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Geography

NSW Syllabus for the Australian Curriculum

Stage 5 9&10

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Contents

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Additional investigative study chapters available in the Interactive Textbook and on Cambridge GO:

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Foreword

Geography is not just about academic learning from a textbook but about developing a holistic understanding of the world. Our team of authors are experts in their field; and with their input, you can be assured that you have been provided with accurate and reliable information that addresses the nuances of the NSW Geography Syllabus in fine detail.

Geography NSW Syllabus for the Australian Curriculum Stage 5, 9 & 10 fully achieves the aims of the syllabus by fostering curiosity about places and cultivating respect for people, cultures and environments around the world. You will develop a strong geographical understanding of Australia and its neighbours through the integration of interesting case studies and examples throughout. New and contemporary insights into events, processes and places from around the world are also explored, which will enrich your geographical knowledge and understanding.

This textbook will help you develop opinions about geographical issues and concepts. Activities seek to target creative and critical thinking skills. The textbook encourages you to immerse yourself in current issues, be aware of media reports and realise that human actions have significant consequences on the environment and for the future of the environment. In this way, the textbook also captures the essence of the cross-curriculum priority of sustainability.

We have achieved a productive balance between geographical knowledge and understanding and geographical inquiry and skills. The incorporation of fieldwork activities throughout the textbook allows you to explore your surrounding environment and to investigate the causes and effects of various human and physical geographical processes. Each activity can be tailored to suit your local area or classroom needs by focusing on developing and applying geographical inquiry methods and skills.

In Stage 5, you will develop a deep understanding of *Sustainable biomes* and its associated issues such as the need to expand food production that is countered by environmental constraints. *Changing places* allows for learning about demographic shifts, such as urbanisation, and management strategies for the future. You will appreciate the challenges and worldviews involved in selecting strategies to manage change when studying *Environmental change and management*. *Human wellbeing* focuses on measurement tools used in monitoring wellbeing in different countries and initiatives for improvement.

As geographers it is our responsibility to adopt an informed point of view, adopt a measured approach and promote environmentally sustainable practices in whatever we do. By thinking geographically, we can work together to contribute to a socially just world.

Kate Thompson
Series Editor

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About the authors

Kate Thompson is the head teacher of secondary studies at Aurora College and lecturer to postgraduate students studying the Master of Teaching/Education at Australian Catholic University. Kate was awarded a New South Wales Premier's Teacher Scholarship in addition to an Outstanding Professional Service Award issued by the New South Wales Minister for Education. She holds a Bachelor of Economics (Social Sciences), Master of Teaching, Master of Industrial Relations and Human Resource Management and a Certificate in Gifted and Talented Education. She has worked in curriculum development, advisory and support roles, has developed HSC exams at the Board of Studies, Teaching and Educational Standards NSW (BOSTES) and is passionate about engaging students, using technology to support learning, differentiation and improving literacy. She is a keen geographer, having taught it for 15 years, and seeks out interesting case studies and fieldwork opportunities. She has worked with stakeholders to develop contemporary integrated units of learning and has also developed a range of online learning modules for Stage 4 and 5 Geography, utilising web 2.0 tools, to improve student outcomes and digital literacy in Geography.

For full biographies of our highly qualified author team, please see the Interactive Textbook or *Cambridge GO*.

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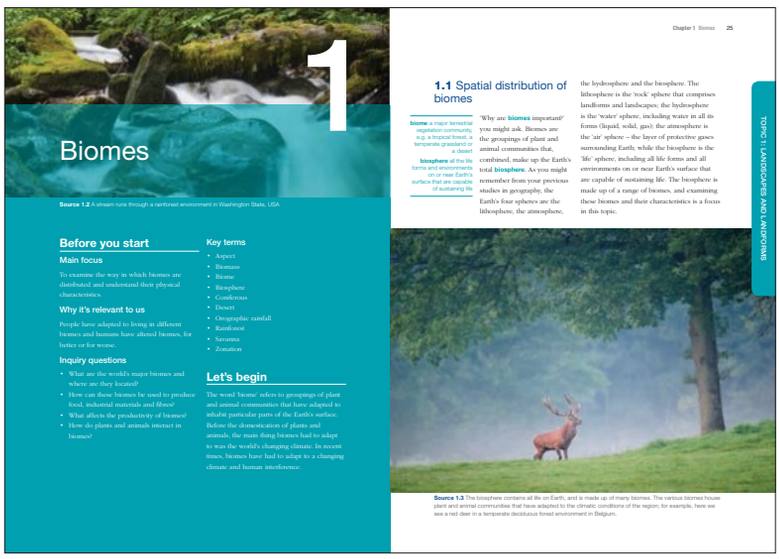


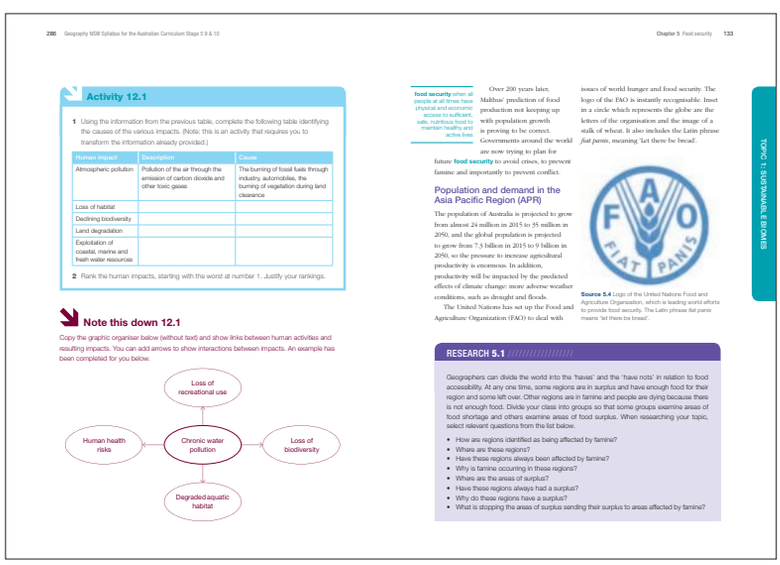
Chapter openers feature **Before you start** and **Let's begin** sections, which focus your attention on the topics being studied to prepare you for your in-depth investigations.

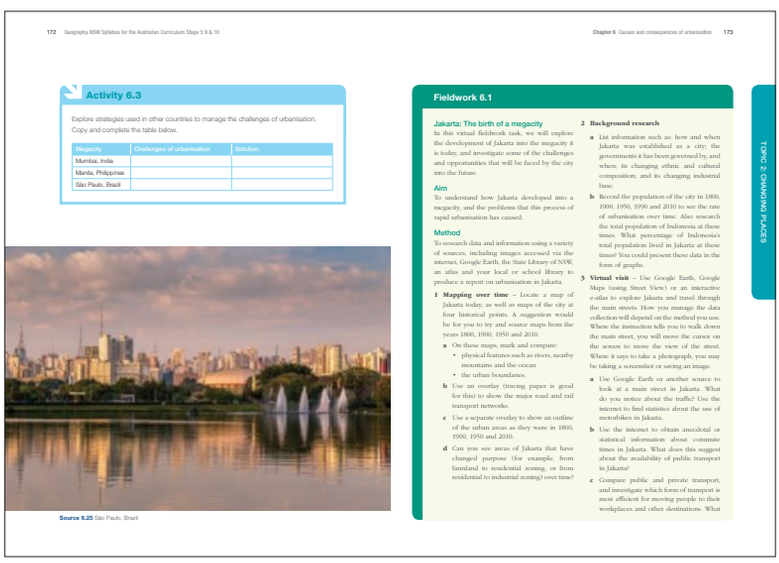
Glossary terms are bolded in the text, defined in the margins and collated at the end of the textbook for easy reference. Some terms are taken from the curriculum and are © BOSTES.

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

Note this down activities recommend the use of a range of graphic organisers to help you record and revise key ideas.

These are also available as **downloadable documents**.





Fieldwork activities provide step-by-step instructions on observing and recording information, enabling you to think like a geographer and utilise geographical skills outside the classroom.

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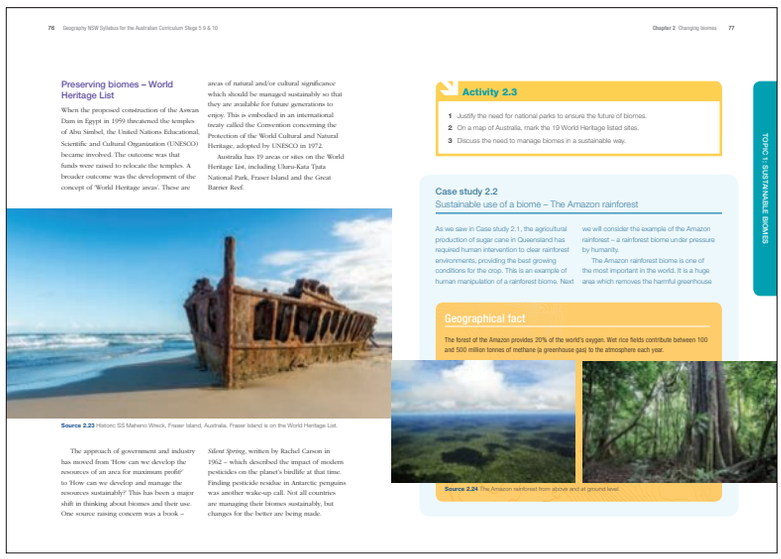
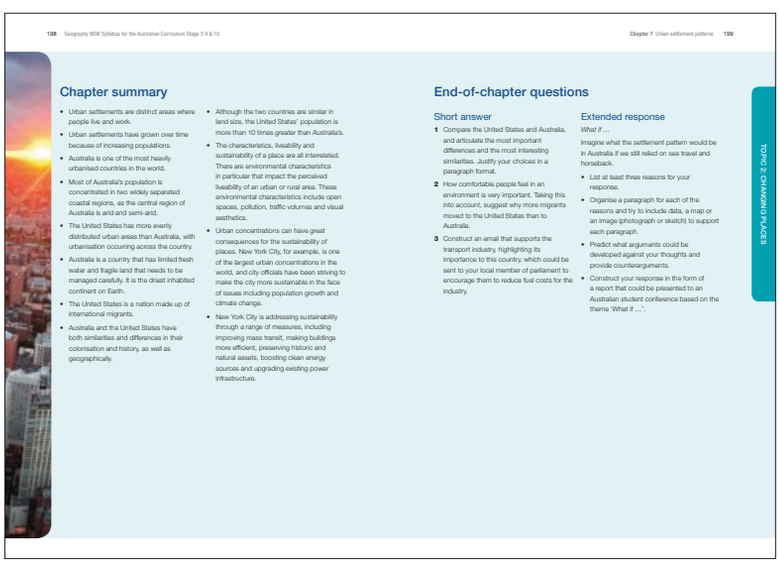
Case studies extend on information to add another layer to your knowledge and understanding.

Geographical facts highlight interesting information to enrich your learning.





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

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

In the interactive Textbook, **video and audio** enrich the learning experience.

Interactive maps enable further engagement by allowing selected elements from the legend to be shown or hidden on the map.

Interactive activities (e.g. drag and drop questions) assist recall of facts and understanding of concepts.

All end-of-chapter content is available as **downloadable documents**.

Also available is the Interactive Textbook Teacher Edition

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Geographical skills toolkit

Source 0.1 Researchers investigate an iceberg off the coast of Antarctica.

0.1 Introduction

The study of geography involves posing questions, reflecting and proposing actions to enrich your understanding of Australia and the world, and to shape a better future. As you investigate the places, peoples, cultures and environments that make up our world, you will develop geographical knowledge and understanding, explore key concepts and apply essential skills and tools using an inquiry framework.

This geographical skills toolkit introduces you to these concepts, skills and tools used in the study of geography. It will help you to think like a geographer as you study sustainable biomes, changing places, environmental change and management, and human wellbeing.

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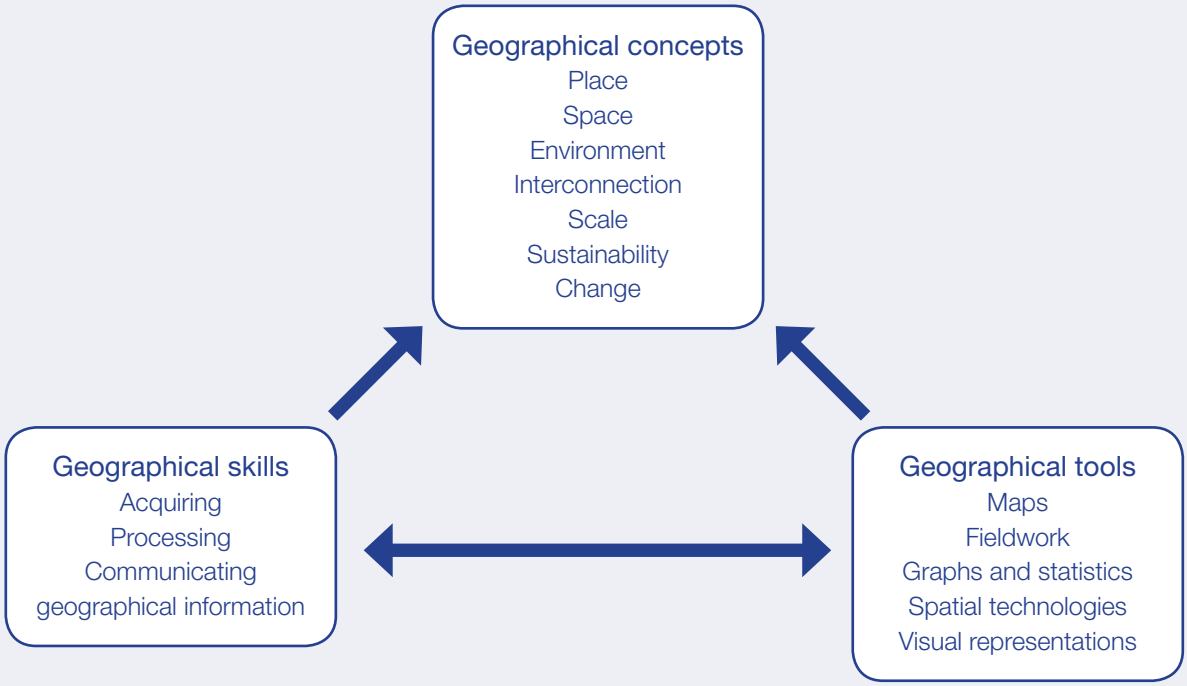
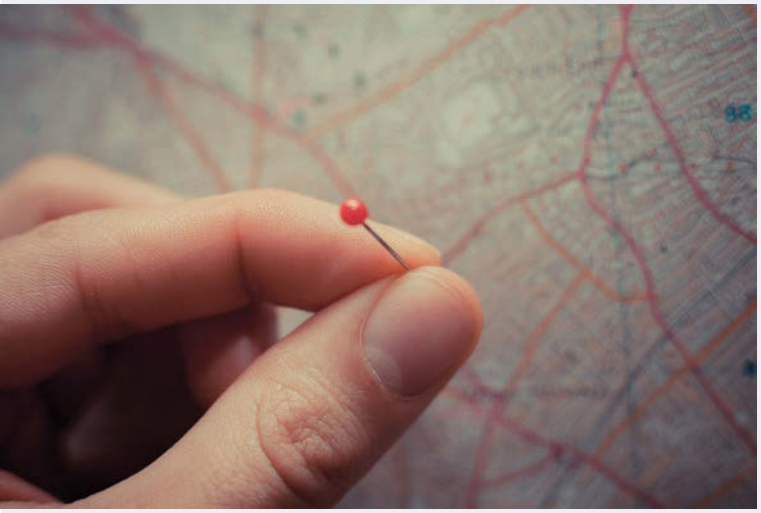


Source 0.2 In the study of geography at Stage 5, concepts, inquiry skills and tools must be integrated to provide meaningful learning experiences.

0.2 Geographical concepts

It is useful to have a framework that supports and guides us in our geographic studies: a range of concepts that will allow us to target our inquiry and support our learning. The concepts for geographical understanding (place, space, environment, interconnection, scale, sustainability 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.



Source 0.3 Geographers at work: marking points on maps

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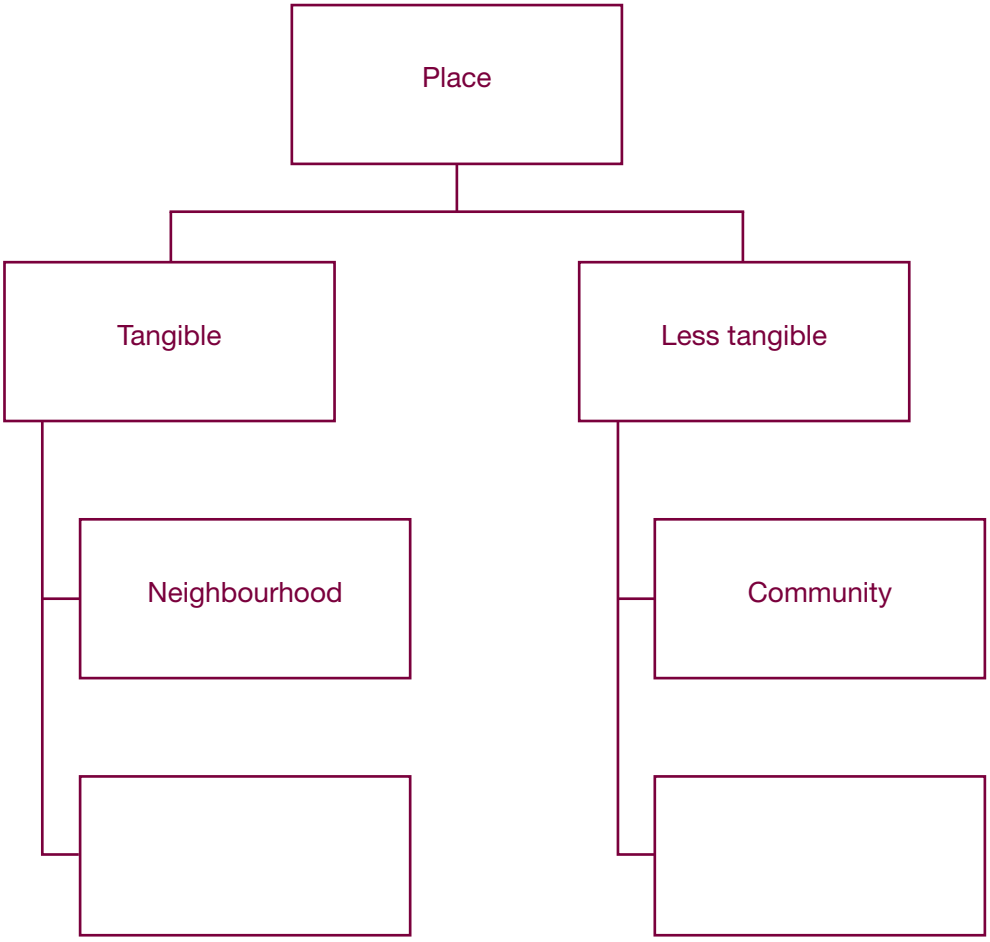
Place

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. They can be affected by local and global geographical processes such as urbanisation, migration and climate change. Places can also be **tangible** as well as less tangible (for example, a country versus a community).

tangible can be touched

Note this down 0.1

Copy the graphic organiser below and compare places that are tangible with those that are less tangible.



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Geographical fact

Where something is – its location – is very important to your studies. You can use the coordinates on a map, called **latitude** and **longitude**, to show others where something is. Latitude and longitude lines divide the world up into a grid, and when you use them, latitude is always stated first. Sometimes a description can help to show others where something is, or landmarks can help you 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 co-ordinates to help you find particular places easily.

latitude distance from the Equator measured in degrees north or south

longitude degrees east or west of Greenwich

Source 0.4 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. Sydney's Opera House, for example, is located at 33°51'31.2"South (latitude), and 151°12'50.5"East (longitude).

Space

In geographical terms, space is the distance between things. Space refers to where things are (location), the organisation of an area, and their distribution in it. It is about how the area is structured and managed. Patterns can be detected when examining **spatial variation**: geographical locations, data and processes. 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 **anthropogenic** (human-made) 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

spatial variation the difference or variation in natural and human features over an area of the Earth's surface, e.g. water, population, Gross Domestic Product (GDP), life expectancy

anthropogenic human-made

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megacities cities with a population greater than 10 million

Source 0.5 Space refers to location, spatial distribution, organisation and management, such as the changing global pattern of **megacities**. Russia's capital, Moscow, is one of the world's largest cities, with over 12 million inhabitants.

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 living and non-living elements of the Earth's surface and atmosphere. Where unqualified, it includes human changes to the Earth's surface, e.g. croplands, planted forests, buildings and roads.

Environment

The **environment** has a great 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

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such as the Murray–Darling Basin supports not only the 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 **geographical 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.

features the tangible elements of a place or environment

geographical processes the physical and human forces that work in combination to form and transform the world, e.g. erosion, the water cycle, migration and urbanisation. Geographical processes can operate within and between places.

Scale

The main focus of this geographic concept is to see things at different levels, from the personal to the local, regional, national and global. How we view an issue or the types of

Source 0.6 The melting of the sea ice atop the Arctic Ocean – as seen in this photograph from July 2011 – is largely the result of the geographical process of global warming (due to rising greenhouse gas emissions). This arguably highlights the interconnection between man and the environment.

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solutions we can put forward will change as we move through these different scales. For instance, 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 therefore need to view geographical phenomena or problems such as the management and protection of places and environments at different levels or scales.

Sustainability

Sustainability refers to the ability of the environment to support our lives and the lives of other living creatures well into the future. Sustainability is not a concept with which only **environmentalists** would concern themselves today; it is increasingly being used to describe any system (natural or human-made) that is in a healthy state of balance. Sustainability relates to the short- and long-term implications of environmental change on environments, the importance of sustainable practices to ensure peoples' wellbeing, sustainable environmental worldviews and management approaches.

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

Change

Change refers to both space and time. It is a concept that considers 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

Source 0.7 The concept of sustainability helps you to question the current state of a space and to pose management solutions to issues and challenges that you are able to identify.

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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 can be gradual or catastrophic. Gradual changes take place slowly; for example, climate change or urban sprawl. Other changes can be drastic and immediate such as during natural hazards. Both the natural and human environments are constantly changing. Therefore, planning and developing management strategies is extremely important in geography.

Activity 0.1

1 In your own words, outline the concepts required for geographical understanding.
2 List one example for each of the concepts you have outlined.
3 Explain how latitude and longitude are used by geographers. What is their link to world time zones?

0.3 Geographical inquiry skills

What sets the geographer apart from others interested in the world is the methods they use to investigate. Geographers are not truly happy until they have collected data in the field and developed a series of **hypotheses** to test

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

Source 0.8 Geographers are involved in highly specialised work that helps you 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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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 stages that represent a complete investigation:

- acquiring geographical information by observing, questioning and planning as well as collecting, recording, evaluating and representing
- processing geographical information by interpreting, analysing and concluding
- communicating geographical information as well as 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.

Acquiring geographical information

geographical questions questions that inquire into the spatial and environmental dimensions of places and environments

The geographer begins an inquiry by observing issues or problems and developing significant **geographical questions**. Information is collected and recorded from various sources, evaluated for reliability and represented in different forms.

Observing, questioning and planning

Geographically significant questions are questions that are worth investigating. The inquiry questions at the beginning of each chapter of this textbook 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 your study, moving you beyond the known and into discussions and debates where there may be no right or wrong answer, just many options and **geographical challenges** to be explored as an integral part of our understanding.

geographical challenges issues and problems arising from interactions between people, places and environments that threaten sustainability, e.g. biodiversity loss, food insecurity, inequality

Inquiry questions

- What are the world's major biomes and where are they located?
- How can these biomes be used to produce food, industrial materials and fibres?
- What affects the productivity of biomes?
- How do plants and animals interact in biomes?

Source 0.9 Examining the questions from Chapter 1, it is 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?

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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 data and secondary information sources

primary data original materials collected by someone, e.g. field notes, measurements, responses to a survey or questionnaire

Information gathered in the field or directly connected to your research is called **primary data**. Primary data is essential to valid scientific inquiry. It is targeted and specific to the task. We understand how the information has been collected, 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 your research – is called a secondary source. **Secondary information sources** can also be valuable, and can even reduce the work we need to do directly.

secondary information sources sources of information that have been collected, processed, interpreted and published by others, e.g. census data, newspaper articles, and images or information in a published report

Source 0.10 Fieldwork is an example of primary data, whereas books or online material would be viewed as secondary information sources.

For example, the Australian Bureau of Statistics 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. When collecting information, we also need to be aware of **ethical protocols** including confidentiality, informed consent, citation and integrity of data.

ethical protocols the application of fundamental ethical principles when undertaking research and collecting information, e.g. confidentiality, informed consent, citation and integrity of data

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Note this down 0.2

Copy the graphic organiser below and summarise what you have learnt about primary data and secondary information sources.

Sources	Definition	Examples
Primary data		Field notes
Secondary information		Census

Processing geographical information

The next stage of the inquiry involves making sense of the information, analysing and drawing conclusions.

Interpreting

Setting a series of inquiry questions and gathering information to try to answer those questions is important, but how you interpret the 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

Source 0.11 Researchers can use offshore platforms like this one to measure seismic activity of the Earth.

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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 an encyclopaedia?

If you can confidently answer 'yes' to all these questions, then you are ready to begin analysing your data and reaching logical conclusions.

Analysing

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 one-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.'

Concluding

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.

Communicating geographical information

This final stage of the inquiry involves communicating information, reflecting on what has been learned and responding by proposing actions.

Communicating

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

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

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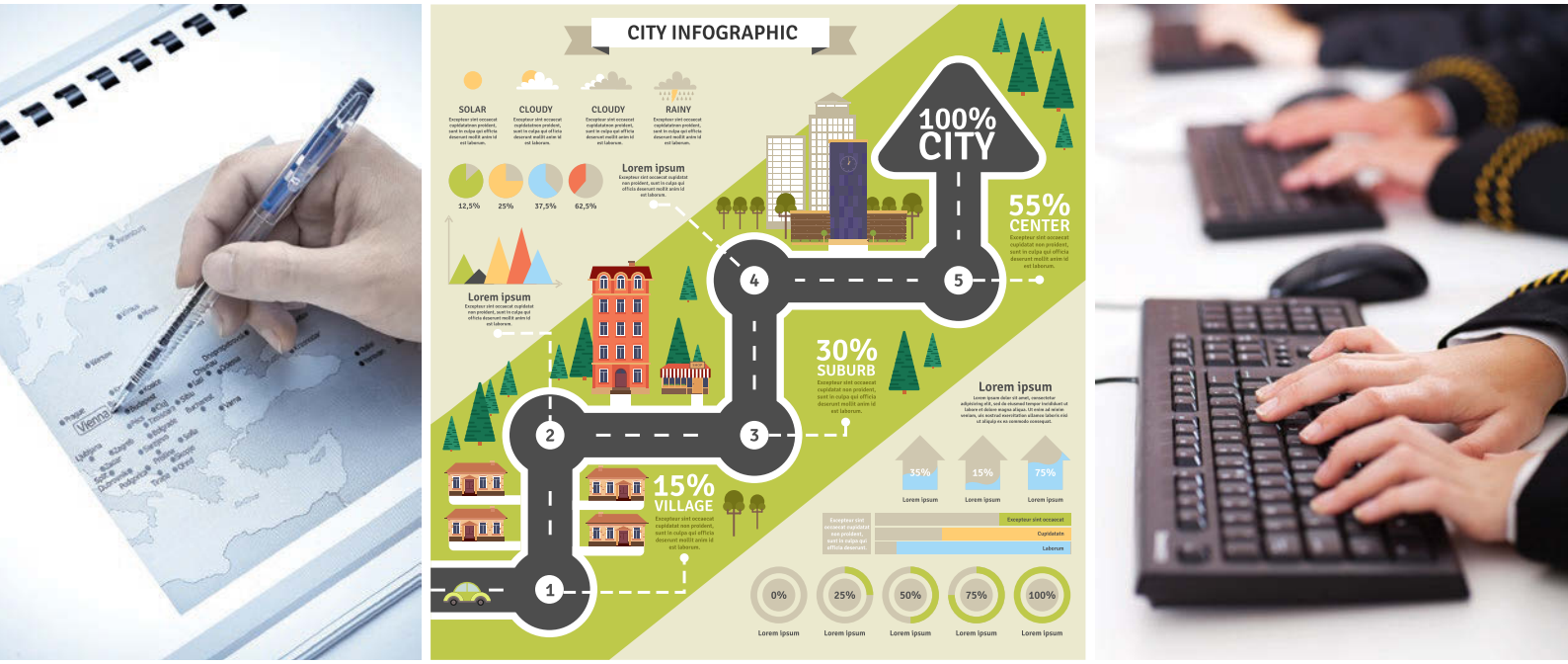

Source 0.12 There are many ways the results of inquiry can be communicated in the study of geography.

doesn't make it difficult to see the information. Always keep the amount of text on the screen to a minimum, saving the space for visuals and allowing your presenter to reveal the information while speaking.

Reflecting and responding

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.

0.4 Geographical tools

In geography, we collect data. Once we have collected our data, we need to present them in the most appropriate form using tools. Tools include maps, graphs and statistics. 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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Maps

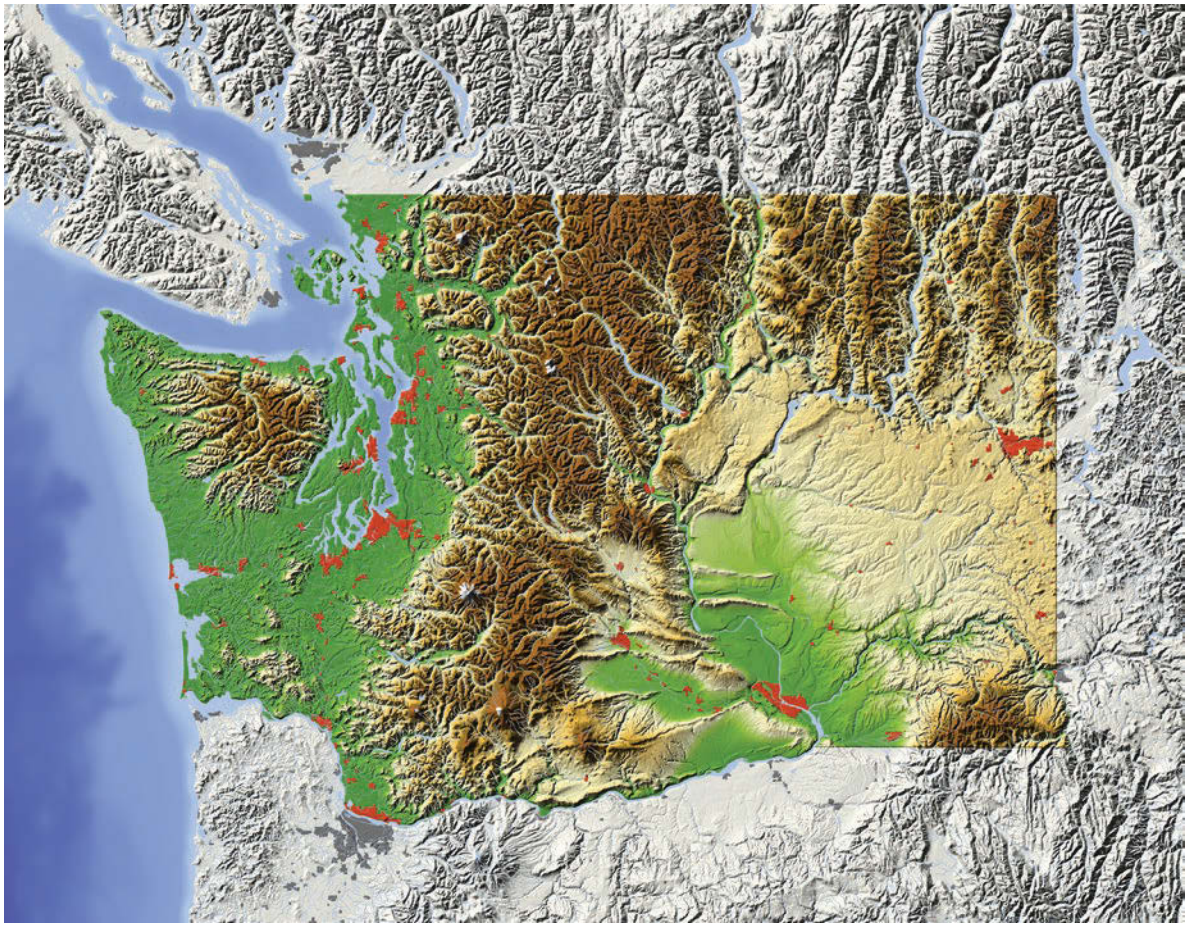
Maps are probably the best known geographic tool. A **map** is a diagrammatic or symbolic representation of particular features of a place, such as landforms, usually drawn on a flat surface. The same river can be viewed from different perspectives on a map, with information adding to our understanding 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 also have various conventions, known as **cartographic 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.

map a diagrammatic representation of particular features of a place, usually drawn on a flat surface

cartographic conventions accepted practices associated with constructing and interpreting maps, e.g. using a border, orientation or compass point, legend or key, title, scale, giving latitude readings before longitude

There are a range of different map types which we will refer to in this book, including:

- **pictorial** – a map using illustrations to represent information on a map



Source 0.13 Maps are probably the best known geographic tool. Pictured is a shaded relief map based on a NASA satellite photograph. It shows the State of Washington, USA, highlighting major urban areas and rivers with surrounding territory greyed out. Darker colours indicate greater elevation.

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- **sketch** – a labelled drawing outlining the main geographical features of a place
- **flowline** – a map showing the flows of people, goods, information or ideas between places
- **relief** – a three-dimensional map showing the shape of the land and distinctive landforms (terrain) or a two-dimensional map representing 3D terrain
- **thematic** – a map portraying a specific type of information, e.g. rainfall, transport routes, climatic zones or population distribution
- **synoptic charts** – a map showing atmospheric conditions at the Earth's surface at a point in time, e.g. air pressure, winds, precipitation. Also known as a weather map.
- **small-scale** – a map showing a large area of the Earth's surface with little detail, e.g. world map where one centimetre on the map scale represents a large distance on the land
- **large-scale** – a map that shows a small area of the Earth's surface in large detail, e.g. a suburb where each centimetre on the map scale represents a small distance on the land
- **cadastral** – a map showing property boundaries
- **cartogram** – a map in which the size of countries is adjusted to illustrate the distribution of a feature or statistic, e.g. population size, hunger, poverty
- **choropleth** – a map with shading to provide quantitative information about different areas or regions, e.g. population density
- **isoline** – a map which has lines joining places having the same value of any selected element, e.g. rainfall
- **précis** – a simple sketch map, drawn from a topographic map or photograph, showing the key patterns and features of an area by omitting minor details
- **topographic** – a detailed, large-scale map of part of the Earth's surface which illustrates the shape of the land and selected natural and human features from the surrounding environment.

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, such as **field sketches** and reports. This method is used in the textbook and explained opposite.

field sketches annotated line drawings created to record features of an environment during fieldwork activities

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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 might find, do that here too. Describe the way you collected 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 and easy to read, follows the mapping conventions of BOLTSS (listed below) 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 using one 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 p.m., Sunday 26 December 2016.* **Scale** – the map's scale shows how big the area shown on the map is in the real world. **Source** – indicate where you obtained the information for the map. This could include your own measurements, a search engine, **GPS** mapping system or the local council offices.
Page 3	**Introduction** Give a brief description of the study sites and any noteworthy features.
Page 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 supports this information.

global positioning systems (GPS) navigation systems that provide location and time information anywhere there is a line of sight to GPS satellites

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Page 7–8	**Description of effects of use, sketches and/or photos** This section needs to be quite detailed and show that you understand the area your fieldwork is based on. 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 might 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 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, do not just describe. Make sure you are giving clear and balanced feedback on the current strategies. 'Evaluate' means to make a judgement based on criteria. Always have reasons and supporting evidence for your judgement.
Page 13	**Appendix, bibliography, glossary** An appendix is the section at the end of the book that provides additional information that supports the main work. You should include an appendix to add meaning to your work. If you undertook a survey as a 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 one 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 in the glossary any words (or special usages of words) that your reader needs to know.

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Source 0.14 Photos can be an important geographic information source. Pictured is a highly detailed NASA satellite image of the southeast coast of Australia, and Earth as seen from the Japanese weather satellite Himawari 8 in 2015.

Graphs and statistics

quantitative methods statistical and other methods used to analyse quantitative data

qualitative methods explanatory and interpretive methods, e.g. participant observation, focus group discussion or interviews, which are used to gather qualitative data

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.

Graphs and statistics are both quantitative **geographical data**. Statistics can include averages, proportion or percentages, total number (such as total number of animals observed in a region) and so on. Statistics are very descriptive and informative, particularly if they are collected in a systematic manner. It is important, therefore, to be able to trust the data you use in your 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.

geographical data quantitative or qualitative information about people, places and environments

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

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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.

There are a range of ways we will consider different types of data in this book, including:

- **climate graph** – a graph showing average monthly temperature (by a line) and precipitation (by columns) for a location
- **pictograph** – a graph using symbols to represent statistical information
- **population profile** – a graph showing the age and gender composition of a population. Also known as a population pyramid.
- **scatter graph** – a graph which plots the relationship between two variables, e.g. rainfall and height above sea level.

Source 0.15 Data can be represented in a range of appropriate forms including climate graphs, compound column graphs, population pyramids, tables, field sketches and annotated diagrams.

Spatial technologies

The use of spatial technologies in geography is becoming increasingly important, both in geographic work and in the wider community. This is not only an employment growth area; 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 you use them when they are the best tools available for the specific task at hand.

Source 0.16 We easily view satellite maps and weather radar from anywhere in the world on smartphones without thinking about the technology that makes it all possible.

Visual representations

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.

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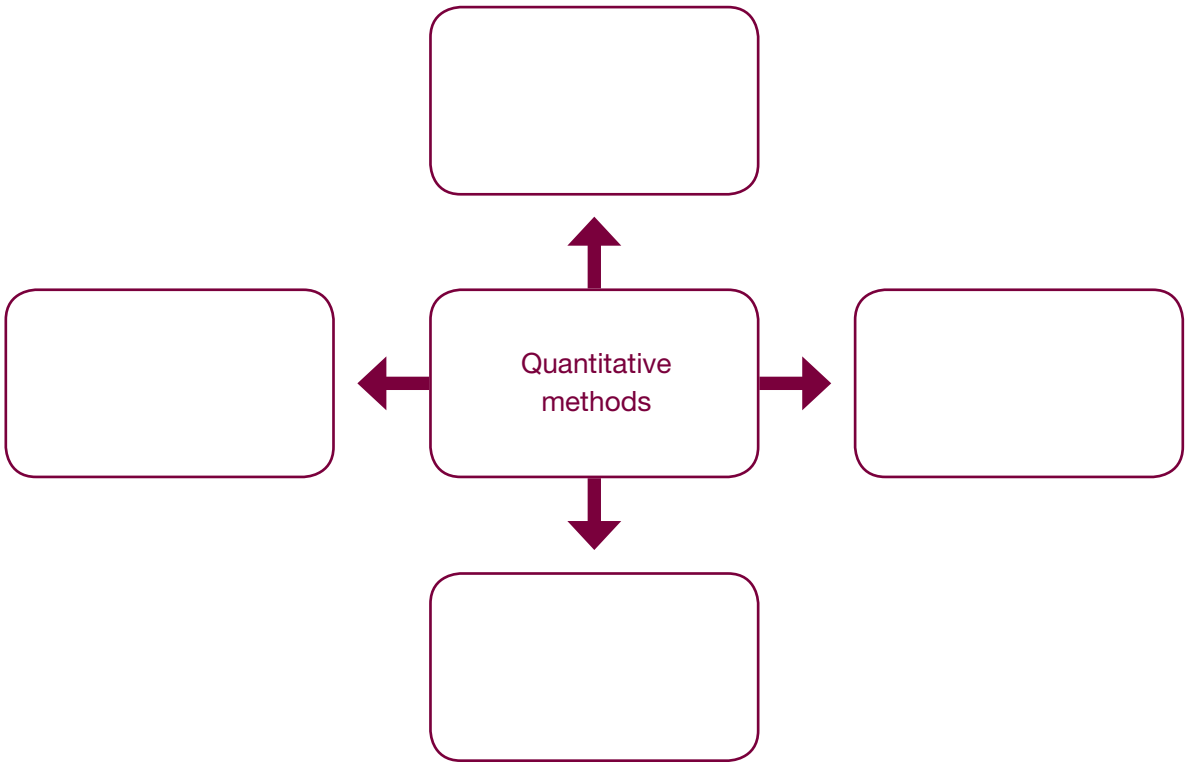
Annotation (notes added to the picture) for field sketches you have taken or other images is useful in a report so you can easily highlight and refer to important sections. You should always acknowledge the source of an image if you did not create it yourself, just as you list information sources in a bibliography.

Note this down 0.3

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



Activity 0.2

1 List five spatial technologies and different ways you could use each one in developing an inquiry.

2 Justify the use of standard geographic conventions when creating a map.

3 Discuss the importance of inquiry questions.

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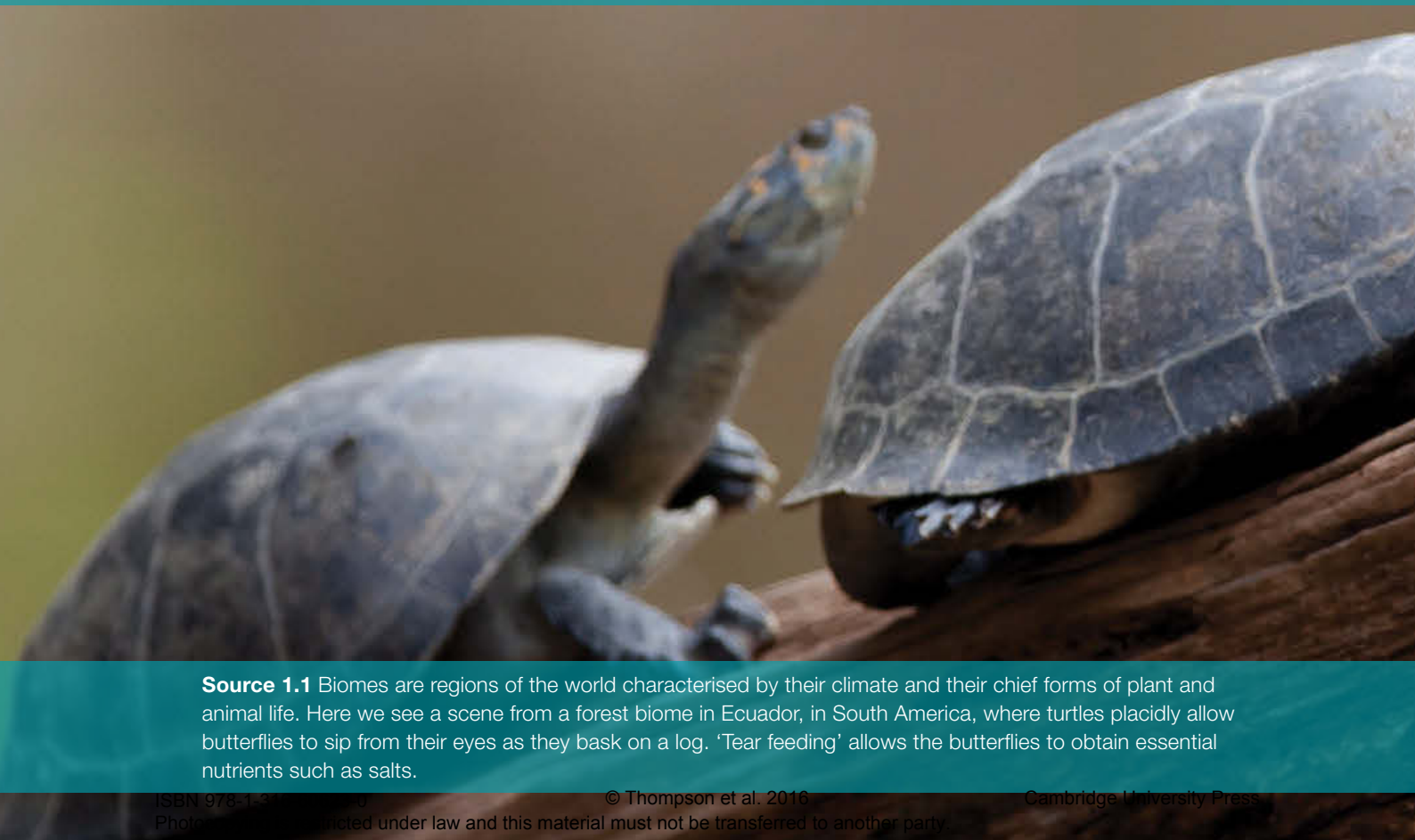
Topic 1

Sustainable biomes



Source 1.1 Biomes are regions of the world characterised by their climate and their chief forms of plant and animal life. Here we see a scene from a forest biome in Ecuador, in South America, where turtles placidly allow butterflies to sip from their eyes as they bask on a log. 'Tear feeding' allows the butterflies to obtain essential nutrients such as salts.

1 Biomes

Source 1.2 A stream runs through a rainforest environment in Washington State, USA.

Before you start

Main focus

To examine the way in which biomes are distributed and understand their physical characteristics.

Why it's relevant to us

People have adapted to living in different biomes and humans have altered biomes, for better or for worse.

Inquiry questions

- What are the world's major biomes and where are they located?
- How can these biomes be used to produce food, industrial materials and fibres?
- What affects the productivity of biomes?
- How do plants and animals interact in biomes?

Key terms

- Aspect
- Biomass
- Biome
- Biosphere
- Coniferous
- Desert
- Orographic rainfall
- Rainforest
- Savanna
- Zonation

Let's begin

The word 'biome' refers to groupings of plant and animal communities that have adapted to inhabit particular parts of the Earth's surface. Before the domestication of plants and animals, the main thing biomes had to adapt to was the world's changing climate. In recent times, biomes have had to adapt to a changing climate and human interference.

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1.1 Spatial distribution of biomes

biome a major terrestrial vegetation community, e.g. a tropical forest, a temperate grassland or a desert

biosphere all the life forms and environments on or near Earth's surface that are capable of sustaining life

'Why are **biomes** important?' you might ask. Biomes are the groupings of plant and animal communities that, combined, make up the Earth's total **biosphere**. As you might remember from your previous studies in geography, the Earth's four spheres are the lithosphere, the atmosphere, the hydrosphere and the biosphere. The lithosphere is the 'rock' sphere that comprises landforms and landscapes; the hydrosphere is the 'water' sphere, including water in all its forms (liquid, solid, gas); the atmosphere is the 'air' sphere – the layer of protective gases surrounding Earth; while the biosphere is the 'life' sphere, including all life forms and all environments on or near Earth's surface that are capable of sustaining life. The biosphere is made up of a range of biomes, and examining these biomes and their characteristics is a focus in this topic.

Source 1.3 The biosphere contains all life on Earth, and is made up of many biomes. The various biomes house plant and animal communities that have adapted to the climatic conditions of the region; for example, here we see a red deer in a temperate deciduous forest environment in Belgium.

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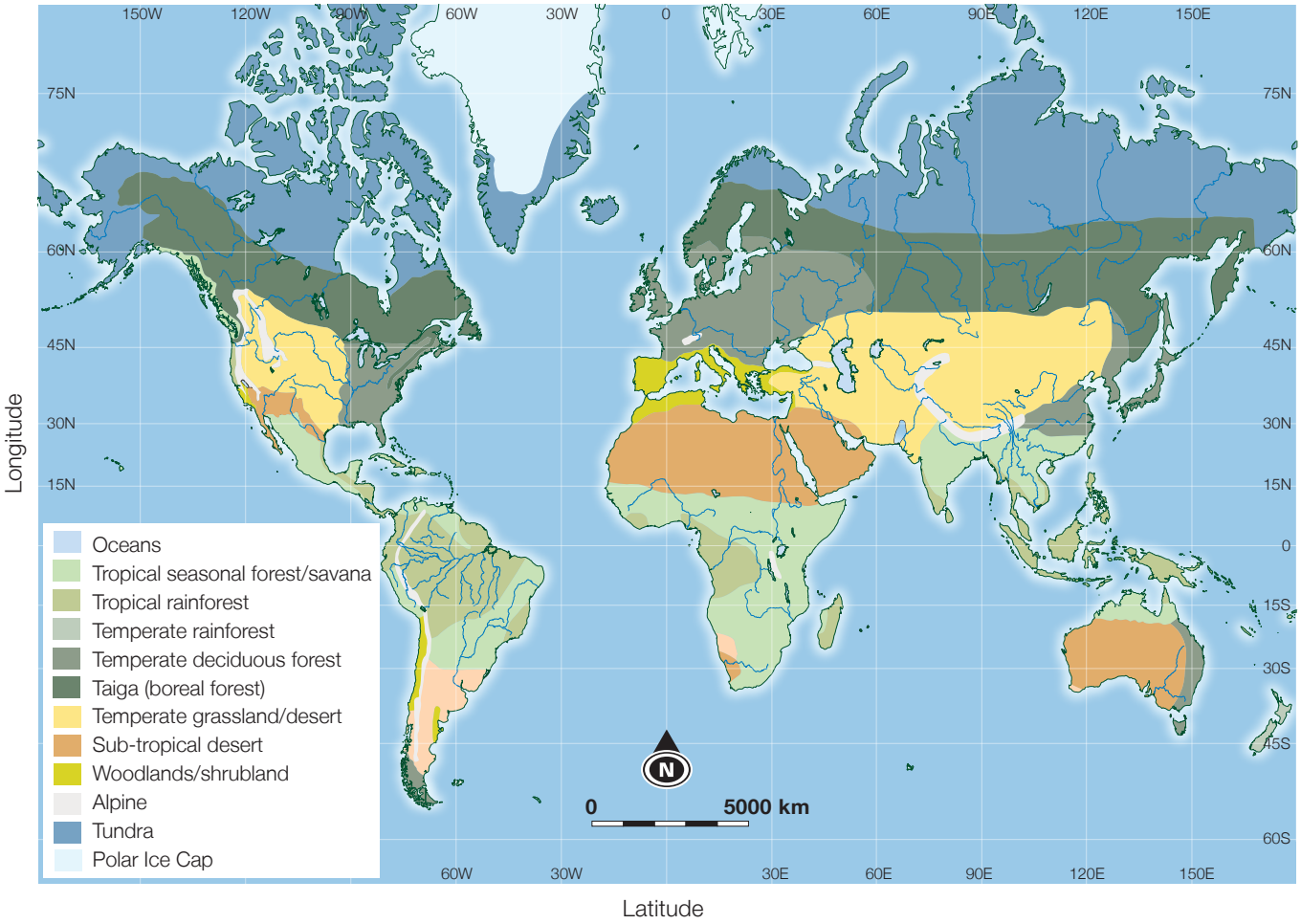

Source 1.4 Spatial distribution of the world's major biomes

Source 1.4 shows the spatial distribution of the world's biomes. There are many different maps of the world's biomes. Some maps use different terminology for the biomes, and Source 1.4 would be even more complicated if the ocean's biomes were added to it.

The normal way of looking at this location pattern of the world's biomes is to look at the change from the Equator to either the North or South Pole. For example, in Source 1.4, start with Africa and move to the North Pole along 30°E longitude.

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Note this down 1.1

Copy the graphic organiser below and name a country that would have each biome.

This examination shows the transition of biomes from the hot, wet **rainforest** of the tropics to the polar ice caps. The same biomes are found in different parts of the world. There is a pattern of biomes from north to south across the globe.

rainforest a tropical forest environment with a large amount of rainfall

Biome	Country
Tropical rainforest	
Tropical seasonal forest/savanna	
Sub-tropical desert	
Woodland/shrubland	
Temperate **deciduous** forest	
Taiga (boreal forest)	
Tundra	
Polar ice cap	

deciduous refers to trees and shrubs that lose their leaves seasonally, usually during autumn

taiga coniferous forest that is found in colder climates in the Northern Hemisphere. Largest biome in the world.

Location and climate of the world's biomes

There are many factors affecting the location of the world's biomes, but one factor stands out above any others: **climate**. The plant and animal communities of our world respond to variations in climate. It is their response to the variations in climate that give the world both this distinctive pattern of biomes and the pattern of changes in biomes as one moves from the Equator to either Pole.

climate the average types of weather, including seasonal variations, experienced by a place or region over a long period of time

This relationship between vegetation and climate was recognised by Russian/German climatologist Wladimir Köppen when he published his world climate classification in 1884. Later modifications were made. His classification recognises that vegetation patterns are a reflection of climate patterns.

Many of the names Köppen gave to his climate regions were based on vegetation terms – rainforest, **savanna**, **desert**, **tundra**. Other descriptors are more related to climate terms – **perpetual frost**, dry climates.

Climate is the major controlling factor in the distribution of biomes. Another influential factor in determining the location of biomes is people. As we will see through the study of this topic, all the elements of a biome exist in some meaningful relationship with each other, and change in one – for example, the **habitat** – leads to a change in the biome.

savanna a grassy plain with scattered trees and shrubs

desert an area that receives less than 250 mm rainfall per year

tundra an area where plant growth is limited by low temperatures and a short growing season; usually found at high latitudes or high altitude

perpetual frost an area that is constantly covered in ice, such as the polar caps

habitat the natural home or environment of an animal, plant or other organism

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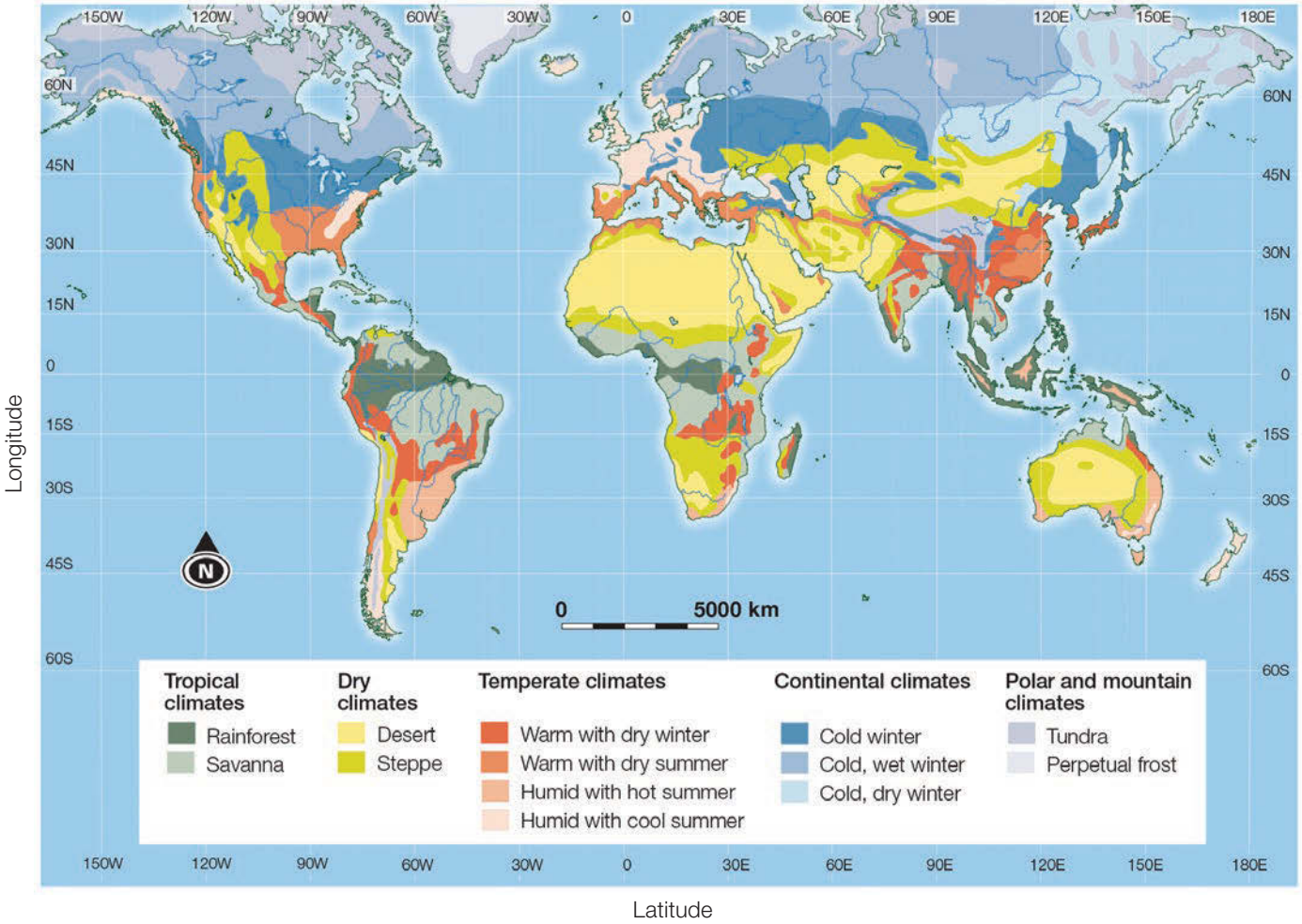

Source 1.5 Köppen's world climate classification

Activity 1.1

Sources 1.6, 1.7 and 1.8 are images of three different biomes.

Think: Examine the photos and try to find the characteristics that could be used to identify different biomes. Examine the photos and write down the characteristics you think are important.

Pair: Next work with a partner to come up with a list of five or six characteristics that you think could be used to identify different biomes.

Share: Share these ideas with your class. Your activity would have identified many features which could be used to identify biomes. The list may have included:

1. plant species
2. special adaptations
3. special relationships between plants.

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Source 1.6 Rainforest biome – Central America

Source 1.7 Savanna biome – Africa

Source 1.8 Desert biome – Australia

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Rainforest biomes

Rainforests are one of the world's most interesting biomes. As Source 1.4 shows, they are found on several continents, both north and south of the Equator.

aerial photograph image taken from the air showing characteristics of an area. It may be at an oblique angle (slanting angle) or a vertical angle (straight down).

Rainforests are such complex biomes that it is often difficult to take a photograph that allows a person to see all their features (even in an **aerial photograph**).

Plants

A rainforest is characterised by a wide variety of plant species growing at various height levels. It will have a number of canopy tree species, and many of them will not grow outside a rainforest environment. There are generally four layers to a rainforest:

Emergent layer: Giant trees that stick out above the canopy. The trees here are much taller than the rest of the canopy – so much so that it is hard to show the emergent layer trees from this angle.

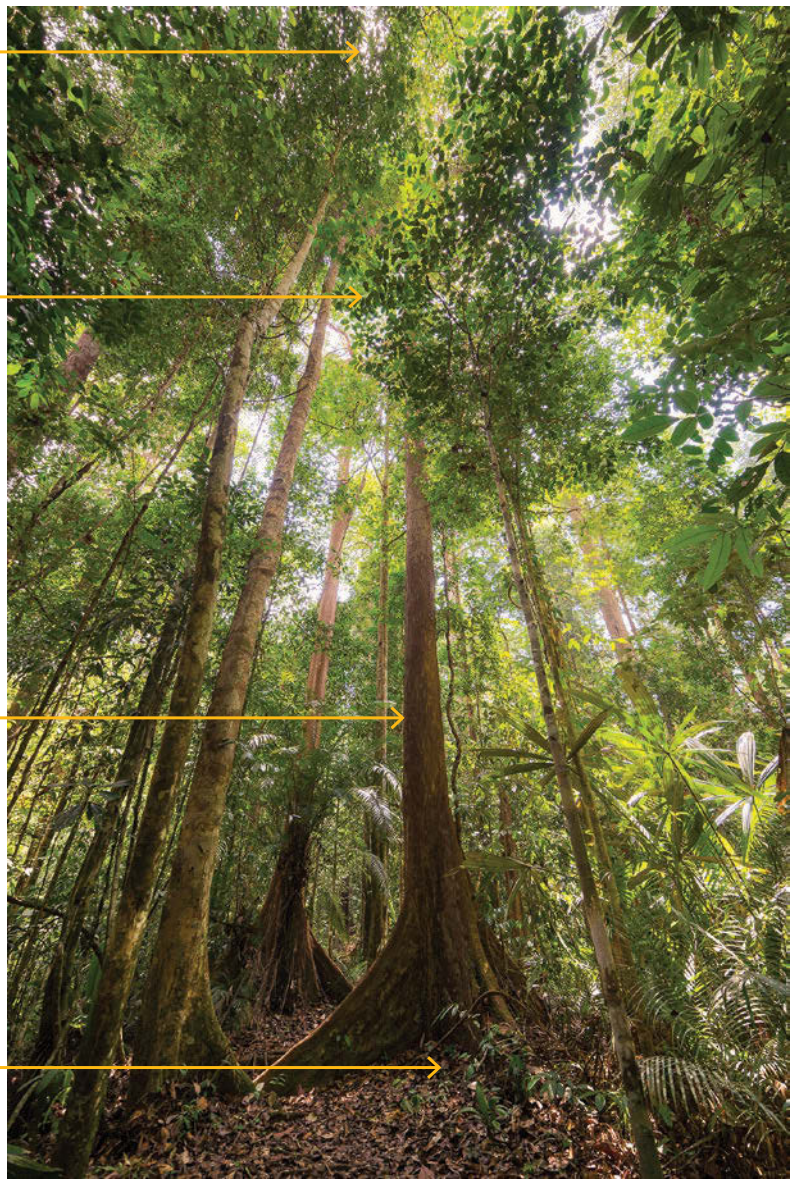
Canopy layer: The upper storey or level of a rainforest, the canopy, tends to be characterised by very tall trees. The trees have few branches until the top (or canopy) of the forest. Rainforests also have a high density of trees per hectare compared with other forests. One of the distinctive features of a rainforest is that the canopy is 'closed' – the branches (or crown) of the trees link together and block out sunlight.

lichen a slow-growing plant which characteristically grows like a crust over rocks, walls and trees

epiphyte a plant that grows on another plant but tends not to be parasitic; instead it survives on nutrients from the rain, air and debris around it rather than the plant it is attached to

Understorey layer: Lower storeys of a rainforest also host a wide variety of plant species. Some of these are young plants of the canopy layer, waiting for a canopy tree to fall and create a space for them to grow up into. Other plants have adapted to living in the moist, humid, dark environment of the rainforest understorey, such as mosses, **lichens**, **epiphytes** and palms.

Forest floor: Very little light reaches the forest floor, which has a major effect on the characteristics of the forest. Unsurprisingly, you don't tend to see grass growing in rainforests.



Source 1.9 Layers of a rainforest

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Source 1.10 Epiphyte tropical fern growing on a tree trunk in Sumatra, western Indonesia

Geographical fact

The canopies of a tropical rainforest are so densely packed that rain falling on the trees at the top can take up to 10 minutes to reach the ground.

Source 1.11 Australian rainforest in north Queensland. Here you can see the buttress roots of the tree.

Source 1.12 Rainforest leaf of the Macaranga plant

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Source 1.12 shows the leaf of a Macaranga plant found in rainforests throughout New Guinea and in coastal Queensland. It is easy to see how this leaf has evolved to assist the movement of rainfall to the ground.

RESEARCH 1.1

Use the internet to research what theories have been proposed to explain the development of buttress roots.

If you live near a rainforest area that can be visited easily, visit that area and conduct some simple observations, keeping the theories you researched in mind. Draw a conclusion, using your photographic evidence as the development of buttress roots. Can you identify any plants or animals? If you don't live close to an area of rainforest, you may have to use Google Earth or Google Images to examine an area.

Animals

Tropical rainforests are home to a diversity of animal life. It is estimated that approximately 30% and perhaps up to 50% of the world's animal life lives in rainforest biomes.

Source 1.13 The red-eyed tree frog found in the rainforests of Costa Rica

Source 1.14 The exotic bird Goura Victoria found in the rainforests of New Guinea

Source 1.15 A langur, found in the rainforests of Java, Indonesia

Source 1.16 The emerald boa constrictor in the rainforests of the Amazon, South America

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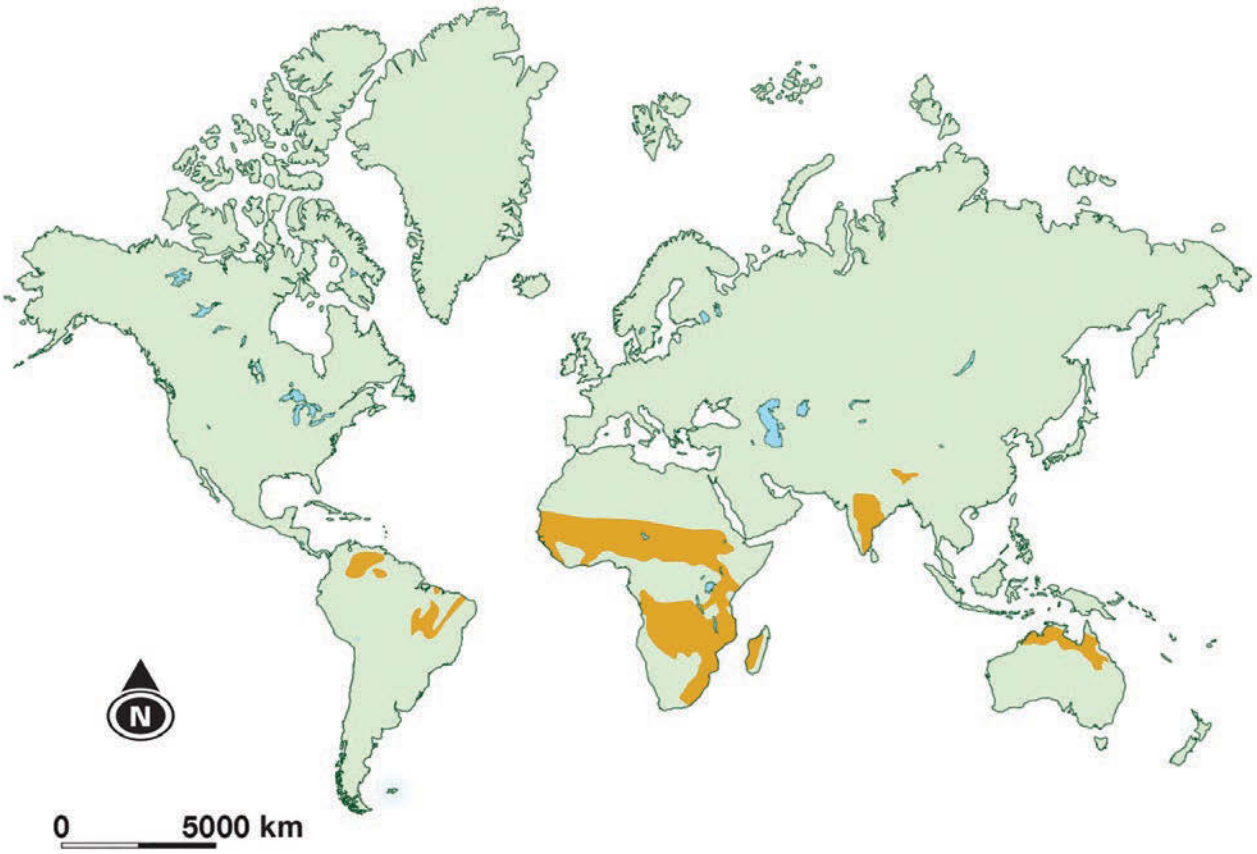
Source 1.17 Colourful butterflies like this are distributed throughout the tropical and sub-tropical regions of the world.

Savanna biomes

The savanna biome is completely different from the rainforest biome. The rainforest biome is dominated by its plant life, whereas the savanna biome is dominated by its animal life. The plant life is important, but it is the animal life of this biome that attracts the most attention. The world's savanna areas are shown in Source 1.18.



Source 1.18 Savanna biomes of the world

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Plants

Unlike plants in the rainforest, trees in the savanna do not grow very high. There is often a sparse shrub layer, and the ground cover is primarily grass. In fact, you tend to see more grass than trees and shrubs. You tend to find more plant species in the ground layer of the savanna than in the tree and shrubs layer.

Source 1.19 (Left) Grant's Gazelles in Tsavo East National Park, Kenya. (Right) A lioness scans the savanna for her next meal in Serengeti National Park, Tanzania.

Source 1.20 (Left) A herd of elephants in the afternoon sun of the dry plains of Serengeti, Tanzania. (Right) The same landscape at sundown.

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Geographical fact

Grasslands cover almost one-fifth of terrestrial environments. They can be found on every continent except Antarctica.

Animals

When the rains come, the savanna vegetation springs to life. The most rapid response is from the grasses, which have died back during the dry period just as they do in your backyard. The rains bring a rapid spurt of growth. This growth attracts a group of animals known as grazers or herbivores (primary consumers) that eat the grass. These animals advance as the pastures grow and retreat as the area dries up and the pastures die back. This movement of herbivores is known as a 'migration'. The animals breed, and their numbers multiply.

While most herbivores graze on the grasses, some, such as the giraffe and the elephant, graze on other new vegetation too. The giraffe's long neck allows it to reach new shoots and its thick rubbery lips allow it to avoid thorns and prickles. The elephant simply knocks the tree down and uses its trunk to get at the leaves it wants.

The herbivores bring with them another group of animals: the carnivores (secondary consumers). These animals eat meat. They prey on the herbivores – they eat the weak, the young and those not paying attention to their surrounds. Some, such as crocodiles, congregate at river crossings and attack the herbivores as they cross.

Scavengers such as vultures and hyenas make up the final major group of animals on the savanna. They obtain their nutrients by eating the rotting flesh left behind by carnivores and devouring the bones of dead animals. These animals, like many other animals on the savanna, produce droppings

Source 1.21 Carnivores like crocodiles are a dangerous threat to herbivores, especially near waterways.

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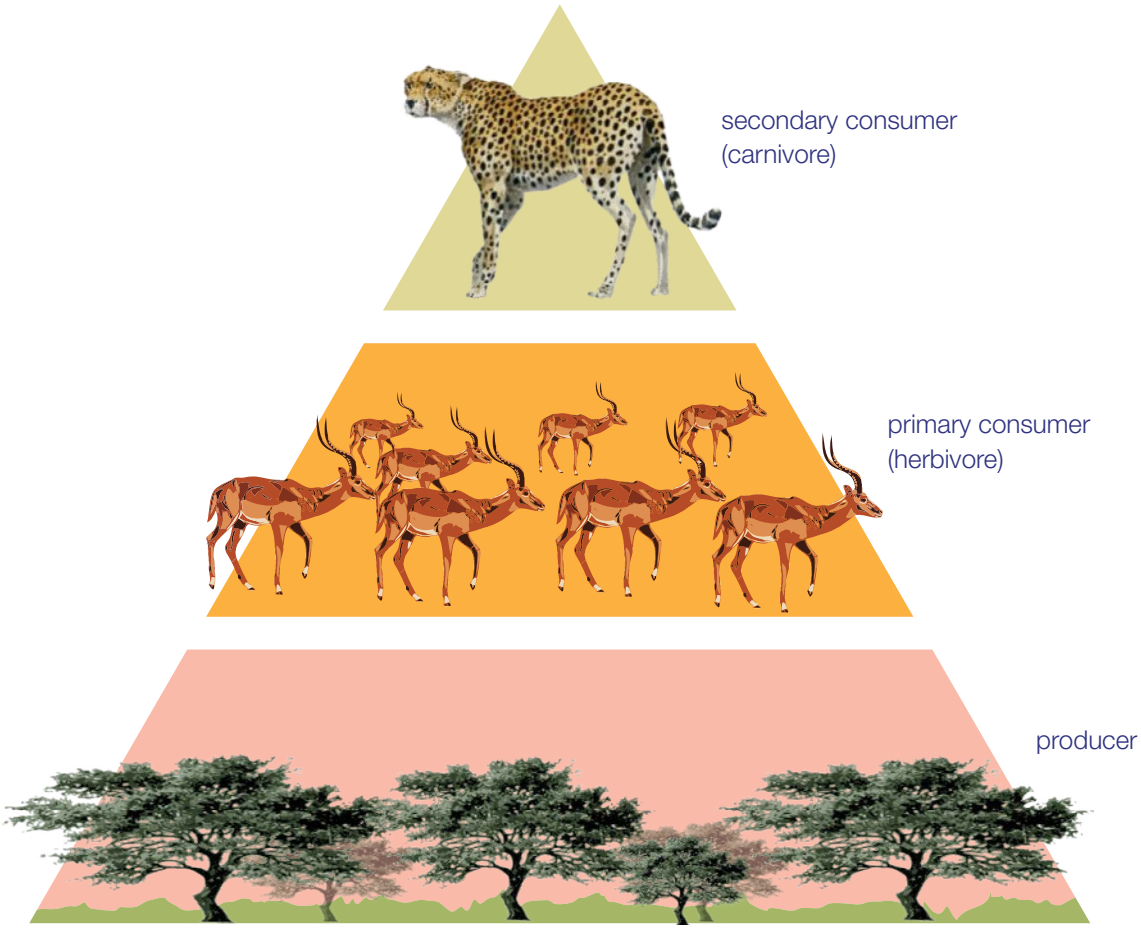
which dung beetles – probably as far removed from the top of the food chain as it is possible to be – use to do their work: they convert the droppings into nutrients, which return to the soil and are used by the plants for their growth. Finally, decomposers such as bacteria, fungi and termites break down dead and decaying plant or animal matter that is then released as nutrients back into the ecosystem, providing energy for others. Thus the 'circle of life' is completed on the savanna.



Source 1.22 Simple African savanna food chain

Activity 1.2

1 Outline the importance of carnivores in the savanna biome.

2 Explain how the removal of weaker herd animals could actually be a benefit to the biome.

3 What might happen in a savanna if the herbivores had no predators?

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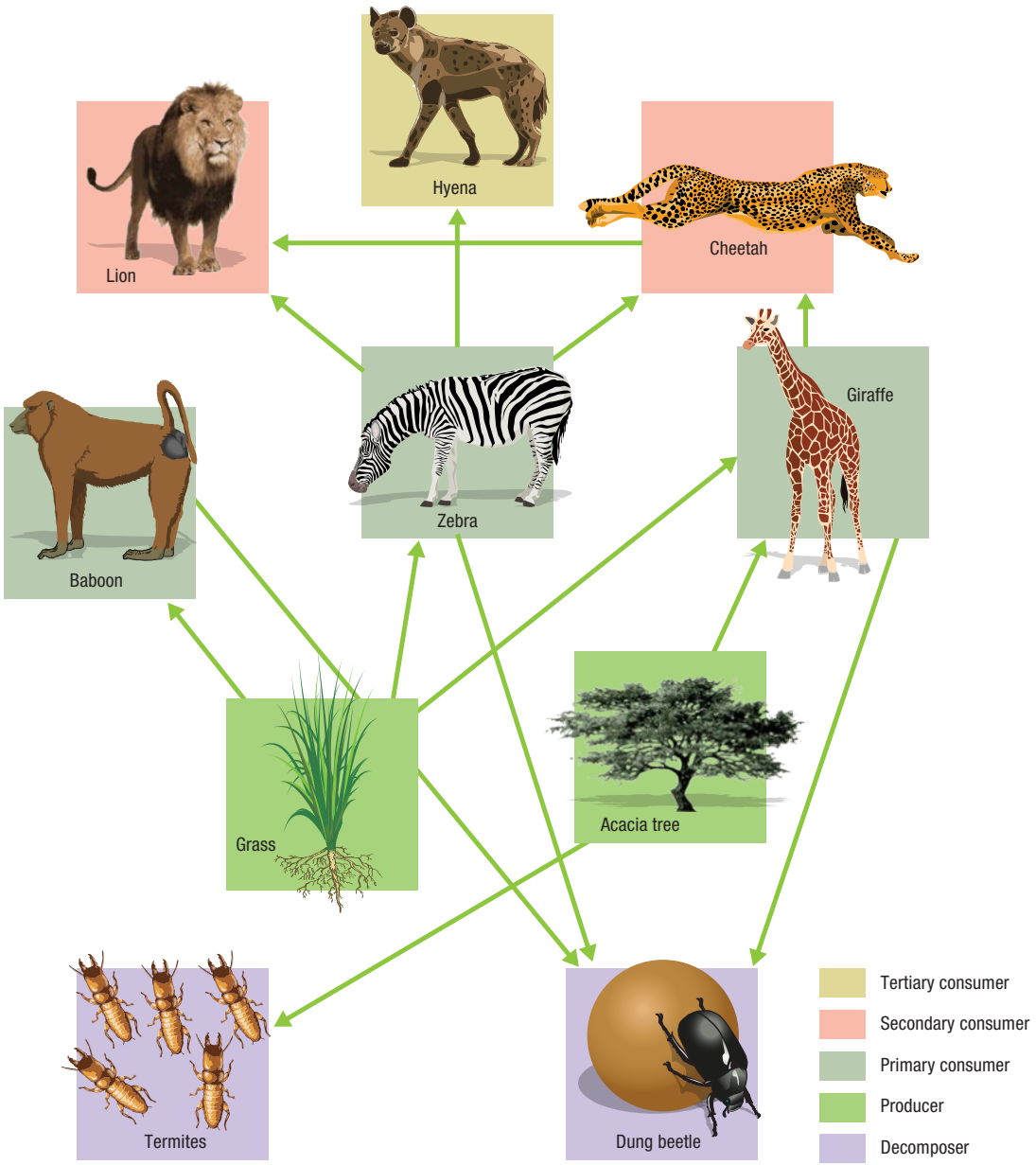

Source 1.23 More complex African savanna food web

Activity 1.3

1 Construct a simple food chain for the Australian savanna.

2 Source 1.23 is a food web, showing a more complicated interpretation of the same food chain in Source 1.22, but still does not show the full extent of the relationships between the plant and animal communities of the savanna. For example, where do the hippopotamus, the warthog, the wildebeest and the oxpecker fit in?

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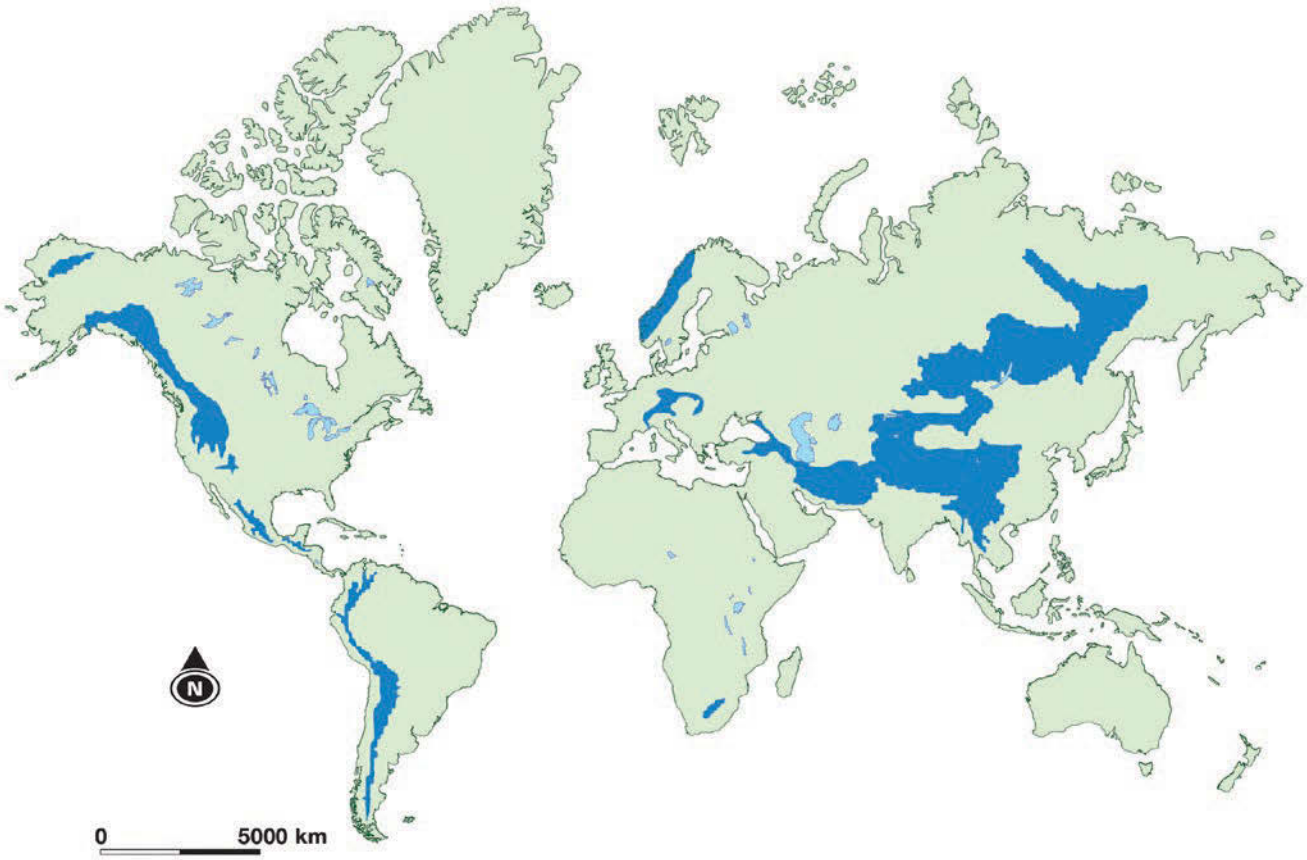
Alpine biomes

Australians are less familiar with alpine or mountain biomes. The highest mountain in Australia is Mount Kosciuszko, which is only 2228 metres high. In comparison, the highest mountains on the other continents are over 3000 metres high. In fact, on world maps of mountain biomes, the scale is often too small for Australia's mountain regions to be shown. However, we do have some alpine and subalpine regions in the southeast of Australia and Tasmania (see Source 1.25).



Source 1.24 Alpine or mountain biomes around the world

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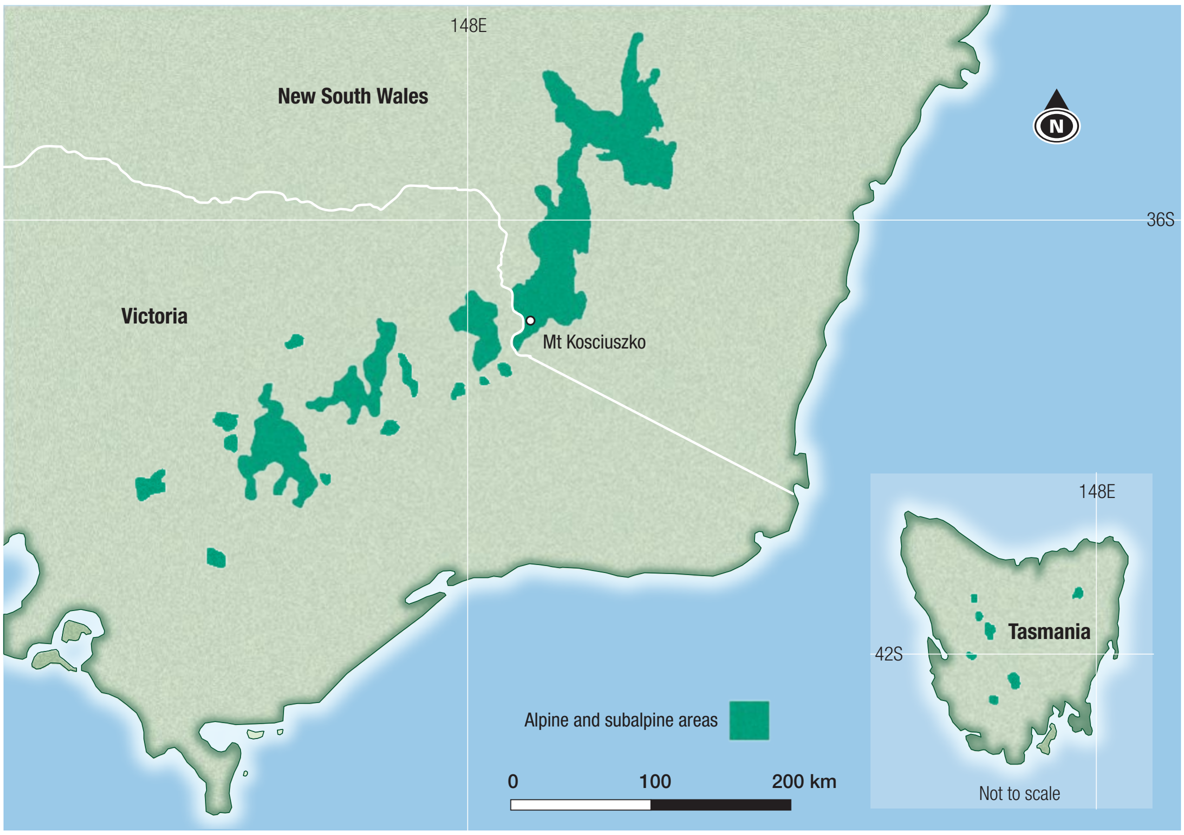

Source 1.25 Australia's alpine and subalpine areas – where the nation's ski fields are located

Source 1.26 Australian National University students on a 2015 field trip to Kosciuszko National Park, New South Wales, admire Mount Kosciuszko from Scammell's Spur lookout

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Plants

In alpine biomes the vegetation changes as the altitude increases.

zonation variation in plant life due to differing environmental conditions

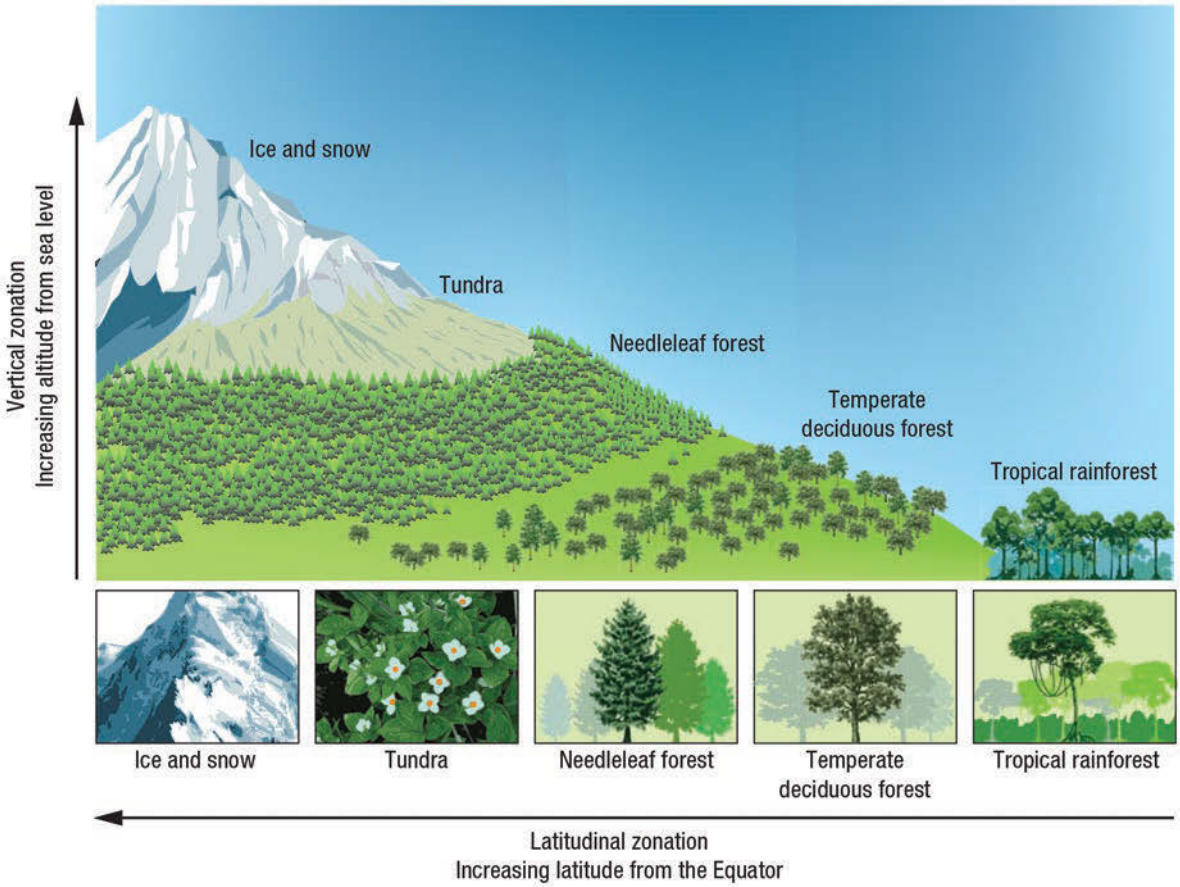
Source 1.27 shows there is a change of vegetation as altitude changes (**zonation**). It also demonstrates that the same type of change occurs with changes in latitude. The relationship is simple:

- vegetation changes as altitude changes
- vegetation changes in a similar way as latitude changes between the Equator and the Poles.

Geographical fact

In the troposphere, the temperature decreases about 6.5°C for every 1000 metres you climb. This is called the environmental lapse rate.

There is a simple reason for this. Temperature decreases as altitude increases. Lower pressure at high altitudes allows air to expand and cool. This means that it is possible in some mountainous areas near the Equator to begin a mountain climb in rainforest and finish it at the top of a snow- and ice-covered peak.



Source 1.27 Vegetation changes with altitude and latitude

There are fewer plant species in the upper zones of alpine biomes due to less carbon dioxide, less water availability and short growing seasons as the altitude increases. Basically, plants in alpine biomes protect themselves from the cold and wind by hugging the ground, as taller plants or trees would soon get blown over and freeze.

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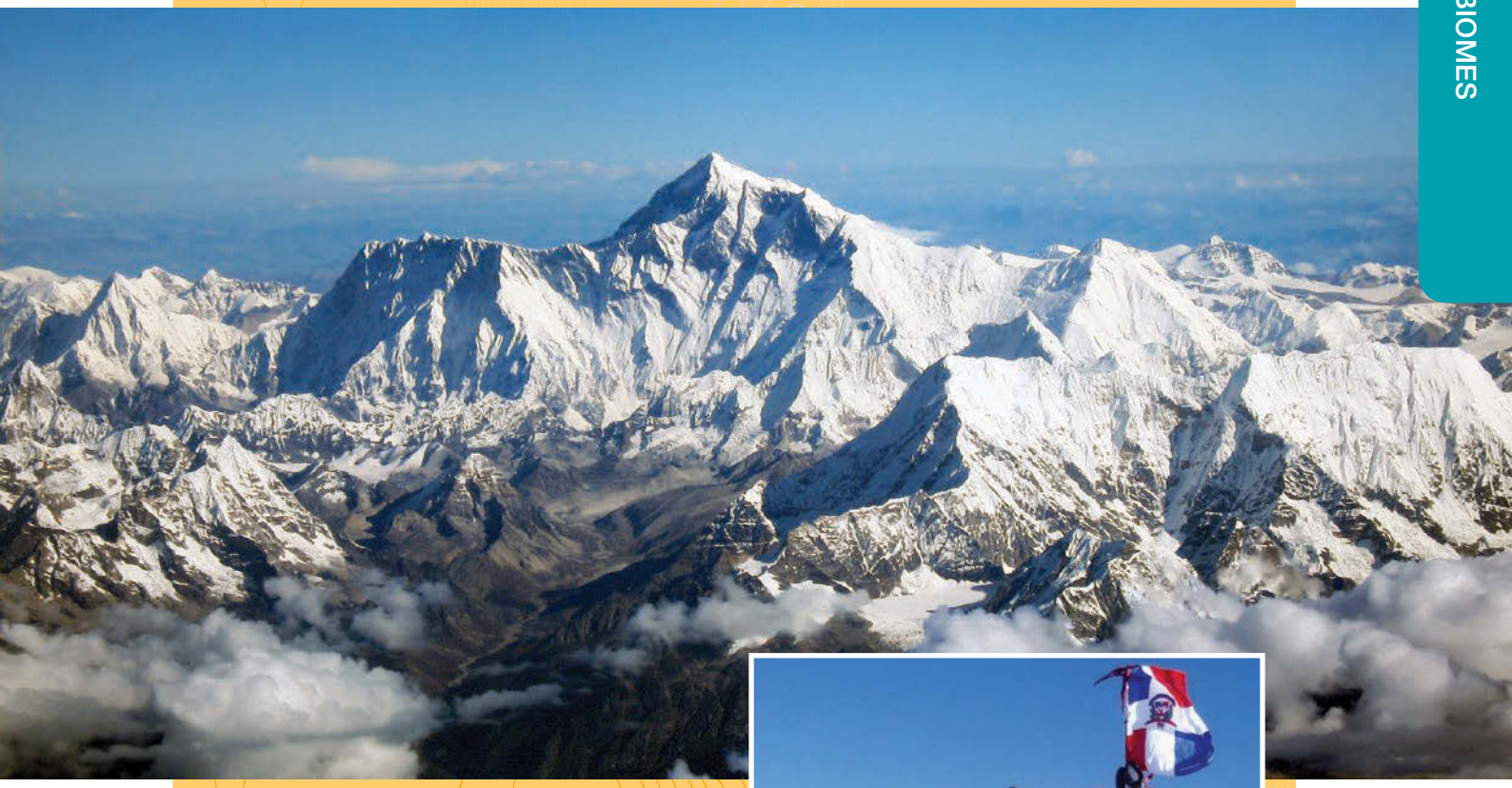
Geographical fact

Mount Everest is the highest mountain in the world, currently at 8848 metres and growing by about 1 cm a year. It is very cold, with temperatures averaging –19°C in summer and –36°C in winter. Climbing Mount Everest is an aspiration for many climbers, but it costs an average of US$50 000 (including preparation) to climb the mountain and it is risky. The 'death zone' of the perilous mountain begins at 8000 metres.

Since the summit was first climbed by Sir Edmund Hillary in 1953, over 250 people have died due to avalanches, falls, acute mountain sickness, exposure and frostbite. Most of their bodies have been left on the mountain. The deadliest single day on Everest in terms of loss of human life was 25 April 2015, when 20 climbers perished after a massive earthquake triggered an avalanche.



Source 1.28 The summit of Mount Everest in the Himalayan mountain range is the highest point on Earth. (Right) Climbers often need to use bottled oxygen to reach the summit.

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Animals

There also tend to be fewer animal species in alpine biomes due to the more severe climate. The majority of animals tend to be warm-blooded, although there are also a variety of insects. Animals in alpine biomes need to be able to cope with the cold and higher levels of UV radiation. For this reason, alpine animals have adapted to their environment in order to survive. They tend to have larger lungs and more red blood cells (and **haemoglobin**) due to the increase in air pressure and lack of oxygen at higher altitudes. They also have more body fat, and shorter legs and tails to minimise heat loss. Alpine animals have also adapted by **hibernating**, or migrating to lower (and warmer) areas. Examples of alpine animals include the yak, alpaca, llama, chinchilla and snow goat.

haemoglobin the part of red blood cells that carries oxygen from the lungs to the body's organs and tissues

hibernating sleeping or staying inactive during winter in order to survive extreme weather conditions

Source 1.29 Herd of alpacas in the snow-covered Andes and a llama in Peru, South America

Source 1.30 Mountain goats in the Glacier National Park, Montana, United States

Source 1.31 A chinchilla in among the ruins of Machu Picchu, Peru. Chinchillas are now endangered due to the popularity of their fur in the early 1900s when tens of thousands were killed for their pelts. They are now protected by law.

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Source 1.32 A brown bear and a polar bear peeking out of their dens after hibernating during winter

Activity 1.4

1. Briefly describe the changes in vegetation shown in Source 1.27.
2. How does elevation affect vegetation patterns that are demonstrated in this diagram?
3. Animals that live in alpine biomes have adapted to their environment. What are some of their special characteristics?
4. Discuss how a warmer climate might affect mountain biomes.

Biomass

The **biomass** production of each type of biome differs, due to the influence of climate. Before we look at the impact of climate on biomass production, we first need to investigate what biomass actually is.

biomass the mass of organisms per unit area

photosynthesis a process by which a plant produces its food using energy from sunlight, carbon dioxide from the air and water from the soil

Biomass is the total amount of living matter in a given area. Most of the biomass is made up of plants. This is because plants are known as 'primary producers' of biomass. In other words, they create biomass through **photosynthesis**. Therefore, when we talk about biomass in this book, we talk about the amount of biomass produced by plants through photosynthesis. There are other ways of measuring biomass – such as subtracting the amount of biomass used by the **respiration** of animals and plants. In this context, when we compare one biome to another, we will talk about biomass in terms of what is produced by plants.

respiration a process living organisms need – inhaling air, particularly oxygen, and exhaling carbon dioxide

Globally, primary production amounts to 243 billion metric tons of dry plant biomass per year. Biomass tends to be measured by the

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energy it provides, as shown in Source 1.33 below.

Therefore, the more heat and water a biome receives, the greater the plant life and therefore the greater the biomass production. Conversely, the more barren the biome (or the more severe the climate), the less plant life, and the less biomass production. Thus, rainforests have a much greater biomass production than deserts.

Ecosystem type	Net primary productivity (kilocalories per square metre per year)	Approximate kilocalories per square metre per day	Type of land	% of Earth's land surface
Tropical rainforest	9000	25	lush vegetation, water rich	11%
Estuary (where a river meets the sea)	9000	25	marshland, swamps, lakes, streams	3%
Swamps and marshes	9000	25		
Savanna (grass, scattered trees, little or no winter snow)	3000	8	grassland, prairie, savanna	21%
Temperate grassland (cold winters)	2000	6		
Deciduous temperate forest	6000	16	temperate forests	22%
Boreal forest (evergreen coniferous forest)	3500	10		
Polar tundra	600	2	barren ice, sand, tundra, desert	33%
Desert	< 200	1		

Source 1.33 Biomass measured by the amount of energy it provides

Geographical fact

The greatest producer of biomass is the ocean. The total primary productivity of the ocean is about eight times the primary productivity of all land surfaces. Seaweed in particular is an important primary producer. Oceans cover about 70% of the Earth's surface, so it is not surprising that they are our biggest biomass producer.

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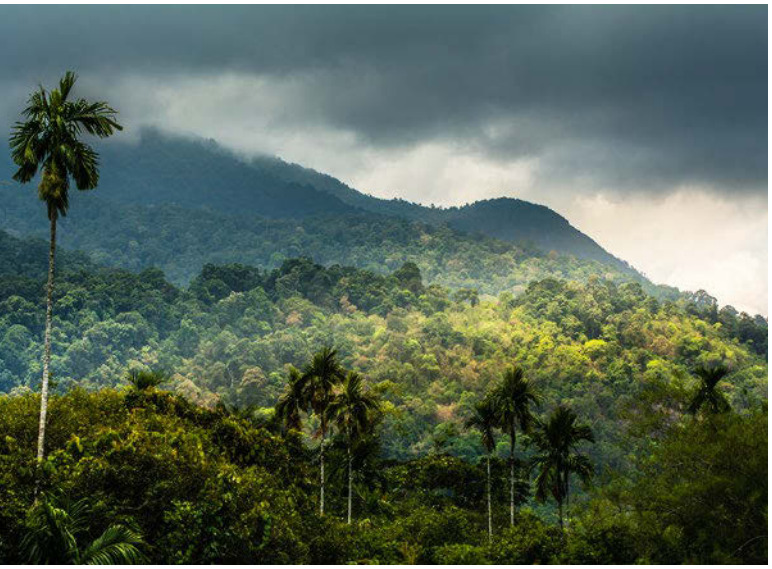

Source 1.34 The biomass production of this rainforest in Thailand would be much greater than this desert in Dubai.

Note this down 1.2

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

Biome	Distinctive features	Special adaptations of plants and/or animals	Other special features
Rainforest			
Savanna			
Desert			

1.2 Biomes used to produce food, industrial materials and fibres

Humans rely on biomes for survival. This is because biomes are sources of materials that can be used to produce food, clothing, shelter and energy. Biomes are adapted by humans in order to produce items we need (or believe we need); for example, livestock/crops for food and livestock/crops to make fibres for clothing.

How people use biomes

The simplest way to obtain an overview of how people use the world's biomes is to examine a map of the world's economic activities. It is interesting to compare the map showing the world's biomes (Source 1.4) with the economic activities in Source 1.35. There are some similarities.

An initial examination of the world's economic activity shows that biomes throughout the world are put to certain uses,

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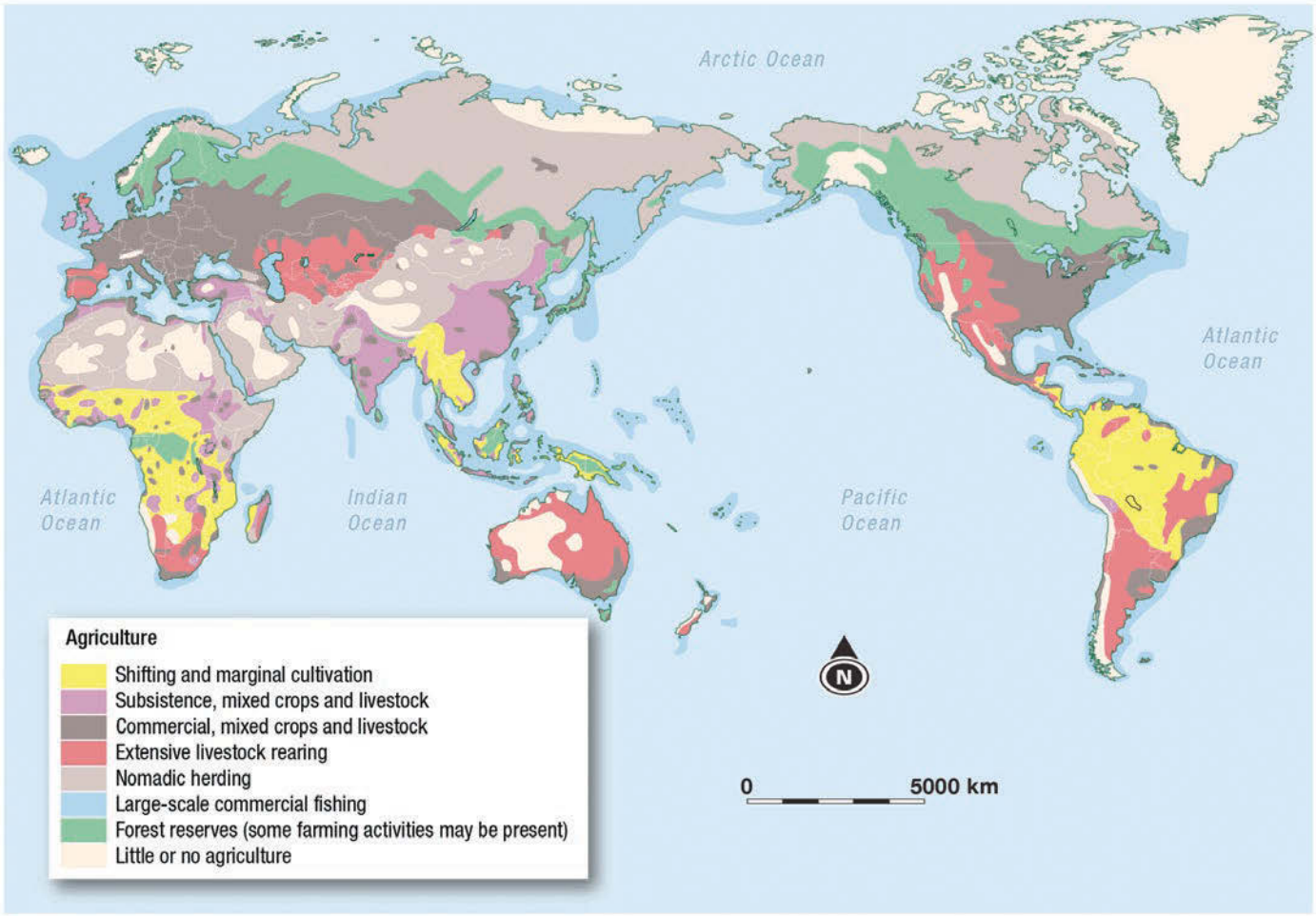

Source 1.35 World economic activity

and that there is a major division in the way people use them. Some people use biomes for commercial purposes, while others use them for **subsistence** purposes.

The people using biomes for commercial purposes are growing crops or raising livestock for sale. They are using biomes for economic benefit. They expect to make a profit and they use the profit they have made to provide the necessities and luxuries of life.

subsistence (agriculture) producing just enough for the family to survive

surplus excess; extra

The subsistence farmers who grow crops in some areas and herd livestock in others are at the other end of the spectrum. They usually have very little **surplus** for sale; their lives are a constant battle to provide food for themselves and their families. The luxuries of life – holidays to Hawaii, a night at the movies, even dinner at a fast-food outlet – are far removed from the way of life of these people. For example:

- Tundra – the tundra area in the northern hemisphere is essentially a biome that is used for **nomadic herding**.
- Taiga – the taiga, or boreal forest, either remains as forest or is used for nomadic herding.
- Desert – one would think that the desert areas would have little or no agriculture,

nomadic herding moving one's cattle or other animals, such as goats or yaks

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but although some areas have little or no use, much of the Sahara in Africa is used for nomadic herding and parts of Australia's desert regions are used for extensive livestock rearing.

- Savanna – the savanna biomes are dominated by grasses. One might expect to see extensive livestock rearing in these regions. The major savanna areas of the world have a variety of land uses, from subsistence mixed crops and livestock in India to mainly subsistence and marginal cultivation and commercial mixed crops and livestock in Africa.

There is another division in the way people use biomes which is not clearly shown in Source 1.35. The key of the map uses the words 'extensive' and 'large-scale' in relation to some land uses ('livestock rearing' and 'commercial fishing'). The key does not use the opposite terms – '**intensive**' and 'small-scale' – in relation to land uses. '**Extensive**' and 'large-scale' refer to agricultural activities that cover a large area, such as large properties and agribusiness. The obvious ones in Australia are the raising of sheep and cattle and the growing of wheat and cotton. In the United States, it is the growing of corn and cotton. These farms cover large areas. 'Intensive' and 'small-scale' land uses refer to activities that cover a small area. In Australia, many land uses fall into this category; for example, sugar cane farming, vegetable production and dairying.

intensive agriculture farming a small area with a crop that has a high monetary value

extensive agriculture crop or livestock production over large areas of land which requires fewer inputs such as labour, e.g. wool production

Source 1.36 Nomadic herders with their yaks in the Orkhon River valley, Mongolia

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A key geographic concept – scale – has been used here in a way that is different from how it is used in relation to maps. A large-scale map is very different from a small-scale map. Source 1.37 clarifies the differences.

When you see a ratio of 1:50 000, it means that the objects portrayed on the map are drawn at 1/50 000 their actual size. 1/50 000 is a larger fraction than 1/250 000, and thus the 1:50 000 map is of a larger scale.

Term	Referring to land use	Referring to maps
Large-scale	Small area, e.g. 80 hectares	Large ratio or fraction, e.g. 1:50 000; i.e. a map of a community with large objects/a lot of detail
Small-scale	Huge area, e.g. 1000 km^2	Small ratio or fraction, e.g. 1:250 000; i.e. a map of a country or continent, with small objects/a small amount of detail

Source 1.37 Differences between 'large' and 'small' scales in maps

Activity 1.5

1. Demonstrate your understanding of the difference between large and small-scale maps. Find an example of each map type and give each a title.
2. Commercial mixed crop and livestock activities are carried out over large areas of Europe, North America and Australia. Outline how these activities may be related to a particular biome.
3. Suggest some economic activities that occur in tropical rainforest biomes.
4. Explain how people have made use of the alpine biomes. You may need to conduct some research on the internet.
5. Suggest why the important sugar-producing regions of Australia are not shown in Source 1.35.

1.3 Impact of the climate, soils and vegetation of biomes on their productivity

As mentioned at the start of the chapter, climate is a major contributing factor to the spatial distribution of biomes around the world. It is the variations in climate and how plants and animals respond to these variations that give biomes their special characteristics. In this final section of the chapter, we will consider how climate, soils and vegetation affect the productivity of three biomes: rainforest, savanna and alpine.

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Source 1.38 A hiker examines a fallen tree's exposed shallow root system after a storm in a rainforest.

Rainforest biomes

In rainforests, one major impact of the climate is the relationship between plants, animals and the soil. Rainforests are among the most magnificent expressions of life on Earth. The profusion of plant life and the size of the forest – in terms of height and area – have led people to believe that this biome grows on very fertile soils. What else could account for the prolific growth?

However, in many rainforest areas the soil was not originally fertile. Over time, the rainforest converts the soil on which it grows into fertile soil that will support its growth. Rainforests expand their area by converting the soils around their edges into soils suitable for this growth. Rainforests are not the only plant communities that change the nature of the soil they grow on, but they are the best at this process. How does a plant community change a soil type?

When you see a fallen tree, one of the things you may notice is how shallow the root system is. The root system which supports and nourishes the tree may be only a few centimetres deep. Only in certain areas do trees have very deep root systems.

Similarly, for crops at your home or on a farm with shallow root systems, the size of the area and the type of soil don't matter. Around the time of planting, three things occur:

- The soil is turned over to aerate it.
- Water is added.
- Fertilisers are added.

The rainforest does all this by itself:

- The soil is turned over by the developing root systems, and by the animals which inhabit the soil, such as worms.

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- The 'drip-tipped' leaves ensure that water reaches the ground.
- Fertiliser is added. Rainforests create their own fertiliser: a deep layer of what is known as 'humus' is created by fallen branches, leaves and eventually the rest of the trees. These decay rapidly in the moist, humid environment and provide the plant food necessary to sustain the life of the forest. Fertiliser is thus provided for the whole rainforest system, including the epiphytes and parasites.

Source 1.39 (Left) Luminescent toadstools growing from the rainforest floor in Madagascar. (Right) Worms are an important part of the rainforest biome as they turn over and aerate the soil.

Savanna biomes

The main characteristic of the climate that has created the savanna vegetation pattern is seasonal change. In savanna areas, the climate changes from hot and wet to hot and dry. The hot and wet season brings an explosion of plant growth, especially grasses, to the savanna. This vegetation change has a major impact on the animal life of this biome.

There are many special adaptations that plants have developed to survive in this environment. These include:

- Plants' canopies have a spreading shape, to shade the root layer.
- Many plants have developed thorns and prickles to prevent animals eating the vegetation.
- Some plants have developed tissues that retain a supply of water they can use during the dry season.

These are not the only adaptations associated with this landscape, but they are the ones that help make it a distinctive biome.

