. Australia's demand that newcomers assimilate quickly and totally to its culture not only implicitly asserted the superiority of Australian culture over theirs, but also guaranteed that Australia's essential Britishness would remain.

assimilation absorbing and making alike; the process of cultural absorption

The process of resettlement was greatly improved when the immigration policy shifted from assimilation to **integration** in the mid-1960s. Integration implied that migrants no longer needed to totally and immediately discard their cultural past, as they had with assimilation.

integration a situation in which a people is able to maintain its own basic culture and have it respected, while living within and respecting another culture

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FIELDWORK 9.1 EXPLORING MIGRANT HERITAGES IN YOUR OWN COMMUNITY

Aims

To discover the cultural diversity in your suburb.
To investigate the positive and negative impacts of cultural heritage in your local area.
To gather and show your findings through graphs and photographs.

Method

Select a shopping centre or street in your local area to conduct your research.

Preparations

Find a map of your local area and indicate the areas that will be visited and studied. You will also need to take a camera, paper (on a clipboard) and a pen.

Data collection

As you complete this fieldwork, stop at various sites and ensure that you collect the following information in preparation for your fieldwork report:

1 List all the evidence of cultural diversity in your fieldwork area. Take photos of this evidence. Mark the locations of these activities on your blank map. Provide a key to interpret your data collection.

2 To what extent does cultural diversity exist in your fieldwork area?

3 Describe the positive and negative impacts of cultural diversity in your chosen fieldwork site.

4 Outline the short-term and long-term impacts of cultural diversity in your chosen fieldwork site.

5 Sketch 2 examples of the ways in which the use of the area has affected the environment. Annotate your sketch with as much information as possible about the use and its impact.

6 Observe the human features in your fieldwork site. Is there a dominance of one culture or a collection of many? Explain your answer.

7 Compare this to the statistics provided in the ABS website, via www.cambridge.edu.au/geography8weblinks – click on 'Community Profiles'.

Fieldwork presentation layout

Front page	Title and name
Contents page	Do this last, as well as numbering pages
Page 1	Aims and methods
Page 2	Location map (title of the shopping centre or street in your local area)
Page 3	Introduction – brief description of the study site
Pages 4–5	Description of cultural groups evident and photos
Page 6	Table that shows the categories the shops or features into dominant cultural groups. Have a data collection (make a tally) for 'others' – those that do not fit into a particular group.
Pages 7–8	Description of positive and negative effects of cultural diversity in your chosen site, sketches and/or photos
Page 9	Association between use and culture – for example, does the fieldwork site you have chosen get visitors from many cultural backgrounds or are some more dominant than others?
Page 10	Table and graphs showing your statistical findings on the different cultures and evidence from the built environment
Page 11	Annotated photo essay showing the cultural diversity in the fieldwork area
Page 12	Evaluation of the strategies used to collect your cultural heritage data
Page 13	Appendix, Bibliography, Glossary

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Chapter summary

- International migration dates back thousands of years, to when the first humans crossed from East Africa over to Asia, then to Australia.
- Immigration can be forced (usually by political circumstances) or voluntary (usually for economic reasons).
- The composition of the Australian population has changed significantly, due to the various waves of historical migration.
- International migration is the outcome of economic and political change.
- Refugees and asylum seekers are an example of forced migration; they come to Australia because they live in fear in their own country, and do not have the same protection afforded to them as we have here.
- The results of international immigration are reflected in our cities: in the architecture, religious and cultural events, food and services provided.

End-of-chapter questions

Multiple choice

1 International migration is:

- **A** the movement of people from one country to another
- **B** forced migration to another country due to fear
- **C** the movement of people from state to state
- **D** the involuntary movement of people

2 A demographer studies:

- **A** communities
- **B** graphs
- **C** town planning
- **D** populations

3 Multiculturalism is:

- **A** having a common culture
- **B** having different cultures coexisting
- **C** not a government policy in Australia
- **D** about having the same religious beliefs

4 SSRM is an acronym of:

- **A** State Specific and Regional Migration
- **B** State Secret and Resettlement Migrants
- **C** State Specific and Recent Migration
- **D** State Specific and Regional Movement

5 Which of the following statements is correct?

- **A** Cities around the world have been transformed by international migration.
- **B** International migration has always been well accepted in Australia's migration history.
- **C** Multiculturalism has always had a positive outcome.
- **D** Refugees are settled quickly in host nations.

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Short answer

1 Explain how international migration has changed Australian cities.

2 Discuss some reasons why refugees may want to live in Australia.

3 Justify your response to the following statement: 'Multiculturalism has enriched the way of life in Australia.'

4 'Australia is not the only country that is made of international migrants.' Discuss this statement with examples to support your answer.

5 Asylum seekers are not 'illegal immigrants' because, under both international and domestic law, they have a legal right to enter Australia to seek asylum. Identify what the difference is between an asylum seeker and an illegal immigrant.

Extended response

Identify and explain the main types and patterns of international migration. Explain the differences between permanent migration, temporary labour migration, student migration, forced migration (including refugees) and family reunion in your response.

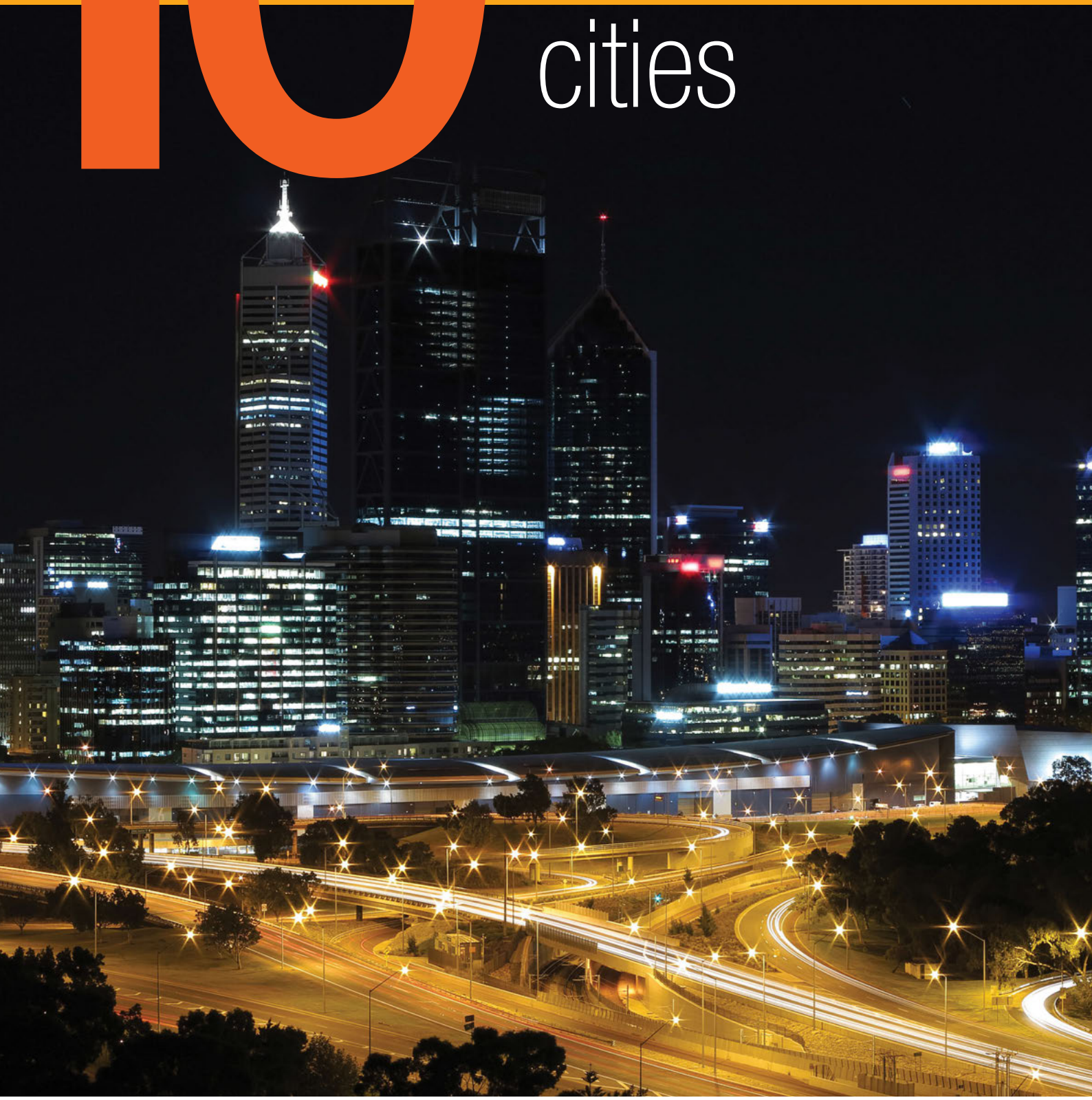
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Source 9.22 Melbourne's Chinatown, Little Bourke Street

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10 Managing Australian cities



Source 10.1 Perth, the capital of Western Australia

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Before you start

Main focus

In order to manage and plan Australia's urban future, policy makers and the community must plan and implement strategies to build and maintain sustainable cities.

Why it's relevant to us

Sustainable cities in Australia support social and economic development while minimising environmental damage. Managing urbanisation as it occurs, rather than trying to fix cities at a later time, is crucial and an important factor in the evolution of our society as a whole. Building and maintaining sustainable cities has implications for our current standard of living, and future generations will be affected by the actions and decisions we make now.

Inquiry questions

- What can be learned from examining the forecasts for the size of Australia's major cities and regional urban centres?
- What are the implications of the size of Australia's major cities with respect to environmental sustainability and liveability?
- How can the projected growth of Australia's cities and regional urban centres be managed?
- What are the advantages of a more balanced distribution of the urban population?
- What are the disadvantages of a more balanced distribution of the urban population?
- What can we learn about how Canberra can be used as an example of urban decentralisation?

Key terms

- Urbanisation
- Decentralisation
- Sustainable
- Suburbanisation
- Urban sprawl
- Gentrification
- Zoning
- Urban consolidation
- Population distribution
- Salinity
- Humpies
- Internment camp
- Town planner
- Metropolitan

Let's begin

The population of Australia's capital cities grew by 1.8% between 2011 and 2012, faster than that in the remainder of Australia (1.2%). Greater Perth had the fastest growth of all capital cities at 3.6%, ahead of Greater Darwin and Greater Brisbane (both 2.0%). The fast pace of urbanisation in Australia is bringing vast challenges for the management of cities.

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10.1 Building sustainable cities

urbanisation the process by which more and more people are coming to live in towns and cities

Urban growth and **urbanisation** have both positive and negative effects. On the positive side, growing urban centres can take advantage of the financial benefits that result from more jobs and increased incomes. A large percentage of Australia's economic growth comes from its urban areas. On the negative side, some of our cities undergoing rapid growth suffer from insufficient services, environmental degradation, growing traffic congestion and an increase in the number of homeless people.

Increasing **decentralisation** and the issues of management are putting more pressure on the responsibilities of local governments, but without the necessary additional financial or human resources. The expectations of residents and businesses concerning lower-cost and higher-quality services are increasing, but the required levels of resources are sometimes not available.

decentralisation the spread of power away from the centre to local branches or governments

With a country as large as ours, which has many diverse needs, the social and economic development of urban areas is focused increasingly on local government management. Priorities for the city of Cairns, for example, may be different from those of Launceston. Population, climate, tourism and the potential for natural disasters are just some of the differences that need to be considered in the planning and maintenance of these cities. In Australia, some cities have a heavier focus on water catchments, whereas others have regular flooding concerns.

sustainable healthy and functional in the long term

The World Health Organization states that **sustainable** cities are cities where the population enjoys a high quality of life and takes care not to leave economic, social, environmental or health problems for future generations to face.

Our cities are growing

As the populations of our cities grow, there is an increasing need to provide services for the people who will live in newly developed suburbs. Services that need to be provided include schools, hospitals, utilities such as water, gas, electricity, solar energy resources, roads, bridges, sewerage and telecommunications. As these population numbers grow, so does the size of our Australian cities, which has an impact on the surrounding areas. This is mainly seen in new suburbs on the outer fringes of cities. The growth of new suburbs is called **suburbanisation**, and is often associated with another process called **urban sprawl**. These processes are evident in all Australian cities. The impacts can be both positive and negative. For example, as suburbs grow there is an impact on areas that were once native bushland or land that was once used for agriculture or the raising of animals for food.

suburbanisation movement of people and work to outer urban areas and middle-distance suburbs

urban sprawl the gradual spread of cities into previously rural areas

Impacts of urban sprawl

Urban sprawl can have negative impacts. The cost of providing such increased utilities and services in growing urban areas is very expensive, and many suggest that this has consequences in terms of the efficient use of natural resources.

- *Increased traffic*. This is caused by many factors, including the distance from amenities such as schools and workplaces. This contributes to greenhouse gases in the form of emissions from car exhausts and the fuel needed to drive the vehicles. It also can lead to traffic congestion and delays in getting to places.
- *Decrease in air quality*. Urban sprawl causes a significant decrease in air quality. People spend much more time in cars commuting to work and running errands. Commuting to work used to take people 10–15 minutes in the car. Today, people are spending 30 minutes or considerably more commuting to work due to urban sprawl.

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- *Urban decline and renewal.* In some older suburbs closer to the city centre, the older-style homes can be abandoned as families seek to live in bigger homes in the newer suburbs on the outskirts of the city. This usually occurs because industries relocate to the outskirts of the city, where land is less expensive and there is more space for expansion. As a result, the inner city areas become unused and fall into decline until there are people who want to live in the older-style houses and renovate them. These are usually professionals without a young family, or 'empty nesters'. This process is known as **gentrification**. This can be seen as a positive, as it is a process that brings new life into older suburbs that previously were in decline.
- *Lack of choice in housing styles.* So that more houses can be 'fitted' into new developments, many dwellings are often built to the same design. This leads to homes in some newer suburbs lacking individuality and a uniform appearance in the character of the suburb.
- *Loss of rural areas.* This is due to the need for land to establish the growth of the population.

gentrification the renovation and growth in social and economic status of previously run-down areas

Geographical fact

In 2012, Melbourne is estimated to have grown by 79000 people, or more than 1500 each week. For the 11th consecutive year, Melbourne had the biggest growth of any city in Australia. Since 2001, it has gained 605000 new residents, up 17%, who are rapidly pushing out the urban boundary in every growth corridor. Perth outgrew Sydney to be Australia's second biggest growth centre, its population swelling by 65 434, or 3.6% – more than twice the national growth rate – to almost 1.9 million.

Source 10.2 The city of Melbourne



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This has ecological consequences, as the rural areas absorb carbon dioxide from emissions.

- *Decline in water quality.* Paved surfaces allow run-off during rainstorms. This run-off picks up oil, chemicals and gravel from the pavement and grass. These chemicals would usually be filtered out of the water through the ground; however, due to the increase in the amount of concrete, they now run off into waterways such as creeks and streams. Fertilisers from gardens also run off into these waterways, causing algal blooms, which in turn decrease the level of oxygen in the water, killing aquatic life. This pollution contaminates the water supply for nearby towns.
- *Decrease in groundwater.* The increase in paved surfaces reduces the opportunity for infiltration of rainwater into groundwater. Areas that depend on groundwater as a source of public water supply are facing a water crisis as aquifers become thin. These areas can also face a problem with land subsidence. The increased demand on the groundwater due to urban sprawl has created air pockets in the aquifer. The land compresses, causing flooding problems and cracking of foundations. There is also an impact on groundwater reserves, the water that would normally infiltrate into the soil now runs off and makes its way to the drains and then to the ocean or other water storages.
- *Loss of biodiversity.* Urban sprawl has a negative impact on wildlife and ecosystems, as they are cleared or fragmented by the development of new areas. In some suburbs, such as Woodcroft in New South Wales, artificial wetlands are created in order to attract wildlife and add a nature reserve to the built environment. There are

Source 10.3 Impacts of urban sprawl: an aerial view of fertile farmlands surrounding the city of Brisbane



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also some areas of Woodcroft that are protected, including the remnant Cumberland Plain Forest. The reason this remnant forest is protected and has not been removed for the construction of houses is that there is a rare species of frog in the forest.

- *Heat island*. Many cities and suburbs experience a heat island effect, caused by the temperature increases in the area due to the increase in the amount of asphalt and buildings. Studies in the north-east of the United States have demonstrated that this increase in temperature can be as much as 7°C.

Geographical fact

According to *National Geographic*, urban sprawl takes up an additional 400 000 ha of open space in the United States every year.

NOTE THIS DOWN

Copy this chart and write down what you know about the impacts of urban sprawl (use red pen) and what you have learned about urban sprawl (use blue pen). For this task, you will need to use each letter of the alphabet to write down a summary of the impacts of urban sprawl.

ABC Brainstorming

Topic: _____

A	G	M	S
B	H	N	T
C	I	O	U
D	J	P	V
E	K	Q	W
F	L	R	XYZ

Ways to reduce the effects of urban sprawl

- *Preserve natural resources.* This includes the preservation of natural resources such as farmlands, parks, open spaces and unused land. Preserving the land keeps it the way it was meant to be. The benefits of this are that biodiversity is encouraged and flora and fauna are not removed.
- *Renew cities and older suburbs.* Urban renewal projects can reduce urban sprawl. In older parts of the city centre and in older suburbs, the removal of contaminated land and investment in original heritage buildings can add life to areas that have undergone decline. This also attracts people back to these urban places, reducing the growth of urban sprawl. Once the areas are improved, the government can provide incentives to get people to move back into these areas. This could take the form of affordable housing for low-income earners.
- *Create a community identity.* This includes building sports facilities, parks and schools in close proximity to residential areas, reducing driving times and fostering a closer sense of community.

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- *Improve public transport.* Providing more options such as light rail and bus transit lanes can help reduce traffic congestion during peak hour.
- *Have more high-density, and a greater variety of, housing.* Higher-rise or medium- density housing can reduce urban sprawl by limiting the amount of land needed to create homes in which people can live. Creating a mix of housing types within a suburb – such as larger homes for big families and smaller homes for singles and couples – can also stop urban sprawl by encouraging a mix of family types and meeting their housing needs. This stops people from wanting to move away from the city.
- *Government policy.* This is important, as governments make plans for future growth through the **zoning** of land. This must clearly support the need for a sustainable future in city living with a long-term plan that is flexible and reflects the needs of the community.

zoning government restrictions about the types of buildings and services allowed in an area

- *Encourage regional settlement.* This will mean there is less demand to live in urban places. This is particularly so in the case of migrants from overseas or those moving intrastate. The Department of Immigration and Citizenship estimates that 90% of new migrants settle in cities. As a result of the various waves of migration, our cities are enriched by cultural and religious diversity and a variety of languages. The reason for this pattern is that there are more resources and opportunities for employment in the quest to become established in their new country. Some claim that this can put pressure on existing city resources, but others say that migrants create new jobs and opportunities for all residents. Government statistics also state that over the last 10 years the proportion of newly arrived migrants settling in regional Australia has seen a slight increase, rising to 15% of all migrants.
- *Improve energy sources.* Encouraging better use of renewable energy sources can benefit and reduce the cost on both the environment and the individual. Solar power and recycled water are areas that can be strengthened in the future. It is important to encourage more energy-efficient housing by such means as ensuring that new housing developments have regulations in place, such as insulation in the walls to reduce the need for air-conditioning, water tanks to collect rainwater and better recycling of household rubbish to reduce landfill.
- *Reduce commercial zones.* With the increase in online shopping, some people feel less need for the physical shopping centre. This can reduce urban sprawl, as consumers would not have to drive to the commercial areas to do their shopping. Another strategy could be mixed-use areas that have commercial properties on the ground floor and apartments on the top floors.
- *Develop regional centres.* Developing regional centres takes the pressure off the larger established urban areas close to the city. Projects such as EVOCITIES have been an incentive for people to move out of the **metropolitan** areas to these regional centres. This government initiative is a positive way to encourage growth in existing regional areas that have the space

metropolitan of a very large city, often the capital of a country or region



Source 10.4 Better transport and connected urban places can reduce urban sprawl.

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for growth and the need to have their local economies stimulated.

- *Urban consolidation*. This can greatly reduce the need for urban sprawl and make our cities more ecologically friendly. **Urban consolidation** is the process of planning and construction of more medium-density housing in existing urban areas. This is more sustainable, as it uses existing roads and amenities and often is used to infill areas that are not suitable for stand-alone dwellings in the city. This has added benefits, as the buildings are often close to public transport facilities such as trains and buses.

urban consolidation the process whereby medium- and high-density housing is added to existing areas in urban places, using existing roads and amenities, with the purpose of reducing urban sprawl

Geographical fact

A way of making cities more environmentally friendly is seen in the Green Roofs Project in Toronto, Canada. The study, undertaken by Ryerson University, praised green roofs as a positive strategy to address issues in urban areas, including management of stormwater run-off and pollution. Precipitation is stored in plants on roofs, reducing the water flow to the hard surfaces below, like concrete – which does not absorb water. The study estimated that the installation of approximately 5000 ha (on roofs larger than 350 m^2) could save the city an estimated C$39 million in pollutant and erosion control, and an additional C$46 million from reduced water-storage costs.

ACTIVITY 10.1

1 Identify the main reason why cities are growing.

2 In pairs, discuss the positive and negative implications of the suggested strategies to improve the impacts of urban sprawl. Copy the table and then summarise and write your answers. The first 2 have been done for you.

Suggested way to reduce urban sprawl	Advantage	Disadvantage
Improved public transport		
Developing regional centres		

3 List the impacts of urban sprawl.

4 Explain why urban sprawl is not an efficient use of resources.

5 Use the internet to write a brief report about the advantages and disadvantages of urban consolidation. Identify examples in your nearest urban area to include in your report.