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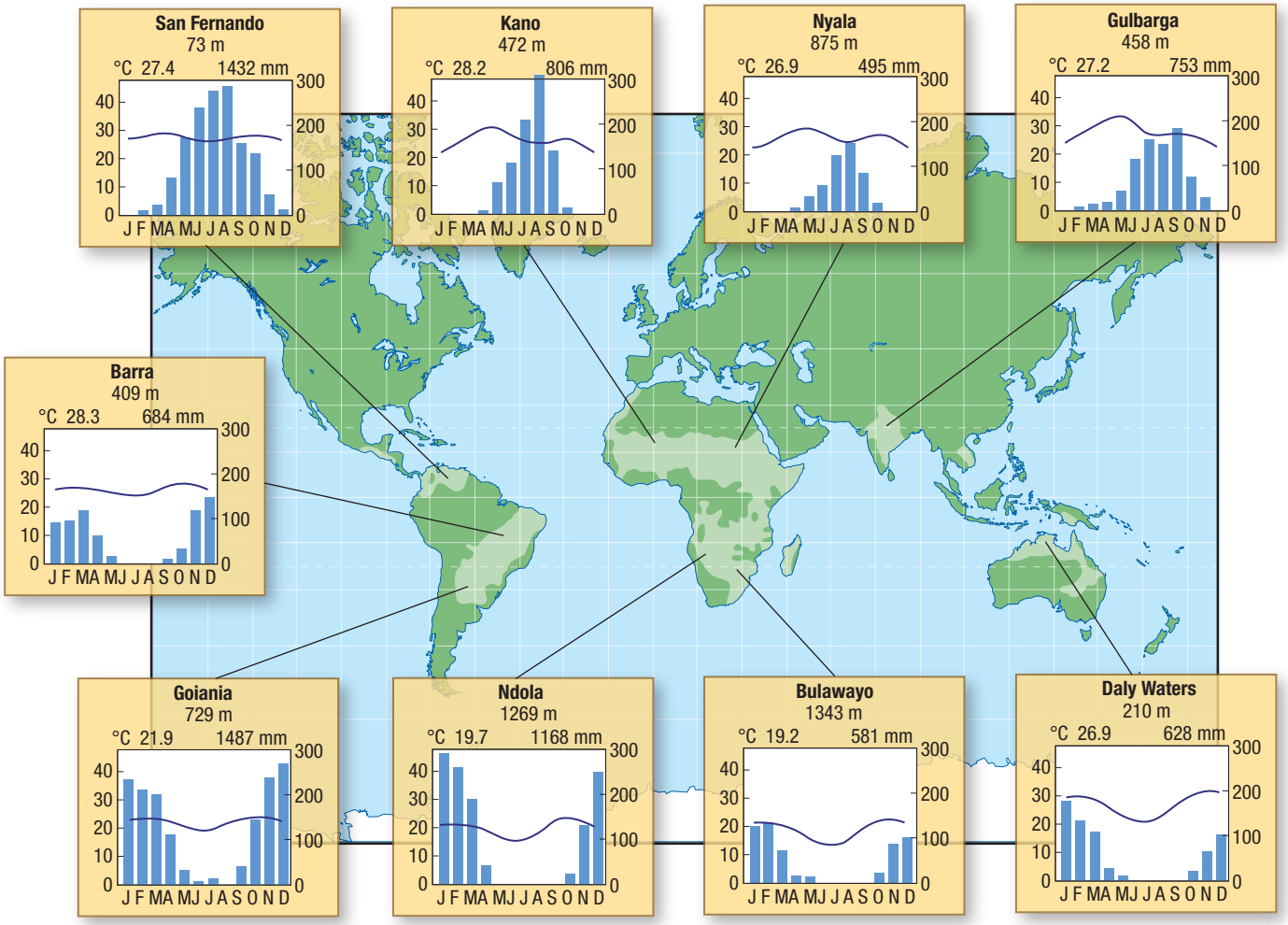
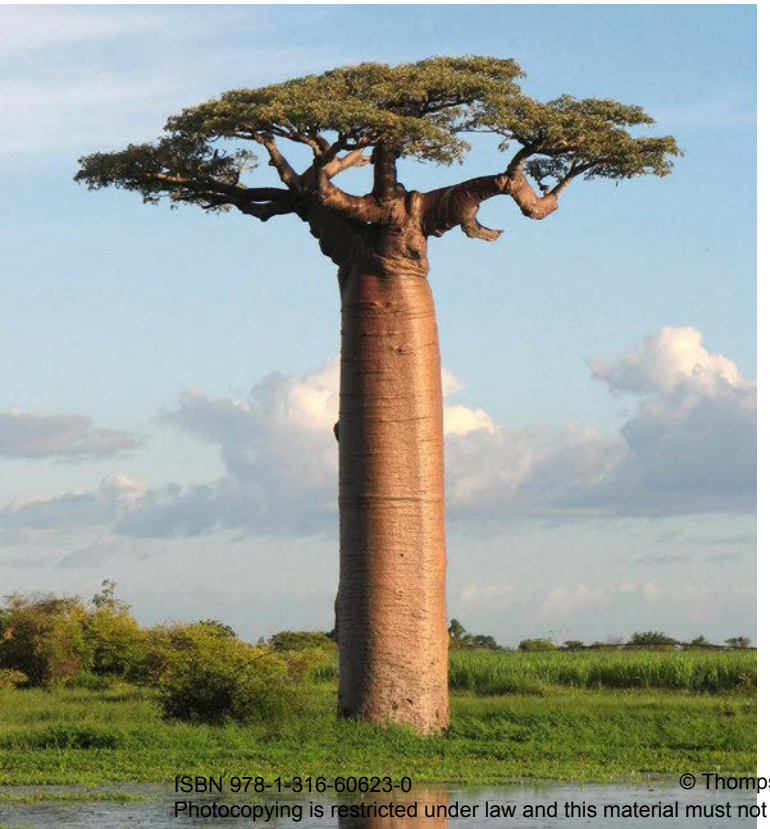
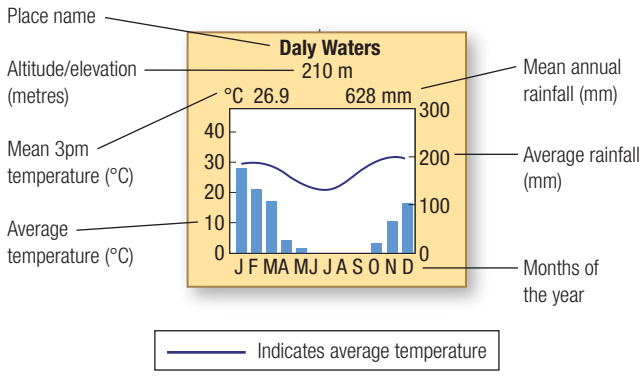


Source 1.40 Climate graphs from savanna areas around the world. An explanation of the information is below.





Source 1.41 A tree (a Grandidier's baobab) with a wide canopy to protect its roots from the harsh sun in a savanna area in Madagascar

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Alpine biomes

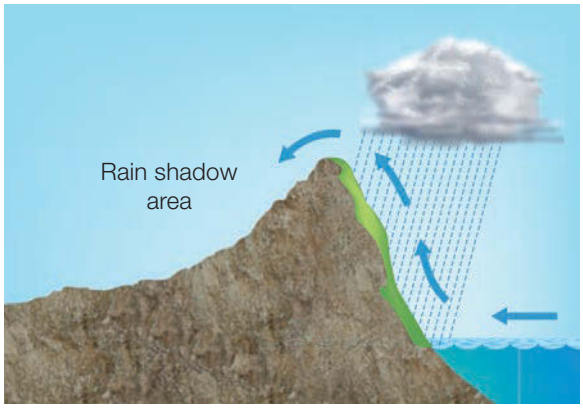
There are two climatic factors that affect alpine biomes. Firstly, many mountain ranges are close to the coast. They block rain-bearing winds that move onto land from the sea and force these winds to rise. As the winds rise, the air cools and water condenses out of the air to form clouds. This often results in heavy rainfall, known as **orographic rainfall**. This can produce biomes associated with high rainfall, particularly rainforests, on the coastal sides of the mountains. The inland slopes of the mountains often receive little rainfall, so very different biomes, such as savanna and desert, may be found on these slopes. These areas are said to be in a 'rain shadow'.

orographic rainfall rainfall produced when rain-bearing winds are forced upwards by mountain ranges

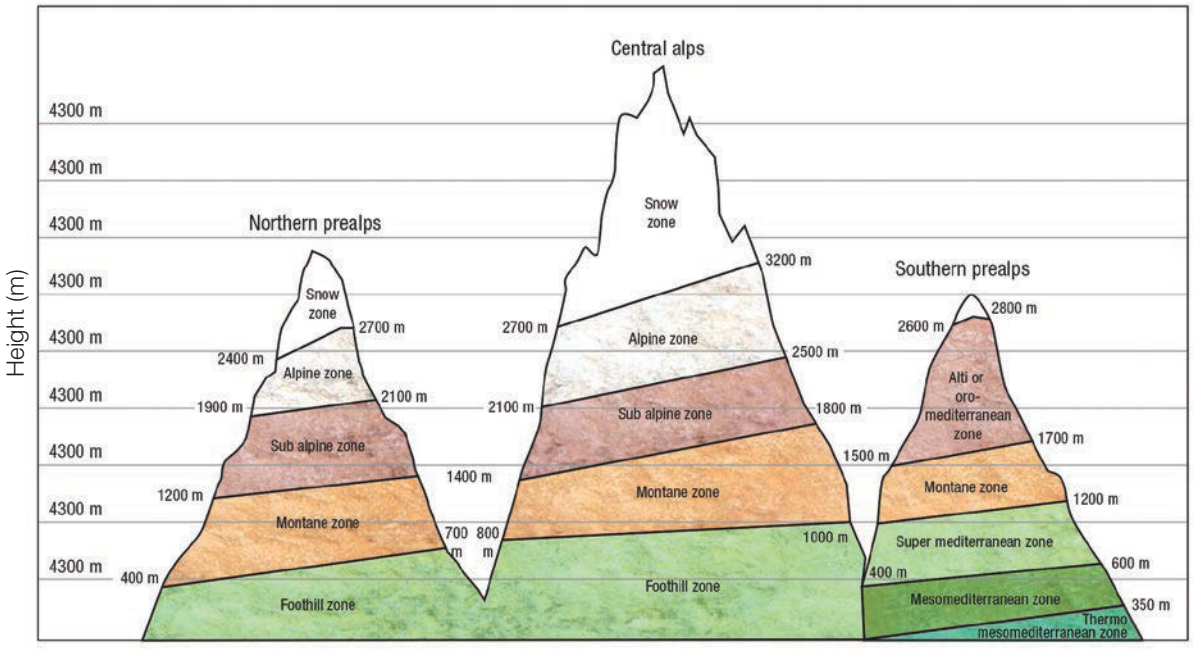
The other factor that makes mountain biomes so complex is the impact of the sun's rays as they warm the land. Mountain slopes that receive direct heat from the sun lose their snow cover quickly. Mountain slopes that do not are cooler, and have a slightly different vegetation pattern. This warming effect is known as **aspect**. It affects mountain biomes closer to the Poles most: some slopes only receive sunlight for a few months of the year.

aspect the direction a slope faces

Source 1.43 shows the different vegetation patterns associated with alpine biomes, from the southern to the northern part of the Alps in Europe.



Source 1.42 Impact of mountains on climate – creation of orographic rainfall



Source 1.43 Influence of mountains on vegetation

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Source 1.44 This photograph of the Jungfrau in Switzerland shows some of the different vegetation patterns from Source 1.43.

Overall, factors such as climate, soil and vegetation types have a great influence on the productivity of a biome. An alpine biome, for instance, would not be best suited to the human need to produce food, industrial materials or fibres due to climatic conditions and their effect on soil and vegetation.

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RESEARCH 1.2

Divide your class into four groups, to study:

coniferous tree an evergreen tree that grows cones

- the **coniferous** forest biome
- the desert biome
- the temperate deciduous forest biome
- the tundra biome.

Complete the following tasks, then give a short presentation of your findings:

1. Describe the vegetation character of the biome.
2. Identify the factors which have given rise to the development of the biome.
3. Identify the special adaptations plants have made to survive in the biome.
4. Examine the relationship between the plants and animals in the biome.
5. Discuss how animals have adapted to survive in the biome.

Source 1.45 An example of the environment of a coniferous forest biome

Chapter summary

- Biomes are groupings of plant and animal communities that have adapted to inhabit particular parts of the Earth's surface.
- Before the domestication of plants and animals, the main factor that biomes had to adapt to was the world's changing climate; now, biomes also have to adapt to human interference.
- The major biomes of the world include the rainforest, savanna and alpine biomes. Each biome has its own characteristics, according to its climate.
- The plant and animal communities of the world respond to variations in climate. These responses give the world its distinctive pattern of biomes.
- Biomass refers to the mass of organisms per unit area. Most of the biomass is made up of plants rather than animals. This is because plants are known as primary producers of biomass.
- The more water a biome receives, the greater the plant life and therefore the greater the biomass production. Conversely, the more barren the biome (or the more severe the climate), the less plant life, and the less biomass production. Rainforests, for example, have a much greater biomass production then deserts.
- The rainforest biome is dominated by its plant life; the savanna biome is dominated by the response of its animal life to seasonal changes in rainfall; and the alpine biome has less plant and animal life due to its more severe climate as altitude increases.
- Humans rely on biomes for survival because they are sources of materials that can be used to produce food, clothing, shelter and energy. We adapt biomes in order to produce the items we need, including livestock/crops for food and livestock/crops to make fibres for clothing.
- Factors such as climate, soil and vegetation types have an influence on the productivity of a biome. For instance, an alpine biome would not be best suited to the human need to produce food, industrial materials or fibres due to climatic conditions and their effect on soil and vegetation.

End-of-chapter questions

Short answer

1 Describe the causes of the major seasonal changes on the savanna and how they affect animal life there.

2 Identify the climatic factors that affect mountain biomes.

3 Explain why there are few seasonal changes in rainforest biomes.

Extended response

Assess the impact of climate change on rainforest, savanna and alpine biomes.

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2 Changing biomes

Source 2.1 Nomads in the Sahara Desert – people who live within a biome in its unaltered, natural state

Before you start

Main focus

Understanding the reasons humans alter biomes and the environmental effects of these alterations.

Why it's relevant to us

It is important to preserve biomes for future generations.

Inquiry questions

- What do people do to the physical characteristics of biomes in order to adapt them?
- What are the environmental impacts of these human alterations?
- What sustainability strategies exist to minimise environmental damage to biomes?
- How can biomes be preserved for future generations?

Key terms

- Agriculture
- Drainage
- Irrigation
- Mining
- Salinity
- Shifting cultivation
- Staple crop/food
- Sustainability

Let's begin

The biomes of the Earth's surface provide food, clothing and shelter to all of the Earth's 7 billion people. We place different demands on these biomes. Some people exist in harmony with the biome in which they live, and have done so for hundreds of years. Others impact biomes greatly due to the demands of 'modern living'.

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2.1 Human alterations to the physical characteristics of biomes

Through the ages, humans have been able to adapt to different biomes and even change biomes to suit their needs. Even early humans changed biomes to suit their lifestyles. As hunter-gatherers, our ancestors had relatively little effect on the environment. As the population increased, however, hunters killed a substantial proportion of large animals, and habitat destruction was caused by small-scale slash-and-burn agriculture and large-scale land clearing.

Source 2.2 The woolly mammoth is a large animal that roamed the earth thousands of years ago, an ancestor to the Asian elephant. It became less populous around 10 000 years ago, and extinct 4000 years ago. Scientists believe that its disappearance was caused by a combination of the hunting exploits of early humans and the shrinkage of its habitat due to climate change.

Source 2.3 An entrance to an underground house in Coober Pedy, South Australia. This is an example of a place where humans have adapted to the specific conditions of the desert biome.

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heat island effect increase in temperature in an urban area due to the buildings and asphalt

terracing a type of farming that involves clearing vegetation then building a series of levelled sections or steps into a steep slope

irrigation applying water to land or soil

While humans may need to change biomes to facilitate settlement and the development of society, this drastically alters natural systems and processes and has had negative consequences. For example, urban areas destroy the naturally pre-existing biome and can create urban **heat islands** and exacerbate flooding. The most common impacts of humans on biomes include vegetation removal: land **terracing**, agriculture, **irrigation** and mining.

Vegetation removal

Vegetation removal is very common in farming, especially for crops such as rice and sugar cane. Rice is a very important crop for our world. Over half of the world's population relies on rice as their main food source, making it a staple food. There are two types of rice cultivation: dryland (upland) and wet rice (terracing).

Dryland rice farming

Dryland rice farming results in forest and vegetation removal. Forest is cleared so that rice can be planted. It is often grown on very

Source 2.4 Dryland (upland) rice field in Sapa, Vietnam. The soil layer is not very deep and the rainfall needed to sustain this crop will wash some of the soil layer away very quickly.

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dry soil, in flooded rice paddies, as shown in Source 2.4. The crop relies on rainfall.

The biome has been significantly altered, as the original vegetation has been removed, and most of the wildlife associated with that vegetation has gone. A new biome is now in place. This biome is controlled by the people who develop the plots. Dryland rice represents about 13% of the rice area planted annually but only produces around 4% of the rice produced annually. Almost 100 million people in Bangladesh, Cambodia, China, India, Indonesia, Myanmar, Thailand and Vietnam depend on this rice source.

Geographical fact

Rice is a subsistence crop. It is grown by the family and consumed by the family. Only 5% of the world's rice crop is exported.

Land terracing

The other major type of rice cultivation is wet rice farming, also known as terrace farming. Land terracing is one of the oldest forms of farming. It involves clearing vegetation and then creating a wall so that the slope becomes a series of levelled sections or steps – hence the term 'terrace'.

Source 2.5 Wet rice cultivation in mountainous regions of Bali, Indonesia

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Water flow is controlled – each terrace catches any run-off from the terrace above it. Some ecologists argue that terrace farming actually *decreases* soil erosion by managing water run-off. Regardless, terracing severely changes the landscape and thus alters the biome. Landslides will occur, because the vegetation that protected the slope and held it together has been removed.

Case study 2.1

Human alteration to a biome for agriculture: Queensland's sugar cane industry

To understand how humans alter biomes, it is useful to compare a biome in its natural condition to one that has been altered. Later in this chapter, in Case study 2.2, we will consider the Amazon rainforest as an example of a biome that is largely in its natural state. In this case study, however, the effects of human alteration to the physical environment of a biome are illustrated through the example of the loss of Australia's rainforests to sugar cane.

Source 2.6 (Above) Sugar cane fields in Cairns, Queensland. (Right) Before and after: sugar cane and a bowl of refined white sugar.

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Agriculture

Agriculture is the science or practice of farming, including cultivation of the soil for the growing of crops and the rearing of animals to provide food, wool and other products.

Even today land continues to be cleared for agriculture. According to ABS 2014 data, around 410 million hectares, or 53% of land in Australia, is used for agriculture, making it the dominant form of land use.

Australia has for many years been one of the world's major suppliers of sugar. Australia is the 3rd largest raw sugar supplier in the world: it produces $2 billion worth of sugar each year. Sugar cane was brought to Australia with the First Fleet in 1788. Early plantings were in river valleys in New South Wales, but the industry began to flourish once areas along the Queensland coast were opened up. In Queensland the industry's development was helped by cheap labour brought to Australia from neighbouring Pacific Islands. However, many of these Pacific Islanders were brought to Australia against their will, and when the

Source 2.7 Sugar cane has been a long-term agricultural pursuit in Australia. (Left) A labourer working on the Hambledon sugar plantation, Cairns, Queensland in the 1890s. (Right) Farmer Norm King cutting sugar cane in Feluga, Queensland.

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Commonwealth of Australia was proclaimed in 1901, laws were passed to stop the practice. Since that time the industry has undergone many changes.

Rainforests have been cleared for sugar cane; it needs to be grown in high-rainfall or irrigated areas along coastal plains and river valleys. The amount of land used for sugar cane production has increased rapidly and this increase is predicted to continue. Sugar cane production mainly occurs between the Great Barrier Reef and the wet tropics of Queensland. As more land is cleared for production, there are risks that areas and habitats will be negatively affected.

'Canegrowers' is the industry group that represents the majority of cane growers, and supports sustainable sugar cane production to minimise impact on Australia's rainforests. Strategies include leaving more plant residue

Source 2.8 Australian sugar cane fields

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undisturbed on the surface to reduce surface water run-off and soil erosion, and less frequent **tillage**, which also reduces the amount of energy farmers use to run tractors, reducing costs and saving resources. Even with these practices, though, some areas of Queensland are still in danger.

tillage the activity or process of preparing land for growing crops

There are other practices used in the sugar cane industry that were once thought of as great advances, but that we now recognise as dangerous to parts of our environment. The article below (Source 2.9), for instance, shows the damage that is being done by one particular pesticide.

Sugar cane production is very important to Australia's economy and agriculture, but it does affect the environment. 'Canegrowers' and other groups strive to educate others about sustainable sugar cane production and to minimise the industry's impact on the environment.

Great Barrier Reef: Public reporting of water quality 'misleading at worst', Queensland Auditor-General says

A report from Queensland's Auditor-General has questioned the State Government's claim that water quality on the Great Barrier Reef is improving.

The Auditor-General's report examines the Queensland Government's handling of agricultural run-off from farms over the last 12 years.

It found the State Government's response has been uncoordinated, lacks purpose, and holds no-one accountable.

The Auditor-General's report said Queensland was yet to design a program for its contribution to the Reef Plan, which was developed 12 years ago.

It said a 2014 reef report card's claims the decline in water quality had been reversed was not necessarily true.

In his recommendations, Auditor-General Andrew Greaves said there was a need for more stringent monitoring on farms and the suite of water quality programs must be reviewed to ensure they were working.

The report also called for the new Office of the Great Barrier Reef to be held accountable for the health of the reef.

Source: ABC Online, 10 June 2015

Source 2.9 Great Barrier Reef: Public reporting of water quality 'misleading at worst', Queensland Auditor-General says

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Source 2.10 Should the new Office of the Great Barrier Reef be held accountable for the health of the reef?

1. Discuss the impact of sugar cane production on the rainforests.
2. Explain why Queensland is considered a good area for sugar cane production.
3. Investigate the impacts of sugar cane production on Queensland's Great Barrier Reef. (Hint: research the town of Tully in Queensland as an example of this.)

Irrigation

Irrigation is a method of agriculture that is important for the success of crop growing or meat farming. Irrigation involves the application of water to land or soil and is an ancient agricultural method. Watering your plants at home, or putting the sprinkler on the lawn, are simple examples of irrigation. On a larger scale, irrigation canals can be built to water surrounding fields, or huge 'sprinklers' known as pivots can be placed in fields and moved around.

Source 2.11 Different types of large-scale sprinklers used for irrigation in agriculture

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The main impact of irrigation on a biome is that it takes water from a natural source (for example, groundwater or surface water such as a river) and puts it somewhere else. Often dams can be built to supply irrigation schemes in an area. This diversion of water can have a very large impact on a biome as the natural flow of water is interrupted.

Mining

Mining is the process of securing precious minerals such as **bauxite**, gold and coal from the ground. Mining, especially when it is not regulated by governments, can cause damage to the air, water and soil of an environment. One of the most common mining techniques is called open pit mining.

bauxite aluminium ore; the rock from which aluminium powder is extracted

Open pit mining can cause environmental hazards, such as leaks of radioactive or toxic elements into the bedrock of a biome. Mining can actually cause damage to a biome or landscape that is much larger than the mining site itself. The environmental impacts of a mine, such as the loss of fauna and flora or the erosion of habitats and land, can last for years after the mine has shut down.

Mining today requires a very large volume of water; water is used in the extraction, processing and waste disposal stages. The wastewater created through mining processes can pollute nearby water sources, which can reduce the supply of fresh water in the neighbouring areas.

One example of a mine's impact on its physical environment occurred in 2002 when Molycorp's Mountain Pass rare earth minerals mine in California, USA, had problems with

Source 2.12 The Super Pit Gold Mine in Kalgoorlie-Boulder, Western Australia. Notice how denuded and barren the surrounding environment is.

Source 2.13 The Molycorp Mountain Pass open pit mining facility in San Bernardino County, California, USA, which caused lasting physical damage to the surrounding environment in 2002

its waste disposal processes. A pipeline that was intended to deposit radioactive waste in evaporation ponds in the desert burst, which led to the spilling of toxic and radioactive waste. Although Mountain Pass mine was eventually shut down, the damage to the surrounding area and water sources may mean they are permanently affected.

Activity 2.1

1 Discuss the advantages and disadvantages of altering biomes through land terracing.
2 Using an internet search, research where irrigation has been used by humans to alter biomes. Construct a table showing the pros and cons of this.
3 Describe the relationship between mining and biomes. Research bauxite and gold mining and use them as your examples.
4 Assess the long-term impacts of open pit mining on biomes.

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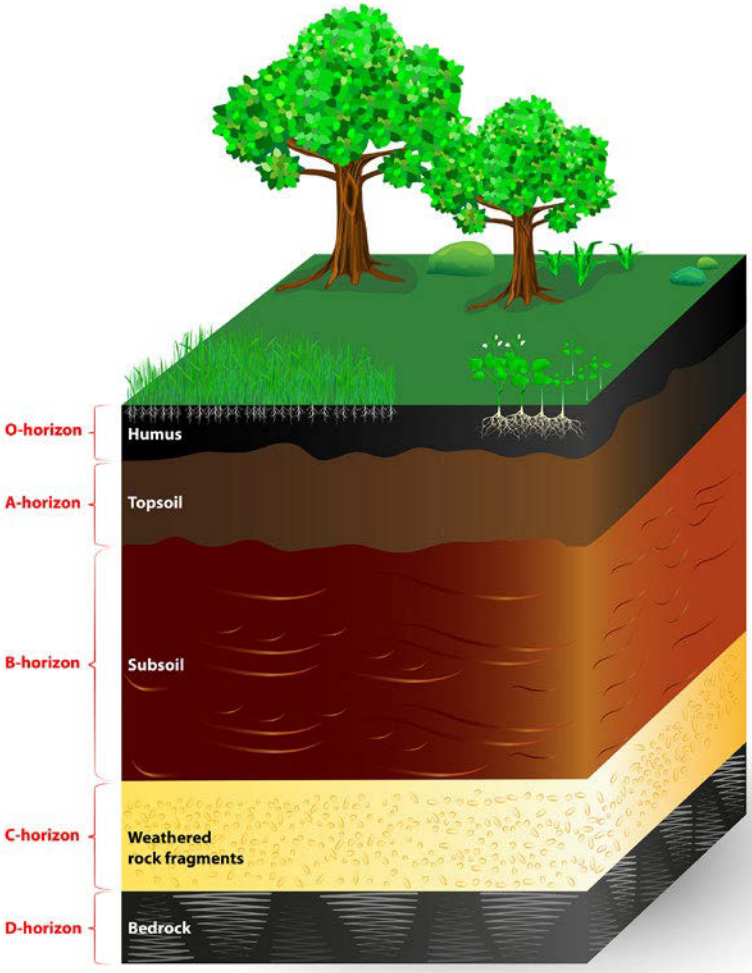

Source 2.14 Radioactive or toxic elements from mines can reach various layers in the lithosphere, ranging from the humus topsoil to the deepest bedrock, causing lasting damage to the landscape of a biome.

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2.2 Environmental impacts of human alterations to biomes

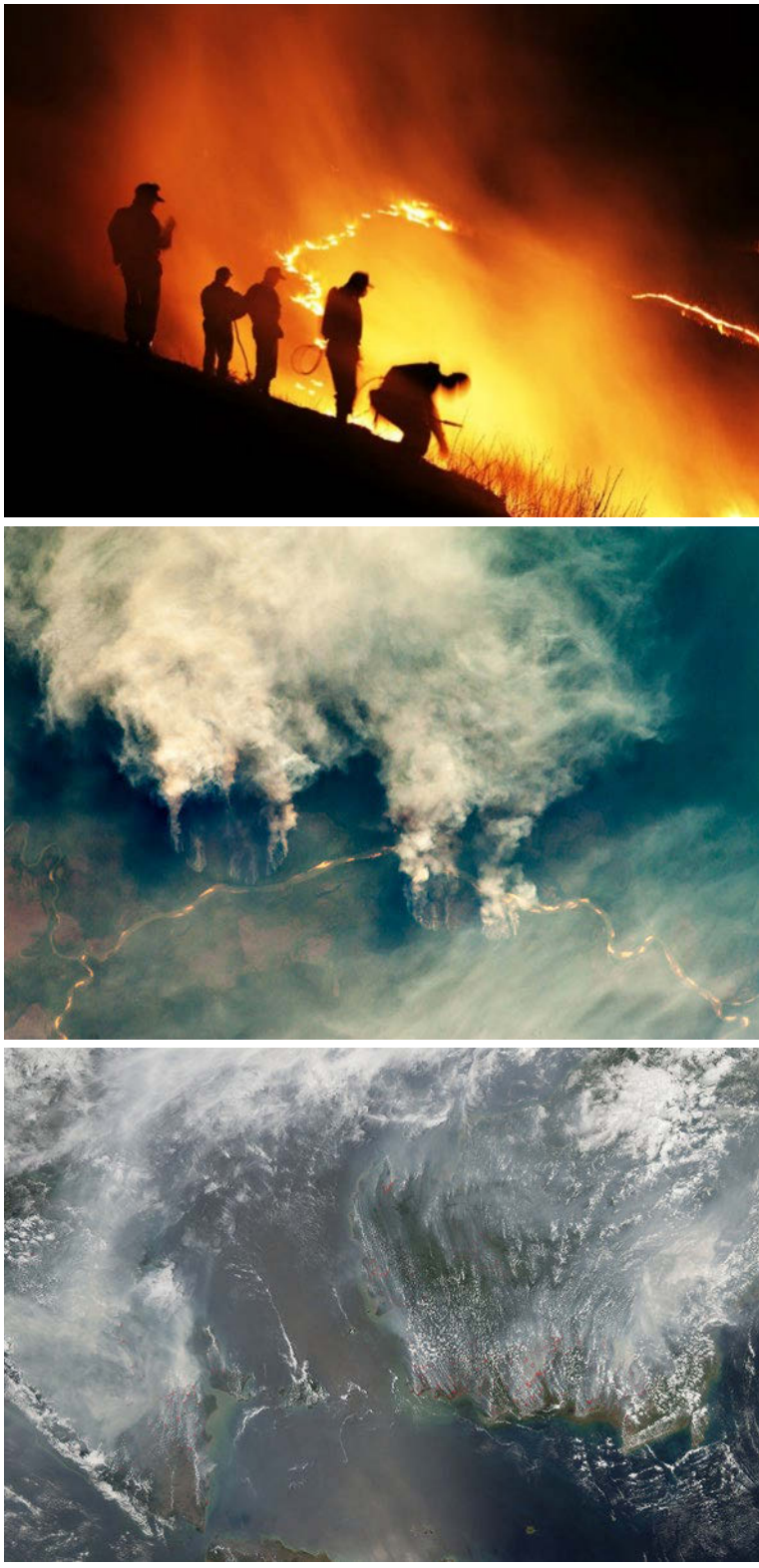
There are advantages and disadvantages to human alterations of a biome.

Advantages to human alterations of a biome

People depend on biomes for a variety of purposes; they are considered advantageous for different groups of people. It is a matter of deciding whether the advantage of the alteration outweighs the disadvantage to the biome.

Advantages of altering a biome include:

- Drainage or clearing of vegetation supplies land for agriculture, housing and roads.
- Housing and transportation for communities and businesses are improved.
- Small-scale (intensive) farming provides food and supplies for families and communities.
- Large-scale (extensive) farming provides income for a region or country.
- Jobs are created for locals.
- The profits from selling natural resources (such as mineral deposits or raw materials such as wood) can be used for infrastructure such as hospitals and schools.



Source 2.15 (Top) A small-scale slash-and-burn in progress. (Middle) An astronaut's photograph from the International Space Station illustrates slash-and-burn forest clearing along the Xingu River in the northeast of the state of Mato Grosso, Brazil in 2011. (Bottom) The immediate results of a slash-and-burn in Chiang Mai, Thailand before replanting begins.

Geographical fact

Exporting up to 80% of its agricultural production, Western Australia is an important producer and supplier of safe, high-quality agriculture products such as grains, meat, fruit and vegetables, dairy products, processed foods and live animals in the international arena.

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Disadvantages to human alterations of a biome

Unfortunately, for every benefit of a human alteration to a biome, there is a cost. The disadvantages to altering a biome include:

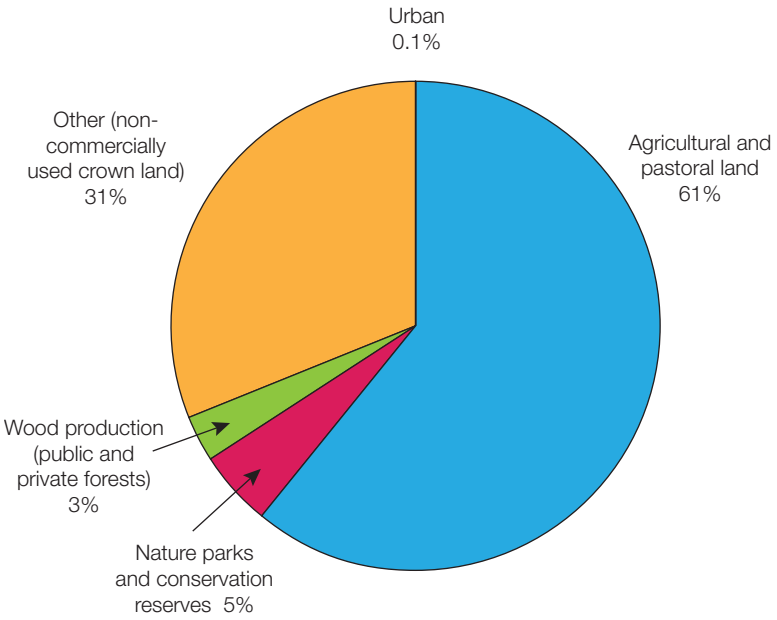
- Land clearance or drainage to allow for the construction of farms, roads and mines can cause erosion and deforestation. These are significant issues, as erosion degrades the land, with soil being washed away into river systems and potentially causing flooding. Additionally, it can take many years for hardwood trees to grow and replace those that have been removed.
- Roads can divide up a biome and cut off essential parts of the ecosystem. For example, in the rainforest biome, roads can prevent animals travelling to gather food and alter distribution of seeds through the forest.
- Profits from large-scale (extensive) farming or the selling of natural resources often go directly to large companies and not to the local communities.

Habitat and biodiversity loss

When land is drained or cleared there can be major loss of habitat, and some animals and plants become endangered or extinct. Although species become endangered due to various factors, habitat destruction is widely considered the largest cause of **biodiversity** loss around the world. When humans make alterations to biomes in order to convert wild areas into spaces for agriculture, urban development, water projects or forestry, the habitats of species that live there can be severely damaged or even eliminated.

biodiversity the variety of living organisms and the environments they form

One example of human alterations to biomes resulting in habitat loss can be seen in New Zealand, which was 85% covered by forests before human settlement, and now is only 23% covered. After humans first arrived in New Zealand, around 1000 years ago, large areas of forest were destroyed by both naturally occurring fires and human-made



Source 2.16 A pie chart showing how land is used in Australia

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Source 2.17 New Zealand's stoat (left) and kiwi (right). The stoat, a relative of the weasel, was introduced into New Zealand in the late 1860s to kill off another introduced European species: rabbits. The stoat might look cute, but it has proven to be a mortal enemy of the flightless, native kiwi. There are five varieties of kiwi and all are endangered. According to the New Zealand government, stoats are responsible for approximately half of all kiwi chick deaths, and without careful management to protect against stoats, only 10% of kiwi chicks survive to the age of 6 months.

Source 2.18 (Left) New Zealand as seen from space – note that the dark green forest areas are in the minority. (Right) The country is famous for its natural beauty such as Lake Matheson on the South Island.

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fires used to clear land or hunt for food. It is believed that early Maori settlers set fire to both upland and lowland forests, which destroyed areas in the drier eastern parts of both the North and South Island. By 1600 more than a third of the forest originally covering New Zealand was gone; however, various habitats such as coastal areas and wetlands remained mostly untouched and unchanged. When European settlers began to arrive, half of the remaining forest land was converted into towns and farmland. The new settlers also introduced plants and many new animals, some of which preyed on or displaced the native wildlife.

Today in New Zealand, many rivers, streams and lakes have also been converted into dams, modified by irrigation and drainage, or polluted by urban areas and farms. The consequences of these alterations have meant that the continuous and expansive area of ecosystems that once covered New Zealand has been replaced by more isolated habitats. While most of the clearing of native forest has now ended, the impacts of human activities on native species are still being felt.

Drainage

drainage diverting or removing excess water from land or soil

Drainage refers to diverting or taking away any excess water off the land. Drains are built to remove water to avoid soil becoming waterlogged and hindering growth of crops or pasture. With proper planning, a drainage system can be effective with minimal impact on the environment. Drainage is also very useful if an area may be prone to flooding. However, drainage can have a big impact. For example, wetlands in some parts of the world are drained to allow for land development (construction of buildings) or farming. This completely destroys a wetland biome, and also impacts surrounding vegetation and wildlife which are not able to access the same amount of water they have had in the past.

For example, the Macquarie Marshes is located in the lower region of the Macquarie River in central northern New South Wales. It is a major waterbird breeding area. It is now protected by the federal government, but sadly it is 40% to 50% smaller than it used to be, due to drainage for agriculture in the

Source 2.19 The pelican and the royal spoonbill are examples of birdlife relying on wetlands in Australia.

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area, and diversion of water to irrigate other areas. It is estimated that 20% of Australia's birdlife relies on wetlands. Waterbirds tend to be highly mobile and migrate from one wetland to another at different times of the year. In fact, waterbird species visit Australia from countries in the Northern Hemisphere, so for the sake of our ecosystem's future it is important to understand the interconnections between places and the impact of drainage on our wetlands.

Water pollution

Water pollution is most often caused by human activities and industrialisation. Bodies of water can become polluted when waste is disposed of either intentionally through dumping or unintentionally though run-off or leaking from industrial, agricultural or municipal waste. While every body of water does have the capacity to clean itself through the dilution and breakdown of some pollutants over time, when excessive pollutants are introduced into water, they can be carried downstream and cause contamination to aquatic populations. Wildlife, birds and fish depend on clean water for survival.

The Natural Resources Defense Council (NRDC) in the USA is currently working to restore and protect significant waterways in order to guarantee that there is sufficient clean water flowing through ecosystems, keeping them functioning and intact. For instance, in the largest estuary on the west coast, the San Francisco Bay Delta, the NRDC is helping to stop unsuitable water withdrawals as these can be a threat to endangered fish species and their habitats.

Salinity

Changes in the way land has been used have led to changes in the movement of water through biomes, which can contribute to problems of salinity. For instance, when native vegetation is cleared on a large scale in order to make room for urban or agricultural development, the natural water balance of a region can be disrupted. This can contribute to a rise in groundwater as well as salt mobilisation.

Furthermore, the removal of vegetation through drought, fire, overgrazing or clearing can leave bare soil that is prone to erosion. When topsoil erodes, it can expose subsoils high in sodium or saline (sodic soils) which can create a hard crust of soil, poor soil structure or increased saline run-off. The waste produced in towns and by industries can contain high levels of salt, and farming practices can impact on the land's ability to shed excess water. Finally, the compaction of soil that occurs when roads are constructed can reduce the permeability of soil and can cause groundwater ponding, evaporation and the accumulation of salt.

Salinity is a major environmental problem that is becoming a major threat to freshwater river systems. The plants and animals that live in these rivers cannot tolerate extreme salinity levels. The increase in salt levels that has been caused by human alterations to biomes is therefore affecting not just individual populations but also entire ecosystems, leading to a loss of biodiversity.

In Australia there are water quality guidelines that are meant to protect against unnecessary salinity problems. However, as salinity has never been viewed as a major problem in Europe, no quality standards exist there. Due to the increase in global temperatures as well as higher demand for water from the world's population, freshwater rivers that have been impacted by increases in salinity have the potential to create huge economic and environmental costs.

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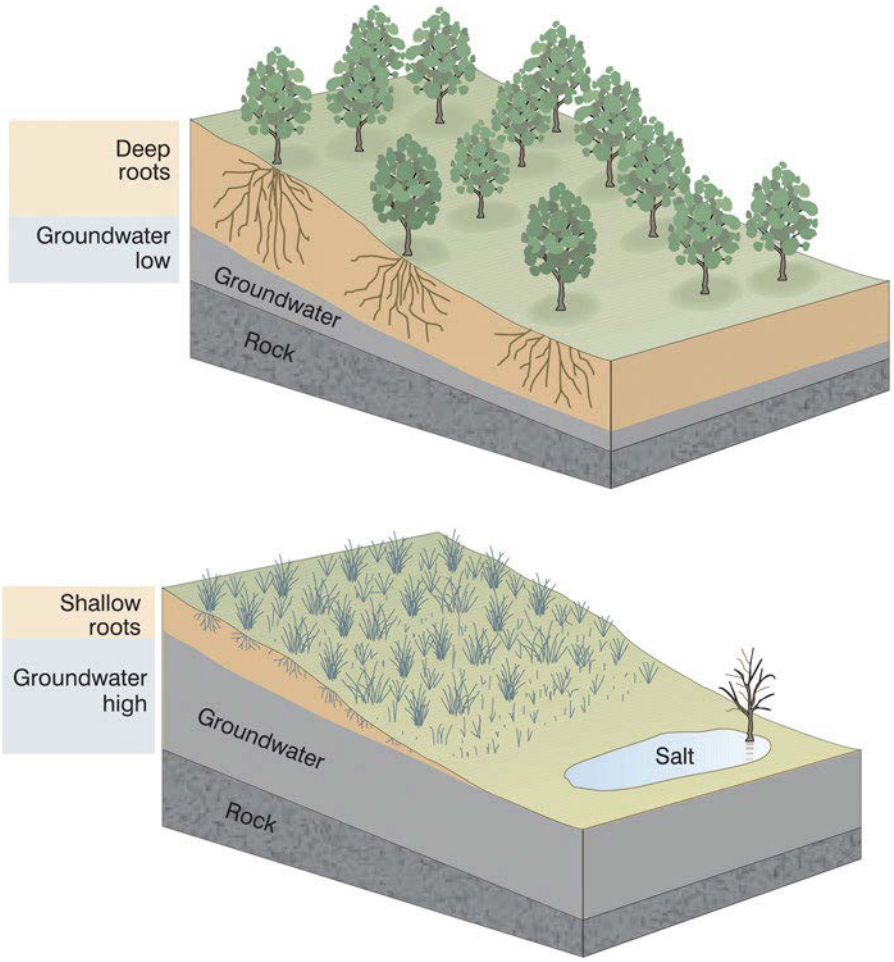

Source 2.20 This diagram shows the basic causes of salinity. Irrigation-induced salinity, as one example, occurs when deep-rooted native vegetation is replaced with shallow-rooted introduced species for crops (e.g. cotton and wheat, which require significant watering) and pastures, causing increased infiltration of water into the soil and the rising of the watertable. This brings salt to the surface where it can be left behind as the water evaporates.

Source 2.21 Salinity is an ongoing problem for Australia. Here is an example of a salt lake at Nambling Lakes in Western Australia.

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Activity 2.2

1 Investigate habitat and biodiversity loss in both Australia and North America since colonisation by Britain. Develop a chart indicating what percentage of both nations was forest before British settlement, and what percentage is forest today.

2 Imagine you are at a local government meeting to discuss the drainage of a local wetland in your area. Identify the different groups of people you might see at this meeting and what their perspective would be on the advantages and disadvantages.

3 Investigate what the Australian Government is doing to manage the problem of salinity. In your own words, explain how the Murray–Darling Basin Authority's Basin Plan aims to address the problem of salinity.

Note this down 2.1

Copy the graphic organiser below and create a Plus, Minus and Interesting chart detailing the advantages (plus) and disadvantages (minus) of each human impact on a biome, as well as any other interesting notes.

Human impact			
	Plus	**Minus**	**Interesting**
Drainage and vegetation clearance			

2.3 Sustainability strategies that minimise environmental impacts

There are a range of informal and day-to-day actions that individuals can take to preserve biomes. However, there is also a need to preserve them using more formal mechanisms such as declaring areas as biosphere reserves, wilderness areas, national parks or World Heritage Sites. Each management strategy permits different levels of human activity and preservation.

Preserving biomes in national parks

Studies to date have shown that humans have had significant impacts on the world's biomes. On 1 March 1872, United States President

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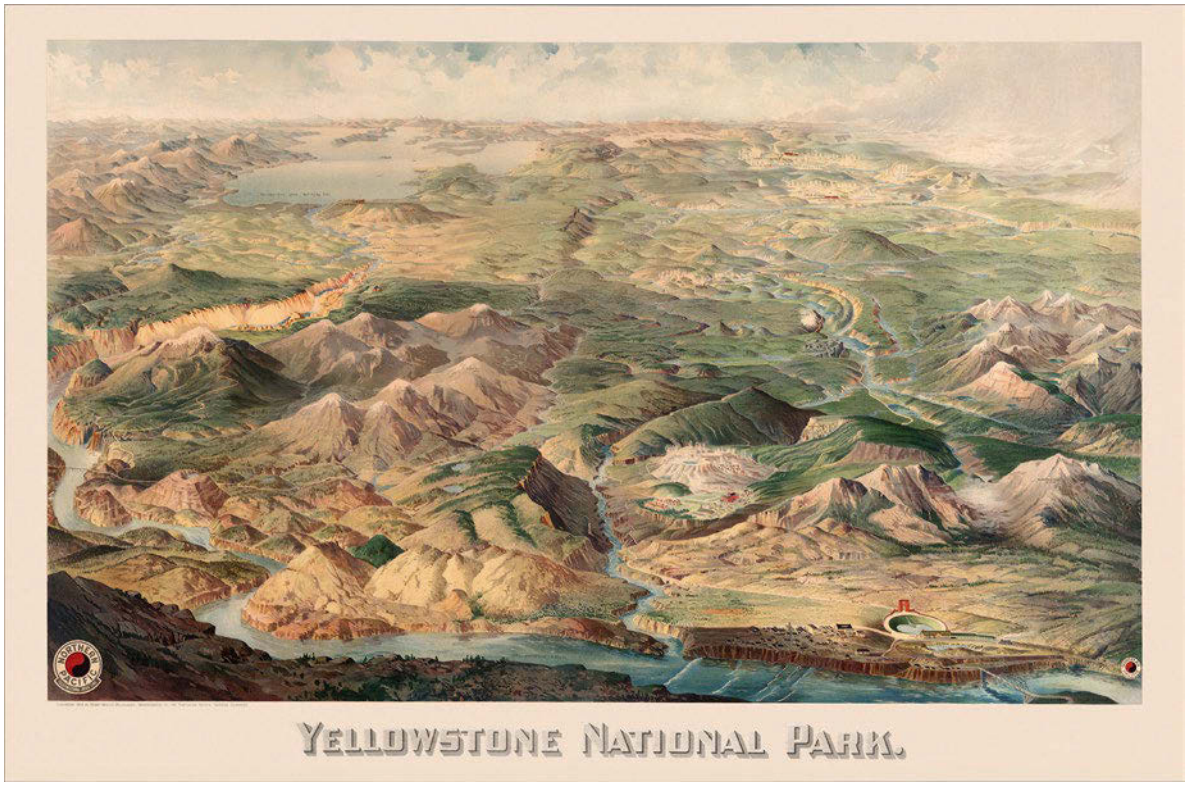
Ulysses S Grant declared the area of Yellowstone (shared by the states of Wyoming, Montana and Idaho) to be a national park. The objective was to save some of the Earth's biomes for future generations. Yellowstone is widely believed to be the world's first national park. Australia was not far behind, declaring the world's second national park, now named the Royal National Park, south of Sydney, on 26 April 1879. Today over 100 nations have designated national park areas. Australia has just over 4% of the country reserved in its 685 national parks.

Source 2.22 (Top) A detailed oblique aerial view pictorial map of Yellowstone National Park, USA by Henry Wellge from 1904. This map shows a range of distinctive geographical features, such as a basin, rivers and mountain ranges. Yellowstone is known today as the world's first national park and was designed to protect the biome in its natural state. (Bottom) Garie's Beach in the Royal National Park, Sydney – the world's second national park.



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Preserving biomes – World Heritage List

When the proposed construction of the Aswan Dam in Egypt in 1959 threatened the temples of Abu Simbel, the United Nations Educational, Scientific and Cultural Organization (UNESCO) became involved. The outcome was that funds were raised to relocate the temples. A broader outcome was the development of the concept of 'World Heritage areas'. These are areas of natural and/or cultural significance which should be managed sustainably so that they are available for future generations to enjoy. This is embodied in an international treaty called the Convention concerning the Protection of the World Cultural and Natural Heritage, adopted by UNESCO in 1972.

Australia has 19 areas or sites on the World Heritage List, including Uluru-Kata Tjuta National Park, Fraser Island and the Great Barrier Reef.

Source 2.23 Historic SS *Maheno* Wreck, Fraser Island, Australia. Fraser Island is on the World Heritage List.

The approach of government and industry has moved from 'How can we develop the resources of an area for maximum profit?' to 'How can we develop and manage the resources sustainably?' This has been a major shift in thinking about biomes and their use. One source raising concern was a book called *Silent Spring*, written by Rachel Carson in 1962, which described the impact of modern pesticides on the planet's birdlife at that time. Finding pesticide residue in Antarctic penguins was another wake-up call. Not all countries are managing their biomes sustainably, but changes for the better are being made.

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Activity 2.3

1 Justify the need for national parks to ensure the future of biomes.
2 On a map of Australia, mark the 19 World Heritage listed sites.
3 Discuss the need to manage biomes in a sustainable way.

Case study 2.2
Sustainable use of a biome – the Amazon rainforest

As we saw in Case study 2.1, the agricultural production of sugar cane in Queensland has required human intervention to clear rainforest environments, providing the best growing conditions for the crop. This is an example of human manipulation of a rainforest biome. Next we will consider the example of the Amazon rainforest – a rainforest biome under pressure from humanity.

The Amazon rainforest biome is one of the most important in the world. It is a huge area which removes the harmful greenhouse

Geographical fact

The forest of the Amazon provides 20% of the world's oxygen. Wet rice fields contribute between 100 and 500 million tonnes of methane (a greenhouse gas) to the atmosphere each year.

Source 2.24 The Amazon rainforest from above and at ground level

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gas carbon dioxide from the atmosphere and returns the gas essential for human life on earth: oxygen.

In other parts of the world, such as southeast Asia, the rainforest in some areas, such as the wet rice terraced areas, was removed generations ago. The Amazon, however, has only been opened up for 'development' in the past 70 or so years. The Amazon has been the home to hunter-gatherers – and, to a lesser extent, **shifting cultivators** – for centuries, but the demands of the outside world are placing enormous pressures on this biome. These demands have also placed enormous pressures on the people who live and have lived sustainably for hundreds of years in this biome.

shifting cultivators people who farm a section of land for 2 to 3 years, then move on to another section to allow the original plot to revitalise itself

Shifting cultivators in the Amazon

The Yanomami tribe is the largest isolated indigenous tribe in the Amazon, and lives in the rainforest and mountains of northern Brazil and southern Venezuela. They inhabit one of the largest indigenous territories in the world. There are currently 32 000 Yanomami living in over 200 villages within their territory. They are within a protected reserve; many of them died between the 1970s and 80s after illegal gold

RESEARCH 2.1

1 Separate your class into groups. Each group needs to select and research one of the following:
   - the number, location and way of life of the indigenous people of the Amazon
   - the number, location and way of life of people living in reservations in the Amazon
   - the number, location and environmental impact of miners in the Amazon biome
   - the number, location and environmental impact of loggers in the Amazon biome
   - the number, location and environmental impact of farmers in the Amazon biome
   - the number, location and environmental impact of dams in the Amazon biome
   - the number, concentration and environmental impact of tourists in the Amazon biome.

2 Once each group has completed its research, hold a class discussion in which groups address the class with their findings, to complete the picture of the Amazon basin.

3 **Extension:** Investigate the social and economic impact of your chosen group of people. There may be positive and negative impacts.

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miners moved into the area and introduced diseases that the tribes were not immune to.

The Yanomami have lived in the Amazon in harmony with the land for over 15 000 years as they are shifting cultivators as well as hunter-gatherers. In the Yanomami tribe, men hunt for animals such as tapir, deer and monkeys, and the women tend to the crops. Although hunting is greatly valued by everyone in the village, meat only accounts for 10% of the village's food. It is the crops that sustain the village, providing at least 80% of the Yanomami diet. The Yanomami also gather nuts, shellfish and insect larvae. Wild honey is highly prized and the Yanomami harvest over 10 different kinds.

Source 2.25 The Yanomami people have lived in harmony with the land for over 15 000 years.

Shifting cultivation

If shifting cultivators like the Yanomami are left undisturbed, they have a minimal impact on their rainforest environment. The cycle of shifting cultivation is shown in Sources 2.26 and 2.27.

The story of shifting cultivators is simple. An area of rainforest is selected as a plot and most trees in it are cut down. If the plot is on a steep slope some are left to hold the soil together, and some may be left for climbing plants to grow on. Some of the felled trees are burned to provide nutrients for the soil and others are used as a barrier, to protect the plot from wild animals.

A variety of crops are planted. This is important because it means the people's diet is varied. It also means that if one crop fails, they will still have food. The first crop is excellent. The plot is only used for around 3 years, because the yields decrease over time. At that point a new plot is established.

Before leaving the old plot, the group will open the barrier around it. Wild animals, such

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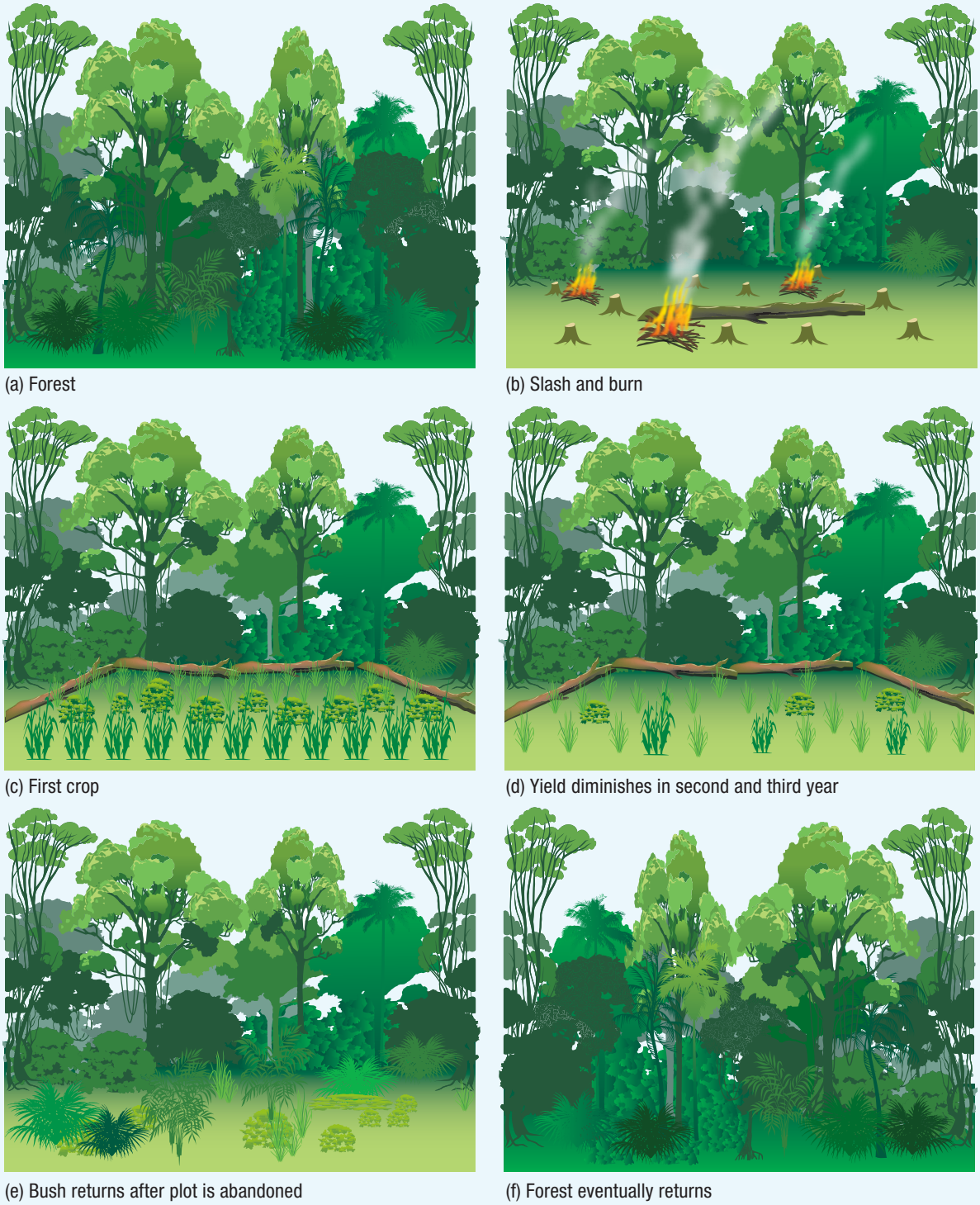

(a) Forest

(b) Slash and burn

(c) First crop

(d) Yield diminishes in second and third year

(e) Bush returns after plot is abandoned

(f) Forest eventually returns

Source 2.26 The cycle of shifting cultivation

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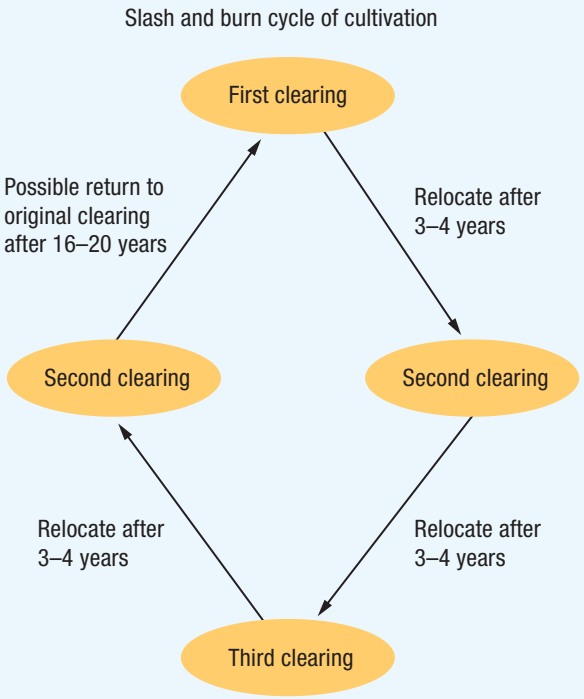

Source 2.27 Shifting cultivation cycle

as the Brazilian tapir, will enter the plot to forage among the leftovers. These will be killed, making for a variation in the diet of the people.

The Yanomami may then move their settlement to the new plot (if it is far away) or they will simply access another plot of land near their village. The old plot and old settlement sites are soon reclaimed by the rainforest. Over 16–20 years the **humus layer** builds up on the floor of the forest and the soil fertility returns. Remember, a rainforest is capable of creating its own fertile soils. When the soil fertility has been restored and a good forest cover has been established, the group can return and use the area again. In this way they shift their plots around, making breaks in the canopy of the forest from time to time and using the fertility of the soil, but never completely destroying the biome because they move on once their crops have exhausted the fertility of the soil.

humus layer the dark, nutrient-rich top layer of soil formed when plant and animal matter decays

Source 2.28 The Brazilian tapir is an example of Amazonian wildlife that tribes such as the Yanomami live sustainably with.

Shifting cultivators, such as the Yanomami tribe in the Amazon, are an example of how a biome can be used **sustainably**. The indigenous tribes have a great deal of respect for their land and biome, and try to look after it as much as it provides for them.

sustainably when a resource is used in such a way as to preserve the resource and its surrounds

Unfortunately, as we have seen, not all rainforest biomes are as well looked after, such as parts of the Queensland rainforest.

1. Identify some wild animals not mentioned in the text that live sustainably alongside the Yanomami in the Amazon rainforest biome.
2. Identify some crops not mentioned in the text that are grown sustainably by the Yanomami.
3. Recall the typical duties of men and women in the Yanomami tribe and suggest how these practices promote sustainable biomes.

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Note this down 2.2

Copy the T-chart below and summarise the points for and against that you think would come with living as a shifting cultivator today. Think about what you would find difficult (reasons against) and what would benefit you (reasons for).

Shifting cultivators	
For	Against

RESEARCH 2.2

In Australia, Aboriginal and Torres Strait Islander peoples have been criticised in the past for their 'firestick-farming' method of vegetation clearance. Research their traditional method of land management and outline the advantages and disadvantages of their method.

Source 2.29 Aboriginal and Torres Strait Islander peoples have long used the 'firestick-farming' method of traditional land management.

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Chapter summary

- Humans use biomes across the globe to produce goods that can be used for food, clothing and shelter. Humans also adapt and change biomes across the world to produce goods that can be used for food, clothing, shelter and energy.
- Some people use biomes for commercial purposes like agriculture while others use them for subsistence purposes.
- The most common impacts of humans on biomes include vegetation clearance, terracing of slopes, drainage and irrigation.
- People depend on biomes for a variety of purposes; they are considered advantageous for different groups of people. It is a matter of deciding whether the advantage of altering the biome outweighs the disadvantage to the biome.
- Preserving biomes is an important step forward for countries around the world.
- It is possible to live in a biome sustainably. The Yanomami tribe has lived in harmony with the land in the Amazon for over 15 000 years as they are shifting cultivators.

End-of-chapter questions

Short answer

1 To what extent do humans impact biomes? Use your notes from Note this down 2.1 and further research to support your answer.

2 Outline the pros and cons of terrace farming.

3 Explain what shifting cultivation is. For how many years does a shifting cultivator use a plot?

Extended response

This chapter has shown how people have changed some biomes from natural systems to systems completely dominated by humans. Write a newspaper article about how urban areas depend on rural and natural systems today. When writing your article, consider the following:

- that urban areas use food produced in rural areas
- the history of food production
- what urban areas would be like without rural food production
- the impacts of urbanisation on the economy, the environment and culture.

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3 Biomes produce food

Source 3.1 Wheat growing in a field: one of the most widely grown crops worldwide

Before you start

Main focus

Crops and livestock are important food and product sources for humans. How environmental, economic and technological factors influence the agricultural yields of biomes both in Australia and internationally are important geographical phenomena to understand.

Why it's relevant to us

The quantity of crops or livestock a biome produces (or yields) has a very real and direct impact on our future survival.

Inquiry questions

- Which environmental factors impact agricultural yields?
- How does the economy influence agricultural yields?
- What types of technology and technological innovations can help increase agricultural yields?

Key terms

- Abiotic
- Agriculture
- Agrochemicals
- Biotic
- Commercialisation
- High-yielding varieties
- Industrialisation
- Livestock
- Precipitation
- Soil
- Temperature

Let's begin

Crops are an essential food source, providing livestock with feed and humans with grains, cereals, fruits, vegetables and oils. Both human-made and natural influences can impact the amount of food that crops are able to produce. The issue of 'food security' revolves around the pressures that the world's growing population are putting on the agricultural yield we can produce. This chapter will focus on the factors that influence agricultural yields including environmental, economic and technological factors.

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3.1 How environmental factors influence agricultural yields

biotic relating to living organisms such as animals and plants

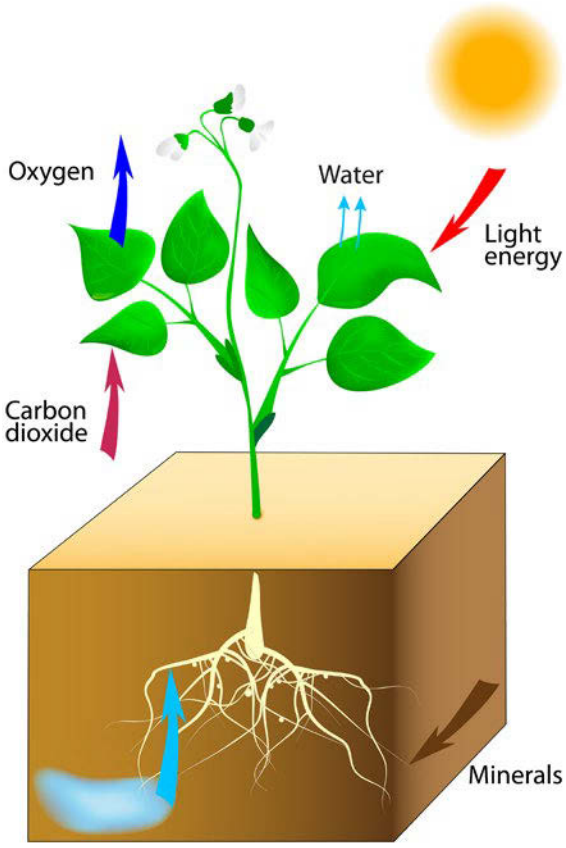
abiotic relating to non-living organisms such as air, light and water

germination the process by which a plant grows from a seed

There are many environmental factors that impact the agricultural yield of a crop. They can be divided into two categories: **biotic** and **abiotic**.

Biotic factors refer to living organisms and can hinder as well as help crops. For example, animals such as goats and insects can eat a crop (and slow its growth), but animals such as birds can help by eating seeds which then pass through their intestines and come out as manure which then helps them **germinate**. Similarly, insects such as bees can be crucial for cross-pollination of crops.

Abiotic factors refer to non-living organisms such as temperature, precipitation, water, soils and landforms. Photosynthesis is a crucial component for crop growth and is an excellent example of the influence of abiotic factors including light, water, oxygen and soil minerals.



Source 3.3 The process of photosynthesis in a plant is a good example of the influence of abiotic factors on agricultural yields.

Source 3.2 Bees are an important biotic factor for crop production.

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Geographical fact

There are over 50 000 different edible plants on Earth. Amazingly, three types of plants provide 60% of the world's food energy intake! These are rice, maize (corn) and wheat.

Source 3.4 Maize is one of the three most commonly eaten crops in the world. In Australia we tend to refer to this plant as corn.

In this section of the chapter we will consider mainly the abiotic factors that influence agricultural yields, including temperature, water availability, soil and topography.

Temperature

All plants require sunlight to carry out photosynthesis. Crops also have their own ideal temperature requirements. Some crops do better in warm and humid climates, and some crops do better in temperate climates. Matching the environment to the crop is really important. For example, broccoli grows well in mild temperatures. For this reason, broccoli thrives in the Lockyer Valley of southern Queensland where there are mild winters and light frost. Broccoli tends to be planted at the end of summer or the start of autumn and then harvested at the end of winter or in early spring.

Source 3.5 Broccoli grows very well in the Lockyer Valley of southern Queensland, which has the optimum temperature and climate for the crop.

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Understanding how temperature can impact crops can be the difference between a low yield and a high yield. Generally, crops in warmer climates need more water than those in cooler climates as there is more evaporation of water in warmer climates. Similarly, crops in humid climates need less water than those in drier climates.

Australia's unique climate

Rainfall, or the lack of it, is the most important single factor determining agricultural land use in Australia, but the impact of Australian rainfall patterns on agricultural land use has only been understood over time.

The Australian continent fluctuates between periods of rain and periods of dry conditions. Vast areas of the continent receive limited rainfall, and even across large areas that do receive good rainfall, high rates of evaporation cause the ground to dry out quickly, depriving plants of moisture.

Much of Australia's interior receives little rainfall in either winter or summer, and experiences high evaporation rates. Many of these areas are only suitable for extensive livestock grazing.

Even the northern half of Australia, which receives more rainfall than the arid interior, receives this rain in the summer months when evaporation is at its greatest, limiting the type of agriculture than can be practised there. In the Kimberley region in northern Western Australia, for example, the land is only capable of sustaining one head of cattle for every 25–30 hectares.

Agricultural production in these **arid** and semi-arid areas in the past has at times exceeded the land's capacity, causing serious land

arid dry; characterised by severe lack of water

Source 3.6 A stockman mustering cattle in the dry landscape of the Kimberley region, Western Australia

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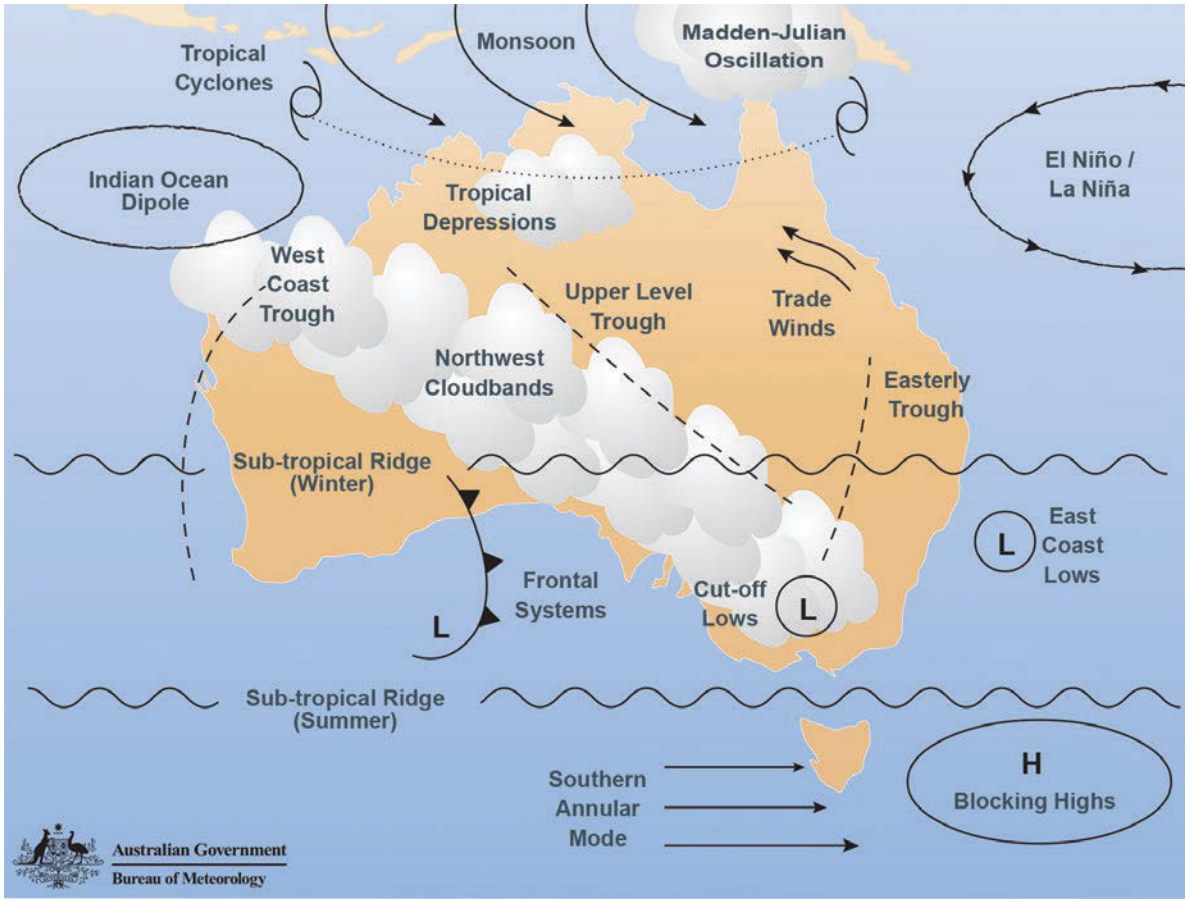
degradation. Erosion and destruction of fragile habitats have resulted from overgrazing and poor crop choices. In some areas government decrees limited the types of agricultural practices that could be used. The Goyder Line in South Australia, for example, was drawn up in 1865 to limit the extent of wheat production in the north of the state.



Source 3.7 Diagram of the climate influences on the Australian continent (Bureau of Meteorology, 2010)

The southern portion of the continent, through New South Wales, Victoria, Tasmania, South Australia and Western Australia, receives most of its rainfall during the cooler winter months, when evaporation rates are lower. This makes these areas more suitable for a greater variety of agricultural enterprises, as soil moisture is generally sufficient to grow cereal crops even in relatively dry land such as the Mallee area of northern Victoria. This region also includes most of Australia's 'sheep belt'.

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RESEARCH 3.1

1 Investigate the Goyder Line on the internet. What factors were used to determine it?

2 Research the historical climate and rainfall data for your area. Start by visiting the Australian Bureau of Meteorology website and clicking on the agriculture link under 'Our Services'. Along the left-hand side of the home page is another series of links. Select 'Climate Data Online'. To get information for your area complete the following:

   a Rainfall
   - Select 'Rainfall' then 'Monthly' for the data type.
   - Select a weather station in the area of interest (by typing in the name of your location).
   - Record the data displayed.

   b Climate
   - Select 'Temperature' then 'Monthly' for the data type.
   - Select 'Mean maximum temperature'.
   - Select a weather station in the area of interest (by typing in the name of your location).
   - Record the data displayed.

3 Describe the climate in your area, i.e. hot summer/cold winter; mild summer/mild winter; winter rainfall/dry summer; uniform rainfall all year round.

Water availability

The amount of water available in any one area is dependent on a number of factors.

Precipitation

Precipitation refers to any product of condensation of water vapour in the air that falls, including drizzle, rain, snow and hail. The most effective form of precipitation for crops is rainfall. Too little and a crop will not survive. Too much and the soil can be washed away or crops can drown or even catch diseases. Therefore, there is a fine balance. Globally, areas of the world that do not get enough rainfall or do not get enough consistent rainfall often turn to irrigation in an effort to grow crops more effectively.

Other than precipitation, general water availability is important for crops. Water can be available from other water sources such as rivers, lakes, streams and groundwater (through bores), or through irrigation schemes. The water availability changes depending on the continent and the region within the continent. For example, Australia is the driest inhabited continent in the world. (Antarctica is the driest continent.) Therefore, water availability is fundamental for crops in Australia.

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How much water does a crop need?

There are three different factors that influence how much water a crop needs.

1 The climate: In a sunny and hot climate crops need more water per day than in a cloudy and cool climate.

2 The type of crop: Crops like corn or sugar cane need more water than crops like **millet** or **sorghum**.

3 The age of the crop: Crops that have just been planted need less water than fully grown (mature) crops.

millet an ancient cereal or grain that can be used to make flour and grows well in warm countries with poor soil

sorghum an ancient grain used as a food source in Africa and parts of Asia, and often used as livestock feed in the United States and Australia

Source 3.8 The millet plant and harvested seed

Source 3.9 A field of sorghum, and individual grains still in their husks

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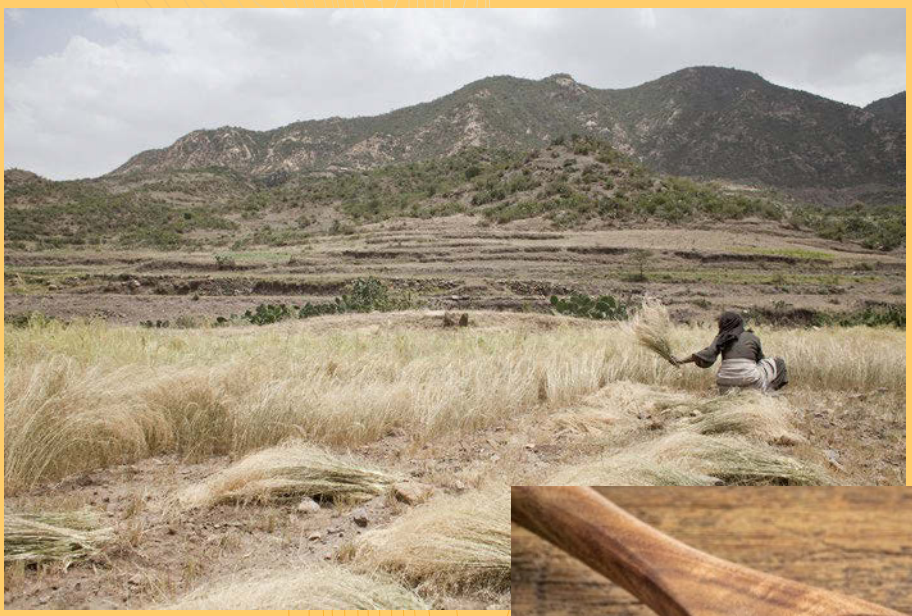
Geographical fact

Fifteen crop plants provide 90% of the world's energy intake: rice, wheat, maize (corn), soybean, yam, rye, barley, lentil, sorghum, millet, oats, potato, cassava, sweet potato and **teff**.

teff a native Ethiopian grain that is a very resilient crop and grows well in both dry and wet conditions, as well as low and high altitude. Eaten as a grain and the flour used to make the traditional bread *injera*. There are now some crops of teff being grown in Australia.



Source 3.10 A farmer in Ethiopia harvests teff – a grain that can be milled into flour or eaten as a grain

Source 3.11 Traditional Ethiopian food: teff flour is used to make bread called *injera*. Ethiopian meals are often served on top of *injera* instead of on a plate.

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Below is a table showing the approximate amount of water needed to grow different types of crops.

Crop	Crop water need (mm/total growing period)	Sensitivity to drought
Alfalfa	800–1600	low–medium
Banana	1200–2200	high
Barley/Oats/Wheat	450–650	low–medium
Bean	300–500	medium–high
Cabbage	350–500	medium–high
Citrus	900–1200	low–medium
Cotton	700–1300	low
Maize	500–800	medium–high
Melon	400–600	medium–high
Onion	350–550	medium–high
Peanut	500–700	low–medium
Pea	350–500	medium–high
Pepper	600–900	medium–high
Potato	500–700	high
Rice (paddy)	450–700	high
Sorghum/Millet	450–650	low
Soybean	450–700	low–medium
Sugar beet	550–750	low–medium
Sugar cane	1500–2500	high
Sunflower	600–1000	low–medium
Tomato	400–800	medium–high

Source 3.12 Indicative values of crop water needs and sensitivity to drought

Activity 3.1

Study Source 3.12 to answer the following:

1. Describe the major limiting climate factor for agriculture in Australia.
2. Identify the crops which need the most water.
3. Identify the crops which need the least water.
4. Suggest which crops you might expect to be a more popular choice for farmers in Australia in general.
5. Sugar cane needs more water than average. Why is sugar cane popular in Queensland? Why is sugar cane not popular in Tasmania?
6. Explain what impact drought might have in a farming area and what choices farmers might need to make.

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Soil

Soil is important for crops for two reasons: support and nutrients. First, soil gives structural support to plants so they can grow in the first instance. Plants are able to spread out their roots and grow upwards due to the soil. Second, soil feeds the plants. Fertile soil is important for crops as it provides crops with essential nutrients. The essential elements needed for crops (particularly green plants) include nitrogen, phosphorus, calcium, magnesium, potassium and sulfur. Other essential nutrients such as iron, zinc, copper, molybdenum, manganese, boron and chlorine are also needed but in very small amounts, so are often referred to as micronutrients.

Source 3.13 Fertile soil is very important for the growth of plants as it provides essential nutrients such as nitrogen and calcium. Soil also gives plants room for their roots to spread, giving them structural support.

Topography

The **topography** and slope of the land describe its shape and relief. Topography relates to the measurement of elevation and is often represented by lines that connect points with equal levels of elevation on a **topographic map**. It is important to consider the slope of land as this can reduce the risks of natural hazards (for instance, landslides or floods), minimise any construction costs and decrease the impact of

topography the relief and configuration of a landscape, including its natural and human features

topographic map a detailed, large-scale map of part of the Earth's surface which illustrates the shape of the land and selected natural and human features from the surrounding environment

Source 3.14 Crops such as cotton tend to grow better on level ground, like at Lake Menindee in NSW. Terrace farming is a good alternative in mountainous areas such as the location of these rice fields in Vietnam.

future developments on natural resources (for example, vegetation, water or soil).

Topography is important for crops as it can impact the microclimate of a field and is related to soil factors (such as its temperature), both of which can affect the growth, germination and production of plants.

Crops grow better in level areas. This is why crops tend to be found in flat areas, and why terrace farming is used in mountainous or sloped areas. Flat areas reduce water run-off and allow rainwater to soak in due to the low gradient.

Activity 3.2

1 Identify some examples of biotic and abiotic factors that influence agricultural yields.
2 Using the internet identify three pests that affect rice fields.
3 Describe how these pests affect rice production.
4 Discuss some of the ways that farmers might replenish the nutrients in their soil.
5 In terms of the farming of livestock, what type of topography do you think is best suited to graze sheep? What about cattle?

RESEARCH 3.2

Does Australia have any native foods (e.g. grains, fruits or cereals) that could be grown on a larger scale as a crop for consumption? Research some of Australia's native foods and discuss their potential as an edible crop.

3.2 Economic factors affecting agricultural yields

There are a number of factors that influence which crops are grown and in what quantities. These include global trade and the commercialisation of agriculture.

Global trade

From the 1970s onwards the nature of agriculture in Australia has changed significantly and farming has become more complex. Changes in national and global economies have put pressure on farmers to become more competitive. Today, farmers compete more with overseas producers than they ever did before. The costs of running a farm have soared. Fuel and other farm input costs – such as **fertilisers** and labour – have risen and competition for limited resources such as water have forced the introduction of such things as water trading, which means farmers have to buy and sell water for their farms.

fertilisers organic or inorganic substances that contain chemical elements that provide one or more essential nutrients to plants to help them grow

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Geographical fact

Supermarket giants, like Coles and Woolworths, favour certain types of produce over others, placing pressure on farmers to concentrate on the crops the supermarkets desire. This decreases the variety of produce, making some produce less readily available for the consumer and decreasing agricultural diversity for farmers.

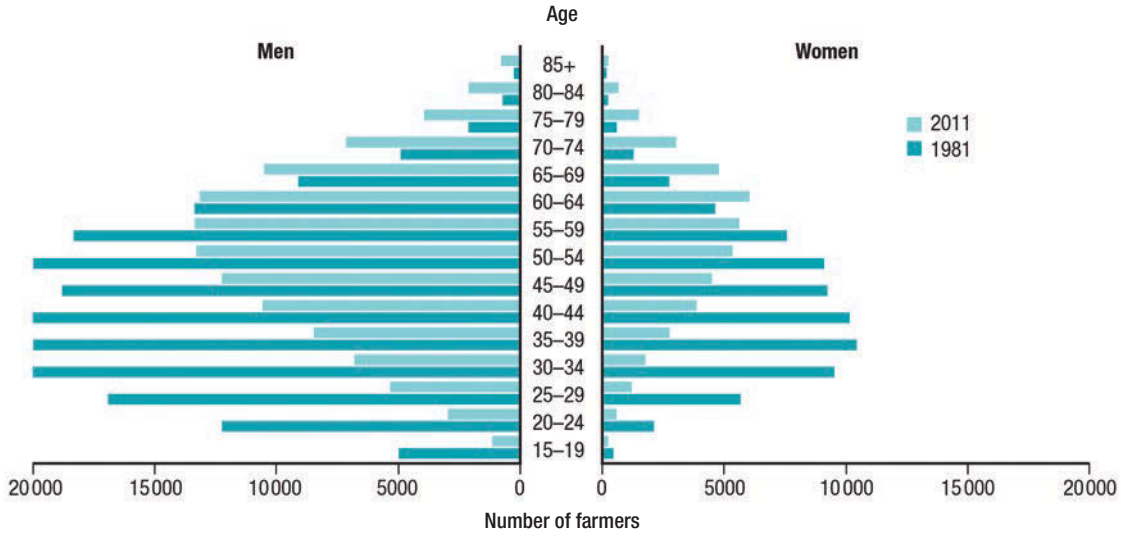
The Australian Bureau of Statistic's 2010–11 Agricultural Census found that in 2009, Australian farms produced 93% of the total volume of food consumed in Australia. After catering for the needs of the Australian population, 60% of Australia's farm produce was exported, helping feed some 40 million people outside Australia each day.

Commercialisation of agriculture

While the family-owned farm is still the dominant form of ownership in Australia, particularly in industries such as dairying and horticulture, the changing nature of agriculture in Australia is changing the business structure of farming. The declining profitability of farming since the 1970s means that the traditional pattern of farm ownership is no longer economically sustainable. Studies have shown that in some regions of Australia only 28% of farms are of a sufficient size and profitability to support the families owning them.

Over the last four decades Australian farmers have faced a decline in the average **terms of trade** of about 2% per year. This means that farmers have had to increase their output by 2% each year just to be able to buy the same bundle of goods and services from year to year. In this environment small farmers are finding it hard to compete and are either leaving the land or being forced to supplement their farm income through employment off the farm.

terms of trade the price farmers receive for their products divided by the price paid for inputs such as fuel, labour and/or fertiliser



Source 3.15 The average age of farmers is increasing as their children decide not to take up life on the land, meaning that farmers are forced to stay working their properties.

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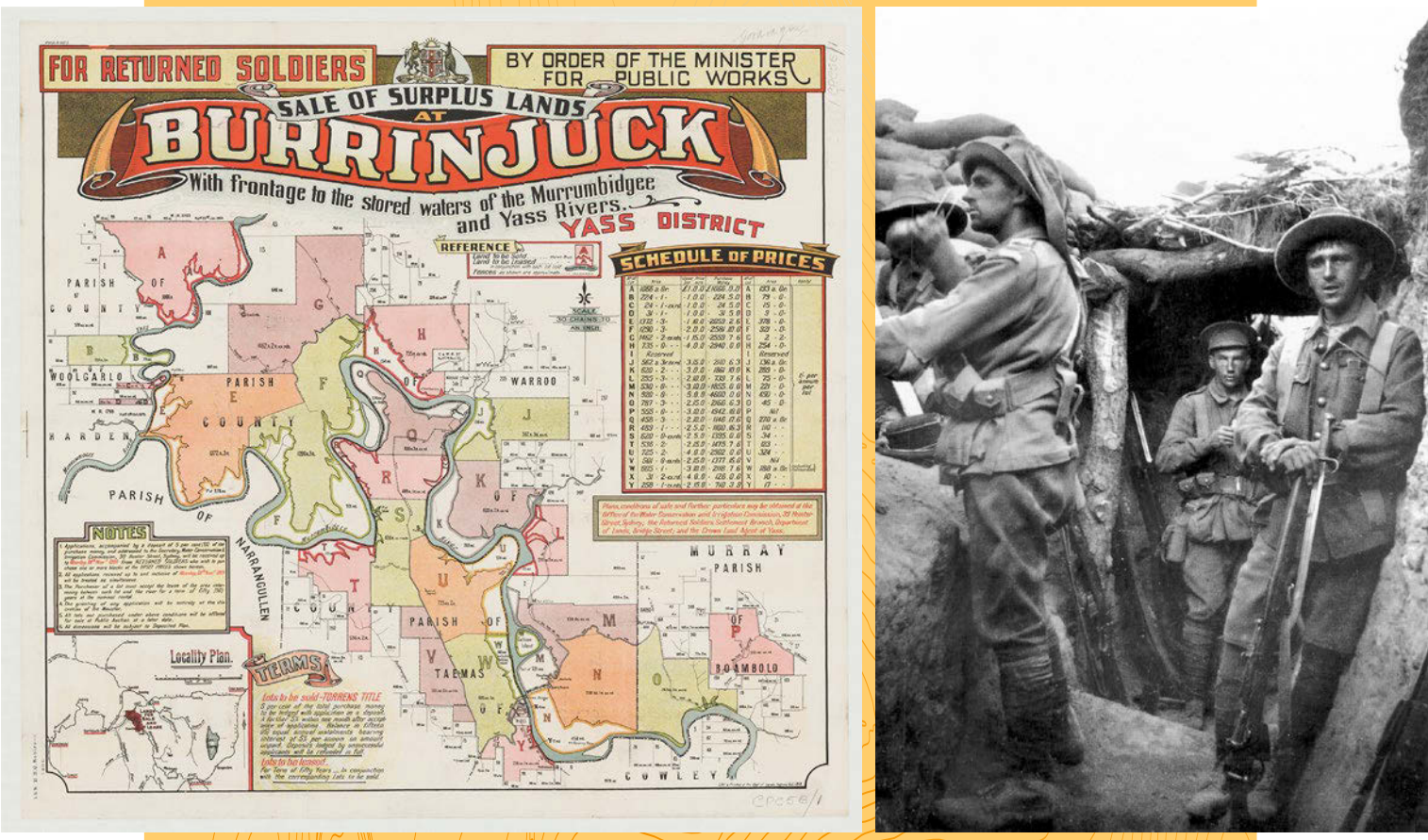
Compared with 1980, there are now 100 000 fewer farmers and the average age of farmers is increasing; many children of farmers decide not to take over the farm when they reach adulthood, so their parents stay working the farm. The sons and daughters of farmers are increasingly leaving the land to find employment in the larger urban centres and the capital cities.

Geographical fact

Systematic agricultural settlement in Australia was further developed in the first half of the twentieth century through the establishment of 'soldier settlement schemes' to repatriate men returning from World War I and World War II. Australian governments, faced with having to provide for tens of thousands of men returning from war, developed various land settlement schemes to place these men and their families on farming allotments. These schemes served a number of purposes:

- They rewarded men for their war service.
- They solved the problem of finding employment for these men.
- They were seen as a means of boosting agricultural production through intensive farming practices.



Source 3.16 (Left) Brochure advertising the sale of land near Yass, New South Wales, to returned soldiers. (Right) Australian soldiers during World War I at Gallipoli in Turkey, August 1915.

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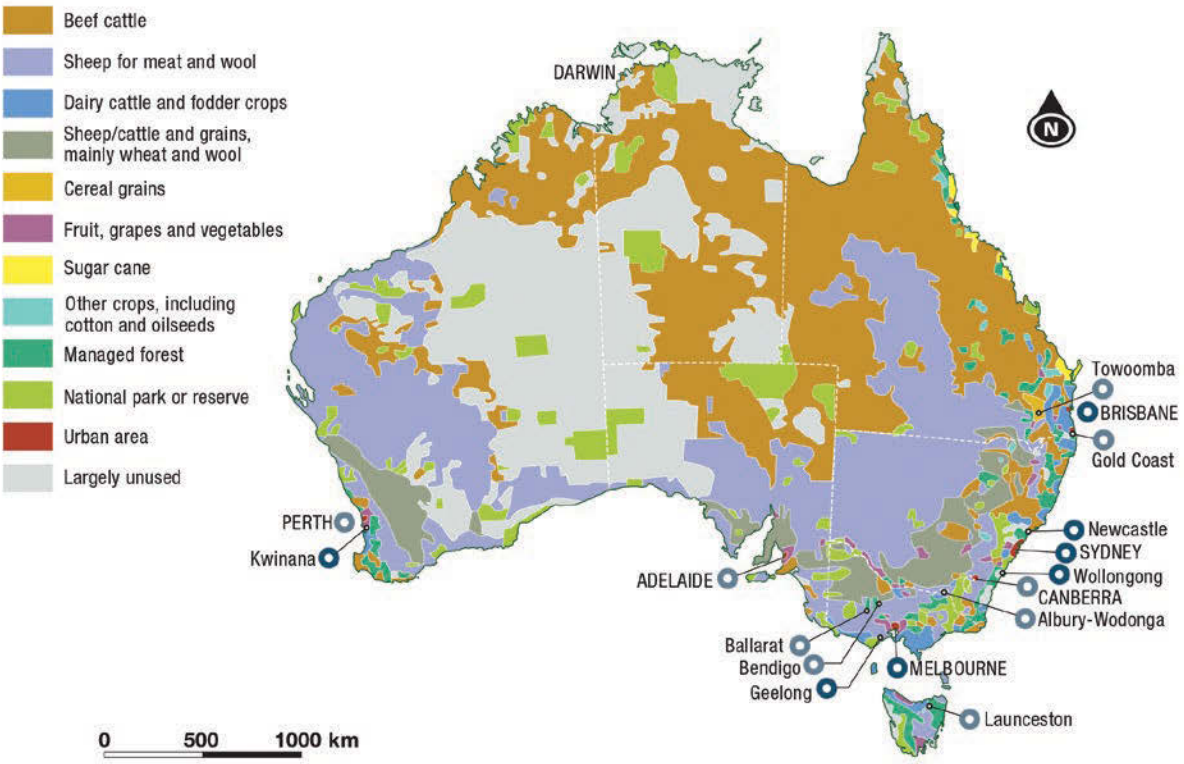
Today the agricultural industry in Australia extends right across the nation, except in the desert areas in Australia's vast inland. The ABS found in their 2010–11 census that there were 135 000 farm businesses across Australia. The majority of these were involved in specialised beef cattle farming (28%), mixed grain-sheep or grain-beef cattle farming (9%), other grain growing (9%) or specialised sheep farming (8%). Other common types of farming businesses included dairy cattle farming (6%), mixed sheep-beef cattle farming (5%) and grape growing (4%).



Source 3.17 Australia – economic activity

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commodity a product that can be bought and sold

Agriculture in Australia encompasses an enormous range of **commodities**, as shown in the table below.

Livestock	Cereal crops	Oil seed crops	Pulse crops	Other crops
sheep goats cattle (dairy and beef) pigs poultry horses deer	wheat oats barley sorghum maize (corn) millet rice	canola sunflower safflower	soybeans lupins mung beans peanuts chickpeas field peas fava beans	cotton sugar cane
Fruit – tropical	**Fruit – general**	**Berries**	**Vegetables**	**Nuts**
banana mango pineapple papaya avocado lychee	apple pear grape stone fruit (peach, apricot, plum) cherry citrus fruit (orange, lemon, grapefruit) melon (watermelon, rockmelon)	strawberry raspberry blackberry kiwifruit passionfruit	root vegetables (potatoes, carrots, onions) cruciferous vegetables (cabbage, broccoli, cauliflower) lettuce tomato	almond macadamia cashew

Source 3.18 Some of the commodities produced by Australia's agricultural industry

RESEARCH 3.3

The average African diet is 46% cereal products, 20% root vegetables and 7% animal products (such as dairy and meat). In comparison the Western European diet is 33% animal products, 26% cereals and 4% root vegetables. Predict how Australian farmers might respond to the demands of these overseas markets. Explain your answer. Share your written research with the rest of your class.

Historically, crops were grown to feed the family or to feed the village. Increasingly, however, agriculture has become commercialised and farmers choose to grow crops that are popular for consumption by the national market or even the international market.

A good example of the commercialisation of agriculture is the introduction of poppy crops in Tasmania. Opium is extracted from poppies; opiates are highly valued as painkillers and used in a wide range of pharmaceutical medicines. People can misuse

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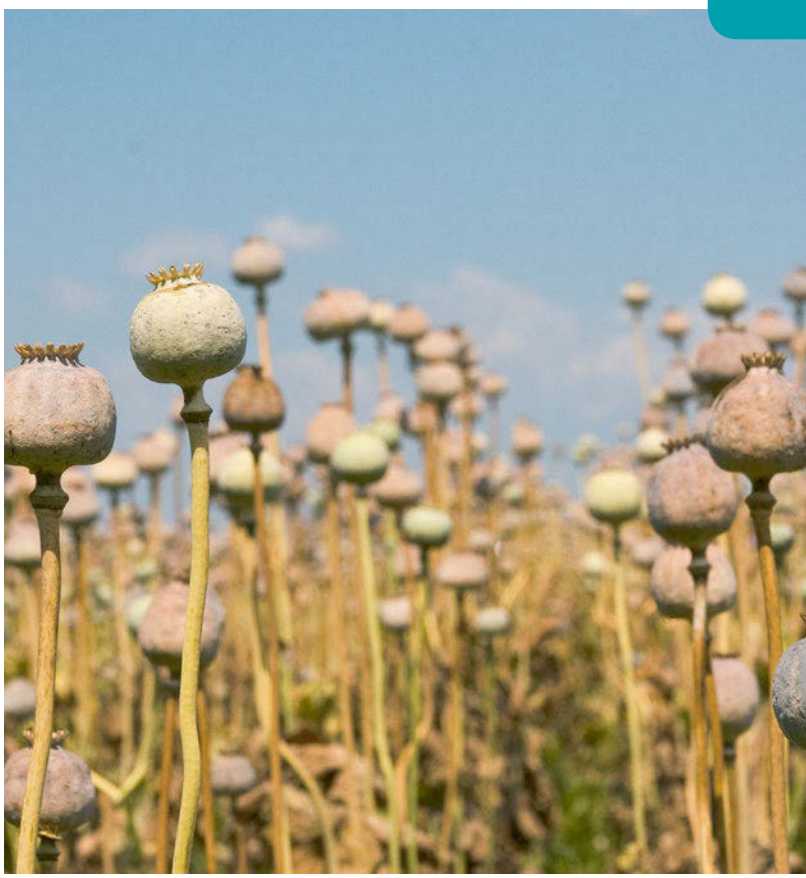
poppies due to opium being highly addictive but growth of the crop can be effectively regulated. The first poppy crop in Tasmania was in the late 1960s. Prior to this Tasmania had primarily concentrated on fruit, vegetable and barley crops, and pasture crops for livestock such as sheep and cattle. Tasmania is uniquely placed to grow poppies. The crops need nutrient-rich soil, reliable water and secure growing conditions.

Tasmania is now the world's largest producer of poppy crops, producing approximately 50% of the world's concentrated poppy straw for morphine and other related opiates for pharmaceutical companies. Poppy crops in Tasmania are a great example of how agriculture can change according to the demands of a commercial market.

Source 3.19 Warning sign on the fence of a poppy farm in Penguin, Tasmania



Source 3.20 Poppies are a major contributor to Tasmania's economy, having been introduced as a crop in the late 1960s.

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Geographical fact

Tasmania's poppy industry provides 40% of the US market's legal needs (or supply). It is a highly valuable export and is a major financial contributor to Tasmania's economy.

Activity 3.3

1 The products in the list in Source 3.18 are only some of the agricultural commodities that are produced in Australia. The list doesn't include **silage** production for animal feed, for instance. As a class, discuss some of the other agricultural products grown in Australia that you are familiar with.

2 Some of the commodities on the list, such as cattle, can be produced in most Australian regions, but some have specific growing or production conditions. As a class, make a list of some of the major factors that influence where agricultural production can take place and what types of commodities can be produced.

3 As a class, discuss the importance of agriculture to the Australian economy relative to other sectors, such as mining, manufacturing or services. Which is the most important, and why?

silage grass or other green fodder compacted and stored in airtight conditions, typically in a silo, without first being dried, and used as animal feed in the winter. Hay is the dry version of silage.

3.3 How technology is used to increase agricultural yields

Modern societies rely upon technological advances in agriculture to ensure the growing demands of humans are met. As populations continue to grow and urban areas expand, often at the expense of arable land, demand for food and agricultural products also increases.

Innovations and advancements in farming practices

Innovation is an important part of agricultural processes globally. Innovation refers to new ideas or new methods or processes. It also includes any changes or transformations made to traditional ideas or ways of doing things.

Australia is considered to be one of the leading innovators in agriculture due to the country's (including the government's) commitment to research and development. In fact, a 2009 study by the Rural Research and Development Corporation found that for

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Source 3.21 Innovation in agriculture is important as we look for new methods and processes, or look into how we might improve and revamp current methods.

every dollar invested, A$10.51 is gained over 25 years.

Australian farmers have been very successful at finding innovative solutions to problems and maximising agricultural productivity. The early development of agriculture was derivative – the crops, livestock, technology and concepts of agricultural production were all imported from overseas – so a lengthy process of adaptation and innovation had to take place before successful systems of Australian agriculture evolved. Australia has a rich history of agricultural inventions and technological adaptations to suit Australian conditions and increase productivity. Some of the more notable ones came around the end of the nineteenth century:

- The stump-jump plough allowed a farmer to plough areas from which stumps and roots had not been fully cleared. This invention was especially important in the opening up of the Mallee country in Victoria and South Australia.
- The combine harvester stripped, threshed and winnowed wheat. This invention, which was pioneered by H V McKay, an agricultural engineer from Victoria, allowed farmers to harvest wheat crops on a large scale.

Source 3.22 A crude scrub roller used by farmers to clear light scrub in Victoria's Mallee region in 1927

The Green Revolution

However, it was during the twentieth century that the most widespread impacts of agricultural innovation and adaptation occurred. Across the world this period became known as the **Green Revolution**, and it was driven by advances in agricultural science and technology leading to a greater understanding of efficient land, soil and water management practices. Coupled with this were advances in the understanding of plant and animal genetics and dramatic improvements in the science of **animal husbandry**.

Green Revolution a period beginning in the 1940s when new agricultural techniques brought great increases in production and greatly decreased the incidence of hunger worldwide

animal husbandry the agricultural practice of breeding and raising livestock

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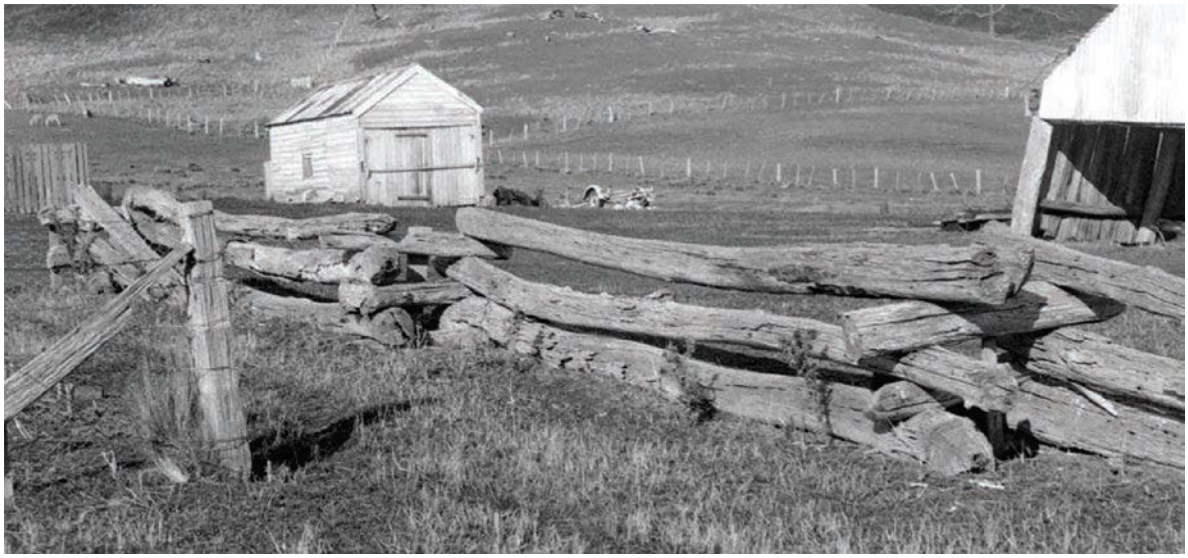


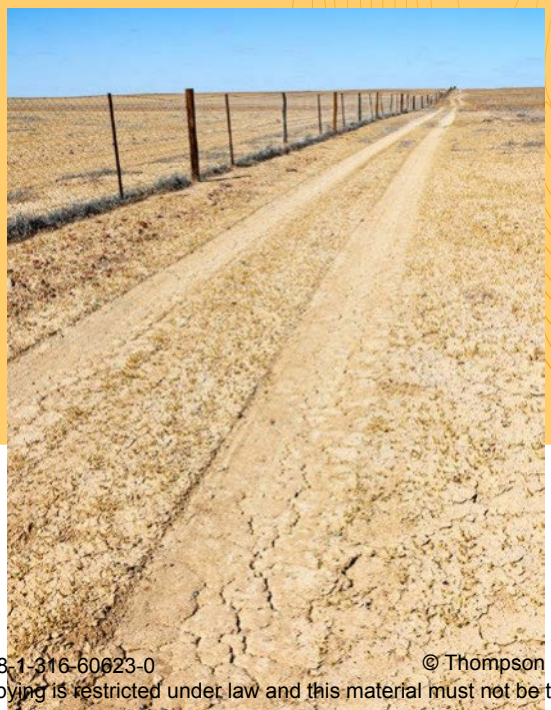
Source 3.23 An early style of chock and log fence in Tasmania

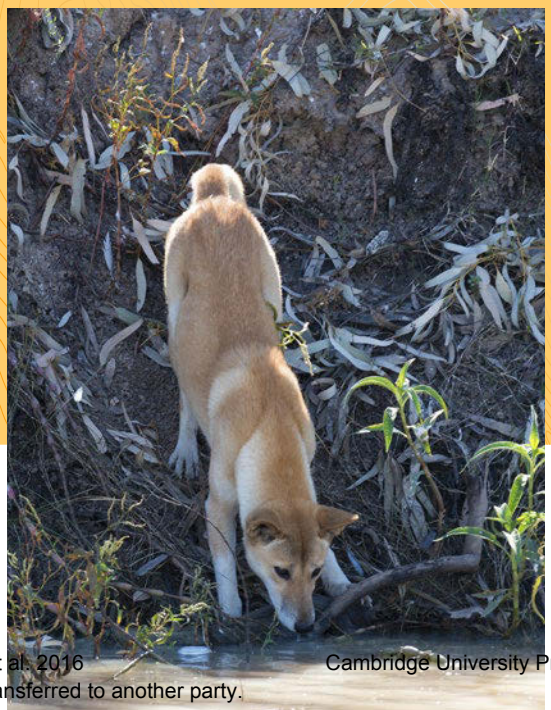
Geographical fact

Some of the longest fences in the world have been created in Australia to protect farming land and livestock from pests and predators. The Dingo Fence, which is 5600 km long – making it one of the longest structures in the world – stretches from the Bight in South Australia through to Surfer's Paradise in Queensland to protect sheep from dingo attack.

Rabbits, which were released in Victoria in 1859 and soon grew to plague proportions, have had a devastating impact on the natural environment and agricultural production. To protect their crops from rabbits, farmers in Western Australia erected three rabbit-proof fences. Rabbits managed to cross the first one, so two more had to be constructed. The total length of all three fences is more than 3000 km.

Source 3.24 (Left) A section of the Dingo Fence in southeast Australia – the longest fence in the world. (Right) A dingo drinking from a river.





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High-yielding crop varieties

One of the outcomes of the Green Revolution was the development of higher-yielding strains of cereal crops both here in Australia and in other parts of the world. **High-yielding varieties (HYVs)** of crops have allowed increased food production to meet the demands of an increased population. Two measures of these improvements are wheat crop yields in Australia and rice production in southeast Asia.

high-yielding varieties (HYVs) varieties developed by selective breeding and cross-breeding to achieve faster growth and to produce more seeds

Wheat production in Australia

By the end of the nineteenth century inefficient agricultural practices such as continuous planting of crops on the same land were having a clear effect on crop yields in Australia: they were declining significantly because of a reduction in soil fertility.

By the end of the twentieth century crop yields had almost quadrupled. In the case of wheat, the introduction of practices which increased nitrogen levels in the soil, and the use of superphosphate from the 1950s onwards, resulted in substantial improvements in crop yields through improved soil fertility.

A better understanding of land management resulted in the widespread adoption of the ley or rotational farming system in dryland agricultural areas. This system involves resting and rejuvenating land through cycles of crop planting alternated with turning the land out to pasture. When the land is under pasture, farmers can graze sheep or cattle and maintain the profitability of the land. This system replaced earlier farming techniques where crops were planted year after year until the soil was exhausted. The rotation of crops with pasture grasses or legumes helps improve soil stability, increases the amount of organic matter in the soil, fixes nitrogen into the soil and improves weed and pest control.

Continued research throughout the twentieth century further assisted wheat production with the breeding of higher-yielding disease-resistant wheat strains, the

Source 3.25 One of the world's major cereal crops is wheat. The wheat in this image has reached maturity and is ready for harvesting.

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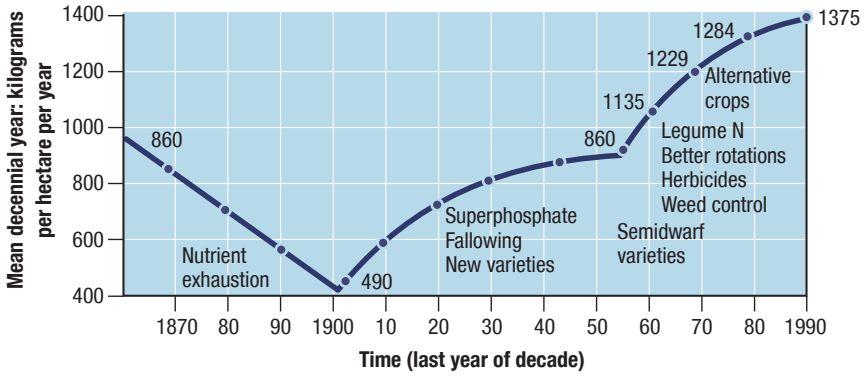


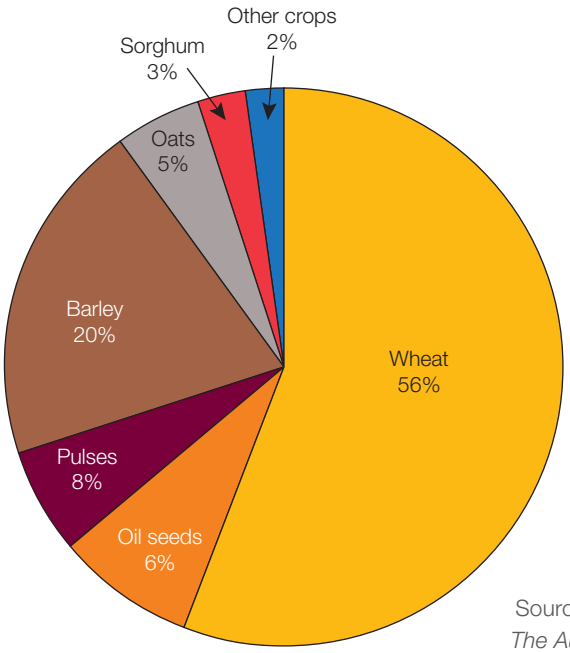
Source 3.26 Trends in wheat yields in Australia since the 1870s, showing declining production towards the end of the nineteenth century and substantial increases throughout the twentieth century

trace element a chemical element required in only minute amounts by living organisms for normal growth

development of chemicals to control pests and weeds, and greater understanding of the role of **trace elements** in plant growth.

Wheat is the main crop grown in New South Wales, with the state producing approximately 7.9 million tonnes a year. There are two types of wheat grown in NSW: winter and spring wheat. Winter wheat needs a period of cold temperature to begin reproduction, whereas spring wheat does not require cooler temperatures. Most of the wheat varieties in New South Wales tend to be spring varieties. Nonetheless, having two different types of wheat means that wheat can be grown successfully for most of the year in Australia.

Recently, the CSIRO created a new species of wheat which has the highest yield yet. The 'super wheat' was discovered by accident as CSIRO researchers were looking at ways



Source: Price Waterhouse Coopers, *The Australian Grains Industry*, 2011

Source 3.27 The total average area planted for each crop in Australia as a percentage

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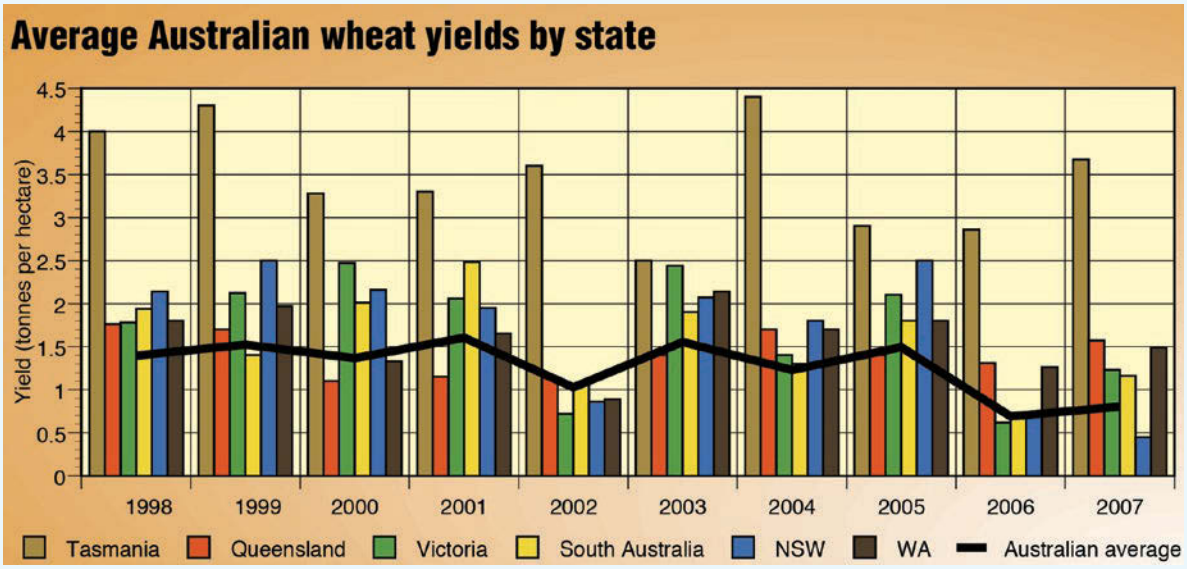
Case study 3.1
Wheat yields in Australia

In terms of export earnings for Australia, wheat is the top agricultural commodity and makes a massive annual contribution to the national economy. Wheat is the largest grain crop in Australia with around 28 million tonnes of wheat produced every year. Although Australia produces just 3% of the world's wheat, this accounts for 10–15% of the world's 100 million tonne annual global wheat trade.

Since the start of the twentieth century wheat yields in Australia have been slowly improving. In the early 1940s the average yield record was broken with 1 tonne of wheat per hectare finally reached (ABS, 2006). The average yield per hectare by state is shown in the graph below (Source 3.28). Tasmania has the highest yield of approximately 4 tonnes of wheat per hectare per year, followed by NSW with approximately 2 to 2.5 tonnes of wheat per hectare per year. The world record for wheat yield is 15 tonnes per hectare held by a New Zealand farmer. It is not possible to have such consistently high yields every year, so an average of 2 tonnes per hectare annually is considered satisfactory.

1. Using Source 3.27 and other statistics and facts as your reference, construct an infographic about Australia's agricultural land.
2. Conduct some research using the internet. Why might Tasmania be the highest producer of wheat in terms of yield per hectare? Compare Tasmania's conditions to those of New South Wales in your answer.
3. Using Source 3.28 as your reference, identify which state produces the lowest yield. Why do you think this might be?
4. Victoria had a steep fall in wheat yield in 2002 but recovered in 2003. Research and explain what happened in 2002 in Victoria.
5. Analyse the interesting patterns or trends can you see in Source 3.28.



Source 3.28 Wheat yields in Australia

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to change starch in wheat and noticed that when they did this the plants ended up with 30% larger heads and a 30% increase in yield. Higher yields of crops such as wheat will become increasingly important in terms of feeding the global population.

Rice production increased dramatically in southeast Asia in the 1960s because of the introduction of HYVs and improvements in fertilisers, **pesticides** and farm machinery. Financial institutions and governments all played a role in financing the uptake of new technologies by providing credit or donating inputs to smallholder farmers. By the 1970s, more than 40% of rice farms involved irrigation, and by the 1980s, HYVs were being widely used. This dramatic, technology-driven increase in rice production was part of the Green Revolution detailed earlier in the chapter and was responsible for a decline in poverty and an increase in economic growth.

pesticides substances used to destroy insects and other organisms that can harm or damage plants or animals

Irrigation practices

Through irrigation we have transformed some deserts into agricultural oases, but many regions throughout the Earth receive enough rainfall to be intensively farmed without the need for irrigation. For centuries, civilisations have relied on rainfall to grow enough food to be self-sufficient. Terrace farming (with rice for example) shows some of the most visually striking examples of agriculture in the world. Crops such as rice thrive in regions with high rainfall, high elevation and tropical climates. Rainfall runs off each terrace and on to the next, like a giant water feature, slowing the otherwise rapid surface run-off – a system that improves soil and water conservation.