6 Conduct a class debate on the following topic: 'Australian cities are unsustainable.'

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10.2 Agenda 21 promotes sustainable cities

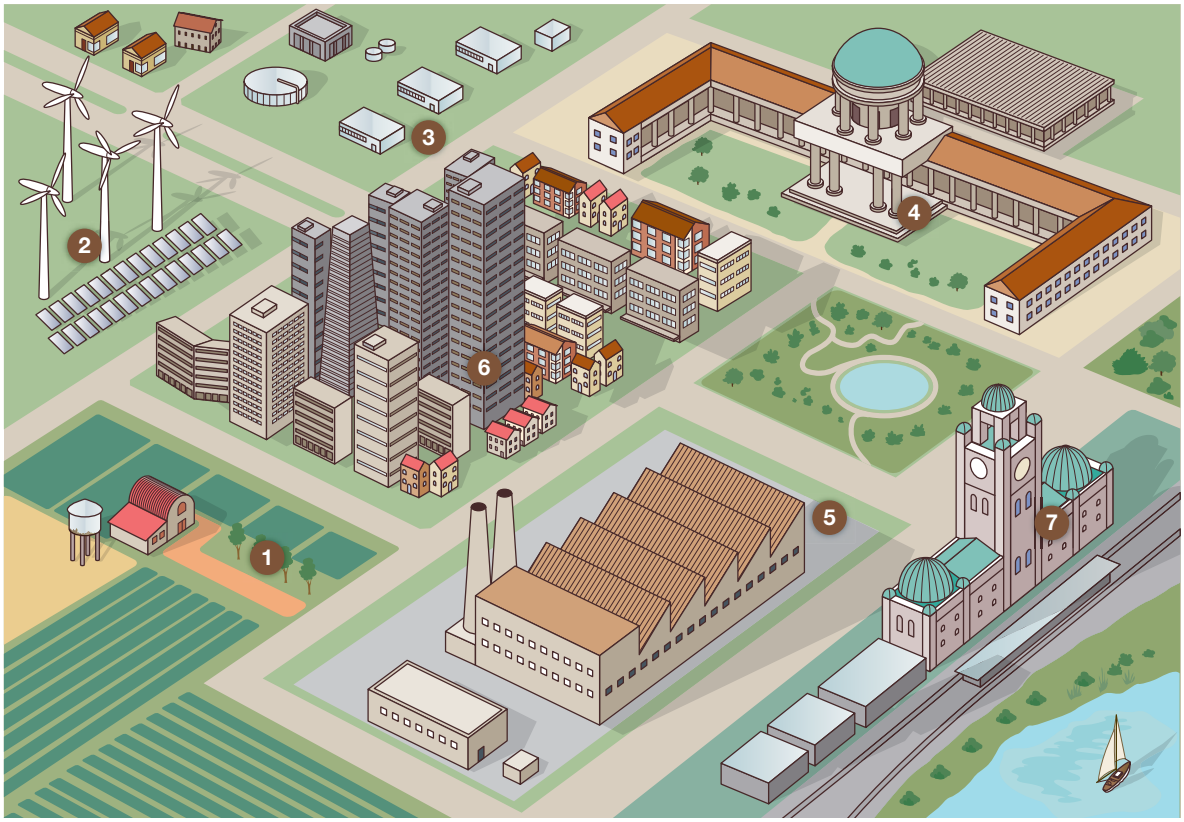
In 1992, the United Nations introduced an action plan for sustainable development called Agenda 21. Agenda 21 is a blueprint that sets out what we can all do to contribute to global sustainability in the 21st century. It recognises that most environmental challenges have their beginnings in local activities, and therefore encourages local governments to promote local environmental, economic and social sustainability by developing strategies that are meaningful to local communities. This process is called Local Agenda 21. It is important to have this global plan for sustainable development of cities. It aims to create sustainable cities by encouraging governments to locally:

- provide better-quality homes for all
- improve the planning of urban places
- encourage better use of land
- reduce waste and recycle
- encourage better use of energy and alternatives to fossil fuels
- encourage environmentally sustainable transport systems
- promote sustainable construction of urban places.

environmental sustainability the management of the world's environment to meet the needs of the present population without reducing the capacity of future generations to meet their needs

There have been many successful urban plans that have implemented the strategies of **environmental sustainability** to make cities more sustainable for the future. These can be seen in the following examples.

Source 10.5 Cities of the future



1. Food supplies will need to be close to the city with plans in place to encourage the growth of market gardens.
2. Need for greater cleaner and efficient use of alternative energy supplies and a reduction in reliance on fossil fuels.
3. Improve recycling capabilities and reduce waste.
4. Allow for people and groups to share ideas of sustainable cities.
5. Reduce air pollution and greenhouse gases.
6. Improved planning by increasing urban consolidation in both cities and suburbs.
7. Improved public transport connections that are fast and use energy efficiently.

(other examples, not pictured)

8. Introduce more native species in green areas to improve air quality and biodiversity.
9. A variety of jobs for the future to maintain a strong economy and the skills of those living in cities.
10. Create more areas of cultural diversity so values and beliefs can be expressed and maintained.
11. Emphasis on local history and heritage to encourage preservation of buildings.
12. Include infrastructure that is sustainable in terms of energy use and design, and that exploits existing features, such as taking into account the direction of the sun and topography.

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Geographical fact

The first Earth Summit for Agenda 21 was held in Rio de Janeiro in 1992; the Summit took place again in 2002 and in 2012, 20 years on from the first meeting.

Examples of sustainable strategies implemented with the principles of Local Agenda 21

Gold Coast, Queensland

The Gold Coast is a high-density **urban area** with an attractive coastline. In response to the population growth predictions, in 1997 the Gold Coast City Council developed a plan that would protect the natural and built resources of the city. This was known as the Integrated Environment Plan. The aims were to create a sustainable city and to maintain the Gold Coast as economically strong. This included strategies to improve the quality of life by providing choices for employment, cultural celebrations and improved health. A core focus of the project was to conserve what remains of the natural environment and to support the tourism industry. Strategies included bushfire-management schemes, wastewater recycling, more ecologically sustainable sewage treatment, a city transport plan and the management of existing sand dunes. The plan also included urban consolidation, aiming to reduce the use of motor vehicles and prevent more land being released for housing. Along with other cities, it has joined the 20% Club for Sustainable Cities, a network aiming to reduce each city's environmental impact by 20%.

urban area an area with a high population density, as well as social and political organisation, that has been transformed from a natural to a built environment

Marion, South Australia

Marion is a suburb of Adelaide with native vegetation, historic sites, groundwater and 7 km of coastline with reefs and coastal cliffs. There is



Source 10.6 Gold Coast, Queensland



Source 10.7 Marion, South Australia

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also a 400-strong Indigenous community – the Kaurna People – who have a strong relationship with the Warriparinga site on the Sturt River. For these reasons, it is seen as a place that needs to be managed wisely and sustainably. The City of Marion Council has adopted Local Agenda 21 to deal with environmental issues affecting the community. These include protecting the water catchment area, maintaining biodiversity, promoting coastal management, improving air quality and managing waste disposal in a more environmentally friendly manner. World Environment Day is celebrated as part of Local Agenda 21, whereby local people can submit ideas and be awarded grants to support their projects. Success stories from this program include the revegetation of eroded and deforested areas. Marion is also committed to the goals of Cities for Climate Change Protection, which involves the council having an energy and emissions audit and establishing targets to reduce greenhouse gas emissions.

You can read more about these strategies in *Our community our future: a guide to Local Agenda 21* at www.cambridge.edu.au/geography8weblinks.

ACTIVITY 10.2

1. Identify how Local Agenda 21 has encouraged the development of sustainable cities.
2. Explain how the Gold Coast and Marion communities have made their urban areas more sustainable.
3. Imagine you are an environmental scientist working for the local council. Design an information brochure that will be distributed to local residents. Suggest ideas for how they can make their suburb, city or town more sustainable. Include images to support your argument.
4. Collect newspaper and magazine articles about sustainability issues facing urban areas. Construct a collage with a headline that summarises your findings.

Case study 10.1

Costly Australian cities

Three Australian cities are now rated as more expensive than London, with the strong dollar and steep rents being blamed for the high cost of living. Sydney, Melbourne and Perth now rank as among the world's 19 most expensive cities, while the British capital dropped to 25th spot, according to the 2012 Mercer Worldwide Cost of Living Survey. All lagged behind Tokyo, Japan and Luanda, the capital of oil-rich Angola, while Japan's Osaka and Russia's Moscow rounded out the 4 most costly cities. Sydney jumped to the no. 11 spot in the survey from no. 14 spot last year, placing it ahead of São Paulo and Rio de Janeiro in Brazil. Melbourne jumped to 15th spot from no. 21 in the previous year, ahead of the Chinese cities of Beijing and Shanghai. Demand for rental properties has also increased significantly in all Australian cities. Perth, meanwhile, soared 11 places to no. 19 in 2012, as the mining boom pushed up costs across the board. Canberra also leapt to 23rd from 34th within a year, while Brisbane rose to 24th from no. 31. Among the major Australian cities, Adelaide

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surged the fastest up the rankings, climbing to 27th from 46th a year earlier.

By a variety of rankings, Australian cities are among the most expensive places in which to live and do business. Housing remains among the most unaffordable in the developed world. The survey ranked 214 cities according to their comparative costs of transportation, food and housing. It placed Karachi, the commercial hub of Pakistan, in the no. 214 spot.

1 Identify why Australian cites have become more expensive places in which to live.
2 Explain why Perth has become such an expensive place in which to live over the last few years.
3 List all the Australian cities in the above article from highest to lowest affordability.
4 Identify which Australian city is the most expensive in which to live, and suggest why this is so.
5 Select one of the cities mentioned in this article and construct an A4 double-sided brochure showing the advantages and disadvantages of living in this city. Include images to support your findings.
6 In pairs, develop your own newspaper article about the advantages and disadvantages of living in your urban place.

10.3 Distribution of urban population

Population distribution

There are approximately 7.3 billion people in the world, but population is not spread evenly, so this is called uneven **population distribution**. Patterns of population distribution tend to be uneven: places that are lightly populated contain few people; those that are heavily populated contain many people. Lightly populated places are usually places in which it is difficult to live – for example, Antarctica. Places that are heavily populated are usually easier places in which to live due to factors such as mild temperatures and easier living conditions.

population distribution where people live in a given area

Australia's population distribution

Australia has a large land area with a low population density; however, the population distribution is very uneven, with the majority of Australia's population located on the east coast of the continent. Around 85% of the population is located along a 50–80 km strip of coastal land that stretches from Cairns in Queensland all the way down the east coast through Brisbane and Sydney to Melbourne.

There are key geographical reasons for this uneven distribution. First, many of the major cities were historically founded on the coast, and that is where they have developed over time. Second, climatic features of most of the central and western parts of the continent – which are covered by desert – make it difficult to access resources to sustain a settlement of people, and this has restricted the development of towns and cities in those areas. Furthermore, the climate on the coast is very temperate, which attracts people to live in these areas.

Economic growth

One of the most important reasons for the uneven distribution of Australia's urban population is that major cities contribute to economic growth. Recent studies claim that 84% of the growth of the national economy has come from major cities. Of this, 74% has been contributed by the capital cities. This was supported by 81% of employment growth in the same period.

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Employment

As the population of Australia is concentrated in the 5 biggest cities, there is a variety of employment, education and training opportunities in urban settlements. Cities employ a great percentage of Australia's population – the growth of employment in cities was more than 625 000 in 2010, according to the Australian Bureau of Statistics. The proximity to work is an important consideration for workers. This is a positive reason for the uneven distribution of the urban population. Cities are the places that support economic growth, and as such have to be able to provide the capacity for people to live in them.

Business and trade

There is a concentration of businesses and trade in cities. These offer the sharing of ideas and employment opportunities at both a local and an international scale. Business and trade create networks, which offer training and specialisation in employment. Since such a large percentage of people live in urban areas, this in turn supports the growth of business and trade.

Open spaces

Open spaces such as landscapes along the coast and rivers, as well as cultural landmarks, are attractive to tourists both from within Australia and from overseas. In 2012, the Tourism Forecasting Committee suggested that, since 2000, 86% of visitors spent nights in the major cities. As a result of this, a further 75% of all spending by visitors was also within our capital cities. This shows the importance of keeping our cities attractive to tourists and the need for our local population to support them by providing services.

Cultural diversity

Cities are a reflection of our cultural diversity, with 89% of Australian residents who were born overseas living in our major cities. A total of 93% of new arrivals live in major cities and 20% of city residents speak another language. Seven per cent of urban residents speak an Asian language compared with 0.6% of the rest of the Australian population (ABS 2006). Having culturally diverse cities has helped us to make connections with other communities in the world. Our Asia-Pacific location and cultural diversity create an economic advantage for all Australians. Consequently, it is important to encourage the population growth of our large cities.