Of Australia's 7.6 million km^2 of total land area, we can only use about one-tenth for crops – and that is with the use of irrigation and other improvements such as agrochemicals.

The mainstays of the Australian agricultural industry prior to major irrigation schemes were wheat and wool. This is known as **dryland agriculture**. Eventually irrigation schemes, funded both privately and by our governments, were established, mostly along the Murray River and its tributaries, to support more intensive agricultural practices such as fruit growing and dairying.

dryland agriculture farming that depends only on natural rainfall and soil moisture to water crops

Agrochemicals

Agrochemicals are any synthetic materials that are used to support or improve agricultural practices. The most common agrochemicals are fertilisers or pesticides. Two of the main fertilisers used in Australia are nitrogen and phosphorus. Australia's ancient soils are naturally deficient in these two elements, and these elements are essential for the successful growth of plants.

agrochemicals any synthetic materials such as fertilisers or pesticides that are used to support or improve agricultural practices

Pesticides are any chemicals that assist in preventing insects, or other organisms, from eating or attacking crops. There are natural pesticides and synthetic pesticides.

Mixtures of oil and water or baking soda or salty water can be used as a natural pesticide. A pepper mix can be very useful for deterring ants. Natural pesticides have ingredients which occur naturally.

Synthetic pesticides are any pesticides with an active ingredient that has been manufactured. The advantage of synthetic pesticides is that they tend to be more effective and can be manufactured so that they only impact a particular type of

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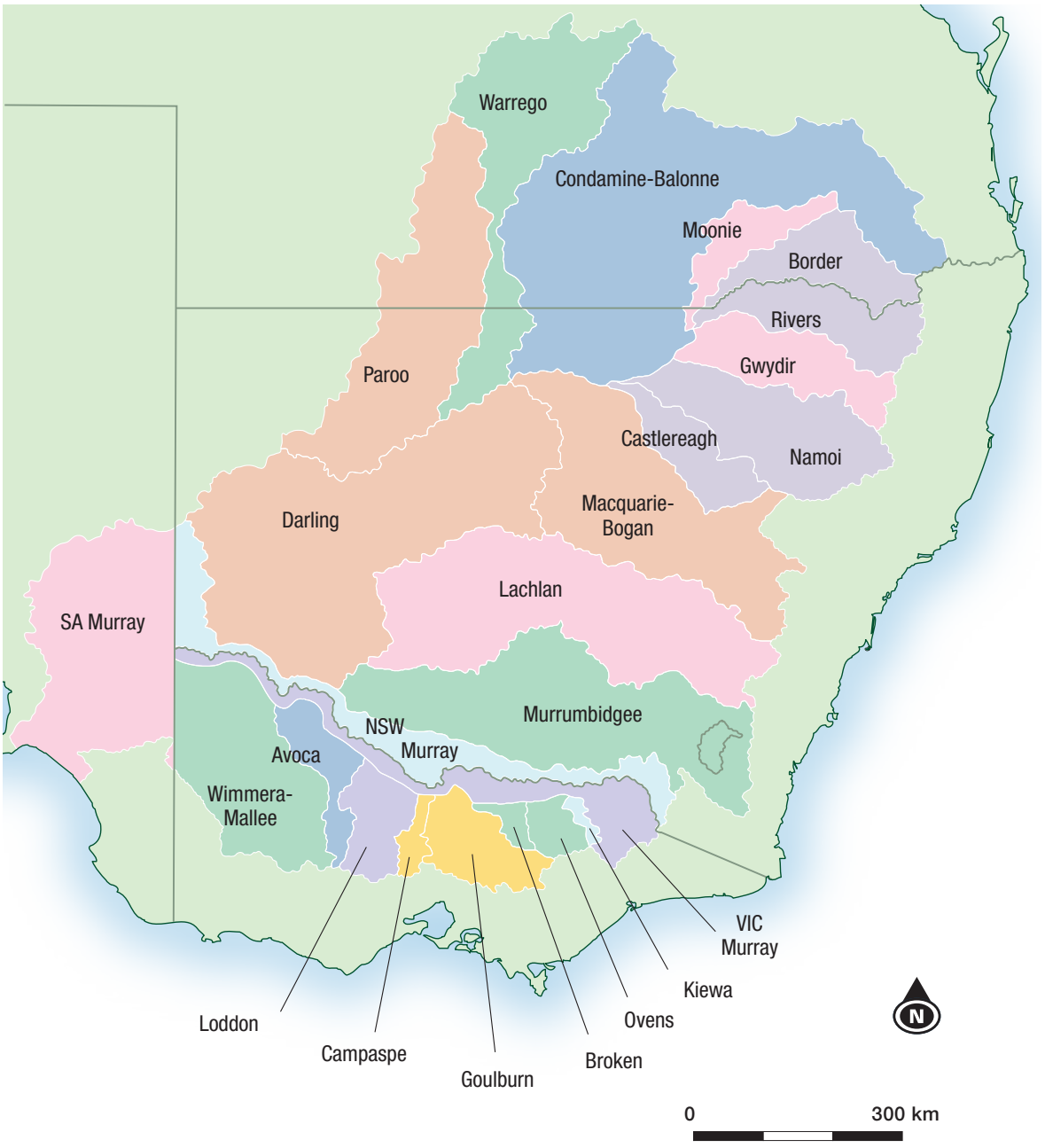

Source 3.29 The Murray–Darling Basin. Irrigation districts used for intensive agriculture are fed from the Murray River in particular.

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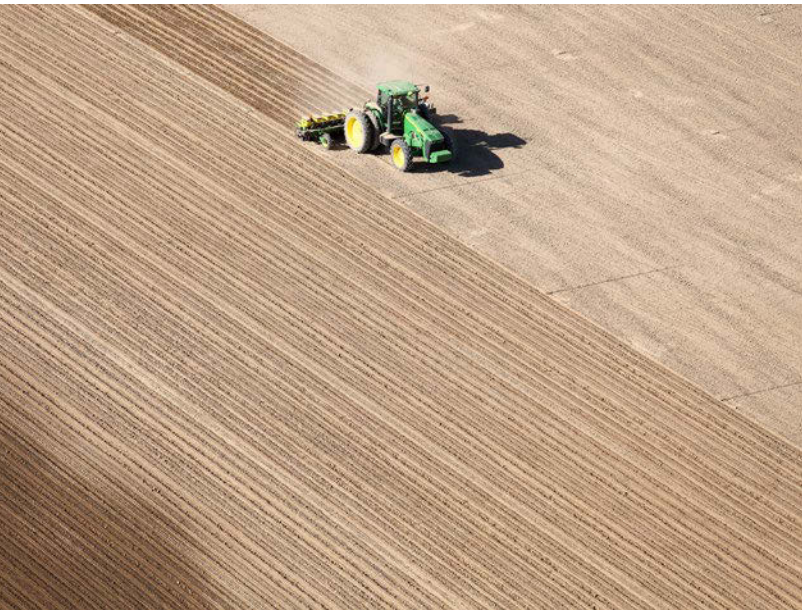
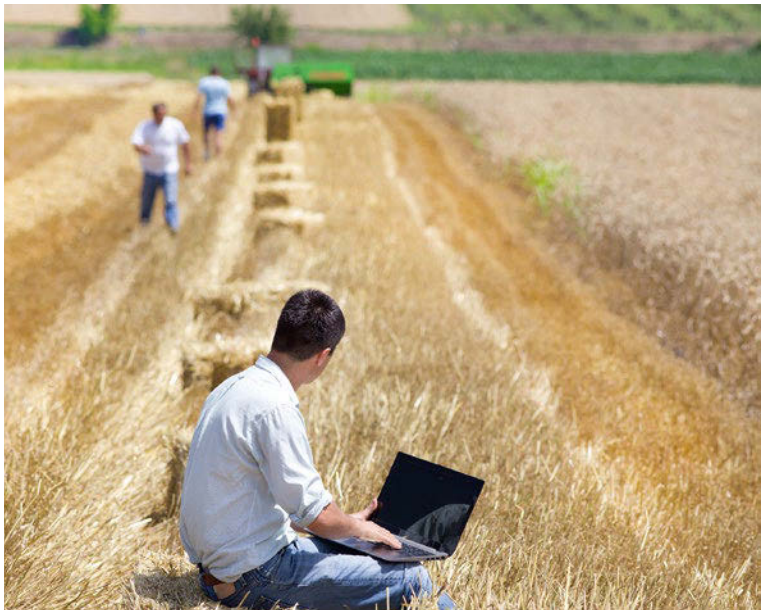
Source 3.30 A farmer spraying a herbicide in a paddock of wheat stubble to suppress weed growth in the following year

organism. The disadvantage of pesticides is that they can contribute to land and water degradation – a topic we will investigate further in the next chapter. Herbicides are a type of pesticide; they prevent the growth of other plants (such as weeds) that might compete with crops for resources.

Precision agriculture

Precision agriculture refers to any processes that measure changes in agricultural production and respond in a timely manner. Precision agriculture is also known as satellite farming. Good examples of precision agriculture include farmers using GPS to map





Source 3.31 (Left) Farmers can use GPS to map out the planting of crops, minimising soil compaction caused by tractors travelling over the same ground again and again. (Right) A farmer using a laptop to input data relating to his wheat crop.

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out the planting of crops so that they can minimise soil compaction caused by tractors travelling over the same ground again and again. They can also use sophisticated software programs that allow them to measure crop yields based on nutrient balances in the soil.

Geographical fact

The first tractor in the world was a steam engine tractor in 1868. The first fuel-powered tractor was created in 1887. Due to its isolation from the rest of the world, Australia was not as exposed to advances in machinery. Australia's first tractor was produced in 1907. It was not until the 1940s, however, that tractor use on farms in Australia became more widespread.

Source 3.32 An old steam tractor from the late 1800s compared to a more modern tractor that you would be likely to see in rural Australia today

Note this down 3.1

Complete the following table describing each innovative practice, as well as advantages and disadvantages.

Innovation	Description	Advantages	Disadvantages
High-yielding crop varieties (HYVs)			
Irrigation			
Agrochemicals			
Precision agriculture			

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Chapter summary

- There are many environmental factors that impact a biome's ability to produce food and especially crops. These factors can be divided into two categories: biotic and abiotic. Biotic factors refer to living organisms. Abiotic factors refer to non-living organisms such as temperature, water availability, soils and topography (landforms).
- One of the biggest environmental constraints in agriculture is the climate. Australia, for example, is the driest inhabited continent in the world. Approximately 90% of Australia's land area is classed as semi-arid or arid.
- There are a number of factors that influence which crops are grown and the quantities of particular crops. These include the commercialisation of agriculture and global trade.
- There are an increasing number of large corporations and multinational companies investing in modern agricultural and food processing enterprises. This is referred to as the industrialisation of agriculture.
- Technological advances and other innovations are an important part of global progress in agriculture. Innovative practices can include planting high-yielding crop varieties (HYVs), improvements to irrigation practices, the use of agrochemicals and precision agriculture. Good examples of effective HYVs are wheat in Australia and rice in southeast Asia.

End-of-chapter questions

Short answer

1 Discuss the Green Revolution and how it changed agriculture.

2 List some of the changes experienced by Australian agriculture in the last 40 years.

3 Examine why innovation is important for agriculture.

Extended response

This chapter has looked at how environmental, economic and technological factors influence crop yields in Australia as well as southeast Asia. Choose one environmental factor, one economic factor and one technological factor. Compare and contrast them, explaining their influence on crops. Conclude your extended response by identifying which factor you think is the most influential and why.

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4 Challenges to food production

Source 4.1 A farmer spraying crops in a tractor

Before you start

Main focus

Food production, a fundamental necessity for human survival, faces many environmental challenges, both in Australia and internationally.

Why it's relevant to us

From the simplest to the most complex of organisms, every living thing on Earth needs food to survive.

Inquiry questions

- What demand is there on water resources, and how does this impact food production?
- How does pollution impact food production?
- Why is land degradation one of our biggest challenges?
- How will the Earth change in the future and will this change food production?
- How will climate change affect the capacity of countries to increase their production of food?

Key terms

- Agriculture
- Biofuels
- Climate change
- Crop production
- Environmental degradation
- Livestock
- Mining
- Pollution
- Recreation
- Soil acidity
- Soil salinity
- Urban development
- Water scarcity

Let's begin

Food production is a fundamental requirement for survival. In Australia, we have an abundance of food for our current population, thanks to successful crop and livestock production. We can produce more food than we need and have the resources to import food if necessary. However, we have faced food crises, such as the banana shortage after Tropical Cyclone Larry in 2006. Challenges such as land and water degradation, competing land uses and climate change are real concerns for food production in Australia and other areas of the world.

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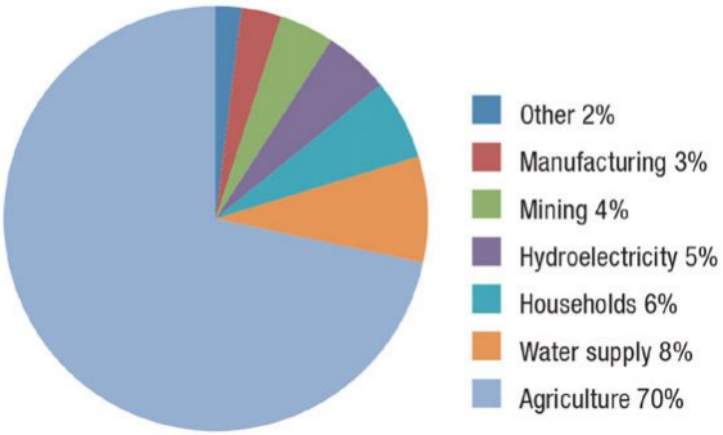
4.1 Impact of water scarcity and pollution on food production

Food production on any scale places demands on land and fresh water resources. Land and water are essential for agriculture and the Australian landscape and water catchments have changed significantly since European settlement. Agriculture is the largest consumer of water in Australia – on average, it represents around 70% of total water use per year – and since settlement around 100 million **hectares (ha)** of forest and woodland have been cleared, mostly for agricultural production.

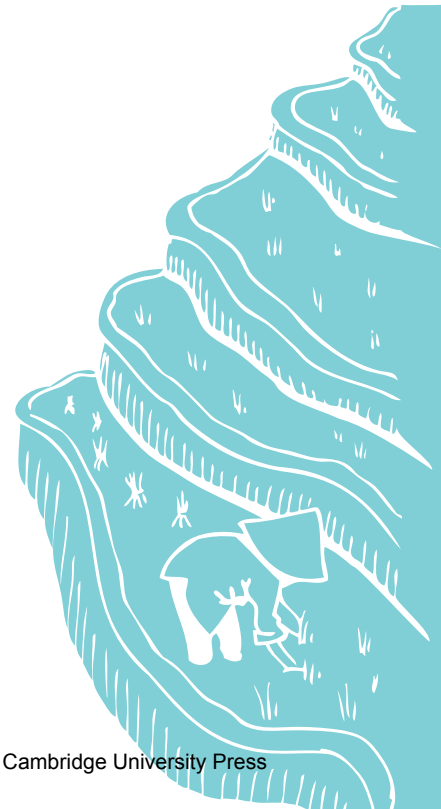
hectare (ha) 10 000 square metres

Source 4.2 This chapter will look at the reasons why water scarcity is such a problem. Here seagulls take advantage of a burst water pipe.

Source 4.3 illustrates current typical water use in Australia in the form of a pie chart.



Source 4.3 Water use in Australia



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RESEARCH 4.1

Research water use in two other nations and present your findings in pie charts like Source 4.3. Be sure to colour-code and use a key to explain your categories. Compare your pie charts with Source 4.3. Can you account for the differences in the statistics?

Water scarcity

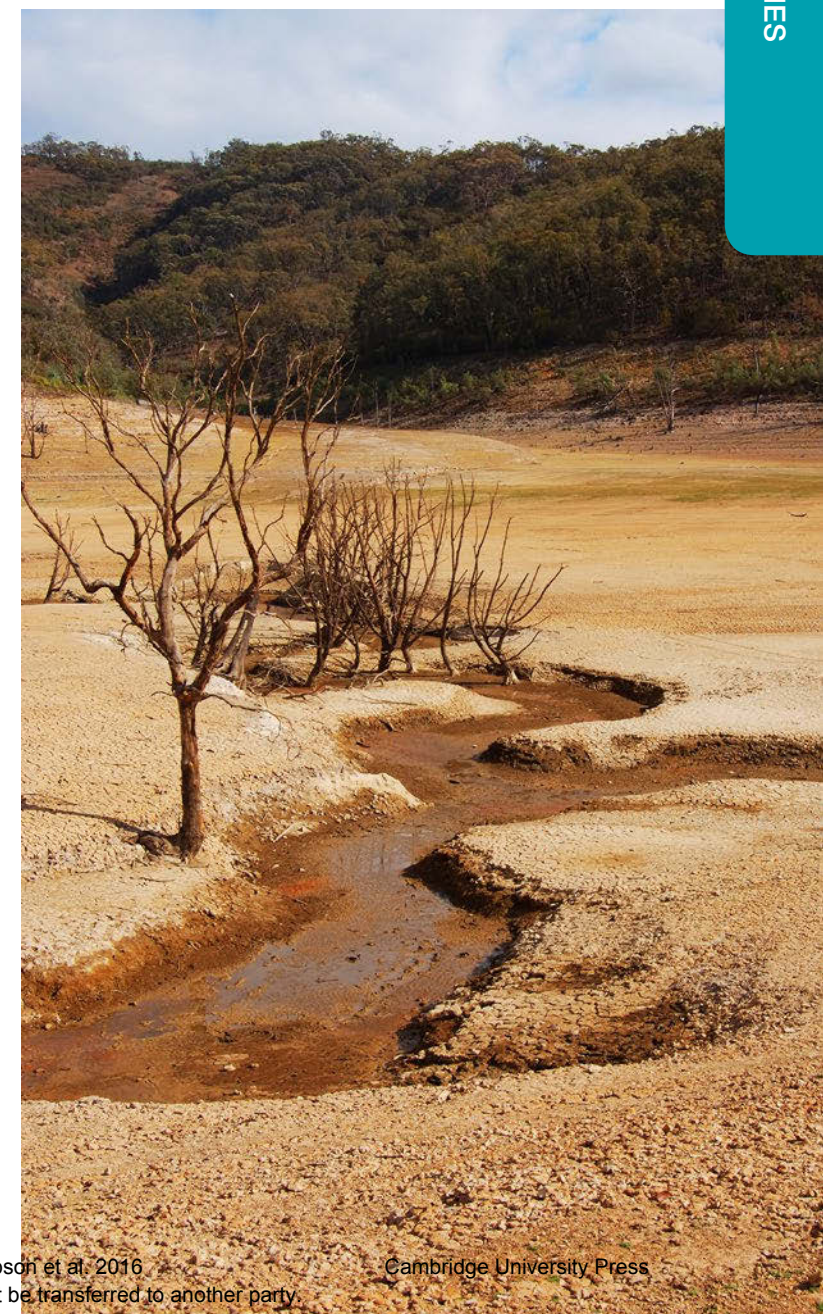
If water is scarce, there can be a large impact on the production of food. Without water, people are unable to irrigate their crops and therefore cannot provide enough food for the population.

water scarcity the lack of sufficient available water resources to meet demand

Water scarcity is an ongoing problem, particularly for countries such as Australia that have a very dry climate and low average rainfall compared to the rest of the world. Efficient use of water will become even more crucial in the future. Ultimately, less availability of water and poorer water quality leads to reduced production and increased prices of crops.

Internationally, water scarcity has been recognised as one of the most pressing food security issues for countries of the Near East and North Africa (NENA). It is predicted that by the year 2050 the availability of fresh water in the NENA region will have dropped by approximately 50%. Agricultural practices such as farming consume over 85% of the available irrigation, groundwater and rain-fed resources, and this will only increase if the demand for agricultural products continues to grow. In 2014 Abdessalam Ould Ahmed, Assistant Director-General of the Food and Agriculture Organization of the United Nations, said, 'agriculture must be central to our responses to the challenge of water scarcity in the Near East and North Africa Region. Agriculture is by far the largest user of water in the region, but it is also fundamental to our survival and long-term resilience, accounting for some $95 billion in added value to regional economies.'

Source 4.4 Water scarcity is a problem in Australia.



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Pollution

Food production can be negatively impacted by water pollution and air pollution.

Water quality decline

The decline in water quality as a consequence of agricultural practices and environmental degradation is a major issue in Australia. One of the most immediate impacts is a decline in the quality of water used for human and livestock consumption. Intensive land use along the Murray River is creating significant issues for the people of Adelaide in South Australia, who rely on water from the Murray River for personal consumption. The increasing salinity of the river system is not only making the water unpleasant for drinking, it also speeds up the deterioration of infrastructure such as water pipes.

Other things that lead to a decline in water quality include increased sediment flows into rivers and streams as a result of erosion, and fertilisers, herbicides and pesticides flowing into waterways from agricultural run-off.

Two of the main fertilisers that are entering Australian waterways as run-off are nitrogen and phosphorus. Australia's ancient soils are naturally deficient in these two elements, and the discovery in the early twentieth century that the addition of phosphorus and nitrogen to pastures and crops could significantly boost agricultural production was seen as a revolution in farming in Australia. It was later discovered, however, that the entry of these fertilisers into Australian waterways through run-off from farms was having major environmental consequences.

Source 4.5 Intensive land use along the Murray River is creating significant issues for the people of Adelaide in South Australia, who rely on water from the Murray River for personal consumption.

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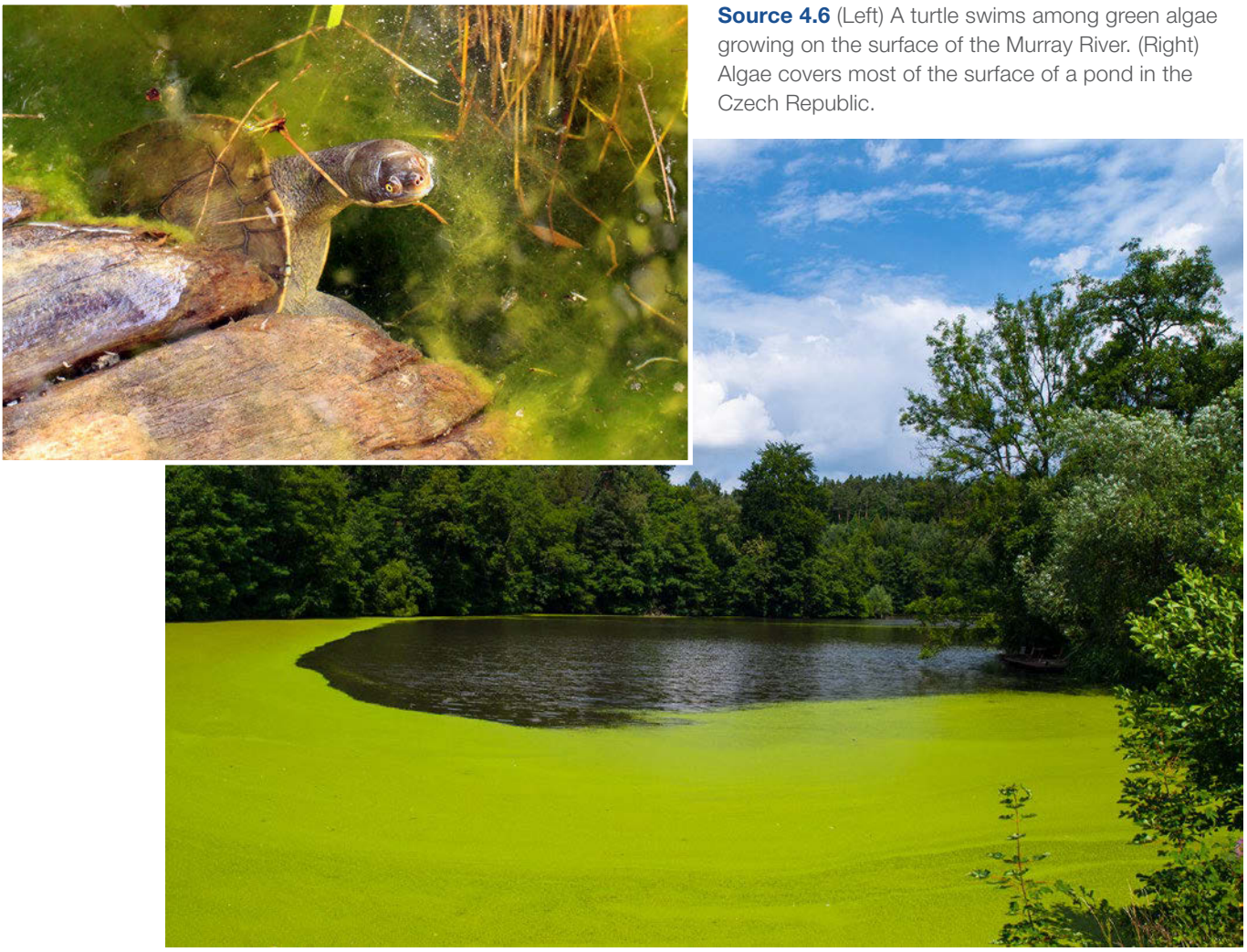
One of these is algal blooms (growth) in rivers and lakes. Algae are naturally occurring microscopic organisms, and in low numbers they are important contributors to the ecology of water bodies. Increased nutrient loads from farm fertilisers, however, are causing some species of algae to multiply to levels at which they can produce toxins that are fatal to humans and animals. Unchecked algae growth also reduces oxygen levels, causing widespread fish deaths. Other consequences include increased **turbidity** and unsightly scums which affect the smell and taste of the water.

turbidity cloudiness in the water due to the presence of extremely fine particles of matter that are held in suspension



Source 4.6 (Left) A turtle swims among green algae growing on the surface of the Murray River. (Right) Algae covers most of the surface of a pond in the Czech Republic.

Air pollutants

When agricultural crops are exposed to a high concentration of pollution in the air, they are at risk. Effects can be seen through the decrease in the yield of crops, premature death of plants, reduction in growth of plants or visible markings on the plants' foliage. How severe these effects are can depend on how long the plants are exposed to the pollutants, the type of plant and the concentration of the pollutant.

Air pollutants can be broadly classified as widespread or local. Widespread pollutants are mainly oxidants and can occur over rural areas as large as hundreds of square kilometres.

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Human activities such as burning petroleum or coal produce sulfur oxides, which are poisonous. Local pollutants are emitted from a particular stationary source and will result in vegetation or crops being contaminated and potentially injured in a well-defined area.

Source 4.7 Air pollution can greatly threaten the production of food crops.

Activity 4.1

1 Referring to Source 4.3, list the top five uses of water in Australia.

2 Describe the short- and long-term effects a change to Australia's water supply would have on the top five uses of water.

3 What impact do water scarcity and pollution have on food production both in Australia and around the world?

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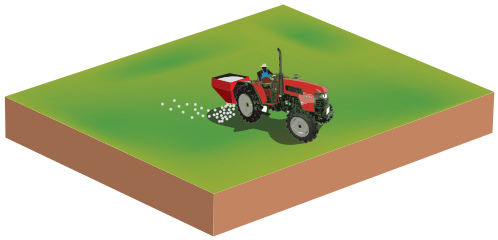
4.2 Impact of land degradation and competing land uses on food production

erosion a natural process that gradually wears down a surface area

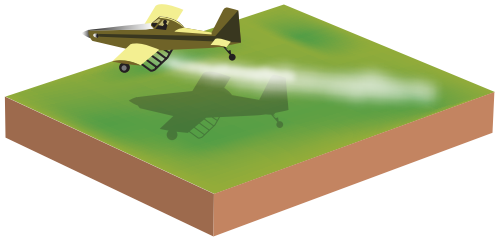
salinity the measure of salt levels in water and soil

Agricultural land use puts pressure on the environment. The results include **erosion**, **salinity** and loss of biodiversity. The term used to describe the impacts on natural systems that are additional to those which occur naturally is **environmental degradation**. Erosion, for instance, is a natural process, but agricultural practices such as cattle grazing which expose the soil to wind and rain are not – they are a result of human

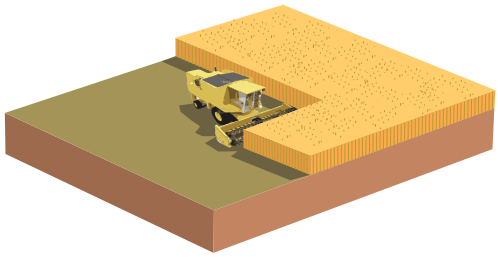
environmental degradation a change or disturbance to the environment perceived as harmful or undesirable



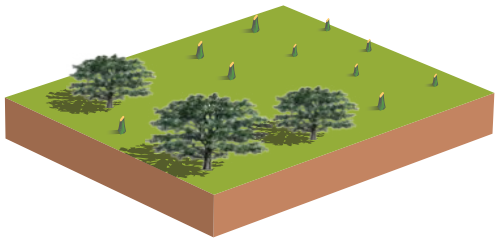
Mechanised farming with heavy use of fertiliser, using finite fossil fuels and generating pollution and CO_2



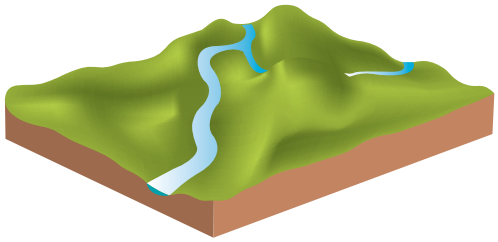
Intensive use of chemicals to control resistant pests



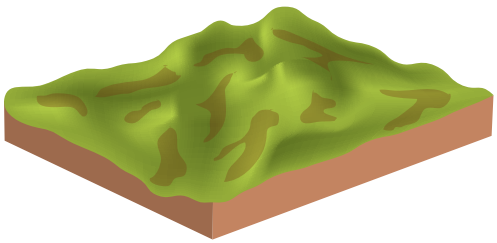
Monocrop cultivation, leading to loss of diversity



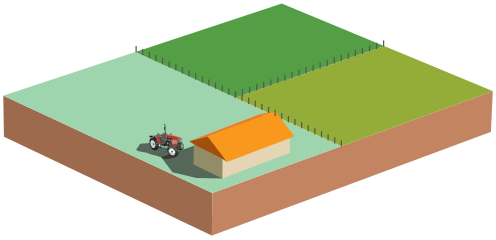
Deforestation, leading to shortages of wood for fuel



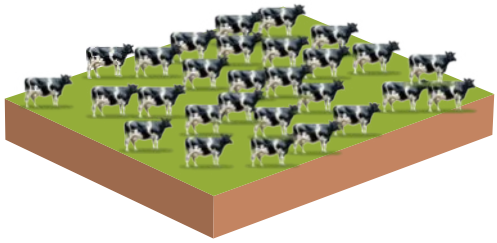
Demands on water resources for irrigation, which can destroy soil by salinisation



Overcropping, overgrazing, leading to soil erosion



Population growth, leading to smaller plots and more intensive farming



Loss of plant and animal genetic diversity caused by large-scale farming

Source 4.8 The environmental costs of modern agriculture

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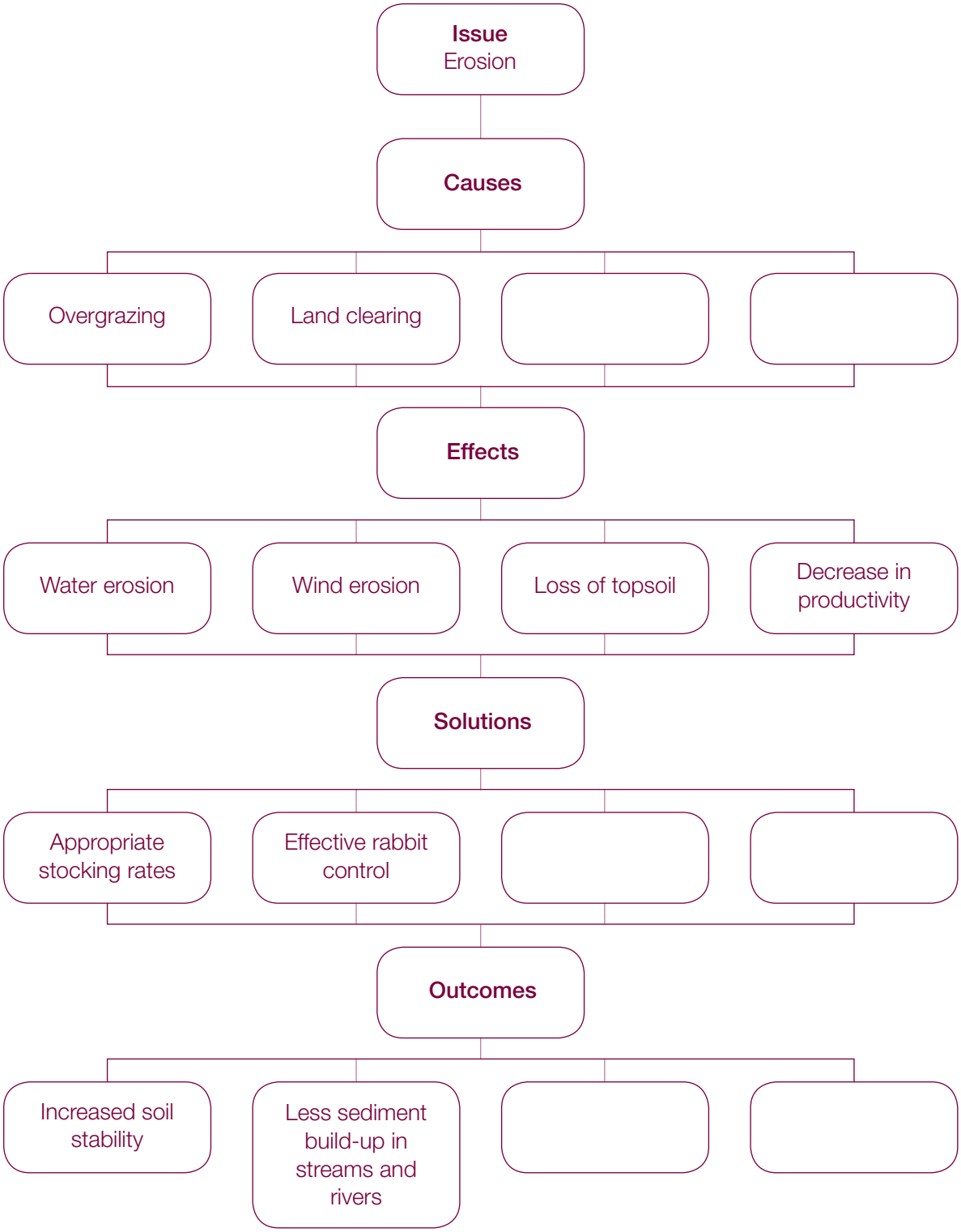
Note this down 4.1

Copy the graphic organiser below (with the five bold headings only) and research and develop a problem and solution map outlining the five main environmental problems occurring as a result of agricultural activity. These are erosion, salinity, soil acidification, biodiversity loss and water quality decline. The graphic below has been partially filled in for you, using erosion as an example.



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behaviour. Today, much is being done in Australia to try to address some of these issues, but some of the damage that has been created by past agricultural practices is substantial and costly to fix.

About two-thirds of Australia's agricultural land is degraded to some degree, and in places the degradation is expected to continue because of the extent of the deterioration and the continued pressure of land use.

Much land degradation is directly linked to the replacement of native vegetation with introduced shallow-rooted pastures and cereal crops. Land degradation has also been a result of poor farming practices. The expansion of grain production throughout the nineteenth and early twentieth centuries in Australia left the land degraded. As each new wave of settlers occupied virgin land for wheat cropping, for instance, many of the farmers had little understanding of the need for crop rotation and resting of paddocks, so they would plant the same crop every year, until the soil was exhausted and fertility declined.

Food production impacts the environment, then conversely the environment impacts food production. For example, over-exploitation of land causes soil quality to decline, which in turn causes the yield of crop to drop dramatically, thus reducing how much of a crop is available and increasing the cost to both the farmer and the consumer.

Soil acidity

Soil acidity is a major problem for Australian agriculture. Soil constraints cost Australian growers millions of dollars in lost productivity each year. To reclaim some of this productivity and profit, the Grains Research and Development Corporation (a federal

Source 4.9 A farmer sprinkles gypsum (an **alkali**) to correct the acidity of the soil

alkali a substance with a basic pH (opposite to acid)

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government department) has invested in a national Soil Constraints Initiative, which commenced during 2015.

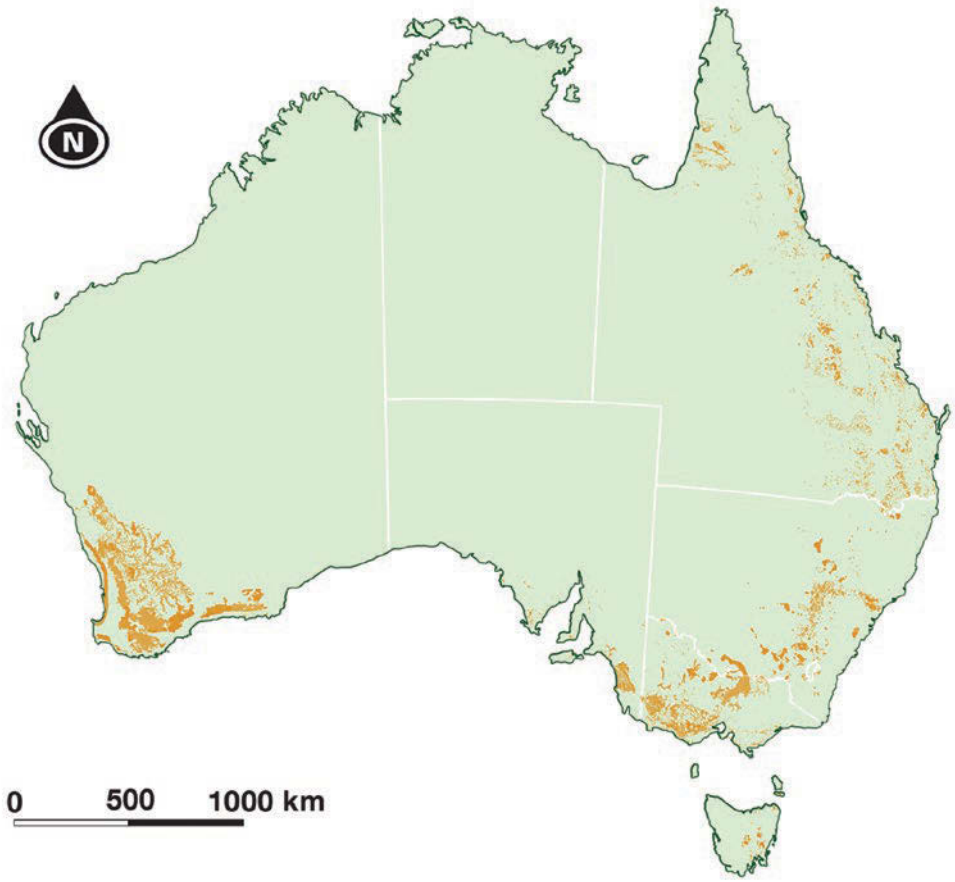
Soil acidification, like erosion, is a natural process, but it is intensified by agricultural practices such as the use of nitrogen fertilisers and nitrogen-fixing pasture plants (such as clover or **lucerne**). These practices change the chemical composition of the soil, leading to a decline in the ability of the soil to support enough vegetation to prevent soil erosion. These practices also limit crop and pasture growth because they affect the availability of nutrients that plants need, such as calcium, magnesium, boron and molybdenum. Acidification can also increase the toxicity of aluminium, iron and manganese in the soil.

lucerne alfalfa

Soil salinity

Salinity is a widespread problem which affects agricultural production in Australia. Over 2.5 million hectares of agricultural land in Australia is affected by salinity; this is expected to grow to 12 million hectares in the next 50 to 100 years. This represents about 4.5% of currently cultivated land. The presence of salt in agricultural land either kills the vegetation or causes a reduction in plant productivity.

With European settlement the water balance has changed. Land clearing for agriculture has replaced woodland and forest with shallow-rooted plants such as cereal crops and pasture grasses. This means that less above-ground water is being taken up by plants, so more water is getting through to the watertable,



Source 4.10 Areas of Australia forecast to have high levels of salinity in 2050. This increase is going to significantly impact on crop production in the next 40 years unless strategies to deal with it are implemented.

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raising it and bringing salt to the surface. Where this occurs in non-irrigated land it is known as dryland salinity. In irrigated areas, where excessive water usage is bringing the watertable to the surface, it is known as irrigated salinity.

The signs of a salt-affected landscape are sick or dying trees, a decline in vegetation, **colonisation** by salt-tolerant weeds, salty bare patches on the earth and saline pools in creek beds. Water quality is affected as the salt is washed into rivers and streams; in extreme cases the water is made too salty for animals and humans to drink.

colonisation the process by which a species enters a new area and dominates it

Activity 4.2

Refer to Source 4.10 to answer the following questions.

1. Identify areas of Australia that will be prone to severe salinity by 2050. Compare this map to a map showing population density, such as Source 7.6.
2. What else do you notice about the predicted spatial distribution of salinity in the future? Why is this a cause for concern?
3. Suggest some preventative measures Australian farmers and other land users (such as mining companies) could put into place to avoid salinity.

Mining

Mining tends to take priority over food production in Australia. This is because raw minerals tend to be more highly valued, and of more worth to a local economy, than food.

For example, in 2013 the Queensland government began reviewing its land priorities for the Central Queensland and Darling Downs regions, which are resource-rich. The Darling Downs region includes the Surat Basin, which has one of Australia's largest energy reserves of coal seam gas and thermal coal, while the Central Queensland region includes the Bowen Basin, which contains nearly all of Queensland's known coking coal reserves. These regions, however, are also highly productive for agriculture with crops such as wheat and barley, and livestock such as meat and poultry. These regions have also proven to be reasonably drought resilient, so they are highly valuable. Land use conflicts have arisen between agriculture and mining stakeholders in these regions because of the potential value that economic activities on that land could yield.

Recreation

Recreational space is another use of land that can compete with food production. There are many activities people enjoy for leisure and these recreational activities contribute to the appeal and popularity of a place. Importantly, recreational space contributes to the liveability of an area and is therefore an important part of any populated area. Recreational activities include playing sport; art; cultural festivities; attending sport as a spectator; and going to the cinema, the zoo, the botanical gardens or the museum.

A good example of current conflict between recreation and food production is the creation

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of golf courses or health resorts in rural or remote areas. Owners of golf courses and resorts prefer them to be built in areas with good water supply and aesthetically pleasing landscapes. However, these tend to be areas that best suit food production.

Source 4.11 Recreation is an important activity for many people, but at times developers of recreational facilities can be at odds with agricultural food producers who are competing for land usage.

Geographical fact

The United Kingdom could run out of land to meet its food, housing and energy needs by 2030. The University of Cambridge (2014) estimates that the UK population will reach 71.4 million by 2030; the country would theoretically require an extra 2 to 7 million hectares.

RESEARCH 4.2

Research some of the ways digital technologies have assisted agricultural production over the last 25 years and create an annotated visual display or timeline.

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Urban expansion

The world is rapidly urbanising. In Australia, the majority of the population lives along the coastline. However, the coastline regions usually receive the greatest amount of rainfall and tend to be the most productive for agriculture. As urban areas spread, land becomes less available for food production. Like mining, urban development has one other negative impact on agriculture and that is land degradation. Both mining and urban development increase the rate of air and water pollution, as well as soil erosion.

Source 4.12 Urban sprawl can impact the amount of suitable land available for agriculture.

Biofuel production

There is increasing competition between growers of different crops and debate about what crops should be produced around the world. According to the CSIRO, the biggest competition is between using crops for food and using crops for fuel. **Biofuels** are becoming increasingly popular, particularly in the United States and South America, as they are greener fuels

biofuel fuel produced using plant material, e.g. ethanol, biogas

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ethanol an alcohol as well as a type of biofuel that is derived from fermentation of sugars or starch

biodiesel a type of biofuel used as a substitute for diesel and manufactured from animal waste products, such as tallow

and emit less greenhouse gases. Biofuel also solves the issues of fossil fuel decline.

Biofuels are fuels created from waste products or from crop products. For example, **ethanol** is a biofuel that can be created from sugar cane or corn crops, or from waste starch from flour milling. Ethanol is also most commonly known and consumed as a principal ingredient of alcoholic drinks. **Biodiesel** is another biofuel that can be manufactured from waste products like **tallow** from abattoirs or recycled cooking oils.

tallow a hard fatty waste product from animal fat usually used to make soap and candles

The biofuel industry in Australia is currently very small, with biofuels making up less than 0.5% of our transport fuel. However, as supplies of fossil fuels decline and our concern about carbon emissions increases, it is likely that at some point biofuel usage in Australia will increase. In the United States the biofuel industry is already competing with food producers for land, as well as competing with the soap industry for tallow.

Source 4.13 Ethanol can be manufactured from sugarcane, or from the flour or 'meal' of corn or wheat. Any starchy grain can be used for ethanol production.

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Activity 4.3

1 Describe how the widespread removal of native vegetation for agricultural production has contributed to dryland salinity.

2 Explain how increased acidity of the soil inhibits agricultural production.

3 List the positive and negative impacts of the use of fertilisers in Australian agriculture.

4 In the left-hand column of the table below are a number of activities that farmers could use to address environmental issues on their farms. Match these with the reasons why these activities might be carried out.

Strategy	Reason
Plant native trees in paddocks	Encourage biodiversity
Build fences around areas of salinity and along creeks and rivers	Promote a natural filter to intercept sediment and fertiliser run-off
Use a balance sheet approach to fertiliser application	Reduce the level of the watertable
Restore wetland areas	Prevent livestock trampling the land, thus reducing erosion and stabilising the soil
Match animal numbers to the availability of feed	Reduce the amount of pesticide needed
Set aside areas of land for nature reserves	Minimise the amount of fertiliser entering waterways
Encourage natural insect predators	Avoid overworking the land

5 In your search engine, type 'Australian Screen superphosphate' into the search facility. This will take you to a documentary made in 1965 called 'Life on a Sheep Farm'. It shows superphosphate being applied by plane. The narrator says that this is the most efficient method of spreading superphosphate. Comment on what the environmental effects of this method might be and why it is not widely used now.

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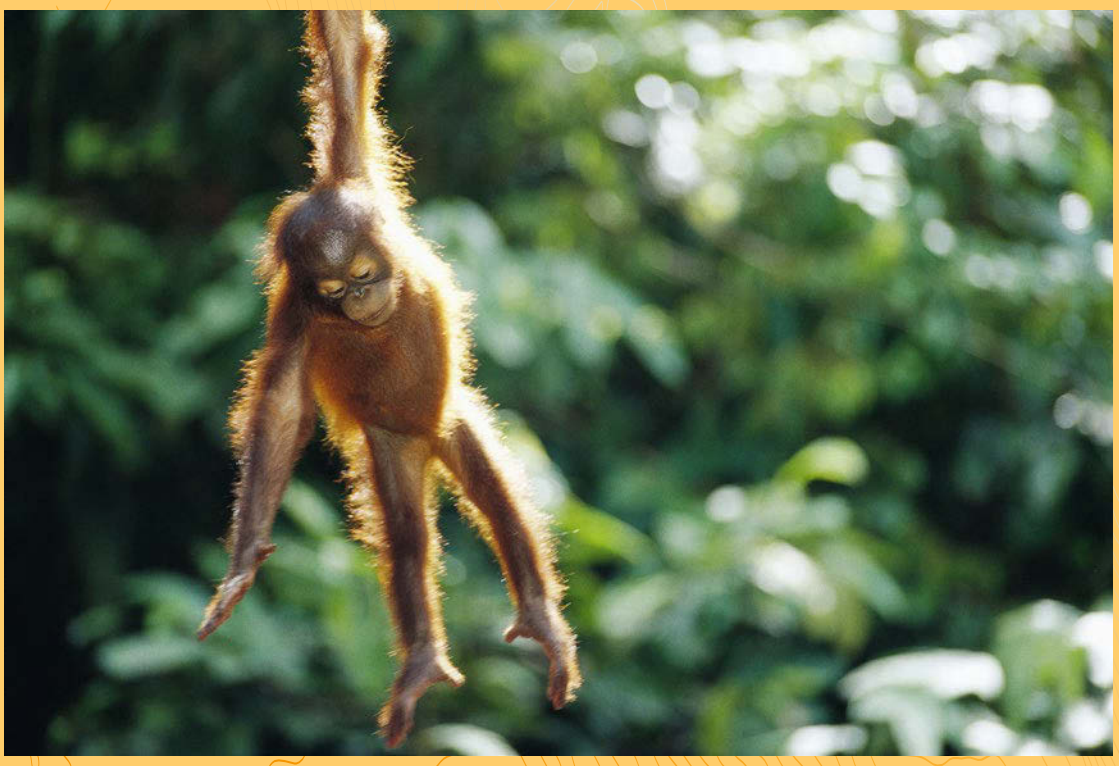
Geographical fact

In southeast Asia, a worrying competitive use of land is the production of palm oil, a vegetable oil that is commonly found in margarines, biscuits, lipsticks and ice creams. In 2014, Oxfam Australia reported that 330 000 hectares of forest is targeted for conversion to palm oil plantations, 75% of which are owned by foreign investors. Palm oil is becoming less popular in countries such as Australia, which recognises the major impact of deforestation on the native orangutan populations in Indonesia and Malaysia.



Source 4.14 Palm oil is a valued vegetable oil but comes at a cost – deforestation and loss of habitat for orangutans, and displacement of other food producers. Here is a young orangutan swinging on a tree in Borneo.

4.3 Climate change and the capacity of countries to increase food production

From the start of the twenty-first century climate change has been a major global issue. In Australia in 2014 the CSIRO and the Bureau of Meteorology released a joint report (*State of the Climate 2014*) stating that Australia (and the rest of the world) is becoming hotter. According to the report, we will experience more extreme heat; longer fire seasons; and an increasing frequency of bushfires, droughts and floods because of climate change.

Climate change is expected to have a significant impact on food production around

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Source 4.15 Climate change is expected to have a significant impact on food production around the world. For example, it is expected that the weather will get hotter in Australia, which will affect growing seasons for crops and conditions for raising livestock.

the world. Current projections are that in Australia we can expect changes in both the distribution of water available for agriculture (such as river flows) and the timing and duration of rainfall events. Higher average temperatures will increase evaporation rates and reduce moisture levels in the soil. If rainfall, water distribution and temperature patterns are altered, land use patterns will change – production may decline in existing agricultural areas.

As well as pointing to an increase in the frequency and intensity of adverse weather conditions such as flood and drought, climate change projections suggest changes in the geographical distribution of pests and diseases. For example, many weeds, pests and fungi thrive in warmer temperatures.

The combination of these adverse conditions will make the production of some cereal crops and livestock unsustainable at certain locations. Widespread adaptation, including the relocation of existing agricultural production, will be required. Also, many existing farming practices will need to change to meet the requirements of reducing carbon emissions and restoring land and water health.

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Note this down 4.2

Complete a SWOT analysis for uses of land other than food production. Some example answers have been provided (using urban development as an alternative land use).

Uses of land other than food production Urban development	
Strengths – what are the benefits of using land for urban development instead of agriculture?	**Weaknesses – what are the downsides of using land for urban development over agriculture?**
Ability to accommodate populations	Need to import more food; consumers pay higher prices for food
Opportunities – What other options could exist?	**Threats – what are the risks in not using land for agriculture?**
Cultivating vegetable patches on top of apartment blocks; community vegetable gardens	Corporations could buy land for more lucrative purposes (e.g. mining, urban development, producing biofuels, recreation)

Source 4.16 Rural land being used for agriculture

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Chapter summary

- Trends in food production place demands on land as well as fresh water resources. For example, due to the high price paid for wheat, it is a popular crop in Australia for exporting. Supermarket giants like Coles and Woolworths also influence food production which in turn places demands on the ecosystem.
- Agricultural land use puts pressure on the environment. The results include erosion, salinity, loss of biodiversity and a decline in water quality.
- Water scarcity will be an ongoing problem, particularly for countries such as Australia that have a very dry climate and low average rainfall compared to the rest of the world. Efficient use of water will become even more crucial in the future.
- Another factor impacting food production is competing uses of land including urban development, other crop production pressures (such as the biofuel industry), and recreational activities.
- Climate change is expected to have a significant impact on food production around the world. Current projections are that in Australia we can expect changes in both the distribution of water available for agriculture (such as river flows) and the timing and duration of rainfall events.

End-of-chapter questions

Short answer

1 Suggest how issues of environmental degradation might affect future agricultural production in Australia.

2 Discuss some impacts that cities and towns may have on local food production.

3 What impact do large companies have on food production? Explain using examples.

Extended response

Problem solving for sustainable development: finding a compromise between Australia's energy needs and those of agriculture, the environment and the economy

Securing energy sources such as gas in Australia is vital for the economy. Food and fibre security is also vital to Australia's future prosperity. The question is how to balance the interests of industries such as mining and energy with those of agriculture, the environment and the economy.

Divide into small groups. Use a problem-solving model to explore the issues involved with coal seam gas exploration and production,

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and evaluate solutions that would be acceptable to all stakeholders. Each group should represent the interests of one of the following stakeholders in the debate:

- coal seam gas industry
- farmers
- environmentalists
- politicians.

Step 1 – Fact finding

- List the facts relating to coal seam gas production.
- Identify where your group stands on the issue: negative, positive or somewhere in between?
- List the information you need in order to develop solutions.
- Create a list of sources where that information can be found.

Step 2 – Problem finding

- Identify all the underlying problems and issues related to coal seam gas production.
- Analyse the information and identify a major problem (or problems) which, if solved, would provide a solution for farmers and environmentalists and the coal seam gas industry.

Step 3 – Idea finding

- List as many ideas as you can for solving the problem(s).
- Brainstorm ideas, focusing on quantity rather than quality of ideas. (Evaluation of the ideas can take place at a later stage.)

Step 4 – Solution finding

- Evaluate the ideas proposed for solving the problem. As a group, debate them and decide on a hierarchy of solutions. Can any of these ideas be combined to make them more suitable?

Step 5 – Acceptance finding

- Develop a plan for implementing your chosen solution. Consider all those who must accept the solution, plan for answering their questions and decide how to convince them that the solution is appropriate.
- Present your arguments to the class and answer any questions they raise.
- Class members from each stakeholder group should ask questions of the group presenting that reflect the interests of their group.

Step 6 – Evaluation

- Were there any solutions that all stakeholders came up with?
- What were some of the disagreements between the stakeholders and why were there disagreements?
- What are some of the ways to find solutions to these types of issues that are acceptable to all stakeholders? Suggest some strategies for managing the interests of all groups.

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5 Food security

Source 5.1 A local farmer prepares to sell harvested fruit and vegetables at a floating market in Ratchaburi, Thailand.

Before you start

Main focus

As the world's population continues to grow, our natural resources – particularly food production – will be placed under pressure. It is important to address whether the world's biomes are capable of achieving sustainable food security for Australia and the world.

Why it's relevant to us

We need to be able to provide enough food for our future population, otherwise we may face famine.

Inquiry questions

- Do biomes have the capacity to produce food into the future?
- How can we predict and evaluate future demands for food?
- How do we sustainably feed the world?
- How can Australia contribute to global food security?

Key terms

- Crops
- Food production
- Food security
- Population
- Poverty
- Sustainable agriculture
- Trade barriers
- United Nations

Let's begin

The capacity of the world's natural resources to deal with an increasing human population is going to be stretched to the limit in the next 40 years. Currently, human activities use one-third to half of the global ecosystem's production such as fresh water and biomass (e.g. crops). To extend this beyond 50% is going to put enormous pressure on the world's biomes. Countries therefore need to plan for future food security, a very real concern for future generations.

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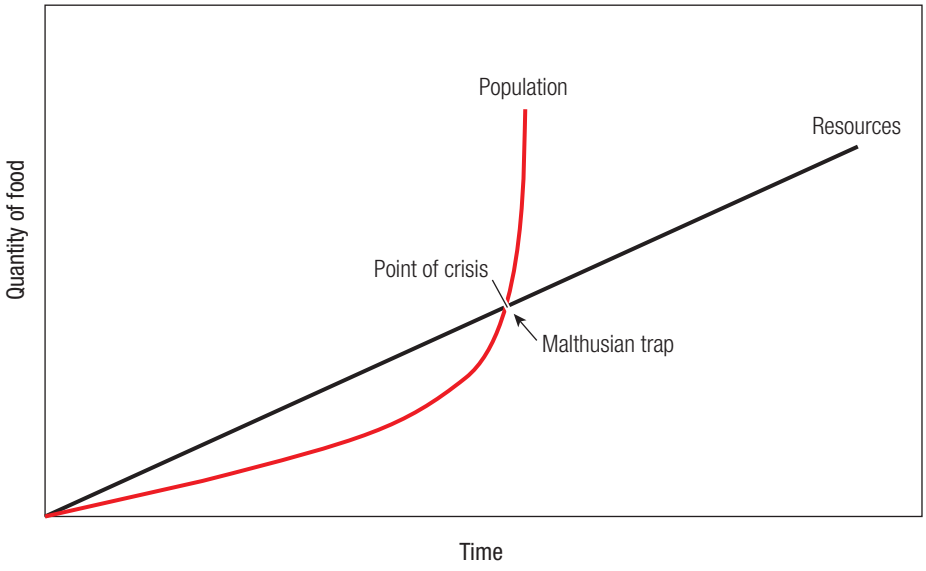
5.1 Capacity of biomes to produce food into the future

The world's population growth has been a topic of interest and concern for many years. However, the pressure it places on our world resources is not a new topic of discussion. Back in the eighteenth century, an English economist and minister of religion, Thomas Malthus, predicted that population growth would be faster than the growth of agriculture. He further proposed that the results would be disastrous, leading to potential famine and conflict, if serious action was not taken. He believed a disaster or a series of disasters would occur when the crisis point was reached.

Source 5.2 Eighteenth-century English economist Thomas Malthus



Source 5.3 Malthus predicted that a crisis point would be reached as population growth would be faster than agricultural growth. When the food requirement outgrows the food produced, that is called the Malthusian trap.

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food security when all people at all times have physical and economic access to sufficient, safe, nutritious food to maintain healthy and active lives

Over 200 years later, Malthus' prediction of food production not keeping up with population growth is proving to be correct. Governments around the world are now trying to plan for future **food security** to avoid crises, to prevent famine and importantly to prevent conflict.

Population and demand in the Asia Pacific Region (APR)

The population of Australia is projected to grow from almost 24 million in 2015 to 35 million in 2050, and the global population is projected to grow from 7.3 billion in 2015 to 9 billion in 2050, so the pressure to increase agricultural productivity is enormous. In addition, productivity will be impacted by the predicted effects of climate change: more adverse weather conditions, such as drought and floods.

The United Nations has set up the Food and Agriculture Organization (FAO) to deal with issues of world hunger and food security. The logo of the FAO is instantly recognisable. Inset in a circle which represents the globe are the letters of the organisation and the image of a stalk of wheat. It also includes the Latin phrase *fiat panis*, meaning 'Let there be bread'.

Source 5.4 Logo of the United Nations Food and Agriculture Organization, which is leading world efforts to provide food security. The Latin phrase *fiat panis* means 'let there be bread'.

RESEARCH 5.1

Geographers can divide the world into the 'haves' and the 'have nots' in relation to food accessibility. At any one time, some regions are in surplus and have enough food for their region and some left over. Other regions are in famine and people are dying because there is not enough food. Divide your class into groups so that some groups examine areas of food shortage and others examine areas of food surplus. When researching your topic, select relevant questions from the list below.

- How are regions identified as being affected by famine?
- Where are these regions?
- Have these regions always been affected by famine?
- Why is famine occurring in these regions?
- Where are the areas of surplus?
- Have these regions always had a surplus?
- Why do these regions have a surplus?
- What is stopping the areas of surplus sending their surplus to areas affected by famine?

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According to the FAO, the Asia Pacific Region (APR), which includes Australia, Asia and Russia, holds half the world's population with approximately 4 billion people. Of those, 490 million go hungry every day. The good news is that the APR is successfully reducing the number of undernourished people, with the proportion of those suffering from hunger dropping from 20% in 1992 to 12% in 2015. However, the APR is still home to the most people suffering hunger in the world, with 62% of people with chronic hunger worldwide living in the region.

Source 5.5 Locals outside a temple in New Delhi, India waiting for **alms** including food

alms food, money or other goods given to the needy as charity

Activity 5.1

Prepare a presentation on the topic of famine. Research and select an event from the FAO in Emergencies website (a useful page is 'Crisis in the Horn of Africa'). Be sure to answer:

a When and where did the crisis take place?

b How did it occur?

c What were the outcomes?

d What was the short-term response from government and aid agencies?

e Were there any long-term strategies put in place to prevent it from recurring?

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5.2 Population projections to predict future demand for food

Apart from during the early period of European settlement at the end of the eighteenth century, when the colony almost starved, Australia has managed to provide the food and fibre requirements of its population and have a surplus to export. Today Australian farmers produce over 90% of Australia's daily domestic food requirements and approximately 60% of their total agricultural production is exported. In the global market Australia contributes 1% of all food consumed in the world and feeds about 40 million people outside Australia each day. Australian agriculture has always been at the leading edge of innovative practices and technological advances and it must maintain this position if it is to continue to provide food security for both Australian and global communities.

According to the FAO, the APR generates about one-third of the world's **Gross Domestic Product (GDP)**. GDP refers to the monetary value of all the finished goods and services completed within a country's borders. The APR is also the world's biggest producer of cereals, fruits, vegetables, fish and meat.

Gross Domestic Product (GDP) the monetary value of all goods and services produced by a country

Geographical fact

China manages to feed 20% of the world's population using only 9% of its **arable** land. It has also increased its cereal production and is the world's biggest exporter of fish and fish products.

arable land used or suitable for growing crops

Source 5.6 Farming of wheat in the Yunnan province of China, and a fisherman in Macau drying fish

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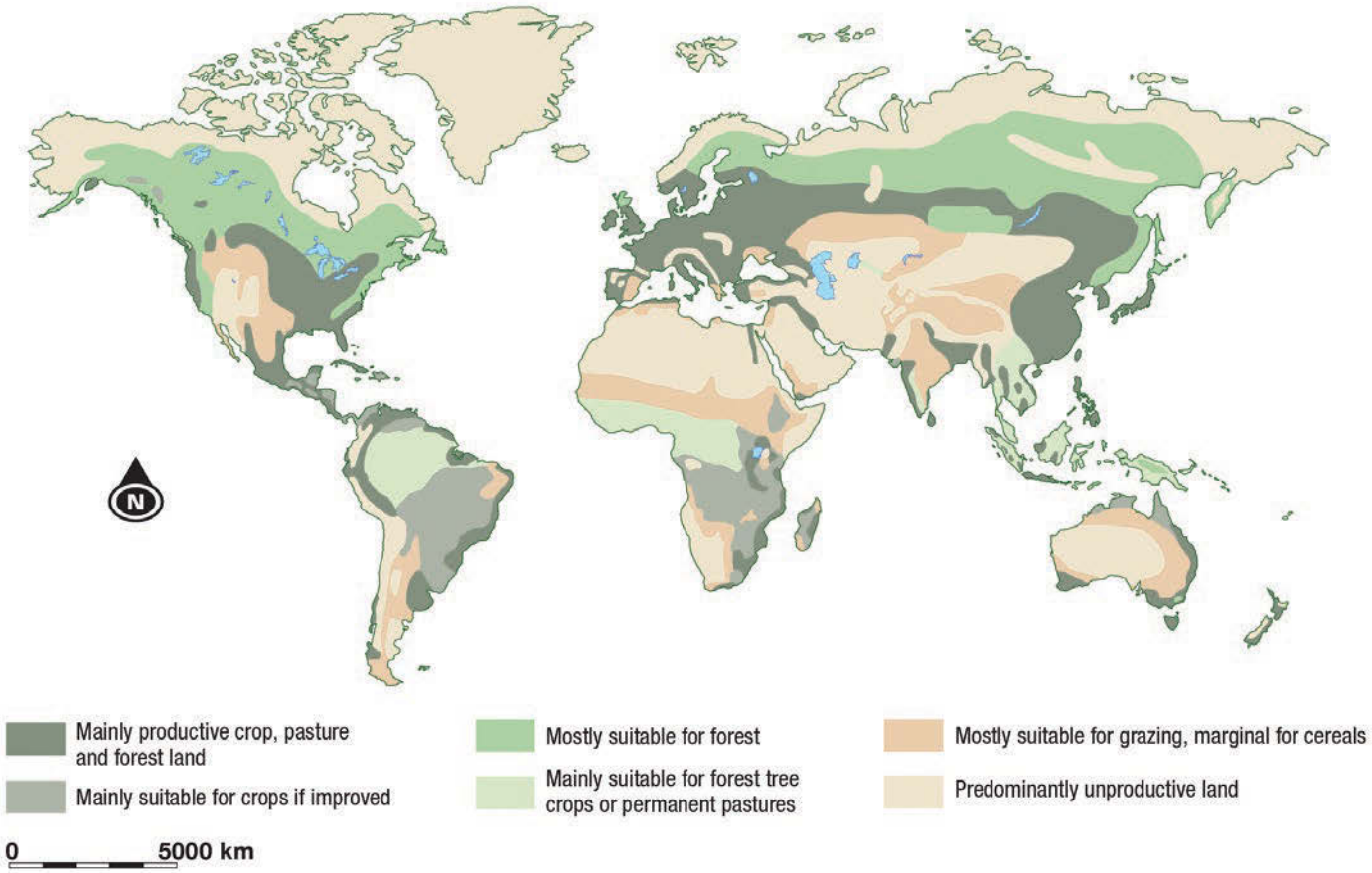
The world's potential

On a global scale, the amount of cultivatable land in the world is finite. That means there is only a certain amount and we need to not only look after it, but also put input into it to maintain its quality.

The United Nation's FAO has released a map (Source 5.7) showing their perception of what the world's current land area could be used for.



Source 5.7 World potential land use capabilities

According to this map, the land suitable for food production is unevenly distributed across the world. Some countries have no arable land reserves, such as Tunisia in North Africa, whereas other countries have an abundant amount, such as Brazil in South America. So while some countries can produce a surplus of food, others struggle with insufficient resources.

Another trend that is going to put enormous pressure on global agriculture is the growth of the middle class in places such as China and India. As these nations become more prosperous, the demands on food production change. In the past, the levels of calorie consumption in these countries have been well below the levels of western nations such as Australia and the United States, and their diets have been based on staple foods such as rice.

However, as prosperity increases, dietary habits change and levels of consumption increase. One of the areas of consumption

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Source 5.8 Tunisia in North Africa is mostly arid and semi-arid and lacks arable land reserves.

Source 5.9 Brazil has a great deal of rainforest and arable land capabilities in comparison to Tunisia.

increase is animal protein products such as meat and dairy. As it takes much more energy and resources to produce a kilogram of meat than it does to produce a kilogram of rice, the extra demands on agricultural production are going to be enormous.

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Source 5.10 Here we see many terraced rice paddies in Yunnan Province, China.

Activity 5.2

1 What percentage of the world does Australia feed each day?

2 List some of the types of products that the Asia Pacific Region is known for producing.

3 As nations like China and India become more prosperous, the demands on food production will change. As a class, discuss whether or not rice will remain a staple crop in nations as they become richer.

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5.3 Sustainable practices used to achieve food security

Improving food security will not only keep those living rurally employed, but also keep food prices stable, so that all people, regardless of socio-economic status, can afford to buy. This would be the ideal situation for the future.

Greater management of both natural and agricultural resources is going to be needed if we are to secure food production over the next 40 years. Some of the strategies required are:

- protection of existing natural ecosystems to ensure the health of natural processes and maintain biodiversity; this means reducing the current rate of land clearing
- restoration of degraded land and water resources
- widespread development of more sustainable agricultural practices
- reduction of carbon emissions from human activities
- greater environmental and resource management of other land use industries, such as mining
- greater control over urban development and the spread of cities that are encroaching onto farming land.

These challenges are going to be difficult in light of present trends in both industry and human development. One such trend is the increasing demand for biofuel production in the developed economies of the world as they seek alternative (renewable) sources of fuel. The biofuel industry, which converts organic products such as corn or sugar cane to fuel, is competing with food agriculture for the use

Source 5.11 Greater management of both natural and agricultural resources is going to be needed if we are to secure food production over the next 40 years. Here we see rice grain threshing during harvest time in northern Thailand.

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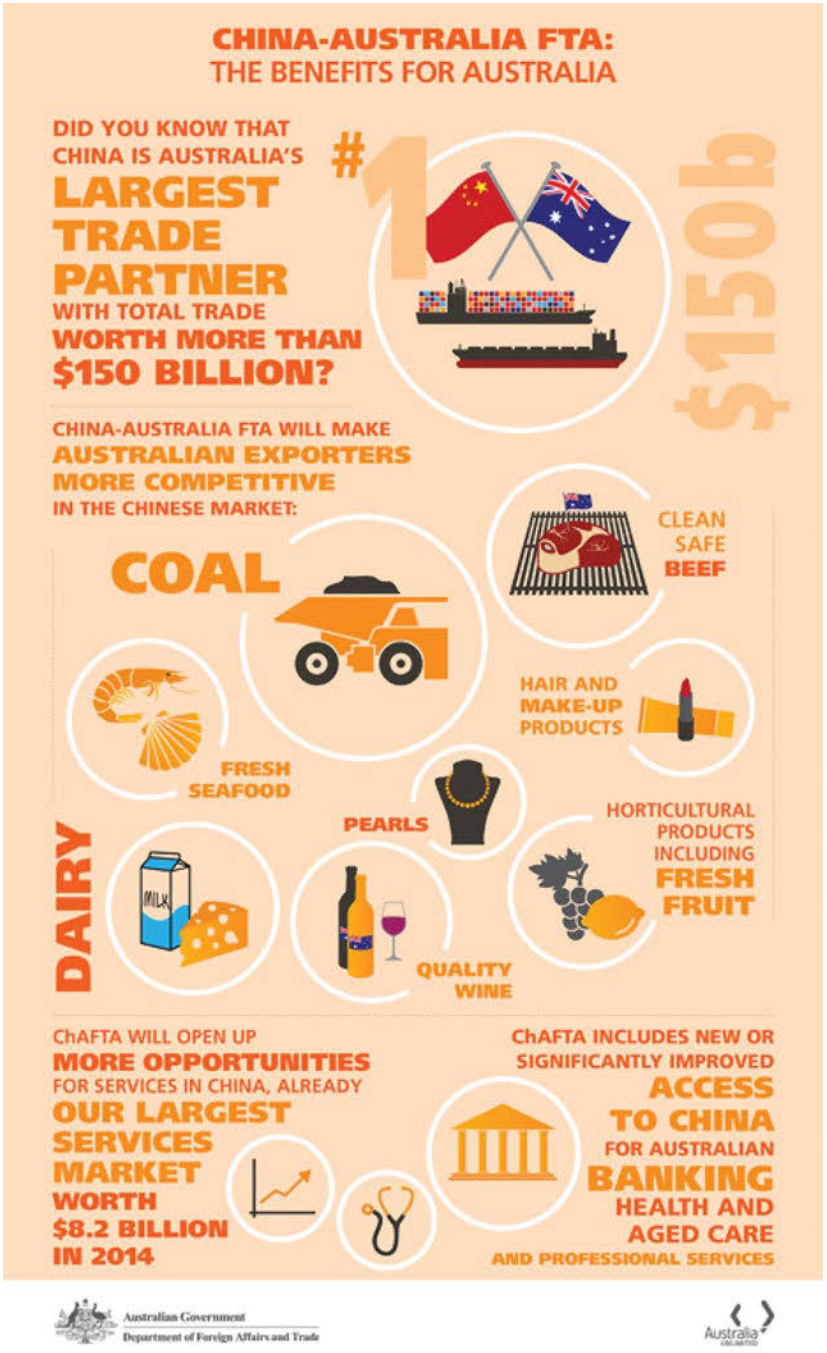
of arable land. The demand is being driven by the increasing cost of oil and the need for countries to secure energy resources while there is political instability in the oil-producing nations of the world.

Government policies

As the issue of food security grows, the responsibility of governments becomes greater. They will need to carefully regulate how food is distributed to their population and ensure that there is a fair system of distribution and trade. Proper government regulation ensures that monopolies and corruption are prevented. There are already government policies in place known as trade barriers.



Source 5.12 Australia's Trade and Investment Minister and China's Commerce Minister signed the China–Australia Free Trade Agreement in June 2015. China is Australia's largest export market for both goods and services, and according to the Department of Foreign Affairs and Trade (DFAT), the FTA will provide many economic benefits for our nation.

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Free trade

Trade barriers become a concern as the issue of food security grows. Ideally, it would be useful for the world's population if there were **free trade** of food products.

free trade no trade barriers, no tariffs to be paid; international trade left to its own natural course

Australia currently has free-trade agreements (FTA) with China, Korea, Thailand, Malaysia, Singapore and Chile. Australia also has bilateral economic agreements with other countries such as Japan and New Zealand, whereby preferential treatment is given to each of the partners' imports, and trade barriers are decreased.

There are many advantages to free trade. Free trade results in competition between producers so that consumers have greater choice and better prices. It also allows producers to trade in a wider market, produce more and therefore make a greater profit. However, some developing countries do not believe free trade would be fair, as due to a lack of infrastructure all they can offer is a cheap labour force, and as there are so many workers, their salary remains low as they are competing with each other.

Source 5.13 Australians love their coffee. Currently Australia imports around $590 million of coffee each year.

Geographical fact

There is a global positive impact of Australia buying a lot of coffee from overseas, as many of the leading coffee producers are developing countries. Coffee is a very important crop for them as it makes a significant contribution to their economy and provides jobs.

Activity 5.3

1 Debate the pros and cons of free trade agreements. As one example, what might be some advantages and disadvantages for Australian farmers of a free trade agreement with China?

2 Identify on a world map the regions in which coffee is grown. What type of biome is coffee grown in?

3 Research and list what Australia's top 10 food imports are. Identify what each product is, where it is produced and its monetary value.

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5.4 Potential for Australia to contribute to global food security

As a 'global citizen' and willing participant in numerous international forums, Australia has an obligation to contribute to global food security.

Sustainable agriculture in Australia

Agriculture in Australia has changed dramatically, particularly in the last 60 years. Two of the drivers of this change have been a real need for increased production because of population growth and an ideology that says that progress and productivity are intrinsically good things. In basic terms, for farmers this means making two blades of grass grow where one grew before. As we have seen, food and fibre production and distribution soared through most of the twentieth century, through technological and scientific developments; the expansion of agricultural enterprises and supporting industries, such as the chemical and seed industries; and increased land clearing. These developments have allowed farmers – and there are now fewer of them – to maximise productivity and reduce their labour costs (by getting more machines to do the work) at the same time.

Although these changes have had many positive effects, including almost quadrupling crop yields in some cases, and have reduced many risks in farming, such as dealing with the unpredictability of Australia's variable climate, there have also been significant environmental costs and social costs.

Environmental costs include:

- land and water degradation
- pollution
- biodiversity loss
- increased energy consumption of non-renewable sources such as oil.

Social costs include:

- economic decline of rural communities: greater unemployment leading to less money being spent in country towns
- reduction in the rural workforce as people leave the country to work in the cities
- relative decline in the wages of farm workers
- ageing population of the farming community.

Coupled with these costs are the threats that a changing climate poses to future agricultural productivity. There is a possibility that current agricultural regions will become unsuitable for the type of farming that is currently being practised there.

Over the past 20 years there has been increasing concern that current forms of agriculture are not going to be sustainable over the longer term. As a result, there is a movement towards more sustainable agriculture. This is based on the principle that we must meet the needs of the present without compromising the ability of future generations to meet their needs.

Sustainable agriculture requires an understanding of the relationship between agriculture and natural **ecology** and the management of that relationship. Sustainable agriculture will:

sustainable agriculture farming that is conducted in a way that preserves resources

ecology the way in which everything living interacts with the world around it

- satisfy human needs for food and fibre
- enhance the quality of the environment so that it supports natural and agricultural processes, leading to healthy soil, stable landforms, clean water and greater biodiversity

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- make the most efficient use of non-renewable resources such as oil
- reduce chemical use and integrate natural biological cycles and controls into agricultural practices (such as using farm-friendly insects to control pests)
- ensure that farming operations are economically viable and support prosperous rural communities
- encourage the ethical treatment of animals and abandon high-density practices such as cage-breeding chickens
- enhance the quality of life for farmers and society as a whole.

Source 5.14 There is increasing consumer demand for free-range chickens because of concerns about the inhumane treatment of caged birds.

Responding to the need for sustainable agricultural practices

Australian farmers and rural communities have always been resilient, resourceful and innovative. Today's Australian farmers are dealing with the environmental consequences of 220 years of Australian agriculture and the impact of restructuring in the agricultural sector over the last 40 years in a number of ways:

- Farmers are now taking steps to rehabilitate the land through the assistance of organisations such as Landcare Australia, which provides advice and assistance to farmers. One of the ways to rehabilitate the land is to return areas of properties to natural habitats. This promotes biodiversity, and the natural vegetation helps return the watertable to manageable levels so that salinity can be kept in check.
- There is better management of irrigation water allocations in river systems such as the Murray–Darling, which helps ensure that there is adequate water for environmental flows which keep the river system and the wetlands healthy.
- Natural wetlands are being restored. They act as buffers, intercepting sediment and nutrient flows in the rivers and streams so that water quality is maintained.
- There is a growing awareness of the value of the native food or 'bush tucker' industry as a sustainable industry.
- There is a growing understanding of the use of fire to keep native grassland areas in Australia's arid and semi-arid zones healthy and provide sustainable fodder for the cattle industry in these regions. These were practices developed by Aboriginal and Torres Strait Islander peoples over thousands of years prior to European settlement.
- There is increased development and use of organic farming methods – such as crop rotation and recycling of nutrients such as compost – in which no synthetic chemicals are used.
- Farmers' markets, where smaller producers sell their products, are growing in number and popularity. These markets offer consumers the opportunity to have closer contact with the producers of the foods they eat.

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Source 5.15 Synthetic chemicals are not used in organic farming.

Source 5.16 Farmers' markets, like this one in Brisbane City, are increasing in popularity in Australia.

- Rural towns are becoming more resourceful in attracting people into their communities by promoting them as tourism destinations, and through niche industries. For example, Clunes, a rural community in central Victoria, promotes itself as a destination for book lovers, and its annual book fair attracts hundreds of visitors.

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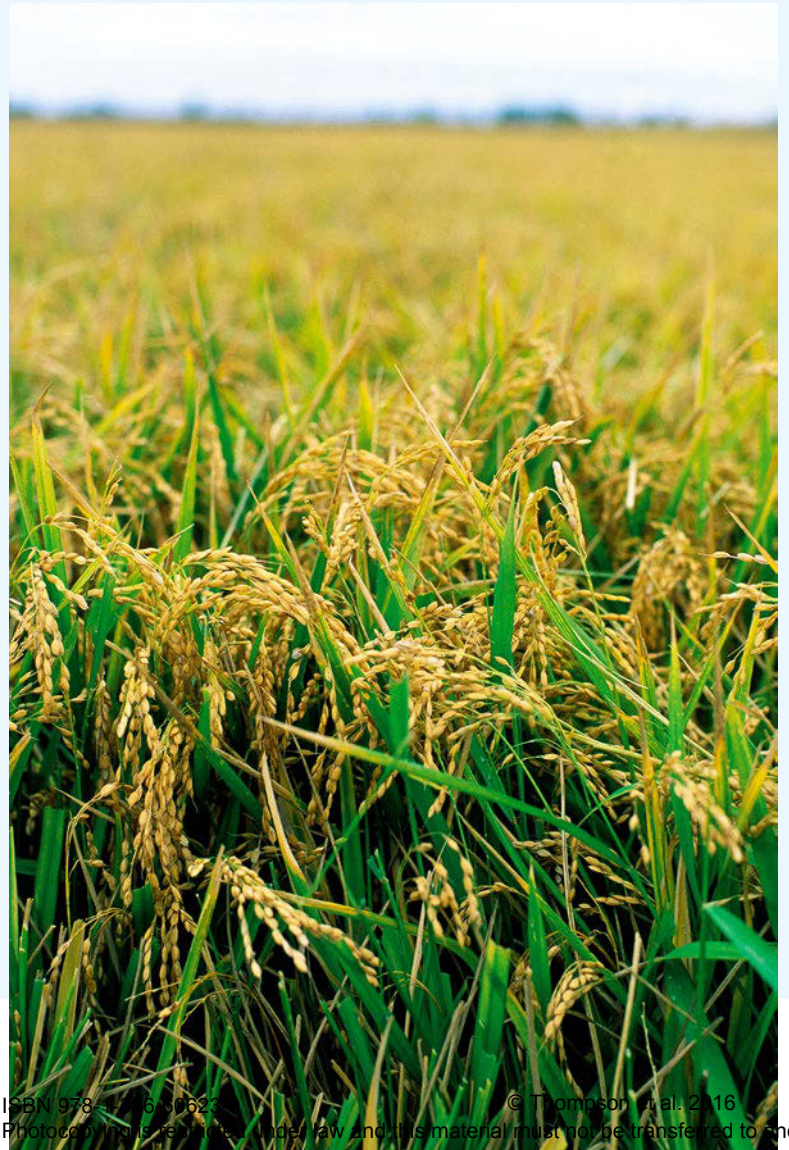
Case study 5.1
The case for rice in Australia

The two crops that most often come under question in debates about sustainable agriculture in Australia are cotton and rice. Both are water-intensive industries which, on the face of it, don't suit Australia's climatic and geographical conditions.

Rice is grown in the Murrumbidgee, Coleambally and Murray irrigation districts in New South Wales and uses waters extracted from the Murray and Murrumbidgee rivers system for irrigation. The issue of whether or not to grow rice is a complex one.

The Australian rice industry is one of the most water efficient in the world, yet it still requires significant quantities of water. Rice production in Australia uses approximately 1200 litres of water for every kilogram of rice produced. While this compares favourably with beef – it takes about 7000 litres of water to produce a kilogram of beef – the difference is that beef can be produced on non-irrigated pastures and needs only natural rainfall. Rice, on the other hand, relies on irrigation systems, which puts a burden on river



Source 5.17 Rice crop at Yenda, near Griffith, NSW

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systems and artificially introduces more water into the watertable, which increases the threat of salinity.

One of the methods of evaluating the viability of farming rice in Australia is to create a SWOT analysis. Source 5.18 is an example.

Rice production in Australia	
Strengths	**Weaknesses**
• Innovative farmers use modern techniques to increase the efficiency of production and water management • The Australian rice-growing region has a good climate for growing temperate varieties of rice • Low disease and pest problems compared with other rice-growing areas in the world • Brings in export income for Australia • Reduces the reliance on imported rice in Australia	• Heavy consumer of water • Is not naturally suited to the Australian climate and conditions • Is reliant on varieties of rice that are susceptible to cold weather and disease • The geographical concentration of rice-growing districts makes rice production vulnerable to out-break of disease or natural disaster such as flood • A relatively small player on world markets
Opportunities	**Threats**
• High-quality product that is in demand overseas • Can limit production during periods of drought or water shortage and cultivate other crops • Water use efficiency and reduction of environmental impact through increased research and development • Industry's strong environmental record can provide a positive image to Australians	• Climate change • Increased salinity and biodiversity loss • Negative image for the industry because of sustainability issues • Reduced competitiveness against cheaper overseas production • Pest and disease resistance to herbicides and pesticides

Source 5.18 Australia's rice-growing SWOT analysis

1 Why should or shouldn't Australia produce rice?

2 Outline the main challenges to rice production in Australia.

3 Explain why some alternative crops might be better suited to the climate.

Source 5.19 Australian-grown brown rice grains

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Agricultural productivity in Australia

Agricultural productivity in Australia is constrained by significant geological and climatic factors, as well as pressures from alternative land uses such as urban development. Of all the inhabited continents, Australia is the driest. It also has some of the Earth's oldest, shallowest and most weathered and infertile soils, making vast areas of Australia unsuitable for intensive agriculture. Over 70% of Australia's land area receives low amounts of rainfall and is classed as either semi-arid or arid. Of the 7.6 million km² of total land area, barely a tenth is suitable for sown crops and pastures, and much of that only after the addition of fertilisers or the use of other soil-improving practices such as the planting of pasture **legumes** (which fixes essential nitrogen to the soil). Australia does have areas of naturally fertile soil, such as in the Wimmera area of Victoria and the Darling Downs region of Queensland, but these are not extensive compared with the deep, fertile soils of the North American prairies or Ukraine in Eastern Europe.

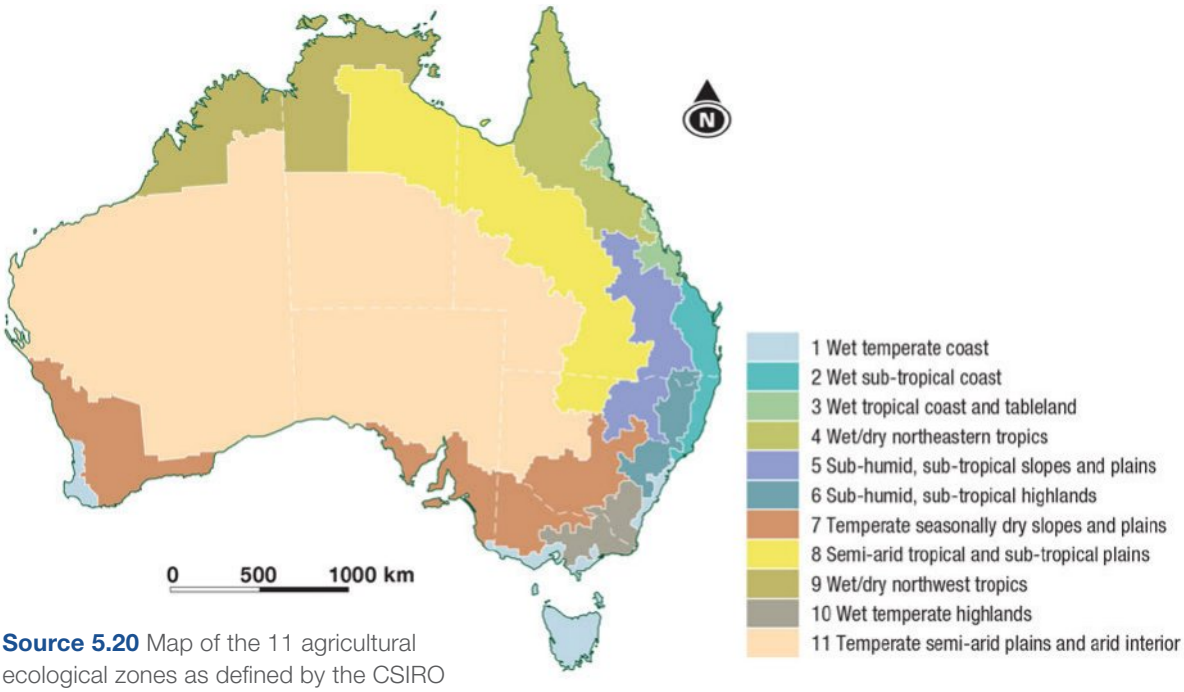
legume a type of plant, such as clover, soybeans and lupins, that carries nodules on its roots; working with certain bacteria, legumes are responsible for the fixing of nitrogen in the soil

Australia is also one of the most urbanised countries in the world, with almost 90% of the population living in towns and cities and most of these within 100 km of the coast along the southwestern, southern and eastern regions of the continent, where the soils are more fertile and rainfall is more abundant. Continual urban expansion is one of the pressures that agriculture is facing in Australia, as more and more land is being claimed for urban development.

Australia's agricultural regions and capability to produce food

Land and water are essential for agriculture. It is very useful for the future of Australia, therefore, to understand the geography of Australia and the potential for future food production.

The CSIRO has identified 11 agricultural regions in Australia, based on soil type, land features, climate and ecology, as shown in Source 5.20.



Source 5.20 Map of the 11 agricultural ecological zones as defined by the CSIRO

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Australian region		Climate	Food production/agriculture
1	Wet temperate coast	Predominantly wet and cool to warm	Dairy, intensive cropping, beef grazing and **horticulture**
2	Wet sub-tropical coast	Warm and wet with rainfall throughout the year, but more dominant over summer	Dairy, beef grazing, intensive cropping (including sugar cane) and horticulture
3	Wet tropical coast and tableland	Hot and wet with temperatures generally consistent. Rainfall over most of the year with occasionally a short dry period over summer	Beef grazing, intensive cropping and sugar cane
4	Wet/dry northeastern tropics	Hot and rainfall is summer dominant, with the winter dry	Beef production, but sugar cane, rice and other intensive agricultural production occur
5	Sub-humid, sub-tropical coasts and plains	Hot summers and mild winters with uniform rainfall throughout the year tending to summer rainfall in the north of the zone	Wheat, sheep, cattle farming and oil seed
6	Sub-humid, sub-tropical highlands	Warm, with cool winters. Rainfall is uniform throughout the year, but tends to be summer dominant in the northern areas	Sheep and cattle, irrigated areas support horticulture
7	Temperate seasonally dry slopes and plains	Hot summers, cool winters and good winter dominant rainfall	Known as the 'heartland' of Australia. Cereal crops and pasture, and is a major wheat/sheep/cattle production area. Also fruit, rice and dairy
8	Semi-arid tropical and sub-tropical plains	Hot with a wet summer/dry winter in the north and warm to hot with low rainfall in the centre	Extensive cattle and sheep grazing
9	Wet/dry northwest tropics	Hot, wet summers and very dry, warm winters	Mostly cattle grazing
10	Wet temperate highlands	High rainfall zone with the elevated areas cool and wet, tending to dry and hot summers towards the inland	Sheep, cattle and dairy
11	Temperate semi-arid plains and arid interior	Warm to hot with minimal rainfall	Extensive sheep and cattle grazing

horticulture the science of plant cultivation and management of fruit, vegetables, nuts and other crops

Source 5.21 The 11 agricultural ecological zones as defined by the CSIRO

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Activity 5.4

1 Identify the regions where the more intensive agricultural industries which need fertile soils and good rainfall – such as vegetable growing – are more likely to take place.
2 List the regions most suited to wheat production.
3 Describe the distribution of beef production in Australia.
4 Imagine you are a farmer seeking to set up an agricultural enterprise in one of the regions listed in Source 5.21.
   a In what ways would the climate data help you decide the type of production and agricultural activity that could take place?
   b Discuss what other information you might need to help you make your decision.
   c Where exactly would you establish a farm and why?

Source 5.22 A windmill on the Darling Downs, Queensland; one of Australia's most naturally fertile areas

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Chapter summary

- In the eighteenth century, English economist Thomas Malthus predicted that population growth would be faster than the growth of agriculture.
- The population of Australia is projected to grow from almost 24 million in 2015 to 35 million in 2050, and the global population is projected to grow from 7.3 billion in 2015 to 9 billion in 2050, so the pressure to increase agricultural productivity is enormous.
- The United Nations has set up the Food and Agriculture Organization (FAO) to deal with issues of world hunger and food security.
- There are key challenges to future food security, including poverty, government policies and trade barriers.
- Agricultural productivity in Australia is constrained by significant geological and climatic factors, as well as pressures from alternative land uses such as urban development.
- Over the past 20 years there has been increasing concern that current forms of agriculture are not going to be sustainable over the longer term. As a result, there is a movement towards more sustainable agriculture.
- Greater management of both natural and agricultural resources is going to be needed if we are to secure food production over the next 40 years.
- The CSIRO has identified 11 agricultural regions in Australia, based on soil type, land features, climate and ecology.

End-of-chapter questions

Short answer

1 Define sustainable agriculture.

2 List the challenges to future food security around the world.

3 Analyse the relationship between poverty and food insecurity.

Extended response

Food security is a very real concern for all countries. How well placed do you think Australia is in facing the key challenges? Explain your answer referring to examples of Australia's features and characteristics that are relevant to its future in food security.

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Source 5.23 Moving cattle from one paddock to another allows the grasses in the fields to regenerate. Therefore, rotational grazing systems keep pastures more productive, and are an example of sustainable agricultural practice.

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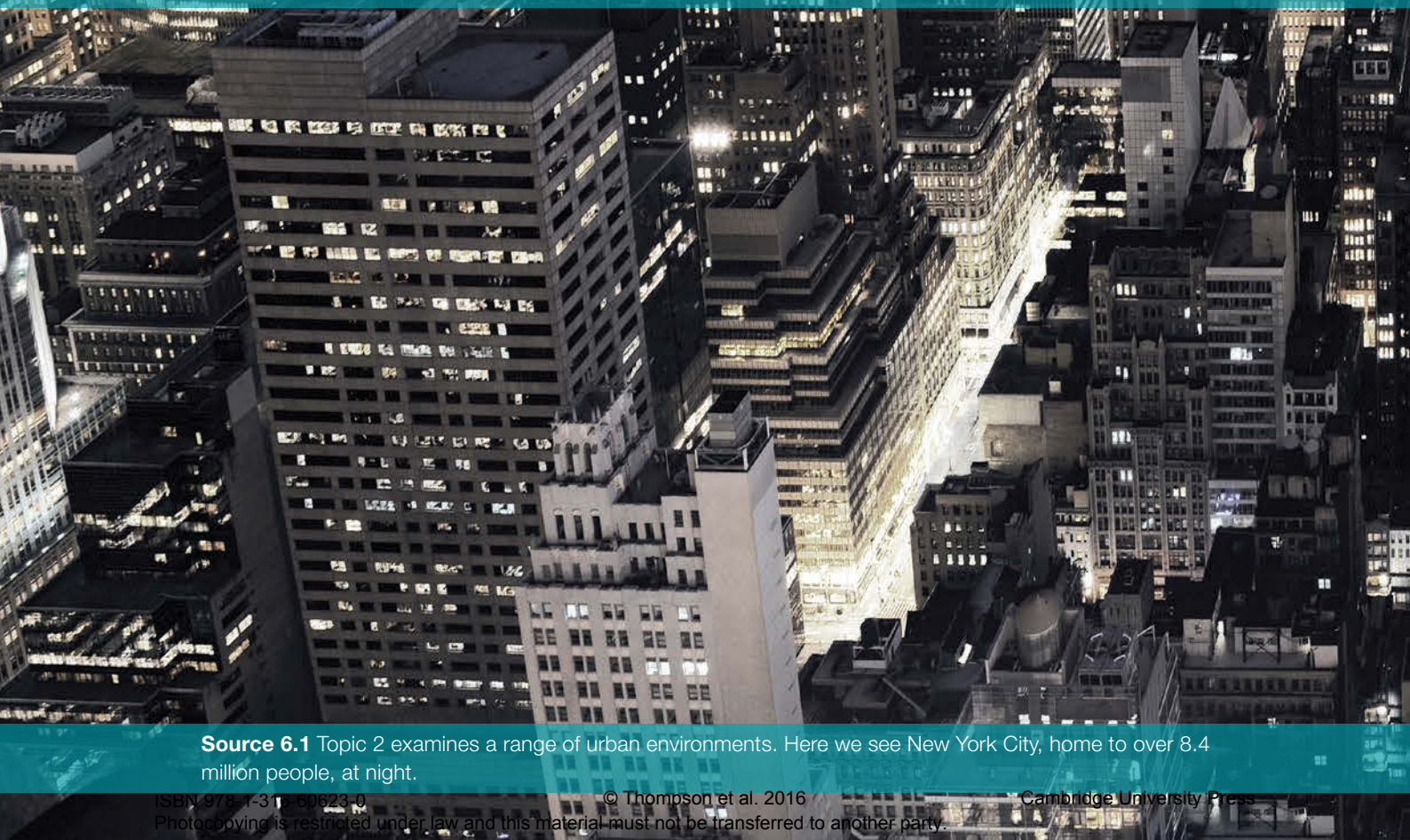
Topic 2

Changing places



Source 6.1 Topic 2 examines a range of urban environments. Here we see New York City, home to over 8.4 million people, at night.

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6 Causes and consequences of urbanisation

Source 6.2 Internal migration figures suggest more people move to urban areas than rural areas.

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 a wider choice of universities and jobs, as well as a larger variety of social activities. Others consider moving away from the city, but 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's population becomes increasingly interconnected, 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 it have on an area?
- What are the causes of urbanisation?
- What are the economic, social and environmental consequences of urbanisation?

Key terms

- External migration
- Industrialisation
- Internal migration
- Push/pull factors
- Urbanisation

Let's begin

There is a global trend of urbanisation occurring as people in many different countries begin to move from rural and remote areas into bustling city centres. There are various factors that contribute to the movement of people from rural to urban areas (for instance, rural push against urban pull), which are examined in this chapter in the context of Australia and Indonesia.

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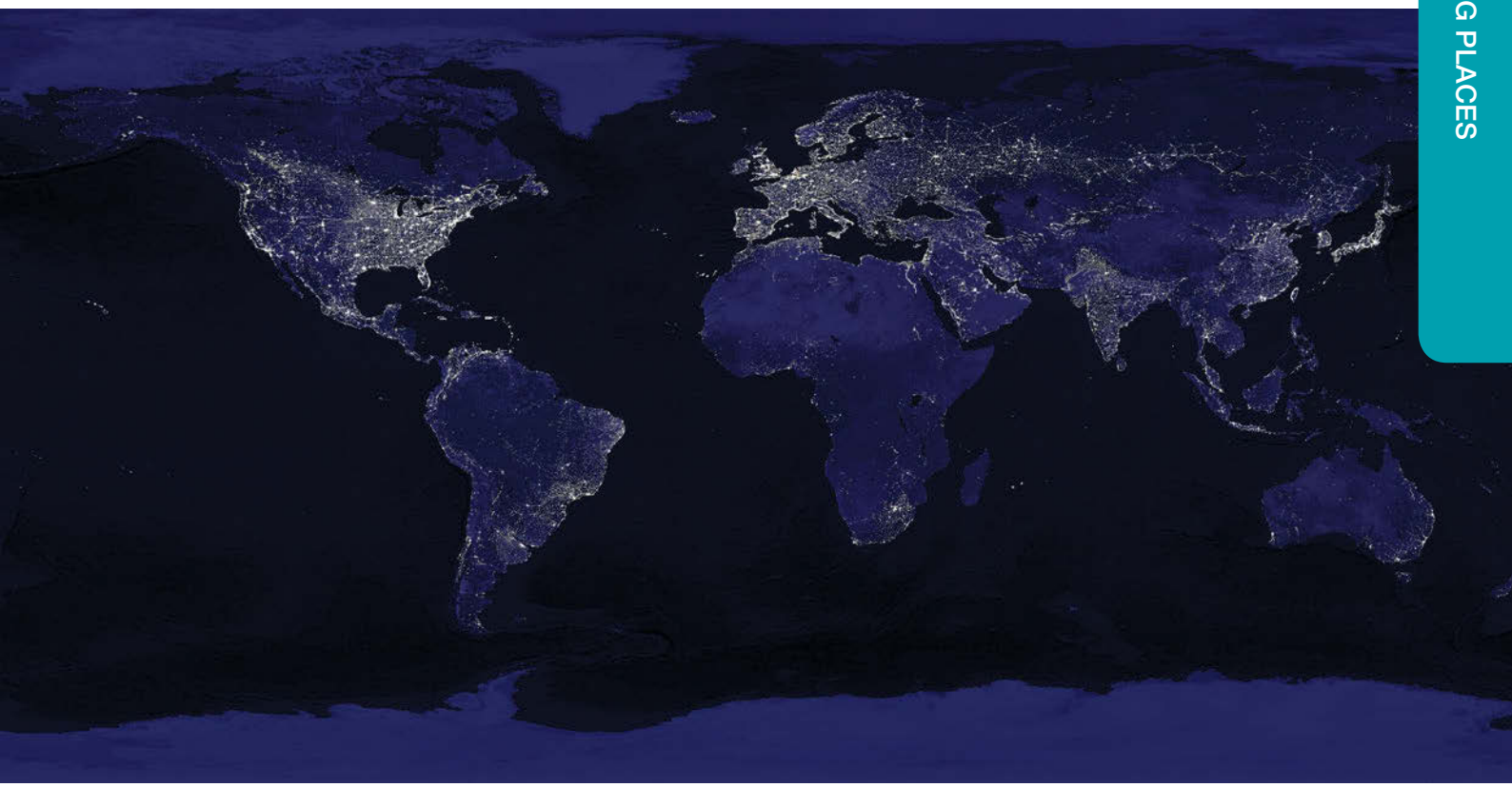
6.1 Spatial distribution patterns of urbanisation

urbanisation the process of economic and social change in which an increasing proportion of the population of a country or region live in urban areas

Urbanisation is the process whereby a population begins to shift from rural areas to urban areas. This can occur both internally (within a country), and between countries when people migrate. For example, the World Bank reported in January 2015 that almost 200 million people moved to urban areas in east Asia from 2000 to 2010. This is known as rapid urbanisation.

Over 90% of urban growth has been occurring in the developing world, adding an estimated 70 million new residents to urban areas each year. During the next two decades, the urban populations of two of the world's poorest regions – south Asia and Sub-Saharan Africa – are expected to double.



Source 6.3 A composite image of the Earth at night as seen from a NASA satellite.

Geographical fact

According to the Australian Bureau of Statistics (ABS), the percentage of people living in major cities in Australia increased from 65% in 1973 (8.8 million) to 66% in 2013 (15.3 million). According to 2015 World Bank data, 89% of Australians live in urban areas. This makes Australia the 15th most urbanised country in the world. Singapore is ranked first, with 100% of the population living in urban settlements.

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Source 6.4 All of Singapore's population lives in urban areas.

Activity 6.1

1 East Asia has experienced rapid urbanisation. As a class, discuss possible reasons for this.

2 Evaluate the accuracy of Source 6.3.

- **a** Identify where the image came from. Is it a reliable source of information? Why/why not?
- **b** Consider the sparseness of lights in the African continent. What might this suggest?
- **c** Do you believe that the concentration of lights in the image accurately represents Australia's urban population? Why/why not?

3 Consider whether you agree with the notion that there is a wider choice of educational, vocational and social opportunities in urban areas.

6.2 Causes of urbanisation

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, seven out of every 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 suggests that much of Asia's urbanisation is still to come, given global trends. Source 6.5 is useful for charting the rise of urbanisation over time.

One common reason for moving from rural to urban areas is that as young people have better access to education, they are likely to seek professional rather than rural careers. This then encourages them to move from rural areas to urban, becoming part of the urbanisation process. However, urbanisation can occur due to a range of factors, including natural population growth, migration and 'rural push'/'urban pull' factors.

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Source 6.6 Historically, people have lived on the land in rural environments like villages. In 2010 for the first time more than half the human population resided in urban areas.

Year	% of population in urban settlements
1800	3
1900	14
1950	30
2014	53
2050	70 (estimated)

Source 6.5 Growth of urban settlements around the world

Source: Information from Population Reference Bureau, including *2014: World Population Data Sheet* (USA)

Natural population growth

Urbanisation can occur due to the natural rise in population. The world's population continues to increase due to advances in medicine and better living conditions. For example, more women and children are now surviving childbirth thanks to medical progress. Due to the improvement in medicine and increased immunisation programs, more children are also surviving to adulthood, and in addition people are living longer. That is, our aged population is also increasing. This means that there are more children being born than people dying.

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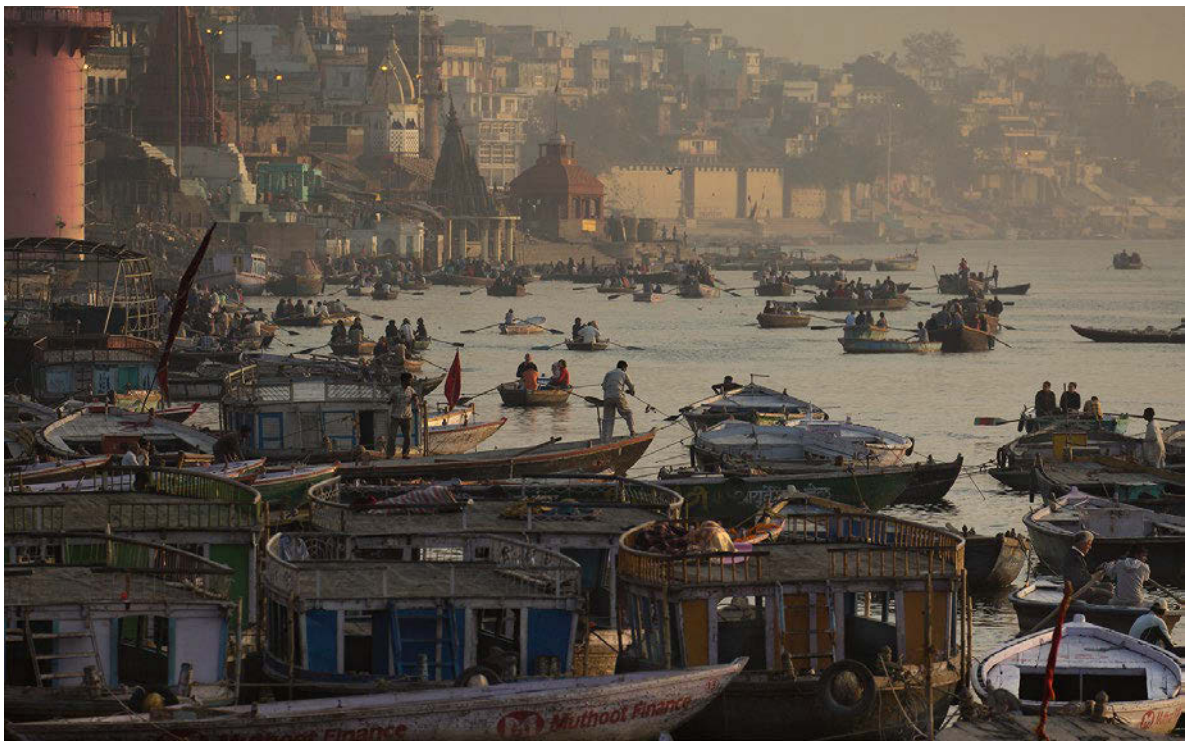
Source 6.7 Shanghai, in China, is one of the biggest megacities in the world, with an estimated population of over 24 million people (roughly equivalent to Australia's entire population).

mortality rate the number of deaths per 1000 head of population, often expressed as a ratio

According to the United Nations, the twentieth century experienced the most rapid decrease in **mortality** in human history. Globally, life expectancy at birth rose from an average of 47 years in 1950–1955 to 71 years in 2005–2013.

The United Nations *World Urbanization Prospects* (2013) expects the current world population of approximately 7.2 billion to



Source 6.8 The UN predicts India will overtake China as the most populous nation on Earth by 2029. Pictured is Varanasi.

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increase to 9.8 billion by 2050. Furthermore, the UN predicts that India's population will be the largest in the world by 2028, surpassing China, and that Nigeria's population will eventually exceed that of the United States.

Migration and push–pull factors

internal migration the movement of people from living in one defined area to living in another within a country, e.g. movement from cities to non-metropolitan coastal locations, or between states and territories

external migration migration to another country

Migration can be internal and external. **Internal migration** is when people resettle within a country; for example, when rural dwellers move into the city. **External migration** is when people move between countries – from one country to another.

A range of factors contribute to the movement of people as a result of migration. These factors are split into two key groups: push factors and pull factors. As the names suggest, push factors motivate people to leave their place of residence, and pull factors attract people to a new place.

Following World War II, Australia attracted European migrants who were looking for a better life than their war-devastated countries could provide. Disruption in some countries pushed people out of their homelands towards more peaceful areas. Wars and civil wars are clear examples of **push factors**. Other examples are poverty, **displacement**, environmental hazards and famines.

push factors reasons that force a person to leave their place of residence

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

pull factors reasons why a person would want to move to a particular area

Pull factors are forces that attract or entice a person to relocate to a new area or location. These factors generate optimism for residents who hope 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.

Australia also actively controlled who came by targeting specific skilled cohorts. Australia enticed prospective **emigrants** by

emigrants people who leave their country to permanently live in another

Source 6.9 External migration to Australia is one contributor to urbanisation.

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'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. Attractions and improvements in lifestyle such as this are known as 'pull' factors. An additional pull factor was passage assistance schemes, to which both governments (of the relinquishing and receiving countries) contributed financially to ensure the adequate movement and resettlement of people.

propaganda information used to promote a political view or perspective; tends to be misleading or biased in nature

Source 6.10 Mywaddy slums, situated along the river that borders Thailand and Burma. This is the type of area that people leave to move to the larger cities.

Activity 6.2

1 Recall two causes of urbanisation.

2 Explain why the natural population of the world is increasing.

3 Compare internal migration to external migration. What are the similarities and the differences?

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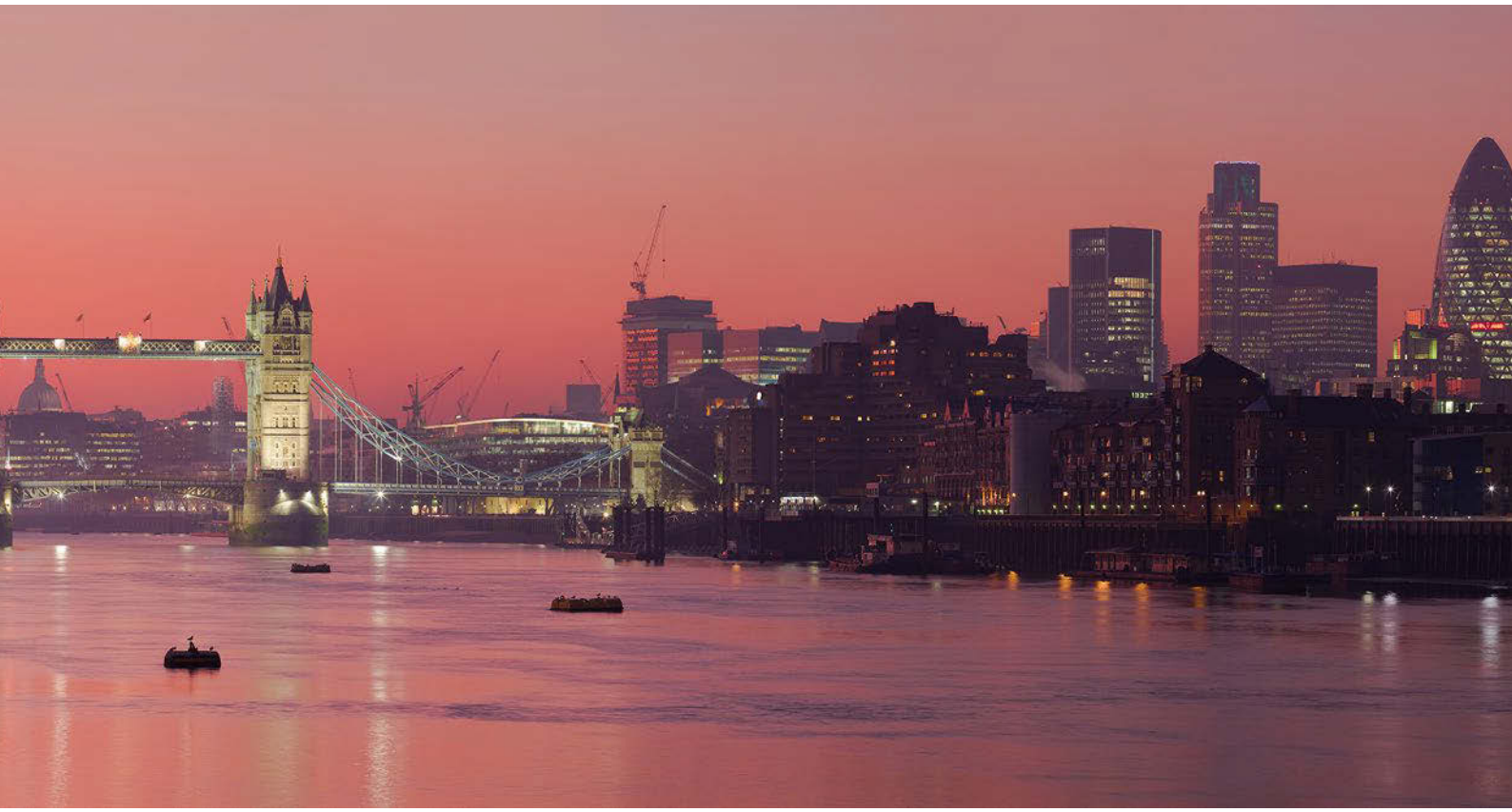
6.3 Consequences of urbanisation

Megacities are some of the most well-known cities or urban areas of the world – these are vast cities with huge populations, defined as having over 10 million people. Shanghai, Tokyo, New York and London are all examples of megacities. Megacities are the result of mass urbanisation. 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 eighteenth century.