Biodiversity

The negative impact on biodiversity is one of the most important arguments against an uneven distribution of the population. Land clearing for new housing estates, highways and other urban facilities has destroyed many valuable habitats and sometimes entire ecosystems – natural systems that have evolved over many millennia. As a consequence of this destruction of habitats, there are broken food chains – major linkages between species that allow for the creation of new life in habitats. This has led to the extinction of plant and animal species found within these specialised communities.

Aquatic habitats are also threatened by the uneven distribution of the population. The Hudson River in New York, the Seine in Paris, the Thames in London, the Nile in Cairo and the Mississippi in New Orleans are all examples of the environmental impacts of the uneven distribution and concentration of people in these cities. There is widespread pollution from high traffic volumes, as these waterways are used for transportation. There is also the impact of sewage and contaminated surface run-off, which disrupt the way these ecosystems function by reducing the biodiversity within them. Overusing these natural water sources for industrial purposes has also posed challenges for environmental sustainability.

Deforestation and agriculture

Another serious consequence of the uneven distribution of populations in urban areas is the impact of deforestation and agriculture. Agriculture is needed as a food source for the millions of people who live in our cities. For example, in Australia it has been said that, during the early years of settlement, 500 000 ha of forest land was cleared to supply timber for the construction of buildings. The land was then used to grow crops and raise animals to feed the people, which in turn destroyed many

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native species of plants and animals. The raising of hard-hooved animals such as sheep and cattle has resulted in compaction of soil. Introduced species of weeds have been an issue, as they have overtaken the native species and slowly invaded and taken over the native varieties. One of the greatest concerns is the impact of dryland **salinity** that has been caused by these agricultural practices. This has had a negative impact on the biodiversity of these habitats, brought about by the uneven distribution of people.

salinity the salt content of water

10.4 The development of Canberra

For 21 000 years, the Canberra region was home to the Ngunnawal people. There is evidence of this in rock paintings in Namadgi National Park and at Birrigai Rock at Tidbinbilla Nature Reserve. In 1913, the Australian Capital Territory was announced as a separate area from New South Wales and pronounced the capital territory of Australia. This territory largely fell within Ngunnawal country, which – as with many of our Aboriginal and Torres Strait Islander peoples' areas – is defined by the language of the people inhabiting the land and not by map grids. The borders of Ngunnawal country approximately cover the area from Yass to Boorowa, through to Tumut, the highlands west of the Shoalhaven and back to Goulburn.

The areas we now know as Yarramundi Reach, Black Mountain and Pialligo are believed to have been important meeting places for the tribes coming together on the trek to the mountains. It is interesting that Australia's Parliament House is in the same locality as a traditional meeting place.

Why is Canberra important today?

Canberra today is the site for many important cultural landmarks such as the Australian War Memorial, the Australian Defence Force Academy, the National Art Gallery of Australia, the National Library of Australia, the High Court, Parliament House, the Aboriginal Tent Embassy and foreign

Source 10.8 The National Gallery of Australia has recently established a dedicated section highlighting the diversity and complexity of Aboriginal and Torres Strait Islander art.



Geographical fact

The name 'Canberra' comes from the Ngunnawal word *kanberri*, meaning meeting place. Canberra has several sister cities: Versailles in France, Beijing and Hangzhou in China, Nara in Japan and Dili in the Democratic Republic of Timor-Leste (East Timor).

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embassies from around the world. It has become one of the most visited places in Australia for both international and domestic tourists. Canberra is where all the national laws are made and where most of the activities for the federal government are completed by public servants.

Origins of our nation's capital city

When Australia became a federated nation in 1901, politicians decided to look for the location of the new capital. At the 1898 Federal Convention, it was decided that there was a need for a new capital city. The important question was 'Where should it be?' In 1899, the colonial premiers decided that the capital city should be in New South Wales, but no closer than 160 km from Sydney. Until a site was chosen, Melbourne would be the meeting place for the federal parliament. It took 10 years for the final decision to be made to put the new capital city in the chosen site. The Federal Capital Territory of 2356 km^2 was established in 1911 and an international competition was held to see who would design the new city. There were over 130 entries and the winner was an American architect named Walter Burley Griffin. His wife Marion Griffin collaborated with him on the design competition entry, and is known to have prepared the design drawings that accompanied the Burley Griffin entry. In 1913, work began to erect the first public buildings. World War I interrupted construction, however, and it was not until 1927 that the Commonwealth government moved from Melbourne to Canberra.

Geographical fact

Canberra is approximately 282 km from Sydney, 150 km from the east coastline and 571 m above sea level. Canberra covers an area of 805 km^2, making it the largest inland Australian city.

ACTIVITY 10.3

1. Using the internet and maps, create an annotated map of Canberra. Include such features as prominent landmarks, both natural and cultural, as well as main roads connecting Canberra to surrounding cities.
2. In what year did the federal government move from Melbourne to Canberra?
3. Copy and create this table, summarising aspects of the built and the natural environments in Canberra.

Natural environment	Built/human-made environment

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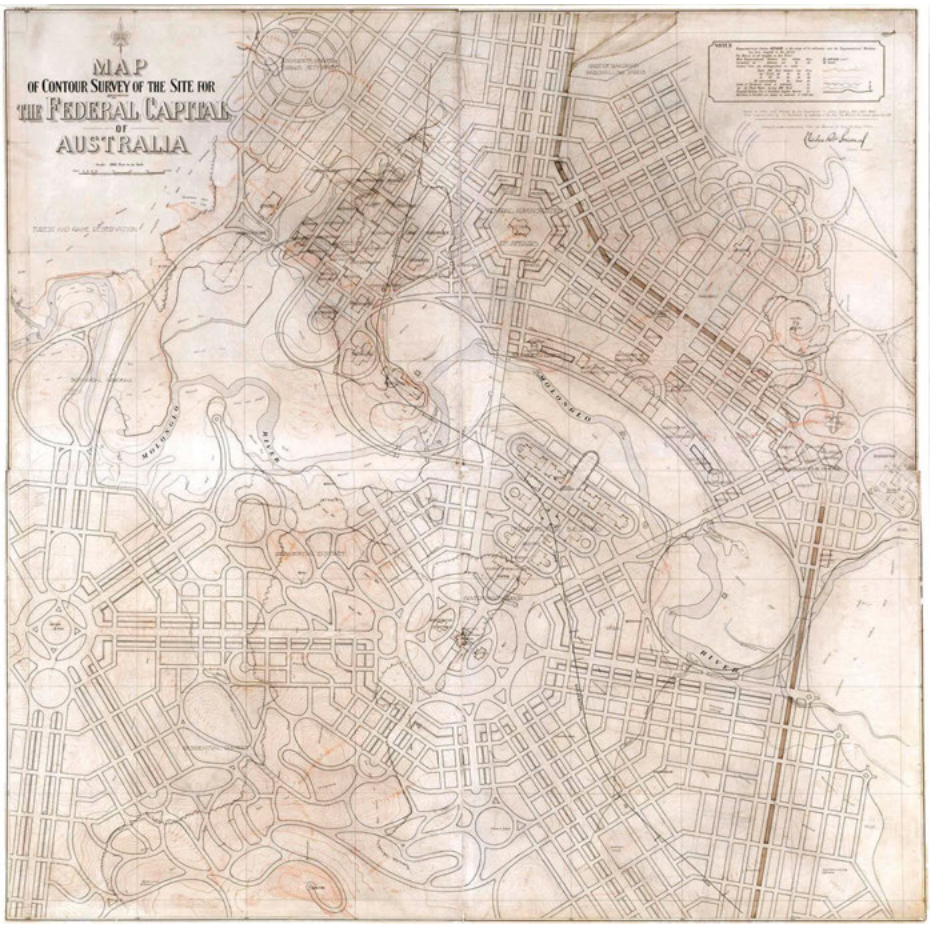
RESEARCH 10.1

Investigate why Canberra has sister cities. Summarise your findings as a brief report using images to support your case. In your findings, include an explanation of why sister cities are important for international relationships. Explain why each of Canberra's sister cities was chosen. There is a website available as a great starting point for your research via www.cambridge.edu.au/geography8weblinks.

Canberra as an example of a planned city

A planned city is a city that has its entire urban infrastructure planned. This includes hospitals, schools, universities, sports facilities, bridges and railway lines. There were many key points that Walter Burley Griffin put into his plan for the city. These included that the city had to be built from 2 axes (imaginary lines that intersect at right angles). The first axis was known as the 'land axis'; it ran in a south-west direction from the top of Mt Pleasant to what is now Capital Hill. The second axis was known as the 'water axis'; it ran in a south-east direction from Black Mountain to the Molonglo River. Together, these axes were the starting point of the plan for the city, with a large lake that would be created when the Molonglo River was dammed.

At the top of the design was the 'Capital Building', used for important occasions and



Source 10.9 An early map of Canberra: Walter Burley Griffin's design for the city

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intended to be the centre of the newly designed capital city. It overlooked all of Canberra, to show the importance and function of this new building as the seat of the nation's new capital. There was also the new library, which would contain all the new capital city archives that needed to be stored and protected.

The plan also connected other land uses in the area. These included residential areas, hospitals, schools, the university, the military academy, retail precincts and land zoned for industry. The interesting thing about Griffin's plan was that the connecting suburbs were planned in a hexagonal grid to connect with each other and the city centre. Another key aspect of the design for this planned city was that the buildings were low rather than high-rise, and all the important buildings were to be modern in architecture.

Griffin's experience in building other cities overseas showed him the importance of gardens and parks as the focus of a built environment. He suggested that the city and the surrounding suburbs should have streets lined with trees, gardens and parks, and should also include water features such as lakes and ponds. He was strongly influenced by radical European and North American architects and the 'City Beautiful' and 'Garden City' movements that were popular in late 19th- and early 20th-century town planning. The natural environment and Australian flora featured so prominently in Griffin's plans that Canberra was often called the 'Bush Capital'.

The first survey peg marking the beginning of the development of Canberra was driven in on 20 February 1913, and the foundation stone was laid on 12 March. Lady Denman, wife of the Governor-General, announced the name of the city as Canberra. The year 2013 marked the centenary of this occasion. While in Australia, Griffin designed both the Capitol Theatre and Newman College at the University of Melbourne. In New South Wales, he planned and developed the towns of Leeton and Griffith, and the Sydney suburbs of Castlecrag and Castle Cove.

Source 10.10 Canberra today



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Source 10.11 The Australian Minister for Home Affairs, King O'Malley, drives in the first peg of the new national capital, Canberra.

The beginnings of a new city

There were many factors to take into consideration when construction of Canberra began. Where would the workers live? The men who came to build the city had to live in tents and **humpies** as well as a few old farmhouses. In the 1920s, there were some small brick cottages built to accommodate the workers and their families; there were also 120 barracks in the ex-**internment camp** at Molonglo that were converted so they could be used by workers during this period. Single men continued to live on site in camps. Establishing a water supply was an important part of the plan. The construction of Cotter Dam began in 1912. A temporary 'tent school' was created to educate the children of the workers; it closed in 1917. In 1913, a brickyard was in operation and the first bricks were made. Then a post office was opened at Westridge in 1917.

humpy a temporary shelter made from bark and tree branches

internment camp a dentention centre, usually during a time of war, for people considered to be political enemies



Source 10.12 Walter Burley Griffin's topographic map of Canberra

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ACTIVITY 10.4

Using the map provided in Source 10.12, complete the following activities.