There were 10 megacities with 10 million inhabitants or more in 1990, which were home to 153 million people or slightly less than 7% of the global urban population at that time. In 2015, according to Demographia's World Urban Areas index, there are 29 megacities worldwide, home to 453 million people or about 12% of the world's urban dwellers. Of today's 29 megacities, 16 are located in Asia, four in Europe, three each in North and South America, and three in Africa. By 2030, the world is projected to have 41 megacities with 10 million inhabitants or more.

Tokyo in Japan remains the world's largest city with 38 million inhabitants, followed by Jakarta (and its surrounding areas) in Indonesia with 30.5 million, Delhi in India with 24.9 million, Manila in the Philippines with 24.1 million, and Seoul in South Korea with 23.5 million. The rest of the top 20 megacities by population can be seen in the table on the next page.



Source 6.11 London is one of the most famous megacities in the world.

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Ranking	Megacity	Country	Population (millions)
1	Tokyo	Japan	38
2	Jakarta	Indonesia	30.5
3	Delhi	India	24.9
4	Manila	Philippines	24.1
5	Seoul	South Korea	23.5
6	Shanghai	China	23.41
7	Karachi	Pakistan	22.1
8	Beijing	China	21
9	New York	USA	20.6
10	Guangzhou	China	20.5
11	São Paulo	Brazil	20.3
12	Mexico City	Mexico	19.4
13	Mumbai	India	17.7
14	Osaka-Kobe-Kyoto	Japan	17.4
15	Moscow	Russia	16.1
16	Dhaka	Bangladesh	15.66
17	Cairo	Egypt	15.6
18	Los Angeles	USA	15
19	Bangkok	Thailand	14.9
20	Kolkata	India	14.6

Source 6.12 The world's top 20 megacities in 2015

Source: Demographia's World Urban Areas index

favela highly populated urban slum areas in Brazil

Source 6.13 Rocinha is the largest ***favela*** in Rio de Janeiro, a megacity in Brazil. About 70 000 people live in the small area of Rocinha, making it the most populous *favela* in Brazil.

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There are a range of economic, social and environmental consequences of urbanisation, as seen in Source 6.14.

Consequences of urbanisation	Positive	Negative
Economic	• Better employment prospects and higher wages • Urban businesses benefit from workers with a greater variety of skills	• Although there are better employment prospects, often there are more people moving to urban areas than there are jobs. Therefore, getting a job becomes competitive. Those who cannot get a job may live in poverty, be homeless or beg on the streets
Social	• Government leaders tend to plan effectively and consider their urban areas' diverse needs, and try to take into account future needs • Greater accessibility to services such as water, education, and health care • Opportunity for people to share resources and bond as a community	• Fertility rate tends to drop in urban areas. This could be argued to be either a positive or a negative • Traditional concept of family can change • Despite more people living in urban areas, social isolation can still occur as new residents acclimatise, having negative social impacts
Environmental	• Development of infrastructure in the urban environment • Access to new technologies in the urban environment	• **Industrialisation** tends to occur with urbanisation and subsequently the burning of fossil fuels increases. This directly relates to the rise of carbon dioxide levels in our atmosphere and speeds up global warming • Increase in air and water pollution • Pressure placed on water and sewerage systems • Traffic congestion • Deforestation due to land development and resulting loss of flora and fauna

industrialisation the process of a society moving from being largely agriculturally based to manufacturing based, often characterised by mass production

Source 6.14 The economic, social and environmental consequences of urbanisation

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Source 6.15 People going to work during rush hour in London

Source 6.16 Cities can provide educational opportunities such as the University of Glasgow in Glasgow, Scotland, and Harvard University in Boston, USA.

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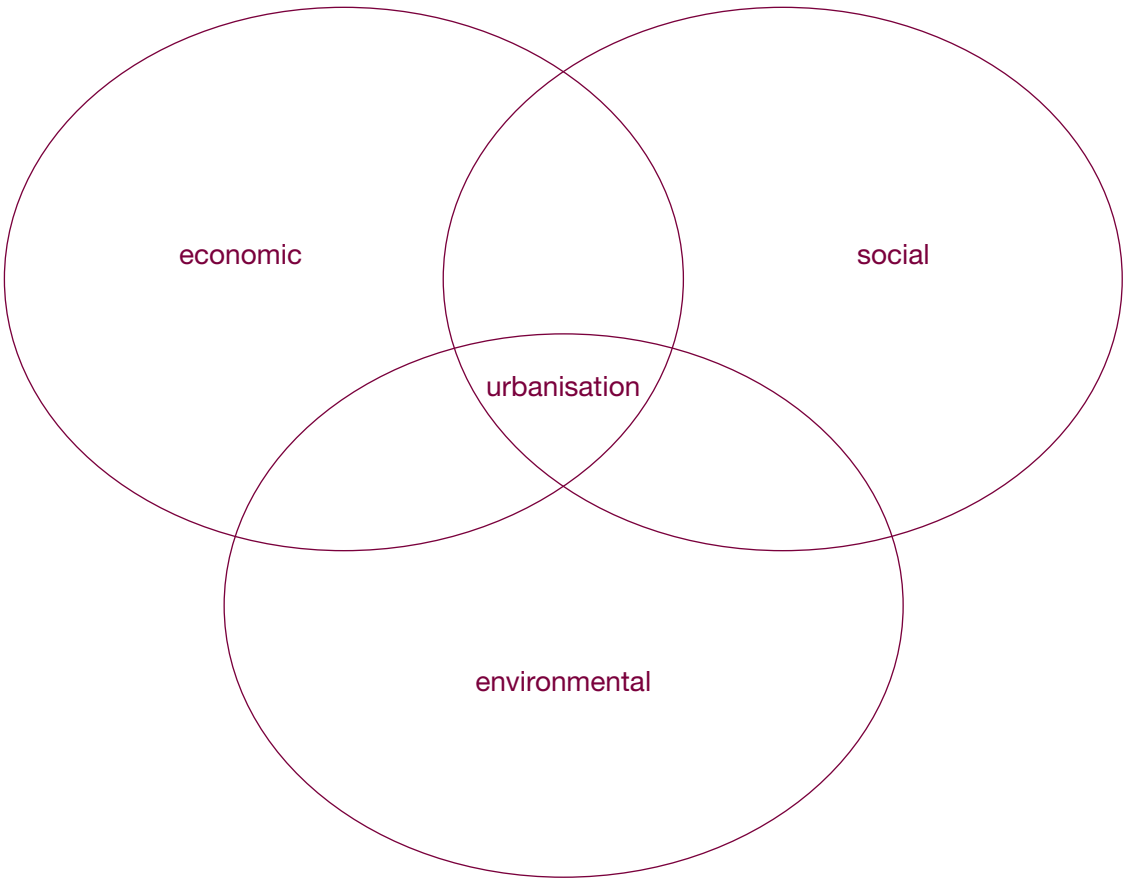
Source 6.17 The not-so-pretty reality of urbanisation is the resulting pollution – as can be seen here in Shanghai.

Note this down 6.1

Copy the graphic organiser below and explore the economic, social and environmental consequences of urbanisation.



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6.4 Investigating urbanisation in Indonesia

More than half of Indonesia's people live in cities, and the capital, Jakarta, is home to over 10 million people, with the surrounding urban areas home to many more. Indonesia has the 4th largest population in the world, after China, India and the United States, and is Australia's closest neighbour.

Indonesia: Our nearest neighbour

The nation of Indonesia is made up of over 17 500 islands, over 6000 of which are inhabited, with an area of 2 million km^2 over a 5000-kilometre span, making it the world's largest **archipelago**. It has a population of just under 247 million – more than 10 times the population of Australia. It comprises 33 provinces, 497 districts, 6651 subdistricts and 77 126 villages.

archipelago a group of islands

Source 6.18 Map of the Indonesian archipelago

Jakarta: Megacity

Jakarta, the capital of Indonesia, is one of the world's megacities. Officially, Jakarta is not a city, but rather a province with several subregions. The province of Jakarta is given special status as the capital of Indonesia.

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.

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Geographical fact

Indonesia has over 400 volcanoes, of which 150 are active. The country also has a high level of biodiversity, including the Komodo dragon, sun bears, leopards, tigers, orangutans, Javan rhinoceros and elephants, which are all found in the jungle forests.

Source 6.19 A Komodo dragon, one of the many animal species residing in Indonesia

Source 6.20 In 2015, Jakarta and its surrounding areas were home to over 30.5 million people.

ISBN 978-1-316-60623-0

Geographical fact

Jakarta's wet season is very long, running from November through to June. The remaining four months are the city's dry season.

Causes of urbanisation

One of the main causes of urbanisation in Indonesia is internal migration; that is, people moving from rural areas to urban areas. Many young people in Indonesia are choosing to move to urban areas from rural areas due to better employment opportunities. This is causing the average age of people in rural areas to increase. In 1950, 15% of Indonesians lived in urban areas. This has risen to over 50% currently, and it is estimated that by 2050 over 80% of Indonesians will live in urban areas.

Source 6.21 Many young people in Indonesia move to urban areas from rural areas due to better employment opportunities.

One of the drivers of employment and urbanisation in Indonesia is the country's industrialisation. Indonesia has developed and strengthened relationships with neighbouring countries, which has supported its economic development, particularly with the import and export of goods.

Economic, social and environmental consequences of urbanisation

Economic

There is a strong trend for Indonesians to move from rural areas to urban areas such as Jakarta, the largest city in Indonesia. Why do they move to Jakarta? Mainly for jobs. However, steady employment in Jakarta is not likely for all who move there. Sadly, more Indonesians are moving into Jakarta than there are jobs. Therefore, there are not enough jobs for all. This results in new residents, who initially are optimistic of finding a job, instead facing the reality of having to compete for the few jobs that are available and staying above the poverty line as they try to survive without an income.

The number of people living in poverty in Jakarta is not exactly known, as different government agencies have different criteria for how they measure 'poverty'. For example, the Indonesian Central Bureau of Statistics (CBS) defines poverty as being unable to afford a basket of food items and not being able to afford housing and schooling. The CBS currently reports Jakarta's poverty at 5% of the urban population. However, critics believe that this figure is inaccurate and too low an estimate.

In Jakarta, those who are poor live in informal settlements called *kampung*. *Kampung* are scattered throughout the city and have low-quality buildings on small plots of land, as well as substandard infrastructure, such as lack of proper sewerage systems and water management.

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Source 6.22 An example of a *kampung* along a polluted canal in Jakarta

Social

Socially, residents of Jakarta tend to benefit from greater accessibility to services and facilities, including education and health care. There are also more jobs available due to a busier economy. In addition, there are more opportunities to network socially with a variety of communities in the area as it is less isolating than rural areas.

Conversely, as more people move from rural areas to Jakarta, there is a negative social impact in rural areas. The average age of farmers in Indonesia is rising, and there is a risk that the knowledge and skills associated with agriculture may be lost to future generations if more youth do not stay to farm.

If people are unable to find employment, they may live in poverty in the slum areas of the city of Jakarta, which continue to grow. The poorer parts of the city are also becoming overcrowded.

Environmental

As the rate of urbanisation is rapid in Jakarta, there are environmental concerns, particularly carbon emissions, sanitation and access to safe fresh water.

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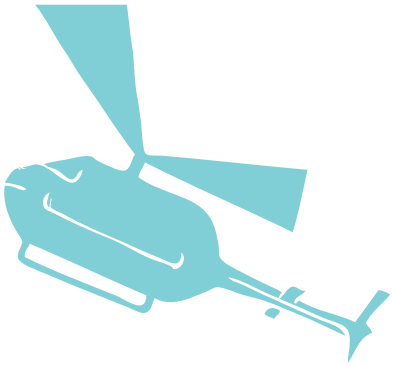
Carbon emissions means the release of carbon into the atmosphere. Carbon emissions/greenhouse gas emissions are a component of climate change. Carbon emissions are known as greenhouse gas emissions when we talk about global warming. Since the Industrial Revolution, the burning of fossil fuels has increased, which directly relates to the rise of carbon dioxide levels in our atmosphere and which speeds up global warming.

Total emissions country rank	Country	Total carbon dioxide emissions from the consumption of energy (million metric tons)	Per capita carbon dioxide emissions from the consumption of energy (metric tons of carbon dioxide per person)
1	China	8715.31	6.52
2	United States	5490.63	17.62
3	Russia	1788.14	12.55
4	India	1725.76	1.45
5	Japan	1180.62	9.26
6	Germany	748.49	9.19
7	Iran	624.86	8.02
8	South Korea	610.95	12.53
9	Canada	552.56	16.24
10	Saudi Arabia	513.53	19.65
11	United Kingdom	496.80	7.92
12	Brazil	475.41	2.41
13	Mexico	462.29	4.07
14	South Africa	461.57	9.42
15	Indonesia	426.79	1.73
16	Italy	400.94	6.57
17	Australia	392.29	18.02
18	France	374.33	5.73
19	Spain	318.64	6.82
20	Poland	307.91	8.01

Source 6.23 Top 20 countries by carbon emission. Source: Union of Concerned Scientists, 2011

Indonesia is currently the 15th largest carbon emitter in the world, with Australia the 17th. China and the United States are the biggest emitters of greenhouse gases in the world.



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Source 6.24 Urbanisation in Indonesia has a negative impact on the environment, with the country being the 15th biggest contributor of carbon gas emissions in the world.

Geographical fact

Jakarta suffers from heavy traffic and congestion on roads. To reduce traffic jams, some major roads in Jakarta have a 'three in one' rule during rush hours, when it is prohibited to have fewer than three passengers per car.

Activity 6.3

1. Does the fact that Indonesia has the 4th largest population in the world surprise you? Discuss your answer in pairs.
2. Besides Jakarta, research which other cities in Indonesia have large populations. List the 10 most populous cities in a table.
3. Create a map of Indonesia, using BOLTSS mapping conventions (explained on page 17). Colour-code the different circles that represent the location of each city, based on population. In your legend, explain what each colour means.

RESEARCH 6.1

Research 'Car Free Day' in Jakarta. What is the government trying to achieve? Create a poster advertising a Car Free Day in Australia. Would it be possible for us to do something similar in Australia? How could we make this work?

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The use of water in Indonesia is also under pressure due to the population growth, poor city planning, pollution, poverty and opposing demands for water. 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 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 the poor.

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.

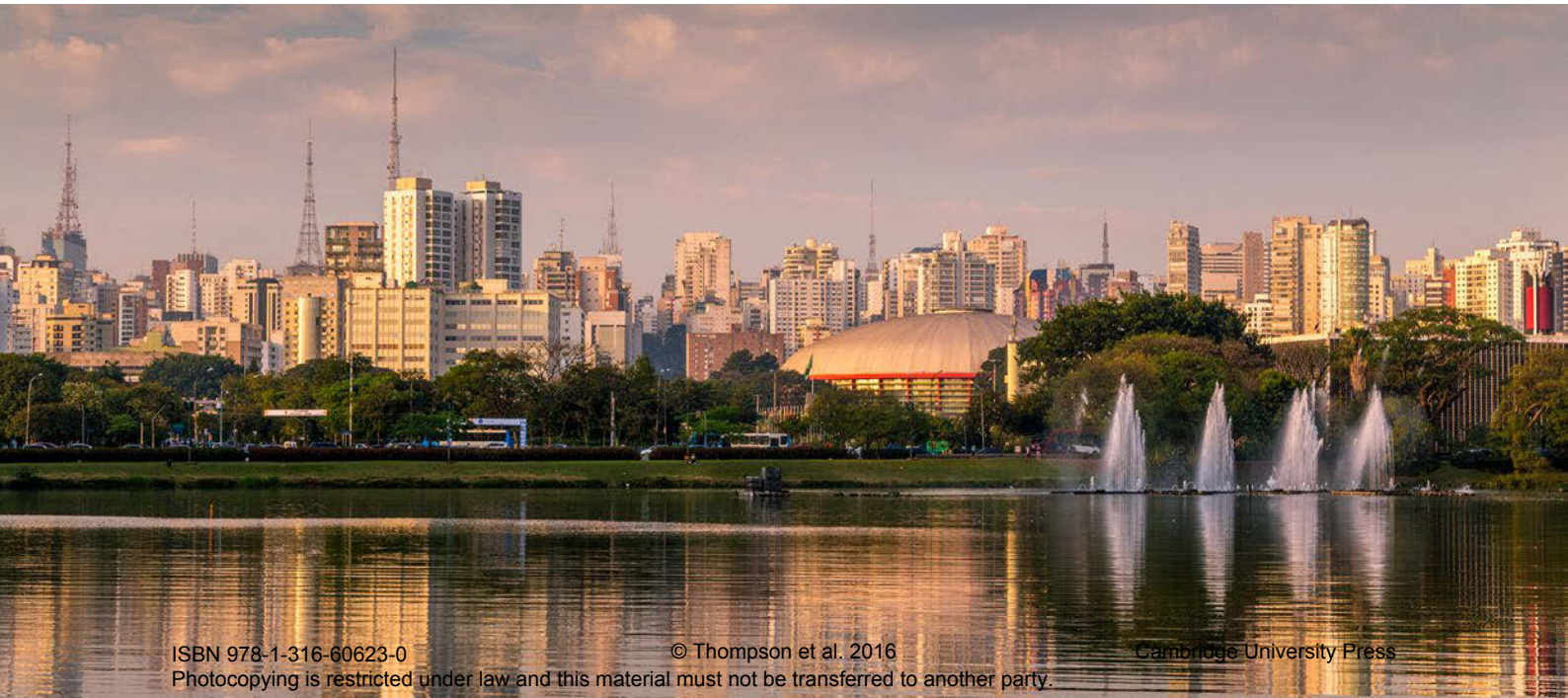
river basin the area of land drained by a river and its tributaries

Activity 6.4

Explore strategies used in other countries to manage the challenges of urbanisation. Copy and complete the table below.

Megacity	Challenges of urbanisation	Solution
Mumbai, India		
Manila, Philippines		
São Paulo, Brazil		

Source 6.25 São Paulo, Brazil



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Fieldwork 6.1

Jakarta: The birth of a megacity

In this virtual 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 images accessed via the internet, Google Earth, the State Library of NSW, an atlas and your local or school library to produce a report on urbanisation in Jakarta.

1 **Mapping over time** – Locate a map of Jakarta today, as well as maps of the city at four historical points. A suggestion would be for you to try and source maps from the years 1800, 1900, 1950 and 2010.

   a On these maps, mark and compare:
   - physical features such as rivers, nearby mountains and the ocean
   - the urban boundaries.

   b Use an overlay (tracing paper is good for this) to show the major road and rail transport networks.

   c Use a separate overlay to show an outline of the urban areas as they were in 1800, 1900, 1950 and 2010.

   d Can you see areas of Jakarta that have changed purpose (for example, from farmland to residential zoning, or from residential to industrial zoning) over time?

2 **Background research**

   a List information such as: how and when Jakarta was established as a city; the governments it has been governed by, and when; its changing ethnic and cultural composition; and its changing industrial base.

   b 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? You could present these data in the form of graphs.

3 **Virtual visit** – 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.

   a 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.

   b 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?

   c Compare public and private transport, and investigate which form of transport is most efficient for moving people to their workplaces and other destinations. What

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other factors do people in Jakarta consider when making their transportation choice? Search the internet for public transport timetables.

d 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? What does this tell you about the way the suburbs have been planned and built?

e 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 in your answer.

4 Conclusion – Write two or three brief summative statements that convey your main findings.

Field work 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
Page 4–5	**Description and analysis of graphs and photos**
Page 6	**Background information on the city**
Page 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

- Urbanisation is a process whereby people move from rural areas to urban areas.
- Urbanisation can occur due to natural population growth, migration and push/pull factors.
- The world's population continues to increase due to advances in medicine and better living conditions.
- Migration can be internal and external. Internal migration is when people within a country resettle; for example, when rural dwellers move into the city. External migration is when people move between countries – from one country to another.
- Push factors force people to leave their place of residence in search of a new place in which to live. Pull factors are forces that attract or entice a person to relocate to a new area or location.
- There are economic, social and environmental consequences of urbanisation. People and cities can benefit economically and socially. However, the environmental impacts of urbanisation tend to be negative with an increase in pollution and demands on resources.
- Indonesia has the 4th largest population in the world, with just under 247 million – more than 10 times the population of Australia. More than half of Indonesia's people live in cities.
- Indonesia's capital Jakarta is home to over 10 million people.
- One of the main causes of urbanisation in Indonesia is internal migration; that is, people moving from rural areas to urban areas.
- Indonesia has benefited economically from urbanisation and industrialisation.
- Socially, residents of urban areas in Indonesia tend to benefit from better employment opportunities, greater accessibility to services, and facilities such as education and health care.
- Environmentally, urbanisation has had a negative impact on Indonesia. Indonesia is the 15th biggest contributor of carbon gas emissions in the world.
- Many Indonesians rely on low-quality drinking water.

End-of-chapter questions

Short answer

1 Explain why Jakarta as a megacity requires an effective public transport system.

2 Describe three effects rapid urbanisation has on water supply and infrastructure.

3 Identify two primary goods and two manufactured goods exported from Indonesia and imported to Indonesia.

Extended response

Evaluate the consequences of urbanisation in Jakarta. Propose and justify a response to one of the consequences in Indonesia.

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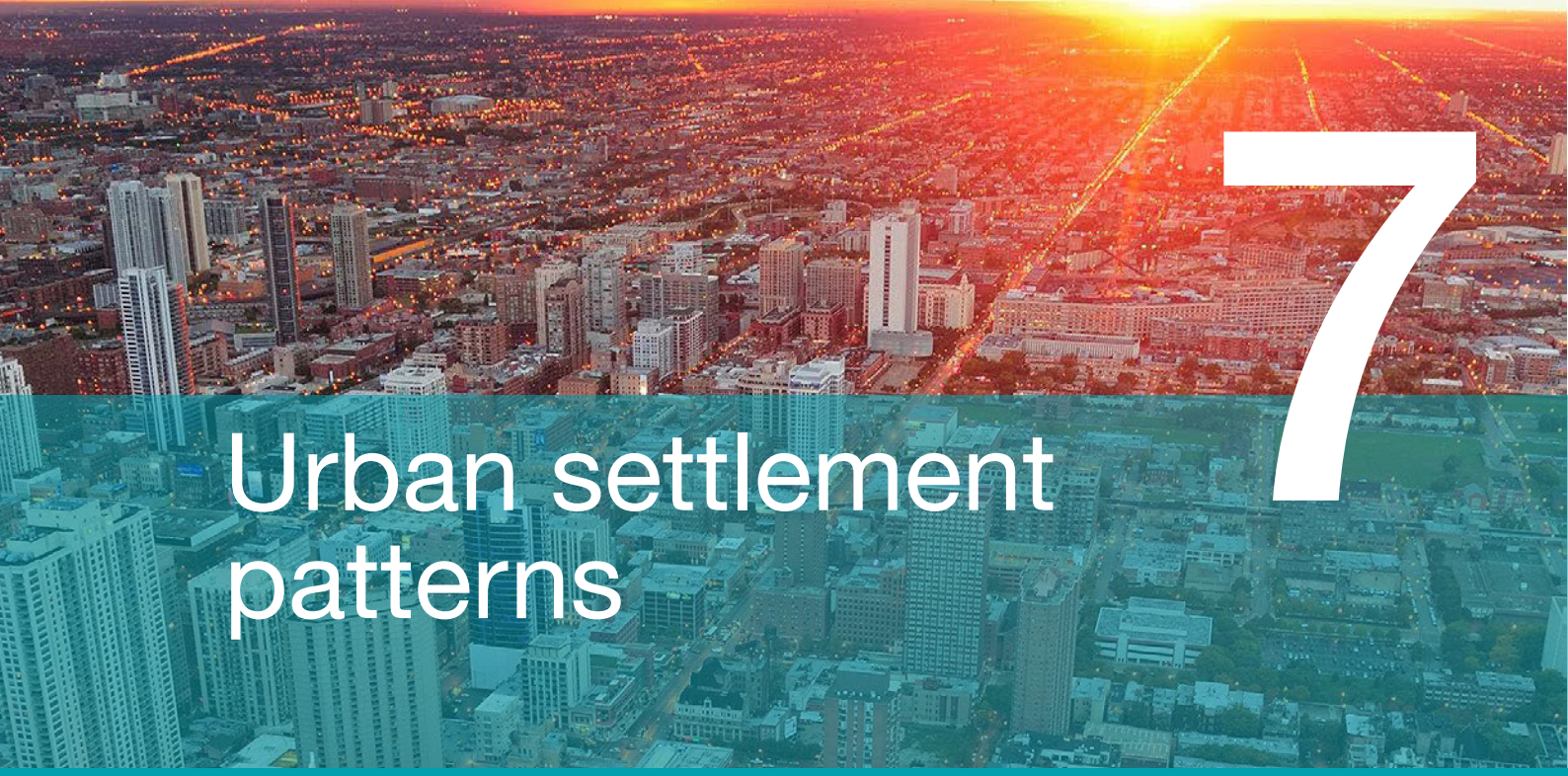

7 Urban settlement patterns

Source 7.1 Aerial view of downtown Chicago, USA

Before you start

Main focus

This chapter will discuss urban concentration and settlement patterns, focusing on Australia and the United States.

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

- Do Australia and the United States have similar patterns of urban settlement?
- What sort of factors influence where urban areas are concentrated?
- What are the consequences of urban concentrations on the characteristics, liveability and sustainability of places?

Key terms

- Agriculture
- Liveability
- Recreation
- Satellite city
- Urban concentration
- Urban settlements

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.
In Australia, some of the early colonial settlements determined the location of our metropolitan areas. Today, people in cities need transportation services, power supplies, drains and sewerage, and access to fresh water and waste disposal, often on a large scale. Our cities also need to be managed sustainably.

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7.1 Patterns of concentration

In the past, cities were important places that protected people. For example, Dubrovnik's Old City in Croatia is completely surrounded by enormous stone walls that were constructed mainly between the twelfth and seventeenth centuries, and have been well preserved to the present day. Dubrovnik's ancient city walls were built to enclose the city and deter would-be invaders.

urban settlements distinct areas where people live and work

Today, however, cities are just one of a wide variety of **urban settlement** types. 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.

The following diagram (Source 7.3) illustrates the different types of urban settlement from smallest to largest.

Source 7.2 Old City's walls, which still stand today, were designed to protect Dubrovnik, Croatia, against invasion from enemies on land and sea.

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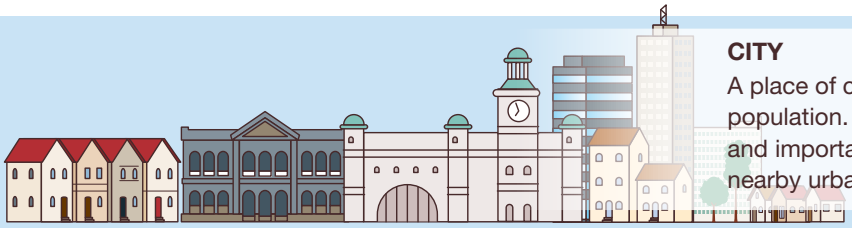
HAMLET
A settlement that is smaller than a village. Found in rural areas. Not many services provided

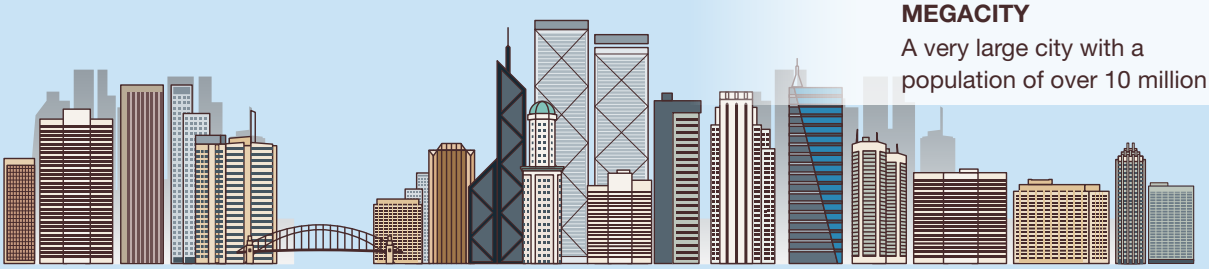
VILLAGE
A group of houses and commercial buildings. Small population, found in rural areas. Smaller than a town

TOWN
Has its own name and local government. Provides a variety of limited services such as doctors, schools and banks



CITY
A place of commerce, culture and population. It is of a significant size and importance compared to nearby urban places

METROPOLIS
The capital city of a country or region. Very dynamic, has universities and large medical facilities. The population is high and there is urban sprawl



MEGACITY
A very large city with a population of over 10 million

CONURBATION
An extended urban area that is made up of several towns combining with the suburbs of one or more cities

Source 7.3 There are a variety of urban settlements, ranging from a tiny hamlet to an enormous conurbation.

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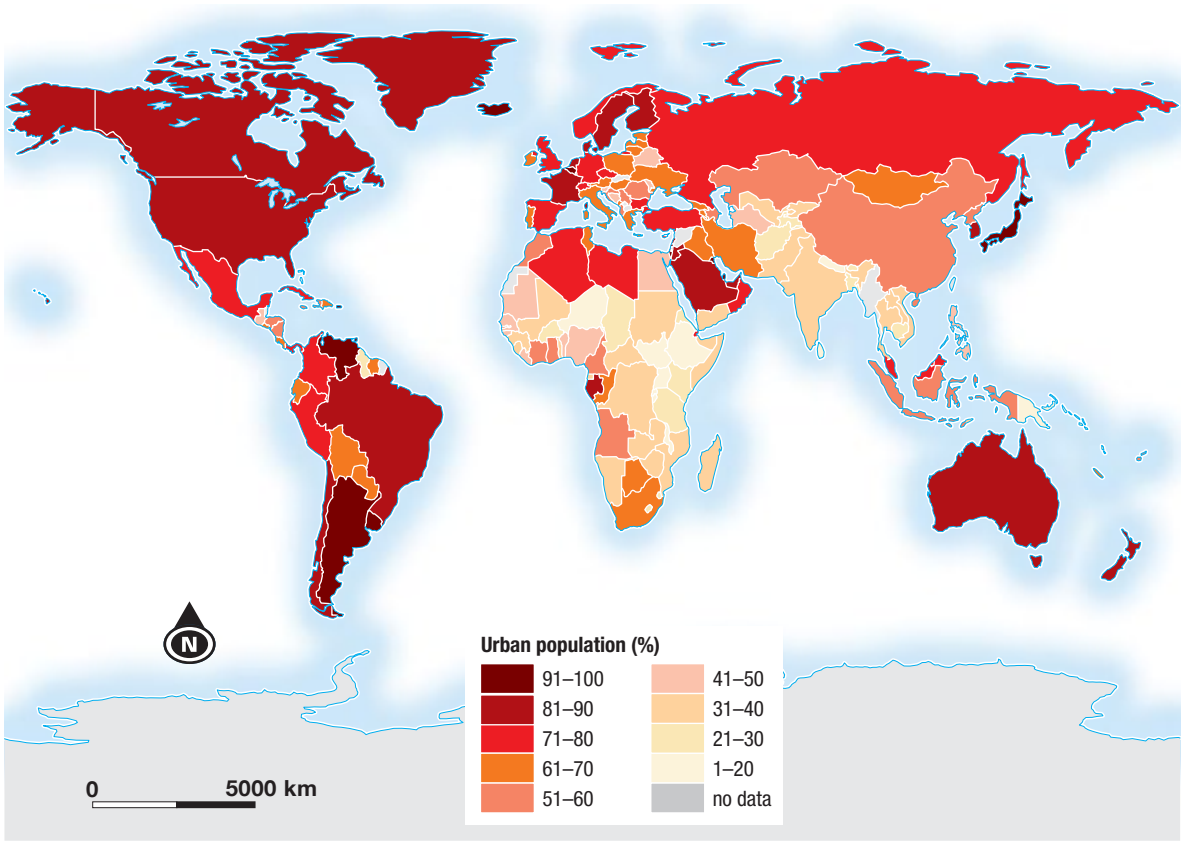
Activity 7.1

1 Discuss in class the types of urban settlements students have lived in. Referring to Source 7.3, how many of the seven different urban settlement types have people in your class lived in?

2 Name three settlements for each of the seven urban settlement types.

3 Check your examples for Question 2 on the internet. Did you categorise your suggested locations correctly?

4 Is Jakarta a megacity or a conurbation in your opinion, and why?



Source 7.4 World urban population map, 2015

Throughout this chapter, we will study urban settlement patterns in both Australia and the United States of America. To begin, let's look at the location, population size, distribution and major landform features of the urban settlements of both nations. As you can see from Source 7.4, both nations have high urban populations.

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Australia's population distribution

According to the Australian Bureau of Statistics (ABS), Australia's population in February 2015 reached 23.7 million. This ranked Australia as the 52nd 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.

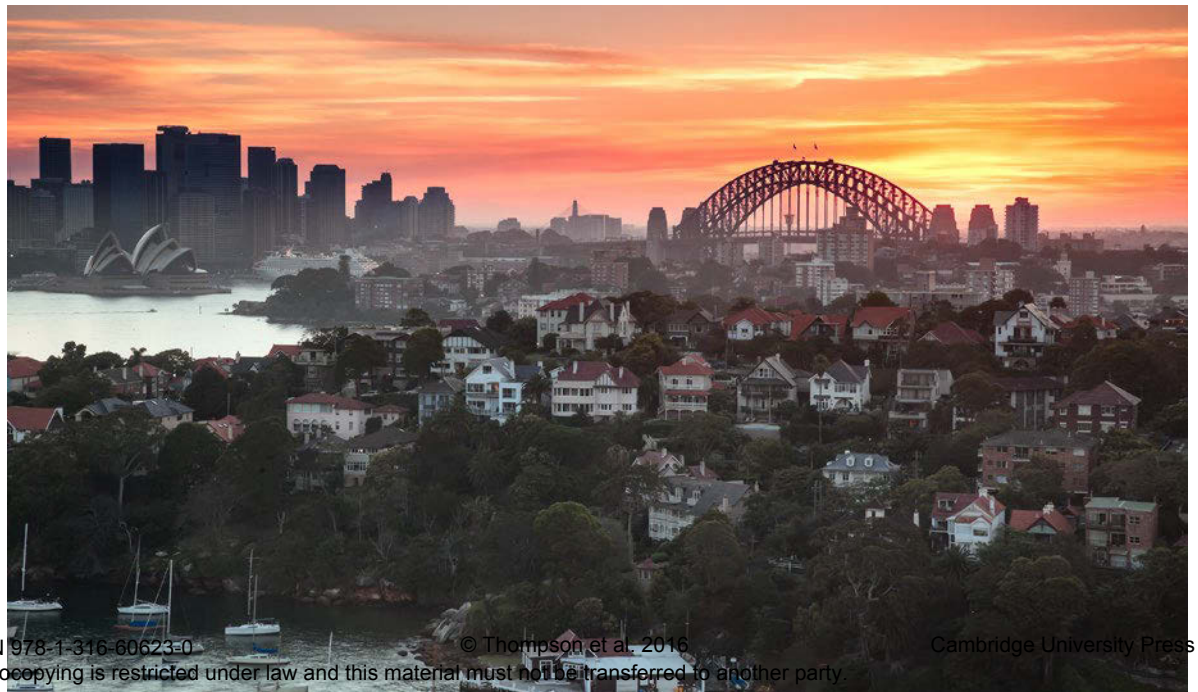
To identify the population density of a country, we divide the land area by the population. This gives the number of people on average per square kilometre. Australia's population density is one of the lowest in the world, with approximately three people per square kilometre. This can be compared with 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.

Most of Australia's population is concentrated in two widely separated coastal regions – the southeast and east, and the southwest. Of the two regions, the southeast 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.

Australia's urban concentration

Australian cities have always been home to a large percentage of the population. More than 120 years ago, author Adna Ferrin Weber, in his 1899 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'. According to World Bank data, Australia is today 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 map in Source 7.6 indicates the distribution of the main urban settlements and population density in Australia.

Source 7.5 Sydney, as a capital city, is one of Australia's most populated urban centres, located on the east coast of the continent.



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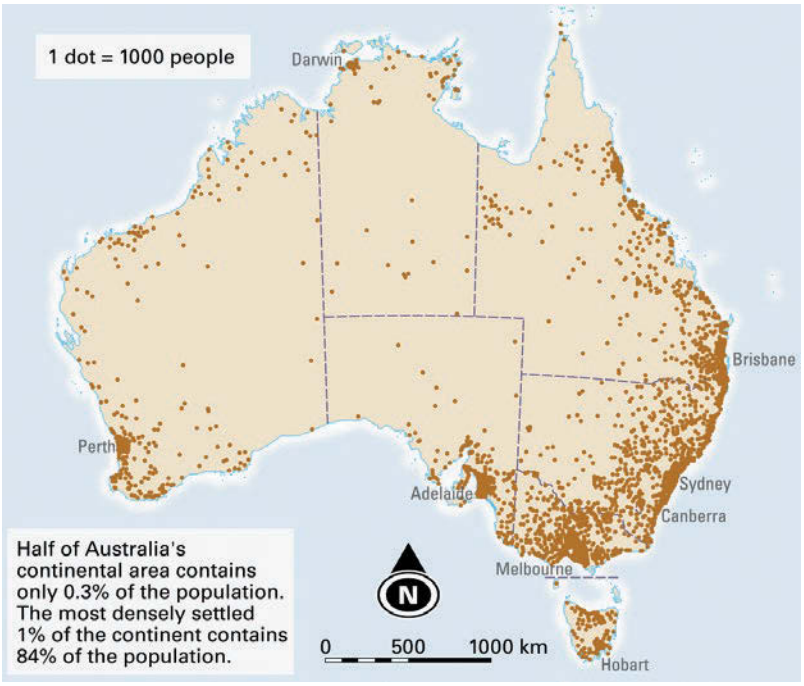
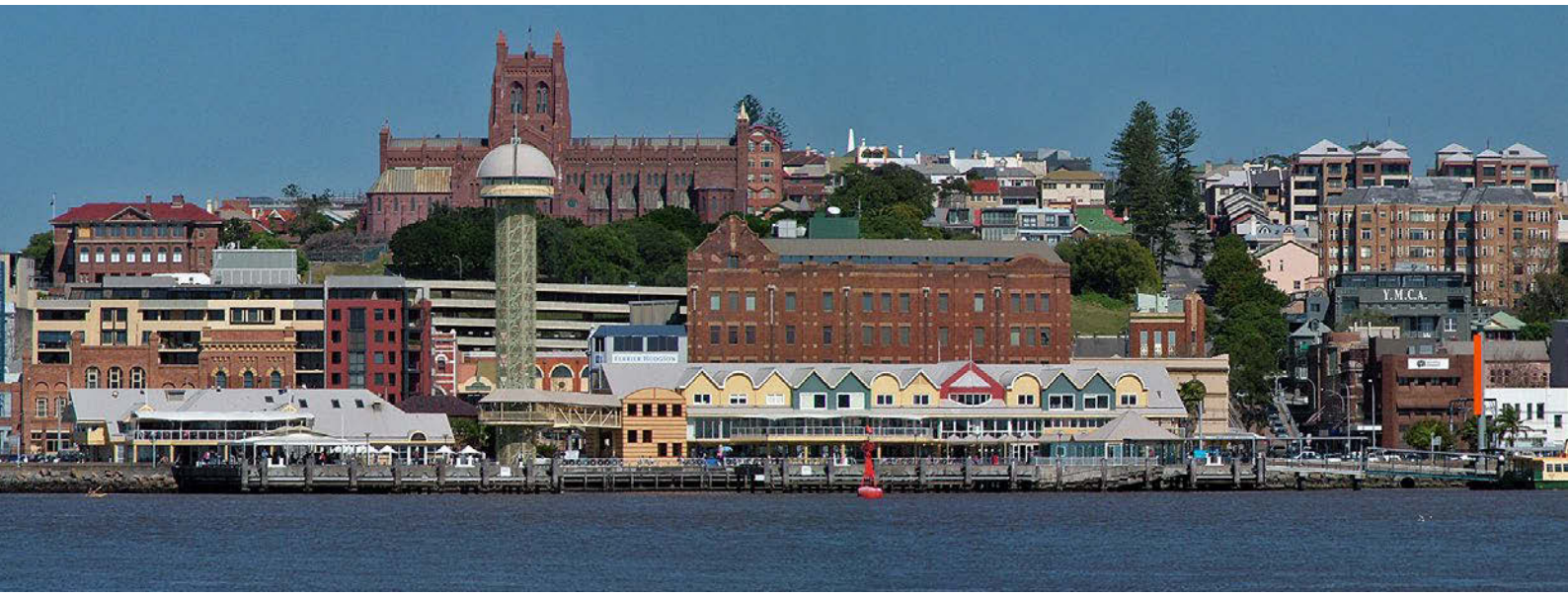


Source 7.6 Dot map showing the distribution of the Australian population. By 2013, 66% of Australia's population was concentrated in the capital cities.

The end of World War II in 1945 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. The percentage of people living in cities grew from 54% in 1947 to 70% in 1971. Since 1971, the growth of our major cities has continued, but at a slower rate. The ABS recently stated 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



Source 7.7 Newcastle is a satellite city of NSW that is experiencing significant annual population growth.

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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

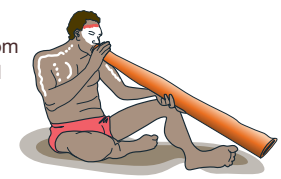
Ambulance officers
- Higher rates of accidents
- Higher rates of drug-related emergencies
- Traffic congestion can be a problem in emergencies

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 a 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 know 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

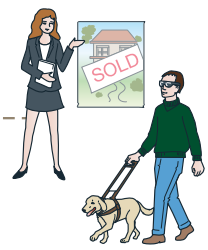
Teachers
- Greater choice of schools and universities to teach at
- More opportunities to network with other teachers/academics
- Often more resources available

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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Activity 7.2

1 Where is Australia's population mainly concentrated?

2 Identify the two main reasons for the growth of Australia's urban concentrations since 1945.

3 Research ABS statistics online and draw a table listing Australia's current population by state and territory from highest to lowest.

Activity 7.3

1 From the diagram in Source 7.8, classify the points of view into the following groups: social, economic and environmental. Place the points of view into 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.

United States population distribution

The concentration of urban settlements in the United States is a lot more evenly distributed than in Australia. When the United States was first colonised by Europeans, the first part of the country to be heavily urbanised was the eastern coastline – which faces Europe. Europe was the colonists' main source of goods and trade. The first major cities in America were Boston, New Amsterdam (New York City) and Philadelphia. These are all port cities –

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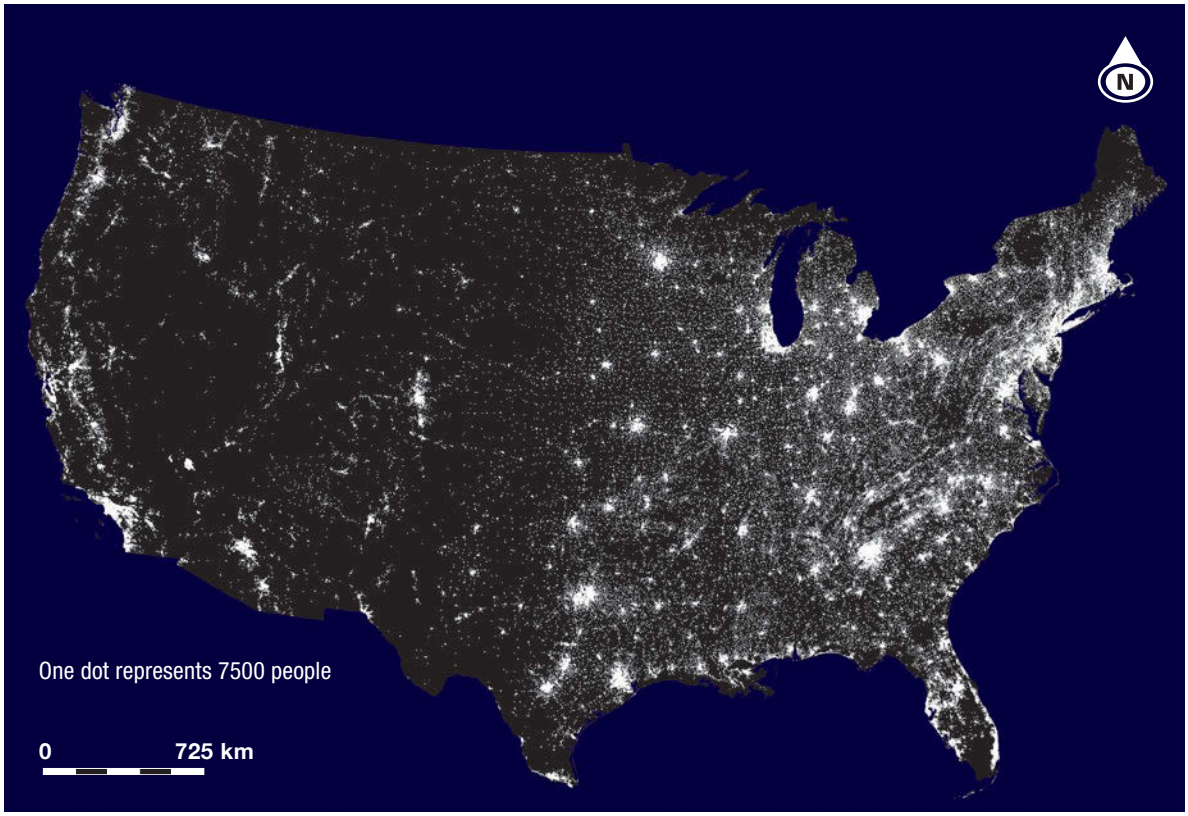
maritime relating to or involving ships or shipping

which shows the importance of **maritime** trade at that time. Due to the large number of new settlers and immigrants, people started to follow the waterways and rivers inland and began moving westward. There were also large portions of land allocated to new settlers, and as labour was scarce in the more remote areas there were plenty of employment opportunities, which then attracted more people.

Agriculture prospered in many regions inland and the movement continued west. Natural resources such as water, wildlife, oil, gas, and minerals were discovered inland as well, which provided industry and jobs. Subsequently, there are many large urban areas spread out all over the United States of America, not just the coastline. A common characteristic of the capital cities in the USA is a major river. For example, Austin, the capital of Texas, lies on the Colorado River, and the capital of Iowa, Des Moines, lies at the juncture of the Des Moines and Raccoon Rivers.

Comparing urban settlement patterns of Australia and America

There are many historical factors that are common to both countries. We need to understand these elements and analyse the reasons for their differences to predict future patterns of development. We should first recognise that both nations were already settled by indigenous peoples who had been living on the land in harmony with the environment for long periods of time. Aboriginal and Torres Strait Islander peoples lived in Australia and tens of millions of Native Americans lived in the USA. In both locations, the native peoples' lifestyle and sovereignty



Source 7.9 Population distribution of the United States from 2010. Adapted from the US Census Bureau. Note the difference in what each dot represents compared to Source 7.6.

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were not valued by the new colonists, and were often seen to conflict with the goals of the new settlers.

Currently, similarities exist, such as:

- concentration of population in eastern states and east coast
- higher levels of coastal settlements than inland
- significant inland regional centres that service surrounding areas
- lower population density in arid areas.

7.2 Factors influencing urban concentration

A comparison of the development of settlements in Australia and the United States reveals both similarities and differences in a range of factors, including climate and topography, transportation networks and perceptions of liveability.

Climate and topography

As mentioned earlier, the spatial distribution of urban areas in Australia tends to be along the coastline, whereas in the United States the distribution is more even right across the country.

One of the major geographical differences between Australia and the United States is that the central region of Australia is arid or semi-arid. The dry conditions discourage settlement inland, particularly as agriculture would be difficult and there are fewer available water resources and rainfall is less dependable.

Source 7.10 The flags of Australia and the United States

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Geographical fact

One environmental similarity between Australia and the United States is the harsh climate of certain parts of both nations. Despite being much colder, Alaska in the USA shares the harshness of its environment with the hot, dry Australian outback, and both have few settlements or people to inhabit them.

Source 7.11 Though one is cold and dry and the other hot and dry, the icy plains of Alaska, USA, are as harsh as the Australian outback. Pictured right is the Nullarbor Plain, South Australia.

The coast generally has higher and more reliable rainfall, more fertile land and more immediate access to transport, especially by sea, of course. In comparison, the United States has a network of rivers running throughout the country as well as significant lakes, allowing access to fresh water for people and natural irrigation for agriculture.

Transportation networks and urban settlements

There are many factors that are important in the selection of a site for a permanent settlement. A very important one is transportation, especially in regards to bringing goods such as food into the town and taking 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. Similarly, in the United States, the settlement of the eastern coast and then the slower movement west was influenced by transportation. Settlements were based as close to water as possible – not just for survival, but also for access to transport. 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 water for large haulage. This led to the development and

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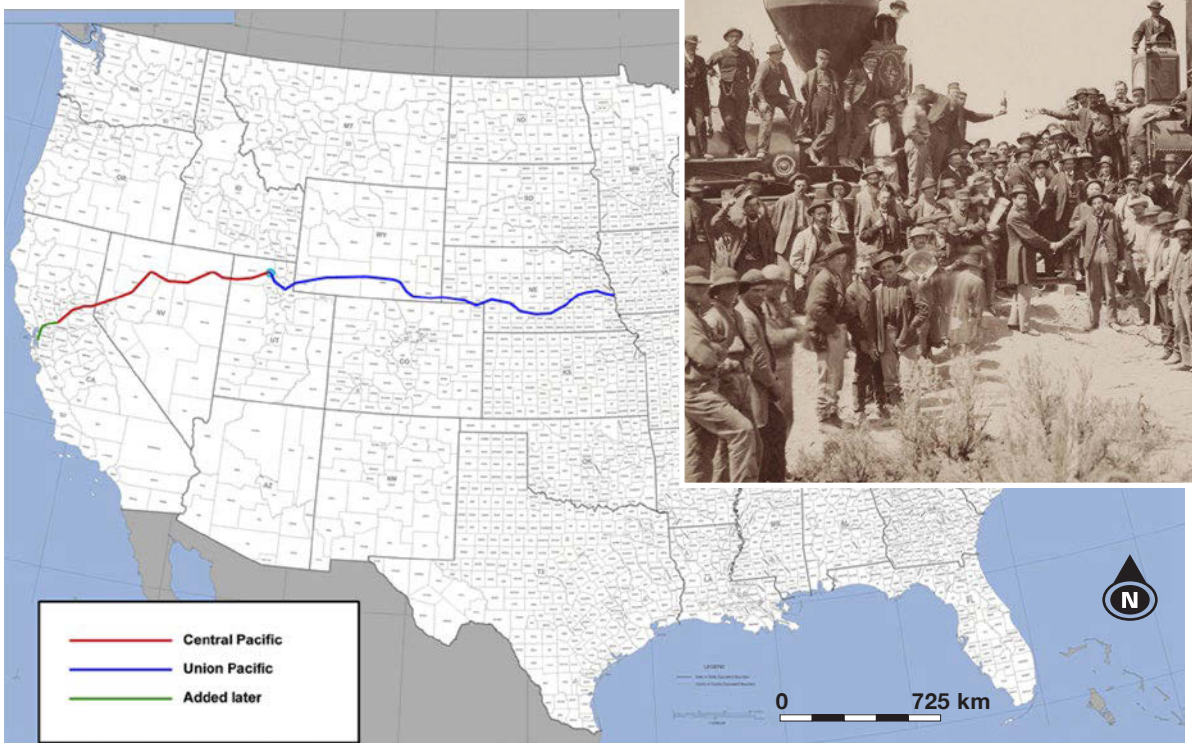
Source 7.12 When Australia was first colonised, water transport was the sole method of international transport and the primary method of moving large quantities of goods. Pictured is a replica of Captain Cook's sailing ship HMS *Endeavour* in Darling Harbour, Sydney.

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 advances in overland transport options such as rail opened up in the second half of the twentieth century, 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.



Source 7.13 The development of rail allowed for the rapid expansion of new cities across the United States of America. Pictured top is the opening of the First Transcontinental Railroad in Utah, May 1869. Pictured bottom is the cross-country route of the First Transcontinental Railroad.

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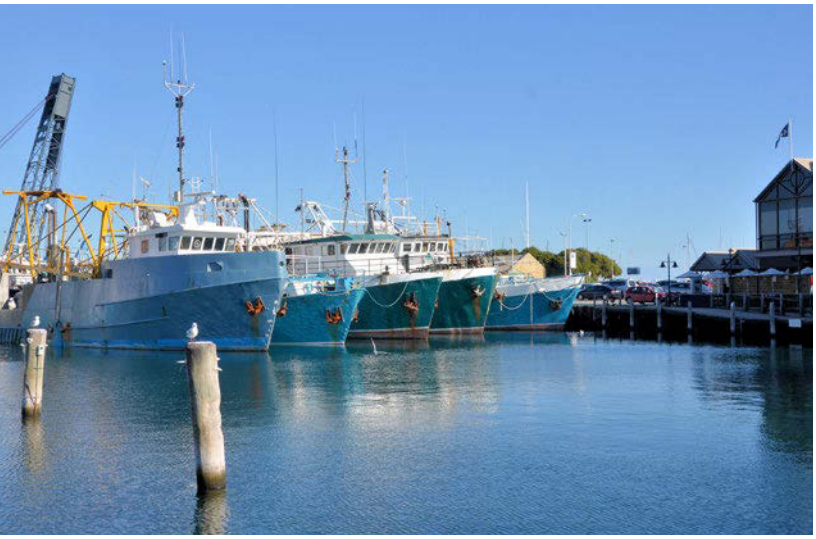
The rail system was not restricted to the rivers, and could take goods to areas that had been difficult to access.

The development of roads and the invention of cars and trucks continued to make it easier to move goods around the country, while the development of 'road trains' made transport even more efficient. These trucks, with their massive engines, are able to pull several loads at once across the continent. They can carry goods from place to place, sometimes replacing 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



Source 7.14 Fremantle Harbour in Western Australia and the Port of Melbourne, Victoria

Note this down 7.1

Using the graphic organiser below, summarise what you have learned about the advantages and disadvantages of different forms of cargo transport.

	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			

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Perceptions of liveability

As you will remember from your previous studies in geography, people constantly make judgements about the **liveability** of places: whether they could see themselves living in a particular suburb, neighbourhood or street. They assess and evaluate liveability as a factor that can influence their quality of life and wellbeing. Perceptions of the liveability of a place certainly play a part in where urban areas are concentrated.

liveability an assessment of what a place is like to live in, using particular criteria such as environmental quality, safety, access to shops and services, and cultural activities

Australia has four cities in *The Economist Intelligence Unit*'s 2015 top 10 most liveable cities in the world: Melbourne (1st), Adelaide (equal 5th), Sydney (7th) and Perth (8th). Interestingly, the United States' most liveable city is Honolulu in Hawaii, ranked 19th and Washington, DC, ranked 31st. *The Economist* claims that North American cities have largely seen declines over the last few years in their liveability rankings. Reasons given include 'escalations in crime rates in some locations, coupled with a number of incidences of religious or politically motivated attacks'. These have led to a degree of civil unrest. Major US cities like New York (ranked the 55th most liveable city) are considered to have 'a wealth of recreational activities', but suffer from higher levels of crime, congestion and public transport problems 'than would be deemed comfortable'.

Source 7.15 Seattle, in the state of Washington, USA, is ranked 46th in *The Economist Intelligence Unit*'s 2015 liveable cities in the world index.

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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.

- Locate your urban settlement on either a world map or a map of Australia. Include the latitude and longitude.
- Describe any important geographical features or features of the population of the urban settlement you have chosen.
- Describe the changes to the natural and human environment that have occurred from the beginnings of the urban settlement until today.
- List the population total and the average population density.
- Recalling the previous chapter, explain the push and pull factors that would impact your chosen urban settlement.
- Demonstrate how your urban settlement is linked to others; for example, there may be a waterway linking them, or perhaps rail transport and roads link them.

Activity 7.4

1 Discuss how land use could affect people's perceptions of liveability in urban areas. Try to find an example of a case where land use in an urban area caused controversy.

2 Record a podcast or recorded news-style report for 'Urban Geographer News' explaining:
   - where and when the controversy occurred
   - who was involved
   - the outcome of the issue.

7.3 Consequences of urban concentrations

Urban concentrations can have an impact on the characteristics, liveability and sustainability of places in a country such as Australia or the United States. These factors are all interrelated. Source 7.16 suggests some ways that the liveability of a place can be enhanced or diminished, and these types of factors would need to be taken into account when city officials consider ways to improve the sustainability of urban concentrations.

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Factors that enhance liveability	Factors that diminish liveability
Pleasant and temperate climate, predictable weather patterns, availability of water	Weather that is extremely hot or cold, lack of water/desert-like conditions
High environmental quality; streets, infrastructure and buildings well maintained and clean	Air and noise pollution, abandoned or run-down buildings and infrastructure
Safety and security from both human and natural dangers	Present dangers: natural hazards, war, violence, crime or drugs
Social connectedness, feeling of community, access to public spaces such as parks, city squares or recreational facilities	Lack of public spaces, socially isolated community, limited or no access to recreational facilities such as swimming pools or cinemas
Strong sense of cultural identity, welcoming attitudes	First language not spoken, racist attitudes
Well connected to facilities and services	Isolated, difficulty obtaining services such as internet or phone reception, limited or no access to public transportation

Source 7.16 Some factors that enhance or diminish the liveability of a place

Environmental characteristics	How they make a place more or less liveable
Open spaces	Open spaces are an important part of a place's liveability, according to the United Nations Environment Programme (**UNEP**). Parks provide essential open space for residents and space for flora and fauna to cohabitate, and they also counteract the impact of carbon dioxide emissions and traffic noise in the city.
Pollution	Pollution is an undesirable but common outcome of urbanisation. With an increase in the populations of urban areas, more pressure is placed on resources. The pollution of air and water decreases the liveability of a place. People are not attracted to polluted places due not only to pollution's impact on quality of life but also its visual aesthetic. The World Health Organization (WHO) estimates that 800 000 people die globally per year due to urban air pollution. According to the World Resources Institute (2015), the United States is the 2nd largest carbon gas emitter in the world. Australia is the 15th largest.
Traffic volumes	A large contributor to air pollution is traffic. The use of motor vehicles in the world is rising. As more cars use the roads, more roads are built, which then impacts on the environment the road is built through. Research into traffic congestion based on Tom Tom navigational data indicates which cities around the world suffer from the highest rates of traffic congestion. Los Angeles is the most congested city in the United States, ranked 10th, while Sydney is Australia's worst city for traffic, ranked the 21st most congested city in the world.
Visual aesthetics	The appearance of a place, its **aesthetics**, plays a large role in the liveability of a place. Pollution can impact the aesthetics of a place. Generally speaking, pollution is much higher in urban areas than rural areas, so rural areas can be more aesthetically pleasing.

Source 7.17 Environmental characteristics of urban areas that can affect liveability

UNEP United Nations Environment Programme

aesthetics the value or appreciation of something due to its beauty

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Environmental characteristics in particular impact the perceived liveability of an urban area, as shown in Source 7.17. All of these characteristics impact liveability, and all of these characteristics can change for better or worse as a consequence of urbanisation.

Source 7.18 Perth is considered a beautiful city. Aesthetically, the city has picturesque natural resources such as the Swan River and beaches like Cottesloe (pictured).

Note this down 7.2

Copy the graphic organiser below and assess how each environmental factor could change for better or worse as a consequence of growing urban concentrations.

Factor	Open spaces	Pollution	Traffic	Visual aesthetics
Description				
Consequence of urbanisation				
Examples from Australia and USA				

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Sustainability

Many people are working towards trying to make urban areas more sustainable. A sustainable city offers a good quality of life to current residents but doesn't reduce the opportunities for future residents. The following case study will consider how one of the largest urban concentrations in the world is addressing the problem of sustainability on a mass scale.

Case study 7.1
New York City and sustainability

New York City is one of the oldest cities in the United States and has been described as the cultural and financial capital of the world. The city itself is home to nearly 9 million inhabitants distributed over a land area of just 790 square kilometres, making it the most densely populated major city in the United States. By 2014 census estimates, the wider New York City metropolitan region also remains by a significant margin the most populous in

Source 7.19 New York is located on the eastern seaboard of the United States, and is the most densely populated major city in the United States. New York has five **boroughs** – Brooklyn, Queens, Manhattan, the Bronx and Staten Island.

borough a subdivision of certain cities

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Geographical fact

One of the most recognisable symbols in the United States is the Statue of Liberty. The 150-foot tall copper statue 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. It was dedicated in 1886.

Source 7.20 The Statue of Liberty on Liberty Island in New York Harbour, with Manhattan, the most densely populated of New York City's five boroughs, seen in the background

Source 7.21 Central Park, in the centre of Manhattan, is the most visited urban park in the United States as well as one of the most filmed locations in the world.

the United States, housing a further 20 million people. On top of this, the city had a record 56 million visitors in 2014, adding further pressure to the city's **infrastructure**, including transport and housing/accommodation.

infrastructure the basic systems and services, such as transport and power supplies, that a country or organisation uses in order to work effectively

So what are some of the consequences of urban concentrations on the sustainability of places like New York City? In recent years, the New York City Mayor's Office of Sustainability (MOS) has worked to address the challenges of sustainability with ambitious goals, long-term planning and program development. For example, working in partnership with The City University of New York Institute for Sustainable Cities (CISC), in June 2013 MOS produced *PlaNYC*, which includes 257 initiatives to make the city, its communities and its infrastructure more **resilient** in the face of sustainability issues. In March 2014, MOS reported that 90% of these initiatives had been completed or were in progress.

resilient able to recover strongly and quickly from misfortune

MOS's work focuses on sustainability challenges in areas including climate change, population growth, and affordability and access. The programs aim to help create housing for a growing population, provide clean and reliable energy, and improve transit capacity.

Geographical fact

The New York City Subway is one of the most extensive metro systems worldwide, with 469 stations in operation.

Source 7.22 (on the next page) explains some examples of ways that New York City has acted in recent years to address the problem of sustainability for such a growing urban location. Through measures like these, according to MOS, New York City is 'uniquely positioned to become the most sustainable big city in the world'.

NYC Sustainability goals	Examples of how NYC is addressing each goal	
Improve mass transit	Upgrading and maintaining NYC's extensive public transit system by: • cleaning the city's 2 million registered vehicles • engineering streets that allow buses to move more quickly • working to improve public transport efficiency and capacity, such as NY's famous subway network	
Make buildings more efficient	One example is the NYC °CoolRoofs initiative. Since 2009, local jobseekers have been hired to paint New York City rooftops with a white reflective coating that reduces building energy consumption and citywide carbon emissions. NYC °CoolRoofs aims to coat 1 million square feet of rooftop annually and connect participants to full-time work.	
Preserve historic and natural assets	Creation of parklands: A 2007 NYC report highlighted that New Yorkers had fewer acres of green public space per person than any other major American city. As a result, the city committed to ensuring that all New Yorkers live within a 10-minute walk of a park and that 90% of waterfronts are open for recreation by 2030. This included opening underutilised spaces as playgrounds, creating and upgrading current parks, and incorporating sustainability throughout the design and maintenance of all public space. One example of this is the High Line public park, where a historic freight rail line has been converted into an urban garden high above Manhattan.	

Source 7.22 An explanation of some of New York City's measures to address sustainability

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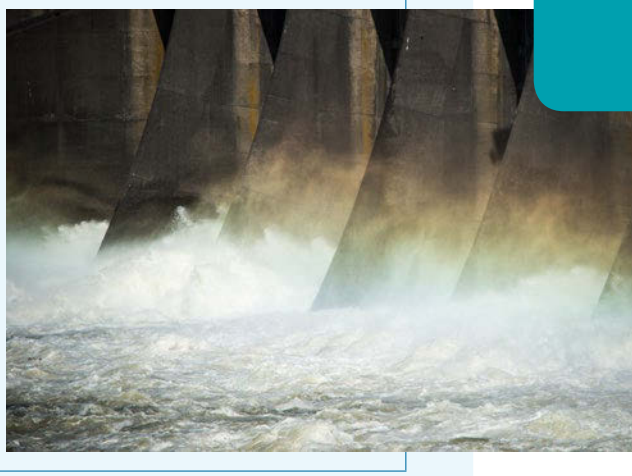
NYC Sustainability goals	Examples of how NYC is addressing each goal	
Boost clean energy	Solar power: New York's capacity for generating solar power is growing. Solar generating capacity has increased from less than 1 megawatt (MW) in 2006 to over 30 MW in 2015. Numerous solar installation companies have also set up shop in the city, creating hundreds of jobs and attracting over $200 million of investments in the industry. Over the next decade, the city aims to facilitate the development of more than 250 MW of solar energy on rooftops across New York City.	
Upgrade power infrastructure	Hydropower: In mid-2013, with strong city support, the Public Service Commission approved for construction the Champlain-Hudson high-voltage transmission line from Quebec to Astoria, Queens. This project, for the first time, allows the direct transmission into the city of 1000 MW of clean energy drawn from hydropower sources.	

1 Describe how urban development could change the characteristics of a place like New York.

2 Analyse how the characteristics, liveability and sustainability of New York City are interrelated.

3 Discuss further strategies for ways to make urban concentrations more sustainable.

4 Choose another major global city other than NYC, and research how city planners are working to ensure its sustainability. Briefly describe some of the strategies used.

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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 two widely separated coastal regions, as the central region of Australia is arid and semi-arid.
- The United States has more evenly distributed urban areas than Australia, with urbanisation occurring across the country.
- Australia is a country that has limited fresh water and fragile land that needs to be managed carefully. It is the driest inhabited continent on Earth.
- The United States is a nation made up of international migrants.
- Australia and the United States have both similarities and differences in their colonisation and history, as well as geographically.
- Although the two countries are similar in land size, the United States' population is more than 10 times greater than Australia's.
- The characteristics, liveability and sustainability of a place are all interrelated. There are environmental characteristics in particular that impact the perceived liveability of an urban or rural area. These environmental characteristics include open spaces, pollution, traffic volumes and visual aesthetics.
- Urban concentrations can have great consequences for the sustainability of places. New York City, for example, is one of the largest urban concentrations in the world, and city officials have been striving to make the city more sustainable in the face of issues including population growth and climate change.
- New York City is addressing sustainability through a range of measures, including improving mass transit, making buildings more efficient, preserving historic and natural assets, boosting clean energy sources and upgrading existing power infrastructure.

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End-of-chapter questions

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 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.

Extended response

What if …

Imagine what the settlement pattern would be in Australia if we still relied on sea travel and horseback.

- List at least three 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 counterarguments.
- 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

Source 8.1 Queensland has one of the biggest rates of positive internal migration in Australia, with people choosing to move there not only for its employment opportunities but also for its warmer climate and lifestyle.

Before you start

Main focus

To understand the reasons for and effects of internal migration as well as 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 and the services available to us, to our daily communication with people in other communities. Looking at both Australia and China's trends in internal migration will shed light on the impact of internal migration on urbanisation.

Inquiry questions

- What are some reasons for internal migration?
- What are the characteristics and features of Australia and China that influence internal migration?
- What are the economic, social and environmental consequences of internal migration on both peoples' places of origin and their places of destination?

Key terms

- Biodiversity
- *Hukou*
- Inter-province
- Interstate migration
- Intra-province
- Intrastate migration
- Manufacturing
- Migration
- Negative internal migration
- Provinces
- Pull factors
- Push factors
- Urban sprawl

Let's begin

This chapter looks at the effects of internal migration on the redistribution of populations, focusing on the examples of 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. Within China, internal migration can be a complex process; it is highly regulated by its government, which wishes to control the movement of the country's enormous population.

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8.1 Reasons for internal 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.

Source 8.2 Through the process of migration, people move from town to town, city to city or country to country.

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.

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A range of factors contribute to the movement of people as a result of rural-to-urban migration. These factors are split into two key groups: push factors and pull factors – concepts you will remember we first considered back in Chapter 6.

Push factors	Pull factors
• Being forced off the land by owner of the land • War and civil unrest • Failure of subsistence farmers' crops • Extremes of weather (floods or droughts) that destroy crops • Rapid increases in population • Lower standards of living in rural areas • Boredom with rural life • Increased mechanisation of farming, leading to loss of employment	• Perception of better employment opportunities in cities • Promises of better access to essential services • Better health facilities • Greater educational opportunities • More access to entertainment and recreation activities

Source 8.3 Push and pull factors associated with rural-to-urban migration

Activity 8.1

1 Suggest which push factors and pull factors would make you most likely to migrate in any circumstance. Can you think of any others not listed in Source 8.3?

2 After conducting a survey in class, list how many class members have experienced internal migration.

3 Discuss as a group some of the advantages and disadvantages that they have experienced. (If there are no members of the class who have experienced internal migration, research this topic on the internet and then discuss it as a group).

8.2 Internal migration trends in Australia and China

Internal migration that occurs in Australia can be classified into two 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**, whereby people move from their current place of residence to another state – for example, from Melbourne to Perth. Internal migration may be temporary or permanent.

intrastate migration movement of a person within their own state

interstate migration movement of a person to another state

A very distinct pattern has emerged over the past 40 years in the internal migration of Australians. Queensland consistently has

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Source 8.4 Intrastate migration is the process whereby people move within their state. Pictured is Brisbane at sundown.

received the greatest number of internal migrants; however, that trend has dropped to the point where it is at its lowest in the last 40 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. There are some other key trends that have occurred over the past 40 years. New South Wales has had fluctuating rates of **negative internal migration**.

negative internal migration a situation in which more people leave a state than arrive as newcomers

This means that there are more people leaving New South Wales than migrating to 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 2015 where only around 6600 people migrated interstate from New South Wales. Victoria has

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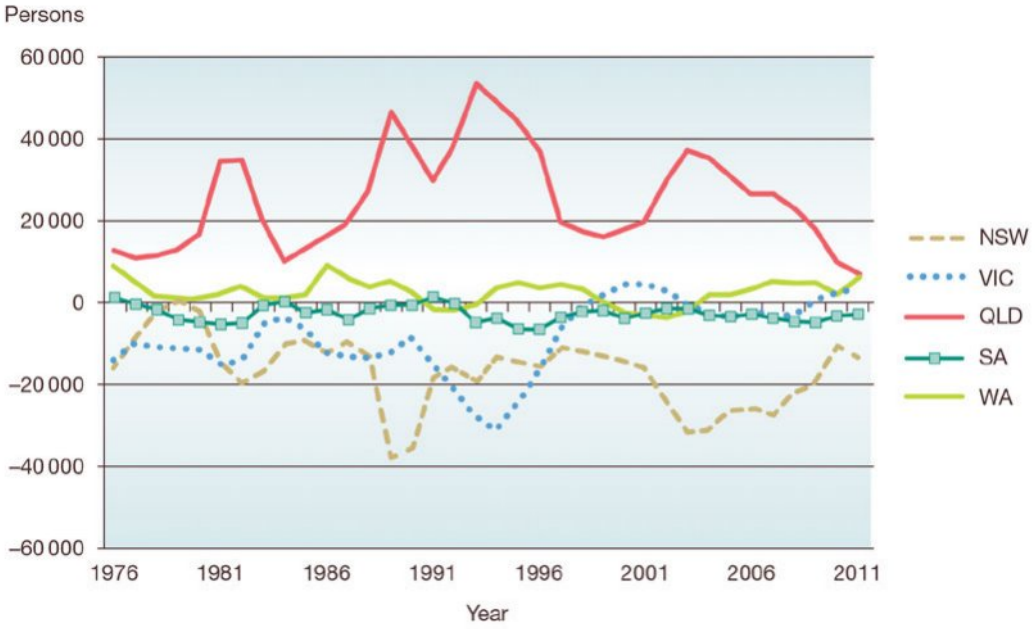
experienced a trend similar to that of New South Wales. Its lowest point was in 1994, with 30 000 people leaving; however, it has now reversed this trend and had a positive figure of 8783 people in 2014. This is because of better employment opportunities and the growth of Melbourne and Sydney as global cities, with increased links into the global economy.

Western Australia has seen an increase in its net internal migration over the period 1976–2013. 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 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 relocated themselves to this state to take advantage of the opportunities offered by resource companies.



Source 8.5 Net internal migration in Australia, 1976–2011

According to the latest ABS data for 2012–14, these trends have generally continued.

State	Net internal migration 2012–13	Net internal migration 2013–14
NSW	–15 527	–6857
VIC	4671	8783
QLD	9460	5753
SA	–4205	–2968
WA	7992	1045
TAS	–2173	–1168
NT	–1797	–3344
ACT	1579	–1244

Source 8.6 Net internal migration in Australian states, 2012–14

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Source 8.7 Western Australia has recently seen a drop in its strong internal migration figures. Pictured is the capital city Perth, whose metropolitan area is home to over 75% of the state's population.

Over time, there has been a general trend of internal migration in Australia of movement towards the cities. Whether it is intrastate 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.

State/Territory	Patterns/Trends
New South Wales	External migrations increasing to Sydney, but internal migration loss (that is, more Australians moving out of Sydney than in).
Victoria	Melbourne's population will continue to grow as external migration increases. There is some internal migration loss but less than Sydney. Due to internal migration there will be a lot of growth in urban regional areas surrounding Melbourne, such as regional cities like Geelong.
Queensland	Out of all states, Queensland has the biggest external and internal migration rates. That is, more people are moving to Queensland.
Western Australia	WA tends to have strong internal and external migration. Regional areas in WA such as the Kimberley and Pilbara are growing faster than Perth.
Tasmania	The population in Tasmania is fairly stable. Potentially Tasmania may have greater growth in the future. See Source 8.10 in the next section for reasons why.
Northern Territory	Measuring internal migration in the Northern Territory is difficult due to the mobility of Indigenous and non-Indigenous Australians.
Australian Capital Territory	Like Tasmania, the population is fairly stable with some losses and gains. Over half of those who leave the ACT move to NSW and conversely over half of those who move into the ACT are from NSW.

Source 8.8 Table summarising the patterns and trends of internal migration for states and territories in Australia

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Activity 8.2

1. Taking Source 8.8 into account, predict the order for the five states in 2025, from highest net internal migration to lowest.
2. Referring to Source 8.5, Victoria's negative internal migration was reversed in 2011. Explain why this was so.
3. Referring to Source 8.6, how can you account for the decline in interstate migration to Western Australia between 2012–13 and 2013–14?
4. Describe a major pull factor for each of the following states: Queensland, Western Australia, Victoria.

Australians may move due to any one of the push or pull factors shown in Source 8.10. Regional populations continue to age as young people move to the cities, so there can be labour shortages in regional areas, which can attract the unemployed. The 'baby boomers' of Australia also tend to have high mobility, as they can choose to have a 'sea change' or 'tree change' when they retire.

In the table opposite, you will see some reasons why people move to and from the states and territories in Australia.

Source 8.9 'Tree changers' are people who move from urban to rural areas to enjoy the natural environment and its many sights, such as wildlife.

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State/Territory	Reasons for internal migration
New South Wales	Cost of living – people moving out of Sydney due to housing costs including high rental. Traffic congestion – people moving to smaller urban areas in NSW.
Victoria	Similar to Sydney – Australians may move out of Melbourne due to the higher cost of living. 'Sea change' and 'tree change' as people move to the Victorian coastline or inland. Despite some internal migration loss, Melbourne has the highest population growth rate in Australia and is also Australia's most liveable city.
Queensland	Queensland is very attractive due to its warmer climate. The state is rapidly growing. Not only people moving there seeking employment, but many moving to retire. Mining and farming are two major drawcards for employment opportunities.
South Australia	Many young people moving out of Adelaide to larger cities such as Melbourne, Brisbane or Sydney. It is anticipated that more people may move to SA in the future as the mining industry expands.
Western Australia	The mining industry in WA is a large drawcard for both internal and external migration.
Tasmania	Tasmania may have growth due to climate change. Tasmania may suffer fewer water supply issues than the rest of Australia and therefore attract people. Furthermore, agricultural industries such as dairy may then shift from the mainland to Tasmania. This would stimulate further population growth.
Northern Territory	People may choose to move to NT due to employment opportunities. As NT has a lot of remote regional areas, there tends to be a labour shortage. Conversely, people may choose to move out of NT to a more urbanised area.
Australian Capital Territory	Canberra is the capital city of Australia and home to the federal government. There is a large government employment sector in the city that attracts people. It is also a university city and may attract young people wishing to attend ANU or the Royal Military College at Duntroon.

Source 8.10 Summary of reasons for internal migration in Australia by state

RESEARCH 8.1

Conduct some research online and outline five more reasons for internal migration to and from New South Wales.

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Temporary and permanent trends in internal migration in China

China has the largest population in the world, has the 2nd largest economy, and is the 2nd largest country in Asia and the world by area, after Russia. Internal migration in China tends to be rural-to-urban migration.

province an area within a country or state

China is divided into 31 **provinces**, with each province governed by a provincial government. There are two types of internal migration that occur in China: intra-province, whereby people move within their province, and inter-province, whereby people move from one province to another.

The household registration system in China

hukou a record of household registration required by law in China

To understand internal migration in China it is important to first understand the ***hukou*** system. A *hukou* is a record of household registration. Every household in China requires registration by law. The *hukou* system is highly regulated. If a family wishes to move, they must first apply to move. China has had a household register for centuries; however, the *hukou* system is stricter and better regulated since the Communist Party came into power in 1949.

Source 8.11 The Great Wall of China was built between 1368 and 1644 to protect China against invasions from the north. It was built by hand and is nearly 9000 km long. It is now a World Heritage Site and visited by millions of tourists every year.

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Source 8.12 (Left) Residents in China require formal approval to move permanently. (Right) The *hukou* – record of household registration required by law in China.

Residents wishing to move within their local area are generally permitted to do so. For example, an urban resident wishing to move to another part of their town or city is allowed to, as is a rural resident wishing to move within their region. However, moves involving a *hukou* change that is more formal or permanent, such as moving outside a city or township boundaries, are strictly regulated. Approval needs to be gained from authorities, and approval is only given if the move serves government interests and policies. Generally, it is very difficult for a person to gain approval to move from a rural area to an urban area, or from a smaller city to a larger city.

The *hukou* system also works as a welfare system. A resident is only entitled to health care and services benefits in an area if they hold a *hukou* for that area. Therefore, a person living in rural China may be able to 'temporarily' move to an urban area to work, but they are not awarded a *hukou* for the area. They are instead called a 'temporary resident' and are ineligible for local benefits and rights, which local urban residents (with a *hukou*) qualify for automatically. For example, temporary residents are not allowed to enrol their children in schools in that area. It is estimated that 60 million children are separated from their parents so that they can attend school elsewhere (in their *hukou* area).

In China, when the government has needed to stimulate growth in urban areas, particularly when needing people for labour, *hukou* change has been made easier. Thus the *hukou* system creates its own push and pull factors.

Characteristics and features that contribute to internal migration

The movement of people internally within China has changed over time. The rise in the 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 rural Chinese in the agricultural sector to the cities in search of higher paid work. According to China's National Bureau of Statistics, the movement of rural Chinese to the major urban areas increased from around 30 million people in 1989 to more than 168 million in 2013. Another estimate puts the total movement of rural people to urban centres in China at 278 million people between 1989 and 2013.

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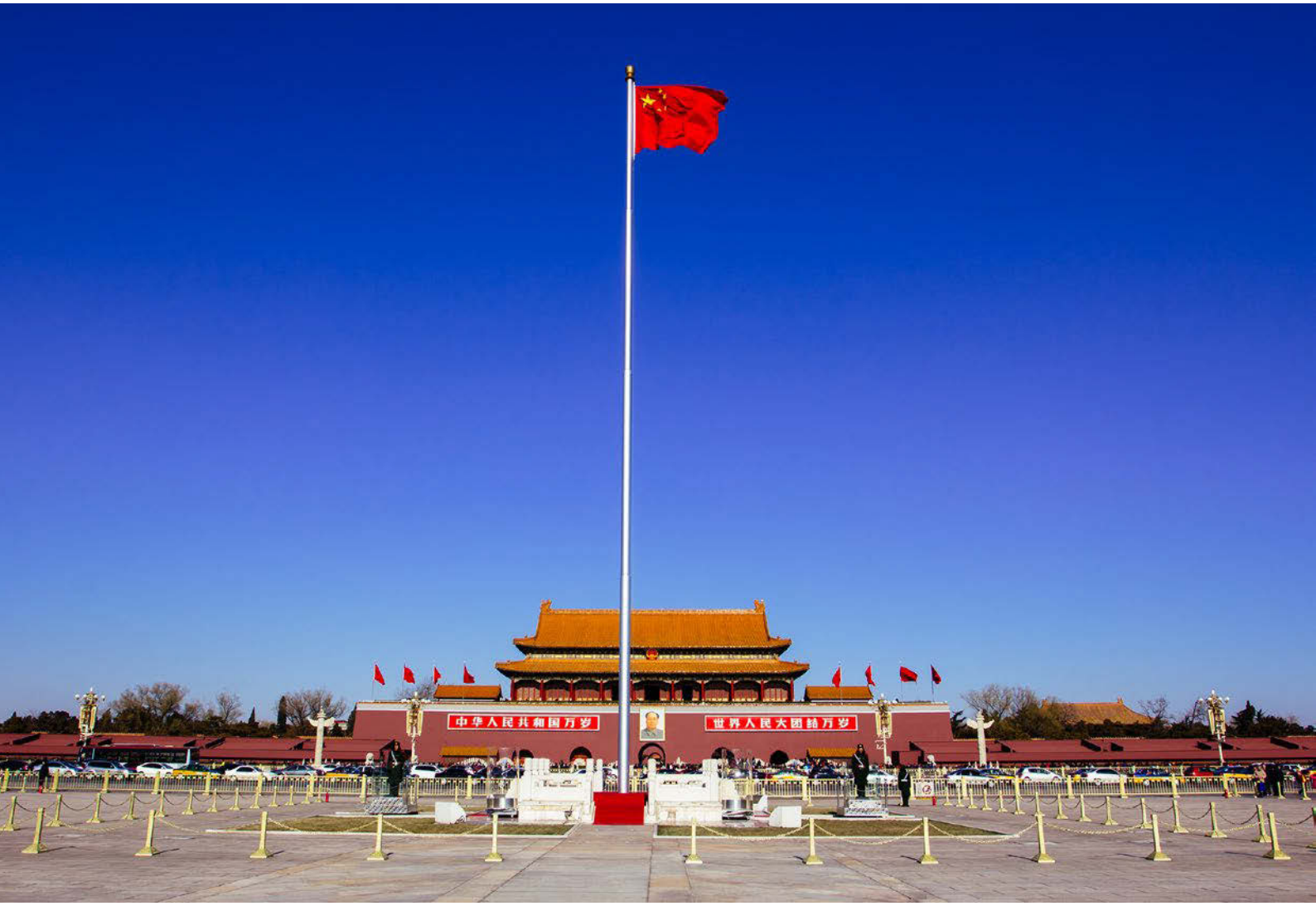

Source 8.13 Tiananmen Square

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 23979 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.

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Geographical fact

The Forbidden City is an ancient palace in the centre of Beijing and was home to 24 emperors – 14 of the Ming dynasty and 10 of the Qing dynasty. In 1912, the last emperor Aisin-Gioro Puyi abdicated his throne and the Forbidden City ceased being the political centre of China. However, it remains an important cultural and historical area in China, and receives millions of visitors every year. The Forbidden City is located alongside Tiananmen Square.

Source 8.14 Ancient Forbidden City in the foreground, with modern Beijing in the background

Source 8.15 Yuan notes

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Where is the internal migration in China occurring?

China is a very large country that is divided into provinces as shown in Source 8.16. Most of the internal migration that occurs in China involves a large movement of people from the central areas of China towards the coastal areas, especially in the southeast of the country. This is illustrated in Sources 8.17 and 8.18, which indicate the internal migration flows in 1995–2000 and 2000–2005.

Source 8.16 China's many provinces

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 of choice for these internal migrants has been Guangdong province. Guangdong is popular due to the large amount of government funding and foreign investment as well as its proximity to Hong Kong.

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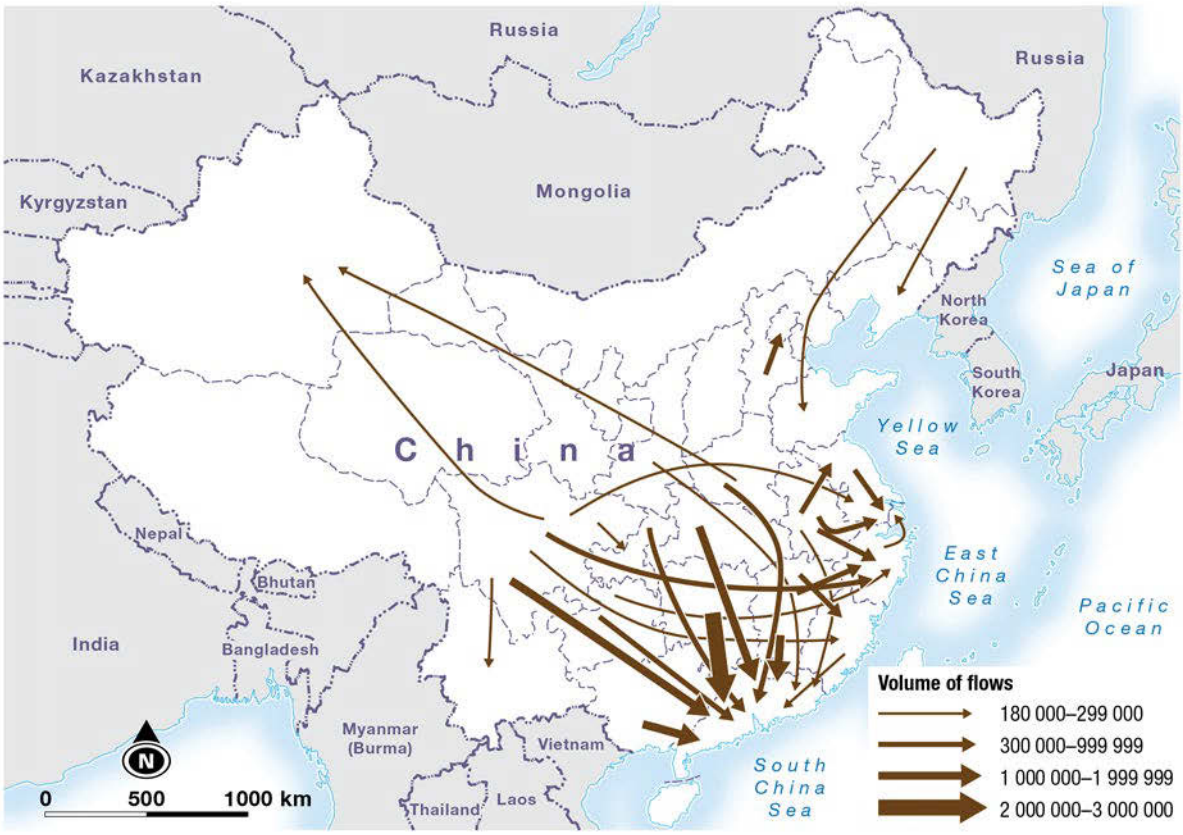
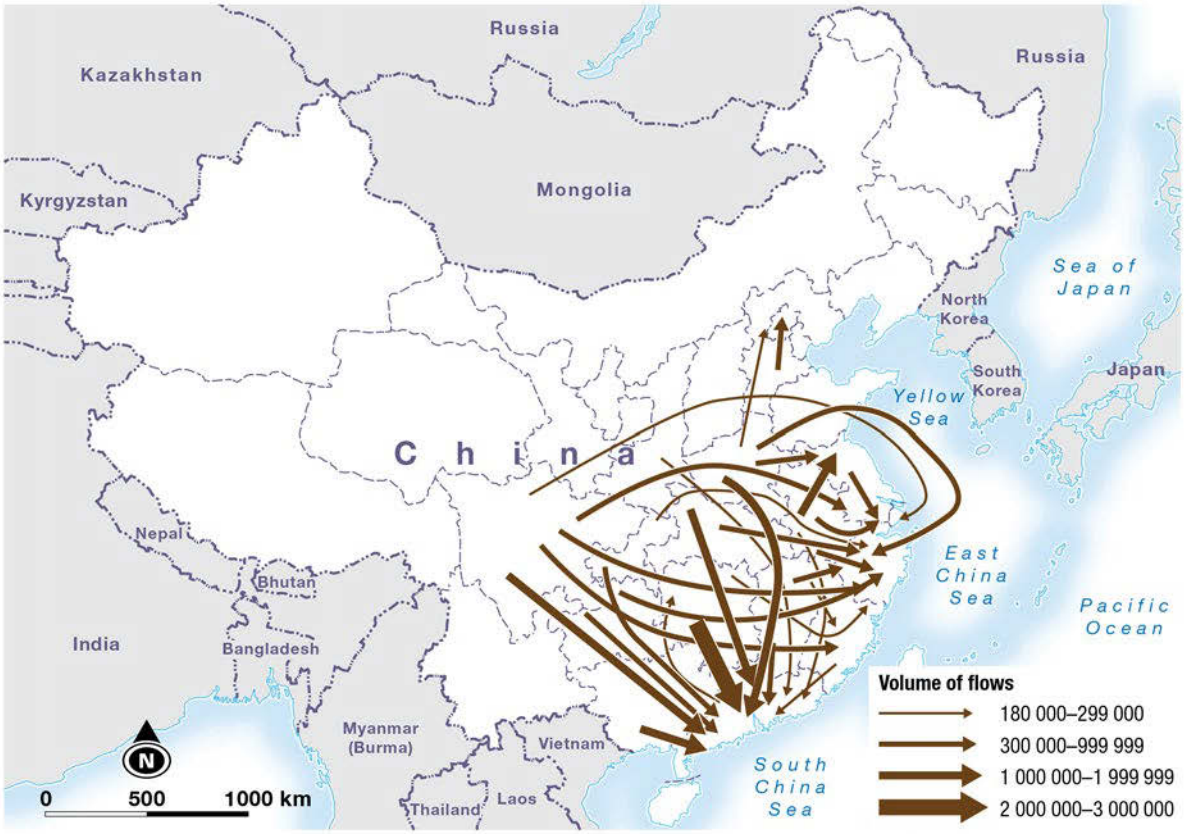


Source 8.17 Chinese internal migration, 1995–2000



Source 8.18 Chinese internal migration, 2000–2005

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Case study 8.1
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 15 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. The port at Shenzhen, which exports the vast array of products manufactured in Guangdong province, is now one of the busiest in the world. Goods from the region are transported all around the world, including to Australia.

1. Explain why many foreign companies have decided to set up offices or factories in Guangdong province.
2. Suggest what problems the rapid population growth in this city may have caused for the region.
3. Describe how busy the port of Shenzhen in Guangdong province is.
4. Research the world's busiest container shipping ports online.
   - **a** Where does Shenzhen rank globally?
   - **b** How many containers are processed through the port annually?

Source 8.19 The city of Shenzhen in Guangdong province

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Activity 8.3

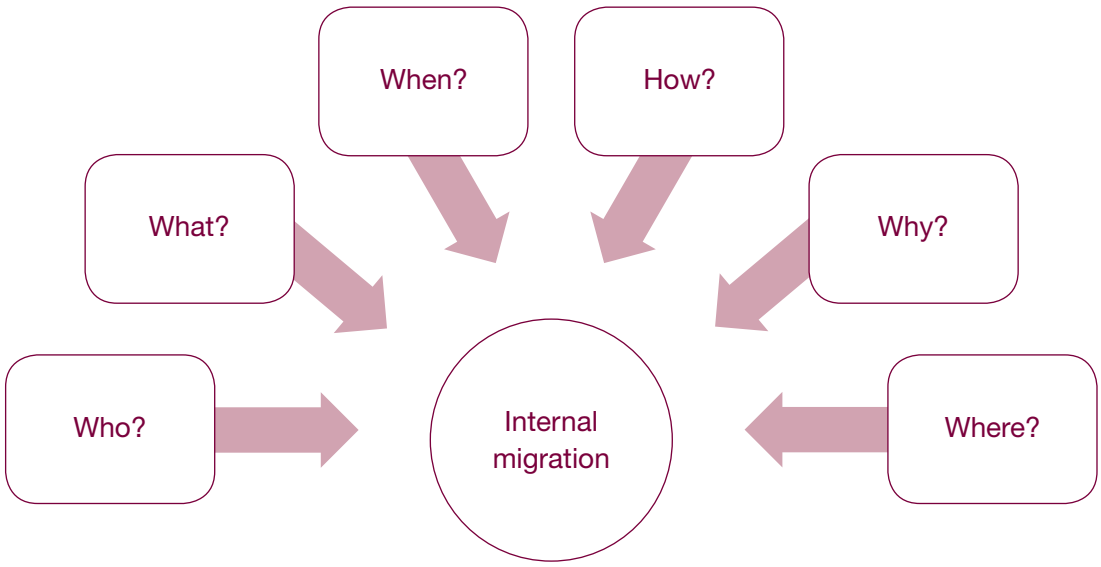
1 Imagine you are a young parent with an infant child who has moved to Guangdong province from rural China. In a paragraph, explain the reasons why you moved.

2 Imagine a *hukou* system being introduced in Australia. Discuss an advantage and a disadvantage that you could foresee.

3 Discuss briefly how drought and other natural disasters restrict employment prospects in rural areas.

Note this down 8.1

Copy the graphic organiser below and summarise what you have learned about internal migration.



8.3 Consequences of internal migration

Wilbur Zelinsky, a past geography professor at the University of Pennsylvania in the United States, came up with a migration hypothesis in 1971. According to Zelinsky's **theory**, areas undergoing urbanisation experience high levels of rural-to-urban migration. As this internal migration continues, rural populations begin to decline and their average age increases. Zelinsky argues that eventually the rural-to-urban migration begins to weaken, to be replaced by inter-urban and intra-urban migrations. Finally, there can be a trend reversal due to a need for more people back in rural areas, so an urban-to-rural internal migration might occur.

theory an idea or a group of ideas intended to explain something

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Activity 8.4

1 Briefly summarise Wilbur Zelinsky's theory of internal migration.

2 Do you think Zelinsky's theory makes sense? Why or why not? In your answer, use examples from this chapter.

3 Analyse the sentence 'Finally, there can be a trend reversal due to a need for more people back in rural areas, so an urban-to-rural internal migration might occur.' Discuss as a class whether you can name an area in Australia where this could occur in the future and why.

Internal migration has many varied effects on countries. Positive effects include increased employment, population growth and economic development. However, there are also negative effects of internal migration, such as environmental destruction, overly rapid population growth and exploitation of workers.

Economic effects of internal migration in China

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

Source 8.20 Rural China: Wuyuan County, Jiangxi

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example, if a resident in China moves from a rural to an urban area, a range of economic transactions takes place, including 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 greater the number of people leaving an area, the greater the economic impact. With decreased services in rural areas, it is very hard to attract new families to replace the people who have left, and this creates further economic stress. 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 goods and services and, most importantly, they will need employment.

However, as mentioned previously, those people who are not granted a *hukou* and are only temporary residents are not granted the same privileges relating to health care and services in the urban area. At times, China is criticised for the *hukou* system, with some referring to it as a '**caste**' system.

caste any group or class of people who have exclusive privileges or are perceived as socially distinct

Environmental effects in China

Internal migration of people also raises some major environmental issues. For example, 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 23.9 million people in 2013, which is a 13.1 million increase in 38 years.

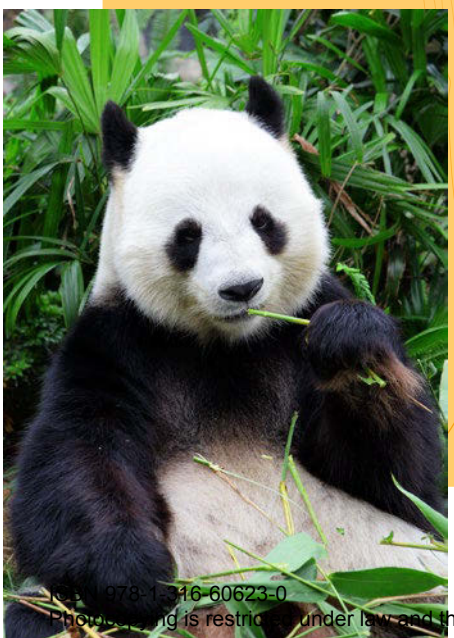
Source 8.21 Shanghai's Lujiazui financial centre

Source 8.22 Shanghai cityscape

Geographical fact

China has a great deal of biodiversity. For example, the giant panda is a national treasure in China. There are only approximately 1000 left in the wild, most of them in Sichuan province. China also has a large variety of bird species. The crested ibis is also a national treasure with only about 1500 of this endangered bird left, most of them found in Shaanxi province. China's oldest tree is the gingko, which first appeared during the Jurassic Age over 160 million years ago.

Source 8.23 The giant panda is considered a national treasure in China, with only about 1000 left in the world, most of them in Sichuan province. The crested ibis, an endangered bird in China. The golden leaves of the ancient gingko trees in Beijing.



Additionally, the land area of Shanghai has increased dramatically to accommodate the growth of in the population. In 1975, the urban area covered 159 km²; by 2013, this had expanded to 6340.5 km². This rapid increase in population and associated expansion in land area, which has been driven by internal migration to the city, has led to a degradation of air and water quality, changes in biodiversity and local climate changes.

degradation a loss of quality

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 2014, there were over 2 million private cars in Shanghai. In an effort to control the number of cars in Shanghai, the government has placed a monthly **quota** on the release of number plates. 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 in the Shanghai area has declined as a result of **urban sprawl**.

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

For example, in the Sheshan area of Shanghai there has been a 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 the biodiversity of the region.

Source 8.24 Looking out over Songjiang district of Shanghai from the top of Sheshan Hill – note the protected forested parks in the foreground

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Social and environmental effects in China

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 away puts pressure on businesses and services, because they find it hard to get people to fill employment positions in smaller towns or cities.

Source 8.25 Elderly traditional Chinese **cormorant fisherman** on the Li River in Yangshuo, China

cormorant fishing a fishing method long used in China and Japan in which fishermen use trained birds – cormorants – to fish in rivers. Today the method is mainly used to entertain tourists.

Source 8.26 As younger people move to urban areas, the rural populations grow older. Here an elderly Chinese woman sorts corn in the yard of her home.

Activity 8.5

1 Determine 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 monthly quota on the release of number plates.

3 Describe the impact the rapid growth of Shanghai has had on the environment.

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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 two main factors associated with internal migration: push factors and pull factors.
- The most common trend in internal migration globally is rural to urban migration.
- In Australia over the past 40 years there have been consistent patterns of internal migration. Many people have moved to Queensland from other states. Employment opportunities in the large cities of New South Wales and Victoria, and the mining boom in Western Australia, are some common pull factors.
- China is currently home to the world's largest population, exceeding 1.37 billion people. It is the world's 2nd largest country, with a land size covering 9596961 km^2 and a density of approximately 144 people per km^2.
- Internal migration within China is highly regulated by its government, which wishes to control the movement of the country's enormous population between the 31 provinces.
- A *hukou* is a record of household registration. Every household in China requires registration by law. The *hukou* system is highly regulated.
- As more and more people from rural areas migrate to cities, especially those in special economic zones, the number of Chinese living in urban areas is predicted to be 90% by 2030.
- Most of the internal migration that occurs in China involves a large movement of people from the central areas of China towards the coastal areas, especially in the southeast of the country.
- There are negative consequences of internal migration, such as environmental destruction, overly rapid population growth and exploitation of workers.

End-of-chapter questions

Short answer

1 Explain the characteristics of both push and pull factors.

2 Why is developing the western regions of China important for China's future?

3 List some strategies China can employ to overcome the negative effects of internal migration.

Extended response

In 500 words, describe the patterns and trends of internal migration between the states and territories of Australia.

OR

Evaluate whether internal migration has had a positive impact on the redistribution of people in China. In your answer, you need to refer to:

- environmental factors
- economic factors
- social factors.

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9 International migration

Source 9.1 People from all over the world have migrated to Australia seeking citizenship and an improvement in lifestyle.

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 migration?
- Where have international migrants come from to live in Australia?
- Why do migrants want to live in Australia, and what impact has this had on Australian communities?
- How have migrant communities in Australian cities changed over time?

Key terms

- Asylum seeker
- Chain migration
- Cultural integration
- Demographer
- Forced migration
- Immigration
- International migration
- Mass migration
- Migrant
- Persecution
- Refugee
- Seasonal migration
- Visa
- Voluntary migration

Let's begin

International migration has shaped many nations. A key theory is that when the first humans left Africa, they followed the coastline, moving 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. Today international migration occurs for many reasons, including those relating to economics, family, employment, education and freedom. Generally, people who migrate are seeking a better future.

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9.1 International migration patterns

international migration the voluntary or forced movement of people between countries

voluntary migration when people move somewhere else by their own choice

migrant an individual who has moved from one country to another

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

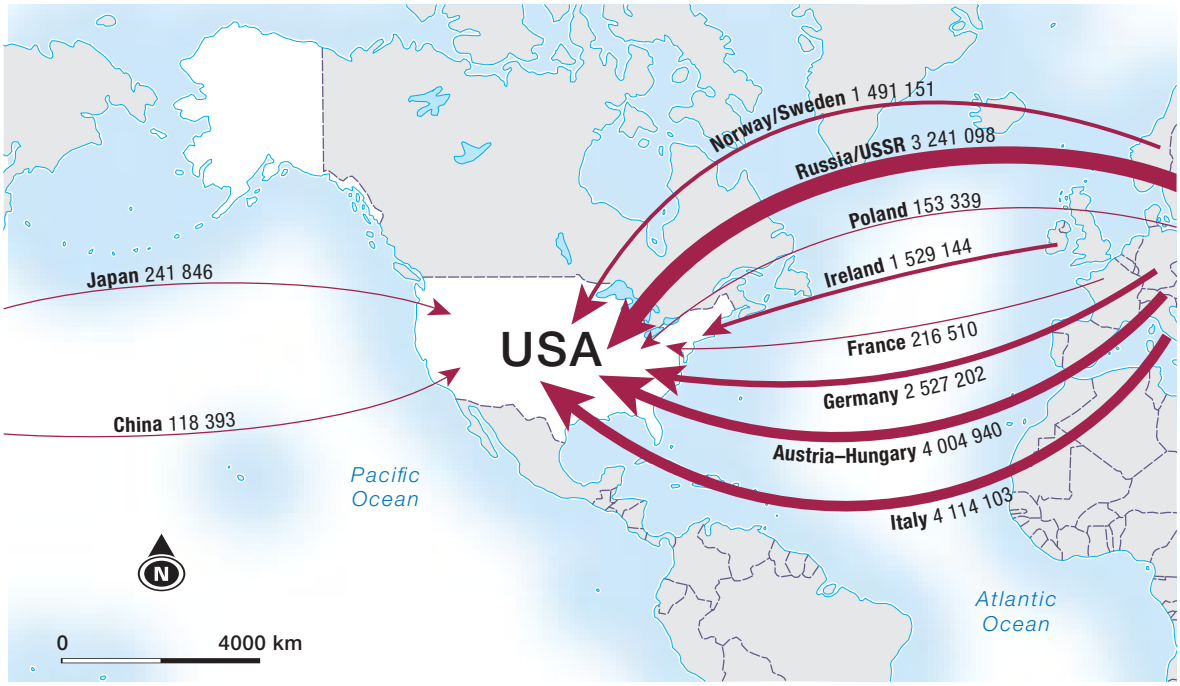
International migration is the movement of people from one country to another. People migrate to live somewhere else. They can migrate because they want to, seeking brighter opportunities for work and family – this is known as **voluntary migration**. Alternatively, **migrants** can move because they are forced to do so, because of political instability in their country, or the threat of war or **persecution** – this is known as **forced migration**.

Migration has occurred throughout history, beginning with the movement of the first humans from east Africa. Migration happens on a variety of scales – from **mass migration**, such as that which followed World War II, to individual migration.

mass migration large numbers of people moving somewhere else for similar reasons

Source 9.2 is an example of how mass international migration over a 40-year period helped to make the United States such a diverse and powerful nation today.

What are the types of migration?



Source 9.2 An example of mass international migration – migration to the United States, 1880–1920

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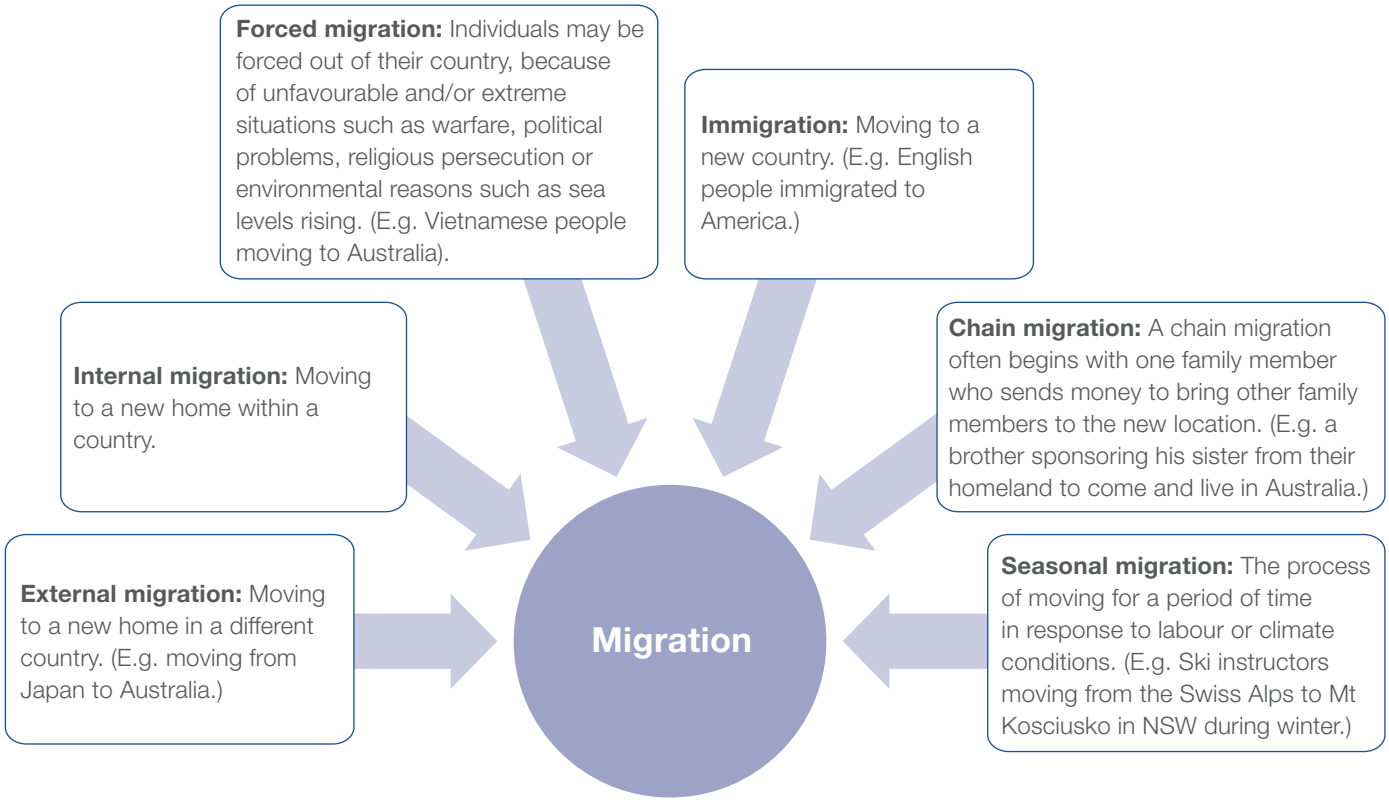

Source 9.3 Different types of migration

International migration to Australia

Historically, international migration has played a key role in populating our island nation. 60 000 years ago the first Aboriginal and Torres Strait Islander peoples migrated from islands of present-day Malaysia and parts of Indonesia. In 1788 the first European colonists arrived, and until 1868 convicts were forced to migrate from countries such as Ireland and England. The gold rush era also attracted many new migrants to Australia, including many Chinese gold diggers. Then after World War II ended in 1945, there was mass migration from Europe. In more recent times, there has been a pattern of migration from the Middle East, Africa and Asia. It is estimated that without this post-war migration, Australia's population would be around 13 million as opposed to the present 23 million.

According to the Australian Human Rights Commission (established in 1986 as an independent organisation that reports to the federal Parliament), Australia's migration program is open to anyone from any country, regardless of nationality, ethnic origin, gender or colour. In 2013–14, for example, 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.

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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Source 9.4 Melbourne's Chinatown

What is the impact of international migration on Australia?

There are many advantages of international migration. The Australian 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.

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 number 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

Source 9.5 Commuters on their way into work on the light rail in Sydney

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Geographical fact

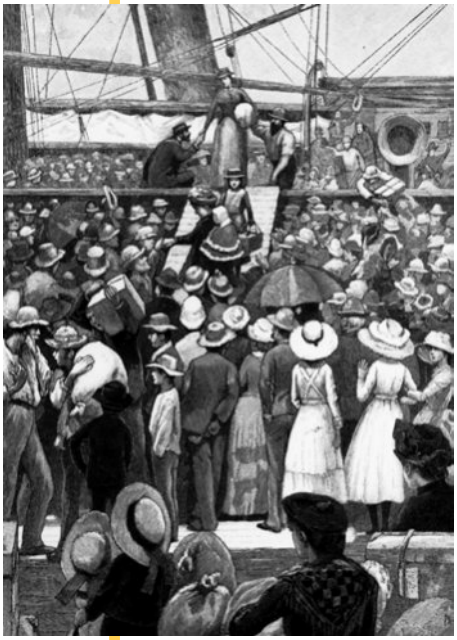
According to the Department of Immigration and Border Protection, almost 7 million people have migrated to Australia since 1945. There are over 260 languages spoken here.

Activity 9.1

1 Identify the main types of migration and provide one example of each.

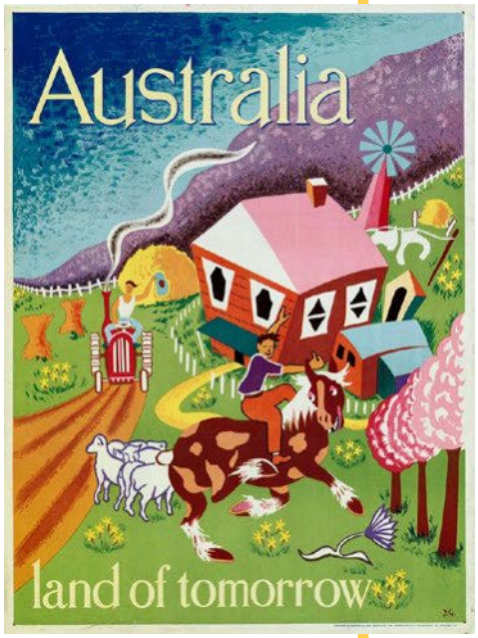
2 Examine the following three visual representations to do with the history of immigration in Australia (Sources 9.6, 9.7 and 9.8). Consider when they were produced, and for what reason they were made. Who is the intended audience? How does each image make you feel? Do they make Australia an inviting place in your opinion, and why/why not? Refer to the images and/or text in the images in your response.

3 What type of lifestyle does Source 9.8 suggest Australia offers for migrants? From your understanding, evaluate whether that is an accurate depiction for migrants around the time the image was produced.



Source 9.6 A painting of migrants disembarking from a ship, from around 1885 (From the State Library of Queensland collection)

Source 9.7 A 1928 Australian Government poster — 'The Southern Cross, the call of the stars to British Men & Women' – issued by the Overseas Settlement Office to attract immigrants



Source 9.8 Australian Government poster by Joe Greenberg in 1949, displayed between 1949 and 1951 in reception rooms and dining halls at various migrant reception centres in Australia

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9.2 International migrants settling within 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 **multicultural** 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 ideology that different cultures can coexist successfully within a country (rather than conform to one national culture)

Source 9.9 Some reasons why migrants choose to live in Australia

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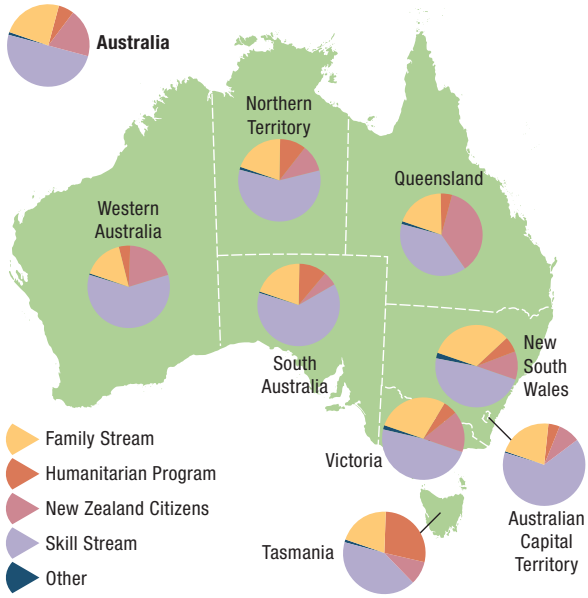
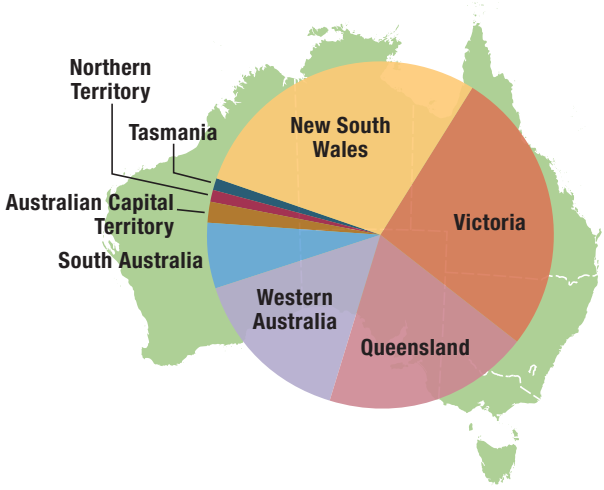
Where do migrants want to live in Australia?

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 9.10 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. For example, in 2009–10, 62.05% settled in Western Australia due to the minerals boom. The map in Source 9.11 reveals a distinct preference for living in New South Wales.



Source 9.10 Map showing the distribution of Australia's migrant population



Source 9.11 The proportion of migrants in each state and territory

Activity 9.2

1. Define 'international migration' in your own words and include an example.
2. Identify three reasons why people may migrate to other countries.
3. Identify the top five countries of origin for migrants who came to live in Australia in the past 2 years.
4. Describe the composition of Australia's population in 1947 and 1997. Identify any notable changes.
5. Using Source 9.10, identify which state has the largest proportion of its permanent residents coming for family stream/reunification. Justify one reason for this pattern.
6. Using Source 9.11, explain why there are such a high proportion of new migrants in New South Wales.
7. *Class discussion*: Imagine that Australia did not accept immigrants from other countries. What would Australia be like?

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Geographical fact

Demography is a science that studies populations. A **demographer** is someone who works with these 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 (maternal) grandmother born?
7. Where was your (paternal) grandfather born?
8. What languages do you or your family members speak?
9. What were the reasons for your family members migrating to Australia?
10. Why did your family 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.

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, nine from the United Kingdom, five from Greece).

1. Identify any patterns that emerge.
2. Discuss the contributions each of these cultures has made to Australia.

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What is the difference between a refugee and an asylum seeker?

refugee a person who has left their own country because of fear for their safety and wellbeing

According to the UN Department of Economic and Social Affairs, the issue of **refugees** is 'a global phenomenon that is growing in scope, complexity and impact'. A refugee is a person who has left their own country because of fear for their safety and wellbeing. Every year, millions of refugees from around the world seek a new homeland.

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 number of people are registered with the **UNHCR**, and of these only 1% are resettled.

UNHCR United Nations High Commissioner for Refugees – basically the UN's refugee agency

Other countries have far greater numbers of refugees than Australia

UNHCR data from 2013 shows that Australia, with 34 503 refugees, ranks 45th in the world. This compares with Pakistan (1 616 500), Iran (857 500), Lebanon (856 500), Jordan (641 900), Turkey (609 900), Kenya (534 900), Chad (434 500), Ethiopia (433 900), China (301 000) and the United States (263 600). On a per capita basis, Australia is far behind poorer countries such as Jordan.

Source 9.12 Some facts about refugees that dispel common 'myths'. Sources: UNHCR, Australian Red Cross and Amnesty International Australia.

Source 9.13 Asylum seekers are people who have left their homeland and sought protection from another country as refugees. Pictured are two Sri Lankan asylum seekers whose ship ran out of fuel in Indonesian waters en route to Australia in January 2013. The ship had 46 asylum seekers on board and all were rescued by Indonesian rescue workers and evacuated to Padang, West Sumatra, Indonesia.

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Geographical fact

The United Nations estimated that there were over 60 million refugees worldwide in 2015. Put another way, that's one in every 122 people worldwide – roughly the equivalent of the entire population of Italy being pushed out of their homes.

Australia's policies on asylum seekers and refugees

According to the Australian Human Rights Commission, about 13000 of these people are permitted to make new lives in Australia per year. 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.

The Australian Government's Humanitarian Program has two main components:

- offshore resettlement for people who are found to be refugees (and others whose need for protection has been acknowledged) in another country before they come to Australia
- onshore protection for people who come to Australia with a valid visa and make a successful claim for asylum after they arrive.

Many governments have been critical of Australia's policies and handling of asylum seekers in recent years. At a UN Human Rights periodic review session in November 2015 in Geneva, delegates from Turkey, Sweden, Norway, the United States, Britain, Canada, Fiji, France, Germany and Switzerland all heavily criticised Australia's border control policies, which have seen asylum seekers — including children — detained on Christmas Island, Manus Island and Nauru. The UNHCR's description of Australia's recent treatment of asylum seekers and refugees is as follows:

> In Australia, restrictive policy changes introduced previously were further reinforced by the coalition Government elected in September 2013. The introduction of (regional) offshore processing in Papua New Guinea and Nauru in 2012, with no prospect of durable settlement in Australia, was combined with 'Operation Sovereign Borders' to implement the Government's policy of intercepting and returning boats to Indonesia.
>
> The new Government reduced the humanitarian programme from 20000 resettlement places in the fiscal year 2012–2013 to 13750 places in 2014–2015, of which 6000 are expected to be available for UNHCR-referred refugees. In September 2014, Australia and Cambodia signed a memorandum of understanding for the relocation of recognized refugees from Nauru to Cambodia.
>
> Source: 2015 UNHCR subregional operations profile – East Asia and the Pacific, accessed 10/11/2015

Source 9.14 The UNHCR's description of Australia's recent treatment of asylum seekers

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Activity 9.3

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 UNHCR Convention Relating to the Status of Refugees (1951). Use the internet to find the text of Article 1.

3 Explain why people seek refugee status in countries like Australia.

Geographical fact

More than 4 million refugees have fled Syria since the war there began in 2011. According to the UN's refugee agency, almost 1.8 million have gone to Turkey, more than 600 000 to Jordan and 1 million to Lebanon – a country whose population is just 4 million.

Source 9.15 Syrian refugees at a clinic in Ramtha, northern Jordan, 2013

2015 Syrian and Iraq refugee crisis

At the time of writing, the dramatic European refugee crisis of 2015 was developing. Though hard statistical data are not yet available, it is safe to say that thousands of refugees have made dangerous crossings by sea and by land to Europe, driven by the wars in Syria and Iraq, as well as conflict and instability in Afghanistan and Eritrea and economic instability elsewhere. As of November 2015, the UNHCR estimates that more than 2500 people have lost their lives attempting to cross the Mediterranean Sea to Europe. This includes the drowning of toddler Aylan Kurdi, one of 12 Syrian refugees who drowned en route to the Greek island of Kos on 2 September 2015. The image of Aylan's lifeless body on a Turkish beach brought the crisis into sharp focus for many people around the world.

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Source 9.16 (Left) In September 2015 UNHCR aid workers register refugees on Kos Island, Greece. Kos is located just 4 km from the Turkish coast, and refugees come from Turkey on inflatable boats. (Right) A beachside memorial in Turkey for three-year-old Aylan Kurdi and the other Syrian refugees who tragically drowned while trying to flee the Syrian conflict.

UNHCR spokesperson Adrian Edwards claimed in late September 2015 that there were seven key reasons for the flood of refugees from the Syrian and Iraqi conflicts. These are:

- loss of hope
- high costs of living/deepening poverty
- limited livelihood opportunities
- aid shortfalls
- hurdles to renew legal residency
- scant education opportunities
- feeling unsafe.

Many refugees have sought asylum in EU member states, and a record 800 000 refugees are expected to arrive in Germany in 2015. In September 2015, the European Parliament voted in favour of a migrant quota system to make sure that asylum seekers are distributed more equally across member states. In Australia, as of November 2015 it was reported that the Turnbull Coalition government has committed to accepting a further 12 000 refugees from the Syrian conflict.

Source 9.17 In September 2015 the European Parliament voted in favour of a migrant quota system to make sure that asylum seekers are distributed more equally across member states.

RESEARCH 9.2

1 Visit the Edmund Rice Centre for Justice and Community Education website and devise your own infographic about refugees.

2 Visit the World Refugee Day website and prepare a speech about the importance of the United Nations acknowledging this day.

Source 9.18 World Refugee Day is an international day that acknowledges the plight of refugees.

9.3 Characteristics and spatial patterns of Australia's cultural diversity

Australia prides itself on the fact that (as confirmed by recent statistics published by the Australian Bureau of Statistics), one in four of its citizens has a migrant heritage. Nearly one-third 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.

cultural integration the process of drawing together various elements of a cultural system, such as ethnic groups, into a wider community

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 four main ideas, shown in Source 9.19. This policy indicates the strong government support that exists for multiculturalism. 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

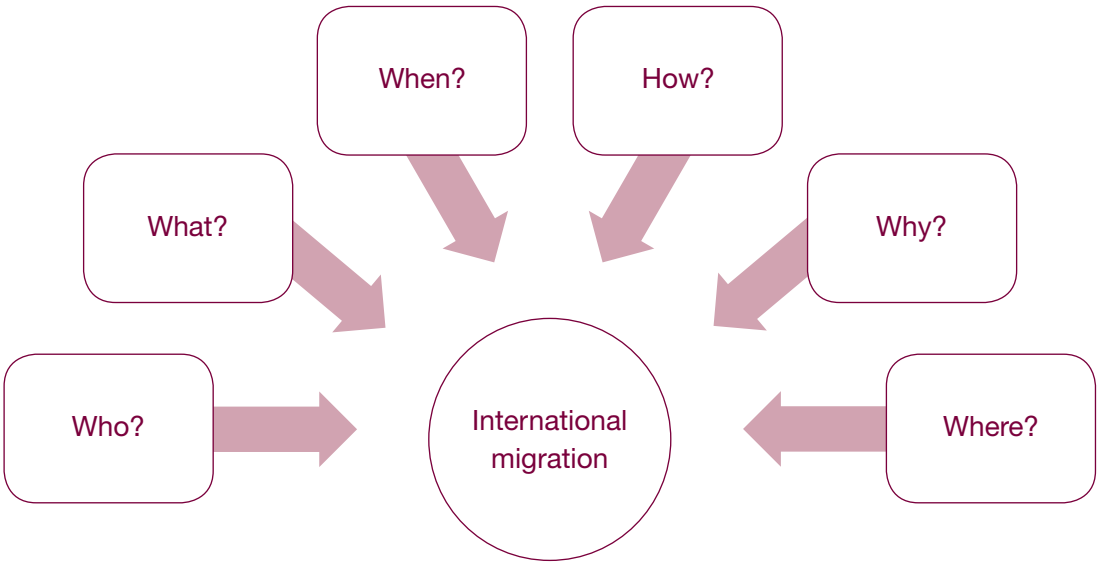
Principle 3:
The Australian Government encourages the economic, trade and investment benefits which come from our multicultural nation

Principle 4:
The Australian Government promotes understanding and acceptance and discourages discrimination. If this occurs the law will be there to support.

Source 9.19 Australia's multicultural policy is built on four principles.

Note this down 9.1

Copy the graphic organiser below and summarise what you have learned about international migration.



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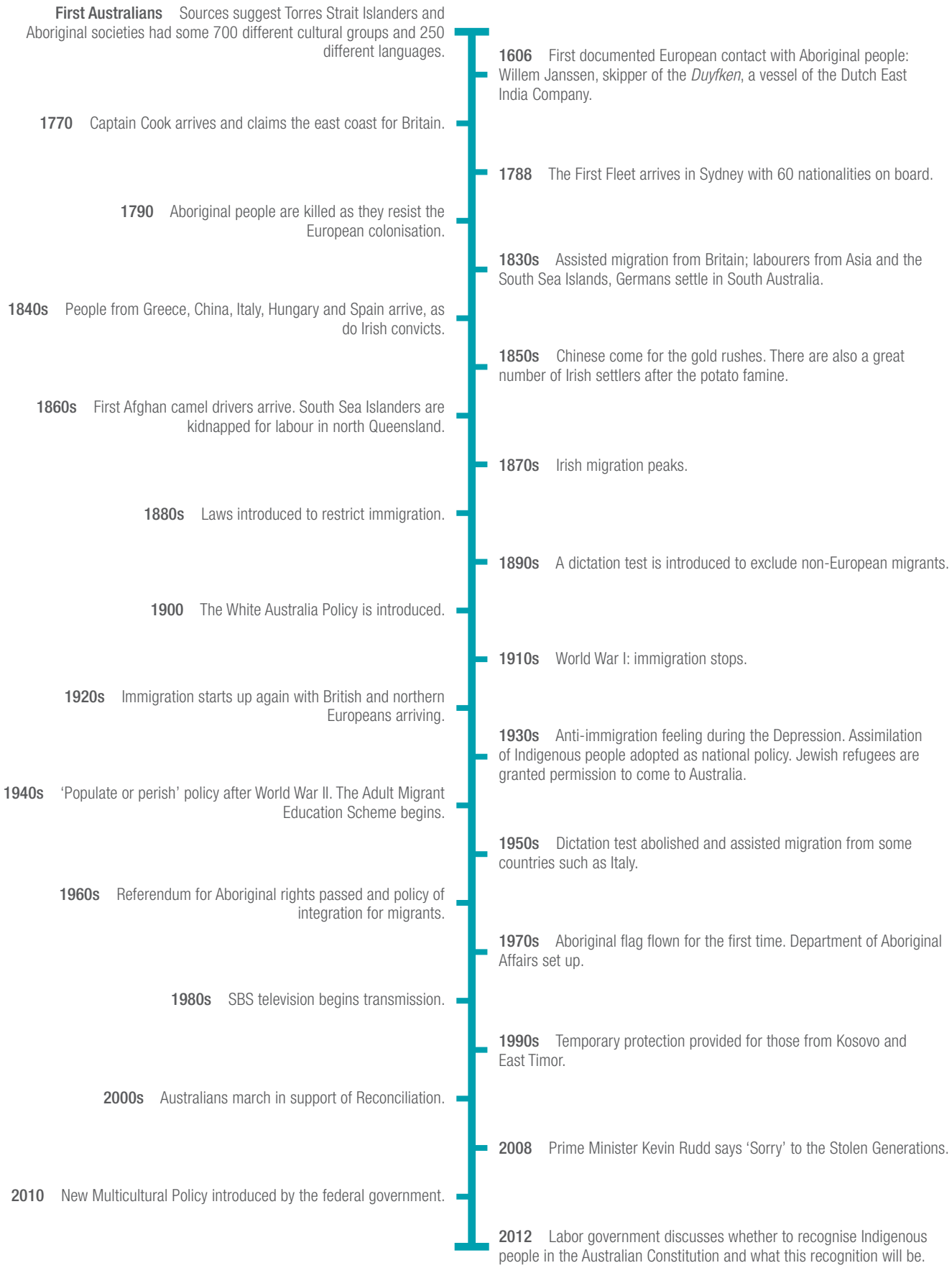

Source 9.20 Some key dates in the history of Australian multiculturalism

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Source 9.21 A key date – a crowd in Melbourne watches a live broadcast of Prime Minister Kevin Rudd symbolically apologising to the Stolen Generations on 13 February 2008

Activity 9.4

1 Discuss some reasons why migrants may choose to live in the capital cities of Australia.

2 Refer to Source 9.20. Reflect on one of the historical events. Explain how it helped or hindered multiculturalism.

3 Complete a think, pair, share activity about Kevin Rudd's 2008 apology to the Stolen Generations.

- **a** Think: reflect on what the event meant to you personally, and to Australia as a nation.
- **b** Pair: find a partner and discuss your thoughts. Together, write a short statement of your opinions on the apology.
- **c** Share: the teacher will choose pairs at random to share their statements with the class.

RESEARCH 9.3

Produce a web page or design an app that provides advice about coming to live in Australia for someone wanting to migrate. Develop the outline, functions and content of the app.

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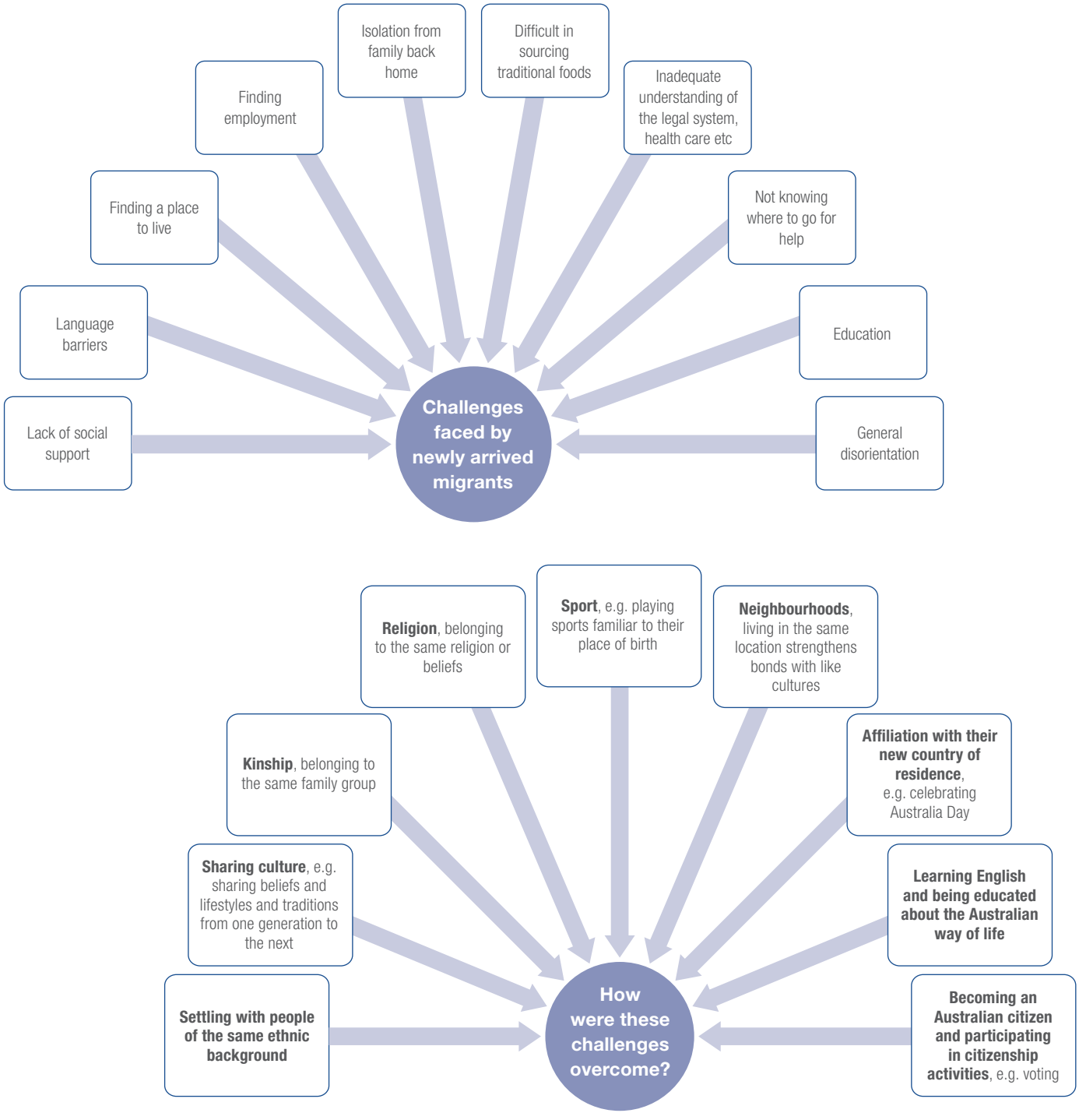
Challenges faced by migrants

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 9.22 outlines some of these challenges and how they were overcome. The Cabramatta case study that follows is a practical example of how people have overcome the challenges listed in Source 9.22.

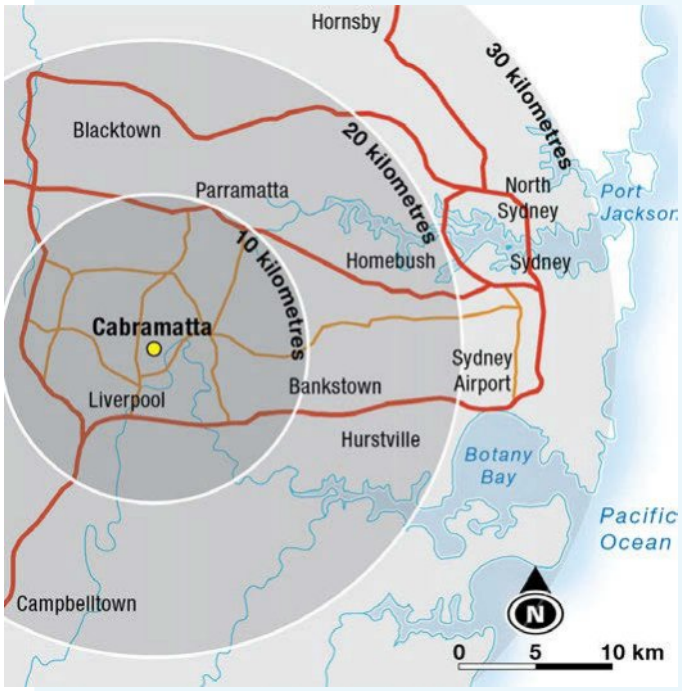


Source 9.22 Challenges faced by newly arrived migrants and how they were overcome

ISBN 978-1-316-60623-0

Case study 9.1

The Vietnamese in Cabramatta, Sydney, New South Wales



Source 9.23 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 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.

Source 9.24 A restaurateur serves traditional Vietnamese food in Cabramatta in the 1990s.

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Geographical fact

Vietnamese is the 5th most commonly spoken language other than English in Sydney.

Cabramatta today

Source 9.25 Indicates the most common countries of birth for residents of Cabramatta.

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 migrants 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 spoken languages 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

Country of birth	Cabramatta	%	New South Wales	%	Australia	%
Australia	6106	29.4	4747372	68.6	15017847	69.8
Other top responses						
Vietnam	6769	32.6	71840	1.0	185039	0.9
Cambodia	1944	9.4	11147	0.2	28329	0.1
China (excludes **SARs** and Taiwan)	1081	5.2	156035	2.3	318969	1.5
Laos	337	1.6	5101	0.1	9932	0.05
Thailand	306	1.5	17539	0.3	45464	0.2

Source 9.25 Origins of people in Cabramatta, NSW and Australia

SARs Special Administrative Regions of the People's Republic of China. Territories such as Hong Kong or Macau fall under the sovereignty of China but are not on the Chinese mainland.

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Source 9.26 Friendship Arch in Freedom Plaza, Cabramatta, NSW

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 onto the 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. 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.

Source 9.27 Images from a recent Cabramatta Moon Festival

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1 List the ethnic groups found in Cabramatta.
2 Explain 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 9.25, construct a pie graph showing the cultural diversity in Cabramatta.

Source 9.28 NSW is not the only Australian state with strong Vietnamese communities. Pictured is a memorial to refugees of the Vietnam War in Brisbane, Queensland.

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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 two 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 Census website, under 'Data & Analysis' – 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** Include name of the shopping centre or street in your local area
Page 3	**Introduction** Brief description of the study site

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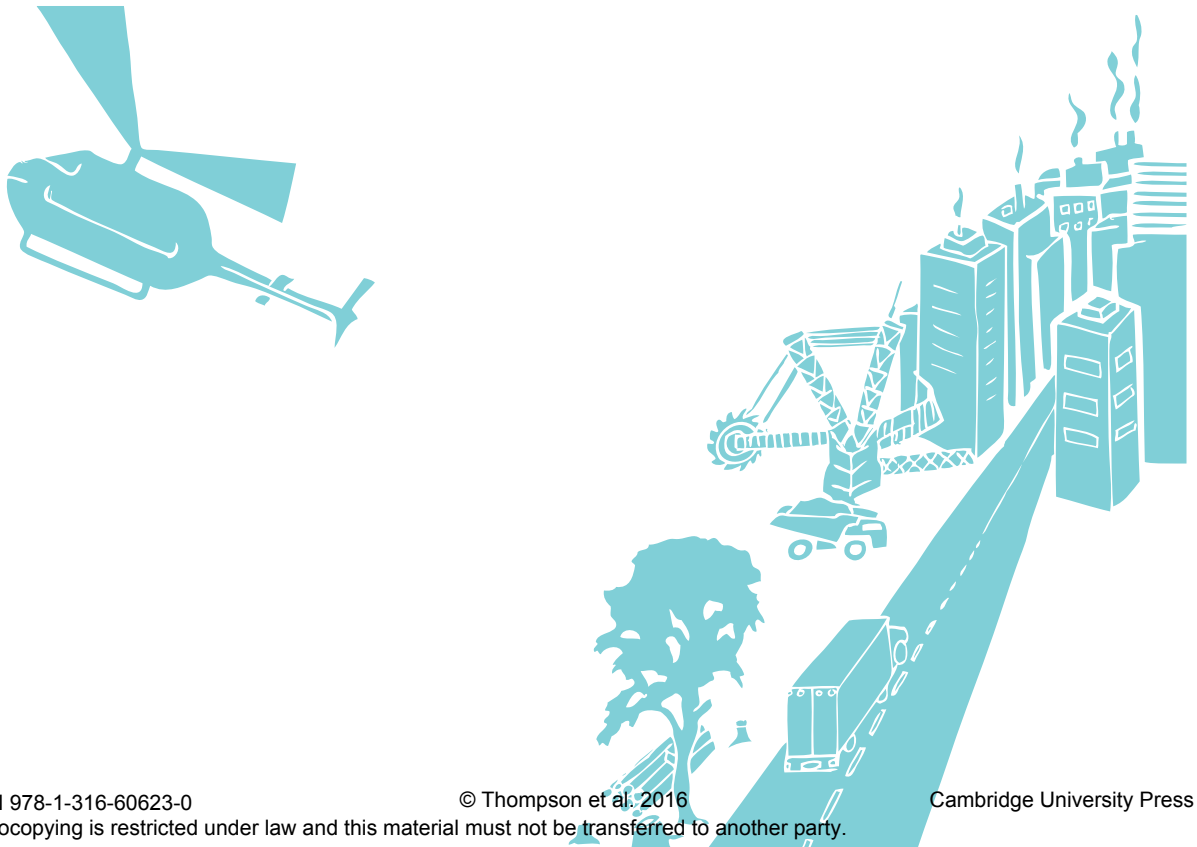
Page 4–5	**Description of cultural groups evident** Include photos
Page 6	**Table** Categorise the shops or features into dominant cultural groups. Have a data collection (make a tally) for 'others' – those that do not fit into a particular group.
Page 7–8	**Description of positive and negative effects of cultural diversity in your chosen site** Include sketches and/or photos
Page 9	**Association between use and culture** Make observations: 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** Show your statistical findings on the different cultures and evidence from the built environment
Page 11	**Annotated photo essay** Show 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 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 multicultural cities: in the architecture, religious and cultural events, food and services.

End-of-chapter questions

Short answer

1 Explain how international migration has changed Australian cities.

2 Discuss some reasons why refugees may want to live in Australia.

3 Identify the main types and patterns of international migration.

Extended response

Justify your response to the following statement: 'Multiculturalism has enriched the way of life in Australia.'

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10 Australia's urban future

Source 10.1 Newcastle is the 2nd largest urban area in New South Wales; only Sydney is larger.

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 a crucial factor in the evolution of our society as a whole. Building and maintaining sustainable cities has implications for our current and future standards of living.

Inquiry questions

- What can be learned from examining the forecasts for the size of Australia's major cities and regional urban centres?
- What is the projected growth of Australia's population?
- What are the implications of population forecasts for the future growth and sustainability of Australia's urban places?
- What are some of the strategies used to create economically, socially and environmentally sustainable urban places?
- What proposals can individuals and communities contribute to a sustainable urban future?

Key terms

- Gentrification
- Metropolitan
- Population distribution
- Salinity
- Suburbanisation
- Sustainable
- Urban consolidation
- Urban sprawl
- Urbanisation
- Zoning

Let's begin

Australia is a large country, though its population is small relative to its size. For every square kilometre of land there are, on average, around three Australians. In comparison, the United States of America has 35 people per square kilometre, China 145 and India 410. Despite Australia's smaller population it is highly urbanised, and as the Australian Bureau of Statistics predicts the population will double by 2075, how we manage and plan for a sustainable urban future will be crucial.

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10.1 Australia's projected population growth

On 23 March 2015, the resident population of Australia stood at 23 920 218 people. Australia's inhabitants comprise two distinct categories: Aboriginal and Torres Strait Islander peoples, and forced and voluntary migrants (and their descendants) from source countries around the world. Many of these migrants are **naturalised Australians**. Australia's descendants from the colonised population and settlers since 1788, along with today's migrant populations, collectively speak about 400 different languages and identify with about 300 ancestries. Approximately one-third of the population are born overseas – in one of over 210 countries. Two out of every five people have at least one parent born overseas.

naturalised Australians individuals born outside Australia who have become Australian citizens

Aboriginal and Torres Strait Islander population

In 2011, the Australian Bureau of Statistics (ABS) counted 669 900 people who identified themselves as being of Aboriginal and Torres Strait Islander origin. This represents approximately 3% of the total Australian population. New South Wales had the highest count (208 500, or 31% of the national total), followed by Queensland (189 000, or 28%) and Western Australia (88 300, 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 number of Aboriginal and Torres Strait Islander people – albeit still small – is increasing. The ABS predicts that the Aboriginal and Torres Strait Islander population will be 945 600 people by 2026, at an average growth rate of approximately 2.2% per year.

Source 10.2 Approximately 3% of the total Australian population identify themselves as being of Aboriginal and Torres Strait Islander descent.

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Urbanisation and population

According to the ABS, the percentage of Australians living in capital cities has increased steadily since Federation, from 36% to almost two-thirds in 2013 (66%). The population of Australia's capital cities grew by 1.9% between 2012 and 2013, faster than the remainder of Australia (1.6%). Greater Perth had the fastest growth of all capital cities at 2.5%, ahead of Greater Melbourne and Greater Darwin (both 2.2 %). The fast pace of urbanisation in Australia is bringing vast challenges for the management of cities.

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 and 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 expansion 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.

suburbanisation
a process whereby people, businesses and warehouses move from the inner city out to the suburbs, usually due to cheaper land, accessibility to major transport routes and labour supply

Source 10.3 A hot air balloon flies over Melbourne's CBD and sprawling urban area.

Population distribution

There are approximately 7.3 billion people in the world, but population is not spread evenly, and this is called uneven **population distribution**. Patterns of population distribution tend to be uneven: places that are lightly populated contain a small number of people; those that are heavily populated contain many people.

population distribution where people live in a given area

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. 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, 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.

Source 10.4 Shaded relief map showing how Australia's urban areas correspond with the more temperate areas around the continent's coastline

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Activity 10.1

1 Suggest why local governments are becoming increasingly important in management of urbanisation.
2 Describe the processes of suburbanisation and urban sprawl in the growth of urban areas.
3 Identify a special characteristic of Australia's population distribution.

10.2 Implication of population forecasts

There are several implications of Australia's projected population growth on the sustainability of our urban spaces.

Employment

As the population of Australia is concentrated in the five biggest cities, there are 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 2013, according to the Australian Bureau of Statistics. Proximity to work and employment opportunities is an important consideration for many people.

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. Businesses and trade create networks that offer training and specialisation in employment. The growth

Source 10.5 Sydney's central business district

of business and trade is stimulated in urban areas because such a large percentage of the population lives there.

Tourism in capital cities

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 2013, 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. Our Asia Pacific location and cultural diversity create

Source 10.6 Tourism is crucial to the future of our economy. Pictured is the front of one of Australia's oldest hotels, Melbourne's Hotel Windsor.

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Source 10.7 Having culturally diverse cities has helped us to make connections with other communities in the world.

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, food chains – major linkages between species that allow for the creation of new life in habitats – have been broken. This has led to the extinction of plant and animal species found within these specialised communities.

Source 10.8 Destruction of habitat can have a negative impact on our unique biodiversity in Australia.

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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, it has been said that during the early years of settlement in Australia, 500 000 hectares 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 native species of plants and animals.

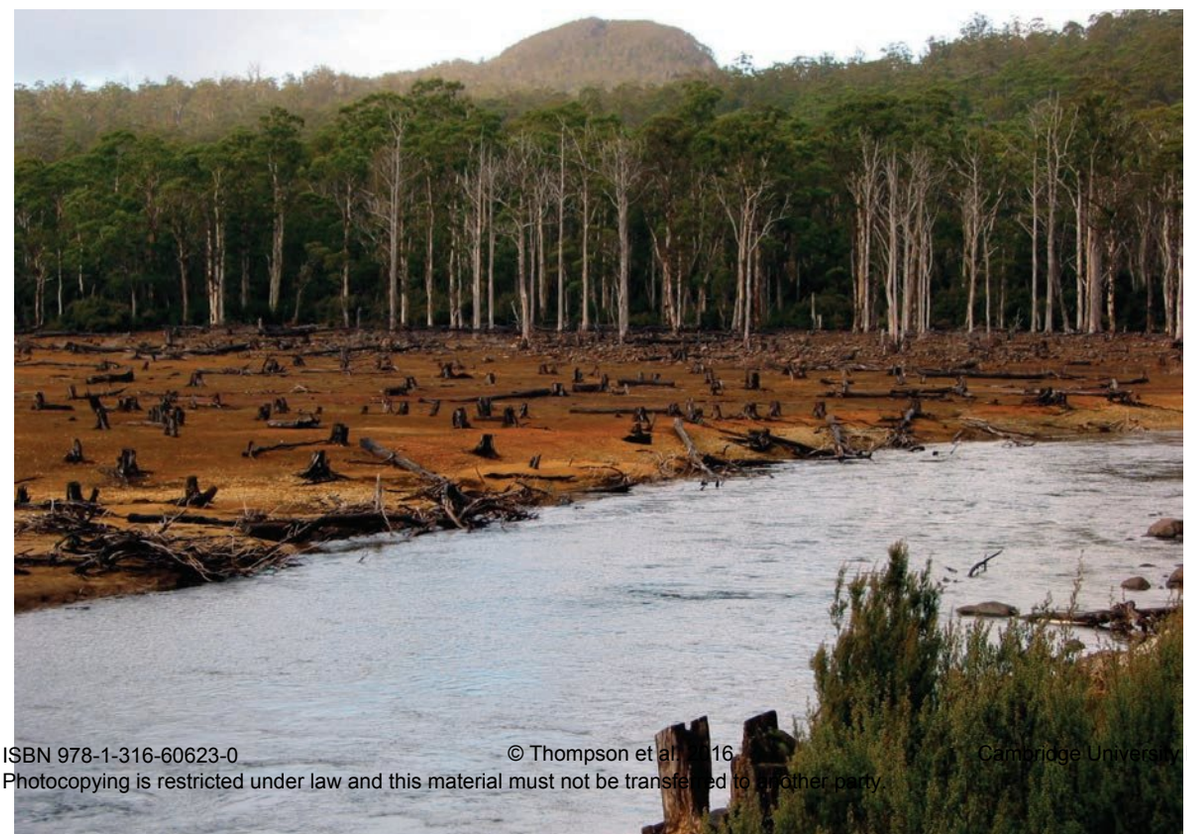
The raising of hard-hoofed animals such as sheep and cattle has resulted in compaction of soil. Introduced species of weeds have been an issue, as they have slowly invaded and taken over the native varieties.

Another concern 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.

Activity 10.2

1. Explain the link between employment, business and trade in cities.
2. Discuss with a partner why cities are places of cultural diversity, particularly when compared to rural areas. Are there any exceptions to this?
3. Assess the negative impacts of cities on the natural environment. Refer to biodiversity and deforestation in your response.

Source 10.9 Deforestation along a river in Tasmania



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Urban sprawl

The many impacts of urban sprawl are summarised in the following table.

Impact	Description
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. 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. E.g. 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.
Loss of rural areas	This is due to the need for land to establish the growth of the population. 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 face 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 creates 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 have been created in order to attract wildlife and add a nature reserve to the built environment. There are 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 effect	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 northeast of the United States have demonstrated that this increase in temperature can be as much as 7ºC.
Urban decline and renewal	In some older suburbs closer to the city centre, the older homes can be abandoned as families move to 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 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.

gentrification the renovation and growth in social and economic status of previously run-down areas

Source 10.10 The impacts of urban sprawl

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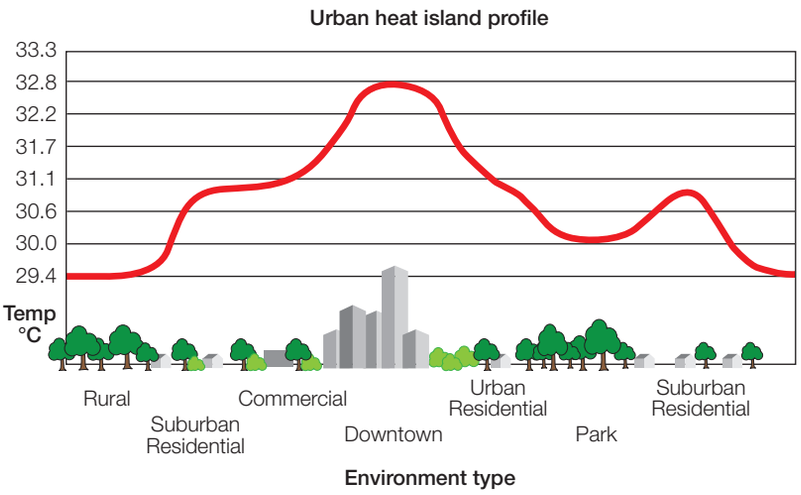
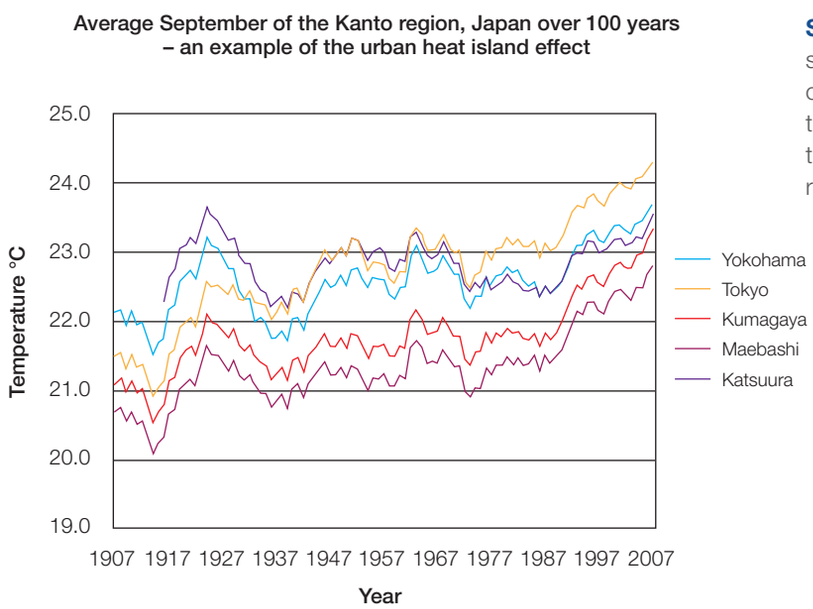


Source 10.11 One major result of urban sprawl is the heat island effect. This source suggests how temperatures fluctuate due to the proliferation of buildings and asphalt road surfaces – the heat island effect at work.



Source 10.12 This source suggests how as the urban areas of Greater Tokyo, Japan, built up throughout the 20th century, so too did the average temperature rise.

Source 10.13 The sun sets after a hot day in Tokyo, Japan

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Note this down 10.1

Copy the graphic organiser below 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). Write down a summary of the impacts of urban sprawl using the appropriate letters; for example, 'H is for heat island effect'.

ABC brainstorming Urban sprawl			
A	G	M	S
B	H	N	T
C	I	O	U
D	J	P	V
E	K	Q	W
F	L	R	XYZ

10.3 Strategies to create sustainable urban places

In 1992, the United Nations introduced an action plan for sustainable development. Agenda 21 is a blueprint that sets out what we can all do to contribute to global sustainability in the twenty-first 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.

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 examples that follow in this chapter.

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

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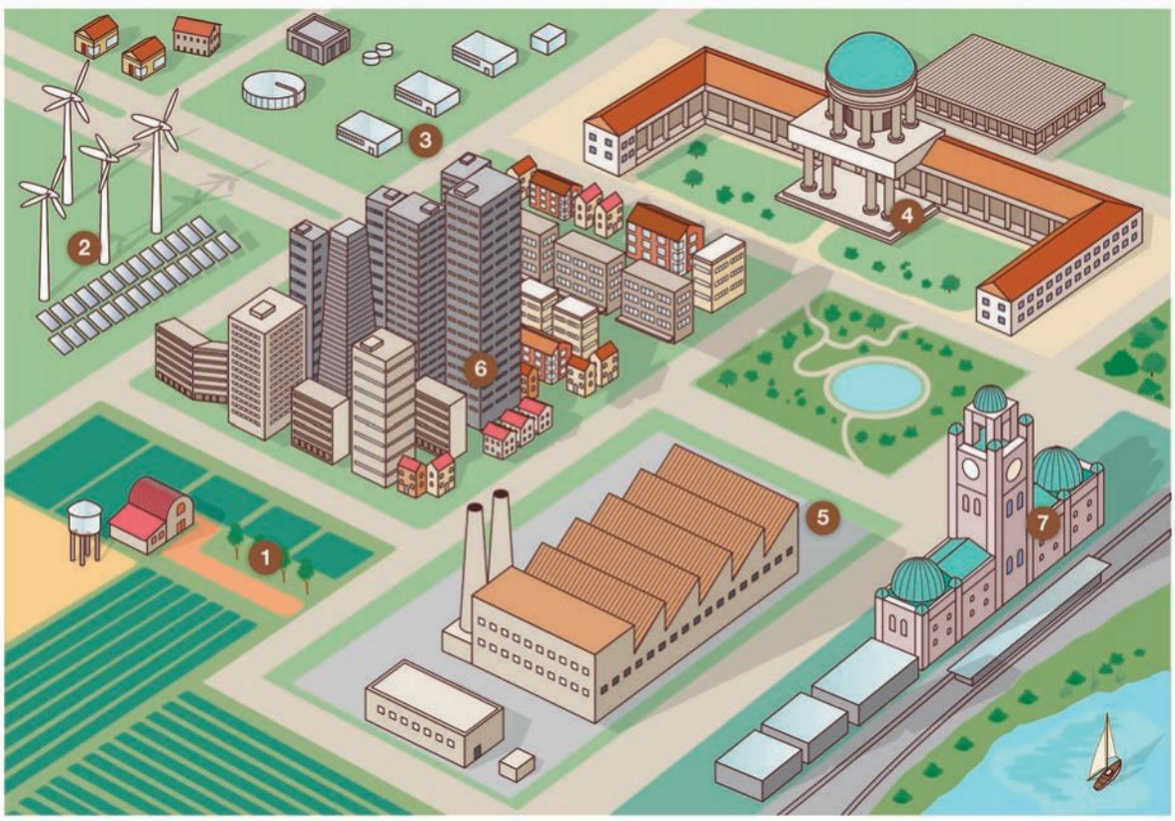

1. Food supplies will need to be close to the city with plans in place to encourage the growth of market gardens.
2. Need for greater cleaner and efficient use of alternative energy supplies and a reduction in reliance on fossil fuels.
3. Improve recycling capabilities and reduce waste.
4. Allow for 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.

Source 10.14 Cities of the future

RESEARCH 10.1

1 Look up the City of Sydney's Sustainable Sydney 2030 initiative online.

2 List the 10 Strategic Directions involved in the initiative.

3 Explain what you think the five most significant achievements of the initiative are to date and why.

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10.4 Ways to contribute to a sustainable urban future

There are many ways of managing the projected growth of our cities and regional areas in Australia. Sustainable urban futures can be achieved through collective action from individuals, community groups, institutions and governments.

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

When regional settlement is encouraged, 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 Border Protection 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 cities for migrants in their 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 increased slightly, rising to 15% of all migrants.

Develop regional centres

Developing regional centres takes the pressure off the larger established urban areas close to the city. Projects such as Evocities (Source 10.15) have been an incentive for people to

Source 10.15 The Evocities project brings together seven NSW regional centres: Albury, Armidale, Bathurst, Dubbo, Orange, Tamworth and Wagga Wagga. Pictured is the historic railway station at Albury.

metropolitan of a very large city, often the capital of a country or region

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 for growth and the need to have their local economies stimulated.

Urban consolidation

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 consolidation is the process of planning and constructing more medium-density housing in existing urban areas. It can greatly reduce the need for urban sprawl and make our cities more ecologically friendly. Urban consolidation is a more sustainable form of development, as it uses existing roads and amenities and often is used to infill areas in the city that are not suitable for stand-alone dwellings. An added benefit is that the buildings are often close to public transport facilities such as trains and buses.

Renew cities and older suburbs

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.

Have more high-density housing 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.

Preserve natural resources

Preserving the land – farmlands, parks, open spaces and unused 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.

Create a community identity

Building sports facilities, parks and schools in close proximity to residential areas reduces driving times and fosters a closer sense of community.

Improve public transport

Providing more options such as light rail and bus transit lanes can help reduce traffic congestion during peak hour.

Improve use of energy sources

Encouraging better use of renewable energy sources can 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 regulate new housing developments to ensure that developers build more energy-efficient homes. This could include putting insulation in walls to reduce the need for air conditioning, installing water tanks to collect rainwater and allowing better recycling of household rubbish to reduce landfill.

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Source 10.16 Solar power plant under construction in Germany

Reduce commercial zones

With the increase in online shopping, some people feel less need for the conventional shopping centre. This can reduce urban sprawl, as consumers do 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.

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 collected in plants on roofs, reducing the water flow to the hard surfaces below, like concrete, which do not absorb water. The study estimated that the installation of approximately 5000 hectares (on roofs larger than 350 m^2) could save the city millions of dollars in pollutant and erosion control, and even more from reduced water storage costs.

Source 10.17 An example of a green roof initiative – Chicago's City Hall building, Illinois, USA

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An example of sustainable strategies implemented in Australia using principles of the United Nations Local Agenda 21 – Gold Coast, Queensland

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

The Gold Coast is a high-density **urban area** with an attractive coastline. In response to 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 economic strength of the Gold Coast. 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%.

Source 10.18 The Gold Coast's attractive coastline

Activity 10.3

1. Identify how Local Agenda 21 has encouraged the development of sustainable cities.
2. Explain how the Gold Coast community has 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.

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 if it will be a sustainable place 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 my local urban place and suggest ways to make it more sustainable.

Method

Use primary sources such as photographs and secondary sources such as newspapers and local government information to 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 place.

Preparation

Step 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 place. Aspects to consider include low crime rates and amount of green space.

Step 2: Use the Egan Wheel (see next page) and categorise the information that you have listed in Step 1 to complete the following table. As an example, the table has been completed for Blacktown City, a suburb 35 km west of the Sydney CBD.

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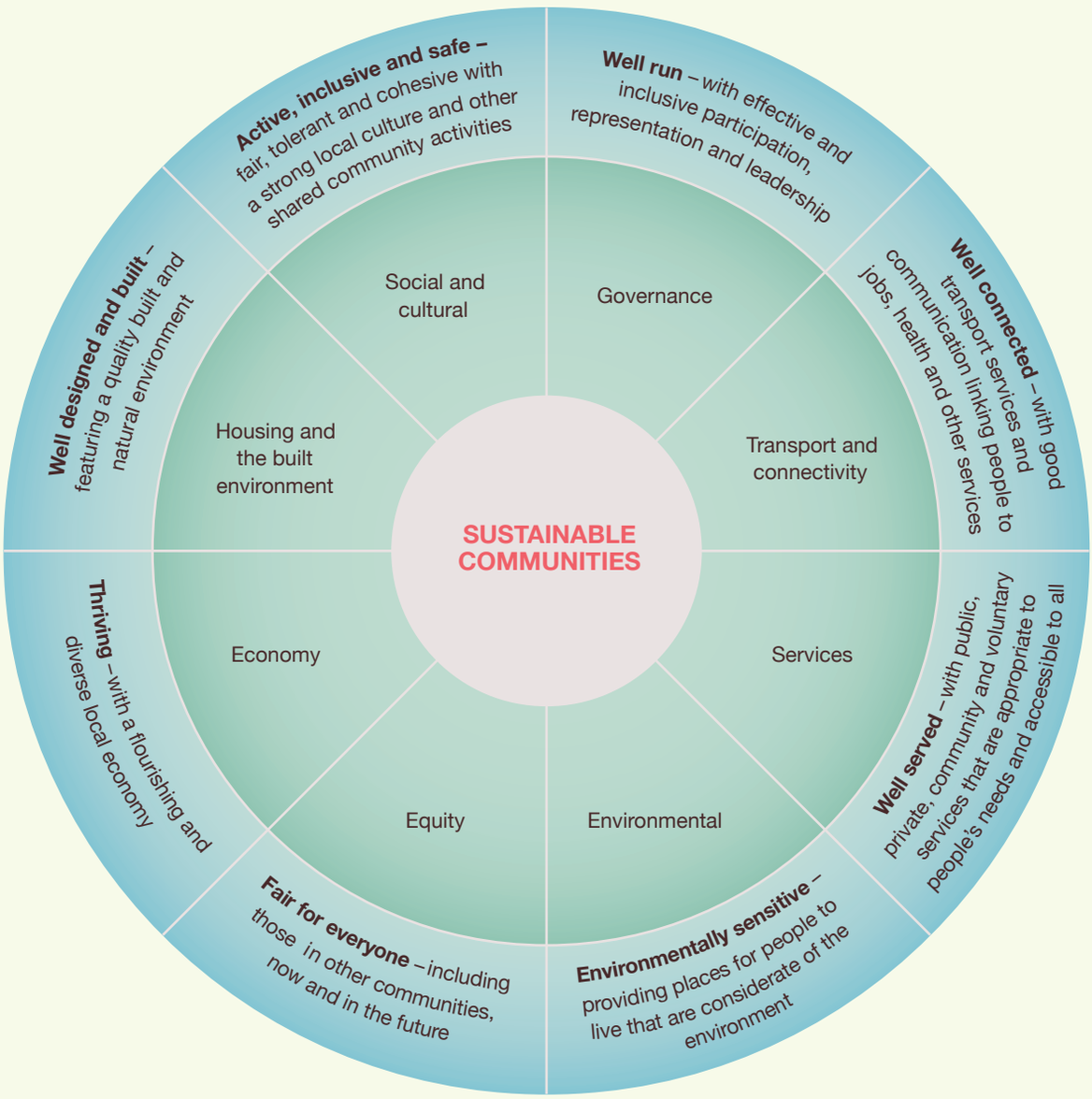
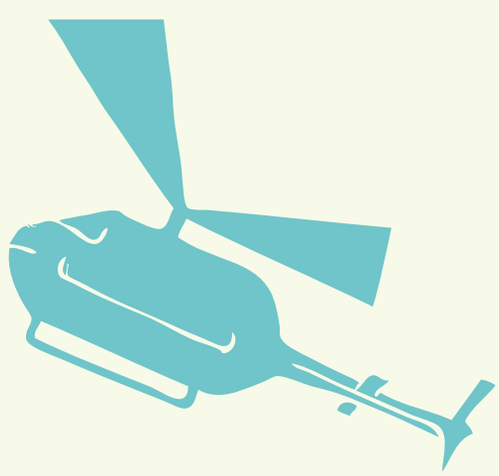


Source 10.19
The Egan Wheel, created by Sir John Egan in 2004, summarises what it takes for communities to be sustainable. It is a useful tool to help you evaluate the sustainability of your local urban area in the future. You will use this in your fieldwork to determine the sustainability of your local urban area.



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The sustainability of Blacktown City, NSW

Egan's Sustainability Wheel	Annotations based on Blacktown, NSW
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. Sustainability Street puts the idea of Think Global, Act Local into practice. Council works with communities to provide the skills and knowledge to make their street the most sustainable environment and community they can. 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 train 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 more 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 paint ball.
Environmental	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 the 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.
Economy	Blacktown City is home to over 10 000 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.

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Egan's Sustainability Wheel	**Annotations based on Blacktown, NSW**
Housing and the built environment	There is a variety of housing including urban consolidation in and around Blacktown station. The newly refurbished Francis Park 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 cultures and provides an event to support community pride.

Step 3: Go out into the local area and take photographs of your local community that 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?			

Step 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 which areas should be improved upon.

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Chapter summary

- Australia's population is growing, unevenly distributed and highly urbanised.
- Australia's small Indigenous population is growing slowly.
- Urban growth and urbanisation have both positive and negative effects.
- The growth of new suburbs is called suburbanisation, and is often associated with urban sprawl.
- Urban sprawl is often seen in 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.
- Impacts of urban sprawl include increased traffic, decrease in air and water quality, loss of rural areas, decrease in groundwater, loss of biodiversity, the heat island effect, urban decline and renewal, and lack of housing choices.
- Methods to manage urban sprawl include government policy, encouraging regional settlement, developing regional centres, urban consolidation, renewing older suburbs and higher density housing.
- Methods to create a sustainable urban environment include preserving natural resources, creating a community identity, improving public transport, improving the use of energy sources and reducing commercial zones.

End-of-chapter questions

Short answer

1 Construct a concept map that shows your understanding of the definition of urban places.

2 Describe the impacts of urban sprawl on our cities and surrounding areas.

3 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 two 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 two chosen cities
- a description of the population characteristics, including total size, density, gender, age structure, growth and ethnic composition
- a description of the main land use patterns of your chosen cities, including where the industrial, commercial, residential and green spaces are found

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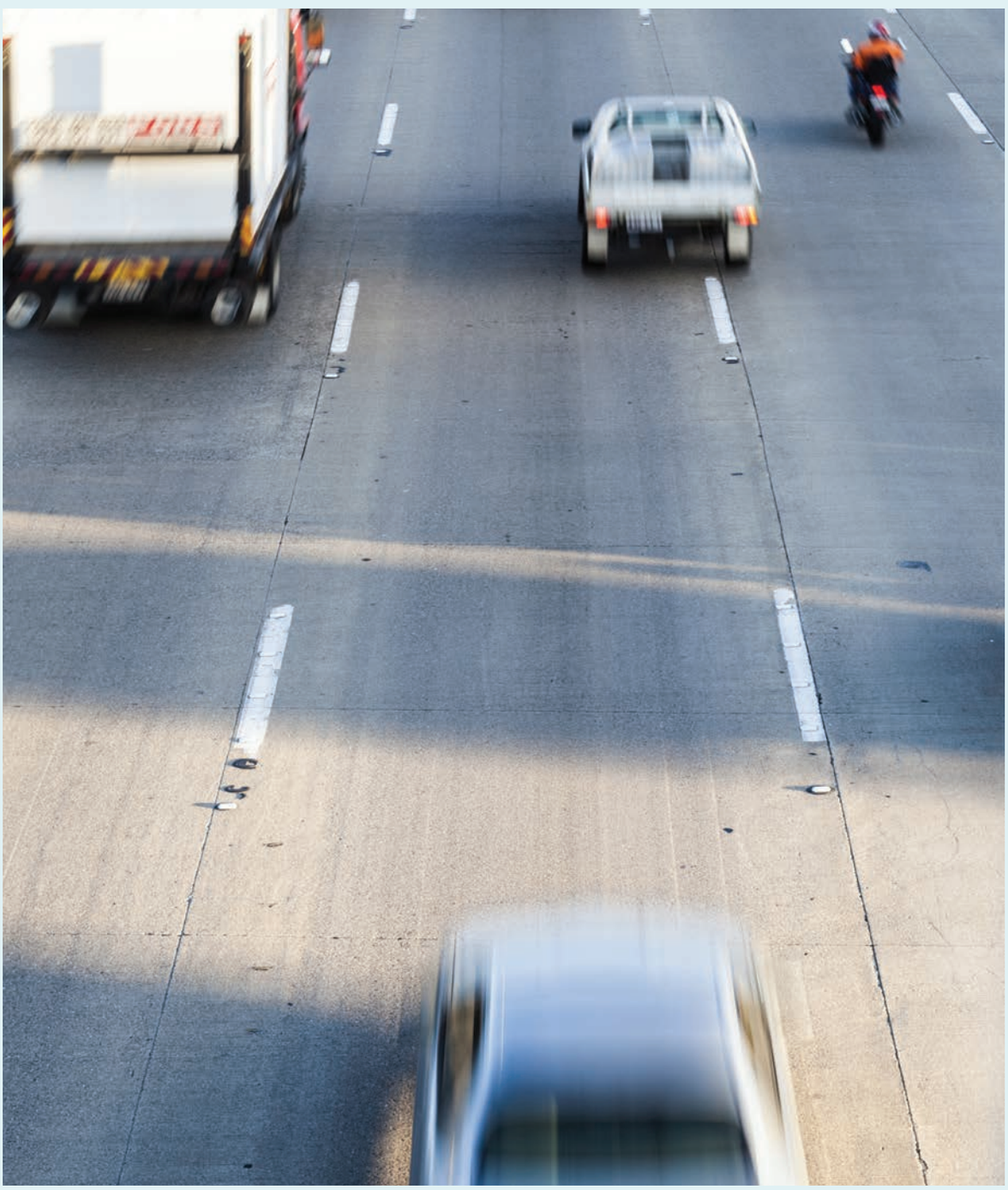
- a sketch map to illustrate land use patterns
- a brief description of how the cities have changed over time
- a list of challenges these cities face in terms of sustainability in the future, including air quality, housing, employment, transport, health, and water and energy supplies
- an explanation of how the cities you have chosen have responded to three of these challenges
- a plan for the cities in the future to meet the needs of the population.



Source 10.20 One major impact of urban sprawl is increased traffic volume.

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Topic 3

Environmental change and management

Source 11.1 Managing environmental change is important for all life on Earth. Here we see emperor penguins in Antarctica.

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11 Environments

Source 11.2 Alternative energy sources can reduce environmental impacts.

Before you start

Main focus

Our natural environment protects and supports life on Earth; in turn we need to care and take responsibility for it.

Why it's relevant to us

Understanding the ways in which the natural environment functions can help people realise the importance of protecting the world they live in.

Inquiry questions

- How do environments function?
- What role does our natural environment play to protect and support life?

Key terms

- Biodiversity
- Biosphere
- Ecological integrity
- Environment
- Fossil fuels
- Function
- Service
- Sink
- Source
- Spiritual
- Sustainability

Let's begin

Earth is home to over 7 billion people and countless flora and fauna. Life is sustained by healthy ecosystems that are increasingly at risk of degradation from humans modifying the environment and over-exploiting natural resources. Humans depend on the biosphere to meet basic needs, but increasing development has led to pressure on natural resources.

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11.1 Function of natural environments in supporting life

As the world population continues to grow, the way we manage our environment becomes increasingly important. The natural environment includes both living and non-living things on Earth that occur in a state that has not been substantially influenced by humans. The different environment types in Australia include land; inland water; and coastal, marine and urban environments. In Chapter 14 we will consider marine environments in detail, and alternate chapters on the other environment types in Australia are available on *Cambridge GO*. But first, what are the main functions of our environment?

Functions of our environment

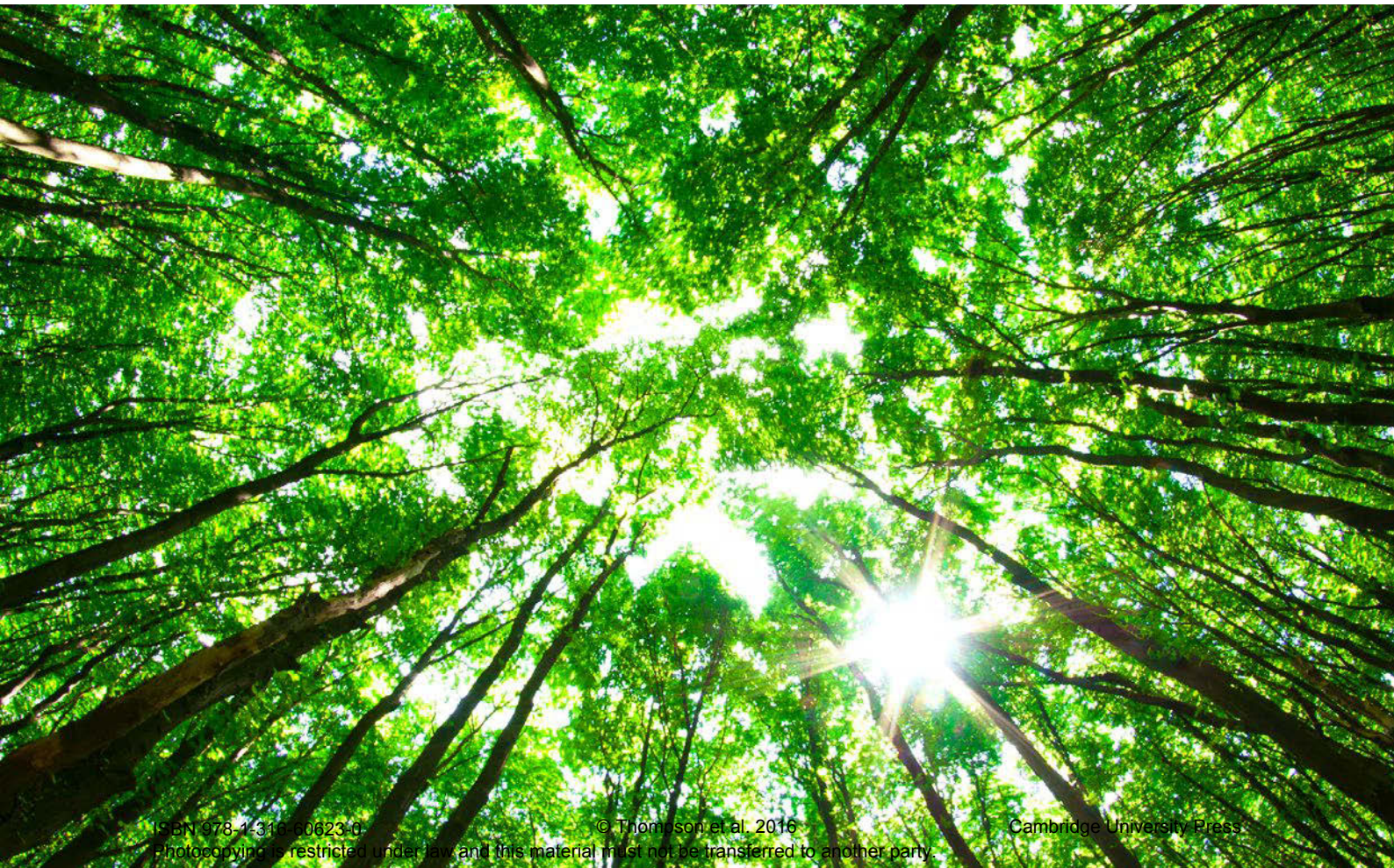
The ways our environment functions and supports human and animal life are diverse. Four major functions of the environment that we will consider here are source, sink, service and spiritual.

Source and sink functions

source function the environment's provision of raw materials and natural resources

The environment has a very important **source function** with its abundant supply of raw materials and natural resources. The amount of raw materials that the Earth's environment provides us with is immense. Some examples are air, water, minerals such as coal and iron, and timber. Natural resources include animal life, including marine life; our forests and plant life; mountains; and even our deserts.

Source 11.3 The environment serves an important source function by its provision of raw materials and natural resources such as forests.



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Source 11.4 Forestry plantations can act as sinks to absorb carbon dioxide from the environment and then release oxygen.

sink function the environment's ability to absorb, break down and recycle wastes including pollution

Another very important function of our environment is its **sink function**. The environment has an amazing natural capacity to absorb, break down and recycle the wastes and pollution produced. For example, when carbon dioxide is produced by the burning of fossil fuels (e.g. by industry and cars), plants such as trees in a forest absorb carbon dioxide during respiration and release oxygen back into the atmosphere.

service function the environment's provision of balance and stability through the atmosphere, biodiversity, ecological integrity and the climate

Service functions

The environment on Earth provides very useful functions for us known as **service functions**. These are services that support life without human intervention or participation; that is, how the Earth's environment supports life independently. For example, the Earth's atmosphere protects us from the sun's ultraviolet radiation. Furthermore, the air we breathe has the right mix of oxygen for us to survive. Other services our environment provides us with are biodiversity, ecological integrity (that is, providing the conditions for species' survival in the ecosystem) and climatic stability.

Our Earth's environment tends to keep aspects balanced and functional. This is why climate change due to human impacts is so concerning. Human impacts can undermine the service functions of our environment, so we need to be careful and use our environment sustainably.

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Geographical fact

When we assess ecological integrity, we look at how well the ecology is able to maintain itself without intervention. Integrity, however, can be undermined by human intervention such as pollution or the introduction of new species or diseases. There are, unfortunately, introduced species all over the world. In Tasmania, the Northern Pacific seastar (native to Asia and Russia) is a threat to the state's marine life as it eats native fish (particularly shellfish) and competes for resources. It is also now thriving in Port Phillip Bay, Melbourne, where the current population estimate is 12 million.

Source 11.5 The Northern Pacific seastar is an introduced species in Australia and threatens the integrity of our marine ecology.

Spiritual functions

spiritual function the cultural, recreational or psychological value of the environment for people

The **spiritual function** refers to the way in which our environment is valued psychologically, as well as recreationally and aesthetically. A spiritual view of the environment suggests a deeper personal connection to the environment, a sense of place as well as responsibility towards it. Our spiritual understanding of the environment can be cultural and evokes awe, humility and wonder. The Aboriginal and Torres Strait Islander peoples of Australia have a deep connection to the land. Landscapes and culture are inseparable; the term 'Country' expresses the idea of a fully cultural landscape where the land, sea, waterways and sky are interconnected. Clan identity is closely related to the land.

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Source 11.6 Landscapes and culture are inseparable in Indigenous Australian culture; here a clan member prepares body paint.

Activity 11.1

1. 'For every source there is a sink.' Do you think this statement is true or false? Provide reasons for your response.
2. What is meant by the term 'ecological integrity', and how is it a type of service function of the Earth's environment?
3. Debate/discussion: Shouldn't we view environments as 'functional' and 'valuable' for their own sake (not necessarily because they provide resources for humans)?

11.2 Importance of natural environments – Maintaining biodiversity

The human population remains, as it always has been, dependent on fundamental biological processes and systems for health, wellbeing, sustenance and quality of life. In fact, human beings rely on both wild and domesticated elements of the natural environment for our food supply and a variety of industrial products and medicines. These resources are also central to many tourist and recreational activities and form part of the ecosystems that provide humanity with services.

Maintaining biodiversity

Biodiversity refers to the variety of living organisms such as animals, plants and microorganisms, and the ecosystems, landscapes and environments that they form. Biodiversity is important because it can increase the productivity of an ecosystem as each species, no matter how small, has an important and distinct role. When an environment has a large diversity of species,

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Source 11.7 Pictured is a sampling of diverse fungi collected from a forest in northern Saskatchewan, Canada. When an environment has a large diversity of species, this can ensure that there is greater natural sustainability for those life forms.

this can ensure that there is greater natural sustainability for those life forms. Furthermore, when an ecosystem is healthy, it is able to better withstand and recover more quickly from natural or human-made disasters. Today, biodiversity is under threat and a reduction in biodiversity should be prevented due to the negative consequences it will cause.

The natural services offered by a healthy biodiversity

A healthy level of biodiversity provides extensive benefits to all species. Generally speaking, for humans these benefits can be divided into three categories: biological resources, ecosystem services and social benefits.

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Benefits	Examples
Biological resources	• future resources • medicinal resources • wood products • food • ornamental plants • breeding stocks, population reservoirs • pharmaceutical drugs • diversity in species, ecosystems and genes
Ecosystem services	• maintenance of ecosystems • soil formation and protection • pollution breakdown or absorption • recovery from unpredictable events • contribution to climate stability • nutrient storage and recycling • protection of water resources
Social benefits	• cultural values • research • tourism • recreation • education

Source 11.8 Environmental services offered by a healthy biodiversity

Biological resources

Biological resources are those associated with living things (flora and fauna), as opposed to mineral resources, for example.

Medicinal resources

Humans have a long history of using biological resources for medical purposes. Many of the medicines used today are products derived from plants, animals or microorganisms. Antibiotics are particularly strong forms of drugs that are derived from microorganisms. In 2014 Sydney's Macquarie University conducted research into whether the secretions produced in the glands of bulldog ants have any potential to be used as antibiotics. These secretions have been found to have strong antibiotic properties as they can kill a large range of selected fungi and bacteria.

Source 11.9 The secretions produced in the glands of bulldog ants may have potential to be used as antibiotics.

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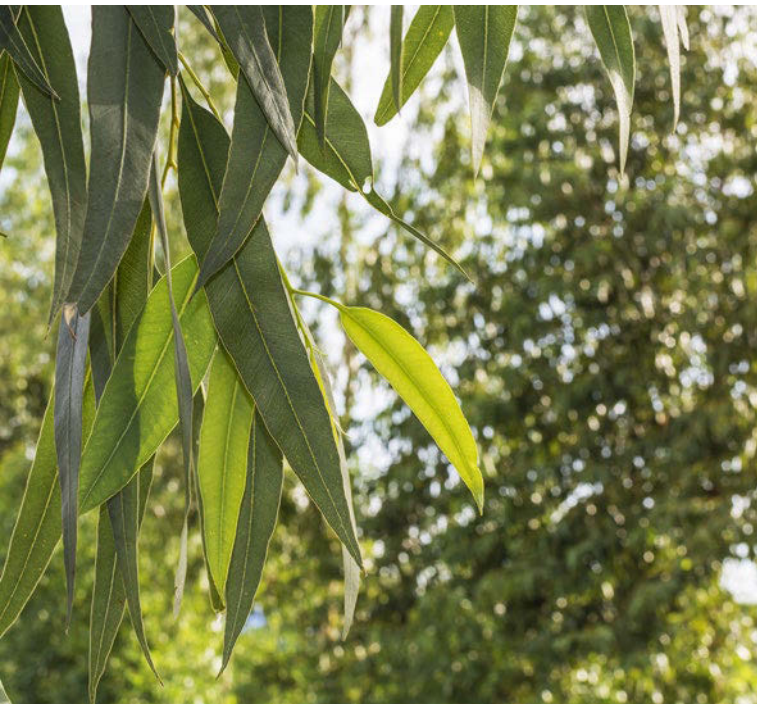
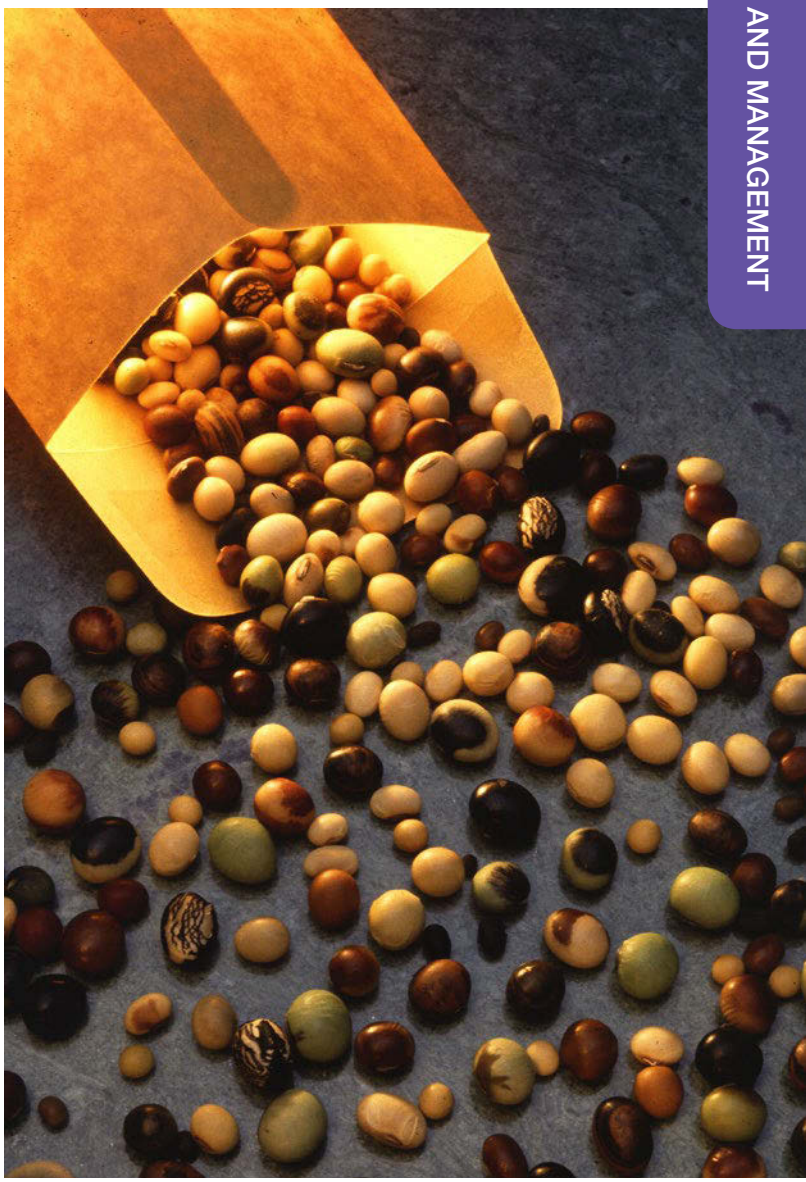
In Australia, Aboriginal and Torres Strait Islander peoples have created medicines out of many different native Australian plants. Several of these medicines have been incorporated into western medicine. A well-known example is the use of eucalyptus oil as a relief for respiratory tract infections. There are many native species that also form the basis of modern medicinal products. For instance, two species of corkwood found in Australia are used to create Hyoscine (or scopolamine), which is a product used to treat stomach disorders, motion sickness and the effects of cancer therapy.



Source 11.10 There are many native species that form the basis of modern medicinal products, such as the leaves of the eucalyptus tree.

Food

Humans, along with most other living organisms, are extremely dependent on primary producers, especially plants. Around 20 000 plant species currently feed a majority of the world's population, including carbohydrate crops that are a dietary staple for a large majority of people. The native animal species of Australia contribute to the global food capacity. For example, there are many crustacean and fish species native to Australia that form an important part of our harvesting industries as well as our natural genetic diversity. Australia is also home to 15 of the world's 16 species of wild soybean, which may continue to increase in value in the future due to the genetic make-up of these wild plants.



Source 11.11 Australia is home to 15 varieties of wild soybean – an important food source from our environment.

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Breeding stocks, population reservoirs

Natural environments provide the crucial support for commercially valuable resources. There are habitats that protect critical life stages or even whole sections of a wildlife population that is also harvested for profit outside of its natural habitat. An Australian example of this is the spawning areas in wetlands and mangroves. If a mangrove area is cleared in order to make space for urban development, populations of commercial fish that rely on these mangroves as part of their breeding habits will decrease in numbers. It is for reasons such as this that many habitats are recognised as protected areas.

Source 11.12 The spawning areas of aquatic species such as prawns in wetlands and mangroves are an Australian example of the natural environment providing support for a commercially valuable resource.

Activity 11.2

1. Explain why biodiversity is important for environments to sustain life.
2. List any resources not discussed in this chapter that you can think of that the environment provides. Use Source 11.8 as your starting point.
3. Discuss with a partner any protected habitats or environmental areas you have visited. What types of animals and plant life did you see?

Ecosystem services

Ecosystem services are those systems and processes that contribute to the natural and efficient functioning of environments.

Maintenance of ecosystems

Ecosystems can be understood as a web that connects one living thing to a network of both living and non-living things. They are crucial for survival as well as maintaining a balance between living things and the resources all living things need to survive (e.g. shelter and food). For example, you can see that plants are needed not only to maintain levels of humidity and water, but also to conserve the balance of oxygen and carbon dioxide present in the atmosphere. The removal or even the disturbance of any part of an ecosystem can have direct impacts on many other parts of the ecosystem.

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When natural environments and habitats are maintained, ecosystems are able to function across a wider geographical area. These habitats can act as sanctuaries for breeding populations of animals but are also home to predators that play an important role in controlling the pest populations of that area. For example, birds and other predators are crucial in controlling insect pest populations in agricultural areas. The benefit of this is commercial as well as environmental, as it can reduce the need for (and cost of) artificial measures of control.

Soil formation and protection

Biodiversity is necessary in order to maintain a soil structure that can retain sufficient levels of nutrients and moisture. When trees are present in an environment, they help to lower the watertable and aid in the removal of deposited salt that sits in the upper soil. Another benefit of the presence of trees and vegetation in an environment is their role in soil formation. The litter formed by vegetation, along with the decay and regeneration of small, fibrous roots, provides organic matter that facilitates microbial activity. Furthermore, roots are able to break up both rock and soil, which can help with the diffusion of water. Roots are extremely important, as they are able to transport mineral nutrients to the surface.

Protection of water resources

Another important role of natural vegetation is maintaining hydrological cycles. Vegetation coverage in water catchments can regulate as well as stabilise water run-off and can act as a buffer against natural disasters such as floods or extreme events such as drought. Vegetation is also involved in less visible yet equally important functions such as regulating underground watertables. Vegetation also helps prevent dryland salinity, a problem that currently affects vast areas of agricultural lands in Australia and presents a great cost to the Australian community.

Source 11.13 Vegetation helps prevent dryland salinity. Pictured is land in Western Australia damaged by salinity.

RESEARCH 11.1

Research the NSW Salinity Strategy online. Prepare a fact sheet that includes:

a how many hectares of land in NSW are affected by salinity today

b how many hectares of land in NSW could be affected by salinity in the future

c five key things that salinity threatens in NSW

d an explanation for why salinity has increased

e five ways to slow down the spread of salinity in NSW.

Social benefits

Social benefits are those that positively affect the interactions between individuals, groups and societies.

Cultural values

We cannot underestimate the cultural value of conserving biodiversity both for present and future generations. Human cultures and natural environments evolve together and the natural environment is a central aspect of Australia's cultural identity. Even though Australia has a highly urbanised population, people rely on the aesthetic value of the natural landscapes and ecosystems as a source of both spiritual and emotional wellbeing. For instance, it is common for Australian society to emphasise the value and importance of native 'bush' as well as the native species such as the emu, wombat, kangaroo and koala, all of which have become Australian national icons.

Relationships with the land and sea as well as native animals and plants also form an important aspect of Aboriginal and Torres Strait Islander peoples' culture. Through traditional hunting and gathering practices, Aboriginal and Torres Strait Islander peoples demonstrate their self-sufficiency while educating younger generations about the importance of their relationship with the land as a part of their culture. The conservation of biological diversity is therefore tied to the conservation of the cultural identity of Indigenous Australians.

Research

While our knowledge about biological resources has come a long way, there is still much work to be done in terms of understanding the natural world. We need to learn how to rehabilitate ecosystems that have become degraded as well as how to maintain the genetic base of harvested resources. Natural environments can be thought of as living laboratories as they can provide invaluable knowledge about ecology and evolution.

Recreation

Finally, biodiversity forms a central or significant part of numerous areas across Australia that both tourists and locals enjoy for recreational purposes. These areas also provide the inspiration for literature, film and photography, as these can be based on natural features, habitats and wildlife. Due to Australia's high level of biological diversity, the aesthetic qualities of various areas are amazingly diverse. Each year millions of

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people visit Australia's natural environments including parks and reserves, zoological gardens and botanical gardens. In fact, studies have shown that more than 85% of Japanese tourists and approximately 70% of American and European tourists identify the unique wildlife and beautiful scenery as integral to their decision to visit Australia.

Source 11.14 The Twelve Apostles in Victoria, on the Great Ocean Road – one of Australia's most famous tourist destinations

Activity 11.3

1 Explain how the removal or even the disturbance of any part of an ecosystem can have an indirect impact on many other parts of the ecosystem.

2 Define what biodiversity is and give one reason why it is so important in Australia.

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Chapter summary

- The ways our environment functions and supports human and animal life are diverse. There are various functions of the environment, including source, sink, service and spiritual.
- **Source function:** The environment has a very important source function with its abundant supply of raw materials and natural resources.
- **Sink function:** The environment has an amazing natural capacity to absorb, break down and recycle the wastes and pollution produced.
- **Service function:** These are services that support life without human intervention or participation; that is, how the Earth's environment supports life independently. Other services our environment provides us with are biodiversity, ecosystem integrity (that is, providing the conditions for species survival) and climatic stability.
- **Spiritual function:** This refers to the way in which our environment is valued psychologically, as well as recreationally and aesthetically.
- Human beings rely on both wild and domesticated elements of the natural environment for our food supply, a variety of industrial products and medicines. These resources also form part of the ecosystems that provide humanity with services.
- Biodiversity refers to the variety of living organisms such as animals, plants and microorganisms, and the ecosystems, landscapes and environments that they form. We can understand biodiversity at a genetic, species or ecosystem level.
- A healthy biodiversity provides extensive benefits to all species. Generally speaking, these benefits can be divided into three categories: biological resources, ecosystem services and social benefits.
- Biological resources include medicinal and food resources.
- Natural environments provide the crucial support for commercially valuable resources.
- Maintenance of ecosystems is another function of the environment.
- The removal or even the disturbance of any part of an ecosystem can have direct impacts on many other parts of the ecosystem.
- One benefit of the presence of trees and vegetation in an environment is their role in soil formation.
- Natural vegetation assists with maintaining water cycles.
- Vegetation is needed to prevent dryland salinity.
- The conservation of biological diversity is tied to the conservation of the cultural identity of Indigenous Australians.
- Natural environments can help us in the area of research. Nature can be thought of as a living laboratory that can provide invaluable knowledge about ecology and evolution.
- The environment is attractive to both tourists and locals who enjoy it for recreational purposes.

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End-of-chapter questions

Short answer

1 Compare the four major functions of the environment, and how they provide and support life on Earth.

2 List three ecosystem services and outline their value to our society and the economy.

3 Identify why biodiversity is important.

Extended response

'The conservation of biological diversity is tied to the conservation of the cultural identity of Indigenous Australians.' Discuss this statement using examples.

OR

Write an essay explaining the role our natural environment plays in protecting and supporting life.

Source 11.15 One important function of our environment is to service a range of animal life.

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12 Environmental change

Source 12.1 Land degradation refers to a natural or human-induced process which impairs the capacity of the land to function. Pictured is severe soil erosion in a wheat field near Washington State University, USA.

Before you start

Main focus

Investigating the ways in which humans have caused environments to change across a range of scales, from local to international.

Why it's relevant to us

There are many human activities that change the environment, degrade resources and threaten our capacity to achieve sustainability.

Inquiry questions

- How have humans changed the environment?
- What is the extent of this change?
- What are the consequences of human changes to the environment?

Key terms

- Community
- Landscape
- Productivity
- Sustainability
- Greenhouse Effect

Let's begin

In this chapter we will investigate sustainability as well as how humans impact the environment and what this means for the management of our ecosystems. As we know, increasing development has put pressure on natural resources to sustain life. Humans can cause widespread changes that affect all living things, but we are intelligent enough to manage the biosphere properly.

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12.1 Human-induced environmental changes

There are many human activities that change the environment. Some of these are positive but many of our activities have a negative impact. Such activities degrade resources and threaten our capacity to achieve sustainability.

The most common human-induced changes are summarised in the table below.

Human activity	Immediate impacts	Short- to medium-term impacts	Long-term impacts
Emission of carbon dioxide	An increase in carbon dioxide in the atmosphere	Quality of air decreases; amount of carbon dioxide in air increases	Carbon dioxide traps reflected heat from the Earth's surface, warming the planet (global warming)
Deforestation	Loss of vegetation cover; increase in run-off; loss of habitat	Soil erosion and soil salinisation; degradation of streams through sedimentation and high turbidity	Reduced environmental quality for humans, plants and animals; desertification; reduced biodiversity
Manufacturing and heavy industry	Contamination of soil, air and water; noise pollution; loss or degradation of cultural sites	Degraded habitats; accumulation of toxins in plants and animals; increase in acute diseases	Climate change; reduced biodiversity; extinction of species; increase in chronic diseases
Impoundment of water (dams and weirs)	Reduced river flows; degradation of water quality; changes in flood regimes; inability of fish to migrate	Erosion of downstream river; 'river chilling' from cold water releases; habitat degradation; reduced recruitment of aquatic organisms; reduced nutrient levels in flood plain soils	Loss of fish and other aquatic organisms; reduced productivity of agricultural land
Mining	Habitat loss or fragmentation; loss or contamination of groundwater resources	Weed infestation; reduced natural food resources; soil acidification and salinisation	Loss of biodiversity; low agricultural productivity; land subsidence
Overfishing and harmful fishing practices	Loss of breeding population; damage to habitat	Habitat degradation; loss of seagrasses and coral; changes in food chain; changes in biodiversity	Extinction of species; reduced number of fish populations; changes in food web; loss of recreational and commercial fisheries and destruction of marine and freshwater systems
Urbanisation	Increased run-off; decreased infiltration; contamination of soil, air and water; stakeholder conflicts	Loss or degradation of habitat; downstream pollution of rivers; increase in invasive species; fragmented habitats	Extinction of species; loss of biodiversity; reduced food resources
Agriculture	Loss of natural vegetation; increased run-off; increased soil erosion; pollution of waterways	Habitat fragmentation; loss of habitat; sedimentation in nearby streams; water quality degradation in downstream areas	Reduction of biodiversity; chronic soil salinisation

Source 12.2 Some of the most common human-induced environmental changes

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Activity 12.1

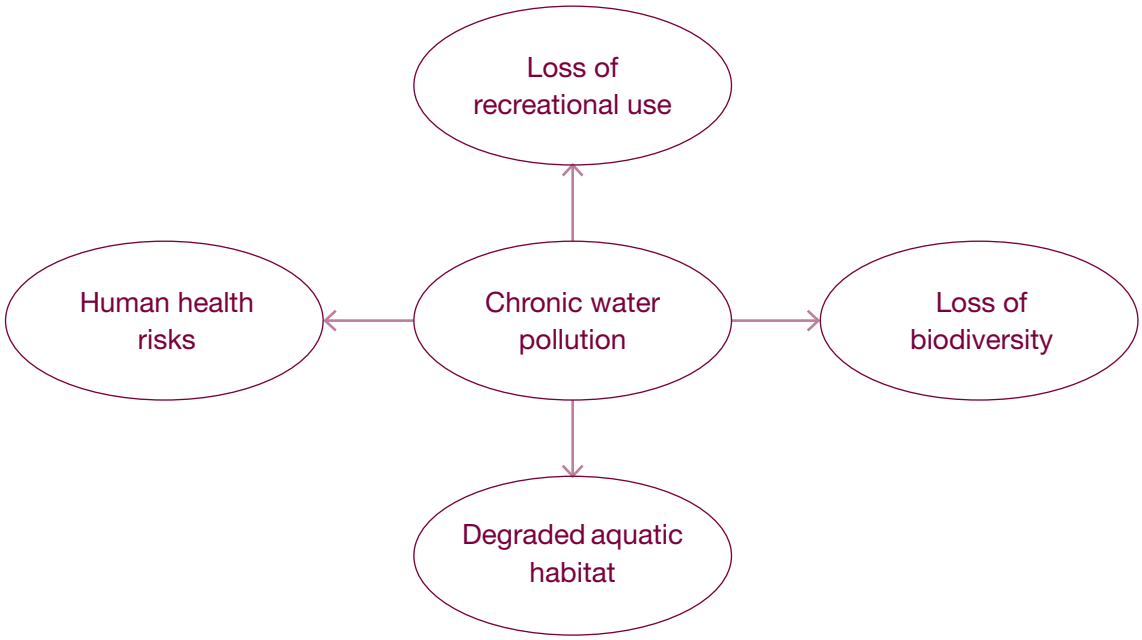
1 Using the information from the previous table, complete the following table identifying the causes of the various impacts. (Note: this is an activity that requires you to transform the information already provided.)

Human impact	Description	Cause
Atmospheric pollution	Pollution of the air through the emission of carbon dioxide and other toxic gases	The burning of fossil fuels through industry, automobiles, the burning of vegetation during land clearance
Loss of habitat		
Declining biodiversity		
Land degradation		
Exploitation of coastal, marine and fresh water resources		

2 Rank the human impacts, starting with the worst at number 1. Justify your rankings.

Note this down 12.1

Copy the graphic organiser below (without text) and show links between human activities and resulting impacts. You can add arrows to show interactions between impacts. An example has been completed for you below.



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Geographical fact

According to the World Wildlife Fund, there are an estimated 100 million different species coexisting with us on our planet. Between 10 000 and 100 000 species are becoming extinct each year.

Source 12.3 A giant panda cub in China – a famous endangered animal

Case study 12.1
The Tasmanian tiger

The thylacine, better known as the Tasmanian tiger, was native to Australia and primarily found in Tasmania and some regions of Victoria. It was the country's largest carnivorous marsupial and existed for over 4 million years.

The introduction of humans and dogs to the environment brought disease and predators to the ecosystem of the thylacine, and numbers declined drastically. Thylacines were kept in zoos, but suffered in captivity. Farmers who assumed the thylacine had been killing their sheep and poultry also hunted them.

The last thylacine died in captivity in 1936, and although sightings have been reported and extensive searches carried out, there is no conclusive evidence of the creature still being

Source 12.4 Drawing of Tasmanian tigers from the Zoological Society of London in 1850

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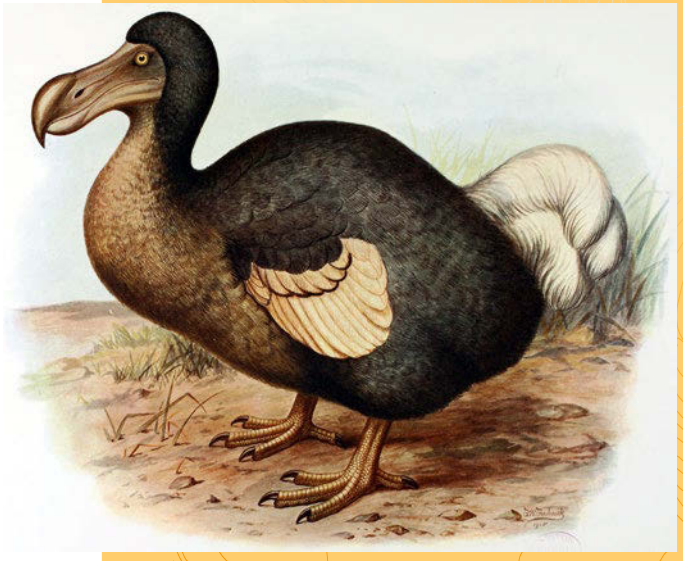
Source 12.5 The last thylacine died in 1936; the animal is now extinct. This specimen is on display in a museum in Madrid, Spain.

in existence. Currently, scientists are making attempts to clone thylacines from preserved specimens.

1. What human-induced changes contributed to the extinction of the thylacine?
2. What impacts might the extinction of the thylacine have had in Tasmania?
3. Discuss how ecosystems in Tasmania would be affected if the thylacine was cloned and returned to its natural environment.
4. Investigate the steps taken by modern conservationists to help prevent more species becoming extinct.
5. Research and list plants and animals that have been rediscovered since they were declared extinct.

Geographical fact



The dodo was a flightless bird, bigger than a turkey, living on Mauritius in the Indian Ocean. The Dutch colonised Mauritius in 1644. Along with groups of people, the ships brought cats, dogs, swine and monkeys. These animals quickly invaded the woods, trampling the dodo's nests and devouring the eggs and young. The interference of the foreign animals coupled with the continued overuse of the birds for food by humans led to the dodo's total extinction by 1681.

Source 12.6 The extinct dodo

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What is sustainability?

Sustainability refers to the capacity to use resources so that they are maintained for future use and managed in a way that brings about economic and social improvements without significant environmental degradation. The environment in which we live is a complex mix of natural and human features and includes different ecosystems that form the biosphere.

Ecosystems are communities of flora and fauna that interact with each other and the physical components of the environment, principally soil, water and the atmosphere. All living things, including humans, depend on the interaction of the biological and physical processes that support **environmental functions**.

environmental functions processes of an ecosystem that support human life and economic activity

When processes or components of an ecosystem are modified by human activities, the capacity of an ecosystem to function is reduced or may cease. Changes in ecosystem functioning also have a negative feedback effect on humans; a loss of ecosystem functioning threatens our health, our access to food to sustain our populations and our ability to prosper. As the most intelligent life form on Earth, humans have the ability to understand ecosystem functioning and modify practices to sustainably utilise natural resources and minimise environmental impacts.

Source 12.7 The concept of sustainability helps us to question the current state of an environment and pose management solutions to issues and challenges that we are able to identify.

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Geographical fact

Some villages around the world are entirely sustainable. The people of Awana Kancha in Peru have no need for cash. They raise their own animals, spin their own fabric and grow their own food.

Source 12.8
The people of Awana Kancha in Peru live in a wholly sustainable manner.

Activity 12.2

1 What is sustainability and why is it so important?

2 On a world map (either a printed map or use Google Earth):
- list at least 10 different endangered species in their natural habitats
- explain what types of human-induced activities have changed the environment and made the species endangered
- record the remaining number of animals.

3 Discuss as a class: are there varying degrees of sustainability? Is your idea of sustainability relative to your culture?

12.2 Types and extent of environmental change

As the world's population continues to grow, the demand for resources also increases. This creates challenges for sustainability, as we need to use resources fairly so that future generations also have access, but also for the greater benefit of all life on Earth. There are some key concepts when trying to understand the challenges for sustainability and these will be discussed in this section: intergenerational

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equity, uncertainty, risk and precaution. We will also look at how climate change (caused by human-induced changes) is our biggest threat to sustainability.

Intergenerational equity

intergenerational equity the responsible use of natural resources to enable fair access to the same resources by future generations of humans

Intergenerational equity refers to the responsible use of natural resources that will enable future generations to have access to the same types and quality of resources. If today's populations deplete the Earth of critical resources, such as topsoil to grow food and fossil fuels to generate electricity and power vehicles, future generations will have less opportunity to prosper. Accordingly, intergenerational equity is a key component of policies, laws and other management approaches that have sustainable development as a primary goal. Whether it can be achieved is highly contentious, because the rate of urbanisation and growth in human population is increasing the consumption of resources.

Geographical fact

Non-renewable resources, such as coal, are resources that are finite. As coal takes a very long time to be formed, once we have used it all, it will be many thousands of years before coal is available again. At the moment, coal is our main source of power. There are over 2300 coal-fired power stations around the world of which 620 are in China. In 2015 it was estimated that there is enough coal to fuel the world for another 120 years. Consequently, by 2125 there will be no coal reserves left on Earth if our current rate of consumption continues.

Source 12.9 A pit coal mine provides coal for a nearby power station. It is estimated that by 2125 we will have run out of coal.

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Uncertainty, risk and precaution

Sustainable development of Earth's resources involves the challenge of dealing with uncertainty and risk. In the context of sustainable development, uncertainty refers to our inability to be absolutely certain of the outcomes and risks of modifying the environment to meet our needs. Predicting the impacts of development depends on sound scientific knowledge of Earth's processes and how our actions modify them.

For example, we know that humans have the potential to change climate by modifying atmospheric processes through pollution. Changing climate is a risk to the environment because it may increase sea levels, destroy temperature-sensitive ecosystems and cause local extinction of flora and fauna. Changes in temperature and water availability, along with the submergence of land from rising sea levels, can destroy habitat and lead to loss of species.

The extent to which we influence climate has high levels of uncertainty. We are uncertain of the magnitude and the timing of climate change, and we are uncertain of how the environment will respond. Furthermore, we are uncertain about the management actions that can mitigate the negative impacts, yet we are compelled to develop in order to prosper. Stakeholder conflicts over development often involve debates about the level of uncertainty and environmental risks.

Climate change and global warming

'Weather' is what happened today or yesterday, or this year. 'Climate' is what you understand about a place when you have lived in it for many years, but actually feeling climate change for yourself is almost impossible. The weather varies widely wherever you are, but the climate remains the same over half a lifetime, because climate is the average of all the weather's variations. From day to day and season to season the temperature change is large, but over the last 100 years **global warming** has seen Australia's average annual temperature rise by 1°C. This might appear to be a small amount, but it is not too small for changes to happen in the life cycle of plants, insects and animals.

global warming rise in the average temperature of the Earth's atmosphere

In climates where life pauses for the cold of winter, plants and animals respond to the warmth of spring. Trees bud, frogs spawn, birds mate and caterpillars hatch from their dormant eggs. And if spring comes early, so does the reawakening of life. In most of Europe, Asia and North America, many plants and insects are now emerging from their winter shutdown a few weeks earlier than they did 50 years ago. This early awakening has occurred because the warmer days happen earlier than they used to.

What makes 'climate'?

To understand climate change we need to know the things that drive the weather and affect the climate.

The sun

Sunshine is made up of heat, light and ultraviolet (UV) rays, with most of its energy coming in as light. The different parts of sunshine, including the part you can see (light and the colours of the rainbow), can be described as having different wavelengths: longer wavelengths at the red end of the spectrum, shorter at the blue end. UV has the shortest wavelength and is the most energetic. Heat – also called infra-red – has longer wavelengths than UV. Heat, light and UV rays all warm the planet. You cannot specifically 'feel' UV, but it can burn your skin nonetheless.

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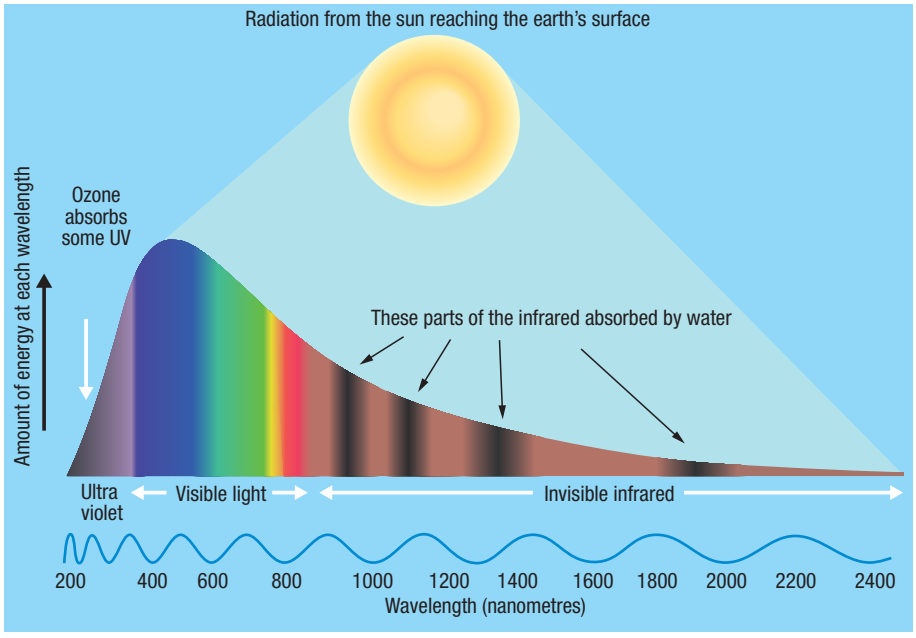
Geographical fact

There is a swan farm in Dorset in England called the Abbotsbury Swannery. The swannery is over 600 years old, and has over 1000 white swans. By tradition, the first day of summer is proclaimed when the first cygnets hatch at Abbotsbury, which for centuries was in mid-May. In 2011 the first hatching was on 4 May; in 2012, it was even earlier: 30 April. The swans know the world is warming.

Source 12.10 A cygnet sits on an adult swan's back at the Abbotsbury Swannery, Dorset, England



Source 12.11 The sun's radiation. Each part of the spectrum, not just the visible part as we see it in a rainbow, has its own wavelength, measured in nanometres (millionths of a millimetre). Various gases in the atmosphere, particularly ozone and water vapour, absorb different parts of the sun's radiation, as shown by the dark bands.

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The sun provides the energy to drive the weather. There is over 1 kilowatt (kW) of energy falling on each square metre when the sun is directly overhead – enough to power a small radiator. By the time it has passed through the atmosphere, that energy is reduced to a little less than 1 kW during the Australian summer, and half a kW or less at noon in winter.

The sun is a very steady source of heat, and though minor variations of solar radiation occur, these are not enough to significantly affect climate. What can change the climate is the proportion of the sun's energy on the big landmasses of the Northern Hemisphere: Asia and North America. When there is slightly less summer sun there, something that happens for reasons connected to the Earth's orbit and the inclination of the Earth's rotation axis, the winter snows do not melt as much as usual; if this lasts for thousands of years the overall amount of ice increases.

Ice reflects almost all the sunshine that strikes it, and that helps cool the Earth – a greater area of ice means less of the sun's heat is absorbed. So the Earth cools and more ice forms. This is an important climate factor known as **feedback**. As this happens the world enters an ice age. There have been eight ice ages in the past million years. During each one the Earth's temperature fell by as much as 6°C.

feedback change in one factor causing a change in a second which then changes the first

Astronomical calculations show we are now in a period called an **interglacial** with very slow cooling, and this should continue for approximately 50 000 years.

interglacial warmer period between ice ages

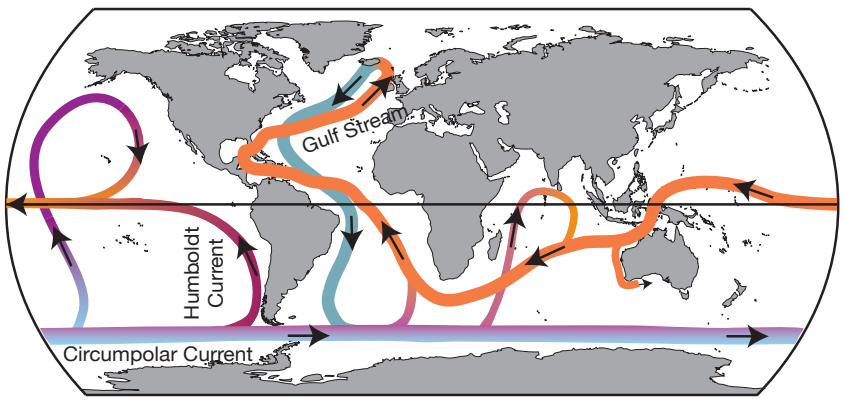
Ocean currents

About 70% of the Earth's surface is ocean, and because water absorbs most of the sun's heat that falls on it, the oceans are the main store of the Earth's heat. Ocean currents encircling the globe are known as the Great Ocean Conveyor Belt. Surface currents take warm tropical waters toward the poles, and the cold, denser polar water sinks to the ocean floor and moves towards the Equator. In this way the sun's heat is distributed around the world.

The atmosphere – Greenhouse Effect

The Earth's climate is ruled by the sun. Some of the sun's heat is reflected, some of the heat is distributed by the ocean, and the atmosphere keeps the warmth in. If the Earth has warmed, then either the sun or the Earth's surface or the atmosphere must have changed. Astronomers are sure that the sun is not to blame; it has barely changed in the past 200 years. Similarly, there has been little change in the Earth's reflectivity. That only leaves the atmosphere, and it is a change in the **Greenhouse Effect** that scientists conclude is responsible for global warming.

Greenhouse Effect the retention of the Earth's heat by atmospheric gases



Source 12.12 Main features of the Great Ocean Conveyor Belt. Note particularly the northward Humboldt Current, which carries cool Antarctic water up the South American coast before it turns west and is warmed. Note also the warm Gulf Steam which carries warm water from the Gulf of Mexico to the North Atlantic.

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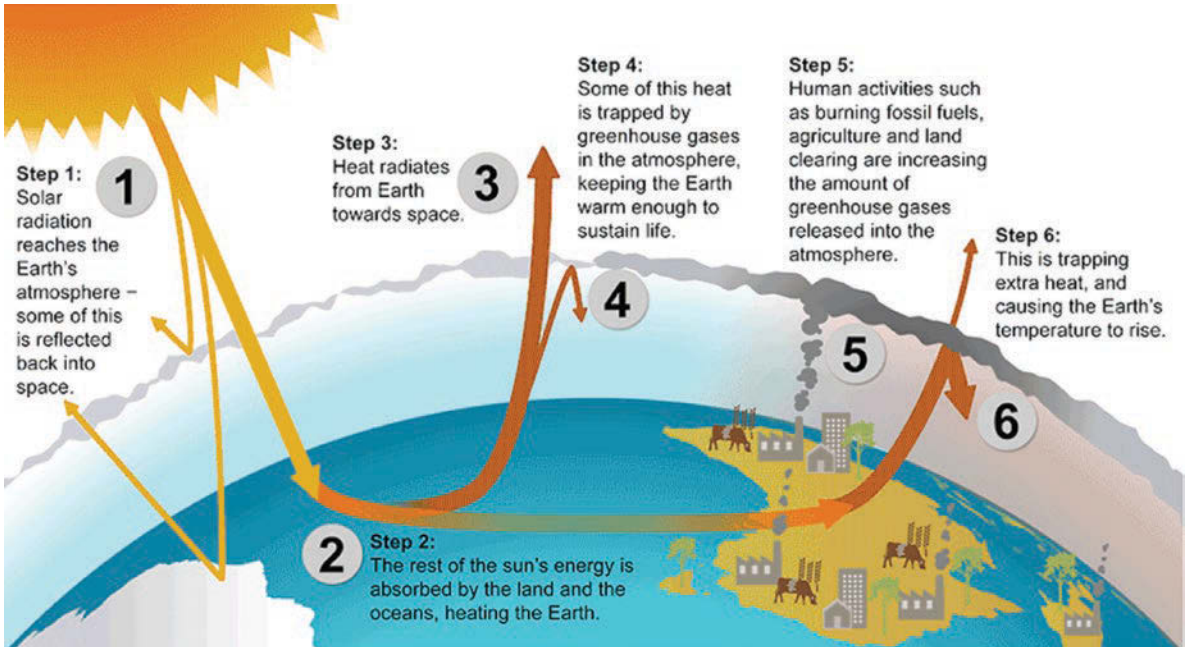
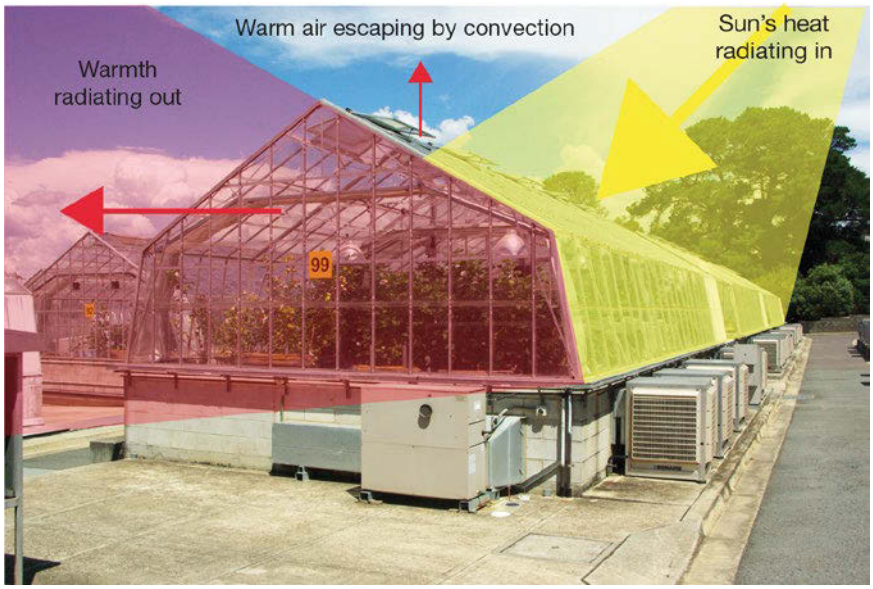


Source 12.13 An Australian Government Department of the Environment diagram demonstrating how the Greenhouse Effect works to sustain life on Earth. Steps 5 and 6 show how human activities have contributed to climate change.

The Earth's Greenhouse Effect is dominated by water vapour (about 60% of the effect) and by carbon dioxide (about 30%). It is water vapour that makes the air humid. In 1800 there were 280 molecules of carbon dioxide for every million molecules of air (76% nitrogen, 23% oxygen, 1% argon). You might think that 280 molecules in a million is not enough to do anything much, but it is enough to provide the carbon for all the plants on Earth. It is also enough to maintain a global temperature of about 14°C, helped by a big contribution from water vapour.

Because of the way carbon dioxide can trap the Earth's heat, an increase in its amount must trap more heat. When that happens the warmer atmosphere can hold more water vapour, and that further increases the



Source 12.14 How a greenhouse works. High-energy heat from the sun warms the interior, while lower-energy heat radiates out, keeping the greenhouse from overheating. Some heat escapes if a window is opened and some is conducted through the glass to the outside air.

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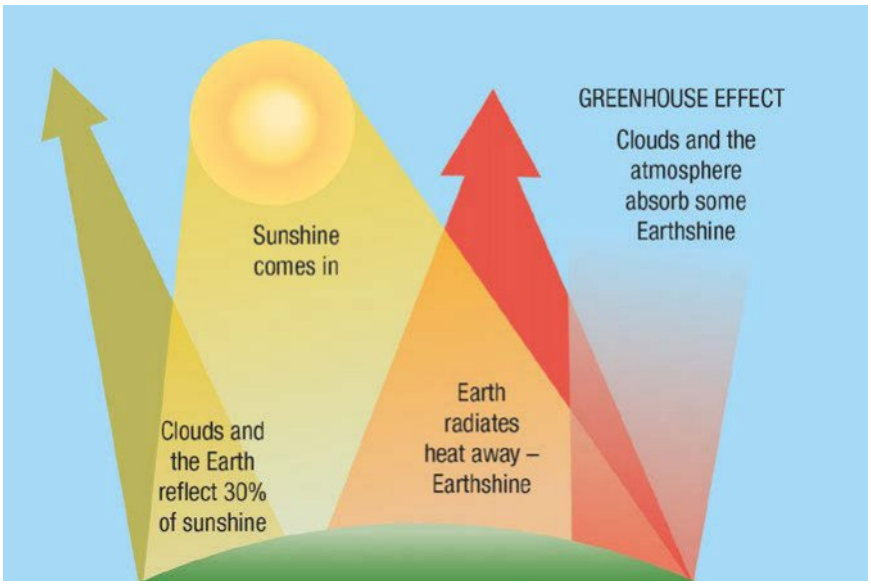
Greenhouse Effect. This is a second climate feedback just like melting polar ice – one warming factor drives another.

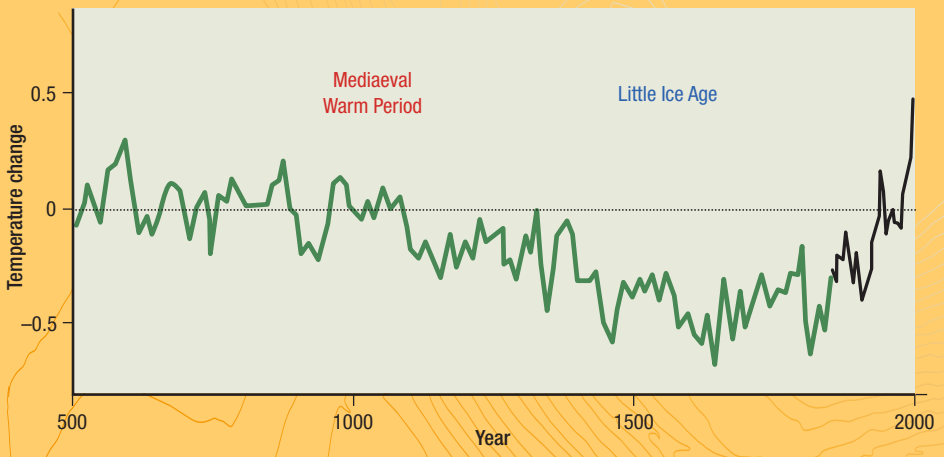
Today the amount of carbon dioxide in the air is growing at a rate of 2 parts per million each year, and has currently reached 400 parts per million; that is, 40% more than in 1800. Not surprisingly, global temperatures have risen as a result. In fact, the average global temperature is rising faster than ever before. During the last ice age the subsequent warming was approximately 1°C over 100 years. Today's rate is almost 20 times as fast: 1°C in 60 years.



Source 12.15 Insolation – incoming solar radiation. Clouds and the Earth's surface absorb some heat, but most (70%) is radiated back towards space. About 10% of the Earth's heat is retained by the Greenhouse Effect.

Geographical fact

At the height of the last ice age, 21 000 years ago, New York was covered by ice as much as 1 km deep. As the Earth warmed, starting 18 000 years ago, the edge of the ice sheet retreated at a rate of about 50 metres a year. Today, the edge of the Arctic sea-ice is retreating at the rate of 8 km a year.