1. Record the natural feature found in I5.
2. Record the human feature found in F5
3. Name the feature found at E7.

Timeline of major events in the building of Canberra

Before World War I

1823 European settlement
1901 Australian Federation
1908 The site for Australia's capital chosen
1911 Population of ACT was 1714
1912 Walter Burley Griffin wins international design competition
1913 Canberra chosen as name for the city
1914 Rail link to Canberra established

1920s

1924 Griffin plan for Canberra gazetted
1927 Provisional Parliament House opened

The Great Depression and after

1930 Federal Capital Commission disbanded
1930 Canberra's population 9000
1931 Federal Highway links Canberra to New South Wales town of Goulburn
1936 Regular air services to and from Canberra commence
1939 Population 10 000

World War II

1941 Australian War Memorial opened
1945 Population 13 000
1946 Australian National University established

Post-war reconstruction

1957 Population 39 000

1960s boom

1960 Population 50 000
1962 Kings Avenue Bridge built
1962 Woden Valley development begins
1963 Commonwealth Avenue Bridge built
1964 Lake Burley Griffin filled
1966 Population 96 000
1966 Belconnen development begins
1968 National Library of Australia opens

1970s

1971 Population 146 000
1973 Tuggeranong development begins
1976 Population 203 100

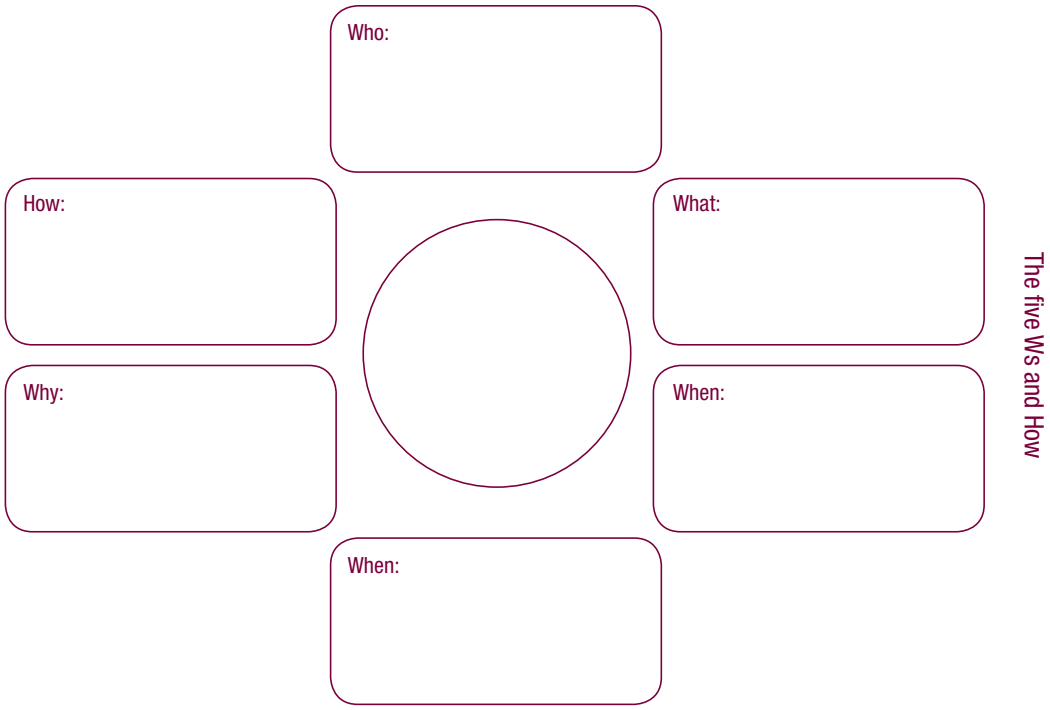
1980s to the present

1980 Mitchell, Giurgola and Thorp win New Parliament House design competition
1981 High Court of Australia
1983 Population 235 000
1988 New Parliament House opened
1988 Population 270 000
2000 Population 311 000
2010 Population 358 222
2012 Preparations for Centenary Celebrations begin

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NOTE THIS DOWN

Using the graphic organiser below, copy and complete a summary of what you have learnt about the construction of the planned capital city of Canberra.



ACTIVITY 10.5

1. Identify why the site for Canberra was chosen.
2. Explain the key human and natural features of Canberra.
3. Describe why Canberra is an important city.
4. Using the timeline provided, construct a line graph to show how the population of Canberra grew over the period 1911 to 2010. Locate the present population of Canberra and add this to your graph.

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Case study 10.2

The challenges of building Lake Burley Griffin

It took 50 years to be constructed, but Lake Burley Griffin has been the centrepiece of Canberra since Walter Burley Griffin's earliest plans. Try to imagine the task of creating a lake in a field of small farmlands! Before the lake could be created, engineers had to study the flow of the Molonglo River and the rainfall patterns. They also needed to work out how the dam would be built, and where the best places for the bridges would be. To do this, they created a concrete model of the lake. The model was used to see what would happen if the lake flooded, so the engineers used different gradients and slopes to see what would be the best way to try to contain the water in the lake. The dam was a key feature of the model and of the lake. It would be used to store water from the floodwaters of the catchment area. The model also played a key role in determining the best position for the two bridges that were constructed over the lake. Before the lake could be built, the dam needed to be constructed; it was completed in September 1963. Then the bed of the lake was cleared and formed into the shape of the design. The water from the dam slowly filled the lake, but it wasn't until the floods of 1964 that the lake was completely filled. Finally, the lakeside capital city was complete. There was then widespread planting and landscaping around the shores of the lake. Roads were constructed to provide access to the various points of the lake, and trees from many countries were planted along the shoreline. On 28 September 1964, Princess Marina, the Duchess of Kent, planted the first oak tree, a gift from the United Kingdom. Prime Minister Sir Robert Menzies inaugurated the lake by stating: 'A lake is more than a sheet of water… it is what is around the sheet of water that helps to set the beauty of the lake… This is a matter of national importance and… is doing a great deal to create a national spirit.'

1 Identify how the model of the lake was used to create the real lake.

2 Imagine you are a **hydrologist**. Explain the importance of changing the slope of the banks of the lake.

hydrologist an engineer who works with water and water regulation

3 Describe how the lake has given 'completeness to this capital city'.

4 Locate images and construct a collage showing how the lake was constructed. Annotate to show how the natural environment was changed.

Source 10.13 Lake Burley Griffin



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RESEARCH 10.2

You are a **town planner**. In groups, design your own planned city. You will have to give your city a name, design the roads and plan for parks, hospitals and residential areas. Where will you place schools and universities? Will you include an airport and railway station? What about a water public transport service such as a ferry wharf? You must also consider where industries and shops will be zoned and located. What about the natural features such as climate and topography? How and where will you obtain water and electricity, and collect wastes?

town planner a person who plans the designs of urban places

Present your findings using an ICT such as PowerPoint to share with the class. Take the following aspects into consideration:

- The population will be 2.5 million residents.
- There is a river that crosses the landscape.
- It is a coastal location with 300 metre-high cliffs.
- The highest point is a mountain 1000 m in elevation.
- There is a desert inland on the landward side of the mountain.
- The closest large city of 6 million is 100 km away.

The future of Canberra as a planned city

The Canberra Spatial Plan outlines a plan that will help to manage the future growth of this planned city. It is a reflection of what the community hopes to see in the city over the next 30 years. It is the ACT's main planning document for directing and managing the urban growth and change that is predicted. The following is a list of the main aspects of this future plan. The aim is to make the city even more sustainable as it grows in the future.

- Higher-density residential will be created within existing urban areas. The aim of this is to provide easy access to work, schools and other activities. This will mainly occur in Central Canberra and Civic.
- Future residential areas will continue to grow in Gungahlin, and may grow into the Molonglo Valley if needed.
- Civic will be the focus of employment and growth. There will therefore need to be an improvement in transport. In the future, there will also be growth in employment in the Molonglo Valley.
- Future industrial and transport will be in the existing areas close to the airport.
- Nature reserves will be managed to protect biodiversity in both urban and rural areas.
- Major transport connections will be kept out of the city centre and link Civic to the Molonglo Valley via upgraded bypasses.
- A bushfire zone will be declared to protect the city from bushfires with the expansion of the suburbs.
- Non-urban areas that are part of the city will be used for sustainable agriculture.
- Water quality in catchment areas will be protected from future developments.
- An aircraft noise-protection corridor will be created to prevent any impact from the increased use of the airport. No new residential zones will be located in this area.

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FIELDWORK 10.1 EXPLORING THE SUSTAINABILITY OF MY COMMUNITY

Background information

Creating sustainable urban places is a significant challenge for community leaders and residents. This is a global issue facing us all. For this fieldwork, you will explore your local area to see whether it will be a sustainable place in which to live in the future. You will need to use a variety of primary and secondary sources to support your research.

Aim

To discover the sustainability of your local urban area and suggest ways to make it more sustainable.

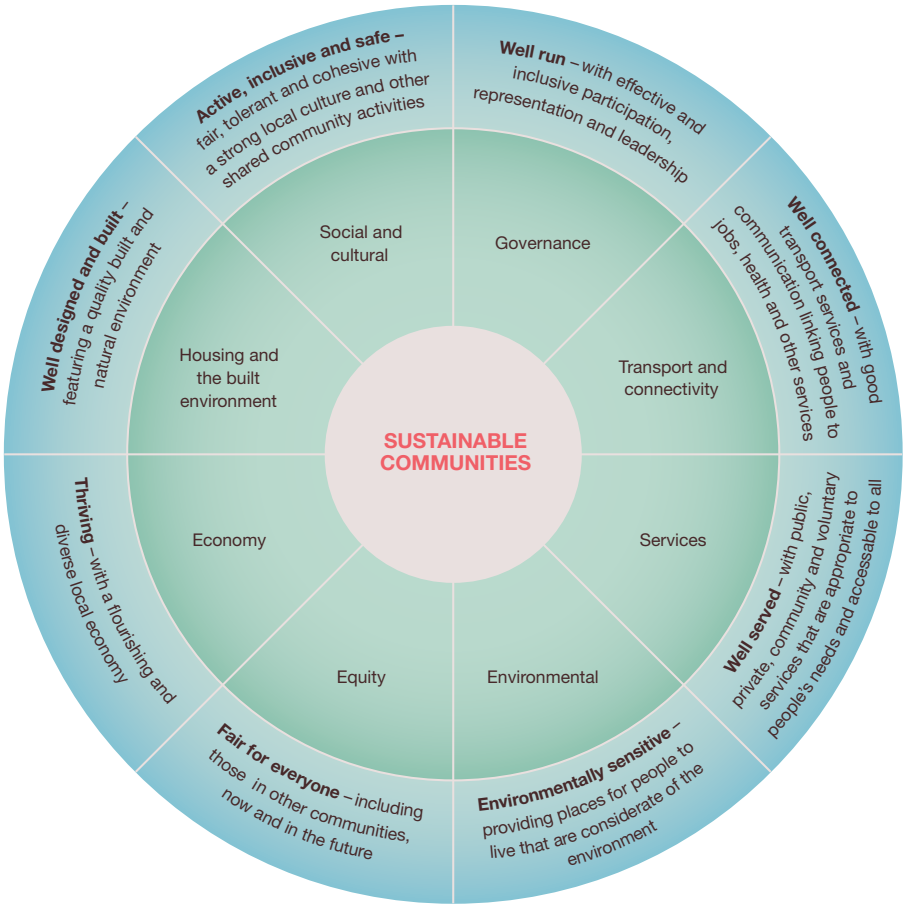
Method

By using primary sources such as photographs and secondary sources such as newspapers and local government information, present your findings. You will also need to refer to the Egan Wheel criteria detailed in Step 2 to measure the sustainability of your urban area.

Preparation

1 In pairs, use the internet to find a map of your local urban area. Annotate this map with reasons why people would want to live there. Base these annotations on your own observations, experiences and facts about the urban area. Aspects to consider include low crime rates, amount of green spaces and so on.

2 Use the Egan Wheel (see Source 10.14) and categorise the information that you have listed in Step 1 to complete the table on the next page. This has been completed below for Blacktown City, a suburb 35 km west of the Sydney CBD.