Source 12.16 The green line shows global temperature reconstructions for the last 1500 years. The black line shows thermometer measurements of the last 150 years. Zero on this graph represents the average temperature from 1850 to 1995.

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Where did the carbon dioxide come from?

There are four sources of atmospheric carbon dioxide:

1 **From life itself.** As organisms live and breathe, their carbon is cycled from the atmosphere into plants and then into animals. When they die the carbon goes back to the atmosphere or ocean. Overall there is no significant change in the carbon dioxide content of the air.

2 **From volcanoes.** Volcanic gases contain carbon dioxide. Emissions from volcanic eruptions and fissures add approximately 300 million tonnes of carbon dioxide to the atmosphere every year. This is new carbon dioxide, but it contributes only 0.03 parts per million each year. Volcanoes are not the source of the global increase in carbon dioxide.

3 **From the ocean.** Most of the Earth's store of available carbon dioxide is dissolved in the waters of the oceans. If the ocean warms, some of the dissolved carbon dioxide comes out. Warming the oceans is certainly one way that atmospheric carbon dioxide can increase.

4 **From burning coal, oil and gas – the fossil fuels.** When a **fossil fuel** is burned, the carbon it contains combines with oxygen in the air to make carbon dioxide. Expressed as a chemical equation this statement can be written: $C + O_2 = CO_2$.

fossil fuels natural fuels such as coal or gas, formed in the geological past from the remains of living organisms

Coal is nearly pure carbon. Burning 1 tonne of coal produces about 3.5 tonnes of carbon dioxide. Oil and gas contain both carbon and hydrogen, and when these fuels burn they produce both carbon dioxide and water. For light diesel oil the chemical equation is: $C_{10}H_{20} + 15O_2 = 10CO_2 + 10H_2O$.

Since the beginning of the Industrial Revolution in 1750, just over half a trillion tonnes of carbon dioxide emissions have been added to the atmosphere from burning coal, oil and gas. The source of the increasing amount of carbon dioxide in the atmosphere is fossil fuel burning.

RESEARCH 12.1

Prepare a poster to illustrate *one* of the following topics:

1 The impact of rising temperature and increased atmospheric carbon dioxide on the ocean.
Aspects you might include are:
- causes of coral bleaching on the Great Barrier Reef
- the effect of rising CO_2 on ocean acidity and marine life
- the implications for a sustainable fishing industry in northern Australian waters as the global temperature rises.

2 How the Earth might be cooled by geoengineering.

Investigate such possibilities as injecting stratospheric sulfuric acid, ocean spray, mirrors in space, reflective surfaces on Earth and CO_2 scrubbers. Sources for these topics can be found in 'A Short Introduction to Climate Change' and many internet sites.

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What will climate change do?

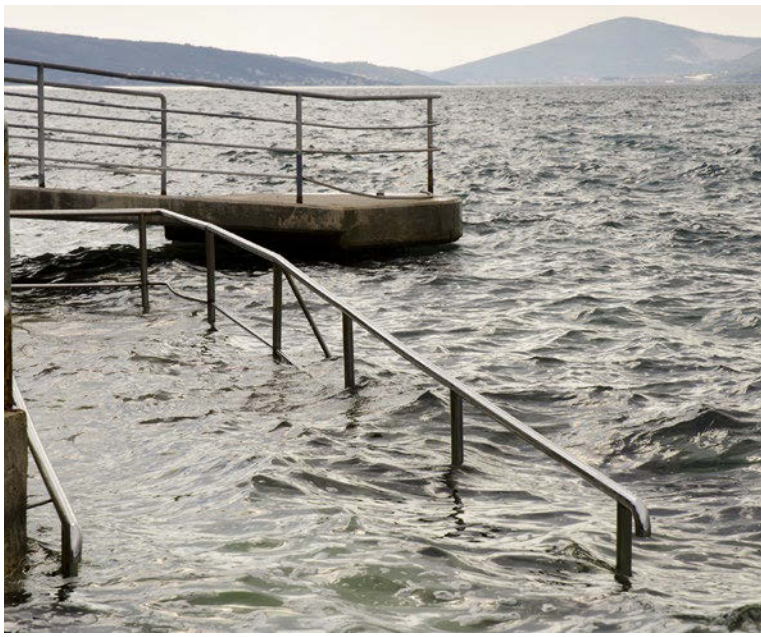
By looking at the geological record of past climates and levels of carbon dioxide, scientists have concluded that if the amount of carbon dioxide in the atmosphere doubles, the global temperature will rise by approximately 3°C. This is not an exact figure though, and estimates by different scientists range between 2°C and 4.5°C, with 3°C the most likely prediction at present.

For the next 20 years, we can expect the following small changes:

- global temperature will rise by at least another 0.3°C by 2030
- heatwaves will be longer and more intense
- rainfall globally will be higher, though in eastern Australia it will be lower and more intense
- droughts will become more frequent
- sea level will rise a further 6 cm
- alpine glaciers will retreat further and many will vanish
- Arctic sea-ice will retreat, possibly vanishing in the summer
- the Antarctic and Greenland ice caps will become thicker from more snow, but with continued melting at lower altitudes
- the oceans will become more acidic
- hurricanes will be stronger and wetter.

If greenhouse gas emissions continue to increase as they have for the past 50 years, by the year 2100:

- Australia will be 4°C hotter
- the Arctic will be 8°C hotter
- sea level will be 0.3 m to 1 m higher.



Source 12.17 Polar ice caps will melt and sea levels are predicted to rise due to climate change.

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Activity 12.3

1 Identify the change in the average atmospheric carbon dioxide content measured at Cape Grim, Tasmania, from 1955 to last year. (Go to the World Data Centre for Greenhouse Gases and click the box Data-Quickplot. Under 'Station name' click the entry for Cape Grim – Australia – CSIRO. In the first column headed 'Parameter' click CO_2 flask. At the end of the fourth column headed 'File inventory/Quickplot' click the file in the 'Monthly data' row, in either png or pdf format.)

2 Describe what has been happening to produce the extra carbon dioxide over this time.

3 Discuss (geographically) where you think most of the increase in carbon dioxide has come from.

4 Research how the atmospheric carbon dioxide content has changed over the last 12 months at Mauna Loa Hawaii and at Cape Grim in Tasmania.

5 Account for monthly variations at each locality.

12.3 Protection of ecosystems against environmental change

An ecosystem is made up of all the living organisms (biotic components) in a physical area, including plants, animals and microbes, as well as the non-living (or abiotic) components of the environment, including the soil, air and water. The ecosystem is defined by the interaction between all the living organisms and with the surrounding environment.

All ecosystems and environments are exposed to changing influences over time, with variations in the climate, nutrient loading, habitat size and connectivity, and exploitation of various species changing the balance of the system.

Ecosystems are a crucial part of our environment, and caring for our environment and ensuring it is used sustainably is becoming increasingly important, particularly with human-induced changes such as climate change.

Latin America contains many ecosystems which are already impacted by human-induced changes including climate change. The ecosystems affected in this region include the Amazon Basin, the Andes mountain range and the Caribbean. Case study 12.2 tells you more about why we should protect our ecosystems.

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Case study 12.2
Latin America and the Caribbean

Latin America spans a vast region of the Earth, from the tropics almost to the Antarctic. Along the length of South America there are many different landscapes and climate zones, and each will be impacted by climate change in its own way.

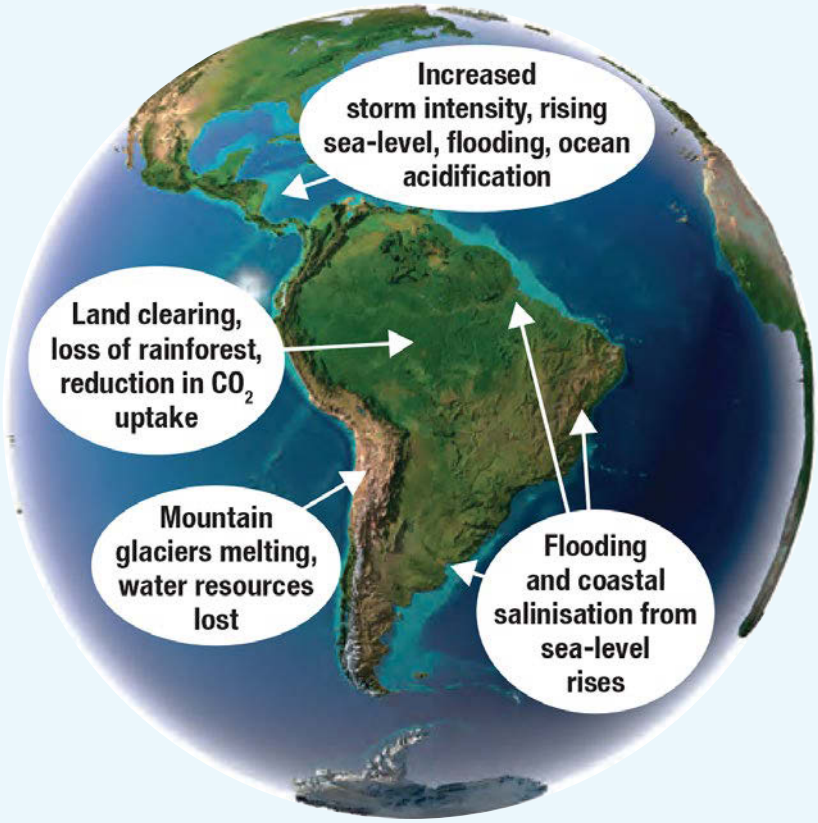
Running along the whole western coast of the continent is the huge mountain range of the Andes. In the high Andes, valley glaciers are important water sources, but through global warming these are melting and water supplies may be jeopardised.

The Amazon Basin holds the world's largest rainforest with an area of 5.5 million km^2, almost as big as Australia (7.7 million km^2). Already a combination of **land clearing**, rising temperatures and changing rainfall is affecting the forest. Rainforests are the land's largest sink for atmospheric carbon dioxide.

land clearing the direct human-induced removal of vegetation cover from forested areas, in order to allow the land to be used for other purposes such as agriculture

In the Caribbean, higher rainfall, increasing storm intensity, floods, an increase in ocean acidity and sea level rise can all be expected to have a significant impact on property, the environment and coral reefs.

According to the Inter-American Development Bank:



Source 12.18 Expected impact of climate change in Latin America

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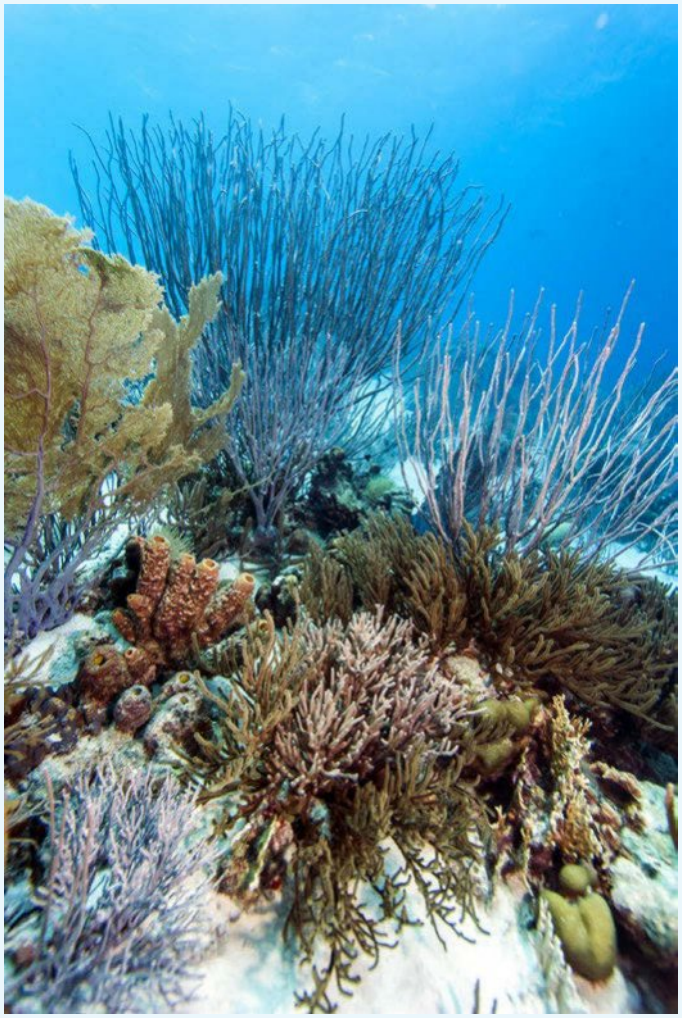
- Latin America and the Caribbean contribute only 12% of the emissions that cause global warming. However, some countries are especially vulnerable to its effects, given the region's dependence on natural resources; an infrastructure network that is susceptible to climate events; and the presence of bio-climate hotspots such as the Amazon basin, the Caribbean coral biome, coastal wetlands and fragile mountain eco-systems.



Source 12.19 Caribbean Coral Reef off the coast of the island of Bonaire

- Estimated yearly damages in Latin America and the Caribbean caused by the physical impacts associated with a rise of 2°C over pre-industrial levels are in the order of $100 billion by 2050, or about 2% of GDP.
- In Mexico and Brazil alone, almost 1 million hectares of land lie within 10 metres of sea level, making those countries vulnerable to rising sea levels. A rise of 1 metre in the sea level could affect 6700 km of roads and cause extensive flooding and coastal damage. A 50% loss of the coral cover in the Caribbean from coral bleaching would cost the economies in the region at least $7 billion.

According to the World Bank:

Even today the global climate is changing, and so regions must adapt to it in order to maximise their resilience to the changes ...

For Latin America, this resilience means:

- ensuring the region's infrastructure can withstand the new climatic 'extremes'
- growing a wider variety of crops, which perform well in droughts, floods and heat, as well as guaranteeing future crops through seed-banks
- prioritising land use to preserve and manage multiple threats
- implementing emergency response plans and early-warning alert systems
- developing social safety nets and insurance to protect the region's most vulnerable groups
- sharing best practices and information systems between countries
- monitoring the region's weather and climate.

Source: World Bank, 'Climate Change: Is Latin America prepared for temperatures to rise 4 degrees?', 19 November 2012

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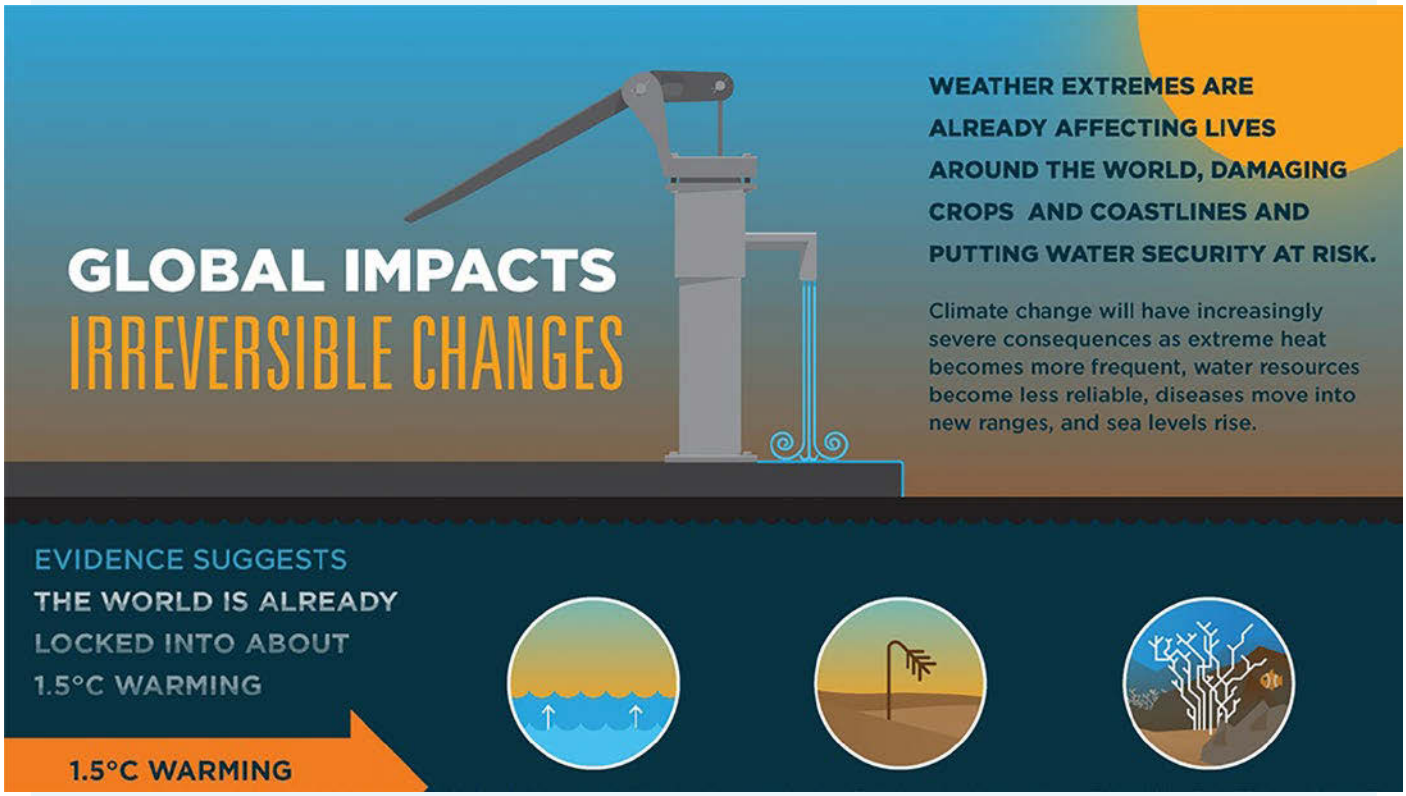

Source 12.20 World Bank infographic

1. Which ecosystems are under threat in the Latin America region?
2. List four major agricultural exports from Latin America, and explain how climate change might affect these.
3. Explain what particular threats are caused by climate changes that could cause the collapse of the coral biome.
4. Discuss your thoughts on what 'prioritising land use to preserve and manage multiple threats' means.
5. What are the main advantages of protecting the major ecosystems of Latin America and the Caribbean?

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Note this down 12.2

Copy the graphic organiser below and list the expected impacts of climate change. Suggest steps that could be taken to mitigate these impacts and explain why these steps should be taken. One example has been filled in for you.

Impact	Solution	Reason
Rising sea level from storm surge	Construct coastal barriers, prohibit near-shore development	Protect low-lying towns

Source 12.21 Scientists predict that frequent and prolonged heatwaves will be another result of climate change.

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Chapter summary

- There are many human activities that change the environment, including emission of carbon dioxide, deforestation, manufacturing and heavy industry, impoundment of water, mining, overfishing, urbanisation and agriculture.
- Major human impacts on the environment include atmospheric pollution; loss of habitat; declining biodiversity; land degradation; and exploitation of coastal, marine and fresh water resources.
- Sustainability refers to our capacity, actions, decisions and strategies to achieve prosperity and meet social needs without compromising the natural environment.
- Intergenerational equity is a key component of sustainability and requires humans to manage their activities and resource use today to ensure fair and reasonable access for future generations.
- The weather and the climate are driven by the sun. Global temperature is set by a balance between the sun's energy radiating in and the heat from the Earth radiating out.
- The Earth's heat is partly retained through the absorption of heat by the two main greenhouse gases, water vapour and carbon dioxide.
- Climate change results from a change either in the sun or in the amount of heat absorbed in the atmosphere. When atmospheric carbon dioxide rises, so does the Earth's temperature and that makes the climate change.
- Burning fossil fuels has increased the atmosphere's carbon dioxide content by 40% since 1850, and this has caused global warming. Global warming might be slowed by reducing dependence on fossil fuels for energy and reversed by removing some carbon dioxide.
- Climate change can be expected to increase Australia's temperature, change rainfall patterns and increase storm intensity. In low-lying places, such as the Amazon Delta, much of Bangladesh and small island communities, sea level rise and storm surges pose significant threats.

End-of-chapter questions

Short answer

1 Identify what the role of the government is in achieving sustainability.

2 Discuss the main threats to the sustainability of our environment.

3 Explain why the Arctic and Antarctic warm faster than the rest of the Earth during periods of global warming.

Extended response

Reflect on the following statement: 'Sustainability can never be achieved. Human populations will keep growing and consume resources at a rate which will one day exceed the carrying capacity of the Earth.'

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13 Environmental management

Source 13.1 Lake Pedder, the 'jewel' of southwest Tasmania, became the centre of an environmental management controversy in the 1970s.

Before you start

Main focus

There are many different approaches to managing the environment, including the traditional practices of Aboriginal and Torres Strait Islander peoples which have been in place for thousands of years.

Why it's relevant to us

The knowledge and practices of Aboriginal and Torres Strait Islander peoples can contribute to broader conservation practices and understanding of sustainability.

Inquiry questions

- What are some of the environmental management approaches?
- How is Aboriginal and Torres Strait Islander peoples' management of land influenced by their connection to Country/Place? How can Aboriginal and Torres Strait Islander peoples' knowledge and practices contribute to broader conservation methods?

Key terms

- Aboriginal law
- Anthropocentrism
- Biocentrism
- Burning
- Commodity
- Community
- Conservation
- Country/Place
- Custodian
- Ecocentrism
- Ecological
- Landscape
- Native title
- Productivity
- Rock art
- Sacred sites
- Songlines
- Spiritual
- Sustainability
- Technocentrism
- The Dreaming
- Worldview

Let's begin

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

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13.1 Environmental management approaches and perspectives

There are a range of perspectives when it comes to environmental management; some are in direct opposition with others.

Worldviews

A worldview is a set of beliefs about what is real, what is valuable and what it means to be a human being. People hold different worldviews about the environment. People's worldviews affect their willingness to protect landscapes for aesthetic, cultural or spiritual reasons. Some worldviews are about benefits to the individual and some are more about ecological wellbeing. All worldviews are based on a set of values.

Value judgements are drivers for how we use and manage the environment. Our value judgements influence our decisions on whether we find environmental impacts acceptable or unacceptable, and also influence political positions on sustainability.

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 purpose of investment. It promotes economic values.

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

Source 13.2 A commercial fishing boat at work. The concept of productivity underpins the role of fishing in the economy.

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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 sometimes ecological values.

Ecological

An ecological view of the environment places value on the biodiversity of genetic make-up, species and ecosystems, and on ecological processes and natural cycles. Conservationists or biologists and ecologists often express an ecological view. 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.

Community

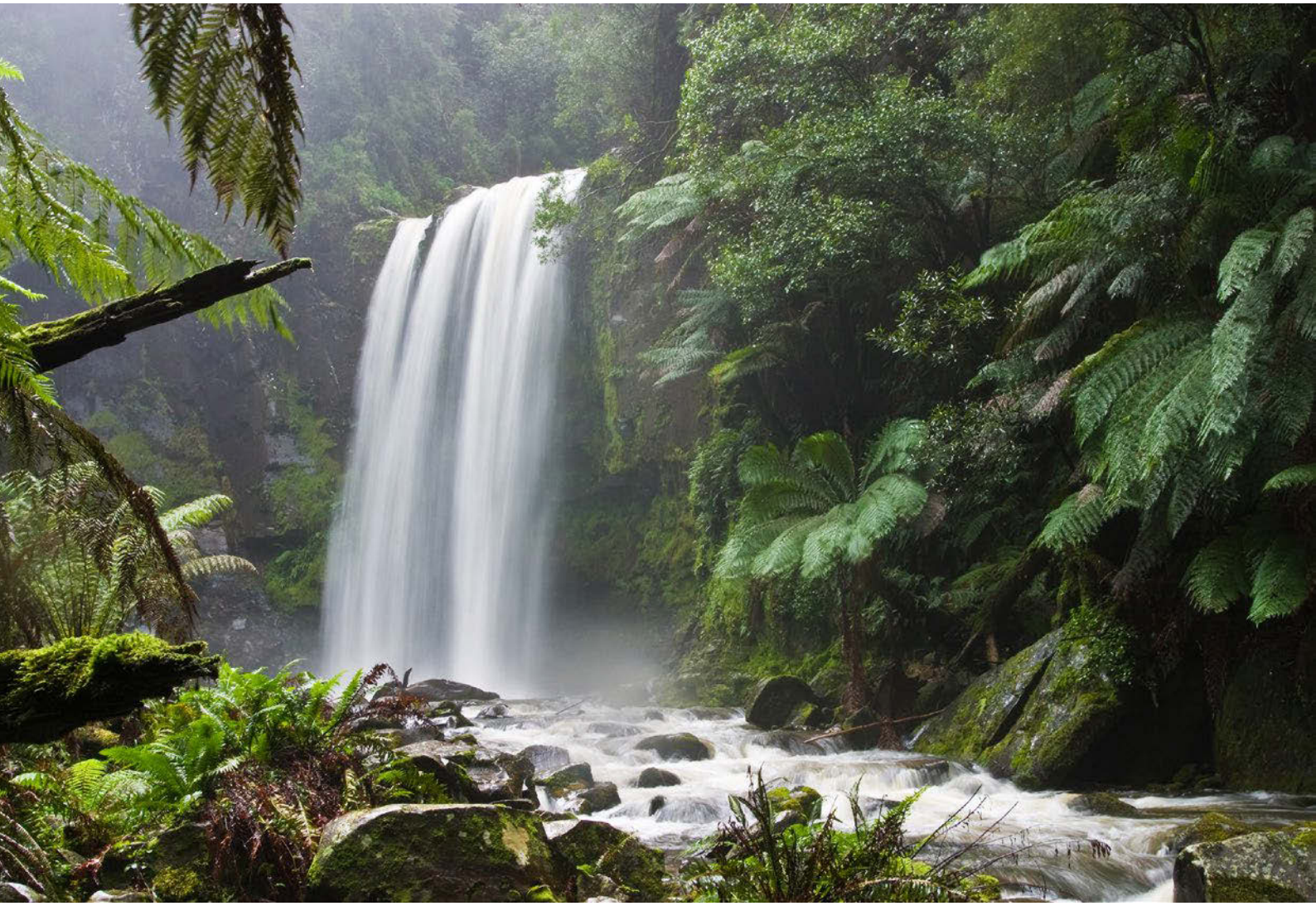
A community view emphasises public access to the environment and the right of everyone to enjoy it freely for social interaction and recreation. In this view, the community has a shared sense of belonging and ownership. It also maintains that the public should behave properly in relation to the environment, 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.

holistic the importance of the entire or whole of something but recognising the interdependence of inner parts

Source 13.3 A community worldview promotes respectful use of the environment.



Source 13.4 In the landscape view of the environment, natural beauty is greatly valued. Pictured is Hopetoun Falls, Beech Forest, near Otway National Park, Victoria.

Sustainability

From a sustainability worldview, we seek to combine rather than trade off ecological, cultural, social and economic values. This means 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 lead to 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 the varying worldviews on the environment can help to gain a shared understanding of all values and how to combine them. Where we can successfully combine ecological, cultural, social and economic values, we are beginning to tread lightly on the Earth and move towards sustainability.

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For example, rather than locating industrial development, nature conservation, social activity and cultural heritage at different points of the landscape, we could make these activities more compatible so they can support each other and exist together in the landscape. Here are some examples of where we are starting to do this:

1 Miners can rehabilitate a mine site to restore its ecological value and can also provide recreational infrastructure like a swimming pool to the local community.
2 A farmer can plant a variety of native trees as windbreaks on his or her farm. The windbreaks provide ecological 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.
3 National parks can be jointly managed by a government conservation agency and **Traditional owners** to support both ecological conservation and Aboriginal and Torres Strait Islander peoples' empowerment. Renewable energy and passive solar design can be used for the park facilities. Tourism can develop as a result of joint management practice. Community education and the local economy can then also improve.

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

Source 13.5 The Purnululu National Park in the far north of Western Australia is jointly managed by a government conservation agency and Traditional owners. The park contains the famous Bungle Bungle range of sculpted sandstone rocks.

Activity 13.1

1 Define the term 'worldview'.

2 Rank each worldview in a list in order of what is most important to you when thinking about the management of the environment.

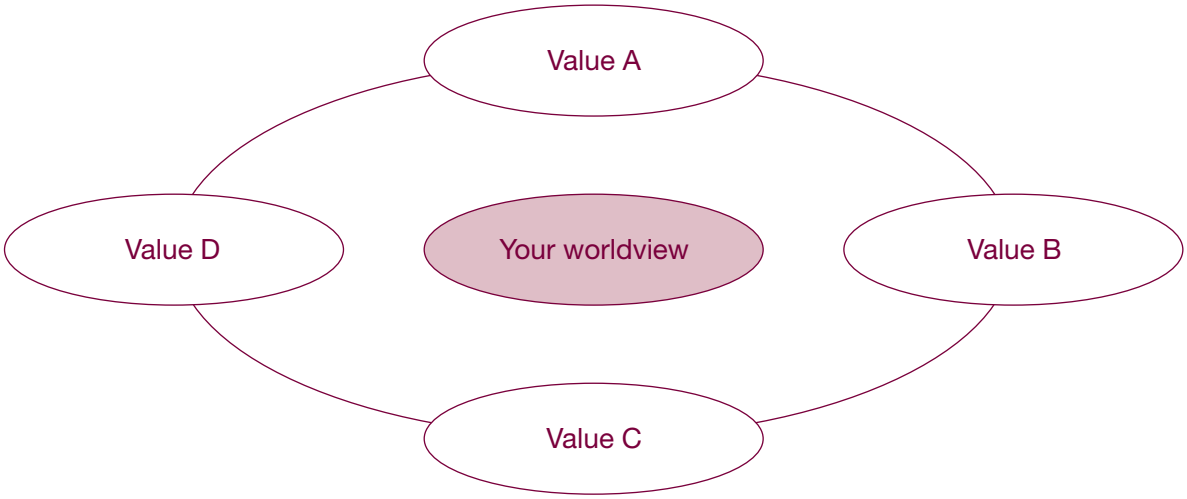
3 In pairs, role-play the conflicting environmental worldviews of a miner and a conservationist. Explore the reasoning behind each worldview.

Note this down 13.1

Copy the graphic organiser below and answer the following questions:

1 What do you value most about your environment? Write down your main values in the outside circles.

2 What do you conclude your worldview might be? Write it down in the centre circle.



13.2 Influence of people's perceptions

Our environmental values are shaped by our exposure to environmental impacts and the influence of the media and education. The following ideologies influence how humans perceive environmental risks:

- **Ecocentrism** – places a focus on nature rather than humans. Ecocentrism proposes that we should consider humans as part of the biotic community and that we should modify our behaviour to protect the ecosystems to which we also belong. Sustainable development must consider our place in the ecosystem and build

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environmental goals rather than focus solely on meeting human needs.

- **Anthropocentrism** – places a focus on meeting human needs and recognises humans as the dominant species on Earth. Ecocentrics consider this ideology to be the cause of unsustainable development.
- **Technocentrism** – proposes that environmental problems can be solved using science and technology. Ecocentrics are in conflict with technocentrics due to a lack of faith in technological solutions and a view that nature should not be controlled through technology.
- **Biocentrism** – endorses ethical treatment of all living things. Biocentrics consider that humans are not superior to other species and promote biodiversity. It differs from ecocentrism because it focuses on living organisms rather than the physical environment.

Source 13.6 Biocentrics consider that humans are not superior to other species, and focus on all living organisms.

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Note this down 13.2

Copy the graphic organiser below and use it to summarise the different views of sustainability. An example has been provided.

Biocentrism			
The ethical treatment of all living things			

13.3 Approaches of Aboriginal and Torres Strait Islander peoples

For tens of thousands of years, Aboriginal and Torres Strait Islander peoples have lived across Australia in hundreds of distinct groups with their own unique languages and cultural practices.

Country/Place Country is a space mapped out by physical or intangible boundaries that individuals or groups of Aboriginal peoples occupy and regard as their own. It is a space with varying degrees of spirituality. Place is a space mapped out by physical or intangible boundaries that individuals or groups of Torres Strait Islander peoples occupy and regard as their own. It is a space with varying degrees of spirituality.

Relationship to Country/Place

'**Country/Place**' is fundamental to the wellbeing of Aboriginal and Torres Strait Islander peoples. It is a richly symbolic and spiritual landscape rather than merely a physical environment.

Aboriginal and Torres Strait Islander 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/Place, as demonstrated by the Dreaming and songlines. They believe that a person belongs to the land – land is not owned. Aboriginal and Torres Strait Islander 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 them today.

Source 13.7 Rock art at Nourlangie in Kakadu National Park, Northern Territory

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Sacred sites that demonstrate the connection to land

sacred sites areas or places with culturally significant meaning to particular people

The **sacred sites** of Aboriginal peoples' 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. 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 Lake Alexandrina, he sliced it into pieces and tossed them back into the lake, where they became new species of fish.

initiation a rite of passage symbolising the acceptance of an individual into a group or into adulthood

Aboriginal law beliefs and expectations recognised by Aboriginal peoples

For Aboriginal and Torres Strait Islander peoples, 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 are covered with paintings. In 1985, the Commonwealth government returned Uluru to its Traditional owners, the Pitjantjatjara and Yankunytjatjara people (also known as the Anangu).

Source 13.8 Uluru (formerly known as Ayers Rock) is a well-known sacred site of Aboriginal peoples. Thousands of sites around Australia, however, remain undisclosed.

Geographical fact

Sacred sites for Aboriginal and Torres Strait Islander peoples can be hills, rocks, waterholes, trees, plains and coastal features, and can range in size from a single plant to an entire mountain range. Generally, sacred sites have one common feature, which is a connection to the Dreaming. Sacred sites are considered very powerful, and each site is the responsibility of recognised **custodians** who 'belong' to the location of the site.

custodians people given the responsibility for keeping a sacred site safe; usually the custodian(s) will 'belong' to the site

> Aboriginal law dictates that if custodians of sacred sites allow a site to be damaged, other Aboriginal people will hold them responsible. This can lead to retribution or sanctions within Aboriginal society. It can also lead to recriminations against non-Aboriginal people who damage such places.
>
> Source: Aboriginal Areas Protection Authority, 2012

Source 13.9 Kata Tjuta (meaning 'many heads') are also known as the Olgas and are located near Uluru. This is a very sacred site as Kata Tjuta is a place of the Dreaming and the largest rock, Mount Olga, is the home of Wanambi (one of the many tribal names for the Rainbow Serpent). Wanambi curls himself in the waterhole at the summit, and his breath is the wind through the rocks.

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Indigenous use of fire and its impact on the landscape

Before European settlement, Aboriginal and Torres Strait Islander peoples modified the environment with fire but over a timescale that enabled the environment to reach a new balance. It is thought that through the use of fire, Aboriginal and Torres Strait Islander peoples had a major impact on the landscape.

Australian historian Bill Gammage published a book in 2011, *The Biggest Estate on Earth: How Aborigines made Australia*, that describes how important he thinks Aboriginal and Torres Strait Islander peoples' land management was for the Australian continent. Gammage draws upon the writings and paintings of early Australian settlers, who would often describe the landscape as looking like an English gentleman's park with large, widely spaced trees and undulating grassy slopes underneath. Often, they could not explain why one area appeared like a well-maintained parkland, whereas next to it, with the same soil, landforms and climate, was woodland or forest. It seems that this landscape was not coincidental; rather it had been created by long-term and deliberate burning by Aboriginal and Torres Strait Islander peoples to create a landscape that was easy to walk through and promoted abundant and easily accessible plant and animal resources.

Although other scientists and land managers have known about 'firestick farming' for many years, Gammage presents a new hypothesis which emphasises how this use of fire created the entire landscape that early settlers encountered. After European colonisation, many traditional cultural practices of Aboriginal and Torres Strait Islander peoples, including burning, were interrupted or stopped completely. It is possible that by stopping this traditional method

Source 13.10 Aboriginal elder George Milpurrurr shows his children how to make a controlled fire to burn off dangerous dry grass in Arnhem Land using the traditional method of land management

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of burning, many grasslands disappeared and were replaced by shrubs, trees and even rainforest, the type of environments Australians are familiar with today. Unfortunately, it is also possible that without traditional burning, the landscape today is more prone to large, destructive wildfires that can damage property and endanger people and wildlife due to the build-up of vegetable litter and foliage that was once burnt regularly.

Indigenous impact on biodiversity

The role of Aboriginal and Torres Strait Islander peoples in the extinction of megafauna is not fully understood. There is evidence that supports several theories for the extinction of Australian megafauna, which include changes in vegetation communities that were essential for food; hunting; climate change; and the evolution of megafauna, through adaptation, to smaller, modern species. Nevertheless, Aboriginal and Torres Strait Islander communities were able to sustain their populations and not exhaust sources of food.

Currently, exciting partnership projects for land management are starting to appear. One of these is a project operated by the North Australian Indigenous Land and Sea Management Alliance (NAILSMA), which aims

Source 13.11 The North Australian Indigenous Land and Sea Management Alliance aims to put Indigenous coastal stewardship in place, with custodians managing the northern marine turtle and dugong population.

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 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** (or custodial responsibility) is more likely to benefit than endanger such species.

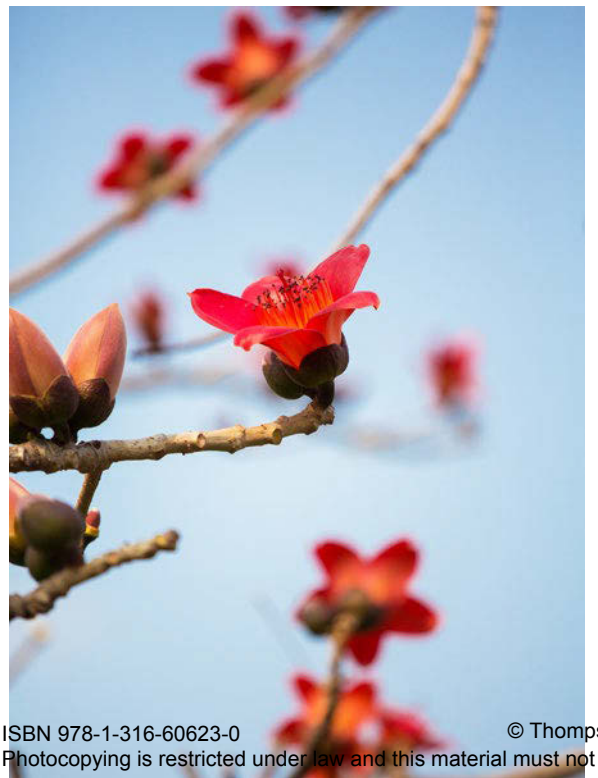
stewardship the responsible planning and management of resources

Traditional knowledge and usage of resources by Indigenous Australians

Traditionally, Aboriginal and Torres Strait Islander peoples had an intimate knowledge of the plants, animals, water and landforms that existed on their country. This knowledge was not written down but rather was held in many forms including songs, ceremonies and Creation stories. This knowledge was passed down through generations and many Aboriginal and Torres Strait Islander peoples continue to hold traditional knowledge and pass it down to the next generation, an important cultural responsibility.

Aboriginal and Torres Strait Islander peoples also held, and continue to hold, detailed knowledge about how plants and animals interact. This allows people to use clues from the landscape to understand what is happening in their environment, such as when particular food resources are ready to eat. For example, in northern Australia some people know that when the red kapok flower blooms, freshwater crocodiles are laying their eggs, a source of food.

Aboriginal and Torres Strait Islander peoples used, and continue to use, a range of methods that help to ensure food resources remain plentiful. This includes techniques like seasonal hunting of animals and types of farming. For instance, the Gunditjmara people from Lake Condah (350 km west of Melbourne) farmed eels through a system of channels and ponds.



Source 13.12 The red kapok flower, which in northern Australia signals that freshwater crocodiles are laying their eggs

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RESEARCH 13.1

Visit the Australian National Botanical Gardens website and research Aboriginal plant use and knowledge. Choose at least five plants to focus on, including one that is commonly poisonous. Identify the plants and explain what they were used for. Explain how Indigenous knowledge makes poisonous plants useful.

Indigenous land management

The Australian Government recognises the importance of Aboriginal and Torres Strait Islander peoples' knowledge in catchment management as well as the rights of native titleholders. Accordingly, laws and policies have been developed or amended to ensure that Aboriginal and Torres Strait Islander peoples' communities are fully engaged in natural resource management without detriment to livelihood opportunities or the loss of cultural heritage.

A network of Indigenous Land Management Facilitators was established to help communities develop partnerships with government agencies and organisations involved in sustainable development. Under the Natural Heritage Trust, Aboriginal and Torres Strait Islander peoples' groups are able to apply for grants to support programs that manage rivers, protect threatened species, conserve cultural assets and improve the productivity of the land.

The federal government has also established the Indigenous Land Corporation to enable Aboriginal and Torres Strait Islander communities to acquire and manage land according to sustainability principles. The goal of the Indigenous Land Corporation is to enable communities to meet their socio-economic needs and fund and facilitate programs that protect cultural and environmental assets for the benefit of all Australians.

Source 13.13 Ayers Rock Resort at Yulara, where the Indigenous Land Corporation has established a National Indigenous Training Academy

Activity 13.2

1 How is traditional burning used by Indigenous peoples?
2 Describe pros and cons of traditional burning methods today.
3 Differentiate between custodianship and stewardship.

RESEARCH 13.2

Investigate the traditional landowners for the region you live in. Find out the name of the Aboriginal nation or language group of your area. Find out as much about them as you can, such as their cultural beliefs and history with the land you now live in. Present your findings to the class. Ask a local Aboriginal person to share their knowledge with you.

13.4 Differing attitudes and approaches to environmental management

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 between Aboriginal and Torres Strait Islander peoples' views and other concerns such as productivity and ecological 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 Aboriginal and Torres Strait Islander peoples' 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.

Competing environmental worldviews causing conflict

Different views are important, but when such views are in opposition to each other conflict can arise, presenting significant risks to the environment. One source of constant debate in Australia is the differing worldviews held by the Australian Government and Aboriginal and Torres Strait Islander peoples about how the environment should be managed.

Australian law

Ecologically sustainable development (ESD) is embedded in environmental decision making in Australia. Legislation provides a legal framework for decision making,

ecologically sustainable development (ESD) the environmental component of sustainability that is embedded in environmental decision making in Australia. It also considers the need to meet economic and social development goals.

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guidelines for developers, processes for public participation and consistent measures to enforce compliance. **Environmental impact assessment** and planning laws were put into place during the 1970s following growing environmental activism that saw the public having a strong influence on environmental decision making in this country. The federal government enacted the *Environmental Protection and Biodiversity Conservation Act* (EPBC) in 1999 to replace a number of environmental Acts from the 1970s and to simplify environmental decisions. The EPBC Act addresses the following matters of national significance:

environmental impact assessment an assessment of positive and negative impacts an action or project will have on the environment

- World Heritage Sites
- National Heritage places
- nationally protected wetlands (Ramsar wetlands)
- nationally listed threatened species and ecological communities
- listed migratory species
- nuclear actions (including uranium mines)
- Commonwealth marine areas
- land owned by the Commonwealth
- activities by Commonwealth agencies.

Responsibility for environmental management and sustainable development is divided between all levels of government in Australia. If a development involves any of the previously mentioned matters of national significance, then the developer must seek approval from the Federal Minister for the Environment. This may require the submission of an Environmental Impact Statement.

Role of the public

Australian federal and state laws include opportunities for the public to make comment or to submit objections to developments. Major developments trigger the need for an **Environmental Impact Statement (EIS)** in most states and under the EPBC Act if there are matters of national significance. An EIS outlines the main activities of the development, predicts the potential impacts and describes strategies to minimise or prevent environmental impacts. The developer or **proponent**, who may also be the government, is required to produce an EIS that is subjected to review by **stakeholders**. Local government councils are also empowered to make decisions on development.

Environmental Impact Statement (EIS) a document that outlines the main activities of a development, predicts the potential impacts and describes strategies to minimise or prevent environmental impacts

proponent a person who is in favour of or advocating a theory, proposal or action

stakeholder a party or person with an interest or concern in an organisation and its actions

Many Australian planning policies and environmental laws traditionally focused on approving single developments in an independent manner. That is, decisions were once made on the sole effects of one development at one location without considering the interactions with, and the degree of impacts of, other developments. There is now greater recognition of growing impacts and the importance of planning development strategically so that the effects of multiple projects can be predicted and considered. Although single developments can be considered sustainable, the environment may not be resilient to the effects of multiple developments.

There can also be an increase in social impacts when multiple developments are approved separately. For example, truck movements to a single factory might cause acceptable noise levels. However, if there are multiple factories at a location, the increase in

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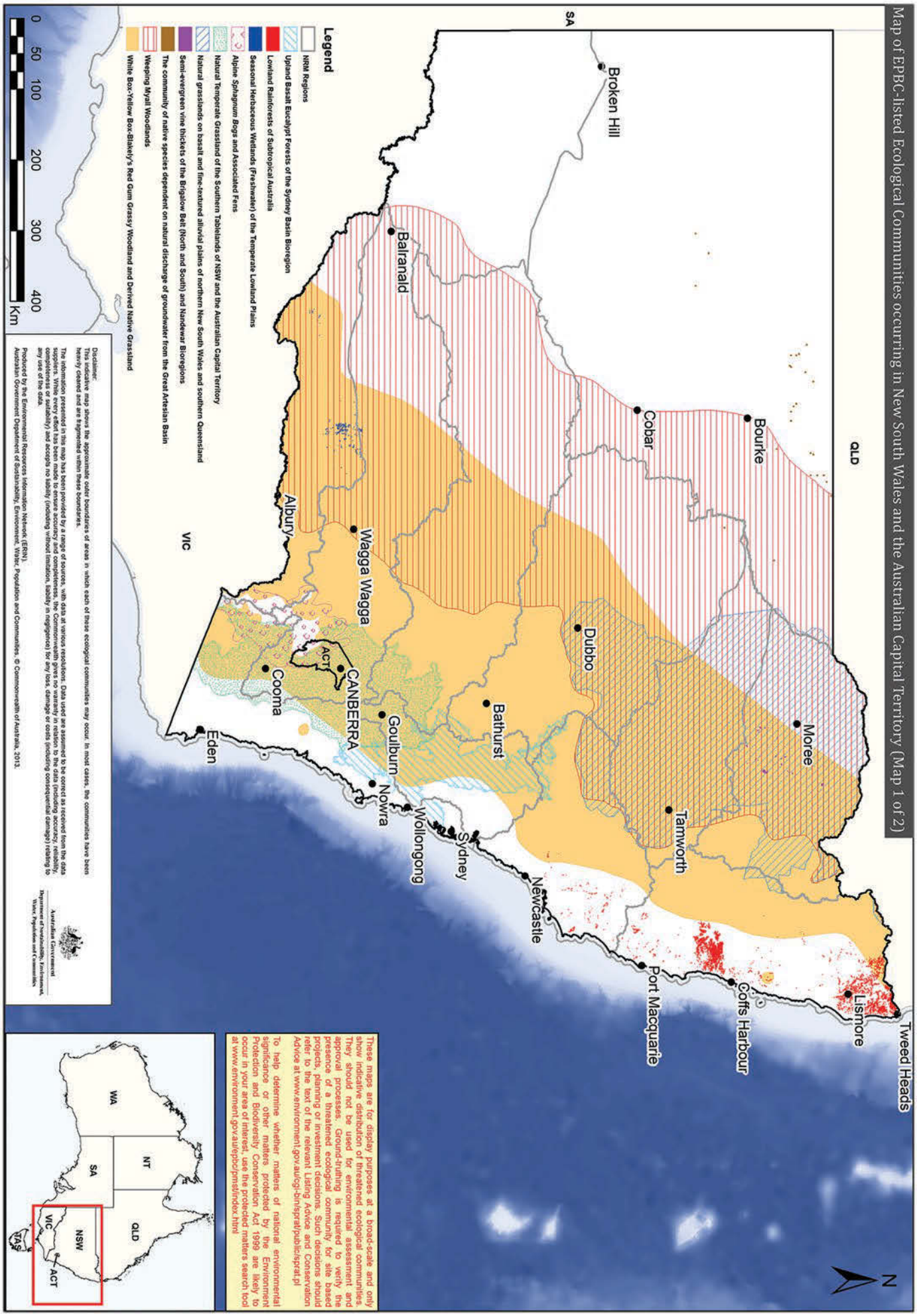

Source 13.14 Map of threatened ecological communities in NSW and the ACT from the Department of the Environment, 2013. Mapping is a useful tool for environmental decision makers. The grey boundaries indicate how the country is divided into National Resource Management (NRM) regions.

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noise from trucks might become unacceptable. To address growing environmental impacts, environmental managers must consider the following:

- the spatial extent of the potential impacts of a development or activity; understanding the spatial extent enables decision makers to determine who, what and where will be impacted and where interactions with other developments might occur
- the time over which an impact might occur and the length of time required to monitor; understanding the time frame for impacts enables decisions to be made about future impacts, future needs to be considered and projections on interactions between the current and future use of the environment to be made
- the interaction of impacts from past, present and future developments and activities; this knowledge is essential because decision makers can more accurately predict if the impacts from a single development will add to or amplify the impacts from other developments
- the use of **contingency plans** and environmental monitoring to address impacts, over time, that were not accurately predicted; a lack of scientific knowledge or errors in past and current decisions on development can lead to an increase of impacts. Contingency plans and monitoring enable managers to quickly respond to negative changes in the environment by modifying development or implementing remediation strategies.

contingency plan a plan designed to help an organisation respond to a future event or uncertain situation

Source 13.15 Coal seam gas exploration in Sydney's suburbs has triggered public objection and calls to apply the Precautionary Principle.

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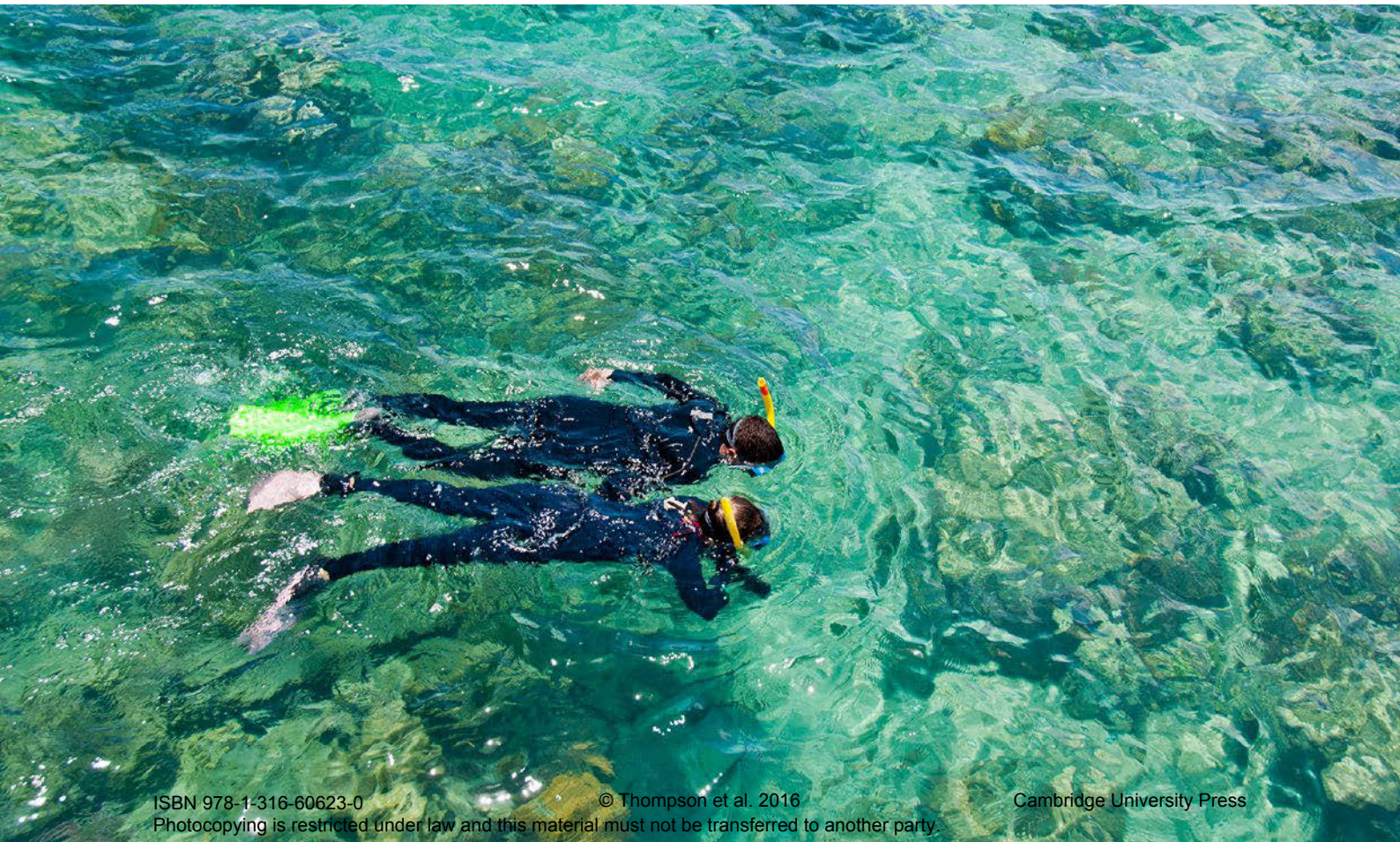
Geographical fact

According to the World Bank, in 2013 Australians generated approximately 36 thousand tonnes of waste per day. By comparison, the USA produced approximately 625 thousand tonnes per day!

Activity 13.3

1. Outline the ways that the environment is protected by Australian law.
2. Research online what the Precautionary Principle is. Define it in your own words.
3. 'Country/Place' is fundamental to the wellbeing of Aboriginal and Torres Strait Islander peoples. Describe your relationship to your country and list the resources of the land that you use in your life in your response.
4. Identify any strategies you could adopt to minimise or prevent environmental impacts in your day-to-day life.

Source 13.16 Human activity in the Great Barrier Reef is contributing to its pollution and impacting the ecosystem of the reef.



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Case study 13.1

Lake Pedder, Tasmania: The result of conflicting worldviews

To this day, the flooding of Lake Pedder remains one of the most controversial environmental issues in Australia; it led to protests both in Tasmania and on the mainland. The conflict also gave rise to the United Tasmania Group (UTG), which eventually became the Australian Greens Party, and was the first Greens party in the world. To understand the significance of the conflict, we need to start at the very beginning, before European settlement.

One million years ago

During the last ice age, Lake Pedder in southwest Tasmania was formed when the Serpentine River was blocked by a glacier. Lake Pedder was therefore a unique glacial lake, and one of its most aesthetic features was the pink quartzite beach (and dunes) that stretched along the boundary of the lake for 3 km. When the water levels lowered during the summer, the beach could be almost 1 km wide. The lake is also cradled by mountains.

Twenty thousand years ago

Indigenous Australians lived in the area and fished at the lake.

The nineteenth century

Following European Settlement, the lake became known as 'Lake Pedder' in 1835 after the first Chief Justice of Tasmania. It became a popular destination for bushwalkers.

Source 13.17 Although it is now flooded, Lake Pedder remains a beautiful part of the Tasmanian Southwest National Park. As of 2015, the government has plans to restore the lake to its original state.

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The twentieth century

Lake Pedder became dubbed the 'jewel' of the southwest and in 1955 became protected as part of the Lake Pedder National Park. However, a new road was built into the National Park in 1963 and suspicions arose among the public, particularly conservationists, who formed their own committee known as the Southwest Committee.

In 1965 the Premier of Tasmania Eric Reece announced that some changes to the National Park would occur as part of the Middle Gordon Hydro-Electric Scheme. Two years later the Lake Pedder National Park was incorporated into the Southwest National Park and the government continued to change the level of protection until it was announced in May 1967 that the lake would be flooded and dam walls erected to trap the flows of the Serpentine and Huon Rivers. Many conservationists became bitter, as some senior executives of the Hydro-Electric Commission (HEC) were members of the Hobart Walking Club, who frequently trekked to Lake Pedder.

In 1972, Bob Brown founded the United Tasmania Group (UTG), to oppose the flooding of Lake Pedder.

Despite statewide and national protests, Lake Pedder was flooded in July 1972. The

Source 13.18 The pink quartzite beach of Lake Pedder in 1963. People accessed the Lake either by foot or by light plane prior to the building of the road.

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pink sandy beach and dunes were lost, and Lake Pedder became larger and 15 metres deeper as part of the HEC scheme. Sadly, the unique trout species as well as earthworm species of the lake were lost and are now considered extinct.

Although the public and UTG had failed to stop the flooding, they did begin a conservation movement in Australia. Australians began to think about the beauty and value of their natural resources. In 1974 a federal inquiry was held. Liberal member and

Geographical fact

On 8 September 1972 Tasmanian conservationists Brenda Hean and Max Price left for Canberra in a Tiger Moth aeroplane to lobby politicians against the flooding of Lake Pedder. Hean and Price never made it to Canberra and the wreckage of their aeroplane was never found. It is alleged that the plane was tampered with by pro-dammers prior to the journey, as the hangar had been broken into the night before but nothing stolen. No substantiated evidence was found, but past Greens leader and senator Bob Brown (and many others) still believe the flight was sabotaged, resulting in the tragic death of Brenda Hean and Max Price.

Source 13.19 The last reported sighting of Hean and Price's ill-fated Tiger Moth aeroplane was by a family at the Eddystone Point Lighthouse at the Bay of Fires, on the southeast coast of Tasmania.

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QC Edward St John famously said, 'The day will come when our children will undo what we so foolishly have done.'

The flooding attracted international attention and criticism as well. In 1982 the International Union for the Conservation of Nature expressed their hopes that the lake would eventually be restored.

In 1995, Liberal backbencher Tony Abbott called for the recovery of Lake Pedder, naming it a national treasure. Bob Brown became the first Greens Federal Senator when he was elected in 1996.

The twenty-first century

The Greens Party is now the 3rd largest political party in Australia; it has held the balance of power in government in Tasmania and later in Victoria.

In 2010, 1.6 million Australians voted for the Green Party in the federal election, with the Greens holding or sharing the balance of power in both houses. In 2012, Bob Brown retired as leader of the Greens.

Lake Pedder today

In late 2014 and early 2015, the Tasmanian Government acknowledged that they are considering reinstating the lake. Amazingly, the lake and its pink sandy beaches and dunes remain intact under a few millimetres of silt.

Lake Pedder is an amazing example of the awakening of the Australian public to the issues of conservation. The current generation of Australians may be fortunate enough to visit the restored lake and its beautiful beach and dunes in years to come.

Source 13.20 Lake Pedder today

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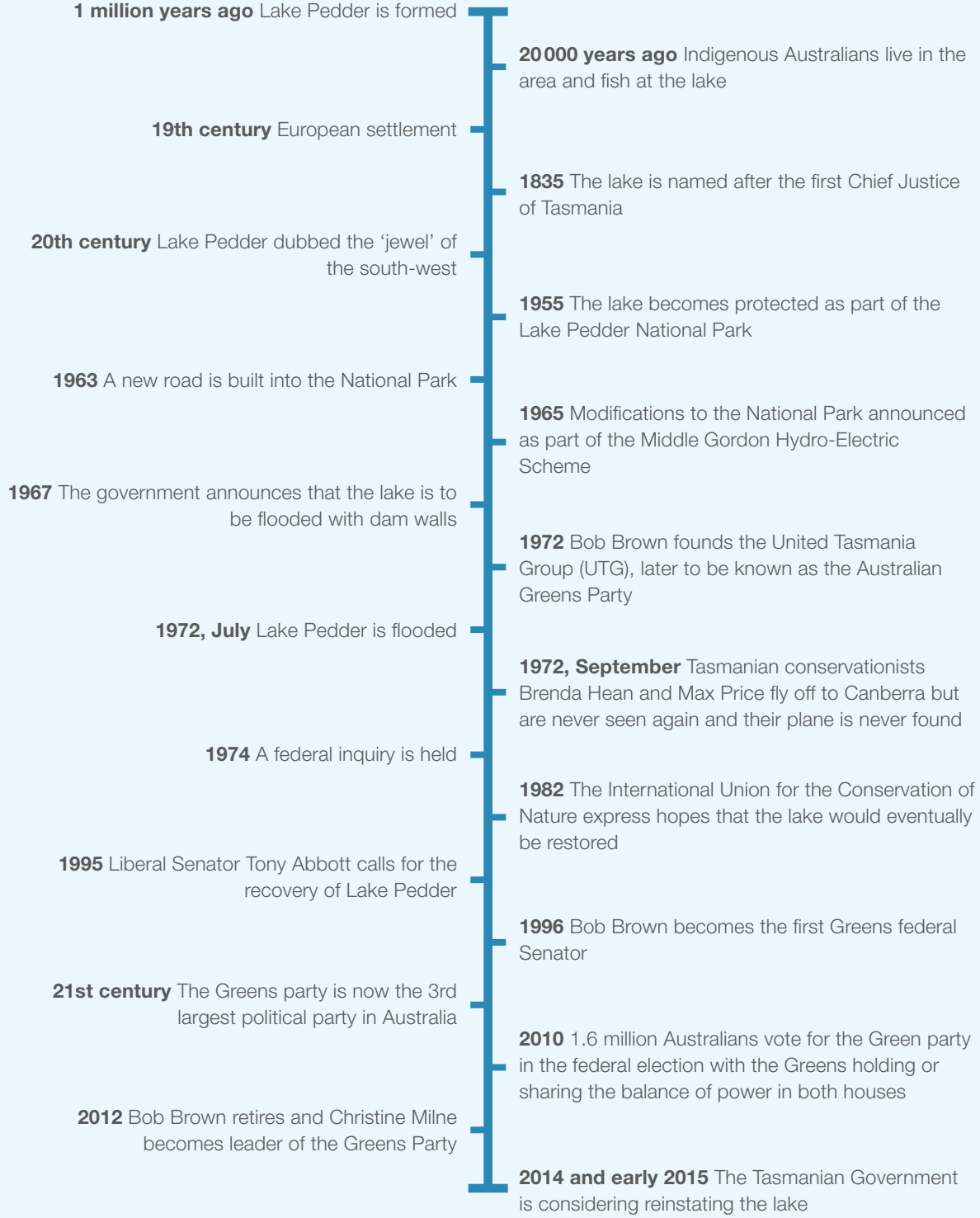

Source 13.21 Timeline of Lake Pedder

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Source 13.22 Since the flooding of Lake Pedder, Australians' understanding of the importance of conservation and protecting our natural resources has grown.

Watch the following ABC News footage about Lake Pedder. These news stories were filmed prior to the flooding. See http://splash.abc.net.au/home#!/media/28755/lake-pedder-s-future and https://www.youtube.com/watch?v=hLSne0ttt3E

1 Although the films are black and white, what geographical features are noticeable of Lake Pedder prior to the flooding?
2 What do you think the opinion is of each of the ABC journalists and the people they interview?
3 What would the worldview held by the journalists be in comparison to the worldview held by the Tasmanian government?
4 Adopt the worldview of either the government or the public (or adopt a different worldview) in relation to Lake Pedder. Deliver a 3 minute speech to the media about the key issues and the best responses. Provide reasons for your chosen responses, refer to quotes and data too. Be prepared for questions from the media (ie: your class).
5 Research online the life of photographer and conservationist Olegas Truchanas. Write a paragraph outlining his life story and the impact he had in the story of Lake Pedder. His photographs of Lake Pedder can be viewed here: http://nla.gov.au/nla.pic-vn3885846

Extension research activity

Read and take notes from the February 2015 ABC News story 'Campaign to drain and restore Lake Pedder gains momentum' online. Summarise the main points of the article in a series of dot points. What do you think should happen?

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Chapter summary

- A worldview is a set of beliefs about what is real, what is valuable and what it means to be a human being. People hold different worldviews about the environment. People's worldviews affect their willingness to protect landscapes for aesthetic, cultural or spiritual reasons.
- From a sustainability worldview, we seek to combine rather than trade off ecological, cultural, social and economic values. This means creating technologies and livelihoods for people that also protect the environment, strengthen society and respect cultures.
- Our environmental values are shaped by our exposure to environmental impacts and the influence of the media and education. Ideologies influence how humans perceive environmental risks.
- Aboriginal and Torres Strait Islander peoples continue to identify with their ancestral or traditional lands, now commonly referred to as 'Country/Place' – all of the landforms, water and living things in an area.
- 'Country/Place' is fundamental to the wellbeing of Aboriginal people. It is a richly symbolic and 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.
- Today, the Aboriginal and Torres Strait Islander people who are the 'custodians' or caretakers for their traditional lands are known as 'Traditional owners' and 'managers'.
- 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 between Indigenous, productivity, ecological and other views. Lake Pedder began a conservation movement in Australia, with the public consciousness rising regarding the importance of protecting nature and appreciating it for its beauty and spiritual value rather than its economic value.

End-of-chapter questions

Short answer

1 Describe the different types of worldviews.

2 Describe the relationship between Country/Place, sacred sites and rock art for Indigenous people.

3 Account for the controversy over the flooding of Lake Pedder.

Extended response

Consider the four ideologies that shape people's perception of the environment (ecocentrism, biocentrism etc). Which ones do you think would be in conflict with each other and why? And would it be possible for people of opposing ideologies to work together cooperatively?

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Investigative study

You are required to select one type of environment in Australia as the context for a comparative study with at least one other country. Chapter 14 features marine environments for your investigative study. Available in the Interactive Textbook and on *Cambridge GO* are optional chapters on alternate environment types: land, inland water, coastal and urban environments.

Source 14.1 A national park in Ukraine

ISBN 978-1-316-60623-0

14 Investigative study – Marine environments

Source 14.2 Marine environment of the Red Sea

Before you start

Main focus

We interact with marine environments in many ways – some positive and others detrimental.

Why it's relevant to us

About 70% of the Earth's surface is covered by water. Marine environments account for about 97% of that. In Australia, our marine environments extend from oceans near the Equator to the sub-Antarctic and are bigger than our landmass. We interact with marine environments in many ways – some positive and others detrimental. We need informed knowledge and skills on how best to work with this all-important resource.

Inquiry questions

- How do humans impact on marine environments?
- How can we better manage our marine environments to reduce environmental degradation and make them more sustainable?

Key terms

- Coastal system
- Environmental management
- Longshore sand transport
- Low pressure system
- Marine environments
- Sediment
- Storm surge
- Waves

Let's begin

Ever wondered what a marine environment is? Is it shallow water, deep water, or both? A helpful definition comes from the US Department of Defense: marine environments are 'the oceans, seas, bays, estuaries, and other major water bodies, including their surface interface and interaction, with the atmosphere and with the land seaward of the mean high water mark'. Better understanding of marine environments gives us the ability to manage them more effectively.

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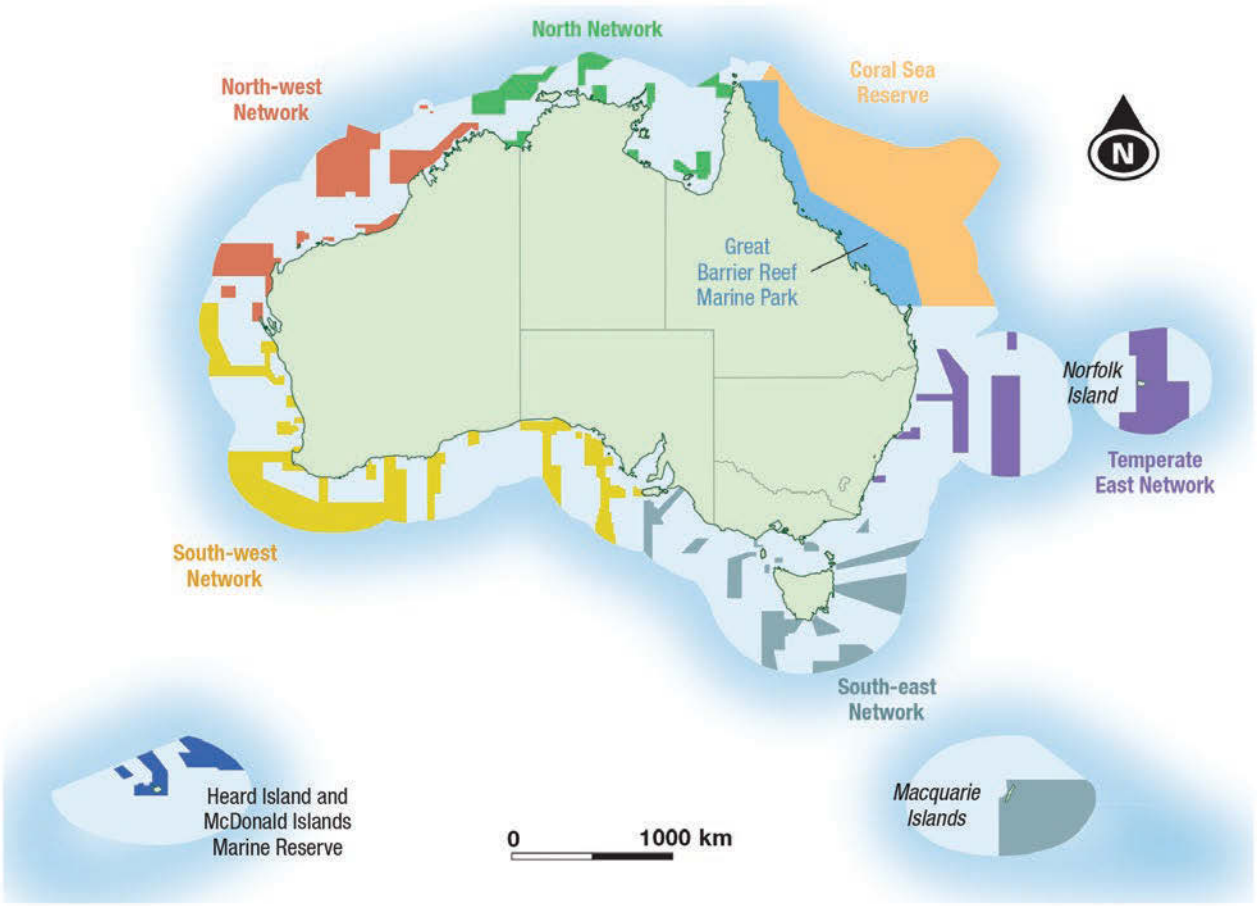
14.1 Biophysical processes of marine environments

In the first section of this chapter we will consider some of the biophysical processes operating in marine environments to maintain their functioning. Australia's **marine environments** are shown in the following map.

marine environments oceans, seas, bays, estuaries and other major water bodies, including their surface



Source 14.3 Australia's marine reserves

Activity 14.1

1. Identify the six marine reserve areas in Australia from Source 14.3.
2. List six ways in which you use marine environments.
3. Briefly describe one way in which people have a negative impact on marine environments; for example, coastal development or an oil spill.
4. Why is informed management of marine environments so important?

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Geographical fact

Approximately 50% of the Earth's oxygen is produced in the oceans. Oceans take up around 70% of the Earth's surface.

A large part of this chapter is a study of the Tweed River Entrance Sand Bypassing Project in New South Wales as well as the Colon Island in the Caribbean. We will investigate the geographical concepts and techniques applied to **environmental management** and engage in geographical inquiry and skills. It is important to understand human influences causing environmental change and the management strategies that may lead to a more sustainable future.

environmental management an attempt to control human impact on and interaction with the environment in order to conserve the environment

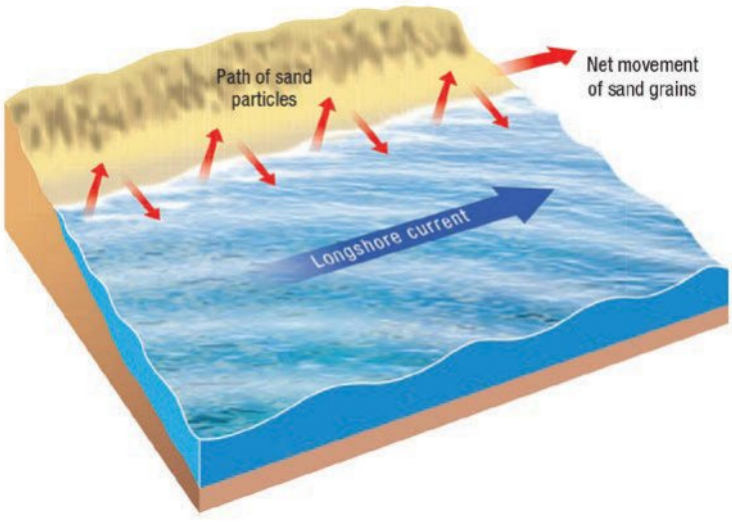
The coastal system

To understand Tweed Sand Bypassing and why the project was necessary, it is important to have an understanding of coastal processes. The coastal zone can be viewed as an intricate system made up of different components that are all interconnected. The three main components of the **coastal system** are:

1 the underlying **geology** such as coastal headlands and nearshore islands

coastal system interconnected components which interact to form coastal processes

geology the study of the Earth: the materials of which it is made and their structure as well as the processes acting upon them. It also studies organisms of our planet and the study of how Earth's materials, structures, processes and organisms have changed over time.



Source 14.4 Longshore sand transport along Letitia Spit, northern New South Wales. Sand moves up the beach at an angle in the swash (whitewash) zone. Sand then moves down the beach under gravity. This process is repeated, moving sand in a northerly direction.

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sediment material broken down by natural processes such as erosion which are transported by wind, water and other means

spatial scale the extent, size and location of something being studied; for example, the climate of a large area such as central Australia versus the microclimate of a small area such as a westward-facing slope

2 the nature and abundance of the coastal **sediment**
3 the influence of waves and wind.

These components all interact to form what are known as coastal processes.

Coastal processes operate over a range of timescales (seconds, days, years, millennia) and **spatial scales** and are responsible for moving sand from one place to another, changing the shape of the beaches.

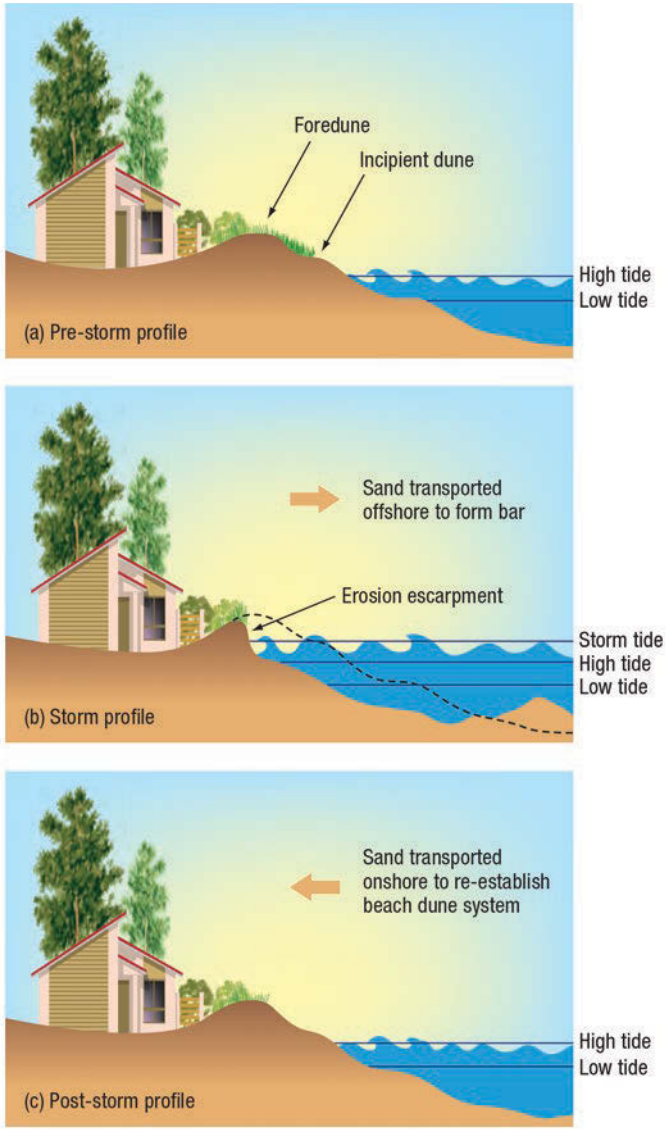
Longshore sand transport is the process that moves sand parallel along a beach or coastline. **Cross-shore sand transport** is the process that moves sand perpendicular to the coastline. Cross-shore sand transport is the dominant process in smaller pocket beaches such as those in Sydney, where headlands impede the movement of longshore sand transport.

longshore sand transport the process that moves sand parallel along a beach or coastline

cross-shore sand transport the process that moves sand perpendicular to a beach or coastline

Coastal processes move sand from one place to another (spatial scales), and also over a range of timescales:

Source 14.5 Cross-shore sand transport at Duranbah Beach, New South Wales. Sand is eroded from the beach due to large waves during storm events and is then pushed back onshore by small waves during calm conditions.



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- When a wave breaks, sand moves through the water, which happens almost *at once*.
- During a storm event, large waves and high tides can erode sand from the beach and deposit it further offshore in deeper water. This process happens over a few *hours*.
- During calmer wave conditions, waves move sand from offshore sand deposits onshore, gradually making the beach wider. This process happens over several *weeks*.
- Beaches can change seasonally, with the beach increasing in width in summer when there are smaller waves pushing sand onshore and then decreasing in width in winter when large waves move sand offshore. This process can take several *months*.
- Climatic effects such as the **Southern Oscillation Index (SOI)**, which is responsible for **El Niño** and **La Niña**, can affect the frequency of storms and cyclone events which are responsible for moving large amounts of sand in a short period of time. These climatic cycles can be many *years* long.

Southern Oscillation Index (SOI) atmospheric pressure differences at sea level between Tahiti and Darwin. Sustained negative values of the SOI are associated with El Niño events, and positive values with La Niña events. As El Niño and the Southern Oscillation are related, the two terms are often combined with the abbreviation of ENSO.

El Niño (Spanish for 'the boy child') during an El Niño pattern, pressure at sea level is lower in the eastern Pacific and higher in the western Pacific. The opposite happens with a La Niña pattern.

La Niña (Spanish for 'the girl child') during a La Niña pattern, pressure at sea level is higher in the eastern Pacific and lower in the western Pacific

Geographical fact

Ninety-nine per cent of the planet's living space by volume is in the ocean. This is the largest space known in the universe to be inhabited by living organisms.

Note this down 14.1

Copy and complete the table, detailing the coastal processes and the time periods over which they operate.

Coastal processes	Time periods

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Activity 14.2

1 Differentiate between longshore sand transport and cross-shore sand transport.

2 Describe the three main components of the coastal system.

14.2 The causes, extent and consequences of environmental change

In the next section of this chapter we will examine how marine environments are undergoing environmental change. We will investigate the causes, extent and short- and long-term consequences of change to the environment by looking at a detailed case study from Australia. In the final section of the chapter we will consider another global case study as a point of comparison.

The Tweed River Entrance Sand Bypassing Project

The Tweed River Entrance Sand Bypassing Project is located on the border of New South Wales and Queensland, approximately 100 km south of Brisbane and 900 km north of Sydney. It falls into the jurisdiction of both the Gold Coast City Council and the Tweed Shire Council and is an area of natural beauty offering world-class beaches and surfing breaks to both local residents and domestic and international tourists.

catchment area the area drained by a river or water body. Also known as a river basin.

caldera a large crater formed by the collapse of land following a volcanic eruption – often as a result of magma being expelled and the resultant reservoir having the land above it collapse

Geographical features

The Tweed River has a **catchment** size of approximately 1000 km^2 and drains the remnants of a large volcanic **caldera**. The volcano has been inactive for many years and Mt Warning remains as the dominant volcanic plug. The river begins in the upper catchment and flows through the regional centre of Murwillumbah and extensive **estuarine** wetlands before flowing out through the trained entrance.

estuarine relating to the wide lower course of a river where it nears the sea and there is typically a mix of fresh and salt water

History of the project

The Tweed River entrance was first used in the 1800s to open up the Northern Rivers region to trade and settlement. Navigation of the Tweed River has historically been very dangerous, with the sand shoals around the entrance constantly moving and changing in response to the varying wave climate. During the early years of use, the Tweed River entrance claimed many lives as boats capsized or were shipwrecked while trying to gain access to the river.

To control the sand shoal movement and improve navigation, training walls were constructed in the late 1890s, and then extended seaward by approximately 380 metres in the early 1960s. While improving navigation temporarily, the problem with the extension of the training walls was that the natural longshore drift that was travelling northwards along Letitia Spit was now being trapped behind the southern wall, unable to cross the Tweed River entrance bar and nourish the southern Gold Coast beaches in Queensland.

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Source 14.6 View of Duranbah beach and Point Danger from one of the coastal walls of the Tweed River

Issue 1

As a result, sand began to build up behind the southern training wall of the Tweed River entrance. Once the sand had built up to the end of the southern wall it began flowing around and into the Tweed River entrance, recreating the bar that had historically been such a navigational hazard.

Issue 2

The beaches of the southern Gold Coast, including Rainbow Bay, Greenmount, Coolangatta and Kirra, are some of the most visited in Australia. Sandy beaches are very important to the tourist industry, as they are aesthetically pleasing and many people like to use the beach for recreational activities such as beach cricket, swimming and surfing. The tourist industry relies on the beaches being sandy so that people will want to come and stay at Coolangatta and put money into the local economy by staying at local hotels and spending money in shops and restaurants. In addition, sandy beaches provide a buffer of sand and can prevent extreme erosion from damaging high-rise buildings, roads and other

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infrastructure that have been built in close proximity to the shoreline.

Before the Tweed River entrance training walls had been extended, in the 1930s and 1950s there had been periodic erosion associated with storm and cyclone events. At this time, the natural coastal drift was not blocked by the Tweed River training walls and waves and currents supplied sand to the beaches after these storm events, replenishing the beach. When the natural sand flow was blocked, there was very little sand available to replenish the beaches and two decades of stormy weather in the 1960s and 1970s left the beaches of the southern Gold Coast very severely damaged.

The area experienced fewer storm events through the late 1970s and 1990s but erosion continued as the sand supply that was once able to replenish the beaches was still blocked by the training walls.

Early efforts to resolve the issues

After the devastating 1967 cyclone, seawalls were constructed along the coastline and sand was periodically dredged from the sand reserve that was building up behind the southern training wall to artificially nourish the beaches and provide some protection to infrastructure and other assets. In 1974–75 a total of 760 000 cubic metres of sand (enough to fill just over 300 Olympic swimming pools) was dredged from the Tweed River entrance and deposited on Kirra Beach. This exercise was very expensive, costing over $1 million, and was not seen as being a permanent solution to the problem.

Source 14.7 Kirra Beach. Sand was dredged from the Tweed River entrance and deposited there.

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Resolution

In 1986 a sand bypassing system was built at the very northern end of the Gold Coast to bypass sand across the Gold Coast Seaway and onto South Stradbroke Island. During the mid-1990s suggestions were made about using a similar bypassing facility that would collect sand on the southern side of the Tweed River, pump it under the river and deliver the sand to the southern Gold Coast. This solution would prevent sand from building up across the Tweed River entrance and impeding navigation, and would reconnect the natural flow of longshore drift.

The Tweed River Entrance Sand Bypassing Project was initiated by the New South Wales and Queensland governments who acknowledged that the problem affected both states and were therefore willing to work together towards a solution. In 1996, an Environmental Impact Statement (EIS) was conducted by an external environmental management consultant to evaluate if the installation of a bypassing system would be of benefit. The EIS was a very thorough document and investigated in detail the environmental effects of installing the system.

The Tweed River Entrance Sand Bypassing Project was to be implemented in two stages. The first stage involved dredging from the Tweed River entrance and direct deposition of the sand on the southern Gold Coast beaches. In 1995–96 and 1998, 3 million cubic metres of sand was dredged from the river entrance and deposited on Rainbow Bay, Greenmount, Coolangatta, Kirra and North Kirra beaches.

The second stage of the project was installation of a permanent bypassing system which was designed, constructed and operated by a private engineering company called McConnell Dowell. This was carried out in 2000 and McConnell Dowell created a separate entity called the Tweed River Entrance Sand Bypassing Company to construct and operate the system. On 4 May 2001 sand bypassing commenced.

Note this down 14.2

Construct a table showing the issues affecting the Tweed River entrance and the southern Gold Coast beaches area and what was done to address those issues.

Tweed River entrance and southern Gold Coast beaches	
Issue	**Resolution**

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14.3 The management of environmental change

The objectives of Tweed Sand Bypassing are to establish and maintain a safe, navigable entrance to the Tweed River and to restore and maintain the coastal sand drift to beaches of the southern Gold Coast.

Sand bypassing system facts and figures

- Longshore drift is a natural coastal process that moves sand in a direction that is parallel to the coast. The direction of sand transport depends on the average wave direction, and at Letitia Spit the predominant southeasterly waves push sand along the coast from south to north.
- Between 200 000 cubic metres and 1 million cubic metres of sand can be transported along Letitia Spit in any year, depending on the wave conditions. The average sand transport rate is approximately 500 000 or half a million cubic metres of sand, which is enough to fill 200 Olympic swimming pools. This river of sand starts in large reserves just north of the Clarence River in mid-northern New South Wales and flows in a northern direction parallel to the coastline, before slipping over the continental shelf and into very deep water, just north of Fraser Island in Queensland.
- Tweed Sand Bypassing consists of a jetty and floating dredge, and was designed to collect the sand that is naturally transported northwards along Letitia Spit before it moves into the Tweed River entrance and restricts boating access.
- The jetty is 450 metres long and supports 10 submersible jet pumps that sit below the sea bed and collect the sand that is naturally transported towards them. The pumps do not 'suck' sand from the ocean bed, or out of the Tweed River, but collect sand that is naturally transported to the jetty through the process of longshore drift.

Source 14.8 Jetty of Tweed River Entrance Sand Bypassing Project

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This sand is then pumped under the Tweed River entrance and is deposited at one of the outlets before being naturally moved by waves and currents to nourish the southern Gold Coast beaches.

- The jetty is unable to collect all of the sand that is transported along Letitia Spit and some of this sand naturally bypasses the jetty and moves into the Tweed River entrance. This process is more pronounced during storm events when large waves and strong currents are able to transport sand in water that is much deeper than usual.
- Some of the sand that ends up in the Tweed River entrance moves naturally across the Tweed bar and forms sand shoals offshore of Duranbah and Point Danger. Over time, more and more sand will accumulate on the bar and when a certain threshold is reached the entrance is dredged.

The pump system

- Water from the Tweed River entrance is used to power 10 submersible jet pumps that sit below the surface of the water and create cone-shaped **depressions** in the seabed.
- Sand moving along the seabed, forced by longshore drift, falls into these depressions and is sucked up by the jet pumps.
- The water and sand mixture is then pumped into the main station, under the Tweed River and to one of the sand outlets.
- There are four outlets: East Snapper Rocks and West Snapper rocks are permanently installed, while Duranbah and Kirra are only temporarily installed when they are needed.

depressions hollowed-out areas in the sea floor, often the result of local currents

Source 14.9 Aerial photo of Tweed River Sand Bypass System

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Stakeholders

Tweed Sand Bypassing has a wide range of stakeholders who each have a certain priority for the management of the coastline depending on their specific interests. Examples of these stakeholders include recreational fishermen, tourism operators, swimmers and surfers. Managing the interests of such a wide range of stakeholders is a very difficult process and not all stakeholders are generally satisfied at any one time.

Kirra Point v the Superbank

Surfing is an important part of everyday life for many southern Gold Coast residents, making surfers a large stakeholder group in Tweed Sand Bypassing. All parts of the coastal system are interconnected, with a change in one component of the system affecting the other. As a result, human-made changes to the underlying geology of the coastal system through the construction of training walls and **groynes** have altered sand movement and both created and taken away surfing breaks.

groyne a wall or similar structure built out from the seashore or riverbank to control erosion

In 1972 a groyne was built at Kirra to assist in retaining sand on Coolangatta when the beaches were badly eroded. Construction of the groyne unintentionally created one of the best surf breaks in Australia with generations of surfers enjoying the fast right-hand point break. The groyne was shortened by Gold Coast City Council in the 1990s to allow more sand to flow from Coolangatta to Kirra, but even after it was shortened Kirra Point still remained one of the best right-hand point breaks in the country.

Source 14.10 Surfers were a large stakeholder group in Tweed Sand Bypassing.

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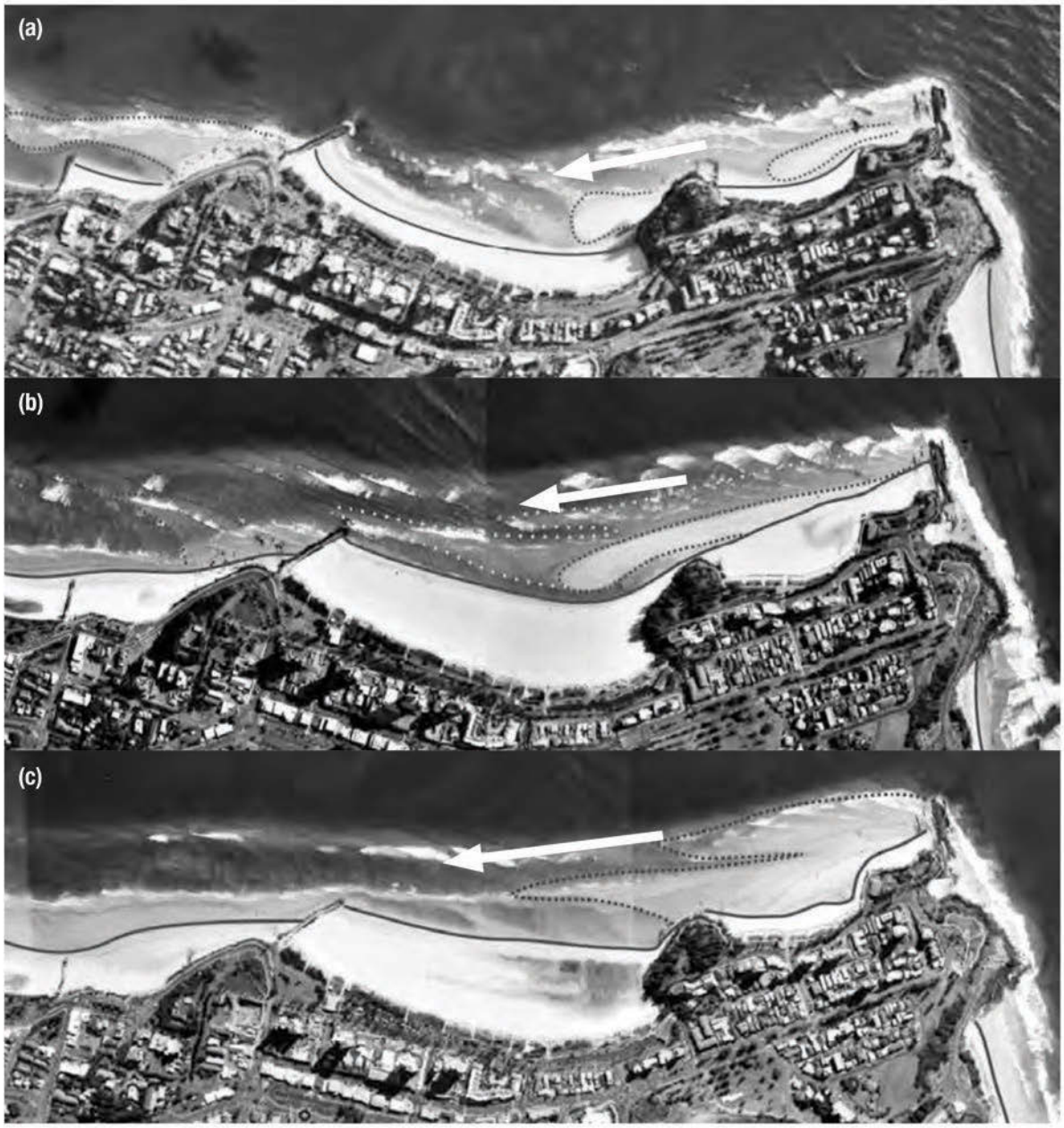
When Tweed Sand Bypassing was commissioned, the river of sand once again flowed from south of the Tweed River entrance and onto the southern Gold Coast beaches. In the early years of sand bypassing, many of the beaches dramatically increased in width and Kirra Point became saturated with sand. As a result, the waves at Kirra Point did not break as well as they used to.

With large amounts of sand now being pumped to Snapper Rocks, there was a trade-off for the loss of Kirra Point with the accidental formation of what was known as the 'Superbank'. The sand that was delivered by the project to the Snapper Rocks East outlet was shaped by waves and currents and created a shore parallel beach bar that extended from Snapper Rocks right through



Source 14.11 Aerial photos of the beach and 'Superbank' development occurring: 29 May 2001 (a), 30 August 2002 (b) and 11 May 2003 (c)

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to Kirra. This sand bar promoted a wave that peeled from Snapper Rocks right through to Kirra Point when the conditions were right. The Superbank became ranked as one of the top 10 surfing destinations in the world.

In the early years, shortly after commissioning, Tweed Sand Bypassing deliberately pumped volumes of sand that were larger than the natural rate. This was to provide a 'catch-up' quantity of sand to the southern Gold Coast beaches that had been so badly eroded for so many years. It was this additional sand that caused the beaches to become so wide and also created the Superbank. Since 2005 the project has been pumping smaller quantities of sand that are consistent with the natural longshore drift.

Source 14.12 Gold Coast, Australia

Source 14.13 In the early years of sand bypassing, many of the beaches increased in size.

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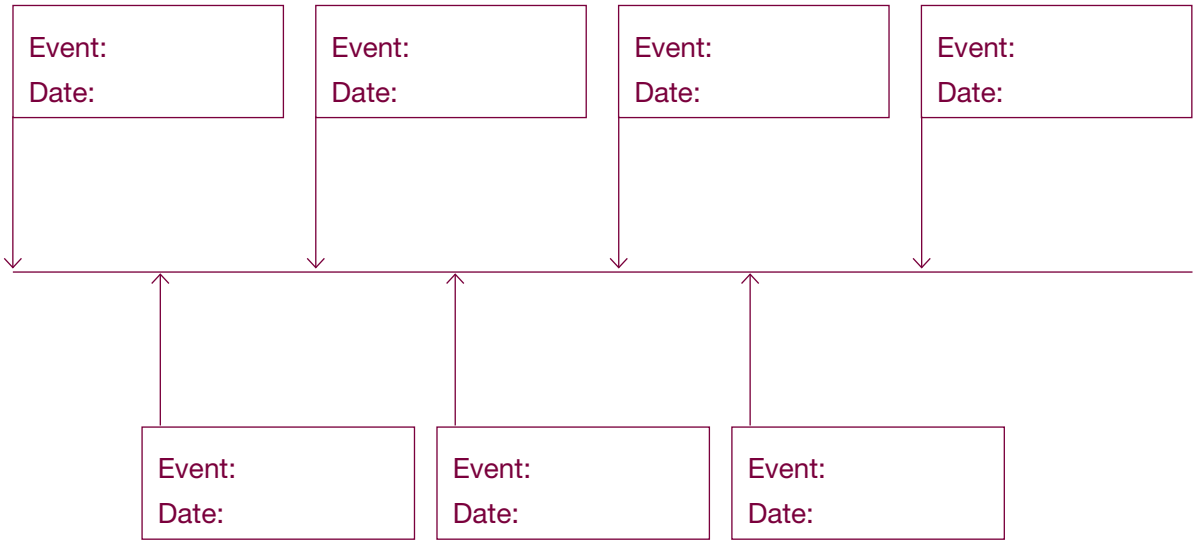
Note this down 14.3

Copy and construct a timeline for the major events associated with the Tweed River Entrance Sand Bypassing Project.

Title:



Economics

Over the years millions of dollars have been spent on restoring and maintaining the southern Gold Coast beaches. A socio-economic assessment of the region found that for every dollar spent on beach protection and enhancement, $60 to $80 was returned to the economy through tourism. This study showed that there is clear economic benefit in protecting the southern Gold Coast beaches as well as providing beach amenity.

Studies have also been done on the amount of money that surfing brings the local economy. When people travel to a certain wave break to go surfing, they might stay overnight at one of the hotels, spend money on breakfast in the morning, and buy some wax and a new leash for their surfboard. This is all money that is being spent in the local economy purely because the surfer was attracted by the waves. There are numerous interconnections between natural, cultural and economic environments.

RESEARCH 14.1

View the video on the Tweed River Entrance Sand Bypassing Project on YouTube.

1. Investigate other areas that may benefit from a project like this.
2. Describe the implications if this project had not gone ahead.
3. Discuss your views on the validity of this project.

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Case study 14.1
Colon Island in the Caribbean Sea

Australia is not the only country that lives with the effects of increased sea levels. In many other countries, particularly in the developing world, people live in environments that are frequently inundated by the ocean. One such example is the town of Bocas del Toro on Colon Island (Isla Colón) in the Caribbean Sea, Panama. The town is situated in a province which shares its name.

Panama's population has a high mortality risk from numerous hazards. Health, coastal zone management, agriculture, water resources and forestry are particularly at risk due to climate change. Recurring and severe storms, floods and droughts cause economic losses and affect people's livelihood.

Bocas del Toro is the northwesternmost province in the Republic of Panama. It borders Costa Rica to the west, the Caribbean Sea to the north, the mountains of Chiriqui Province to the south and the Ngäbe and Bugle indigenous reservation to the east. Like other regions along the Caribbean coast, rainy seasons and dry seasons are not as distinct as in other parts of Panama.

History

The province of Bocas del Toro had been dominated by the banana industry, dating back to 1880. In the 1930s at the height of the region's prosperity, a fungus known as Panama Disease destroyed the banana industry. In the 1950s disease-resistant plants were developed and the industry once again began to grow.

Around this time large numbers of Ngäbe families migrated from the mountains looking for work with banana companies. These people often settled in the established towns and then others followed suit. Eventually the area became crowded and people had to settle in rural lowland valleys along rivers and streams. They continued farming, fought for available land and eventually formed communities.

Issues

Bocas del Toro receives a remarkable amount of rain, sometimes 3 metres per year. The small town is very low lying and during the winter, low

Source 14.14 Bocas del Toro

pressure systems frequently cause elevated water levels in the town and surrounding islands that can last for weeks to months at a time. Prolonged and intense rainfall can also contribute to flooding events.

Sea level change is a source of increasing concern for environmental scientists. Sea level rise causes changes to shorelines and disturbs delicate environments such as beaches, barrier islands and wetlands through increased erosion and deluge. These changes affect the terrestrial biodiversity of areas due to the loss of habitat.

tide gauges installations that measure relative sea level at a specific point along the shoreline. They are usually secured on piers or on platforms a few metres off.

satellite altimeter an instrument for determining elevation, especially an aneroid barometer used in aircraft that senses pressure changes accompanying changes in altitude

Measuring the sea level assists with understanding its variability. Data from **tide gauges** is one form of measurement that is easily obtained and evaluated. Though tide gauges do not provide measurements as exact as **satellite altimetry** does, benefits can be gained from this form of data and its analysis.

Resolution

The people of Bocas del Toro are very well adapted to living with elevated water levels. Some of the strategies that they use include:

- houses constructed on stilts
- transport by boat
- temporary dozing of sand in front of properties
- 4WD taxis to navigate eroding coastal roads
- abandonment of older buildings that were subject to ongoing inundation
- use of rubble from the mainland to reclaim some of the lower lying foreshores
- use of tyres and rubble to create ad hoc sea walls
- professionally designed sea wall structures.

1 Briefly describe the history of banana production in the province of Bocas del Toro.
2 What impact would rising sea levels have on Bocas del Toro?
3 Identify some strategies that the community could use to manage rising sea levels.

Source 14.15 Buildings constructed on stilts, Bocas del Toro

Fieldwork 14.1 Investigating the impacts of people on a marine environment

Aim

To analyse the impacts of people on a local marine environment and identify management strategies using fieldwork to create a report.

Method

A local marine environment will be investigated using information such as maps and aerial or remotely sensed imagery, and field observations.

Preparations

Locate images for a local marine environment from Google Maps and other sources. Construct your own map of the marine environment following mapping conventions (title, north arrow, print labels, legend etc).

Search local newspapers and other sources such as the internet to get background information about the impact of humans on this marine environment and write down a brief summary of your key findings.

Name at least two spots of interest in the marine environment from where you would like to do field observations.

Data collection

At each of the two or more stops you identified for your marine environment, using field sketches and notes, record information on the human and natural components of the marine environment. Record the following in your notebook and label, as required, your map and/or aerial photo:

1. Label the key features that you can see and the main uses of the marine environment on your map/image of the area.
2. Describe the characteristics of the marine environment at each stop. Take field photos and draw a field sketch of what you select as the most salient features of the marine environment. Write brief notes focusing on the key features of the marine environment. These may be things such as: natural features like the dominant wind and wave direction; the size and intensity of waves observed (things like wave height and period – the time taken for two successive wave crests to pass a point); features built by people such as groynes and rock walls; and the extent of houses, roads and other structures.
3. Note any signs of pollution and where and how people may have any stormwater or greywater outlets in the area. (Greywater is treated wastewater from urban and industrial sources.)
4. What is the evidence, if any, of people managing this marine environment? If there is management evident, what sorts of things are being done and how effective do you think these are?
5. Discuss your observations with your class and make a general assessment of the environmental issues in this marine environment. Prepare a report using the following layout:

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Fieldwork presentation layout

Front page	**Title and name**
Contents page	Do this last, as well as numbering pages.
Page 1	**Executive summary** In a succinct manner state what you did (fieldwork at two or more marine sites) and what your key findings were.
Page 2	**Aims and methods** State these clearly and succinctly.
Page 3	**Introduction** Provide a brief description of your marine environment. Include a map/aerial photo showing the area. Include, at a minimum, title, north arrow, relevant printed labelling and a legend.
Page 4–5	**Field stops** Provide notes and photos as well as relevant field sketches to describe the main features of the marine environment observed at each stop.
Page 6–8	**Human impacts and environmental management** Summarise the impacts that you observed in written and diagrammatic form.
Page 9	**Key recommendations** Identify recommendations that you may have from your fieldwork, background readings and viewing videos etc to further improve the management of the marine environment studied in the field management strategies.
Page 10	**Conclusion** Summarise your key findings from your report. A reader should be able to read your Introduction and have a good idea of what you will be looking at. They should then be able to go to your Conclusion and, as it succinctly summarises your key findings, have a very good idea of what is between the Introduction and the Conclusion.
Page 11	**Bibliography** State the various resources used following the Harvard (author, year) or similar style.

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Chapter summary

- Marine environments are fundamental to life on Earth and their sustainability involves interconnections between natural processes and human activities.
- The Tweed River Entrance Sand Bypassing Project provides a valuable example of quality environmental management strategies to effect positive outcomes for the environment and for people. Considerable cooperation between stakeholders was required for the project to come about and to be continually managed effectively.
- Marine environments are subject to natural events such as cyclones, storm surges and rises in water levels that have impacts on both the natural environment and people.
- Poorly managed marine environments can have significant negative impacts on people; however, people in some parts of the world such as Colon Island in the Caribbean are testimony to how the negative effects of marine environments can be well managed. Their clever use of available resources and technology has lessons for the developed world.

End-of-chapter questions

Short answer

1 Briefly describe the importance of marine environments to people.

2 List the key features of the Tweed River Entrance Sand Bypassing Project.

3 Contrast the marine management strategies of the Tweed River Entrance Sand Bypassing Project and Caribbean examples given in this chapter.

Extended response

Recommend a range of strategies you might use to protect your home from water inundation from the ocean if you lived on Colon Island in the Caribbean.

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Additional resources

14a Investigative study – Land environments

Source 14a.1 Tundra during autumn in Denali National Park, Alaska, USA

Before you start

Main focus

This study explores various human actions that affect the environment and consider how the negative impacts can be reduced and ecosystems regenerated. We consider the drivers of environmental impact, the resilience of ecosystems and various methods of managing environmental impacts and changes.

Why it's relevant to us

Land is where humans mostly live and work. To understand the environmental basis of how land is planned and managed is to understand the past, present and future of human civilisation.

Inquiry questions

- What are the various land types?
- How can impacts on land be reduced and managed?
- How can the resilience of ecosystems be estimated?
- How can land be restored and regenerated?

Key terms

- Ecological footprint
- Land degradation
- Land management
- Regenerative
- Resilience
- Terrestrial ecosystem

Let's begin

Humans have successfully created society on earth based on their ability to shape terrestrial ecosystems and harness the ability to create food, extract resources and alter landscapes to create cities and towns. Their ability to do this without degrading the land is less successful and the impacts of such degradation are being felt in Australia and around the world.

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14a.1 Biophysical processes of land environments

In this first section of the chapter we will consider some of the biophysical processes operating in land environments to maintain their functioning.

Human actions that produce environmental changes

The earth is some 4.53 billion years old and human-like hominids existed from about 3.6 million years ago. Human beings began making tools and modifying the environment, especially through fire, some 100 000 to 200 000 years ago. They have since spread to every land ecosystem on the planet and used these tools to create a future for their families and societies. The earth has many different land-based ecosystems across its nearly 149 million km^2 of solid surface.

Bushfire

Many landscapes around the world have evolved with bushfires. Bushfires are a natural phenomenon, helping landscapes to regenerate. In Australia, some plants are so well adapted to particular fire regimes that bushfires are both an advantage and, in some cases, a necessity for survival. Some plants have seed capsules that need to be burnt to release seeds before they germinate. Bushfires enrich the soil with ash which assists plant regrowth. Experts try

Source 14a.2 Wildfires endangering homes in Pelican Waters, Sunshine Coast, Queensland

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to manage fire regimes in ways that maximise biodiversity while reducing fire fuel loads which can, in dry conditions, enable bushfires to get out of control and lead to natural disaster, loss of life and significant costs. 'Wildfires' are bushfires which burn uncontrollably or in an unintentional way. Wildfires can cause deaths, injuries and millions of dollars in damage.

Geographical fact

According to the CSIRO, while we consider it a threat, fire is a natural part of our landscape and many of our native plants have evolved to depend upon it.

Note this down 14a.1

Using the following T-chart, summarise the arguments 'for' and 'against' the use of bushfire as a **land management** tool in Australia.

land management the process of managing the use and development of land resources

The use of fire as a land management tool	
For	**Against**
Many plant species in Australia have evolved to depend on fire	Fire can get out of control and threaten developed areas
Fire reduces the vegetation load and minimises the risk of larger periodic 'wildfires'	Fire destroys vegetation in the short term which may affect tourism to scenic areas

Activity 14a.1

1. Define the 'McArthur Forest Fire Danger Index (FFDI)' and explain how it is used in Australia.
2. Identify the link between bushfires and climate change and how this may affect the FFDI of an area.
3. Suggest three ways that the risk and vulnerability of homes to bushfires can be reduced.

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Agriculture

The loss of natural ecosystems to agriculture has been occurring for around 8000 years, when people found that the growing of crops created more opportunities for humans to survive. It has spread across every biome and now covers 15.3 million km^2 of land in intensive agriculture and 33.6 million km^2 of pastoral or rangeland grazing. In addition, forestry has modified or replaced 39 million km^2 of ecosystems. This means that 33% of the earth's land surface is agricultural and pastoral land, and forested land is 26%. So what is the rest of the earth's land cover? About 20% of the earth is desert and 20% is permanently snow covered. This leaves just 1–2% of land that is used for cities and industry.

Agriculture contributes AUD$39 billion annually to the Australian economy, roughly 3% of GDP, and employs about 4% of the total workforce directly. The food processing and manufacturing industry, which depends significantly on the Australian agriculture sector, contributes over 6% to Australia's GDP, or AUD$71 billion per annum.

Geographical fact

According to the Garnaut Review, by 2100 some 92% of current agricultural production may be lost due to climate change.

Source 14a.3 Approximately 20% of the Earth is desert.

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Activity 14a.2

1 View 'Global land cover change from 8000BP to -50BP' on YouTube. Reflect on the changing nature of land use during this time to support the growth of civilisations.

2 Identify the link between agriculture and climate change and how this may affect agricultural yield in Australia.

Urban development

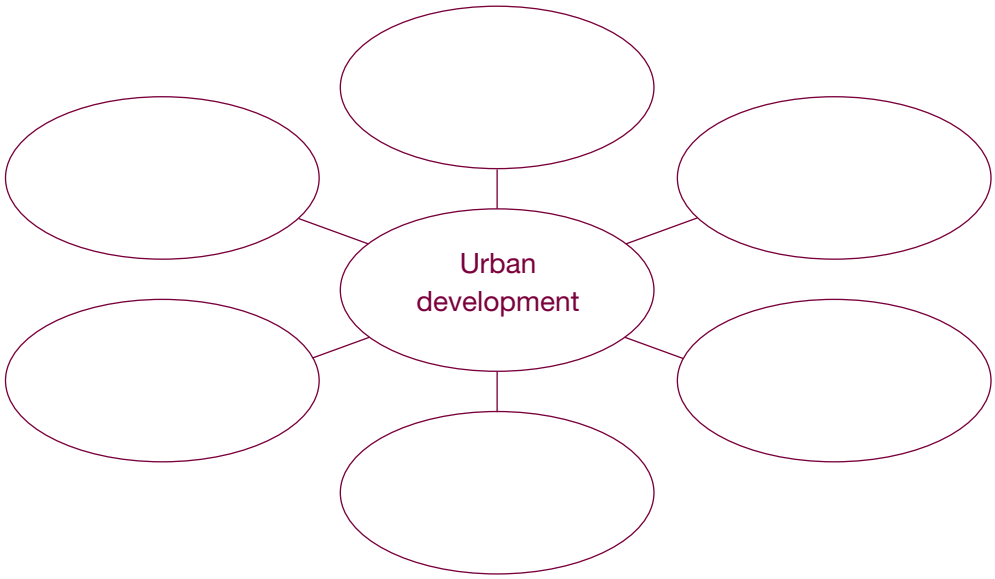
terrestrial ecosystem a system of plants, animals, nutrients and elements, and the interactions between them, that is only found on land

Although cities in Australia cover a small percentage of land, some 1% to 2%, they have both a direct and indirect impact on the quality of **terrestrial ecosystems**. The direct impact is from the clearing of land to make way for new suburbs, roadways and other civil infrastructure. The indirect impact is from the greater demands on agriculture that growing cities produce, calling for greater yields in rural areas that result in both greater coverage of land for agriculture and the use of fertilisers and pesticides that have adverse effects on natural ecosystems. There are various ways to measure this impact such as the '**ecological footprint**'.

ecological footprint the measure of human demands on the Earth's ecosystems

Note this down 14a.2

Create a mind map to identify the various impacts that urban development has on land, both directly and indirectly.



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Activity 14a.3

1 Based on the mind map, consider how climate change will affect each impact and identify evidence to support your answers.

2 Based on the mind map, consider each impact and identify at least one method of reducing it that also assists Australia's response to climate change.

Drivers of environmental impacts

There has been much investigation of what drives environmental impacts around the world. A simplified formula, referred to as IPAT, is widely used to estimate the impact of human activities on the environment:

Impact = Population x Affluence x Technology

This model suggests that all forms of technology have a direct impact on the environment and that this impact will be multiplied by the number of people with access to the technology and their ability to afford to use it. Hence according to the model, in order to reduce the impact on the environment efforts need to be made to reduce all three factors. This model provides a valuable basis for discussion of what is a very complex area; however, it has some limitations. For instance, how would you apply the IPAT formula to **land degradation**?

land degradation degradation of the health of land resources through human actions in ways that threaten their ability to maintain their environmental functions, e.g. salinity, accelerated soil erosion, loss of biodiversity and habitats

Source 14a.4 Soil erosion due to overgrazing which has led to desertification

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The biggest land degradation issues in Australia are related to overgrazing in pastoral areas and the salinisation of agricultural soils in the wheat belt. A common attribute of these areas is that they have reducing populations; in fact these areas are already among the least populated in the world. Land degradation in these areas came from the use of a model for producing wealth that did not consider the environment and led to overclearing or overstocking of the land with grazing animals. Hence in this case, the problem was not caused by excessive population; indeed if some of these rural areas did not have such population losses their local economies could have been more diverse and the need to have such local environmental impact would have reduced.

Activity 14a.4

1 Research the history of the development of the IPAT formula. Construct a timeline showing your results.
2 Identify three criticisms of its use that relate to its application to land degradation.
3 Identify three technologies that can reduce the impact of land degradation.

The resilience of ecosystems

An ecosystem is made up of all the living organisms (biotic components) in a physical area, including plants, animals and microbes; as well as the non-living (or abiotic) components of the environment, including the soil, air and water. The ecosystem is defined by the interaction between all the living organisms, and with the surrounding environment. These interactions include biological interactions, such as certain species feeding on other species and producing waste material that is in turn food for yet another species; physical processes, such as the weathering of rock or transportation of sediment and nutrients in and out of the ecosystem by wind and water; and chemical processes, such as the fixation of nitrogen in the soil.

All ecosystems and environments are exposed to changing influences over time, with variations in the climate, nutrient loading, habitat size and connectivity or exploitation of various species changing the balance of the system. It used to be assumed that natural systems respond to these changing influences in a smooth and linear way that could be predicted and managed. However, studies of ecosystems such as lakes, coral reefs, oceans, forests and deserts have shown that while ecosystems often do respond to changing influences in a smooth and gradual way for a while, at a certain point there is a sudden and drastic change in the ecosystem – and the ecosystem often becomes fundamentally different to how it was beforehand after crossing an 'ecological threshold'.