Source 10.14 The Egan Wheel, created by Sir John Egan (UK) in 2004, summarises what it takes for communities to be sustainable. It is a useful tool to help you evaluate the sustainability of your local urban area in the future. You will use this in your fieldwork to determine the sustainability of your local urban area.

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The sustainability of Blacktown City, New South Wales

Egan's Sustainability Wheel	Annotations based on Blacktown, New South Wales
Governance	Blacktown City Council has encouraged sustainability by encouraging residents to apply for Sustainability Streets. The idea stems from the reality that everyone wants to create a safer and healthier living environment for themselves and their children. The best way to do that is by bringing people together to pool knowledge and resources. The Sustainability Street puts the idea of 'thinking global, acting local' into practice. Council works with communities to provide the skills and knowledge that will make your street the most sustainable environment and community possible. The program is based on a simple, efficient training program, and each group receives a Sustainability Street manual.
Transport and connectivity	Blacktown has a great railway station that connects it to the CBD of Sydney and surrounding suburbs. An efficient T-WAY used for buses only is also a highlight of sustainable practice, as this separate lane makes public transport faster and connects to areas that do not have a railway line.
Services	Westpoint Shopping Centre has been expanded over the last few years to offer residents an excellent and energy-efficient shopping centre. There are plans for expansion in the near future. It has provided a much-needed entertainment precinct that has restaurants and sporting facilities, including a ten-pin bowling alley and paintball.
Environment	There are over 50 nominated Sustainability Streets in Blacktown. The council maintains the many parks and waterways, including Breakfast Creek and Woodcroft Lake. There are plans in the future to improve the condition of the wetlands in the surrounds of Woodcroft Lake.
Equity	There are many social services for the newly arrived refugees from the Sudan. Special migrant services for women's health and legal matters are offered on a needs basis by the various community organisations. Blacktown is an official Refugee Welcome city.
Economy	Blacktown City is home to over 21 000 businesses that provide over 71 000 jobs to the residents of Western Sydney. Most jobs are in retail and manufacturing. The new Wet'n'Wild water park will also create jobs in the future. The city also has an increasingly skilled workforce, with relatively low rates of unemployment. As a home to over 300 000 residents and with a strong higher education presence, the city has a sustainable future.
Housing and the built environment	There is a variety of housing, including urban consolidation, in and around Blacktown Station. Larger family homes are found in newly subdivided farmlands such as Stanhope Gardens. The newly refurbished Francis Park, a sports and entertainment precinct, has added beauty to the built environment.
Social and cultural	The annual Blacktown City Show is a celebration of the diversity of local cultures, and provides an event to support community pride. Indigenous arts and cultures are displayed in the Arts Centre for all visitors to see.

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3 Students are to go out into the local area and take photographs of their local community, which show aspects of the natural and built environments. For each photograph, complete the following worksheet.

Skill: photo analysis – is this a sustainable urban place?

Photograph number			
Where you took the photograph (show this on your annotated map)			
Description of photograph			
Sustainability criteria	*Yes*	*No*	*Explanation*
Well run?			
Well connected?			
Well served?			
Environmentally sensitive?			
Fair for everyone?			
Thriving?			
Well designed and built?			
Active, safe?			

4 Write a 500-word report. Critically analyse whether the urban area in which you live is sustainable for the future. Describe the most sustainable parts of your community and suggest which areas should be improved upon.

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Chapter summary

- Cities have diverse employment opportunities, health and education services, cultural activities and vibrant social networks.
- Cities are very complex places, which are the result of the interactions between people and the natural and built environments.
- There are both positive and negative impacts of living in cities; these can be classified as economic, social and environmental.
- Urban sprawl is often a result of cities that have grown too fast to meet the needs of growing urban populations. This process has had a negative impact on biodiversity as competition for land for housing and infrastructure encroaches on green areas.
- All levels of government have a responsibility to ensure the sustainability of our cities. This has been achieved to some extent by initiatives such as Local Agenda 21.
- It is important to ensure environmental sustainability so that both present and future generations can have a high quality of life.
- The nation's capital city, Canberra, is a purpose-built city that is important for the identity of our country.

End-of-chapter questions

Multiple choice

1 The World Health Organization states that sustainable cites are cities where the population:

A enjoys a high quality of life and leaves economic, social, environmental or health problems for future generations

B enjoys a moderate quality of life and takes care not to leave economic, social, environmental or health problems for future generations

C enjoys a high quality of life and takes care not to leave economic, social and environmental problems for future generations, but health is a future concern

D enjoys a high quality of life and takes care not to leave economic, social, environmental or health problems for future generations

2 In Australia, there is an uneven distribution of the population. Most of the population lives:

A along the western coastline

B in regional cities

C in large suburbs

D within 100 km of the coast

3 The density of Australia's urban population is:

A increasing

B decreasing

C staying the same

D evenly distributed

4 Paved surfaces create run-off during rainstorms. The substances in the run-off usually go into:

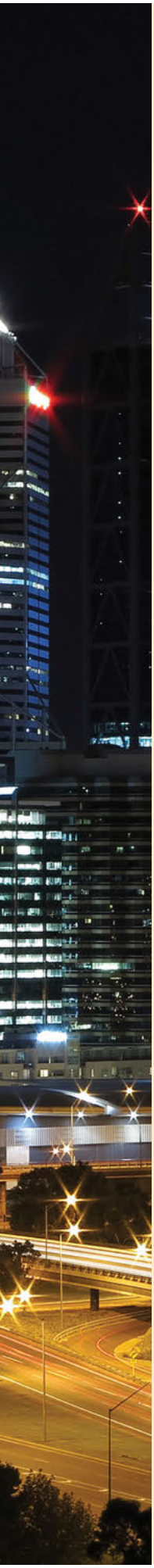
A streams

B the ground

C waste areas

D forests

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5 Canberra was created because:

- **A** there was a need for a capital city after Federation in 1901
- **B** there was a competition to design the city
- **C** there were too many people living in New South Wales
- **D** Melbourne was too far away from Sydney

Short answer

1 Construct a concept map that shows your understanding of the definition of urban places.

2 Explain why increasing numbers of people live in urban areas.

3 Describe the impacts of urban sprawl on our cities and surrounding areas.

4 If you had to design your own city, list 5 of the most important aspects you would need to take into consideration to make the city a better and more sustainable place in which to live. Justify your answers.

5 Explain why it is important to have global sustainability initiatives such as Local Agenda 21 for our urban areas.

Extended response

In groups, develop a report that compares and contrasts 2 cities of your choice. Include images, statistics and diagrams to support your findings. Your report must include the following:

- a world map, including the names and locations of the 2 chosen cities
- a description of the population characteristics: include the population numbers, density, gender, age structure, growth and ethnic composition
- a description of the main land-use patterns of your chosen cities; include where the industrial, commercial, residential and green spaces are found; also include a sketch map to show your findings
- a brief description of how the cities have changed over time
- a list of challenges these cities face in terms of sustainability in the future; write about air quality, housing, employment, transport, health, water and energy supplies
- an explanation of how the cities you have chosen have responded to 3 of these challenges
- a plan for the cities in the future to meet the needs of the population.

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Glossary

abattoir place where animals are killed for human meat consumption

Aboriginal law beliefs and expectations recognised by Indigenous peoples

abrade to wear down by rubbing against something

abrasion result of rocks or sediment impacting against each other, usually when being transported by water, wind, ice or ocean waves

accordant being in agreement or harmony (e.g. the same height)

aesthetic value value or appreciation placed on something due to its beauty

agriculture use of the land to raise crops or livestock

air pollution substances in the air that affect the health of humans and the environment

alluvial deposits sediments deposited by rivers

alluvial fan water-deposited sediment that spreads out into a fan shape when viewed from above

annexed taken possession of

anthropogenic human-made

anthropologist an expert who studies humankind

anticline the upward bulging of rocks caused by compression

aqueduct a human-made channel or passage for conveying water

aquifer a layer of soil or rock that contains groundwater

archipelago a group of islands

arid dry or parched refers to regions such as deserts

arroyo dry creek or stream bed; gully

artesian water underground water that flows freely when bores intersect the sediments in which it is found

assimilation absorbing and making alike; the process of cultural absorption

asthenosphere the plastic mantle layer below the Earth's crust, composed mainly of sima

asylum seeker a person whose claim for refugee status has not yet been approved

autonomy independence or freedom

avalanche the failure or collapse of a snow-covered slope, resulting in the movement of snow and debris downslope

ballast water water held in tanks and cargo holds of ships to increase stability and manoeuvrability while under way

base flow low flow period in streams when water is not derived from run-off but from groundwater and slow lateral sub-surface movement

bedding plane surface between layers of deposited material or sandstone that make up sedimentary rocks

bias having a particular interest or view that limits one's ability to make a fair judgement

bilateral between two nations

billabong see **ox-bow lake**

biodiversity the variety of life forms and the interaction between them in a given area

block fault large area of land upthrust by earthquake activity

bloodline line of descent of an individual

blowhole a gap or hole in rock through which seawater is intermittently ejected

boat people refugees arriving by boat

brackish containing salt levels between those of fresh water and seawater

breccia angular pieces of rock of various sizes that have been broken and fractured along a line as a result of fault movements

British subjects British citizens under British rule and laws

burning ritual practice of setting fire to areas of bushland for environmental purposes and to attract wildlife to the new growth

bushfires uncontrolled fires that destroy the environment and property

calcite the main mineral in limestone and marble, composed of calcium carbonate

caldera large basin-shaped depression caused when the summit of a volcano collapses into the empty magma chamber below or explosions destroy the summit

capillary movement water movement, mainly upward and horizontal, in permeable materials (soil, sediment, rock, cement or bricks)

cartographer a person who constructs and draws maps

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cay a small, low island on a coral reef formed of sand and/or coral pieces

cession the transfer of land from one individual or group to another

chain migration a series of migrations within a family or distinct group of people. A chain migration often begins with one family member, who sends money to bring other family members to the new location.

channel a hollowed-out path formed by a river or stream

chelation chemical weathering process involving removal of ions from minerals by organic compounds

chemical weathering changes to the composition of the rock as a result of interaction between elements in the air or water

chiton a type of hard-shelled mollusc, which moves slowly by strongly clinging to intertidal rock surfaces

cirque armchair-shaped semicircular hollow with a steep back wall and downslope lip found in glaciated areas

clay small mineral particles with a diameter of less than about 0.005 mm

climate change a long-term trend in the Earth's weather patterns, including a change in average weather conditions (such as increased atmospheric temperature) and/or in the distribution of weather around the average conditions (for example, more extreme weather events)

climatologists people who study the climate of an area (long-term changes in weather)

coastal zone where the sea and the land meet

cockeyed bob a Western Australian name for a small but violent cyclonic disturbance, particularly one that causes localised wind damage

cohesive holding together strongly with few fractures or weak spots

collision plate boundary the point where two tectonic plates of similar strength or speed collide

commodity a product that can be bought and sold

comparative advantage in economic terms, the ability of one country over another to provide goods at a cheaper price

compensated paid for or reimbursed

compressional squeezing from the side

conduction the molecule-by-molecule transfer of energy through a substance

conquest the victory of one party over another (e.g. through battle or voting)

conservationists people who believe in and work to protect the natural environment

constructive forces those that build new landforms or add to those already there

continental drift theory the idea that major continents may have split from a common original landmass

continental shelf gentle slope offshore from most continents to about 180m, where there is a sharp drop to the floor of the ocean

continuous resources resources that are in no danger of being used in excess of their long-term availability

convection the current-like motion of fluids in response to an uneven distribution of heat

convection plume an accumulation of hot molten rock at the boundary between the Earth's core and mantle. The molten rock then rises in a plume through a thin or fractured zone of the mantle.