Ecological thresholds are the points at which an ecosystem undergoes a sudden change in its quality, property or phenomenon, or where a small incremental change in an environmental driver results in a proportionally large response in the ecosystem. Thus, ecological thresholds are the 'breaking points' or 'tipping points' of ecosystems, at which the pressures on the

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Source 14a.5 Australia's Great Barrier Reef is the world's largest coral reef ecosystem.

system result in a sudden and often large change to the ecosystem. This phenomenon is a very important area of research, as humans are now exposing most of the world's ecosystems to changing influences that are greater than at any other point in history, and at a faster rate.

Another key concept is that of 'resilience', being the ability of a system to absorb and adapt to disturbance, so that it retains essentially the same function, structure, identity and feedbacks, and doesn't suddenly change into a different state, often by collapsing. Resilience is an emergence property of an ecosystem, and is said to have at least three main physical components: latitude, resistance and precariousness.

- **Latitude**: The maximum amount a system can be changed before losing its ability to recover (before crossing a threshold which, if breached, makes recovery difficult or impossible).
- **Resistance**: The ease or difficulty of changing the system; how 'resistant' it is to being changed.
- **Precariousness**: How close the current state of the system is to a limit or 'threshold'.

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A resilient ecosystem can handle more external shocks, or changes in external influences or pressures, without shifting to an alternative state. For example, a resilient lake ecosystem might be able to handle the sudden introduction of a lot of organic material that gets flushed into the lake when there are sudden rains and flooding, without the lake becoming eutrophic. (Eutrophic means that when nutrient levels in a river, lake or other water body become too high, they cross a threshold and the system has excessive plant growth; and then decay (often algal) depletes the dissolved oxygen in the water, and can lead to widescale death of fish and other organisms.)

However, in a system that is already being strained, such a sudden event may cross a critical threshold and result in dramatic changes to the system. In practice, it can be very difficult to know when an ecological threshold is being approached in an ecosystem – although in retrospect, it is often more clear that warning signs were present, hence the call for a precautionary approach.

Geographical fact

Natural systems often respond linearly to external pressures (a small increase in the external pressure causes a comparable, small change in the ecosystem) up until a point when an ecological threshold is reached, at which point a further small increase in the external pressure causes a sudden and very large change in the ecosystem.

Source 14a.6 A shallow eutrophic lake

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RESEARCH 14a.1

The Sahel is an African ecosystem zone that lies between the Sahara desert to the north and the Sudanian savannas to the south; it has experienced desertification due to poor land management practices.

How resilient is the Sahel? Investigate its latitude, resistance and precariousness. As part of the research identify the key factors that have led to desertification including changing rainfall and land management activities.

Activity 14a.5

1. Identify five key drivers that affect the resilience of Australia's rainforests and sclerophyll forests.
2. Consider how these drivers will be affected by climate change.
3. Investigate the 'ecological thresholds' of Australia's rainforests and sclerophyll forests and identify any warnings regarding the potential for ecosystem collapse.
4. Identify three ways that the resilience of Australia's rainforests and sclerophyll forests can be improved.

14a.2 The causes, extent and consequences of environmental change

In this next section of the chapter we will examine how land environments are undergoing environmental change. We will investigate the causes, extent and short- and long-term consequences of change to the environment by looking at two case studies; one from Australia and another from the United States.

The human population has increased sixfold since the 1800s, with the resulting demand for agriculture, housing, resources and transport utilising over 83% of the land globally. As natural habitats are converted by humans to meet our needs, the biodiversity that was once there is threatened or lost. Biodiversity is a contraction of 'biological diversity', and refers to the wealth or multitude of animals, plants and microorganisms. Thus it refers to both the diversity of species in an ecosystem and the genetic diversity within each species. Biodiversity also refers to the variety of ecosystems, such as those found in deserts, forests, wetlands, mountains, rivers, lakes, and landscapes more influenced by humans such as urban areas or agricultural land.

Preserving ecosystem services

The loss of biodiversity is something that should concern us greatly, and call for greater

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understanding of methods to manage and reduce environmental impacts. Biodiversity is essential for ecosystem services, which are in turn essential for human health and wellbeing – almost every aspect of how the world works is underpinned by ecosystem services, without which we may not be able to survive as a species.

Ecosystem services include:

- **Provisioning services**, such as providing food and clean water. Everything that we eat and drink comes originally from nature – the fruit, vegetables, grains, meat and dairy products. Imagine if all the bees suddenly died and we had to pollinate all the plants by hand, or if we had no more topsoil and couldn't grow fruit and vegetables, or if our water sources became so polluted we couldn't use the water to drink or grow food.
- **Regulating services**, such as flood and disease control – natural systems help to regulate the climate by absorbing and gradually releasing water. Trees help to raise groundwater and can create microclimates that are cooler and have more regular precipitation. Natural processes can disinfect water and reduce the risks of transmitting disease.
- **Cultural services** are those that benefit us spiritually, psychologically, culturally and socially – for example, experiences of nature have been shown to help people recover from stressful experiences, to be less depressed and anxious, to recover from illness more quickly and to have greater life satisfaction. Nature plays a role in many world religions, and people find that places with more natural features are more aesthetically pleasing to them.
- **Supporting services** are those that ensure that ecosystems function, and although we may not directly benefit from these, without them, we would have none of the other ecosystem services. This includes, for example, biomass production, the creation of atmospheric oxygen by plants and microbes, soil formation, erosion prevention, nutrient cycling, water cycling and providing habitat for other species.

Source 14a.7
Biodiversity is essential for ecosystem services, which includes the provision of clean water.

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It would be impossible to find other ways of providing these same services if the ecosystems that provide them were damaged or destroyed beyond recovery in our lifetimes. Such loss of service provided by the environment also leads to significant economic impacts. For example, the destruction of coastal mangroves in Pakistan is estimated to have led to around US$20 million in fishing losses, US$500 000 in timber losses, and US$1.5 million in feed and pasture losses.

Activity 14a.6

1 Identify five key ecosystem services provided by the tropical and sub-tropical rainforests of southeast Asia.
2 Investigate the economic impacts of the loss of these services.
3 Recommend three strategies to protect the ecosystem services in the tropical and sub-tropical rainforests of southeast Asia.

On the other hand, protecting such ecosystems can reap significant financial benefits. New York City faced the challenge of either having to build and maintain a filtration plant to clean the city's water supply, or to ensure that the water provided to the city's 9 million inhabitants was clean enough to drink without such treatment. The filtration plant would have cost approximately US$6 billion to build, and a further US$250 million each year to maintain. When the city realised that they could purchase the land in the watershed and protect it for only US$1.5 billion, it was an easy choice. By buying the land upstream and protecting it from pollution, upgrading treatment plants and septic systems, and assisting with environmentally sound development throughout the watershed, the city has saved itself between US$6.5 and US$8.5 billion in today's dollars, while providing a host of other social and environmental co-benefits.

Preserving biodiversity through reserves and corridors (a spatial strategy)

In recent years there has been growing attention globally on efforts to preserve and enhance the remaining pockets of biodiversity. However, research is showing that it is not enough to simply protect an isolated reserve of habitat; rather, these efforts need to be combined with corridors between different habitats and the creation of buffer zones.

There are various categories of habitat, such as:

- **Core habitat reserves:** Land that is protected or managed as habitat for one or more target species of plant or animal.
- **Habitat corridors:** Strips of land that enables species to move between pockets of their natural habitat. These help ensure genetic diversity within species, can decrease population fluctuations by enabling mixing and repopulating of core habitats, and enable animals to migrate if

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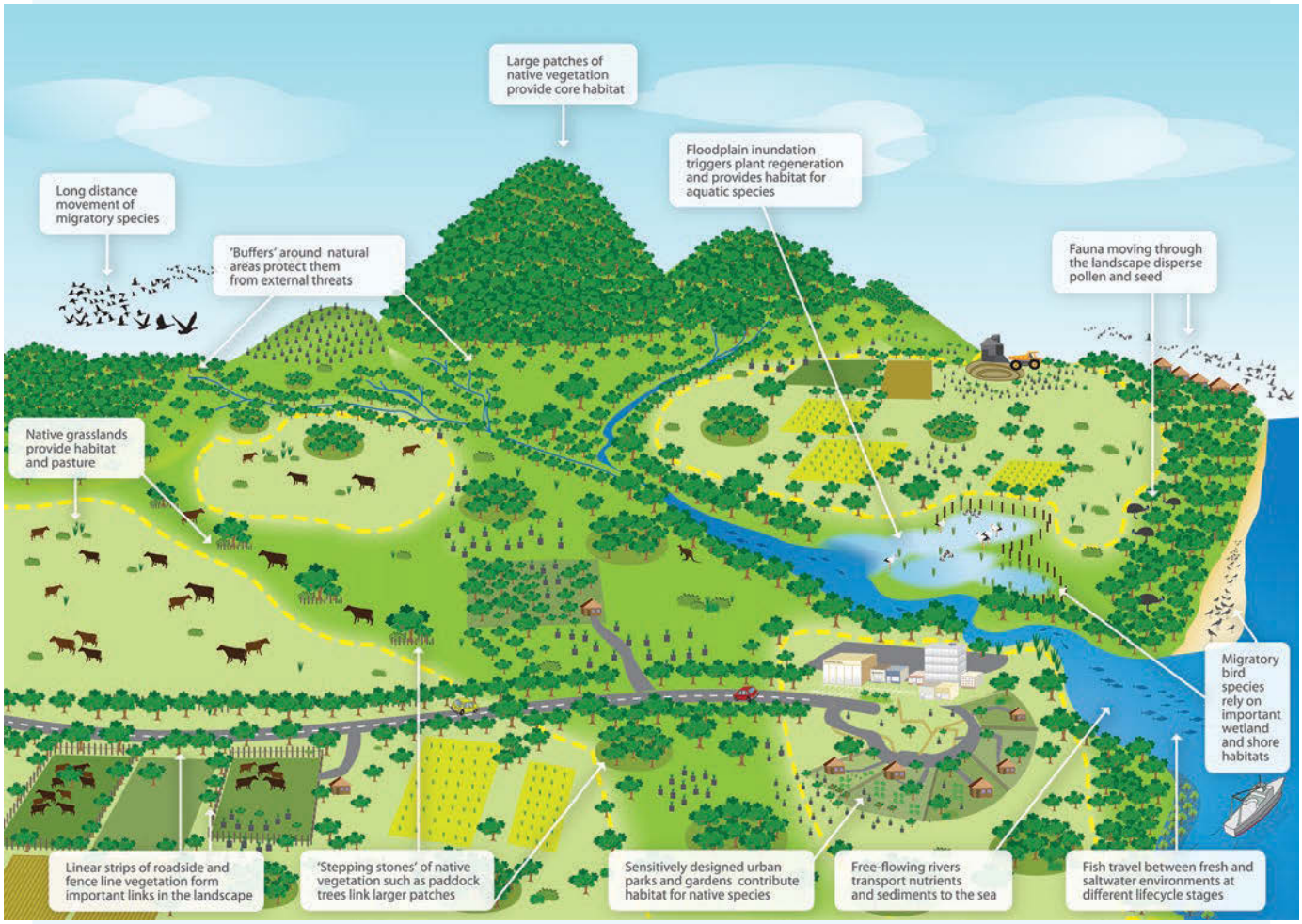
conditions in a given core habitat change and cannot support them.

- **Buffer zones:** Area surrounding a core habitat, separating it from other landscapes (such as agricultural land, or urban areas). Buffer areas are often unsuitable habitat for many species, however are essential to protect the core habitat from the different microclimatic conditions, species, noise and other activities.

Case study 14a.1
Australian conservation plans and strategies

The National Wildlife Corridors Plan is the Australian Government's strategy to restore and manage ecological connections in the Australian landscape. The Australian Government is working with private landholders, as well as managing publicly owned land, to develop corridors between habitat areas. These are on a wide range of scales, from revegetated areas along creeks that connect patches of forest, through to



Source 14a.8 Landscape elements that contribute to wildlife corridors

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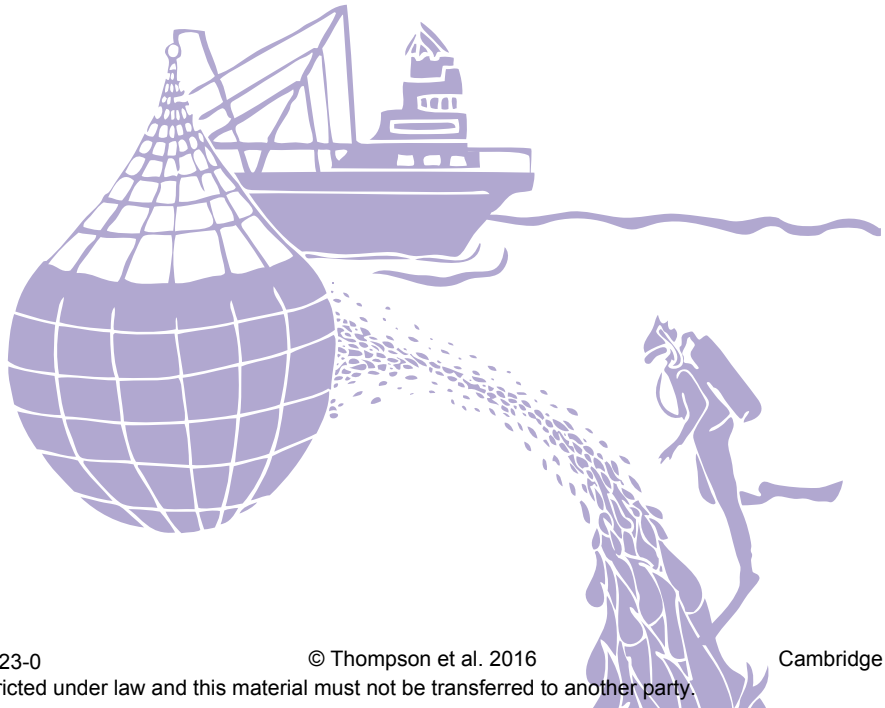
large-scale corridors that span hundreds of kilometres to connect habitat areas.

Developing such large-scale corridors can require the cooperation and coordination of multiple jurisdictions and working groups. The plan allows communities to nominate an area that can be recognised as a National Wildlife Corridor and these areas may receive priority for Australian Government investment.

The Victorian Government introduced the The Melbourne Biodiversity Conservation Strategy (BSC) to simplify conservation in growth areas of Melbourne, and make it easier for property and land developers to understand and fulfil their requirements to protect native vegetation and animals. It sets aside areas of land that must be conserved within the growth areas, and also simplified the process of evaluating what offset requirements are necessary when native vegetation is removed from land allowed to be developed. The time-stamping project was introduced as an initiative for keeping data and maps of the growth corridors and helps to calculate native vegetation requirements for urban development. Overall, the strategy is estimated to have increased the amount of conserved habitat in the growth areas, while significantly simplifying processes.

1. Explain what is meant by the term 'corridor'.
2. Identify what kind of areas these corridors are developing and how they fulfil their purpose.
3. Suggest why it is important for property and land developers to understand why native vegetation needs to be protected.
4. Study Source 14a.8 and list the landscape elements that contribute to wildlife corridors that exist in your town.
5. Describe an area in Australia or overseas you believe would benefit from a corridor plan.



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Case study 14a.2
The Yellowstone to Yukon project

The Yellowstone to Yukon (Y2Y) project aims to connect the Yukon National Park in the Yukon Territory, Canada, to Yellowstone National Park in Wyoming in the United States. This encompasses an area of 1.3 million km^2, is 3200 km long, 500–800 km wide, and runs through five US states and four provinces and territories in Canada.

The area contains habitat for many threatened species, including grizzly bears, wolves, wolverines, lynx and some native fish, and the corridor will protect the migration route of large mammals including grizzly bears, wolves, caribou, elk and bison. As only 10% of the region is national park, the Y2Y project includes public education and community assistance to understand and adapt to living harmoniously with nature.

Source 14a.9 Yellowstone National Park, USA and Yukon Territory, Canada

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RESEARCH 14a.2

Climate change is increasingly threatening the survival of many species around the world. As humans have altered landscapes and reduced natural habitat to isolated pockets, many species may not be able to migrate or adapt as the climate changes and their existing pockets of habitat become unsuitable for them. Species that require specific temperature ranges to survive, or a certain fire regime, precipitation pattern or other conditions affected by climate change can become locally, or globally, extinct if they are not able to migrate as the locally conditions become unsuitable. Wildlife corridors can enable species that are able to migrate to move to other areas; however, this will not necessarily mean that they will find suitable conditions elsewhere.

How have the habitats of endangered marsupials from Australia's dry environments been affected by human activity? Discuss three strategies to reduce human impact and provide suitable habitat for these animals.

14a.3 The management of environmental change

Approaches to the management of environmental change have developed over time.

Ecosystem-based management (an environmental strategy)

Ecosystem-based management (EBM) is a management approach that considers how human activities affect the health and resilience of ecosystems, and impact on the ability of these ecosystems to provide invaluable services to the environment and to society. It considers the entire ecosystem – including humans and the environment – rather than only looking at one issues, species, or resource in isolation. It recognises that there is a complex network of interrelationships between all of the living and non-living components of an ecosystem, and that the long-term management of the system has to consider the impacts on any and all of these.

Conventional environmental management has typically focused on a single resource, species or issue – and often one that is of particular interest to us as humans. For example, if on the Great Barrier Reef we only consider protecting certain species of fish that attract tourists, by limiting catch numbers and size, we may miss the fact that the Reef and the target fish are being affected by fishing of other species (that may be prey or predator), declining water quality due to run-off from the land, and pollution from other sources.

Hence EMB has a goal of sustainably managing all species in an ecosystem, or restoring habitat to maintain ecosystem services. It recognises that all species and elements of the ecosystem play an important role in the overall health and integrity of that ecosystem – and that it is often not possible to protect a target species or resource in the long term without considering the whole ecosystem.

The key points of EBM are that it:

- emphasises the relationships and connectivity within the ecosystem, and also between

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ecosystems (such as how marine ecosystems are affected by run-off from the land)
- considers the impacts of human activity, and their various uses for resources from the ecosystem, on ecosystem dynamics
- focuses on protecting and restoring ecosystem structure, function and key processes
- integrates biological, socio-economic and governance perspectives.

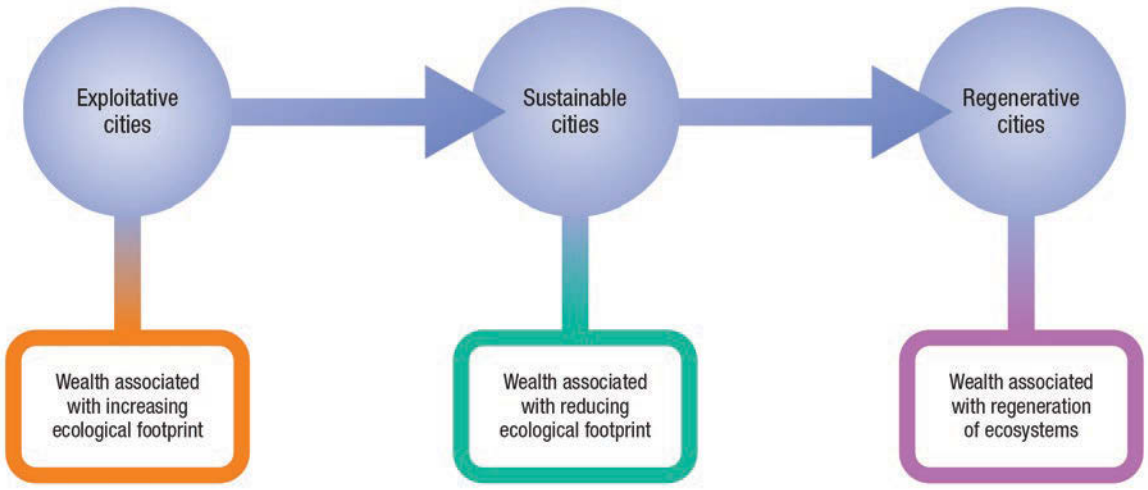
Urban planning to reduce environmental impacts (a spatial strategy)

Throughout history cities have been expanding their environmental footprint while creating wealth for their inhabitants.

Regenerative cities

The visionary concept of Sustainable Cities was created to help us reduce the impact of our cities associated with the use of fossil fuels, reduce the consumption of water and the production of waste, and ease the loss of biodiversity while maintaining or improving liveability. This is now under way as technology, planning regulations, governance and financing have combined to show we can reduce impact while improving liveability. So what's next for our cities? The future of cities as shown in Source 14a.10 is to transition from their wealth being based on the exploitation of the environment through to being based on reducing environmental impacts, to being truly **regenerative**, meaning that the operations of the city actually regenerate and nurture ecosystems.

regenerative able to regenerate (be reborn or renewed)



Source 14a.10 The transition of cities from exploitative to regenerative and the associated wealth association

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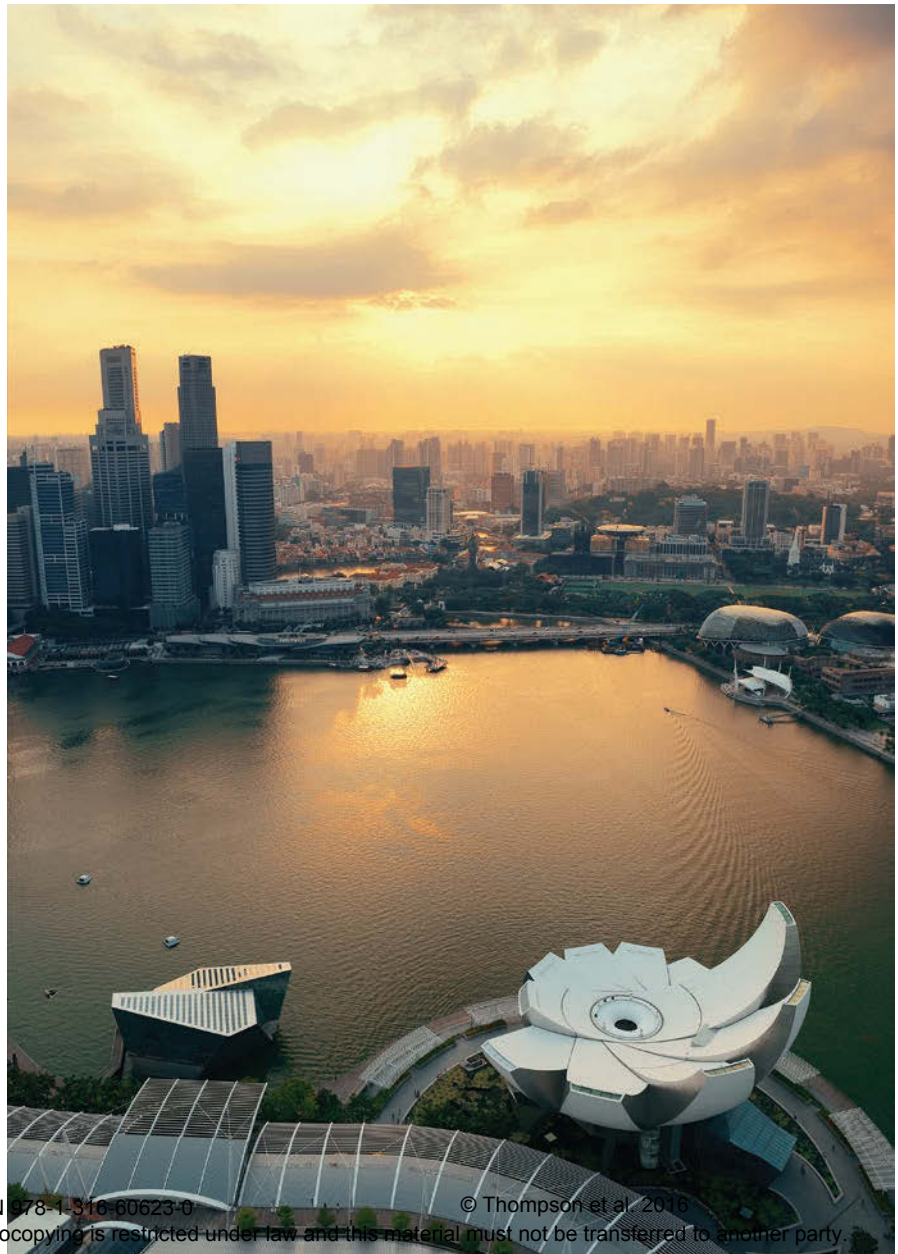
Activity 14a.7

1 In groups, brainstorm responses to the following questions:
   - **a** Would it be possible for us to develop a new vision of how cities can begin to be *regenerative*?
   - **b** Could cities be a major part of the planetary solution instead of being part of the problem?
2 Following discussion with the group, identify five ways that cities can become regenerative of the world's ecosystems.
3 View 'Singapore: Biophilic City' by Professors Peter Newman and Tim Beatley on YouTube and list five ways that Singapore is regenerating the environment in and around its city.



Source 14a.11
Will Singapore become a regenerative city?

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Chapter summary

- Everything in nature exists as part of a system – any impact to any part of the system will have repercussions throughout the entire system.
- Human actions result in a range of changes to the environment, with most of them resulting in negative impacts and reduced health of ecosystems.
- The estimation of such impacts on ecosystems is difficult to measure, and where measures such as the IPAT formula are used they must be balanced with an understanding of the conditions of the particular ecosystem being considered.
- The notions of resilience, ecological thresholds and adaptability are highly theoretical; however, they are widely accepted as important tools to inform the management of ecosystems and assist efforts to understand and manage our impact on the environment.
- It is very difficult to actually determine the resilience of an ecosystem, and where its thresholds lie. As these are complex systems, it is hard to fully appreciate all the interrelations and impacts.
- Typically, ecosystems around the world tend to display some level of resilience and many human activity-related impacts can be 'absorbed' by the system, and after a certain amount of time, it will return to an equilibrium. Similar shocks occur naturally in the world, such as storms, floods, fires and volcanoes. Humans create other shocks to the system – such as pollution, harvesting of species, changing land use and introduction of new species.
- Once an ecosystem has been pushed beyond a critical threshold, it will find a new equilibrium that is different to the previous equilibrium. In many cases, it is not possible to reverse such changes to reinstate the previous equilibrium.
- The Precautionary Principle is one that acknowledges our inability to properly understand such thresholds, and the irreversibility of such changes, and recommends a cautious approach.
- In the past, human impact was largely localised – we may have impacted and fundamentally changed local ecosystems beyond their point of ecosystem resilience. We are now influencing ecosystems on a global scale – such as the global climatic system. The ramifications of pushing a global ecosystem beyond certain thresholds, to unknown ones, are unprecedented.

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End-of-chapter questions

Short answer

1. Identify a type of biome close to your home and outline its key characteristics.
2. In what ways has research supported the protection and management of koala populations?
3. Outline the reasons for and against the use of fire as a land management tool.
4. Outline three ways that society can reduce the negative impact of urban development on the environment.

Extended response

Many scientists and environmental managers suggest the use of the 'Precautionary Principle' in situations where we cannot be certain of the impact on ecosystems from human activities. The precautionary principle suggests that if an action or policy could plausibly cause harm to people or the environment, then it should be avoided. However, there is a lack of scientific certainty over where the critical threshold for that harm is, or the extent of the harm that would occur. Those who would like to take the action or implement the policy in question have the responsibility to demonstrate that this is not harmful to the environment before taking action.

Write an extended response on the application of the Precautionary Principle to the management and conservation of Australia's soils. Pay particular attention to key factors that will reduce the quality of Australia's soils and how the precautionary principle can inform management of the soil.

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Additional resources

14b Investigative study – Inland water environments

Source 14b.1 We all live in a catchment, no matter where we call home.

Before you start

Main focus

Most life on Earth depends on ecosystems and other resources found in catchments. Humans affect the quality and availability of natural resources by modifying catchment environments to meet their needs. Fresh water and fertile soils are valuable assets for humans and ecosystems. Understanding the interactions between humans and natural environments in catchments is central to achieving sustainable development goals.

Why it's relevant to us

Humans require terrestrial and aquatic resources for economic growth and to sustain growing populations, yet the activities that drive prosperity also threaten catchment health and sustainability. Catchment ecosystems may not be sufficiently resilient to recover from the effects of rapidly expanding development.

Inquiry questions

- How do humans impact streams and catchments?
- How can we manage streams and catchments?
- What are the social issues that must be tackled to ensure sustainable development of catchments?

Key terms

- Dam
- Drainage basin
- Erosion
- Flow regulation
- Groundwater
- Infiltration
- Integrated Catchment Management
- Riparian
- Run-off
- Surface water
- Water quality
- Wetlands

Let's begin

We all live in a catchment! Streams, rivers and groundwater store and transfer water through a catchment and deliver nutrients to ecosystems. Lakes, wetlands, soils and vegetation are temporary stores of water and influence its availability and quality. Most catchments drain water to the marine environment through large rivers. Catchments that drain water to inland areas are called 'endorheic basins' or 'terminal basins', and may include inland seas that have no connection to the marine environment. Subcatchments are smaller drainage basins that comprise a larger catchment.

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14b.1 Biophysical processes of inland water environments

In this first section of the chapter we will consider some of the biophysical processes operating in inland water environments to maintain their functioning.

What is a catchment?

drainage basin an area drained by a river system which includes all areas that gather precipitation water and direct it to a body of standing or streaming water

A catchment is a **drainage basin** that captures rainfall and is bounded by a watershed. In some countries the term 'watershed' is used to describe a catchment. In Australia a watershed is a ridge or elevated land that separates the flow of water between adjoining catchments. Catchments vary in their character based on a number of factors, which include:

- **Geology** – the geology of a catchment can influence the shape of the drainage basin, soil development and the type of streams, rivers and estuaries.
- **Size** – the size of the catchment determines the amount of rainfall that can be captured in a catchment. Large catchments capture more rain and, therefore, tend to have many subcatchments.
- **Rainfall** – rainfall, or precipitation, recharges **groundwater**, replenishes streams and rivers through **run-off**, and shapes the landscape through erosion and deposition.
- **Topography –** run-off moves faster over steep land and has less time to infiltrate than on flat land. Steeper areas in catchments may also have shallower soils thereby lessening storage of water in soils and vegetation.

groundwater bodies of water that can occur beneath the land surface

run-off the draining away of water from the surface of an area of land or structure

Source 14b.2 The build-up of nutrients from agricultural and urban areas, combined with low flows, can cause eutrophication, the over-enrichment of nutrients in waterways. It leads to excessive algal growth and reduced oxygen concentrations.

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- **Soils** – soils develop through the interaction of water, vegetation and geology. Soil depth and texture control the amount of water that can be stored in a catchment. Soils with high clay content tend to repel water and the water they absorb moves slowly to the groundwater. Sandy soils are more permeable than clays and have higher **infiltration** rates. Soils with high organic content can store water for longer periods than sands.

infiltration the process by which water on the ground surface enters the soil

- **Land use** – hard surfaces, such as roads and footpaths, prevent infiltration and, therefore, increase run-off. Agriculture exposes soils to erosion and may change groundwater or increase the salinity of soils through irrigation practices. Humans also alter river flows by storing and consuming water and redirecting flows to areas where there is a water deficit. Chemical pollutants and nutrients from land use can degrade soil, groundwater and **surface waters**.

surface water water found on the surface of continents and islands

- **Vegetation** – terrestrial vegetation increases infiltration by slowing down run-off and allowing water to enter the soil and the groundwater system. Vegetation also reduces erosion and is a key driver of catchment health.

Catchment water

Only 2.5% of the world's water is fresh and 70% of fresh water is locked up as ice. Fresh water is a valuable resource but vulnerable to over-exploitation and contamination. Water connects surface and sub-surface environments in a catchment and is a key factor in the type of ecosystems that exist in both terrestrial and aquatic areas. Surface waters include:

- **Streams and rivers** – a stream is a small to medium-size natural channel or tributary that connects to a river. Some streams and rivers are ephemeral because they may stop flowing during dry periods or their water is lost as they pass through porous sediments or fractures in bedrock. Streams and rivers are important components of the hydrological cycle and they can transport pollutants, eroded soils and excess nutrients sourced from human developments.
- **Natural lakes** – natural lakes are small (a few square metres) or large (many square kilometres) standing water bodies. They may or may not have a connection to a stream, river or the sea. Estuarine embayments that are seasonally cut off from the marine environment by sand barriers are also classified as lakes.
- **Inland seas** – inland seas are large landlocked water bodies and usually features of endorheic catchments. They contain diverse ecosystems and resources utilised by humans but are vulnerable to pollution and over-exploitation of their water resources. The Aral Sea is an example of an inland sea that is under stress from human activities. The Aral Sea is now only 10% of its original size due to diversion of waters and irrigation.
- **Artificial lakes** – humans can create lakes by damming rivers or by constructing them in impermeable soils. They can be used to store water or create recreational opportunities, e.g. Lake Burley Griffin in Canberra.
- **Freshwater and brackish water wetlands** – **wetlands** provide habitat for flora and fauna and also trap sediments and cycle nutrients. Freshwater wetlands can be permanently or periodically saturated with water and may have

wetlands land consisting of marshes or swamps

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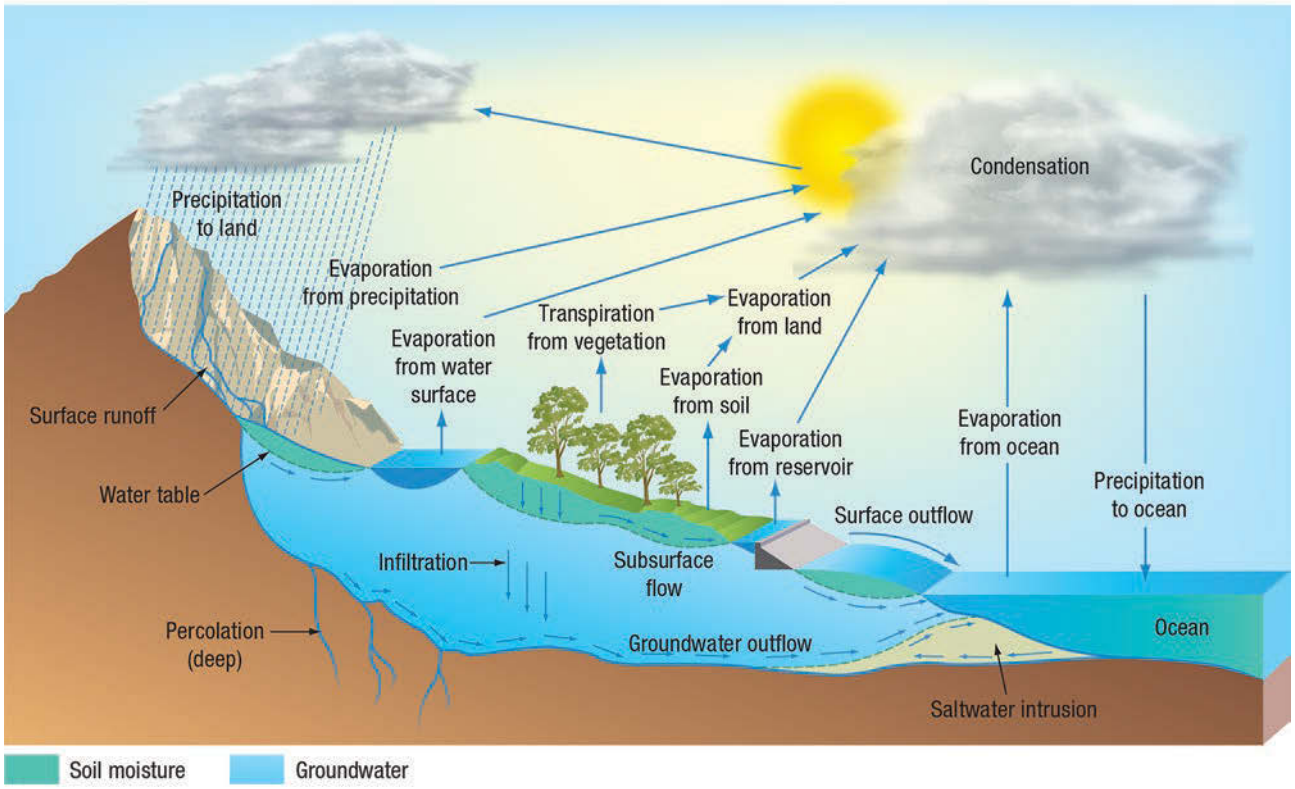
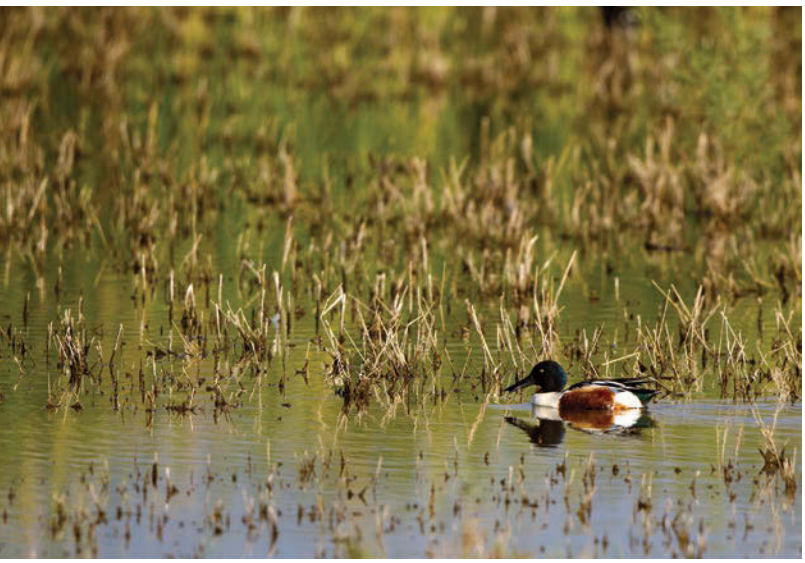


Source 14b.3 The hydrological cycle is comprised of rainfall and surface and sub-surface bodies of water that interact with catchments and marine environments.

intermittent or no connection to a stream or river. Most freshwater wetlands require periodic flooding to enable their aquatic fauna to migrate to spawn or recruit.

- **Estuaries** – fresh water that drains into the sea or ocean may pass through estuaries where it interacts with marine waters. Estuaries are sinks for nutrients, sediments



Source 14b.4 Wetlands (left) and rivers (right) are important surface water environments in catchments. They are, however, connected to sub-surface waters that can maintain water during droughts.

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and pollutants that originate from other parts of the catchment.

lentic (of surface waters) standing; not flowing – the classification of lakes and wetlands

lotic (of surface waters) permanently or intermittently flowing

With the exception of lakes and wetlands, which are classified as **lentic** or standing water bodies, most surface waters are **lotic**, i.e. they have permanently or intermittently flowing waters.

Small and large bodies of water can also occur beneath the land surface. Sub-surface waters are generally known as groundwater. Shallow groundwater can be recharged by rainfall over short time periods (weeks to months), whereas deep groundwater, such as the Great Artesian Basin in Australia, recharges over tens of thousands to millions of years. Water is also retained in the soil and is important to plants and microorganisms. More than 80% of the world's agriculture is rain-fed and, therefore, depends on water stored in the soil. Soil water is usually found in the top 140 cm of soil and is critically important to natural vegetation and crops and pasture that are not irrigated.

Geographical fact

The Great Artesian Basin is the largest sub-surface supply of water in the world. It lies beneath 23% of the Australian continent.

Activity 14b.1

1 List two surface and sub-surface water compartments found in catchments.
2 Explain where river systems drain in an endorheic catchment.
3 Describe what streams and rivers transport through a catchment.
4 Why is water retention in soil important for the environment?

14b.2 The causes, extent and consequences of environmental change

In this next section of the chapter we will examine how inland water environments are undergoing environmental change. We will investigate the causes, extent and short- and long-term consequences of change to the environment by looking at a detailed case study on the Murray–Darling Basin Plan, with reference also to other global contexts.

Although catchments are often perceived to be hydrological units, they contain environments that are characterised by diverse flora and fauna, different soil types and a variety of climatic conditions. Humans undeniably need to modify catchments for the wellbeing of populations and to drive the economy. Soil and water, in particular, are easily degraded in the absence of sound management. Soils form over hundreds to thousands of years and their loss through erosion can be devastating to humans and

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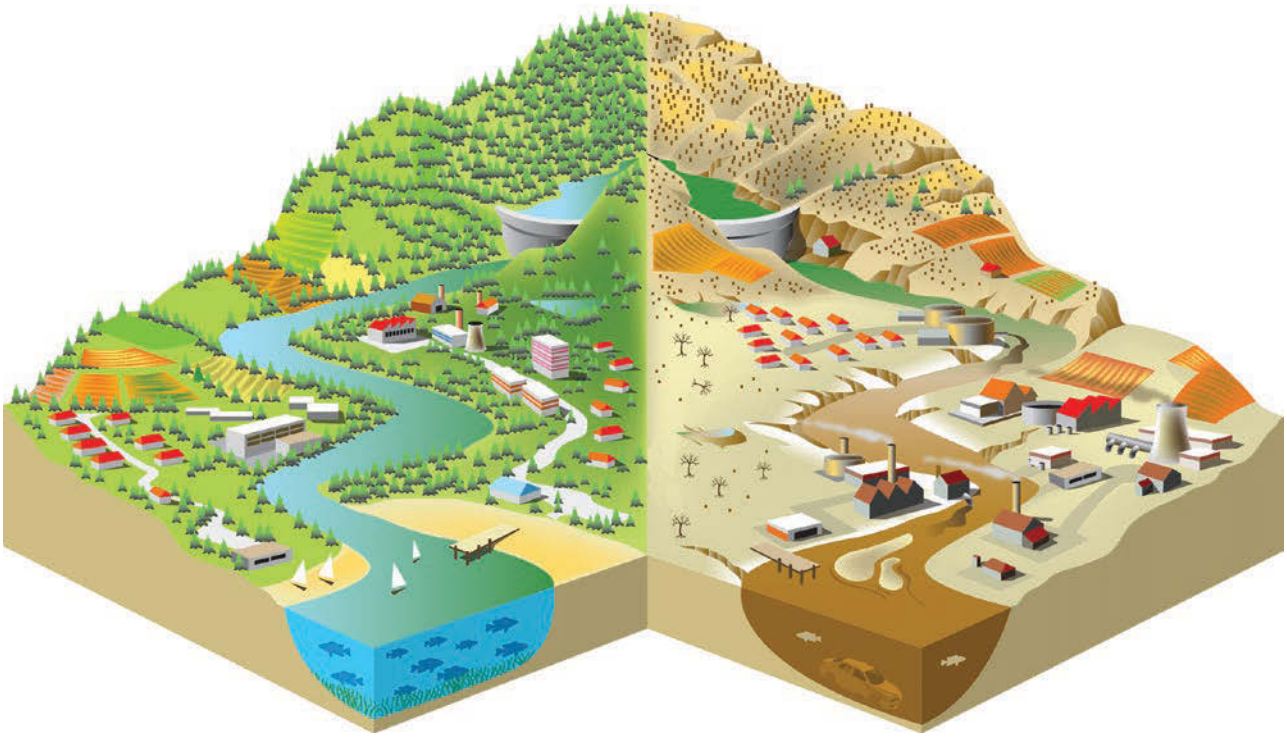

Source 14b.5 Sustainable use of soil, vegetation and water (left) can enable humans to prosper without degrading catchments. Extensive tree clearing, soil erosion, and pollution (right) resulting from poorly planned development can cause irreversible harm to catchments.

the environment. Humans nonetheless have the technological capacity and scientific knowledge to strike a balance between meeting the needs of populations and conserving the environment.

Land degradation

Overgrazing, intensive cropping and deforestation are the main causes of erosion and trigger sedimentation in streams, rivers, lakes, wetlands and estuaries Overgrazing can denude vegetation and expose bare soils to wind and water erosion. Overgrazing occurs when pasture or grasslands are overstocked with cattle and/or sheep or as a result of continuously grazing land without intervening periods for recovery of grass cover. Overgrazing can also occur when the population of wild herbivores increases; this can occur when humans introduce species to an environment or create favourable conditions for population growth.

Land is made available for grazing by clearing natural vegetation and introducing grasses. The change in vegetation type destroys habitat and reduces biodiversity. Overgrazing is a worldwide problem and has been responsible for extensive areas of soil erosion in Australia. Reduction in soil depth and fertility are also associated with erosion from overgrazing.

Cropping is another cause of erosion in catchments. Poorly managed cropping, which exposes soil to wind and water erosion between crops, can lead to many tonnes of lost soil per hectare per year. Soil losses of up to 300 tonnes/ha per year have been reported in Australian soils that are intensively used for crops. Intensive cropping can reduce soil fertility and also trigger soil salinity and acidification by modifying the local hydrology and increasing the amount of nitrogen in the soil by excessive, compensatory fertilising.

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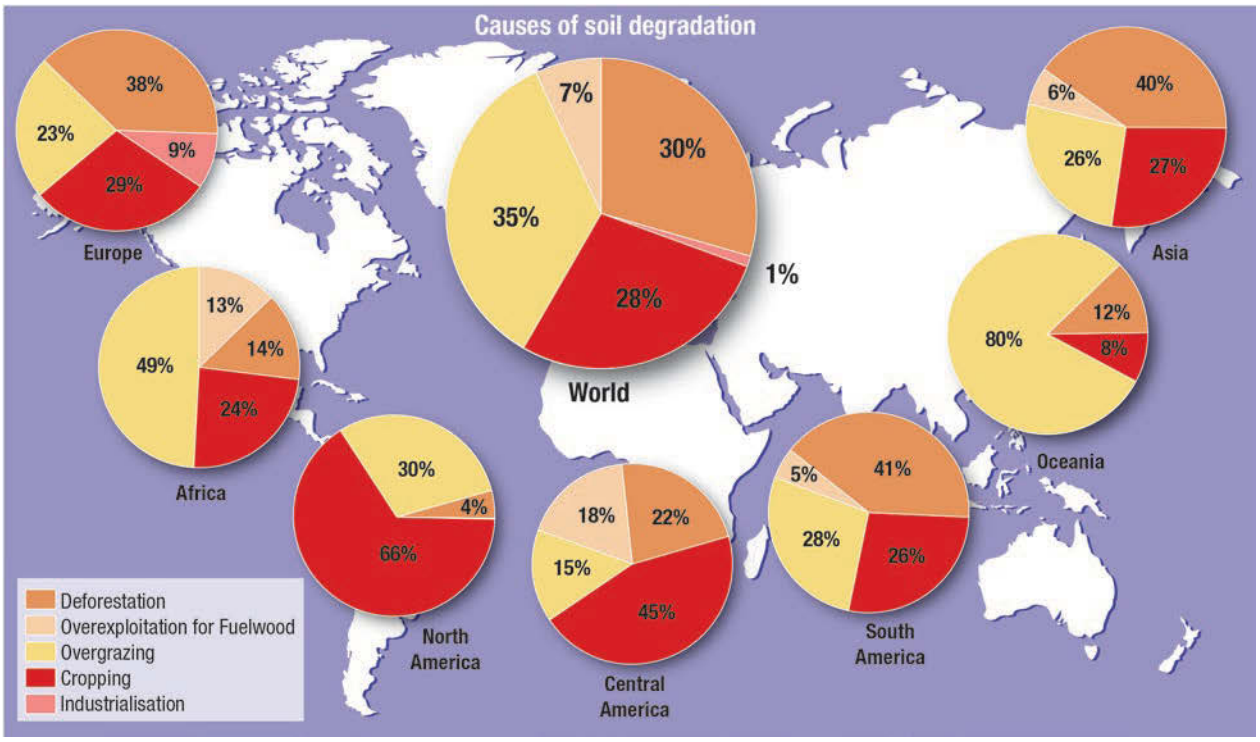

Source 14b.6 Overgrazing, cropping and deforestation account for most of the world's degraded lands.

Sheetwash and rill (hillslope)	• highest in tropical northern Australia • average erosion rate 4.4 t/ha/yr • on average hillslope erosion is three times higher than the natural rate
Gully and riverbank erosion	• main source of sediment delivered to streams in southern Australia • 4.4 billion tonnes of soils have been lost to erosion from 325 000 km of gullies since European settlement • gully sediments cause poor water quality and require targeted restoration
River sediment loads and deposition	• major problem in eastern Australia – native vegetation cleared from the riparian zone of two-thirds of steams in agricultural areas • 30 000 km of streams have sand and gravel from gully and stream-bank erosion, impairing stream health • 14 million tonnes of sediment is transported to the Queensland coast, and 3 million tonnes to the New South Wales coast each year • river sediment loads are generally 10 to 15 times higher than pre-European settlement in some river basins • on average 90% of suspended sediments reaching estuaries comes from 14% of the catchments • sand deposits are significant in the Murray–Darling Basin, coastal New South Wales, southeast Queensland and the Glenelg region of Victoria and are moving slowly down the low-energy river systems, causing problems for dams and weirs.

Source 14b.7 Australia's scorecard on erosion and sedimentation. The amount of soil loss from human practices continues to be a management challenge in Australia.

Deforestation is undertaken to supply timber, create agricultural land and to develop land for industry and housing. Only 50% of the world's forest cover remains. Deforestation is often intended to permanently transform the landscape whereas managed logging involves selectively removing trees or replanting logged areas.

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Deforestation exposes soil to the erosive effects of wind and water, and may also modify the interaction between surface and sub-surface waters by increasing run-off and reducing infiltration of water into the groundwater.

Run-off transports eroded soils into waterways where it either causes localised sedimentation or sedimentation of areas many kilometres downstream. The topsoil, necessary for crops and natural vegetation, can be severely depleted by run-off leaving infertile subsoils exposed. Sheet erosion (uniform layer of soil loss) and rill and gully erosion (formation of small and large eroded channels) can contribute hundreds of thousands of tonnes to the sediment load of rivers. Stream bank erosion, caused by the removal of **riparian** vegetation or wave action from boating, also contributes to the sediment load of rivers.

riparian living or located on the bank of a natural watercourse such as a river or a lake

In developing countries vegetation is often cleared to supply a cheap source of fuel. This practice also contributes to land degradation. Human changes to fire regimes may also expose soils to erosion.

Reduced river flows, caused by humans regulating flows with **dams**, diversion and irrigation, can increase sedimentation of streams and rivers leading to shallower environments that are not suitable for local species of aquatic fauna. Consequently, streams and rivers may experience an ecosystem shift in response to physical changes. The turbidity of water may also increase, thereby reducing the depth to which light can penetrate. Photosynthesis in aquatic plants and phytoplankton can be affected by the reduction of light in unnaturally turbid rivers.

dam a barrier constructed to hold back water and raise its level, forming a reservoir used to generate electricity or as a water supply

Land degradation also has significant impacts on the local, regional and national economies. Agricultural productivity can decline due to low soil fertility and the effects of salinisation and acidification. Navigation in estuaries and rivers can also be significantly affected by sedimentation.

Activity 14b.2

1 How does overgrazing degrade the environment?

2 How does vegetation cover encourage infiltration of water into soils and groundwater?

3 Describe what role run-off plays in sedimentation of streams and rivers.

4 What is the average rate of soil erosion in Australia?

5 Refer to Source 14b.5. Complete the table below with a list of sustainable and unsustainable practices.

Sustainable practices	Unsustainable practices
• development away from riverbanks	• extensive tree clearing

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RESEARCH 14b.1

Research the effects of rabbits in Australia and answer the following:

1 Outline why rabbits were introduced into Australia.

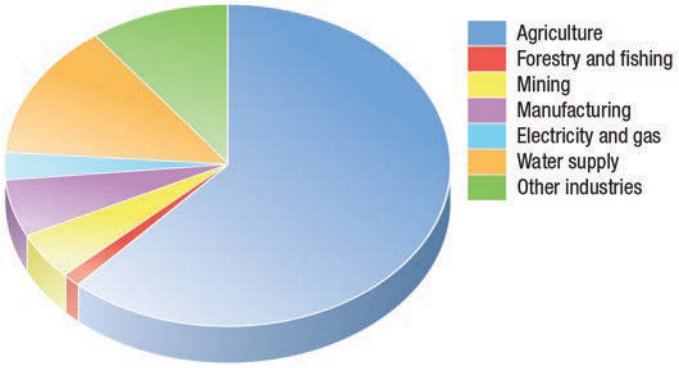
2 Assess the environmental impacts of rabbits.

3 Evaluate the success of strategies that have been used to control rabbits.

Water use

Humans depend on clean, fresh water for domestic and agriculture activities, and are increasingly dependent on water for industry and energy production. More than half of the world's population faces water stress resulting in inadequate sanitation, competition for potable water and low agricultural productivity. Consequently the lack of fresh water has implications for human health and food and income security. More than 3 million die each year due to a lack of access to clean, potable water; 2 million of them are children. The East Africa Emergency in 2011, caused largely by drought, affected 8 million people.

According to the United Nations, 40% of urbanisation is occurring under slum conditions and 50% of the world's urban population lives in cities of greater than 10 million people. In Australia almost every household has access to piped water and sewerage, yet almost one-third of the world's households still lack plumbing and sanitary disposal of sewage. Under these conditions, demands for water in urban areas are likely to be exceedingly high and the risk of polluting water sources is considerable.



Source 14b.8 Water use in Australia in 2010–11. Agriculture is the dominant user of water in Australia and the rest of the world.

Allocating water for human use is highly contentious because water has become a commodity that can be bought, sold or traded. Stakeholders compete for access to water resources and governments have responded by allocating water using licensing schemes, quotas and pricing. The commoditisation of water has the potential to cause social inequalities because water can become unaffordable for many. Balancing water use to meet human needs and economic growth against environmental needs can trigger conflict between stakeholders. The extraction and pollution of water reduces access to quality water by other users. Conflict over water can cross international borders and trigger political debate over access. The Middle East and Africa have experienced inter- and intra-nation conflict over access to surface and groundwaters for decades.

Large catchments that include multiple international borders are difficult to manage

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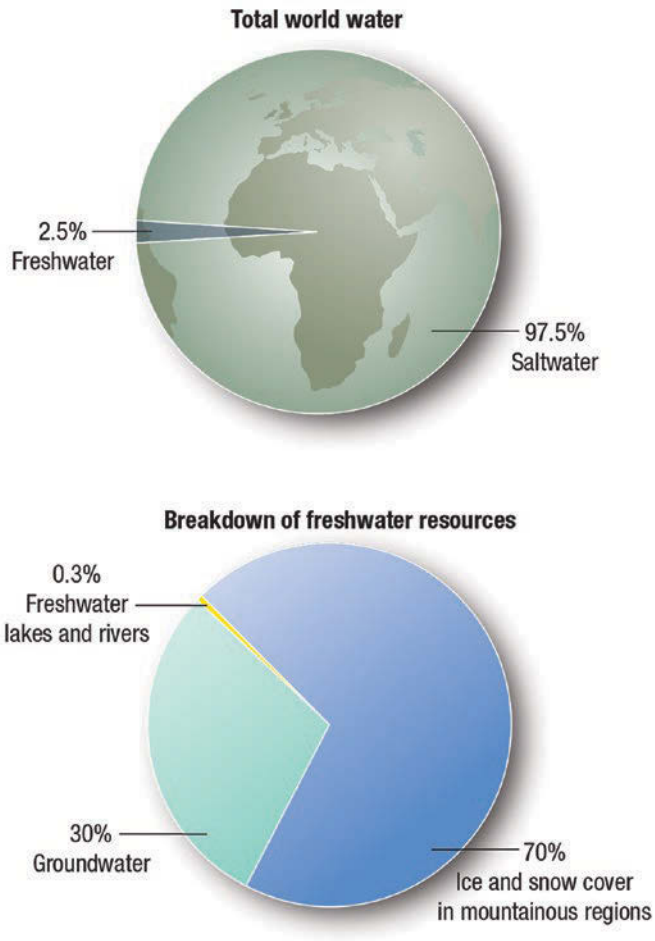

Source 14b.9 Fresh water is scarce and much of it is inaccessible to humans. Groundwater is a major source of water but is vulnerable to over-exploitation and contamination.

because of differences in jurisdiction and planning laws, and competing interests. For example, impounding water in one country can deny a downstream country fair access to the water resource. The degradation of catchment environments and variable rainfall can also reduce the supply of fresh water and drive up its price. The quality of water is threatened by pollution from urban areas and industry, and the quality of run-off from the upper catchment can be degraded by deforestation, loss of wetlands that naturally filter water, and fertilisers and pesticides.

Around the world, agriculture is the largest user of water. Agriculture meets most of the world's food requirements. More than 40% of agricultural land is now degraded as a result of nutrient depletion, salinisation, erosion and acidification. Humans face the dilemma of conserving water for the environment without compromising food production, manufacturing and household needs.

Pollution from industry and urban areas (drains and sewerage outlets) are point sources that contaminate streams and rivers that then transport pollutants to estuaries, wetlands and other environments. Non-point sources, such as agriculture and urban run-off, contribute pollutants (usually pesticides and fertilisers) when run-off transports them to waterways. Toxins from non-point pollutants can contaminate ground and soil water; the toxins can be taken up by terrestrial vegetation. Point sources can also contaminate groundwater through recharge via polluted surface waters.

Geographical fact

According to the United Nations, more than 2 million tonnes of sewage are discharged into waterways every day. More than 70% of industrial waste is discharged into usable water.

Flow regulation

flow regulation when humans control river flows to ensure access to water when it is required and to supply water where it is most needed

Humans control river flows to ensure access to water when it is required and to supply water where it is most needed. **Flow regulation** has been used for over 5000 years to irrigate crops and is now widely practised to supply urban areas with potable water. Natural river flows are variable because of seasonal disparity in rainfall; this can be

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problematic for human activities that require a regular supply of water. Also, demands for water may exceed supply from natural sources of water. To address deficiencies in the supply and access of water from natural waterways, humans have applied engineering works that alter natural processes and the form of waterways.

Large dams

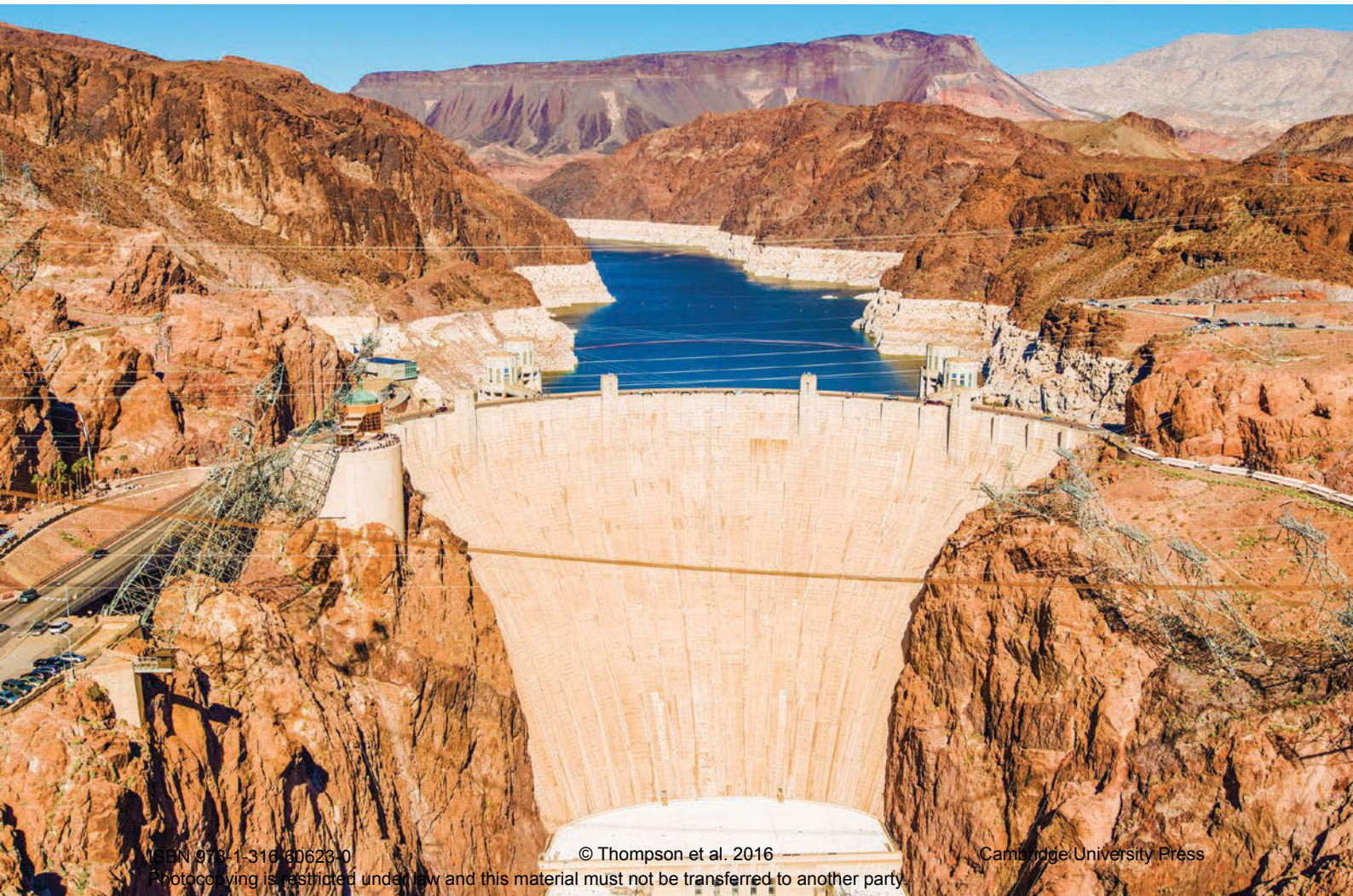
Large dams are built to impound water for irrigation, domestic water, energy production and for flood mitigation. The impounded water body directly behind a dam is called a reservoir or impoundment. Some dams meet all of the abovementioned needs while others are for specific purposes. Dams mitigate floods by controlling the volume of water that can flow downstream. Dams constructed for agriculture, domestic supply and industry are designed to store water that is released on demand; generally, they store water in wet periods and then control the release of water to meet downstream requirements. Stored water in dams can also be transferred to other catchments through tunnels and pumping stations without any need to release water downstream.

Weirs and causeways

Weirs are small dams or barriers that are used to increase the upstream depth of streams and rivers. They are often constructed downstream of dams to compensate for

weirs low dams that are built across rivers to regulate flow or raise the water level

Source 14b.10 Large dams create deep impoundments that submerge habitat and restrict access to upstream resources.



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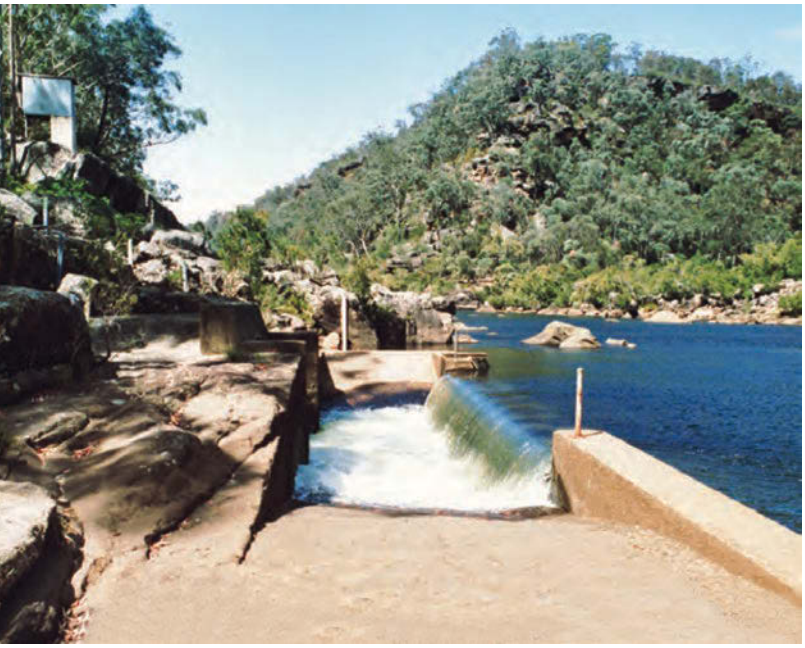

Source 14b.11 (Left) Entrance to an interbasin diversion tunnel on the Upper Nepean River, NSW. (Right) The downstream reaches experience low flow conditions for extended periods.

reduced water depth caused by lower flows. Weirs can be constructed from concrete, stone or wood. Weirs are also built across tidal channels to block tides and create freshwater conditions upstream. Causeways are raised areas or embankments constructed over watercourses or wetlands. Their main purpose is to enable road, rail and pedestrian access in areas that are permanently or periodically submerged.

Canalisation

Canalisation refers to the conversion of natural streams and rivers into concrete canals. Canals can also be constructed where no watercourse previously existed and may or may not have concrete banks. Canals control the direction and rate of flow. Natural watercourses in soft sediments are able to meander by following the path of least resistance in the landscape. Riparian vegetation slows water flows and reduces erosion. By contrast, canals, usually in urban areas, often have concrete banks and direct flow over a planned pathway. Canal networks can increase the drainage density of a catchment and this leads to more efficient removal of water from the landscape. Canals are constructed to:

- supply water to irrigation areas
- transfer water for domestic supply
- channel storm water to the sea
- transfer water between catchments (interbasin diversion)
- reduce flooding in urban areas
- transfer water to flood detention basins
- improve navigation.

Canals are routinely used in the lower catchment areas of the world to prevent flooding of urban areas. Cities such as Amsterdam in the Netherlands, St Petersburg in Russia and Venice in Italy depend on canals to reduce the impacts of floods.

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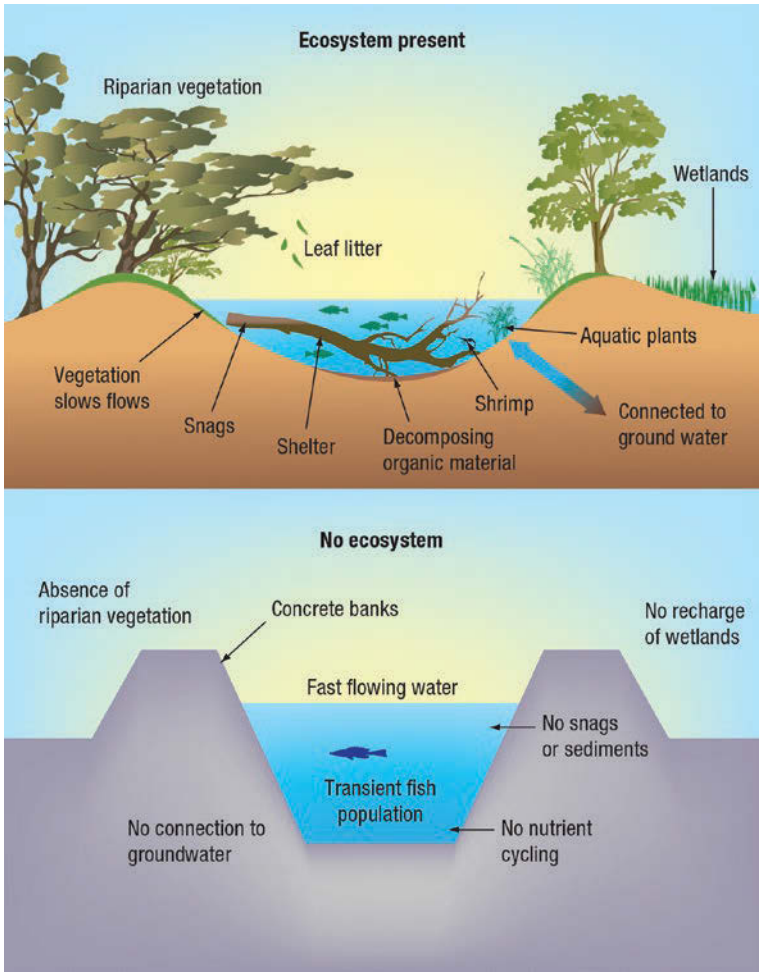

Source 14b.12 Canals have uniform dimensions and are devoid of riparian vegetation. They have low biodiversity because of their lack of habitat.

Floodgates and barrages

Coastal lowlands are desirable for urban development, industry and agriculture.

coastal lowlands an area of low-lying ground close to estuarine and marine environments

Floodgates are usually one-way valves that open on low tide to allow fresh water to flow into estuaries, and close on high tide to prevent tidal water entering canals and affecting farmland and urban areas. Barrages are larger structures that incorporate many floodgates. Floodgates and barrages have converted brackish water reaches of coastal rivers into freshwater environments. The Richmond River in northern NSW has over 270 floodgates that protect agricultural land from tidal inundation and reduce flood impacts. They have also reduced brackish water habitat and drained wetlands.

Source 14b.13 Barrages in tidal areas convert upstream areas into freshwater by preventing the daily ingress of tidal water.

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Interbasin diversion

Surface waters can be diverted between dams, lakes and rivers using canals, tunnels and pumping stations. **Interbasin diversion** is used to increase water supply in another catchment that is experiencing a water deficit. Hydroelectric dams, such as the Snowy Mountains Scheme in Australia, utilise interbasin diversion to ensure there is sufficient water to turn power-generating turbines. The Sydney water supply scheme diverts water between dams to improve supply to the Sydney, Wollongong and South Coast urban areas.

interbasin diversion transferring water from one catchment to another

Activity 14b.3

1 Outline the differences between a canal and a natural watercourse.
2 List three functions of a large dam.
3 Reflect on the issue of water consumption and availability. In your view, how can humans reduce their consumption of water yet meet their basic needs and also protect environments?

RESEARCH 14b.2

Explore the benefits and drawbacks of river engineering and channel straighening. Refer to specific examples in your response.

Impacts of flow regulation

The various forms of flow regulation have triggered many environmental impacts in catchments. Flow regulation is the primary cause of water deficits in the natural environment and its impacts are most obvious in the downstream river reaches. Humans benefit from, and are also affected by, flow regulation.

Impacts of large dams

Large dams cause upstream (above dam) and downstream (below dam) impacts. Upstream impacts include:

- **Flooding** of natural habitats, urban areas and agricultural lands – impounded waters can be tens of metres deep leading to expansive areas of submergence. The submergence leads to loss of riverine habitat, forced relocation of human populations and loss of agricultural land. Historical and cultural sites are also lost.
- **Stratification** of water – the deep waters of dams can experience thermal and associated oxygen **stratification**. Surface waters remain at similar temperatures to the natural, pre-dam riverine environment, but sunlight can only warm several metres of the reservoir water. During summer, the upper layers are warmer than lower layers and become less dense. Wind-driven mixing of the

stratification the process of waters with different properties forming layers to act as barriers to water mixing

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epilimnion the upper, warm layer of water

hypolimnion the deeper, colder layer of water

metalimnion (thermocline) a transitional layer of water where temperature decreases

upper layer maintains normal oxygen concentrations. The upper, warm layer is known as an **epilimnion** whereas the deeper, colder layer is called a **hypolimnion**. There may be a transitional area, called a **metalimnion** or **thermocline**, where temperature decreases over a gradient. Oxygen also changes with depth and anoxic conditions can be present in the hypolimnion. There is very little mixing through the water column during summer. However, during winter the epilimnion may become cold and sufficiently dense such that it sinks and mixes the entire water body. This process is called 'overturn'.

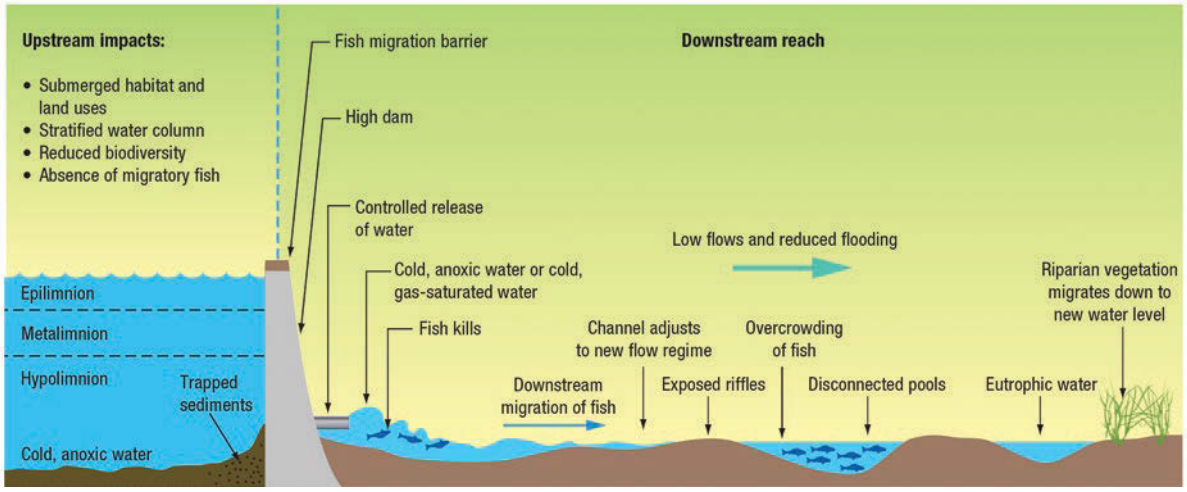
Stratification has ecological consequences. The differences in temperature and oxygen concentrations between the surface and bottom of the reservoir alter habitat. Fish that depend on the bottom environment are often unable to survive in the cold anoxic conditions of the hypolimnion and are forced to live close to the shoreline.

- **Sediment trapping** – dams can trap up to 99% of the sediments that enter the impoundment. The high sediment trapping efficiency can reduce the supply of sediment to downstream channels leading to changes in channel shape and form.

The downstream impacts of dams include:

- **Water quality degradation** – even the purest of water released from dams can affect **water quality** and hence aquatic organisms and vegetation. Dams that release water from the bottom of the reservoir can cause water temperatures in the downstream areas to fall dramatically, particularly during summer when reservoirs are thermally stratified. This can lead to 'river chilling' and force fish and other aquatic organisms to migrate downstream, where river water is closer to their preferred temperature. Dams can also release anoxic water that can cause fish kills. Some dams can release water under enormous pressure, which can have the opposite effect: the water can become supersaturated with dissolved gases, which can be harmful to aquatic organisms. Fish kills can occur below hydroelectric dams due to the saturation of gases caused by water flowing

water quality the physical, chemical and biological characteristics of water



Source 14b.14 Thermal stratification of a deep impoundment during summer. Water released from the hypolimnion can cause 'river chilling' in downstream areas.

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through turbines (that generate electricity) or plunging from great heights. The downstream effects of dams can extend for many kilometres. The distance over which the river reaches pre-impoundment conditions is known as the recovery distance or discontinuity distance.

- **Changes in flow regimes** – the storage and controlled release of water changes the flow regimes of river reaches downstream of dams. Flows are often reduced and river water levels fall, exposing riffles and creating disconnected pools of water. When water is released, flow conditions may be temporarily higher than natural conditions and cause erosion. Floods are important to natural environments because they replenish water in wetlands and lakes, enable fish to migrate and also supply nutrients to soils. Dams reduce the frequency and magnitude of floods. Although urban areas benefit from flood mitigation, agricultural soils and natural environments can be negatively affected through reduced nutrient inputs.

Note this down 14b.1

Copy the graphic organiser below and outline the positive and negative dimensions to dams.

The impacts of dams	
Positive	**Negative**

Impacts of canalisation

Canalisation has multiple environmental impacts. The key impacts include:

- **Artificially lowered watertables** due to the diversion of run-off into the canals – wetlands depend on shallow watertables to maintain saturated soil conditions and surface waters. Wetlands are important ecosystems and their loss can reduce biodiversity and degrade habitat for migratory and resident bird populations, aquatic and semi-aquatic organisms.
- **Reduction in riverine habitat** through the removal of riparian vegetation and snags – vegetation provides structure and leaf litter, and traps sediment eroded from other parts of the catchment. Fish populations may decrease due to a lack of food, shelter, spawning areas and nursery grounds.
- **Loss of aesthetic value** – humans value the aesthetic appeal of natural watercourses. Storm water canals, for example, are considered to be ugly features in the urban landscape and can lower land value. By contrast, the canals of Venice and Amsterdam are appealing because of the surrounding architecture and human activities that depend on them.

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Impacts of interbasin diversion

Diversion weirs and tunnels can lead to cease-to-flow conditions for extended periods in downstream reaches. The impacts of lower flows or cease-to-flow conditions are similar to those of dams and include:

- **Exposure of riffles** (shoals or other shallow areas in between pools) for extended periods. Riffles are important for spawning and temporary shelter from predators.
- **Inability of fish to migrate** due to a lack of flowing water. Fish may become trapped within pools that are disconnected. The sudden cessation of flows, due to diversion, can leave fish stranded in downstream reaches.
- **The build-up of nutrients and warming of remaining pools** leading to anoxic conditions and eutrophication. Fish kills can occur when bacteria and algae deplete oxygen in eutrophied water.
- **Reduced navigation** – lower water levels in downstream river reaches may restrict the movement of boats.

Impacts of weirs and causeways

The main impacts of weirs and causeways include:

- **Lower opportunity to migrate** – fish are only able to migrate during floods because weirs and causeways can be a barrier to movement. A reduction in migratory fish populations can occur upstream of weirs.
- **Stratification of deep weir pools**, generally those that are greater than 2.5 metres in depth.
- **Submergence of riffle zones** and loss of shallow habitats for small fishes and macroinvertebrates.

Activity 14b.4

1 Briefly describe three downstream impacts of large dams.
2 During which season is thermal stratification likely to occur?
3 What is meant by a 'riffle zone' and why is it important to fish?
4 Explain how flow regulation affects humans.

RESEARCH 14b.3

Conduct an internet search on the Three Gorges Dam, China and take notes on the purpose of the dam and its effects on humans and the environment.

1 Explain how the dam was constructed.
2 Describe how the dam has degraded the natural environment.
3 List the impacts of the dam on communities upstream and downstream.
4 Do you think that the economic benefits of the dam compensate for the environmental and social impacts?

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Case study 14b.1

The Murray–Darling Basin – a catchment in crisis

The Murray–Darling Basin comprises the Murray and Darling Rivers, covers 1 million km^2 and is responsible for approximately 40% of Australia's agricultural production. Approximately 65% of Australia's irrigated farmland occurs in the Murray–Darling Basin, along with extensive areas dedicated to grazing. There are approximately 25 000 wetlands that cover 62 000 km^2. The Murray–Darling Basin drains river systems from South Australia, Victoria, Queensland, the Australian Capital Territory and NSW. Although the Murray–Darling Basin has a large drainage area, it experiences low rainfall and low river flows.

Source 14b.15 The Murray–Darling Basin comprises a number of catchments and management areas (coloured) that drain water from Queensland, NSW, ACT, Victoria and South Australia.

Geographical fact

The Murray–Darling Basin holds 1000 times the volume of water in Sydney Harbour. The Murray River is the 16th longest river in the world.

The Murray–Darling Basin has been farmed since the 1800s and is described as the 'food bowl of Australia'. During early European settlement, pressure on water and soil resources was low. As Australia's population grew, so too did demand for water to irrigated farmland. Soil fertility also decreased, and soil salinity became a problem due to over-irrigation of farmland.

By the late nineteenth century, concern over water supply was exacerbated by recurrent drought conditions. Between 1922 and 1935, 10 weirs with locks were constructed to raise water levels in the river for irrigation, water diversion and navigation. There are now over 4000 weirs, dams and other infrastructure that regulate flows in the Murray–Darling Basin. The high level of regulation has fuelled conflict between stakeholders such as farmers, fishers, environmentalists, urban and rural communities, industry and government.

The River Murray Commission was established in 1917 following growing concern over declining water availability. For decades the River Murray Commission focused on the quantity of water and acted only as an

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advisory body for all concerned states except Queensland.

Increasing salinisation of farmland and waterways triggered changes to the role of the Commission in the early 1980s. In 1985 the Murray–Darling Basin Agreement was adopted and the Murray–Darling Basin Commission was then established in 1988. The Commission's main responsibility was to coordinate the management of water resources and the environment following decades of dispute between the five states and territories.

The responsibilities of the Commission were transferred to the Murray–Darling Basin Authority (MDBA) in 2008 under the *Water Amendment Act*. The MDBA is an independent authority and the first agency to have the responsibility to manage the water assets of the Murray–Darling Basin 'in the nation's interest'.

Environmental impacts of development

Irrigation draws more than 95% of water allocated to human use and is associated with declining river flows and the reduction of wetlands in parts of the basin, particularly during drought when natural flows are low and water demands for agriculture are high. Large dams have reduced the frequency of small to medium floods, which are important for wetlands. The impacts of flow regulation and over-exploitation of water include:

- eutrophication of waterways and recurrent blue-green algae blooms
- increased salinity of soils and water
- degraded in-channel and wetland habitats
- reduced opportunity for fish to migrate due to low flows and barriers such as weirs
- damage to Aboriginal sacred and cultural sites and reduced value of native title land
- reduction in the population of fish and birds
- reduction in riparian vegetation and the death and/or poor health of over 80% of river red gums.

The Murray–Darling Basin Plan

The Murray–Darling Basin Plan is a Federal Government initiative to address both environmental and land use issues. It was approved in 2012. The plan follows the principles of sustainable development that are embedded in natural resource management legislation and policy in Australia. The plan is the first to take a national approach to managing water resources in the Murray–Darling Basin after over 100 years of political conflict between states.

The plan has set a target of 2750 gigalitres to be recovered from current water allocations for environmental purposes. The amount of water could increase or decrease based on monitored environmental outcomes of the current target. Each of the five states and territories will reallocate water for environmental purposes. The overall objective is:

> for the Basin Plan as a whole is to achieve a healthy working Basin, which will include a healthy environment, strong communities and a productive economy, through integrated management of the water resources of the Murray–Darling Basin.

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The environmental goals of the plan are:

- Protect and restore the water-dependent ecosystems of the Basin
- Protect and restore the ecosystem functions of water-dependent ecosystems
- In the context of the Basin Plan, 'protect and restore' refers to retaining or improving the ecological character and ecosystem functions of a site, such as connections along rivers and between rivers and wetlands, end-of-system water quality and flow, habitat diversity and food webs.
- Ensure that water-dependent ecosystems are resilient to risks and threats
- Ensure that environmental watering is co-ordinated between managers of planned environmental water, owners and managers of environmental assets, and holders of held environmental water.

Source: Murray–Darling Basin Authority, 28 November 2011

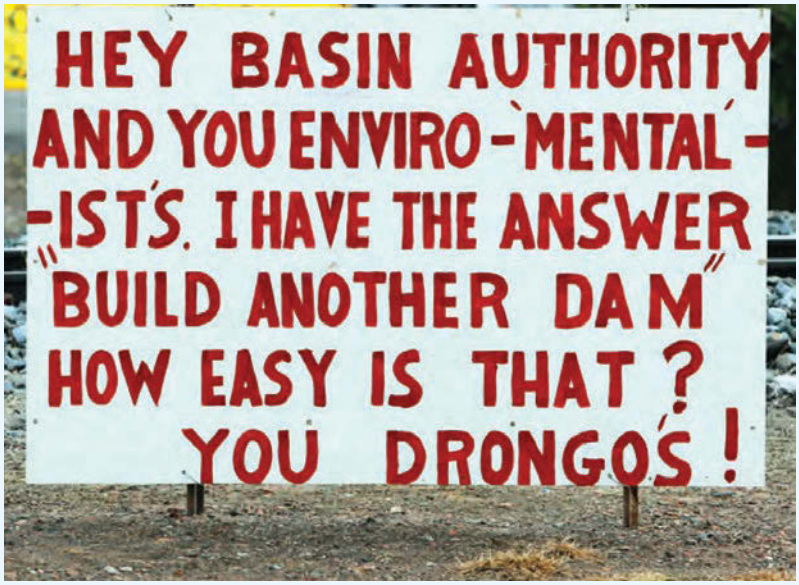
Although the plan has advanced management of water assets and the environment, not all stakeholders have responded positively. Communities in the lower basin, farmers and environmentalists have continued to protest over the upstream extraction of waters.

1 Discuss which human activity draws the most amount of water from the Murray–Darling Basin.

2 Explain why the Murray–Darling Basin is important to Australia's economy.

3 Identify the stakeholders in the Murray–Darling Basin and examine the relationships between them. Do they function on consensus or conflict?

4 List three environmental objectives of the Murray–Darling Basin Authority.



Source 14b.16 Social conflict over water management in the Murray–Darling Basin has divided stakeholders.

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14b.3 The management of environmental change

Catchment management involves activities that restore or rehabilitate degraded terrestrial and aquatic environments, and environmental assessment and planning to ensure that current and future development does not continue to cause harm to the environment. Without cooperation between stakeholders it is not possible to foster stewardship of the environment or fully engage all stakeholders in decisions that affect them as well as the resource base that they seek to utilise.

Catchment management practices

Catchment management is a responsibility for all of us. Humans are unable to vacate catchments to prevent environmental harm. Rather, humans must manage their activities in catchments to ensure sustainability goals are achieved.

To effectively manage human activities and their impacts at the catchment scale, environmental decision makers must consider the following:

1 **Environmental processes and their interaction across the catchment** – efforts to manage localised problems that ignore catchment-wide factors often fail.
2 **Past changes to catchment processes and their impacts, how catchments are currently used, and future development** – reactive approaches to management deal with impacts that have already occurred, whereas proactive approaches, such as environmental planning, help to protect catchments from current and future developments.
3 **Human and environmental needs within the context of sustainable development goals** – humans depend on catchment resources, but without sustainability goals, catchment resources can be depleted or irreversibly degraded.
4 **Interactions between humans and catchment processes over time** – many environmental impacts are interconnected and negative feedback effects can occur many years after a human activity alters catchment processes.
5 **Stakeholder perceptions of the environment** – stakeholders have a vested interested in the commercial, recreational and environmental value of catchments and their perception and knowledge of the limits of the environment will influence their involvement in managing catchments.

Integrated Catchment Management

Integrated Catchment Management (ICM) a management strategy that takes into consideration that catchments are made up of different terrestrial and aquatic ecosystems that are interconnected through physical and biological factors

Integrated Catchment Management (ICM) is a management strategy that takes into consideration that catchments are made up of different terrestrial and aquatic ecosystems that are interconnected through physical and biological factors. Importantly, ICM brings stakeholders together.

The main goals of ICM are to:

- Increase awareness of catchment problems and engage stakeholders in management decisions and activities.
- Develop strategies for catchment management that are based on social, economic and environmental sustainability goals.

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- Implement whole-of-catchment management strategies – that is, to consider the whole catchment rather than disconnected areas.

Australian state governments have adopted ICM as a framework for catchment management. State governments have created authorities to oversee ICM; for example, the Catchment Management Authority in NSW and Victoria, Catchment Councils in Western Australia and Natural Resource Management Boards in South Australia. These authorities have a statewide responsibility but establish Catchment Management Coordinating Committees (CMCC) to coordinate management across the many catchments under state jurisdiction. States also cooperate when catchments occur across state boundaries, such as the Murray River.

These CMCCs are responsible for:

- identifying and prioritising catchment problems
- facilitating cooperation between government agencies and stakeholders
- identifying resource needs and allocating resources following sustainability goals
- making recommendations on statewide policies that facilitate ICM
- implementing and monitoring catchment management programs.

CMCCs are established in catchments that are vulnerable to human activities and where uncoordinated initiatives to tackle problems have been ineffective and require wider, catchment-level interventions.

The state governments are responsible for developing or amending laws that relate to ICM and ensuring that development decisions and ICM programs are legally implemented and consistent with the principles of ecologically sustainable development (see Chapter 1). All levels of government fund ICM activities often in collaboration with the business sector.

Activity 14b.5

1 What factors must be taken into account in catchment management?

2 What are CMCCs responsible for and how can they be made more effective or influential?

3 Find out the name of your local CMCC. Report on their suggestions for how to best manage that catchment.

Catchment management practices: Environmental flows

'Environmental flows' are planned releases of water from dams to meet the needs of humans and ecosystems in downstream rivers. Environmental flows do not restore river flows to normal conditions. Rather, they are designed to:

- enable selected species of fish to migrate to and from spawning areas and to repopulate episodically isolated habitats
- provide the agricultural industry and urban areas with water during periods of low flow caused by drought
- sustain ecosystem functioning in rivers and the upper reaches of estuaries

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Source 14b.17
Fish ladders enable fish to migrate upstream and downstream to complete their life cycle requirements.

- minimise the concentration of nutrients and pollutants in rivers
- stimulate the growth of riparian vegetation
- replenish the supply of water to wetlands.

Environmental flows are often implemented during drought to ensure there is sufficient water flowing in downstream rivers. However, most aquatic flora and fauna require variable flow conditions and at different times, which can be difficult to achieve because dams are designed to meet human rather than environmental needs. Some fish species, for example, require specific flow rates and water temperatures during a particular phase of their development in order to migrate and successfully spawn. Poorly timed environmental flows or those that focus on a single species of fish may not enable other species with different flow requirements to successfully migrate. Fish ladders or fishways are sometimes incorporated into dams and weirs to facilitate fish passage.

Continuous release of water can be a challenge to water regulation authorities because the original purpose of impounding water can be undermined. Environmental flows can rarely reproduce all of the flow scenarios that influence downstream environments particularly large floods which are beneficial to ecosystems, but impact human activities. Unsurprisingly, setting environmental flows is controversial. Environmentalists lobby for the return of natural flow conditions or at the very least, an increase in environmental flows. By contrast, industries lobby for increased downstream water allocations, which can reduce the available water for ecosystems.

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RESEARCH 14b.4

Investigate the catchment management practices around the Snowy River and the case for 'environment flows'.

Wetlands management

Wetlands management is a challenge because of competition for water resources, changes in flow regimes and pollutants from human activities. Restoration and management of wetlands involves restoring water supply by enabling frequent flooding or reconnecting streams, preventing pollution, replanting vegetation and excluding harmful activities. Designating them as significant environments under local laws and international agreements can also protect wetlands. The Ramsar Convention (also known as the Convention on Wetlands of International Importance) protects wetlands that are considered critical habitat under an international treaty. There are now over 2100 wetlands around the world listed for protection under the Ramsar List of Wetlands of International Importance. The total area protected in Australia is over 8 million hectares.

Buffer zones

Buffer zones along the shoreline of natural channels, lakes and wetlands, which may be created by retaining or replanting shoreline vegetation, can help reduce sedimentation by trapping sediments in the terrestrial environment. Riparian buffer zones can enable streams and rivers to re-establish habitat by improving water quality and contributing leaf litter. The retention or construction of buffer zones can be a condition of development consent. Buffer zones may also exclude human activity with the vegetated area. The use of buffer zones has been recommended by UNESCO and can also be applied to cultural areas within catchments.

Activity 14b.6

1. You have been selected to represent Australia at the next Ramsar Convention. Deliver a speech to the other delegates from around the world calling for urgent action on the protection of wetlands. Refer to specific examples.
2. Explain how buffer zones protect streams, rivers and wetlands.
3. Research the use and effectiveness of buffer zones. Develop guidelines for the implentation of buffer zones for either African wildlife parks or marine areas. Use a diagram to help convey your information.

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Land management

Land management is not independent of other catchment management practices. Rather, it contributes to efforts to manage soil and water quality and involves reforestation of previously cleared land and changes in farming practices. Soil conservation practices in urban and agricultural areas reduce erosion and sedimentation and protect valuable topsoils that are needed for natural vegetation and agriculture. Examples of soil conservation practices include:

- reforestation
- land capability assessment and classification to avoid inappropriate use of landscapes
- on-farm strategies such as reduced soil tillage and crop rotation to conserve nutrients and reduce erosion
- use of windbreaks to reduce wind erosion and contouring of steep slopes to reduce the erosivity of run-off
- buffer zones along river banks to reduce sedimentation of streams and rivers.

Note this down 14b.2

Copy the graphic organiser below and complete the PMI table by outlining different perspectives of each catchment management practice.

Catchment management practices			
	Plus	**Minus**	**Interesting**
Environmental flows	Provides the agricultural industry and urban areas with water during periods of low flow caused by drought		
Wetland management		Competition for water resources, changes in flow regimes and pollutants from human activities	
Buffer zones			
Land management			

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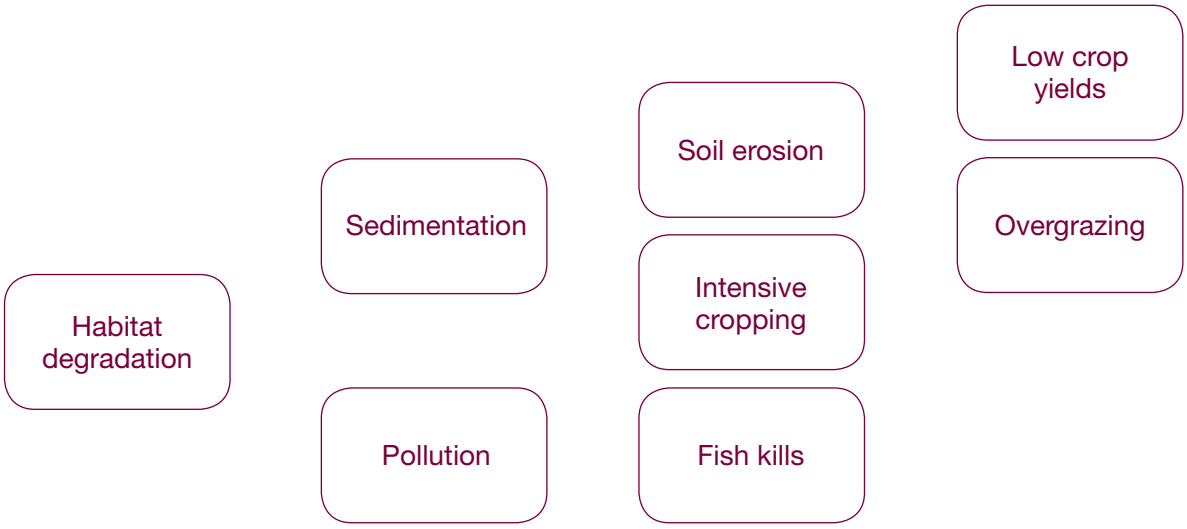
Note this down 14b.3

Copy the graphic organiser below and demonstrate the complex connections between human activities and environmental processes that can result in habitat degradation. Use the examples below as a guide, build on this and add more boxes as you demonstrate the connections.



Fieldwork 14b.1 Investigating the impacts of land use on a local catchment

Aim

To describe the impacts of land use on your local catchment and identify management strategies.

Method

Your local catchment will be investigated using information such as maps and aerial or remotely sensed imagery, and field observations.

Preparations

Locate a topographic map and an aerial photograph or remote sensing image for a local river from a mapping website. Draw a boundary around your local catchment area. The boundary can be determined from a topographic map by identifying ridges and other elevated areas that separate your local catchment from adjacent catchments. Streams and rivers can also be used to determine your catchment. Identify at least four stops in your catchment which should include streams and rivers. Attempt to locate stops that have easy access and represent different land uses.

Data collection

Record information on the human and natural components of the catchment at each stop. Take notes on the environment surrounding the river rather than focusing only on the immediate channel and its banks. Record the following in your notebook and label, as required, your map and/or aerial photo:

1 Label the land use and outline its spatial extent. Describe the land use in your notebook. Take photos of the land use,

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especially activities that influence your catchment. Note the characteristics of the ground surface, e.g. grass, native vegetation, bare soil, hard surfaces, rills, eroded soil.

2 Describe the channel characteristics at each stop. Note the presence or absence of vegetation. Is there a buffer zone? Is the water flowing or stagnant? Is there any evidence of sedimentation?

3 Are there any barriers to fish migration such as weirs or dams?

4 Are there any canals and pipes that discharge water into streams or a main river? If so, where do they originate and what type of effluent or water are they likely to discharge? Is there any evidence of environmental impacts below any pipes? Note any signs of pollution, litter, dying vegetation and evidence of vegetation having been cleared.

5 Is there any evidence of catchment management? Examples include: riparian buffer zones, signposting, fencing, trash traps, revegetation works, fish ladders and constructed wetlands.

6 Note down any terrestrial or aquatic fauna. Describe sources of food and other habitat qualities such as trees, aquatic plants and in-channel environments, such as riffles and pools that can provide opportunities for spawning or shelter.

7 Discuss your observations with your peers and make a general assessment of the environmental issues in your catchment. Prepare a report using the layout below:

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	**Catchment map** Show the boundary, streams, rivers, lakes and wetlands, and label land use. Use a legend.
Page 3	**Introduction** Provide a brief description of your local catchment.
Page 4–5	**Describe each stop** Use photos to enhance your description.
Page 6	**Summarise the effects of land use in a table**
Page 7–8	**Describe any environmental impacts** Use a diagram to present your information or label the impacted areas on another map. Discuss associations between land use, run-off, water flowing through natural channels or canals and pipes, and any terrestrial or aquatic impacts.

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Page 9	**Table of impacts and any management strategies**
Page 10–11	**Recommend management strategies** You may use a table or summarise them in expanded bullet points.
Page 11	**Photos or sketches of examples of management strategies** You can annotate them onto a map.
Page 12	**Conclusion** How healthy is your catchment?
Page 13	**Appendix, bibliography, glossary**

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Chapter summary

- Catchments are drainage basins that are bounded by a watershed. They capture rainfall that supplies water to streams, rivers, soil, lakes, wetlands and groundwater.
- Water and soil are important to the prosperity of humans and the maintenance of ecosystems. Poorly managed human activities can severely degrade both soil and water, leading to economic losses and irreversible harm to ecosystems.
- Agriculture is the largest user of water. Poorly managed agriculture can cause severe erosion and salinisation of soils.
- River regulation involves the engineering of watercourses to either divert flows from one catchment to another or store and release water as required. River regulation is a major threat to the environment because it reduces downstream flows in streams and rivers.
- Integrated Catchment Management (ICM) has been widely adopted in Australia and other countries to tackle environmental impacts from human activities by using a whole-of-catchment approach. ICM considers that ecosystems are connected in catchments. It facilitates cooperation between stakeholders.

End-of-chapter questions

Short answer

1 Explain why fresh water is considered a scarce resource.

2 Outline three environmental impacts of river regulation.

3 Assess the benefits of Integrated Catchment Management.

4 Discuss the factors that may lead to social conflicts over water.

Extended response

Assess the effects of two human activities on catchment processes and the resulting environmental impacts. Recommend management strategies that address existing impacts and prevent future degradation.

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Additional resources

14c

Investigative study – Coastal environments

Source 14c.1 Coastal environments are under increasing pressure from development. Activities, such as urbanisation, can irreversibly modify coastal environments.

Before you start

Main focus

The coastal zone is made up of dynamic and interacting environments shaped by human and natural processes. Coastal environments are important for the prosperity of humans but also vulnerable to degradation caused by human activities. Coastal zone management involves multiple stakeholders with a vested interest in the recreational, economic and environmental assets of the many coastal ecosystems and their resources.

Why it's relevant to us

Coastal environments are under increasing population pressure. More than 3 billion people live within coastal environments and depend on their physical and biological resources to thrive. Humans have a responsibility to repair degraded coastal environments and prevent further impacts. To achieve sustainable development goals, locally and globally, coastal environments and their resources must be managed.

Inquiry questions

- What are the functions of coastal ecosystems?
- What are the threats to coastal environments?
- How are coasts managed to ensure they are not degraded?

Key terms

- Aquaculture
- Coastal erosion
- Estuaries
- Hard engineering
- Integrated Coastal Zone Management (ICZM)
- Mangroves
- Saltmarsh
- Seagrass meadows
- Soft engineering

Let's begin

The term 'coast' describes the area where terrestrial and marine processes interact. Coastal environments contain a variety of fragile ecosystems that contribute significantly to biodiversity on earth. Humans have utilised coastal environments and their abundant resources since early human evolution. Today coastal environments are used for urbanisation, industry, recreation and for food.

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14c.1 Biophysical processes of coastal environments

In this first section of the chapter we will consider some of the biophysical processes operating in coastal environments to maintain their functioning.

Evidence of coastal degradation is now widespread and includes pollution of waterways, erosion of beaches and dunes, declining fish stocks and loss of habitat for a variety of terrestrial and aquatic flora and fauna. Humans have responded to the impacts of their activities through reactive measures that focus on rehabilitating or restoring degraded coastal environments, and strategic measures to prevent future damage.

There is a long-held misconception that coastal environments are resilient and capable of assimilating pollution and recovering from various activities that exploit coastal resources. However, this is often far from the reality; coastal areas need careful management in order to survive and thrive. Planners and environmental managers consider interactions between the various coastal processes and environments that comprise or influence a larger spatial area known as the coastal zone.

Defining the coastal zone

coast a much wider area of land and water beyond the shoreline where terrestrial and marine processes interact

The term '**coast**' is not precise in common language. The term is often used to describe the shoreline or shore where land meets the sea. This interpretation of what comprises a coast provides limited scope for coastal management because it defines a geographically narrow area and does not consider the interaction of coastal processes both **landward** and **seaward** of the shoreline. Accordingly, the term 'coast' is often considered by planners, environmental managers and scientists to describe a much wider area of land and water beyond the shoreline where terrestrial and marine processes interact. The term 'coastal zone' has been adopted to cover all landward and seaward environments influenced by coastal processes.

landward tending toward the land and away from the coast

seaward tending toward the sea and away from land

The boundary of a coastal zone may vary at any location based on the purpose. Planners and politicians may focus on political or administrative borders to define the boundary of the coastal zone. By contrast, scientists often define the boundary of the coastal zone by the margin where terrestrial and marine processes cease to interact. Factors such as elevation, **geomorphological** and geological features, the transition from one ecosystem to another, and catchment and marine features may all be used to define the boundary of the coastal zone.

geomorphology the study of the physical features of the surface of the earth and their relation to its geological structures

The NSW Coastal Policy 1997 defines the coastal zone for planning and management purposes. In NSW, the coastal zone is defined using the following criteria:

- 'three nautical miles seaward of the mainland and offshore islands;
- one kilometre landward of the open coast high water mark;
- a distance of one kilometre around all bays, **estuaries**, coastal lakes, lagoons and islands; and tidal waters of coastal rivers to the limit of **mangroves**, as defined by

estuaries the wide lower course of a river where fresh and marine water mix

mangroves trees that have managed to adapt to growing in the harsh and difficult tidal zone between the land and estuarine waters

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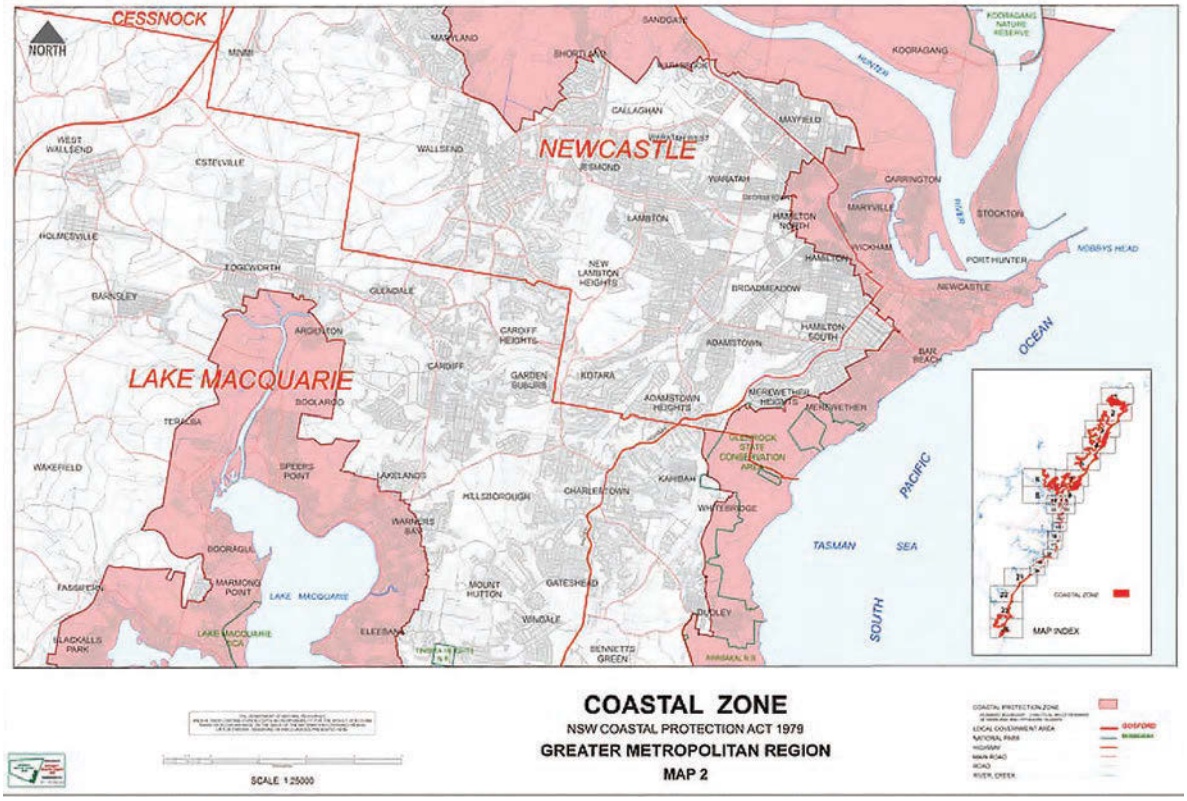
cadastral a public record, survey, or map of the value, extent and ownership of land as a basis of taxation

NSW Fisheries (1985) maps, or the tidal limit, whichever is closer to the sea; with the line on the maps being taken to the nearest **cadastral** boundary and/or easily recognisable physical boundary, in consultation with local councils.'

This definition uses fixed distances, cadastral boundaries, and physical and biological features in the landscape as the basis of defining the boundary of the coastal zone. These fixed distances and landscape features are easily mapped, enabling planners and environmental managers to develop policies and management strategies using a clearly defined zone of interest. Natural environments and their ecosystems do not always have discrete boundaries that can be defined by fixed distances from tidal waters or shorelines. More often, natural boundaries tend to be 'fuzzy'. These fuzzy boundaries require significant data collection and synthesis in order to define them on a map. Nevertheless, the criteria used in NSW meet most planning and management needs.

Activity 14c.1

1 Why do we need to define the coastal zone?
2 Why do planners largely rely on fixed distances from natural features, such as shorelines, to define the coastal zone?
3 Account for the variation in coastal zone boundaries.



Source 14c.2 An example of the boundary of the coastal zone using the NSW Coastal Policy criteria

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Coastal environments

Coastal environments vary quite dramatically. Each different type of environment is home to specific flora and fauna that have adapted to the conditions.

The open coast

The open coast is the shoreline that faces the sea or ocean. The open coast is often subjected to high-energy conditions from waves and currents. Surfing beaches are a good example of a high-energy open coast. Some open coasts are protected from waves by coral reefs and offshore islands that dissipate wave energy. The shoreline can comprise cliffs and beaches consisting of boulders, sand, pebbles or coral materials. The aquatic flora and fauna of the open coast are adapted to live in seawater which is more saline than estuarine waters. Terrestrial flora and fauna are adapted to survive the effects of wind, salt spray and **storm surge**.

storm surge local and temporary rise in sea level that is primarily caused by a low pressure system

Estuaries

An estuary is a semi-enclosed bay where seawater, that enters the bay through tides and currents, mixes with freshwater from the catchment. More than 70% of the world's marine fish species spend part of their life in estuaries. Australia has over 1000 water bodies classified as an estuary. Estuaries are an important component of the coastal zone because they provide:

- sheltered habitats and low-energy environments for seagrass meadows, mangroves and salt marshes
- nursery and spawning grounds for fish and other organisms
- recreational opportunities for humans, e.g. fishing, swimming and boating
- safe anchorage for ships and calm waters for port facilities
- a **fishery** for commercial supply of seafood.

fishery a place where fish are harvested for commercial purposes

In contrast to the open coast, estuaries are low-energy environments; they

Source 14c.3 (Left) A sandy shoreline with rocky headlands at Coogee, NSW. (Right) cliff shoreline in Gozo, Malta.

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are largely protected from high wave-energy conditions normally experienced on the open coastline. Estuaries vary in depth, water quality and landforms depending on their basin shape, the width of their entrance, which controls tidal flows and currents entering the estuary, and the size of their catchment.

Catchment size can determine the level of riverine influence mainly by the volume of freshwater and sediment that enters the estuary. Deep estuaries experience greater marine influence than shallow estuaries with narrow entrances. Sydney Harbour, for example, is a deep estuary, and experiences a wide tidal range. Consequently, it has water salinity that is close to that of seawater.

Geographical fact

Many estuaries were formed over the last 10 000 years following a period of rising sea level. Before sea levels rose, the open coast and estuaries were located kilometres seaward of their present-day location.

Coastal plains

Coastal plains are broad, flat areas adjacent to the sea and estuaries, often with ground elevation only a few metres above mean sea level. Many coastal plains are overlain by **alluvial** sediments deposited by floods and are, therefore, known as coastal floodplains. Under natural conditions, coastal plains may contain lagoons, swamps and other wetlands. Coastal plains are developed for urbanisation, agriculture and light and heavy industry because their flat landscape is well suited for building.

alluvial sediment deposited by flowing water, as in a riverbed, flood plain, or delta

Freshwater wetlands and lakes

Freshwater wetlands can occur in the **swales** of dunes and in depressions or **meander** cut-offs in coastal plains. They may also occur as swamps along the margins of estuaries if a sand barrier prevents tidal water from entering shallow depressions. Freshwater wetlands and lakes develop in the coastal zone when contact with tidal water ceases or is **ephemeral**. They provide an environment for freshwater aquatic flora and fauna.

swales a low tract of land, in between sand dunes or ridges, that may be moist or marshy

meander a winding curve or bend of a river

ephemeral lasting for a very short time

impervious incapable of being penetrated

In swales, the presence of indurated sands, also known as coffee rock, can create an **impervious** barrier that prevents infiltration of water. Indurated sands form when organic material and iron in the sediments cement sand grains together creating a hard, rock-like structure. Compacted organic matter can also reduce infiltration. Freshwater becomes perched on top of the indurated sand or compacted organic layers, creating a permanent or semi-permanent freshwater wetland or lake. A window lake may develop when a natural depression in the landscape exposes a fresh groundwater table. Barrage lakes can form in sandy environments when moving sands create a natural dam across a freshwater stream or river and prevent tidal waters from entering depressions in the landscape.

The freshwater lakes of Fraser Island in Queensland are a good example of lakes that form in sandy environments surrounded by the sea. There are over 100 freshwater lakes on Fraser Island, many of which are vulnerable to human impacts because they cannot assimilate pollution. Aquatic organisms in these lakes are also at risk from introduced fish, aquatic weeds and cane toads. Introduced species

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can outcompete the native species and also modify food resources and habitat. Any species lost as a result of human actions may not recover because most lakes are not connected to waterways that would normally allow repopulation.

Freshwater lakes can also form on coastal plains when a meander loop of a coastal river is cut off from the main river flow. These lakes are called oxbow lakes, or billabongs in Australia. These lakes also occur outside of the coastal zone. In the coastal zone, they can persist as freshwater lakes because tidal flows do not enter the water body enabling freshwater conditions to persist. Flood events replenish freshwater in these lakes and also enable freshwater fauna, such as fish, to enter and exit the lakes in order to complete their life cycle.