convergent (subduction) plate boundary the point where two plates are moving towards each other and collide, with one plate being pushed beneath the other; the lower plate is the 'subducted' plate

convict a person found guilty of a criminal offence and serving a sentence of imprisonment.

country the Aboriginal concept of place, which includes all aspects of the environment including life

crown land land owned by the government – originally by the British monarch

cultural integration the process of drawing together various elements of a cultural system, such as ethnic groups into a wider community

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cultural value the emphasis placed on something for its importance and place in society, such as the inclusion of water in rituals, heritage and the Dreaming

curvilinear in a curved line when viewed from above

customary according to the practices of a particular group or place

cyclone an atmospheric system characterised by the rapid inward circulation of air masses about a low-pressure centre, usually accompanied by stormy, often destructive weather

decentralisation the spread of power away from the centre to local branches or governments

degradation a loss of quality

delta fan-shaped deposit of river sediments found at the mouth of a river

demographer a person who works with statistics to examine populations

demographic factors factors of a population expressed statistically, such as age, sex, education level, income level, marital status, occupation, religion, birth rate, death rate, average size of a family and average age at marriage

demographic profile information used to create an image of the age/sex composition of a population

deposition the last stage of the erosion process, when the material being moved settles on a surface

depressions sunken places or hollow surfaces

destructive forces those that wear down and degrade landforms, infrastructure and property

developing country a country with a low standard of living and a developing industry base and/or economy

dhari a type of headdress

diaspora people of a particular nationality who live outside their country of origin

die-back a condition in a plant where the shoots or branches die from the tip

discharge release

discordant at different heights, as occurs with hanging valleys

displaced person someone forced to leave their home country because of war, persecution or a natural disaster – a refugee

displacement the situation of people forced to leave their home and community, either because others have made them leave, or because life in the community has become intolerable or unliveable

dispossessed deprived of property and possessions

divergent plate boundaries the point where plates are pulled apart, allowing molten rock to emerge at the Earth's surface

downcutting downward erosion by a river through its bed

drainage basin an area of land where surface water from rain and/or melting snow and ice joins at a single point at a lower elevation another water body such as a river, lake, dam, estuary, wetland, sea or ocean

drainage network pattern of gullies, streams, rivers and lakes in a drainage basin that allows water to flow to the lowest point

Dreaming a central concept in Aboriginal culture that explains how the world works through creation stories

drought an extended period of time when there is an absence of sufficient amounts of water

dykes thin vertical intrusions into other rock types

earthquake the result of the Earth's tectonic plates moving against each other

earthquake focus depth where rupture from an earthquake occurs

economic value a dollar amount placed on an asset to show how much it is worth

eddy water running contrary to the main current

elastic able to expand without breaking

emigrants people who leave their country to permanently live in another

empowerment the ability to make decisions, access resources and create change

engineer a professional employed to develop systems, buildings and materials

entrenched meanders those meanders eroded deeply into bedrock and thus unlikely to change their pattern over time

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environmentalist a person who acts to preserve the quality of the natural environment

environmental sustainability the management of the world's environment to meet the needs of the present population without reducing the capacity of future generations to meet their needs

ephemeral drainage drainage lines without permanent water flow

erosion the process of transferring rocks, sediment or solutions (transportation) from one place to another (deposition)

erratics boulders carried in glaciers and then left behind when ice melts

escarpment a sharp and continuous break in slope that may extend for hundreds of kilometres

estuary a body of water formed where freshwater from rivers and streams flows into the ocean, mixing with the seawater

ethnic group a collection of people sharing the same nationality, religion, culture or language

eutrophication a process whereby excess nutrients run off the land into lakes and rivers, causing unhealthy levels of plant growth

evaporation the part of the water cycle where water changes from liquid into a gas and escapes into the atmosphere

exotic not native to an area, usually introduced from another ecosystem or country

extinction disappearance of a species

extruded pushed out through a vent or fissure

faults fractures in rocks or sediments where movement has occurred as a result of compression or shear stress

Federation the creation of the Australian union of states

feldspars a widespread group of minerals in igneous rocks, possibly making up nearly half of the Earth's crust

flood plain low-lying ground that is subject to flooding from a nearby river

flood the flow of water through an area that normally is dry, such as when a river breaks its banks

flow-on effect other changes that will follow if a change is made

fluvial processes processes associated with rivers and streams

forced migration movement of people somewhere else because they have to leave

freehold a form of land ownership, which is inherited or held for life

frost shattering a process that occurs when water in cracks and crevices in rocks freezes and expands, causing the rock to shatter

genocide the deliberate killing of a large group of people, especially those of a particular ethnic group or nation

gentrification the renovation and growth in social and economic status of previously run-down areas

geologist a scientist who studies the composition of the Earth's surface and interior; its rocks and fluids, how they were formed and how they may be useful to people

geomorphology the study of landscapes and landforms, and the processes that have made them the way they are

glacier a huge mass of ice slowly flowing over a landmass

glacial polish smooth and sometimes shiny rock surfaces created by debris transported under moving glaciers

global scale a view that includes the entire Earth or a large part of it

gneiss originally a granite-type or a sedimentary rock that has been subjected to strong pressure, which also involves high temperatures, resulting in light- and dark-coloured minerals forming bands

Gondwanaland one of two supercontinents believed to have existed 510 to 180 million years ago

government services fundamental services provided by the government, such as law enforcement, education and health care, considered to be necessary for the functioning of society

graben a chunk of fault-bounded land that is lower than the land on either side

groundwater flow water that moves slowly below ground through sediments and cracks in rocks

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groynes low barriers built from the beach into the sea, intended to reduce beach erosion

gully a deep channel, usually with very steep sides, carved into sediments on sloping ground

hanging valley where the floor of a tributary valley whose floor lies at a height well above that of the main valley; the junction may be marked by a waterfall

hazard a known feature of an area that may cause loss of life, injury and/or property damage

heavy-textured subsoils clayey B horizons

heritage monuments, physical objects or customs and traditions inherited from previous generations

High Court of Australia the highest court in Australia

historical time the period during which humans have recorded events

holism a belief that complex environmental processes need to be understood as a whole, rather than seen simply as a collection of individual parts

Holocene a geological epoch characterised by the growth and impact of the human species between the present and 10 000 years ago

homogeneous all the same or all together

honeycombing a network of pits several centimetres deep that looks as if bees have made a honeycomb in rock

horst a chunk of fault-bounded land that is higher than the land on either side

hotspot activity current volcanic activity associated with convection plumes

humpy a temporary shelter made from bark and tree branches

hydration a reversible process of water combining with a mineral

hydraulic action the process of waves compressing air within gaps in the rock, and this air being explosively released when the waves retreat

hydrological hazard a natural hazard, such as a flood, whereby water may cause loss of life, injuries and/or property damage

hydrologist an engineer who works with water and water regulation

hydrolysis an irreversible process of water combining with a mineral to form a new mineral

hypothesis a proposition made on the basis of limited evidence, used as the starting point for further investigation

identity the way you see yourself and the way others perceive you

immigration moving into a new country

indentured labourer a worker, typically a labourer or tradesperson under contract for a fixed period of time in return for payment of travel expenses and accommodation

industrialisation the modernisation of a country, involving large-scale infrastructure development, economic growth and a movement towards more efficient, mechanised methods of production

inferred fault a fault that is assumed to exist from field evidence but that cannot be located precisely

infrastructure structures and services needed for society to operate properly, such as transport, water supply, health services, education systems, waste disposal systems, telecommunications

initiation a rite of passage symbolising the acceptance of an individual into a group or into adulthood

inselberg an isolated steep-sided hill, often made of bare rock

insolation weathering heating of rocks by the sun, causing thermal expansion and fracturing with heating and cooling cycles

integration a situation in which a people is able to maintain its own basic culture and have it respected, while living within and respecting another culture

international migration the movement of people from one country to another

internment camp a dentention centre, usually during a time of war, for people considered to be political enemies

interstate migration movement of a person to another state

intertidal zone the area at the edge of a body of water (such as the ocean) that is exposed at low tide and under water at high tide

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intrastate migration movement of a person within their own state

ions atoms formed by the loss or gain of one or more electrons

irrigation watering of crops

joint planes vertical, horizontal and angled patterns of cracks in rocks

karren small grooves or furrows in rock (usually limestone) formed by running water

karst limestone region where underground water is the main cause of distinctive landforms

kinship system the system of social relationships that constitute kinship in a particular culture

lahar mixture of water and rock fragments flowing down the slopes of a volcano, usually following river valleys

land degradation destruction of vegetation, soil, landforms and landscapes by human activity

land title an official record of who owns a piece of land

landform a naturally formed feature on the Earth's surface, having a characteristic shape or form

landscape the visible features of an area including both the natural (mountains, forests, rivers etc) and human elements (roads, houses, bridges etc)

landscape quality the human value placed on the condition and aesthetic appeal of a landscape

landslide the failure or collapse of a slope, resulting in the movement of debris downslope under the influence of gravity

landsliding downslope movement of saturated soil and sediment by gravity

latitude imaginary lines measured in degrees north and south of the equator

lease contract allowing temporary management or use

levee a sediment embankment bordering a channel

lichen a flat-lying symbiotic association of algae and fungi that adheres firmly to rocks and plants

limestone a rock made up of calcium carbonate ('lime'), originally deposited under the ocean and formed from broken-up shells, corals, animal skeletons and other carbonate materials

linguistic relating to language

lithology the general physical characteristics of rocks

lithosphere the solid upper zone of the Earth, including soil and underlying rocks to a depth varying between about 7 and 200 km

liveability living conditions in a place that make it easy or difficult to live there

livestock farm animals

loam a sediment with a texture that is a mixture of sand, silt and clay

local scale point of view that focuses on the local area

locks barriers in the form of large steel gates constructed to control the flow of water and allow boats to travel both up and down stream

loess extensive deposits of silty sediments, probably windblown, which develop almost vertical slopes when eroded by water

longitude imaginary lines measured in degrees east and west of the Prime Meridian (or the Greenwich Meridian)

longshore drift the movement of sediment, usually sand, shingle or mud, along a coastline driven by the direction of the prevailing wind

lunette a crescent-shaped dune blown up on the downwind side of an intermittently filled lake

Mabo a case fought and won by Indigenous Australian Eddie Mabo that first recognised native title

macro-tide tide with a wide daily tidal range

Mallee agricultural district where mallee vegetation was cleared for cropping

manufacturer maker of goods

manufacturing the production of goods, often on a large scale and for sale to others

marble limestone that has been subjected to high pressure and temperature, resulting in recrystallisation of the original calcite crystals into a dense non-banded rock

marginalised treated or thought of as less important

marooned abandoned on an isolated shore with little hope of rescue or escape

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mass migration large numbers of people moving somewhere else for similar reasons

meandering a series of wide curves and loops of a river channel when viewed from above

Meckering Fault the displacement of rock layers as a result of earthquake activity in and around Meckering, Western Australia in October 1968

metamorphic rocks igneous or sedimentary rocks that have been subjected to extreme pressures or temperatures that have changed their original characteristics

meteorologists people who study weather and climate

metropolitan of a very large city, often the capital of a country or region

migrant an individual who has moved from one country to another

millennia thousands of years

minority a smaller section of the population, sometimes experiencing discrimination

Miocene a geological epoch characterised by the development of grasslands and grazing mammals

molluscs a diverse group of invertebrate organisms

monocline a simple fold that occurs singly rather than as part of a series of anticlines and synclines

morphology form and structure of shape of landforms

multiculturalism an ideology that different cultures can coexist successfully within a country (rather than conform to one national culture)

national scale point of view that focuses on an area the size of a nation

Native Title Act Australian law recognising the ownership of traditional Indigenous land

natural disaster the occurrence of an expected natural event that adversely affects the environment and people in the area

naturalised Australians individuals born outside Australia who have become Australian citizens

negative internal migration a situation in which more people leave a state than arrive as newcomers

nomadic having no fixed home; moving according to the seasons and availability of food and shelter

notch an indent at the base of a cliff caused by wave erosion

ocean–ocean convergence boundary the point where two oceanic plates move towards each other and one is pushed beneath the other

offsets horizontal displacements

open-cut mining (also known as open-pit or open-cast mining) extracting rocks from the earth from an open pit

oral history information about important events, traditions and individuals passed on in families and communities through spoken stories

outcrop surface exposed rock surface

overburden material (usually rock) overlying a resource found close to the surface (often coal) which can be removed to access the resource

overland flow unchannelled run-off flowing over land

ox-bow lake (billabong) an old looped river meander that has been cut off from the present channel

paleosol ancient soil not formed under present-day conditions

parent material original mineral material

pastoral zone inland areas of Australia where the climate is too dry to sow pasture or crops but livestock can be grazed on native vegetation

pedogenic processes soil-forming processes

pedologists scientists who study soils

periglacial referring to an area, often near glaciers, where water freezes and melts each year

permafrost permanently frozen ground

permeable having interconnected pore spaces into which water can move

persecution unfair or cruel treatment over a long period of time because of race, religion or political beliefs

physical (or mechanical) weathering processes that break up rocks into smaller pieces without chemical change

physico-chemical weathering a combination of physical (mechanical) and chemical weathering

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physiographic or geomorphic region an area of the Earth's surface with similar landforms and topography

place an area that has a specific meaning or purpose

plate tectonic movement the movement of continental and oceanic plates of the Earth's crust

playa a lake, usually in an arid or semi-arid area, where local streams drain into a low-lying area that is often dry for long periods

Pleistocene a geological epoch characterised by the formation of widespread glaciers between 10 000 and two million years ago

population distribution the way a population is spread in a given area

pore space tiny air space in weathered rock or sediment

precipitation water that falls from clouds and may be in the form of rain, hail, snow or sleet

pre-contact refers to the period before the arrival of Europeans in a particular area

primary resources (also known as natural resources) products from the Earth that can be used to produce or run human-made inventions

primary source information that comes directly from the event or area we are studying. It is 'first hand', and is how we classify most of the data collected during fieldwork

proclamation a public announcement or declaration

productivity the total economic output compared with the input of resources

provenance the source rock or sediment of a weathered material

province an area within a country or state

pull factors reasons why a person would want to move to a particular area

pumice a light-coloured rock with many holes (vesicles) due to gases mixing with rapidly solidifying lava and trapping multiple air bubbles. Pumice is light and floats on water.

push factors reasons that force a person to leave their place of residence

pyroclastic describes a superheated mixture of rock, ash, gases and water that moves rapidly downslope as a result of a volcanic eruption

qualitative methods methods used to gather data that are expressed in non-numerical form (that can only be described)

quantitative methods methods used to gather data that are expressed in numerical form

quartz rock composed of silicon dioxide, a hard mineral that resists weathering

quota a specific number that must be achieved or not exceeded

radiocarbon dating a technique that uses the decay of Carbon-14 to measure the age of organic material, such as leather or wood

recession period when the economy shrinks

reciprocity relationship involving mutual exchange

recreation activities for the purpose of relaxation during leisure time

recreational facilities programs and structures, such as libraries and parks, that provide enjoyment for communities

recreational value the emphasis people place on something for its leisure purposes and potential for enjoyment

recumbent folds those that have folded over themselves or appear to have flopped over

refugee a person who has left their own country because of fear for their safety and wellbeing

regional relating to a particular geographic region, for example, the Asian region, comprising East Asia, Southeast Asia, South Asia, etc

rehabilitate to restore an ecosystem to health through, for example, tree-planting

renewable resources resources that can be replenished in a relatively short amount of time through reproduction or other biophysical processes

ribbon development the spread of urban areas along transport routes, such as main roads, bus routes, railway lines

Richter Scale the scale developed by Charles Richter and Beno Gutenberg to measure the severity of earthquakes. The scale was based on a logarithmic progression so that an earthquake of magnitude 5 was 10 times stronger than a quake of magnitude 4.

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rills very small and shallow channels formed by running water, initially measuring less than a few centimetres long and less than 1 cm deep, but developing into channels up to 30 cm deep

river basin the area of land drained by a river and its tributaries

riverine associated with rivers

run-off water (from precipitation, glacier or snow melt, or groundwater seepage) that flows over the land and collects in rivers, lakes, seas and oceans

sacred rituals traditions and practices of cultural significance to particular groups of people

sacred sites areas or places with significant cultural meaning to particular people e.g. Indigenous Australians

saline high in levels of salt

salinisation the build-up of salts at or near the soil surface, either by natural processes such as evaporation or by land clearing

salinity the salt content of water

salt weathering physical weathering of rock by the growth of salt crystals

sandstone a rock composed mainly of sand-sized grains (diameter of 0.2–2 mm), most often quartz grains, with the matrix between these grains being made up of clay-sized particles (<0.05 mm in diameter). The rock is welded together by a cement or binder, generally siliceous (silica) or sometimes calcareous (calcite).

sanitation the provision of adequate facilities such as toilets, and services such as garbage collection, to promote community health and hygiene

satellite city a smaller metropolitan area that is located near a major city, which may be economically and politically independent

scarp a cliff or sloping surface caused by earthquake activity

scientific consensus the agreed view of scientists about a particular topic, such as climate change

sea stack a pillar-shaped remnant of land that has been eroded by the sea

sea walls rock or concrete walls erected to stop the sea from eroding a land area

seafloor spreading the separation of tectonic plates on the floor of the ocean which allows molten rock to emerge and form new ocean floors and mountains, such as the Mid-Atlantic Ridge

seasonal migration moving for a period of time in response to labour needs or climate conditions

secondary source information that is put together by someone else or someone not directly involved in the event or area that is being investigated

sedimentary rocks rocks formed from sediments that have later been welded or pressed together

sediments fine particles of rock, including mud, sand or silt, and gravel

seismic waves shock or energy waves caused by earth movements

self-determination freedom to live as one chooses

shale a rock composed of mostly clay-sized particles that have been compressed

shear stresses stresses caused by two objects moving at an angle to each other

sheeting fractures large-, medium- and small-scale cracks that develop in rocks that have been subject to pressure and that do not have other existing fractures to allow for the release of pressure

shore platform fairly smooth, gently sloping rock surface lying between high and low tides

sial crust or outer part of the Earth, forming the continents, which are mainly made up of rocks containing **si**lica and **al**uminium

siltation sand or earth being carried by running water and forming sediments in marine areas or water reservoirs

sima the lower part of the Earth's crust on which the continental plates float, made up of rocks which contain large amounts of **si**lica and **ma**gnesium

slate shale changed into a stronger rock by heat and pressure within the Earth's surface

soil horizons soil layers with different physical and chemical properties

soil profile the vertical sequence of horizons that make up the soil

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solifluction slow soil flow caused by freeze–thaw activity in saturated surface sediments in periglacial areas

soluble able to be dissolved

solution a reversible process of ions dissolving in water

songline a sequence of short verses that form a sung map of an ancestral being's creative journey, providing a mental map of country

Southern Oscillation Index (SOI) a figure calculated on the air pressure differences between Tahiti and Darwin

sovereignty indenpendent power over one's own place

special economic zone region that has conditions designed to ensure competitive trade between countries

speleothems cave formations produced by the evaporation of water flowing down or slowly dripping off cave surfaces

spit narrow, low-lying line of sand developed naturally by longshore drift and extending from the land into the sea

spray zone the area above the high tide line that is regularly splashed, but not submerged, by ocean water

stalactites dripstone features that hang from the cave roof

stalagmites dripstone features that build up on the cave floor

stewardship the responsible planning and management of resources

Stolen Generations a term that refers to the Aboriginal children removed from their families and institutionalised in western orphanages or sent to foster homes

storm surge an increase in the height of coastal waters as a result of onshore winds, usually associated with a cyclone

striations gouge-lines in rocks caused by the scraping of sharp debris transported under moving glaciers

strip mining the removal of resources (usually coal) found close to the Earth's surface by the removal of overburden along a long line and then mining by open-pit operations

strongly folded squeezed into sharp folds as a result of great horizontal pressure

sub-aerial processes processes occurring on the Earth's surface

sub-artesian referring to underground water that has to be pumped to the surface

subsistence collection or production of food for oneself and one's family, but not for sale

suburbanisation movement of people and work to outer urban areas and middle-distance suburbs

suspension solid particles remaining dispersed through water

sustainable healthy and functional in the long term

sustainability wise use of resources so they are available indefinitely into the future; society, environment and economy must all be considered carefully

sustenance something that maintains life, such as food or water

swale low-lying land between two sand dunes

syncline the downward squeezing of rocks caused by compression

TAFE Technical and Further Education training college

tectonic plates layers of the Earth's crust that move and float

terra nullius land belonging to no-one

terrace a 'platform' of fairly flat land, often a former flood plain that has become stranded by later downcutting by the river

texture size of the individual mineral particles making up a sediment or soil. Particle sizes are: clay < about 0.005 mm; silt 0.005–0.02 mm; sand 0.02–2 mm. Particles with a diameter >2 mm are classed as gravel.

thermohaline currents ocean currents resulting from temperature and salinity differences that create density differences

tidal range difference in height between low tide and high tide

topography the layout of the land

topsoil surface soil, usually the A horizon

totem an object representing an animal or plant that is of special significance to a particular group, family or tribe

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tower karst towers or pinnacles remaining after limestone has been weathered in tropical regions

town planner a person who plans the designs of urban places

trading nation a nation with an economy that greatly benefits from the export of goods to other countries

traditional owner Indigenous person recognised as having primary spiritual responsibility for the land

transform plate boundary the point where two plates slide, grate or jerk past one another

transportation the carrying of sediment from one place to another

tsunami a series of ocean or lake waves with enormous destructive potential, usually created by an undersea earthquake

turbid cloudy or muddy

UNHCR United Nations refugee agency (United Nations High Commission for Refugees)

unsustainable impossible to maintain

uranium-thorium uranium is a radioactive element that decays to radioactive thorium at a known rate over time. The proportion of uranium to thorium thus allows people to date materials.

urban consolidation the process whereby medium- and high-density housing is added to existing areas in urban places, using existing roads and amenities, with the purpose of reducing urban sprawl

urban area an area with a high population density, as well as social and political organisation, that has been transformed from a natural to a built environment

urban settlements distinct areas where people live and work

urban sprawl the gradual spread of cities into previously rural areas due to population growth

urbanisation the process by which more and more people are coming to live in towns and cities

variability refers to differences – in this case, the different measured amounts of rainfall

vegetation trees, shrubs and other plants

vent opening in a volcano through which molten rock, gas and water can escape

vesicles holes, often round in shape, where air bubbles were trapped in lava

visa a document allowing a person to enter and stay in a particular coutry for a specified time period

viscous with a thick consistency that allows for flow (neither completely liquid nor solid)

viticulture the practice of growing grapes

volcanic eruption the process of lava (originally magma from the Earth's core) spilling from fissures or vents in the Earth's crust

voluntary migration when people move somewhere else by their own choice

wages payment to employees for work

weathering the breakdown of rocks and sediments into smaller particles or a solution

weathering by fire flaking or slabbing off in fire

wheat-belt zone agricultural area where wheat is grown

Wik a case which decided that pastoral leases did not extinguish native title

zoning government restrictions about the types of buildings and services allowed in an area

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