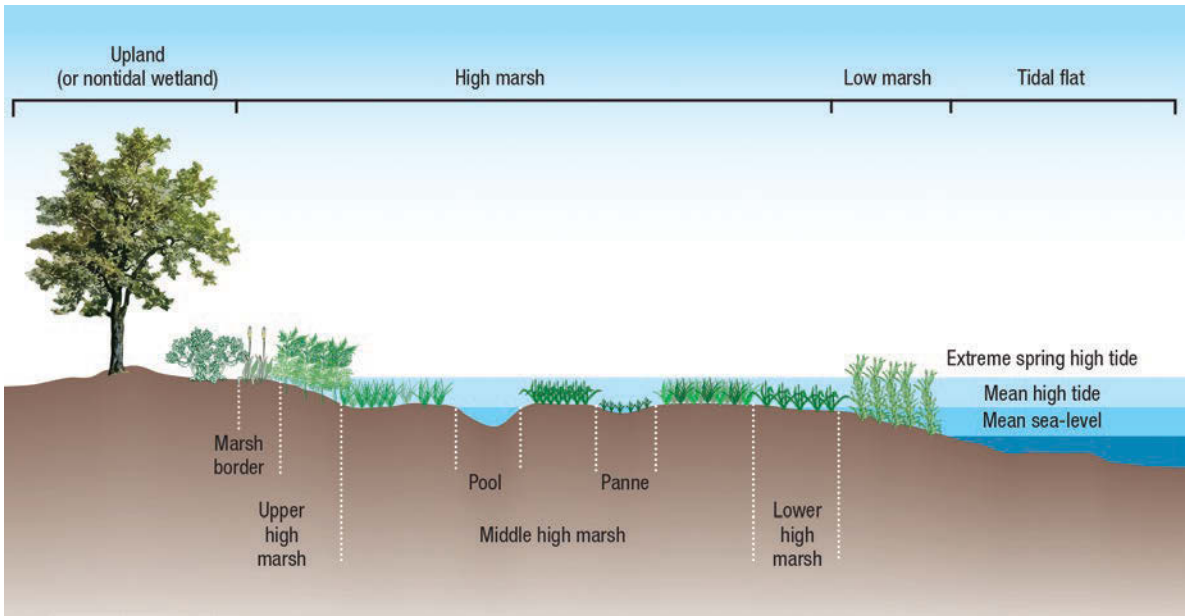
Saltmarshes

saltmarsh a coastal wetland that is flooded and drained by salt water brought in by the tides

Saltmarshes occur in estuarine areas that are protected from wave energy and strong currents. Salt marshes develop in the upper areas of the inter-tidal zone on sandy or muddy **substrates**. They are occasionally inundated by tides but for lesser periods than mangroves. Salt-tolerant, terrestrial grasses, herbs and small shrubs dominate saltmarshes. Although they are salt tolerant, these plants do not tolerate prolonged or continuous submergence by seawater. Saltmarshes were once considered a wasteland and were destroyed through land reclamation or degraded by rubbish dumping and trampling by vehicles and pedestrians. Saltmarshes are found throughout the temperate and high latitude shorelines of the world. Saltmarshes differ from adjacent terrestrial environments because of their exposure to tides. Tides deliver nutrients, sediment and water to the saltmarsh environment.

substrate surface or material on or from which an organism lives, grows, or obtains its nourishment

Saltmarshes can be divided into lower and upper marsh zones that are determined by the response of plants to the level of tidal inundation. The lower marsh, close to



Source 14c.4 Saltmarsh cross-section showing the relationship between the marsh zones and tides

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the shoreline, is a more saline environment because of the more frequent inundation by tidal waters. Plants in this zone have a high tolerance to salt and waterlogged conditions. By contrast, the upper marsh is less saline because it is submerged by irregular spring high tides. Plants in this zone are less tolerant of continuously high soil salinity and prolonged submergence but more tolerant of low nutrient conditions. Salt-tolerant shrubs may inhabit the upper marsh area and provide habitat for terrestrial fauna.

Saltmarshes help to trap and stabilise sediments and therefore contribute to the evolution of coastal landscapes. Their productivity is close to that of tropical rainforests but they are vulnerable to the effects of excessive nutrients from agriculture and urban areas. An excess of nitrogen, often sourced from fertiliser use and sewage disposal, can change the vegetation communities in saltmarshes. Saltmarshes have also been severely damaged as a result of mosquito control measures, such as the construction of canals to drain saltmarshes and reduce standing water where mosquitoes breed. Weed invasion is also a common problem. Sources of weed invasion include waterborne and airborne seed dispersal, nearby domestic sources such as parklands and gardens, and the dumping of plant materials.

Activity 14c.2

1 Where in an estuary are saltmarshes most likely to occur? Provide reasons for your answer.

2 List three reasons why estuaries are important for aquatic organisms.

RESEARCH 14c.1

Conduct a literature or internet search on Chesapeake Bay and investigate its estuary resources, human activities and environmental impacts.

1 Discuss the main environmental resources of Chesapeake Bay.

2 Analyse how humans have affected the ecosystems of Chesapeake Bay.

3 List two strategies used to manage human impacts in the bay.

Mangroves

Mangroves are shrub-like trees that are able to grow in saline soils in coastal areas. Mangroves cover approximately 137 700 km^2 of the world's coastal area. The term 'mangrove' is often used to describe the individual trees or a habitat dominated by mangroves. Habitats dominated by mangroves are also called

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Source 14c.5 Young mangrove plantation in Satun, Thailand

mangrove swamps because of the waterlogged environment in which they occur.

Most mangroves are found in tropical and sub-tropical environments, but in Australia mangroves are found as far south as the temperate Victorian coastline. There are no mangroves in Tasmania. Although they are predominantly found in the low-energy areas, they can also occur along the open coast provided they are not subjected to high-energy conditions. Australia has approximately 11 600 km^2 of mangroves, about 7% of the world's mangrove area.

Mangroves are considered environmental assets for humans and important for ecosystem functioning in the coastal zone. The benefits of mangroves include:

- Habitat for many aquatic and terrestrial species: they provide habitat structure, food resources and shelter.
- Sediment trapping capacity: over time new land is formed. Other vegetation communities, such as **littoral forests**, can replace mangroves and create a new ecosystem.

littoral forests occur within the influence of the sea, or a large coastal water body such as a lake or estuary

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- Protection of the coastline and inland environments: mangroves dissipate the energy of waves from boats and storm surge. They may also reduce the effects of tsunamis.

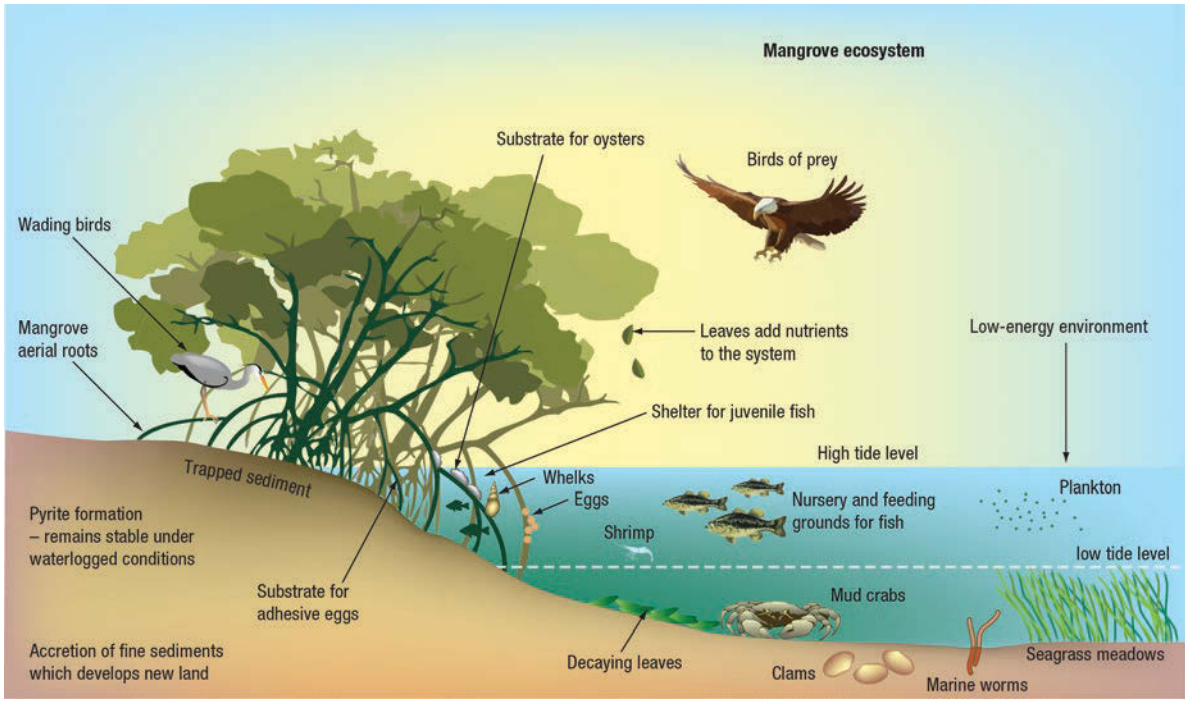
aquaculture the cultivation of aquatic animals or plants in a natural or controlled environment

Mangroves are threatened by many human activities such as **aquaculture**, charcoal production, mosquito control, use of mangroves for timber, rubbish dumping and pollution. Flood mitigation works, such as the construction of canals and installation of floodgates, can convert brackish water areas into fresh water thereby creating conditions that are not suitable for mangroves. In the 1960s and 1970s, governments around the world promoted and funded the conversion of tidal streams into flood mitigation and irrigation canals leading to extensive degradation of mangroves.

The reclamation of mangroves for dry land activities is one the most destructive human activities in estuaries because it permanently converts mangroves to urban, agricultural and industrial land uses. The pollution of mangrove sediments can lead to **bioaccumulation** of toxins in the food chain. Bioaccumulation of toxins is a major concern for humans because it has been linked to cancers and birth defects. Loss of habitat and food resources may impact marine species that depend on mangroves for spawning and nursery grounds.

bioaccumulation the accumulation of a substance, such as a toxic chemical, in the tissues of different organisms in a food chain

The construction of canal estates on mangrove swamps and saltmarshes and along tidal creeks is now banned in many Australian states and other countries. Canal estates involve the stripping of mangroves and coastal vegetation and the construction of concrete banks to form artificial water bodies. The canals provide anchorage for boats and waterfront access to urban areas.



Source 14c.6 Mangrove ecosystems provide food and habitat for a variety of aquatic and terrestrial organisms.

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Source 14c.7 Land reclamation, vegetation clearing, canal construction and housing cause irreversible changes to coastal environments such as mangroves and saltmarshes.

The destruction of mangroves affects human activities in various ways:

- increase in mosquitoes due to reduced numbers of fish that prey on mosquito larvae
- corrosion of infrastructure and building caused by acid sulfate soils and exposure to salt
- land subsidence because of changes in soil moisture and the use of landfill
- iron staining of boats and submerged infrastructure; iron leaches from acid sulfate soils and contaminates canal waters
- decline in oyster farm productivity due to poor water quality associated with urban run-off and acid and toxic metals from drained acid sulfate soils
- reduced recreational and commercial fishery catches.

Geographical fact

More than 17% of Australia's mangroves have been destroyed. Almost 40% of the world's mangroves were cleared over several decades in the late twentieth century.

Seagrass meadows

Seagrasses depend on sunlight for photosynthesis and a stable substrate to anchor their roots and extract nutrients. Seagrasses are not true grasses; they gained their name because many species resemble terrestrial grasses. Seagrasses are flowering plants that complete their life cycle under water. They can survive fully submerged in seawater because of their capacity to control the amount of salt and water they absorb through a process called **osmoregulation**. Seagrasses are an important source of food

seagrasses flowering plants that can live under water

osmoregulation a process of regulating water potential in order to keep fluid and electrolyte balance within a cell or organism

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for aquatic animals and they create habitat for bottom-feeding fish and crustaceans. Because seagrasses depend on sunlight for photosynthesis, they occur in shallow waters typically found in estuaries. They thrive in low-energy environments.

The ecosystem functions of seagrasses include:

- absorption of dissolved nutrients and conversion of the nutrients into leaf material that is used by grazers
- oxygenation of the water column which is important for gilled organisms
- dissipation of wave energy which reduces erosion
- storage of carbon; over 15% of the world's carbon is stored in seagrass meadows
- physical habitat for small fauna
- spawning and nursery grounds for fish and crustaceans.

Seagrasses are under threat from global warming and are often damaged by boat anchors, jet skis, boat propellers and changes in the wave regimes. **Dredging** is responsible for the extensive loss of seagrasses because it directly removes seagrasses and creates water that is too deep to enable seagrasses to re-establish. High water turbidities, due to forest clearing in the upper catchment and increased run-off, can also limit the depth that light can penetrate, and thus inhibit the growth of seagrasses.

dredging the use of any of various machines equipped with scooping or suction devices, used to deepen harbours and waterways and in underwater mining

Activity 14c.3

1. List three benefits of mangroves.
2. In which part of an estuary would you find seagrass meadows?
3. Which factors enable freshwater lakes and wetlands to exist adjacent to marine environments?
4. Identify one ecosystem service of seagrass meadows.

RESEARCH 14c.2

Use the internet and other information sources to investigate the Sunderbans.

1. Investigate which countries share the resources of the Sunderbans.
2. Explain why the Sunderbans' mangroves are so extensive.
3. Discuss which activities threaten the environmental integrity of the Sunderbans.

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Coastal dunes

Wind, waves and currents readily transport sand in the coastal zone. Coastal sands originate from weathered and eroded rocks in catchments, which are delivered to the marine environment by rivers and then reworked by marine processes. Sands can be transported into the marine environment many kilometres from their original source. The process can take hundreds to thousands of years. For example, sand on Fraser Island in Queensland has been sourced to catchments on the mid and north coats of NSW. The sand was transported by currents along the coast and then deposited onto Fraser Island, first by wave action on the shoreline and then by wind into the inland areas.

Many sand dunes along the coasts of the world were formed due to onshore winds entraining sand washed up on beaches by waves. Periodic, strong onshore winds entrain sands and deposit them further inland where vegetation can trap and stabilise the sand. This process of trapping, accumulating and stabilising sand is commonly known as 'dune building'.

Coastal sand dunes occur immediately behind a beach system. Dunes can be divided into zones:

1 **Incipient fore dune** – this is an embryonic dune that forms at the back of the beach due to primary plant species that stabilise sand. Incipient fore dunes do not necessarily develop into an established fore dune because they are vulnerable to the effects of strong wind and storm surge. Primary plants are tolerant of salt spray and low nutrient conditions. They include grasses and small leafy plants.
2 **Fore dune** – fore dunes develop when sufficient sand accumulates on the incipient fore dune to create a larger dune that is stabilised by secondary plant species. Secondary plant species grow taller on the landward side of the dune where there is more protection from wind. Secondary species enable the dune to **accrete** sand and increase dune height. Their leaves provide a source of nutrients for the fore dune soil. Primary species are

accrete to make larger or greater, as by increased growth

Source 14c.8 Primary vegetation on a fore dune (left) and an eroded fore dune at Curonian Spit and Curonian Lagoon, Nagliai (right). Primary vegetation plays an important role in re-establishing an eroded fore dune.

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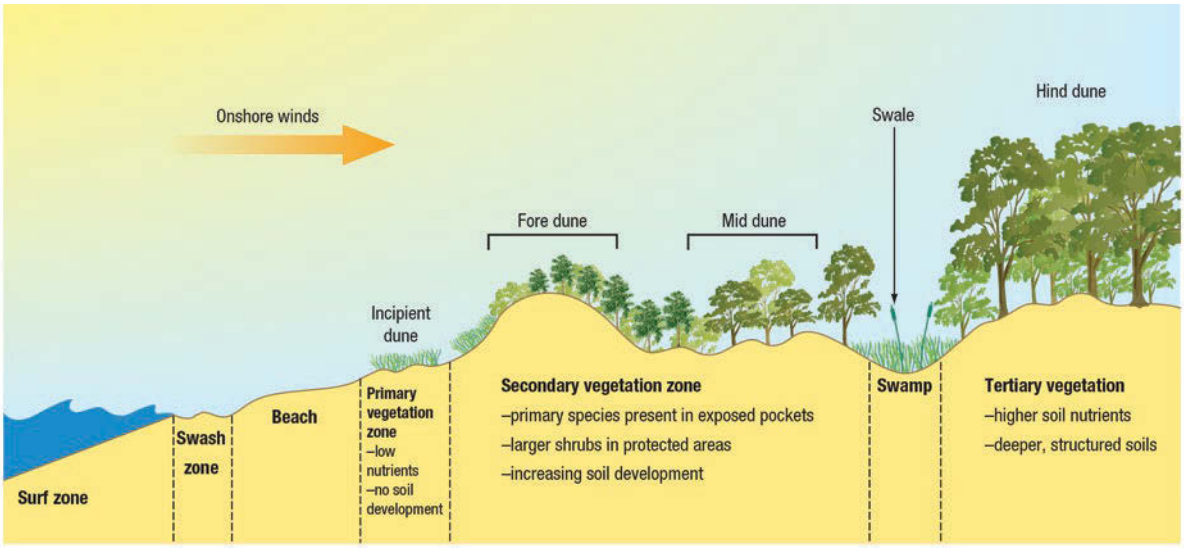
still present on the fore dune, usually at the seaward toe of the fore dune.

3 **Mid dune** – the mid dune is a transitional environment between the fore dune and hind dune. Mid dunes contain larger secondary species, often of the same species found on fore dunes. Because the fore dune protects them, shrubs grow larger. Primary plant species occur in smaller numbers, and usually on exposed areas that have not been stabilised by secondary species.

4 **Hind dune** – this zone is well protected from wind and salt spray. Hind dunes may occur immediately behind large, established fore dunes where there is sufficient protection from wind and salt spray. Hind dune soils are well developed and have sufficient depth and nutrient levels to support large trees. The hind dune is the oldest and most stable dune environment. Many hind dunes have been converted to car parks and urban areas.

Dunes are vulnerable to the effects of regular fires, 4WD activity, pedestrian traffic and weed invasion. In eastern Australia large tracts of dunes have been infested with noxious weeds such as Boneseed and Bitou bush, which were introduced from South Africa in the early 1900s. These two species outcompete native vegetation and can completely invade a dune system. They reduce the biodiversity and habitat value of dunes.



Source 14c.9 Cross-section of a typical coastal dune system. Vegetation is a major determinant of dune-building processes and the development of different zones in the dune sequence.

14c.2 The causes, extent and consequences of environmental change

In this next section of the chapter we will examine how coastal environments are undergoing environmental change. We will investigate the causes, extent and short- and long-term consequences of change to the environment by looking at a detailed case study on Australia, with reference also to other global contexts.

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Case study 14c.1
Acid sulfate soils in Australia

How do acid sulfate soils form?

Most coastal sediments in low-lying areas are, or once were, influenced by tides. The breakdown of organic material, and regular inundation of accreted sediments by saline water, creates waterlogged conditions deficient in oxygen. Bacteria, adapted to this environment, convert iron from the sediments and sulfate from seawater into a mineral called pyrite. The bacteria utilise the decomposing organic material for energy. You can only see the pyrite crystals under a powerful microscope.

Waterlogged conditions maintain pyrite in a stable state. Pyrite continues to form in present-day coastal sediments and is found close to the surface in mangroves and saltmarshes, but can be buried by alluvial sediments in coastal plains. Coastal sediments that contain pyrite are called potential acid sulfate soils or pyritic sediments.

Under natural conditions, pyrite remains stable in the absence of oxygen. When oxygen enters the soil, pyrite oxidises and releases sulfuric acid. This often happens when humans drain the soil for dry land activities such as agriculture, urbanisation or industry. The strong acidic conditions dissolve iron, aluminium and other metals present in the soil. Ground and surface waters that are in contact with the acidic soil can also become acidic. Aluminium is particularly toxic when it is dissolved and can pollute coastal water bodies. Pyrite may also be exposed to oxygen when waterlogged sediments are dredged for land reclamation or the construction of **canal estates** and aquaculture ponds.

canal estates any development that requires a constructed waterway, canal or water body that is then inundated by or drains to a natural water body

Once the sediments become acidic they are called actual acid sulfate soils. The acidity of the soil and water is represented by pH. The lower

Source 14c.10 Fish kill (left) and an acidic plume (right) discharged from a drained swamp on the Richmond River, NSW. The acidic plume is 4.5 km in length.

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the pH, the higher the acidity. Under natural conditions, coastal sediments containing pyrite have a neutral or slightly alkaline pH (between pH 7 and pH 7.5 is common). When sulfuric acid is released through the oxidation of pyrite, the pH can fall rapidly (i.e. acidity levels increase). Soil pH can fall to less than 2 but is generally around pH 3.

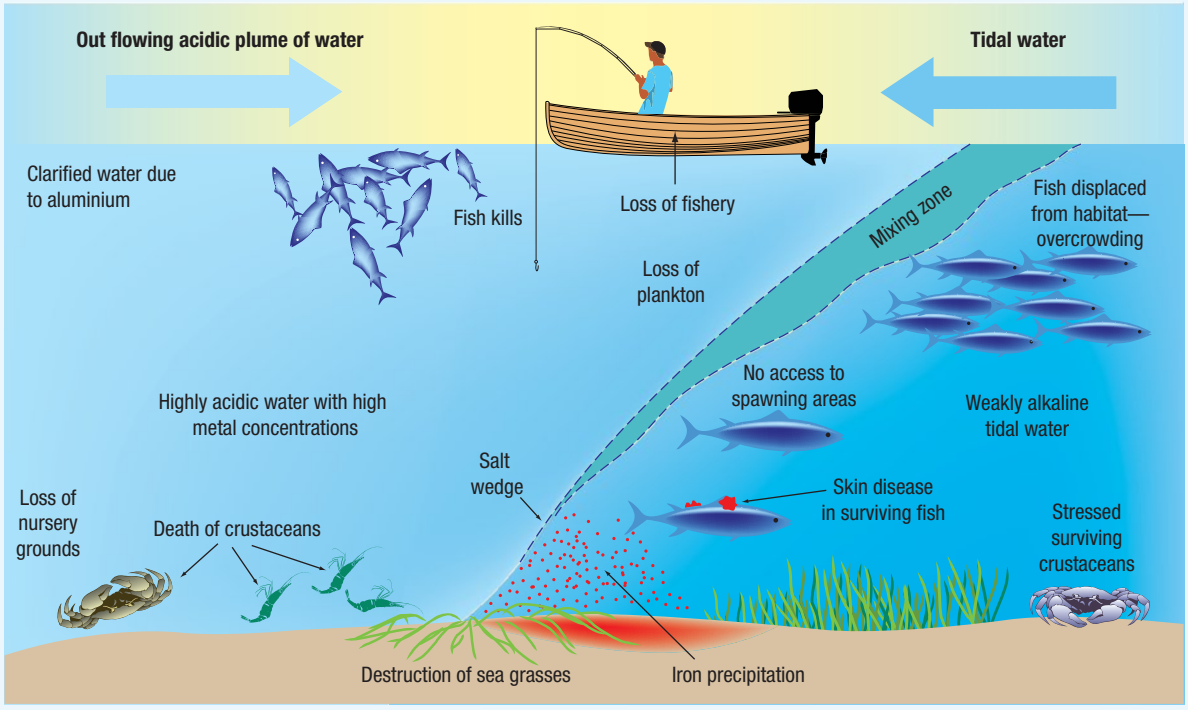
What is the extent of acid sulfate soil?

Acid sulfate soils are found throughout the coastal areas of the world where mangroves, saltmarshes and other low-energy environments are frequently inundated by saline water. Australia has approximately 80 000 km^2 of acid sulfate soils.

Why are acid sulfate soils harmful to coastal environments?

The acid and metals produced by acid sulfate soils cause on- and off-site impacts. The immediate soil and ground water environment become extremely toxic. Heavy rain can flush the acid and metals many kilometres downstream causing off-site impacts. The plumes of acid water are often green or blue because of the aluminium. Aluminium also causes clay particles to drop out of suspension; this makes the water unusually clear.

The acid in the soil and water is directly toxic to flora and fauna. Iron reduces the availability of phosphate, an important nutrient



Source 14c.11 Acidic water, originating from floodgates draining acid sulfate soils, cause significant environmental impacts in downstream reaches.

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for plankton and plants, and can precipitate and smother habitat when it enters saline water. Acidic water that enters streams and estuaries can cause fish kills by damaging the gills and skin of fish. Oysters stop feeding in acidic water, and after prolonged exposure, their shells break down and the oysters die. Saltmarshes, mangroves and seagrasses can be killed by direct, prolonged contact with acid and dissolved metals. Acidic water and aluminium can also trigger ulcerative diseases in fish. Frequent or prolonged discharges of acidic water from floodgates can degrade habitat and destroy food resources. Important spawning grounds and nursery areas can be destroyed by the toxic conditions.

Socio-economic impacts of acid sulfate soils

Commercial fishers in Australia have reported annual losses of up to 23 million dollars because of acid sulfate soils. Diseased fish caught in nets are discarded, and regular fish kills are thought to reduce catches. The tourism and oyster industries have reported significant economic losses; many oyster farms have been abandoned due to acidic waters. Coastal councils have spent millions of dollars repairing damaged infrastructure.

A major fish kill on the Tweed River in 1987 raised awareness of the severe environmental and economic impacts caused by acid sulfate soils. Over 23 km of the river became acidic and a massive fish kill followed. The sight of thousands of dead fish alarmed many stakeholders and gained national media coverage. Land drainage, flood mitigation works and farming were blamed for the extensive acidification of the river.

Commercial fishers, conservationists and farmers conducted fiery media debates in NSW and Queensland during the early to late 1990s. The issue became political and divided stakeholders over who was responsible and who should pay for the economic losses and efforts to remediate the problem. The environmental problem developed into a major environmental and social issue as a result of activism by affected stakeholders.

How are they being managed?

Although acid sulfate soils were discovered in the Netherlands over 270 years ago, they have only been widely recognised as a problem in Australia and other nations in the last 30 years. Many of the impacts of acid sulfate soils in Australia were erroneously blamed on other factors for over a century.

The Tweed River fish kill, and the resulting social conflicts and public debates, was a turning point for acid sulfate soil research and management. Scientists implemented research projects to understand where acid sulfate soils occurred, how they degraded the environment and how they could be effectively managed. Scientists, landowners and government agencies formed committees and working groups to collectively resolve the problem.

Attempts to manage acid sulfate soils have had mixed results because of the high cost of the approaches and the wide distribution of

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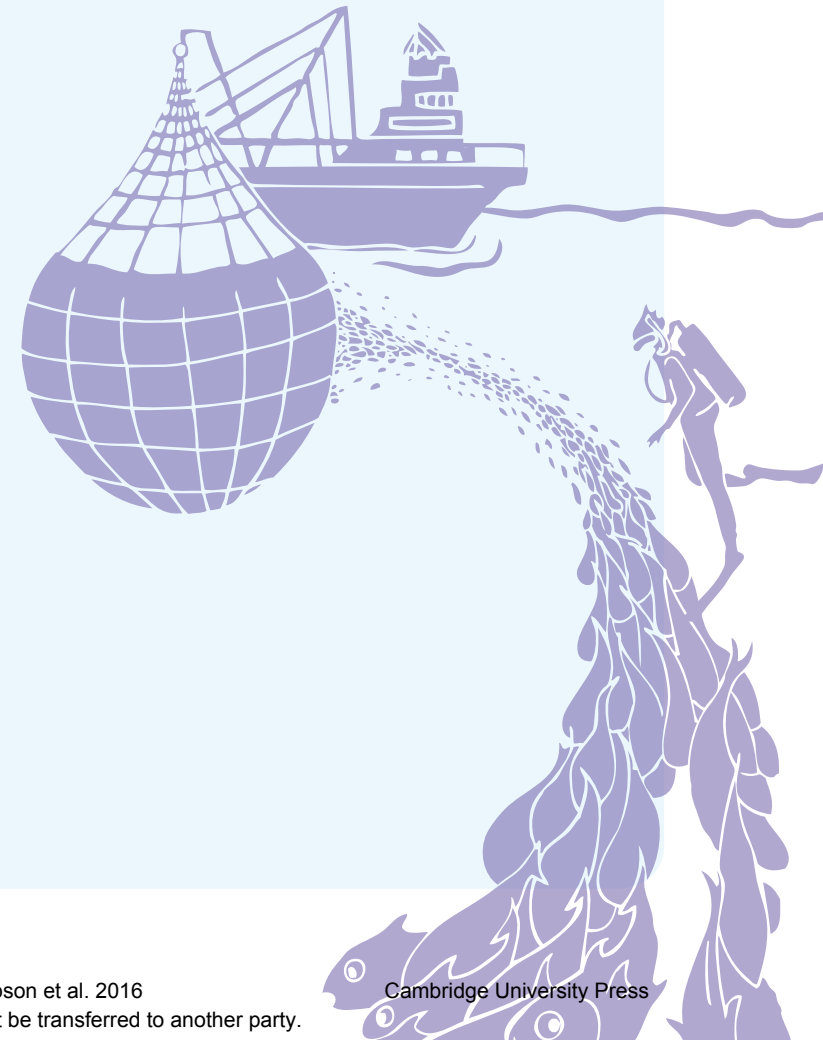
affected coastal environments. Some of the common approaches include:

- Increased liming of agricultural soil to neutralise acid.
- Use of acid-resistant concrete and cement, and plastic coated pipes.
- Removal of flood gates to enable brackish water to neutralise acid in flood mitigation canals.
- Redesign of flood mitigation canals to prevent artificially lowering watertables.
- Policies and guidelines for development to minimise disturbance of acid sulfate soils or to ensure that developments implement appropriate management plans.
- Zoning of land to prevent or control development. Acid sulfate soil maps underpin zoning decisions in NSW and Queensland.
- Educating developers and decision makers about the risks of disturbing acid sulfate soils.
- Formation of scientific and management communities to develop strategies to manage acid sulfate soils.
- Creation of granting schemes to support universities, government agencies and community groups to develop and implement remediation strategies.
- Conversion of agricultural land back to wetlands that can be inundated by saline or freshwater.

Australia has become a leader in the management of acid sulfate soils. Although social conflicts are considered undesirable, activism, led by fishers, oyster farmers and conservationists, led to government action. Many farmers who were once blamed for the problem have also worked with governments and affected stakeholders to find and fund solutions.

1. Discuss the role of bacteria in the formation of pyrite.
2. List three coastal environments that contain acid sulfate soils.
3. Analyse human activities which cause pyrite to oxidise and acidify the soil.
4. Investigate the identity of the stakeholders affected by acid sulfate soil-related impacts.



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Coastal resource management

Since the 1970s, there has been a large focus on managing the coastal zone to reduce impacts, sustain its valuable resources and protect ecosystems from irreversible damage. Coastal management is fundamentally tied to the principles of sustainable development. Coastal managers face the challenge of addressing social conflicts between multiple stakeholders, meeting social and economic needs and conserving coastal resources.

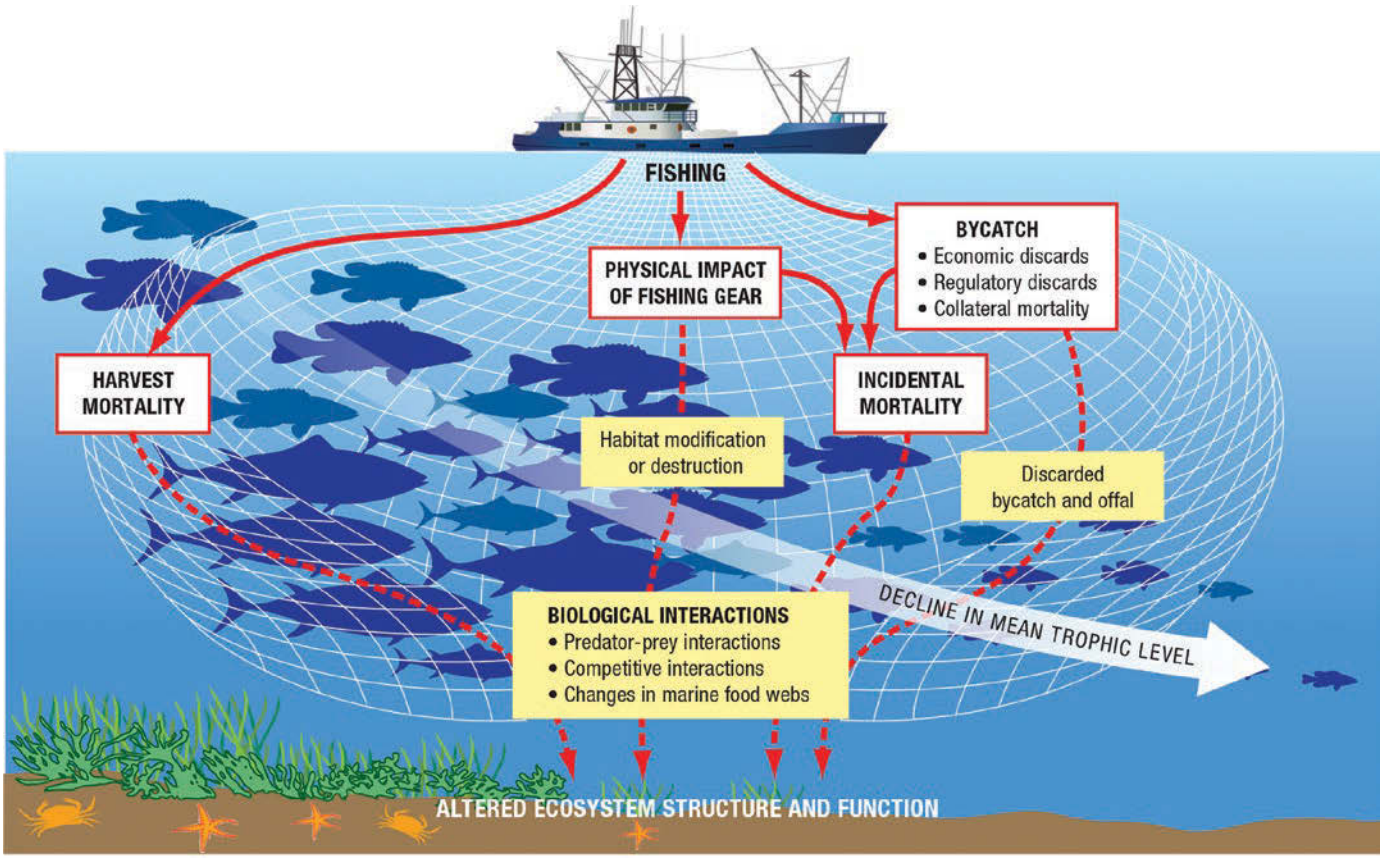
Human use of coastal resources and their threats

The following human uses of coastal resources are common throughout the world. These activities are considered important for economic prosperity, but if not properly managed, they interfere with environmental processes in the coastal zone and can cause irreversible damage or complete loss of resources:

- **Commercial fishing** – commercial fishing involves a range of practices. **Artisanal** fishers use low-intensity methods such as handheld nets, spears and fishing rods. Their level of impact is considered negligible. By contrast, commercial-scale fishers use high-intensity fishing techniques such as large set or trawled nets, long lines with multiple hooks and large arrays of fish traps. Over-exploitation of fish stocks has been associated with an increase in the size of trawlers and the improved efficiency of fishing technologies. **Trawling** also destroys

artisanal made by a skilled manual worker; using low technology

trawling a method of fishing that involves pulling a fishing net through the water behind one or more boats



Source 14c.12 Overfishing in coastal waters can deplete fish stocks and alter ecosystem structure and function.

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fish that are not targeted for human consumption; juvenile fish are also caught in nets and often crushed to death. These unwanted fish are known as by-catch or 'trash fish' because they have no or limited commercial value. Overfishing has caused declines in wild fish stocks, changes in food webs, ecosystem shifts and degradation of coastal habitats.

- **Sand and heavy mineral mining** – heavy minerals, such as rutile, zirconium and titanium, along with sand, accumulate in dunes and beaches. **Extraction** involves stripping away vegetation and removal of topsoil in dunes, in order to mine the sands. Sand mining is a controversial extractive industry because it competes with recreational uses and conservation of beaches and dunes. Sand mining has been associated with **coastal erosion**, loss of habitat and reduced biodiversity. It is now banned in many areas.

extraction stripping away vegetation and removing topsoil in dunes, in order to mine the sands

coastal erosion the gradual loss of material from a coast by the action of wind and waves

- **Shipping and ports** – shipping and port facilities often require dredging of shallow estuaries to enable large container ships to move through the water. Dredging results in higher wave energy, loss of seagrass meadows which depend on light to thrive, and changes in habitat that favour deepwater predator species. **Ballast waters** from ships have been linked to the introduction of invasive species.

ballast waters water that is pumped in and out of ballast tanks on board a vessel to increase the draft, change the trim, regulate the stability or to maintain stress loads

- **Urbanisation** – urban areas expand in proximity to major cities and ports to access services and employment and to utilise the recreational resources of the coast. Urbanisation places pressure on coastal zones through construction of housing and commercial buildings, road networks, pollution of waterways through storm water run-off, and disposal of waste.
- **Sewage treatment** – there has been a long history of disposing sewage into coastal waters. Before populations grew, the dumping of raw sewage was considered an acceptable practice because of a perception that coastal waters can assimilate organic materials. However, coastal populations have grown, and the level of treated and untreated sewage has led to pollution and **eutrophication** of coastal waters. Sewage disposal has been linked to the spread of human diseases and is a major threat to the oyster industry.

eutrophication an environmental response to high nutrient concentrations. Algal blooms and bacteria can deplete oxygen and degrade habitat.

- **Light and heavy industry** – light and heavy industries are often located in coastal areas to access port facilities. Coastal areas also have a high consumer base for consumption of products produced by industry. Oil refineries are often constructed in the coastal zone in order to access a supply of imported oil and to transport fuel to coastal communities. Industrial activities are considered a coastal hazard because of the risk of chemical pollution of surface and ground waters.
- **Agriculture** – sugar cane farming, cropping and grazing commonly occur on coastal plains where alluvium provides nutrients. Agriculture is important for sustaining human populations but presents a threat to coastal environments because of fertilisers and chemicals that can be transported into nearby ecosystems. Land drainage, commonly practised in coastal plains with high watertables, may alter

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the hydrology of the landscape and affect saltmarshes and wetlands. Land drainage, described in the next section, also triggers soil acidification by exposing acid sulfate soils to oxygen (see Case study 14c.1).

- **Land reclamation** – land reclamation involves creating new land from dredged coastal sediments. Common sources of sediments are estuaries, coastal rivers and also nearby marine areas. Examples of reclaimed lands include Port Botany in Sydney, Hong Kong International Airport and The Fenns in England. About one-fifth of the Netherlands is reclaimed land. The deepening of estuaries, through dredging, can also increase wave height and wave patterns, which also increases erosion.
- **Drainage** – dry land is also created by draining swamps and other wetlands. These environments are drained through the construction of canals and floodgates that channel run-off and groundwater into the estuary. Floodgates are installed at the end of the canal network to prevent tidal water from entering canals. Dry land created by artificial drainage is often used for grazing, sugar cane production, industry and also for housing areas. Reclaimed land is susceptible to subsidence and soil liquification caused by severe earthquakes. Drained land can also sink because of oxidation of peat soil, shrinking of clays and compaction from the overlying land use.
- **Land-based aquaculture** – fish and shrimp are often farmed in earthen ponds constructed in the coastal zone. Aquaculture depends on tidal waters to fill ponds and to export waste such as uneaten food and excrement from fish and shrimp. Chemicals, such as antibiotics, can also be discharged

Source 14c.13 Abandoned shrimp farm constructed in acid sulfate soil in southeast Sulawesi, Indonesia

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pathogen an agent that causes disease, especially a living microorganism, such as a bacterium or fungus

into nearby waterways. Fish and shrimp disease outbreaks can occur in aquaculture ponds and the **pathogens** can enter the natural environment and affect wild populations of fish and shrimp.

- **Recreation** – the coastal zone attracts activities such as swimming, boating and fishing. Boating can generate waves that erode the shoreline. Anchors can destroy seagrass meadows. Pedestrian access to beaches causes loss of dune vegetation as a result of trampling. Four-wheel driving is a popular coastal activity in sand dunes. If not properly managed, recreational activities can destroy dune vegetation and lead to erosion and reduced biodiversity.

Activity 14c.4

1 Discuss the effects of dredging.
2 Differentiate between land reclamation and land drainage.
3 Explain the ways in which agriculture can affect coastal waterways.

14c.3 The management of environmental change

Managing coastlines is a delicate operation because these areas are highly vulnerable to both natural changes and human impacts.

Coastal management strategies

Humans are faced with existing problems in the coastal zone caused by past poorly managed developments. Reactive approaches involve the design and implementation of strategies that address the existing problems. Some reactive strategies can be applied as preventative measures. For example, methods that rebuild dunes can be used to maintain relatively stable dunes that could be impacted by future storm events. Preventative measures are considered to be proactive. Environmental managers predict the effects of existing and future use, and consider natural and human-induced changes in coastal processes to develop strategies that protect coastal environments.

Controlling shoreline erosion

Shoreline erosion can involve hard and soft engineering techniques. They are used to reduce the erosive effects of waves and also trap and rebuild sediments along the shoreline. Examples of **hard engineering** techniques include:

hard engineering a controlled disruption of natural processes by using artificial structures such as concrete breakwalls

- construction of rock or wooden groynes perpendicular to the shoreline to trap sediments and prevent loss of sediments through longshore currents
- construction of rock walls along shorelines at risk of erosion. Rock walls dissipate energy and prevent the loss of sediments, but they can also deflect energy onto other, unprotected shorelines.

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Source 14c.14 Wooden groynes in the surf on the German Baltic coast

soft engineering the use of ecological principles and practices to reduce erosion and achieve the stabilisation and safety of shorelines, while enhancing the habitat, improving aesthetics and saving money by using vegetation and other materials

Soft engineering techniques avoid the use of physical structures and depend more on ecological principles or changes in human activities. Examples of soft engineering techniques include:

- replanting mangroves along eroded shorelines
- nourishing beaches with imported sand
- relocating urban and industrial areas further inland and allowing the shoreline to naturally readjust to local processes
- restricting access to the shoreline to minimise further disturbance.

Dune management

There are over 2000 Coastcare and Dunecare groups in Australia who work with government agencies and businesses to rehabilitate degraded coastal environment. Dune rehabilitation is a targeted activity of these groups. Dunecare and Coastcare groups undertake activities such as weeding dunes, installing fencing, revegetating bare dunes and improving the quality of coastal habitats. These volunteer groups are funded by various environmental granting schemes and by the support of businesses.

Already degraded dunes are often rehabilitated by:

- use of wind drift fences to trap and accrete sand
- planting primary species to recolonise exposed sand
- reshaping dunes with earth-moving equipment
- import of sand to replace eroded sand
- temporary surfaces that prevent erosion and enable plants to re-establish; these may involve the use of organic sprays that coat the surface sands.

Measures that prevent further dune degradation include:

- use of fences to restrict access to dunes
- use of wind drift fences to protect sensitive areas and create a more robust dune
- signs that educate and warn people about their effects
- use of boardwalks to prevent trampling of vegetation

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- regular weed management to prevent invasion of dunes by exotic species.

Water quality management

Water quality management begins at the source of pollution. Water quality studies are regularly undertaken by managing authorities to test for the type and potential source of pollution. Most countries have developed licensing schemes to control the level and type of pollutants that can be discharged into waterways. Improving water circulation by temporarily opening estuary entrances is sometimes used to flush a build-up of nutrients and pollutants in intermittently closed estuaries.

Zoning and planning controls

Land and water is now routinely zoned to control the types of human activities that can be undertaken. Areas that are vulnerable to human activities, or are considered to be historically or environmentally significant, can be zoned as conservation areas, reserves or national/marine parks. Fishing exclusion zones are declared, to minimise fishing pressure on stocks. Planning controls can be embedded into legislation or policies. Planning controls are intended to limit human activities so that the environment's carrying capacity is not exceeded and to ensure that there is fair access to resources for present and future generations.

Zoning and planning controls rely on scientific knowledge of processes and the potential for humans to modify processes. Maps are used to zone land and water according to its suitability for human activities. Site selection criteria for specific land and water uses facilitate decisions on where to undertake developments that won't harm coastal environments. In Australia, many coastal industries follow strict guidelines and site selection criteria when embarking on new developments. Environmental impact statements and other forms of environmental reporting are used by government agencies to guide decisions on approving developments in the coastal zone.

Integrated Coastal Zone Management

Integrated Coastal Zone Management (ICZM) is an approach to coastal zone management that fosters intergovernmental cooperation, the involvement of other stakeholders, and a recognition of the co-dependence of economic growth, social needs and protection of environmental assets. Australia has adopted ICZM as a framework for coastal management in recognition of the national significance of protecting coastal resources. The main aim of ICZM in Australia is to 'maintain, restore or improve the quality of coastal zone ecosystems and the societies they support', according to the Natural Resource Management Ministerial Council, *National Cooperative Approach to Integrated Coastal Zone Management – Framework and Integration Plan,* 2006. The Framework for a National Cooperative Approach to ICZM was introduced in 2003 in an effort to facilitate coastal management at all levels of government and to include various **coastal stakeholders**. The main priority areas of the framework are:

Integrated Coastal Zone Management (ICZM) an approach to coastal zone management that fosters intergovernmental cooperation, the involvement of other stakeholders, and recognition of the co-dependence of economic growth, social needs and protection of environmental assets

coastal stakeholders individuals, organisations, community groups or government agencies that have an interest in, or are affected by, use of coastal resources

- integration across the catchment–coast–ocean continuum

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- land and marine-based sources of pollution
- climate change
- pest plants and animals
- planning for population change
- capacity building.

ICZM utilises advisory groups and stakeholder inputs to develop management plans that can achieve sustainability goals. ICZM also employs adaptive management approaches because coastal environments are dynamic, human needs change and new issues emerge. Adaptive management enables managers and scientists to build an understanding of human impacts on the coastal environment and revise management strategies accordingly.

Geographical fact

Australia is the 6th largest country. It is the only country in the top six that is completely surrounded by marine waters.

RESEARCH 14c.3

Use the internet to collect information on the 'sea change' phenomenon in Australia. Form groups of two to three students and discuss the following:

- Describe the sea change phenomenon.
- List the social and economic factors driving the sea change phenomenon in Australia.
- Discuss some of the negative and positive impacts of sea change on rural, coastal areas.
- Will the sea change phenomenon continue? Explain your answer.

Source 14c.15 Hind dunes are often developed for housing, car parks and recreational areas

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Note this down 14c.1

Copy and complete the graphic organiser below to demonstrate your understanding of coastal environments, their ecosystem functions and the effects of human activities.

Ecosystem functions		
Coastal environment	**Ecosystem functions**	**Effects of human activities**
Mangroves are found in the tidal zone, particularly along the shoreline of estuaries	Mangroves are important because they: – provide habitat – trap and stabilise sand – protect the shoreline from erosion	Mangroves can be degraded by: – clearing – conversion to aquaculture ponds – pollution
Seagrass meadows		
Saltmarshes		
Coastal dunes		

Fieldwork 14c.1 Assessing human threats to coastal dunes

Coastal dunes are often located within the vicinity of beaches and parklands used for recreation. The impacts of humans on dunes can be prevented or reduced through a variety of soil conservation measures that involve controlling access and the influence of nearby land use. You will identify reactive measures to rehabilitate dunes and preventative measures that minimise future impacts.

Aim

The aims of the fieldwork are to:

1. investigate human impacts on a dune system
2. describe the effectiveness of existing strategies for dune management
3. make recommendations to improve dune management.

Method

This activity involves using desktop skills such as map reading and interpreting satellite imagery. The field component requires observational and recording skills. The final output is a poster or information booklet and applies skills in written and visual communication.

Preparations

Locate a map and a satellite image of a dune system nominated by your teacher. A 1:25 000 topographic map of the area is also a useful tool. Satellite imagery can be sourced from websites. Print the map and satellite image at the same scale. On either the map or satellite imagery, label the following features using coloured pens and highlighters:

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1 Location of walking tracks and areas from which you can observe the dunes without damaging the dune vegetation. Label at least five stops, which may include the beach, fore dune, mid dune and hind dune.

2 The boundary of the fore dune, mid dune and any hind dune. Use vegetation and any available topographic information to determine the boundaries.

3 Exposed bedrock, headlands, the beach and any other landforms.

4 Human features such car parks, fencing, boardwalks and parkland.

You can add more labels during the field trip.

Data collection

Stop no.	Location description	Vegetation type	Evidence of human impacts	Evidence of management
1	Fore dune – approximately 0.5 metres high and 3 metres wide. Coarse sand with no topsoil.	Sparse cover of stunted shrubs.	Trampling of vegetation; litter.	Previous attempts to control pedestrian access with fences; signs noting that it is a revegetation area; sand drift fences to trap sand.

1 Take photos of the vegetation and any evidence of human impacts and management strategies.

2 Describe the vegetation community in terms of the type of plants (e.g. grasses), their height and density (e.g. sparse). You may use common terms.

3 Describe evidence of human impacts. Evidence may include: trampled vegetation, the effects of fire, the presence of litter, garden plants and weeds, unmanaged tracks and vehicle tracks. Note the extent of the human activities. How have these activities affected the environment?

4 Create a cross-section of the dune system using distance and height. Sketch the dune shape and the form of the vegetation onto the cross-section. Label each zone (e.g. beach, fore dune, mid dune and hind dune) and any key natural or human features (e.g. swales, wetland, car park, reserves).

5 Observe the changes in vegetation from the fore dune to the hind dune. What are the changes in height of the plants? What are the changes in the density of the vegetation? Is there any evidence of the effect of wind and salt?

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6 Describe past attempts to manage the dunes. Look for measures such as constructed walkways, fencing, signposting and revegetation. Have they been effective? If not, explain why. Suggest ways they dunes could be better managed.

Poster layout

Create a poster or information booklet that summarises what you observed. Use the following suggested section titles and content.

Section heading	Content
Title	Brief descriptive title
Introduction	Provide a brief background and include a location map showing stops
Dune features	Insert your transect into this section. Use brief text to describe the key features of the transect.
Human impacts	List the main human impacts. Use photos to illustrate the impacts.
Management strategies	List management strategies that would improve the dune system. Relate the strategies to key components of the dune system. Use photos or sketches to demonstrate at least one method of management.

Source 14c.16 Does this fence look like it has been an effective protective measure for the coastal dune?

Chapter summary

- The coastal zone is defined as the area where terrestrial and marine processes interact.
- More than 3 billion people live in the coastal zone and depend on coastal environments for economic prosperity.
- The coastal zone is under threat from human activities. Impacts include the loss of habitat, coastal erosion, pollution of sediments and water, and loss of biodiversity.
- Mangroves, seagrass meadows, saltmarshes, freshwater wetlands and lakes, and dune systems provide habitat. They are economically and environmentally important components of the coastal zone.
- Estuaries are low-energy environments that contain many significant coastal ecosystems. They attract populations because of their abundant resources.
- Integrated coastal management brings stakeholders together to manage the coastal zone through a holistic approach.

End-of-chapter questions

Short answer

1 Explain the differences between 'hard' and 'soft' engineering used to control coastal erosion. Give examples of each.

2 Describe one major coastal management issue in Australia and what is being done to tackle it.

3 Discuss the recreational, economic and environmental benefits of healthy mangroves.

4 Outline the roles of the community, government and industry in coastal management.

Extended response

Discuss the challenges of applying Integrated Coastal Zone Management in Australia. Your answer should cover the following:

- A definition of Integrated Coastal Zone Management and its objectives
- Current and emerging population pressure
- Key human activities that impact the coastal zone
- Addressing competing needs; these can be a mix of social, economic and environmental needs associated with sustainability goals
- Collaboration between stakeholders.

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Additional resources

14d Investigative study – Urban environments

Source 14d.1 Aerial view of Tokyo, the world's largest city

Before you start

Main focus

The 'urban environment' refers to everything around us that is human-made. Humans have always changed the landscape that they live in, and this change has sometimes caused pollution, disease, extinction of plant or animal species and other environmental damage. In this chapter we will investigate some of the types and extent of change caused by urban environments and consider management strategies that can be used for prevention or response.

Why it's relevant to us

To minimise the impact that we have on our surroundings and the environment, we need to study the changes that occur in urban environments. Only by understanding how human behaviour and increases in population affect our environment can we develop strategies for managing land space, resources and pollution, strategies that will improve the world we live in.

Inquiry questions

- How have humans affected the degradation of urban environments?
- How can urban environments be better managed to reduce pollution and the affects of pollution?

Key terms

- Air pollution
- Biomimetics
- Conservation
- Heritage
- Management
- New urbanism
- Urban environment

Let's begin

Throughout history, humans have developed unique and extraordinary urban environments. However, the management, restoration and preservation of cultural and historic sites have at times been controversial issues. Modern approaches to the development of urban environments are being implemented around the world, using new technologies to reduce pollution and its effects and implementing new urban development philosophies to improve quality of life.

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14d.1 Biophysical processes of urban environments

In this first section of the chapter we will consider some of the biophysical processes operating in urban environments to maintain their functioning.

urban environment the human-made areas that allow human activities to take place

The **urban environment** is defined as the human-made areas that allow human activities to take place. The scale of the urban environment varies from houses and buildings to large cities such as Tokyo, which has around 30 million people. The urban environment also consists of human-made green spaces such as parks and gardens, which are integrated into the structure of towns and cities. Infrastructure such as roads, railways, water, waste and electricity services are also part of the urban environment because they provide the fundamental services that allow towns and cities to function.

To gain a greater understanding of the changes that occur in the urban environment, the focus of this chapter will be on efforts to manage pollution in densely populated cities, the use of environmental design to make buildings more efficient and sustainable, and to understand the importance of the **conservation** of culturally and historically significant sites. The concluding section focuses on a modern development called 'new urbanism' (see later in this chapter) and how this has been applied to locations in Australia and the United States.

conservation the protection of plants and animals, natural areas, and interesting and important structures and buildings, especially from the damaging effects of human activity

14d.2 The causes, extent and consequences of environmental change

In this next section of the chapter we will examine how urban environments are undergoing environmental change. We will investigate the causes, extent and short- and long-term consequences of change to the environment by looking at a range of Australian and global contexts.

Environmental change: Smog

What is **smog**? How can it be managed?

smog a mixture of smoke and fog that has come to mean human-made pollution that can be seen in the atmosphere

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Case study 14d.1
What caused the Great Smog, London 1952?

'Pea soup' thick smog was a common occurrence in 1950s London, but on 5 December 1952 conditions became so bad that 4000 people were left dead, animals at the Smithfield Show dropped dead and there were reports of cows choking to death in the fields. Visibility was so bad that people reported not being able to see their feet. Buses and taxis were unable to operate.

Sulfur dioxide was identified as the main pollutant, caused by much higher than usual coal burning as London residents fought off the winter cold. The government estimated the number of deaths caused by the smog were between 3412 and 4075. Respiratory diseases accounted for 59% of the increase in deaths in the week ending 13 December and 76% in the week ending 20 December.

According to meteorologist Peter Cockroft:

> Winter arrived early in 1952 and very cold snowy weather in November continued into December.
>
> Londoners tried to keep warm by burning lots of coal on their home fires. This extra domestic smoke added to that belched out by power stations and factory chimneys.
>
> As an area of high pressure arrived over the capital, the skies cleared and the wind fell light. On 5 December fog started to form.
>
> In a 'high' the air is pushing down – exerting a higher pressure. So, anything in the lowest part of the atmosphere becomes trapped; in this case the noxious combination of smoke and fog – smog.
>
> Because the winds remained light there was nothing to blow it away.
>
> Thousands of tonnes of soot and carbon dioxide were pumped into London's air, made worse by some of the fog droplets turning into harmful acids.
>
> Little wonder then, at the time, Londoners described 'gasping for air'.
>
> Source: Peter Cockroft, Meteorologist, BBC London online

Source 14d.2 London smog 1952

The UK government responded with the *Clean Air Act* of 1956, which introduced measures to try to cut **air pollution**. The main target of the legislation was to reduce the dirtiest

air pollution when the air contains gases, dust, fumes or odours in harmful amounts

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pollutants. Factory furnaces were prohibited from emitting 'dark smoke' and grants were offered to householders who converted their coal-burning fireplaces to smokeless fuel.

Public opinion was that the Clean Air legislation of the 1950s had resulted in a major improvement in public health. But according to the Department of Environment, Food and Rural Affairs (DEFRA), of the 29 000 deaths that still occur each year in the UK related to air pollution, around 4000 are in London. New pollutants such as nitrogen dioxide from vehicle exhaust fumes are causing the mortality rate to stay high.

The UK is failing to meet European Union (EU) air quality standards and London has one of the highest levels of nitrogen dioxide of the Union's capital cities, reaching three times the legal limit on busy roads. ClientEarth, an environmental organisation, says 16 UK regions and cities will have air pollution at levels above the legal limits until at least 2020, and London will not comply with air quality regulations until 2025 at the earliest.

Dr Frank Kelly of London University's King's College said that the *Clean Air Act* had had an impact on pollution but that new laws were needed now to deal with new problems. Car ownership has dramatically increased and exhaust fumes from traffic have caused a new kind of pollution that needs new legislation. He said that the Congestion Charge legislation of 2003 and the Low Emission Zone (LEZ) legislation of 2008 had made just a tiny difference to air quality in the city.

Air quality is a key factor in a variety of health issues, such as heart disease, strokes and diabetes. Politicians across the world are realising that only action to clean up the air will make a difference to health issues.

In the first 4 months of 2012, air pollution in London had exceeded EU daily limits more

Environmental change: Air pollution

Air pollution is a significant global issue. The atmosphere is considered a 'global common', so it is in every person's interest to improve air quality to ensure the future sustainability of ecosystems and societies alike.

China

Coal and other fossil fuels are burned in power plants across China. While the power generated is used to fuel China's economic boom, the plants emit pollutants such as ozone and particulates that mix with sunlight and form smog. Some of the ozone produced in this smog rises high into the atmosphere and joins the flowing air stream to spread across nations and continents.

Ozone forms when oxides and nitrogen react with sunlight in the atmosphere. In the upper levels of the atmosphere it absorbs UV rays, preventing the rays from reaching the earth's surface. However, at lower levels, ozone is a pollutant

ozone gas formed when oxides and nitrogen react with sunlight. In the upper atmosphere it absorbs UV rays, preventing them from reaching the earth. At lower levels, ozone is a pollutant caused by vehicle and industrial emissions, the main component of smog.

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than 35 times. EU air quality laws state that daily pollution levels must not be above the legal limit on more than 35 days in a calendar year.

DEFRA has said that the aim is to keep improving air quality and reduce the impact it can have on human health and the environment. Much of the UK already meets EU standards and air quality is generally good. However, there are limited areas, including London, where air pollution remains an issue.

Management of air quality in London			
Legislation	**Clean Air Act**	**Congestion Charge**	**Low Emission Zone**
Date	**1956**	**2003**	**2008**
Description	Factories banned from emitting 'dark smoke'. Grants to householders who convert from coal to smoke-free fuel	A fee charged on motor vehicles during peak times on weekdays, aimed at reducing traffic in the centre of the city and raising investment funding for public transport	A scheme to charge commuters if their cars emit higher than the allowed level of pollution. The scheme gets stricter over time to encourage commuters to switch to cleaner forms of transport

1 What causes smog?

2 Discuss a range of causes of smog.

3 Evaluate the success of air pollution management strategies.

Source 14d.3
Severe air pollution on 12 January 2013 in Beijing, China. Air quality index levels were classed as 'Beyond Index' (PM 2.5 of over 700 micrograms per cubic metre).

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Source 14d.4 Smog over Sydney

caused by vehicle and industrial emissions and is the main component of ground level smog.

Air pollution and dust from central China rises a kilometre or more and joins an air current heading east towards Beijing. Some of the pollutants may drop in rain over the city, but additional pollution from the city itself rises to join the noxious cloud. This pollution continues to rise higher into the atmosphere into faster moving air currents, taking the pollution east over Korea where it picks up more pollutants from industry and other sources there.

The pollution stream then heads north across Japan and joins the strong air currents of the Pacific Ocean. After passing over Hawaii the stream continues over California and the western United States. Along the way, some particles and gases will drop to the ground, having an impact on air quality in western North America, while the remainder of the pollution heads inland, resulting in 'Asian dust events' in Arizona and Colorado.

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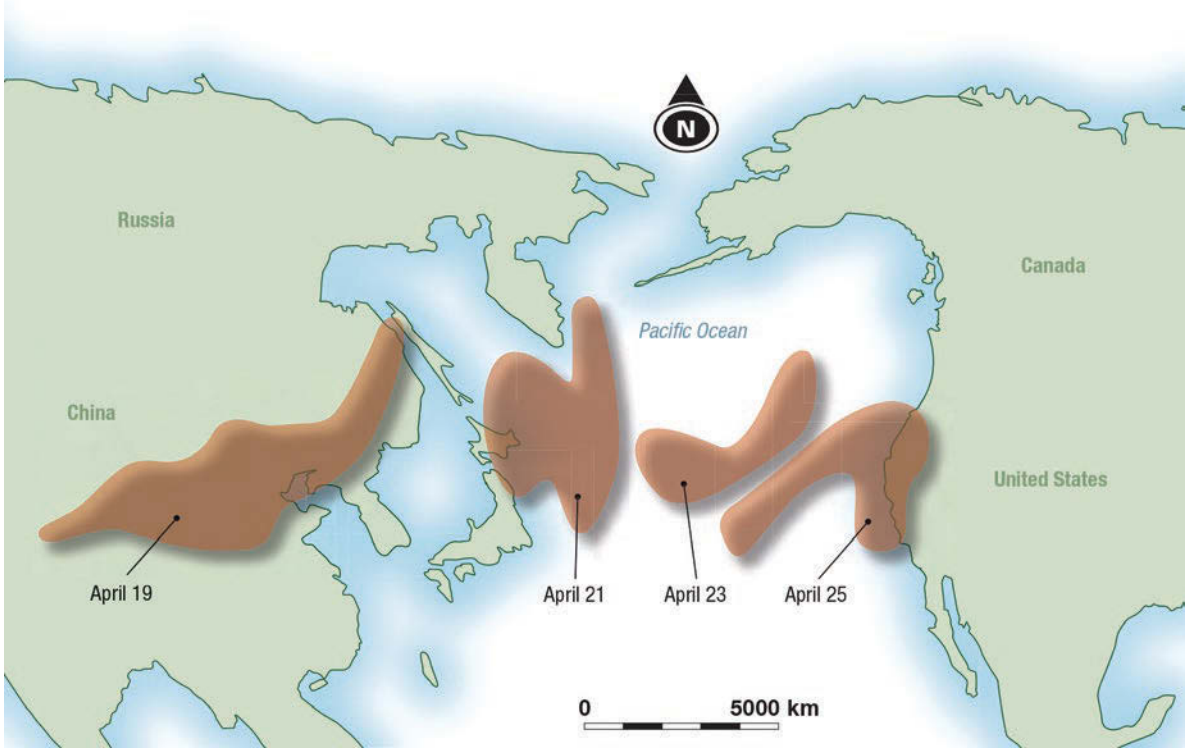

Source 14d.5 Pollution travels the air stream from China to the USA.

Global air pollution

In the USA, the National Oceanic and Atmospheric Administration's (NOAA) Earth System Research Laboratory's (ESRL) Global Monitoring Division is part of efforts to monitor and measure global air pollutants. Agencies such as the ESRL have been collecting data for decades. There is evidence showing that the mixture of pollutants such as ozone, particulates and mercury flows in a continual stream high up in the Earth's atmosphere. One country's industrial emissions become another country's air as the mixture crosses the borders of nations and demonstrates the ineffectiveness of country-specific air quality laws.

Air pollution from Asia is not a new problem. While California breathes the pollution from China, Europe lives with air polluted by North America, a phenomenon that has been going on for decades. Any pollution rising into the atmosphere from China, the USA or anywhere in the world will travel around the world in a matter of weeks.

According to the NOAA, the amount of ozone crossing the Pacific Ocean to North America may soon exceed levels permitted by US law. One of NOAA's network of observatories sits on Trinidad Head in California, a remote site that sticks out into the Pacific Ocean. The remote site was chosen as it is far from centres of population, making it ideal for measuring cross-border air pollution streaming across the ocean. These observatories collect jars of air that are studied and stored; and at night particles are measured in the air using lasers.

In 2011, the first of four missions by unmanned planes to investigate high-altitude air pollution was launched from California. One of the remaining three will be launched from Australia. With the aim of understanding

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more about the global consequences of burning fossil fuels, these windowless aircraft carry scientific equipment to measure ozone, greenhouse gases and other pollutants. This equipment is so accurate that it can identify where pollutants come from, sometimes even the actual factory of origin. The study found that although the USA itself contributes to the global ozone pollution problem, rising air pollution recorded over the western USA is not locally originated.

Management options

Since the 1970s, the USA, Canada and Europe have agreed to work together on the issue of air pollution and have agreed on some standards. However, as we have seen, air pollution in one country is often increased because of activities in another part of the world. Asian countries have not yet agreed to standards – there is no global agreement. Air quality experts say local emissions from cars and power plants are still more harmful to human health than travelling air pollution.

Efforts are being made to globalise existing international air pollution agreements. The aim is to get climate and air quality scientists from around the globe to collaborate on a full understanding of how pollution migrates, and inspire forward-thinking air pollution regulations in China and other countries.

The main effort comes from a group chaired by the USA and the EU called the Task Force on Hemispheric Transport of Air Pollution. This task force operates under a convention dating from 1979 called the Long-Range Transboundary Air Pollution (LRTAP) Convention. LRTAP covers the USA, Canada, Europe and central Asia. The agreement addresses sulfur oxides, nitrogen oxides, ammonia, heavy metals and other pollutants and is considered the most important air pollution treaty so far. Asian countries have shown interest in developing LRTAP into a global agreement and negotiations so far have involved more than 750 scientists from 38 nations, but agreement is still a distant hope.

In China, monitoring by government and private organisations has improved. Beijing's smog has been so bad at times it has forced flight cancellations, leading to pressure for change from citizen groups angry over air quality in major cities. Just as the people of London had to stop burning coal in the 1950s, the people of Beijing are switching from coal to natural gas for their heating needs.

While local laws are still the most effective way to reduce air pollution that travels across borders, officials are working on improving collaboration between scientists from around the globe.

Australia

Australian scientists are predicting climate change will cause the number of hospitalisations in Sydney to increase threefold and deaths of elderly people due to heat stress will double by 2060. At the Greenhouse 2009 conference, scientists presented evidence that suggests yearly heat-related deaths in Sydney will rise from about 150 to 200 to between 300 and 400, even without allowing for an ageing population that will see the number of over 65s increase. Climate change is likely to increase the number of days per year where temperatures are in excess of 30°C from 24 to 30 days in the city and from 40 to up to 50 days in western Sydney.

Rising temperatures increase fire risk and air pollution. Pollutants from motor vehicles or bushfires react and make ozone, the main component of smog. Human health issues such as asthma, emphysema and bronchitis are set off by high levels of smog.

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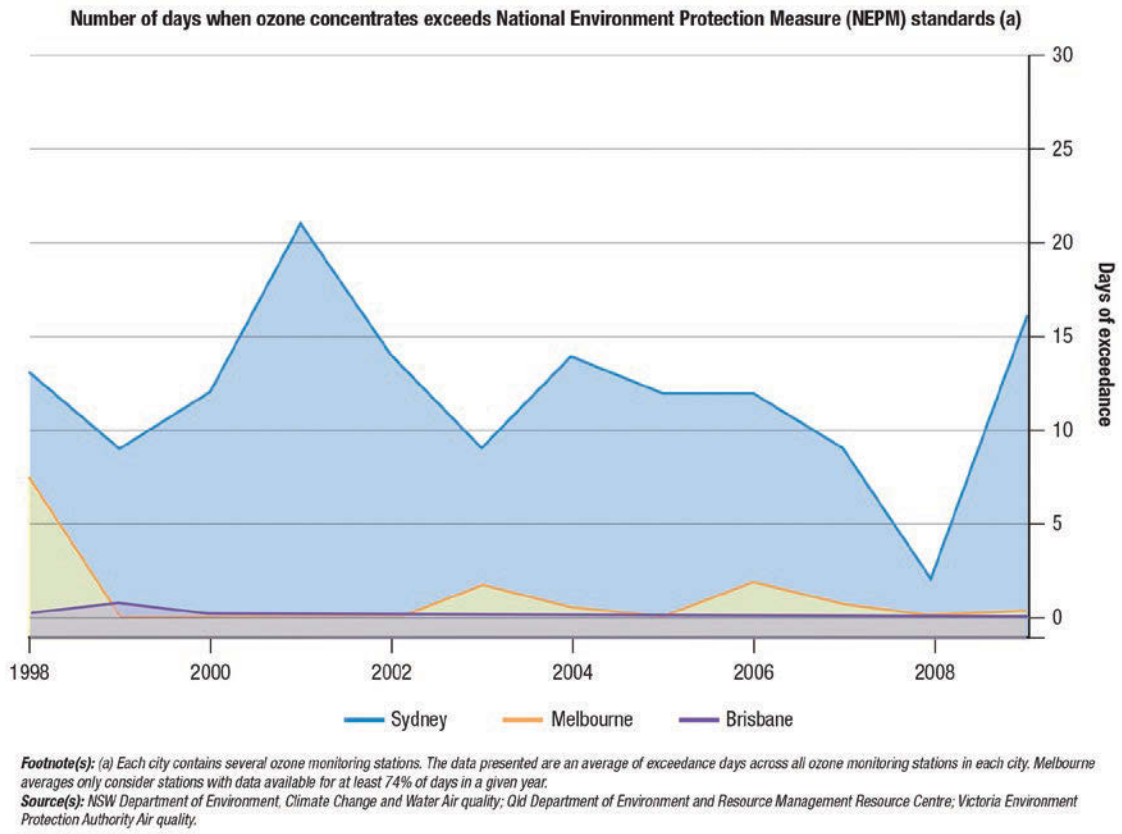

Source 14d.6 Air quality in Australian cities

Around 250 people a year visit hospitals in Sydney suffering from the effects of photochemical smog caused mainly by vehicle emissions. This number will likely treble to 750 a year. Compounding this, increased temperatures caused by climate change would cause an expansion of air pollution in the atmosphere.

The New South Wales Department of Climate Change is planning for an increase in health problems and is looking into ways to control increases in pollution.

14d.3 The management of environmental change

In the interests of sustainability, designing buildings with minimal environmental impact is crucial. The vast majority of organisations and workplaces have changed their processes and practices to become more sustainable.

Environmental design: Sydney Opera House

The Sydney Opera House is one of the world's most iconic buildings – a busy centre for the performing arts, a major tourist attraction and internationally recognised for the originality of its architectural design. Jorn Utzon designed the building after winning a competition established by the NSW Government in the late 1950s. His design was deemed unique and the construction of the building was challenging and at times controversial. An indication of the complexity of its design and construction is that the Sydney Opera House was not officially opened by Queen Elizabeth II until 20 October 1973. In 2007, the Sydney Opera House was awarded World Heritage listing.

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Sustainable management of the Sydney Opera House

As with all major structures, the impact on the surrounding environment of the Sydney Opera House is important to consider.

In February 2012, the management of the Sydney Opera House released an 'Environmental Sustainability Policy' to counter any ecological damage that the Opera House may cause within its environment. In this policy, the Sydney Opera expresses a commitment to sustainable management of the site in the following four areas:

1 conserving natural resources
2 minimising waste and pollution
3 reducing greenhouse gas emissions
4 enhancing the natural environment.

Three objectives, encompassing a variety of measures geared towards ecological sustainability, have been set.

The first objective aims to reduce energy use by moving the Sydney Opera House towards a low-carbon future. It aims to achieve this by:

- reducing electricity consumption by 15% by implementing energy efficiency upgrades to the building
- exploring possible carbon offset programs.

The second objective aims to embed environmental sustainability in everything that the Sydney Opera House does including:

- reducing or recycling 70% of the Opera House precinct's paper through the implementation of a waste reduction and recycling plan

Source 14d.7 Sydney Opera House and its unique design

- reducing drinking water by 15% by implementing a water-saving action plan.

The final objective positions the Sydney Opera House in the role of engaging and inspiring others in the area of ecological sustainability. It aims to do this by:

- engaging staff by creating a culture of environmental awareness through leadership and strategic direction
- collaborating with external commercial partners to achieve these ecological goals.

RESEARCH 14d.1

Go to the Opera House project website. Read through the site to gain a greater understanding of the development of this unique Australian building. Investigate the issues that were caused throughout the construction of the Opera House. Can you suggest alternative solutions?

Environmental design: Living buildings

Deep in the ocean there lives a glowing sea sponge called the Venus Flower Basket. This animal forms a lattice-like exoskeleton from shiny silicon-based material that gives it both a strong structure and efficiently filters water and nutrients. In London, Lord Norman Foster's 200-metre-high glass tower, finished in 2004, affectionately known locally as 'The Gherkin', was inspired by this strange sea creature. The building's spiral lattice naturally directs the air flow from ground level upward, funnelling it through its offices and reducing the need for energy needed to run air conditioning.

The world's population is 7 billion and increasing. The pollution produced by the manufacture of materials needed to make and sustain our urban environment rises with population. The way we build and maintain

Source 14d.8 The Venus Flower Basket

Source 14d.9 The 'Gherkin'

our cities is undergoing a necessary and radical change. Experts at the United Nations Intergovernmental Panel on Climate Change claim that this change is humankind's best chance of reducing greenhouse gases.

Architects, scientists and designers are investigating the natural world – even to microscopic levels – to look for ways to mimic biological systems that have already evolved solutions to similar problems. The '**biomimetic**' architecture movement has brought synthetic biologists, botanists and other scientists together with builders, manufacturers and artists to learn how to create structures that work with nature, instead of against it. In nature, an organism cannot expend more energy than it produces and so evolves over billions of years to be as efficient as possible.

biomimetics the study of the structure and function of biological systems to create models for the design and engineering of materials and buildings

Innovations have already given us new revolutionary concepts for heating and cooling, one of the highest energy-consuming systems in buildings. By studying how animals cool themselves, such as by absorbing water in hot, dry and resource-scarce environments, we have already made advances in sustainable design. For example, why add solar panels to a building to run the cooling system if there is a way to use natural design to cool the building without the need for electricity?

Learning from termites

In Zimbabwe, architect Mick Pearce studied the way that termites construct their earthen towers. The mounds are constructed in a way that captures desert breeze and channels it into subterranean chambers where the moist earth is cooler. Warm air is expelled through a flue in the top of the mound while cooler air is drawn up through the mound. Without this design, termites would not survive the desert heat. Pearce used the termite's concept in his design of the huge retail and office building called the Eastgate Centre in Harare.

In the Eastgate Centre, fans take the cooler night air into chambers under the office floors. In the daytime when temperatures are higher, the air is circulated through the structure, allowing the offices to be cooled at 10% of the cost of conventional air-conditioned buildings.

Source 14d.10 Eastgate Centre, Harare, Zimbabwe

Source 14d.11 Termite mounds

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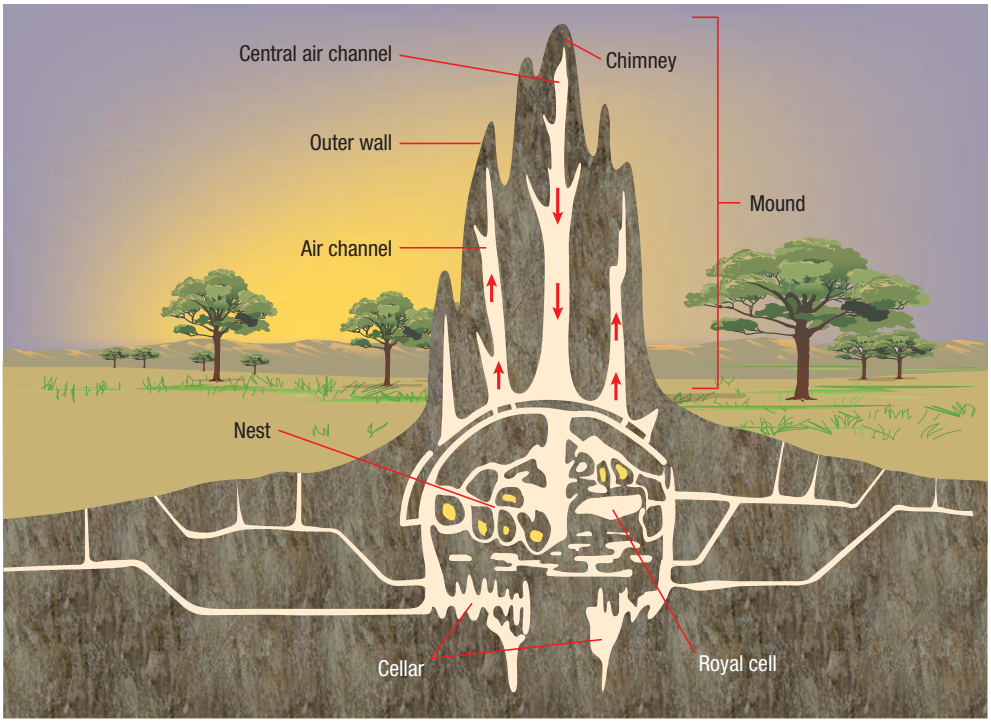
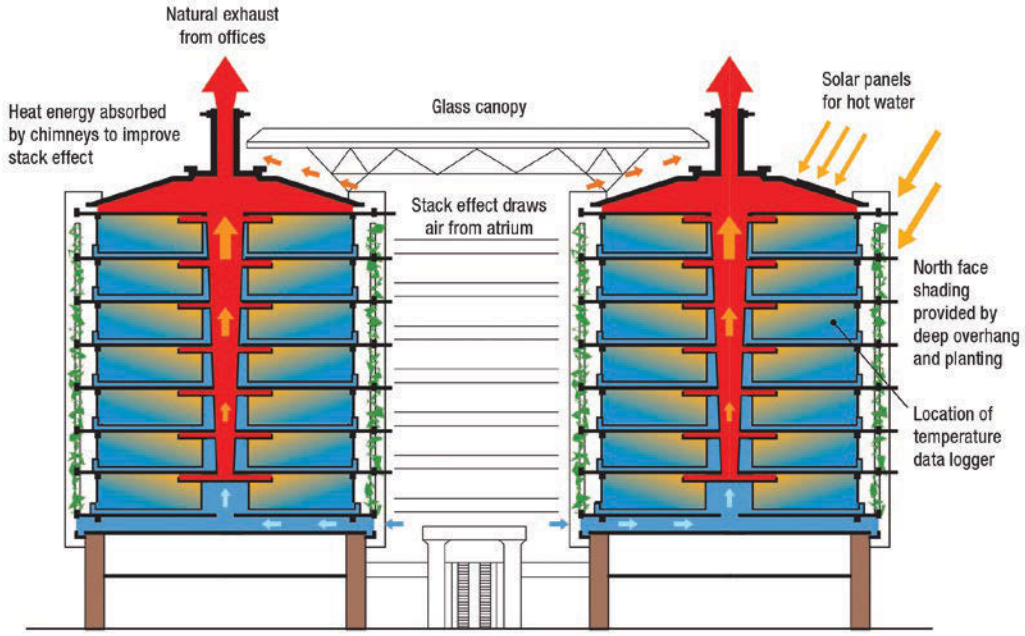
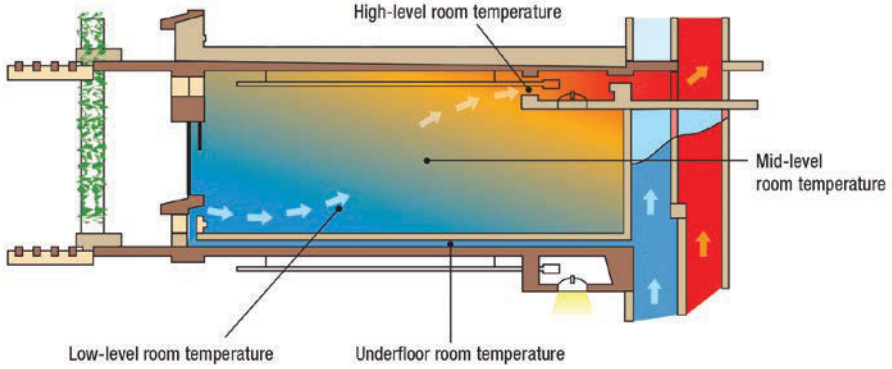


Source 14d.12
Diagram of termite mounds





Source 14d.13
Diagram of Eastgate Centre

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Forest in the city

Italian architect Renzo Piano collaborated with San Francisco botanists to create a 'living roof' at the California Academy of Sciences. Instead of a traditional hard roof, 1.7 million plants, including many native plants and a field of California poppies, form the canopy.

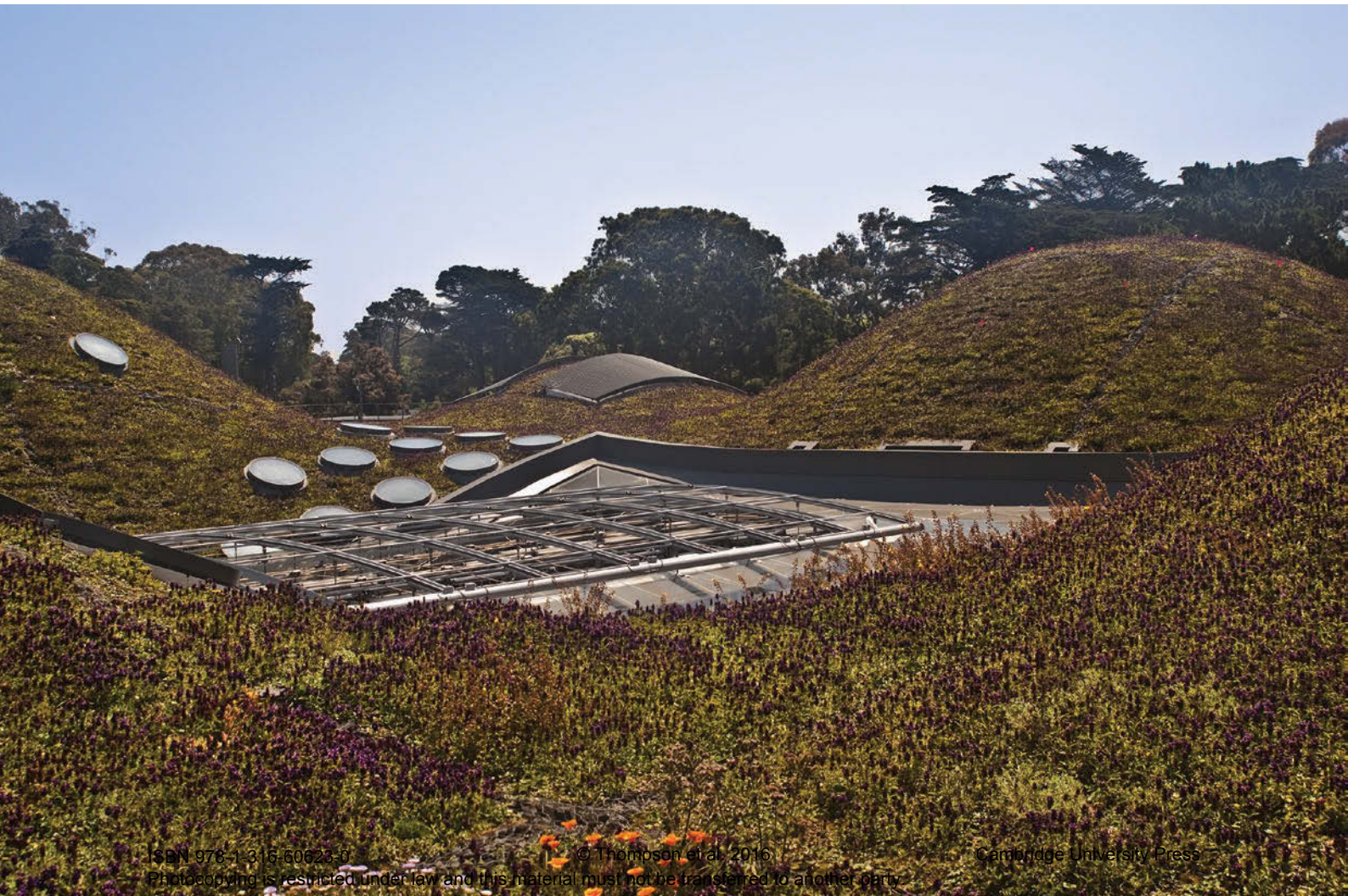
Although roof gardens are not new, Piano's roof is constructed with seven vegetation covered 'hills' that channel the cool Pacific Ocean breeze into grates. A computer takes data from weather monitoring instruments on the roof, causing vents to open and close to control the flow of natural cool air through the building underneath.

Green roofs still require considerable energy to maintain, so architects and synthetic biologists are collaborating to design wall coverings that could be used to absorb greenhouse gases from the air.

Buildings are still made of materials that are difficult to recycle, and often end up as waste. Huge amounts of energy are used in dismantling and disposing of old buildings, let alone the energy and pollution caused by building new ones. Architects and scientists are investigating resins as replacements for plastics.

In order to accommodate the world's ever-expanding population in ways that are more sustainable, designers and botanists are searching for practical ways to blur the line between human-made construction and nature. This could be called the 'reforesting of cities', where rooftops and industrial sites are repurposed and give a positive contribution to the urban environment.

Source 14d.14 The living roof at the California Academy of Sciences



Living buildings

Research suggests that soon the designs of Foster, Pearce and Piano will seem old and quaint. Scientists are working on actual living materials for use in architecture. Some examples are:

- Bioluminescent bacteria to provide lighting without needing electricity. These bacteria could also be grown in decorative patterns on walls or used as warning indicators when certain pollutants are present.
- Bio-paint to absorb carbon from air pollution and at the same time provide insulation.
- Synthetic biological materials that respond to the environment by growing, repairing or replicating.

As populations of cities increase causing issues of pollution to worsen, architects and scientists are working at breakneck speed to rethink how the urban environment interacts with the natural world. Using technological advances inspired by the biological processes of nature, dreams are becoming a reality.

Activity 14d.1

1 Why is it necessary to change the way we design buildings and our urban environment?

2 How has nature inspired efficiency in new buildings?

3 Discuss further innovations that are likely to come and why they are significant for the future of humanity.

RESEARCH 14d.2

In New York, designers and architects worked with planting designers to repurpose an unused, elevated railbed called the 'High Line'. Research the New York High Line on the internet and discover what they did and why.

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Case study 14d.2
The heritage of Kolkata

Kolkata has a rich legacy of architecture from its days as the first British capital of India. However, as late as 1984, there was still no movement to preserve this heritage. By then it was already too late to save some of its landmark urban environment – including the Senate Hall of Calcutta University, the most ornamental portion of the Bengal Club, Darbhanga Palace, the original office of the All India radio at Garstin Place and Dalhousie Institute.

Since there was no official or private organisation for conservation in Kolkata at that time, public protests were not strong enough to prevent the demolition of these significant structures. In 1984, a Kolkata chapter of the Indian National Trust for Art and Cultural Heritage (INTACH) was established and awareness began to rise. However, efforts to protect the architectural **heritage** of the city were still difficult until the Kolkata Municipal Corporation legislated in 1997.

heritage features belonging to the culture of a particular society, such as traditions, languages, or buildings that were created in the past and still have historical importance

The 1997 legislation separated the heritage buildings of the city into three categories according to level of importance. There are 611 buildings regarded as Grade 1 – the highest priority for preservation. Buildings are chosen as Grade 1 either because of how early they were constructed or because of the significant events or personalities associated with it. The law states that no changes can be rendered to the facades of these Grade 1 buildings.

Conservationists like GM Kapur of INTACH believe that although awareness has risen, conservation is still not a priority, especially in the case of family-owned properties, due to legal issues and lack of funds. For state-owned premises it is often bureaucracy which causes heritage buildings to fall into a state of irreparable damage.

Owners of Grade 1 buildings need to be educated about the difference between restoration and simple repair. In a large number of cases involving private owners, buildings were not restored using compatible materials used in the original construction. In these cases the repairs actually make the damage worse.

A massive restoration project is underway at St James Church (Jora Girja). The steeple and spires of the church are extremely high, making it difficult to reach them using scaffolding. This unique project is being done by labourers

New urbanism

new urbanism an urban design movement, which promotes walkable neighborhoods that contain a range of housing and job types

New urbanism is a city planning movement that promotes a hybrid of traditional town planning and contemporary infrastructure to meet the needs of the modern community. This town planning strategy uses a pedestrian-orientated approach and focuses on elements such as sustainability and convenience.

Towns and suburbs built according to a new urbanism planning strategy focus on a community approach, ensuring residential,

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Source 14d.15 Currency Building at Dalhousie Square, Kolkata

sourced from Murshidabad, who are experts in lime work. These labourers are key as there has been widespread use of concrete in heritage buildings, which causes irreparable damage.

Similarly, the landmark Currency Building at Dalhousie Square has been restored under the guidance of the Archaeological Survey of India (ASI).The building had stood abandoned for decades, leaving vandals to destroy cast-iron railings, wooden doors and coloured glass murals.

1 List the factors that make a site culturally or historically significant.

2 Explain why some efforts to preserve the architectural heritage of Kolkata have failed.

retail and employment sectors are in close proximity, thus cutting down on motor vehicle and traffic congestion.

Cities have expanded outwards to accommodate population growth. Residential areas develop further and further away from main central business districts, forcing people to commute long distances in cars or on public transport. New urbanism counteracts the repercussions of this growth by developing smaller communities with all the necessary amenities that a town or a suburb needs in close proximity, to maintain a sustainable environment.

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The key principles of new urbanism include:

1 Walkability

- Residential and business sectors are in close proximity to each other.
- Streets are designed specifically to promote pedestrian-oriented living with enforcement of slow speeds for traffic and easy access to buildings and on-street parking.
- Pedestrian-only streets are incorporated into the design.

2 Connectivity

- A street grid network plan is created that allows every street to be accessible on foot and provides multiple alternate routes to alleviate traffic congestion.
- A system of street hierarchy is designed which includes streets, boulevards and alleyways.
- Accessible walkway and pathway networks encourage walking.

3 Mixed-use and diversity

- Residential and business sites are combined and mixed within blocks and buildings.
- Socially and ethnically diverse areas are created, accommodating all types of families and individuals.

4 Mixed housing

- Different types of housing are created in close proximity, ranging in sizes and prices.

5 Quality architecture and urban design

- Surroundings are aesthetically pleasing.
- There is easy access to public amenities within the community.
- The emphasis is on design for efficient use of space rather than grandeur.

6 Traditional neighborhood structure

- There is a distinct centre and edge.
- There is a city centre for the public.
- Attractive open planned public spaces are included.
- Amenities are in close proximity to each other, within a 10-minute walk.
- A higher density centre is created, which reduces towards the edge of the town.

7 Increased density

- A large number of residences, businesses and buildings are close together to promote convenience and travel on foot.
- The design can be applied for all sorts of urban environments, from small towns to large cities.

8 Green transportation

- A quality public transport network conveniently connects all areas.
- Accessible walkways and bike paths promote use of bicycles and other forms of green transport.

9 Sustainability

- Eco-friendly town planning means ensuring minimal impact on the environment.
- Eco-friendly infrastructure is created with technologies using natural systems.
- There is an energy-efficient town structure.
- Use of sustainable energy and less finite fuel is encouraged or mandated.
- There is a focus on local production of goods and services.
- There is a focus on pedestrian living rather than reliance on motor vehicles.

10 Quality of life

- The focus is on having a high quality of life using all the amenities the town has to offer.

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RESEARCH 14d.3

1. Using the 10 new urbanism principles, evaluate the suburb, town or city that you live in. How many principles does your local area achieve?
2. If you were a town planner, would you change any aspects of your local area? Justify your reasons.

Source 14d.16 A range of architect-designed houses close together is a feature of new urbanism.

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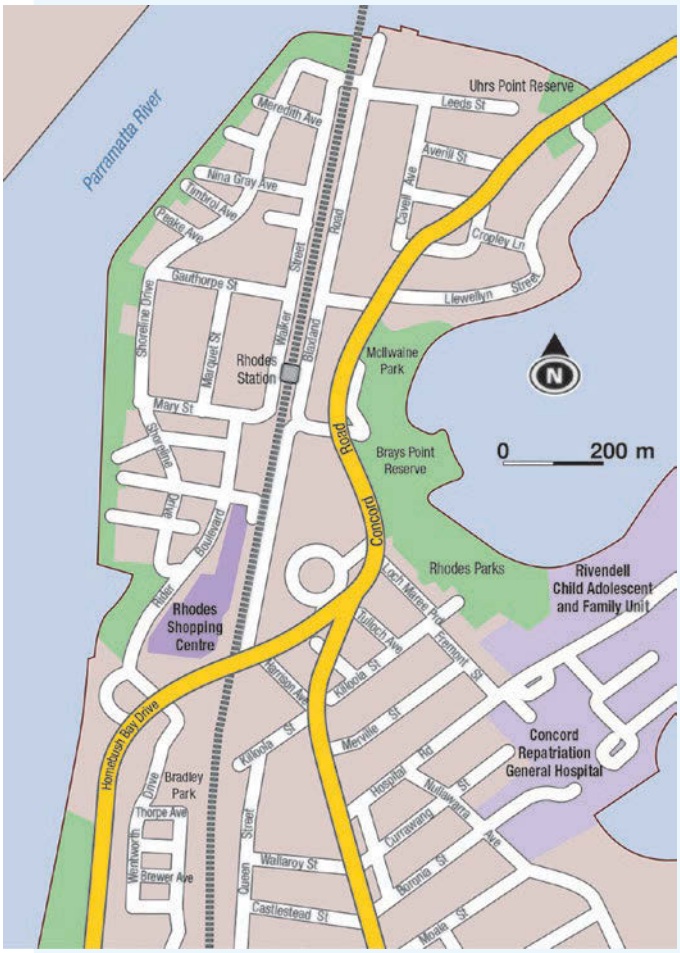
Case study 14d.3
Rhodes, NSW, Australia

Rhodes is a suburb located in the inner west of Sydney around 16 km from the central business district of Sydney. Rhodes is a peninsula that has Brays Bay to the east, Homebush Bay to the west and the Parramatta River flowing along its northern tip. According to the 2011 census, Rhodes has a current population of 5679 people, an increase from 1668 people in 2006. Once urban development is complete it is expected that Rhodes will have a population of 11 000 people.



Source 14d.17 Layout of the suburb of Rhodes

Rhodes has undergone a major urban regeneration and renewal program. The western part of the peninsula was an industrial area with a range of heavy industries causing major environmental damage to the soil and waterways. Companies such as Union Carbide, who manufactured banned pesticides and the defoliant Agent Orange used during the Vietnam War, polluted the soil and waterways with dioxins from the manufacture of these chemicals.

In 2002 the NSW Government approved a $90 million large-scale remediation program undertaken to remove dioxins from the soil. Once the remediation program was complete the sites were sold to be developed into an urban area of medium- and high-density apartments.

Rhodes development

The Rhodes Redevelopment Project was a multi-billion dollar infrastructure and development project designed around a major retail centre and public domain, office developments and residential units; integrated with major highway improvements (Homebush Drive) and the railway line and station upgrades. Similarly, increasing the density of development within the vicinity of the railway station was desirable from a public policy perspective to meet the needs of the state government's Population Policy.

The Rhodes development was set up using the principle of new urbanism; all the stakeholders (Canada Bay Council, the State Government and developers) believed that the best use of this site was to develop a suburb that utilised the existing infrastructure

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Source 14d.18
Remediation of the former Union Carbide Australia Limited herbicide and pesticide plant at Rhodes, New South Wales

(railway), mixed-use (integrating residential, retail and commercial together), was more sustainable (encouraging greener transport options such as rail, walking and bicycle) and had higher urban densities (medium- to high-density residential apartments). Therefore, a development plan was established that segmented the development into stages. The first stage was the development of the Rhodes Waterside Shopping Centre, a commercial tower adjoining the shopping centre and one residential complex. This stage was completed in December 2004.

In the following years another commercial complex was built and around 13 more unit complexes have been built that have greatly increased the permanent residential population within the area. Retail shops have developed outside of the shopping centre with a number of cafes, restaurants, gyms and convenience stores being established to cater for the increased number of residents in the area.

Another major design feature of the Rhodes development which fits into the new urbanism principle is the development of a foreshore cycle way around the western edge of the peninsula. This cycleway links up with the cycleway to the adjoining Bicentennial Park and Sydney Olympic Park. This allows people to walk or cycle to the Olympic site and the multiple events hosted there. It also allows residents to cycle to other parts of Sydney including to other centres of employment, thus deceasing the number of cars on the roads.

The greening of the suburb is another indicator of new urbanism. Green spaces and parks provide valuable recreational areas for residents especially needed to balance the medium- to high-density housing in the area. The establishment of a high proportion of trees and shrubs along the streets lessens the impact of the urban environment and creates a more natural landscape for residents and visitors to the area.

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Case study 14d.4
Seaside, Florida, USA

Seaside is located on the northwest coast of Florida, in Walton County. It is an 80-acre community development that is promoted as the first development in America of the new urbanism style. It has become well known for its unique architectural styling of the housing in the community. Seaside became internationally recognised because it was the main location used during the filming of the movie *The Truman Show* (1998).

In the late 1970s, Robert and Daryl Davis planned to create a unique residential community with the 80-acre site they had inherited. They toured the southern United States looking at the architectural features that give small towns their distinct character. In collaboration with Miami architects Andres Duany and Elizabeth Plater-Zyberk, the elements of small-town design were used to create Seaside, a sensibly laid-out town that would have all of the necessities and pleasures of daily existence within walking distance of one's residence.

Created in 1981 the development is built on a 'neighborhood' scale and is designed to foster a sense of community. The streets are all interconnected, creating a network that eliminates 'collector' routes and reduces

Source 14d.19 Seaside's location within the northwest of Florida

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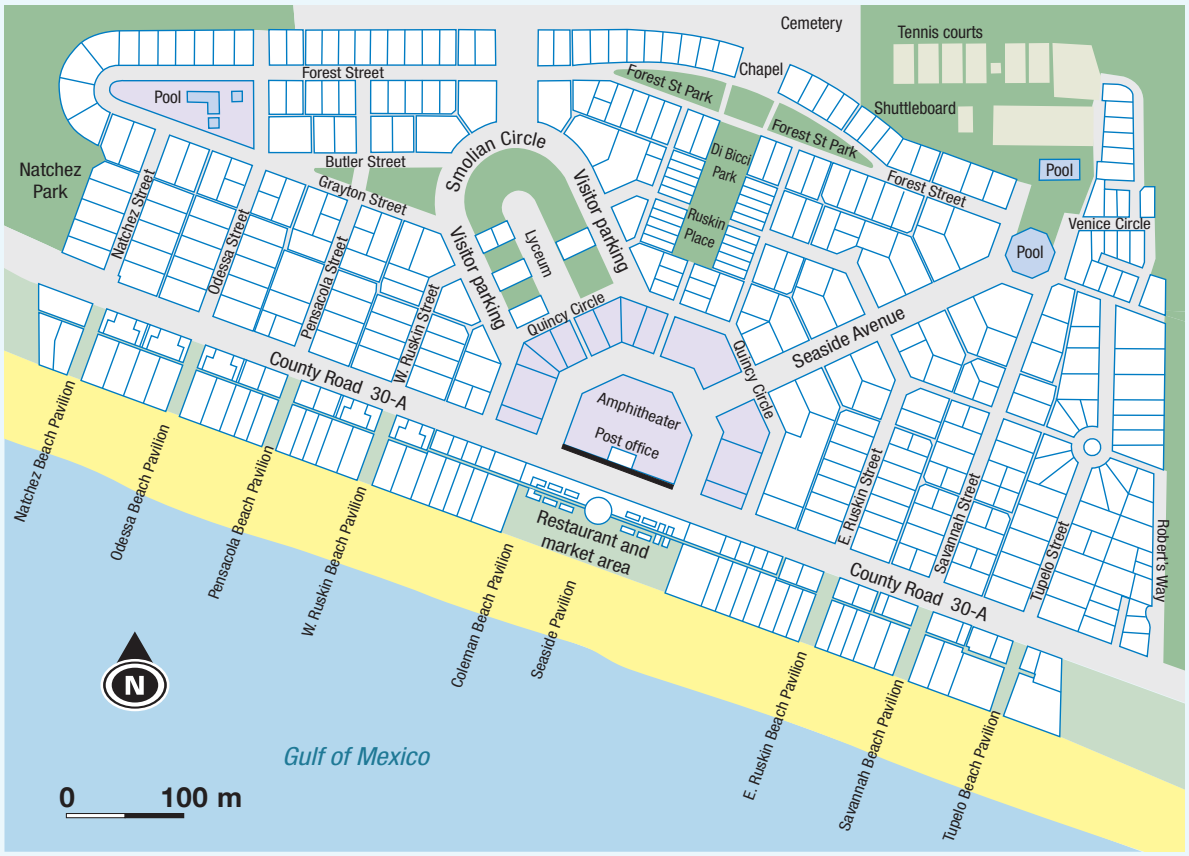
Source 14d.20 Entrance sign to Seaside, Florida

congestion. Walkways crisscross the development to encourage walking and cycling, while narrow streets serve to reduce traffic speed. By keeping the number of parking lots in the community to a minimum, parallel street parking is encouraged, providing pedestrians with a buffer between them and the traffic. Building fronts are a uniform distance from the curb and all streets are tree-lined.

The most important features of this development are the ones that promote interaction among community residents. Mandatory porches are set close enough



Source 14d.21 This map illustrates the layout and design of Seaside. You can see the central square is the focal point with all roads leading to the central point.

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to walkways to enable porch sitters and passersby to communicate without raising their voices. The community has a discernible centre, creating a common gathering place, and essential services such as shops, schools and post offices are located within a 5-minute walk of each home.

Community zoning provides for a mix of residential structures, ensuring that the community can provide homes to everyone, including young and old, rich and poor. Seaside contains 350 houses and 300 other dwellings, including apartments and hotels. The town's population of 2000 compares in size to a typical American small town or city neighborhood from the 1920s or 1930s, as does its mixture of uses.

Features of Seaside

- The Seaside plan was designed to optimise waterfront access and views for all of the town's residents, not just those with beachfront sites.
- The community's porch-lined streets and walkways all lead to the beach or town centre.
- Seaside's design places an emphasis on the town's public spaces, which range from its main square to the pedestrian-only footpaths at the centres of blocks.
- Considerable architectural variety exists at Seaside.
- A network of sand walkways cuts through the middles of blocks, enabling one to walk comfortably to the beach in bare feet.
- The majority of the buildings on the beach are public.
- Fences must be of a different style to all the others on the block.
- Front porches are set back about 5 metres behind the fences.
- The streets offer pedestrians the feeling of being in a public room. Keeping the streets narrow and having buildings with uniform fronts achieve this.

1 Explain what the common features are of the design of Rhodes and Seaside.

2 Discuss the benefits to people of living in a town or city designed this way.

3 Justify the benefits of new urbanism for the environment.

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Chapter summary

- The urban environment is defined as the human-made areas that allow human activities to take place.
- The management of air quality is a major global concern as pollution travels across borders.
- Environmental design is making buildings more energy efficient by mimicking nature.
- Sydney Opera House has implemented an Environmental Sustainability Policy to counter the effects the site has on the local environment.
- Architects are working with scientists to discover ways to use biotechnology to make the urban environment more efficient.
- Efforts to preserve historically significant buildings in Kolkata have sometimes failed or made structures worse by poor repairs.
- New urbanism is a movement in city planning that tries to recommit traditional town planning designs to a modern context.

End-of-chapter questions

Short answer

1 Describe two ways that architects are making buildings more energy efficient.

2 Explain the difference between new urbanism and traditional urban planning.

3 Give reasons why Rhodes would be classified as a new urbanism development.

4 Would you like to live in the Seaside development in Florida? Explain your reasons.

Extended response

What constitutes an urban environment for cultural or historical purposes and how should planners balance the need for modern sustainable architecture with the preservation of heritage? In your answer refer to:

- sustainable design
- new urbanism
- spiritual sites of cultural or historical significance.

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Topic 4

Human wellbeing

Source 15.1 Human wellbeing is a geographical concept. Pictured is a young girl from Raisen district, Madhya Pradesh, India.

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15 Human wellbeing and development

Source 15.2 Human wellbeing is a multifaceted concept.

Before you start

Main focus

To explore the multifaceted nature of human wellbeing and development – how they relate to each other, how they are measured, and to consider trends in human wellbeing and development over time.

Why it's relevant to us

The level of human wellbeing is crucial to the effective functioning of society. Standards of living, health and education are top priorities for all governments. Society always seeks to improve people's level of wellbeing.

Inquiry questions

- What is human wellbeing and development?
- What are some global indicators and benchmarks for human wellbeing?
- How is human wellbeing and development measured and mapped?
- What are some contemporary trends in human wellbeing and development?

Key terms

- Demographics
- Development
- Gross Domestic Product (GDP)
- Gross National Product (GNP)
- Life expectancy
- Happiness
- Human wellbeing
- Spatial trends
- Wellbeing measurements

Let's begin

What do we mean by the terms human wellbeing and development? Certainly wellbeing encompasses happiness – the feeling that our basic needs and wants have been met, that we are safe and well. Human wellbeing has two sides – firstly, how people actually feel (a subjective side); and secondly, what the conditions are for people to feel this way (an objective side). Development refers to the broader economic, social and political changes in a society that effect human wellbeing. There are constantly efforts made to describe and measure both human wellbeing and development across countries and regions.

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15.1 Global indicators and benchmarks for human wellbeing

human wellbeing people's quality of life and happiness that can be measured by health, income, life expectancy, literacy rates, women's participation in public life, infant mortality and many other indicators

Human wellbeing is a multi-dimensional term, which refers to people's quality of life and happiness. According to the Commission on the Measurement of Economic Performance and Social Progress, key dimensions of human wellbeing (in no particular order of significance) are:

1 Health
2 Social connections and relationships
3 Environment (present and future condition)
4 Education
5 Material living standards (income, consumption and wealth)
6 Personal activities including work
7 Political voice and governance
8 Security, of an economic as well as a physical nature.

The subjective nature of wellbeing

It is important to note that the concept of wellbeing can be quite **subjective** and dependent on personal opinion. For example, economic wellbeing depends on your viewpoint. Everybody in society does not seek after the pursuit of a high income. Volunteers may have a low level of economic wellbeing compared to those in other occupations, but they may have an incredible sense of social and emotional wellbeing as they are contributing to society and acting for the benefit of others.

subjective regarding personal views and feelings associated with a topic. Opposite to 'objective' which is factual information.

Human wellbeing encompasses physical, social, economic, and emotional and spiritual characteristics. Improving overall living conditions, reducing inequality between people and increasing opportunities for all are essential to achieving high levels of human wellbeing. Despite being essential for human wellbeing, improving economic conditions

Source 15.3 Health is one of the key dimensions of wellbeing.

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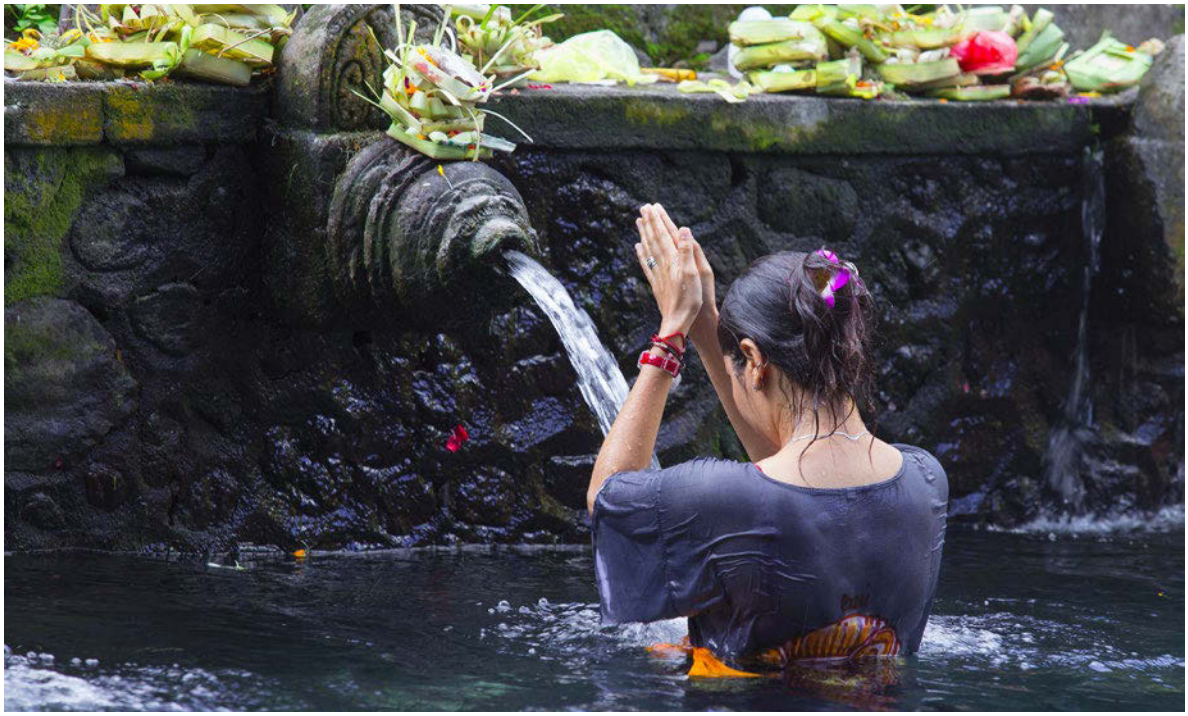
development economic, social and political changes that improve the wellbeing of people

through **development** is not enough for real progress to be achieved. While economic wealth can meet demands for material goods and services, people also need clean air, access to water and contact with a healthy natural environment for their mental and physical health. This is in part why human wellbeing and development are geographical issues.



Source 15.4 Wellbeing is a subjective concept – for example, religious devotion is a key to happiness to the lives of many people around the world.

Activity 15.1

1 Define the terms 'human wellbeing' and 'development' in your own words.
2 Rank the eight key dimensions of human wellbeing in the order you think are most significant, from highest to lowest.
3 Why is the concept of wellbeing subjective?

Indicators of wellbeing

Human wellbeing can be measured in a number of ways such as income, life expectancy, **literacy rates**, women's participation in public life, infant mortality rate and many other indicators.

literacy rate the percentage of people who can read and write

However, one commonality is that collecting accurate data is important for planning for, monitoring and solving issues associated with a country's level of wellbeing, and even more important for ensuring equal opportunities and access to socially valued resources for everybody in society.

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Demographics and wellbeing

Demography is the study of people and human populations. Aspects associated with populations that can be used to measure wellbeing include:

- population density
- percentage of people aged 15 and under
- percentage of people aged 65 and older
- population projections.

fertility rate or birth rate; the number of live births in a population, usually shown as a ratio of births per woman per lifetime, or births per 1000 people per year

mortality rate the number of deaths in a population, usually shown as a ratio of deaths per 1000 people per year

The **fertility rate** and **mortality rate** are the basis of any set of detailed demographic data. They are usually calculated for larger regions or countries, but can be used in smaller areas. They are also used to work out the rate of natural population increase or decline and can therefore be used to decide if migration is required to maintain a stable population size or if an area's population is growing too fast for the environment to adequately cater for it. These data help to inform government policy and action, including the 'Populate or perish' policy, an Australian Government strategy from the 1940s that encouraged mass migration from Europe after World War II. These migrants provided much-needed labour for Australia's reconstruction, industrialisation, and defence. We can analyse specific data for a range of countries to make judgements about how quickly their population is growing and what this might mean for their government. In general, more economically developed countries tend to have lower, or even negative, natural population growth.

Country	Fertility rate (births per 1000 people per year)	Mortality rate (deaths per 1000 people per year)
Mali	45	13
Madagascar	42	7
Pakistan	23	6
Mexico	19	5
Australia	12	7
United Kingdom	12	9
European Union	10	10
World average	18	8

Source 15.5 Fertility and mortality rates for 2015 (estimated)

Source: The World Factbook

Source 15.6
A pregnant African woman with her five daughters

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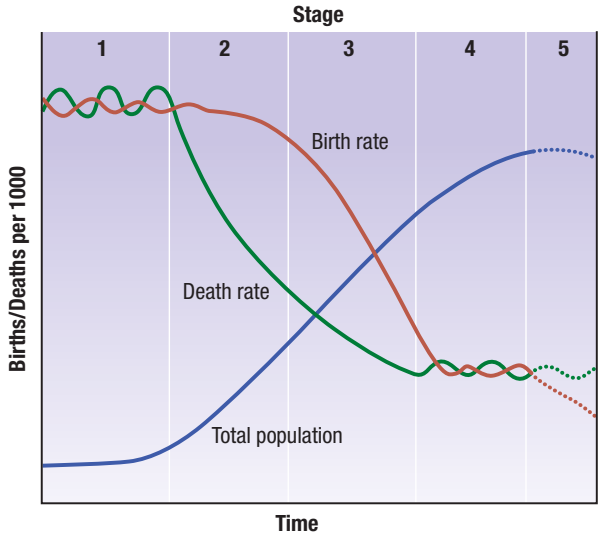
The Demographic Transition Model

The Demographic Transition Model shows population change over time. It studies how the fertility rate and mortality rate affect the total population of a country, and in turn how this can impact the wellbeing of that population.



Source 15.7 The transition from high fertility and mortality rates to low fertility and mortality rates as a country develops

The five stages of the Demographic Transition Model are:

1 High fertility and mortality rates. This indicates low levels of contraception (knowledge and use) and medical intervention. There are also low levels of medical intervention to increase lifespans, and as a result, population numbers are stable. There are very few countries left in this stage.
2 High fertility rate, declining mortality rate. While contraception is not yet widely used, medical practices are increasing life expectancy and improving overall health for the population. Population numbers are increasing.
3 Declining fertility and mortality rates. Contraception becomes more accepted by the population and there continues to be improvement in the health and life expectancy for the population. Population continues to increase, but at a slower rate.
4 Low fertility and mortality rates. Contraception and small families are common while medical care for people is very good and results in a high life expectancy. Many westernised countries are in this stage.
5 Fertility rates continue to drop while mortality rates are stable. This indicates an ageing population and a country that will need to supplement population with migrants if population levels are to be maintained. There are an increasing number of western countries entering this stage.

How demographic changes can impact wellbeing

At any point in time, countries are at different stages on the Demographic Transition Model, and are usually moving towards Stage 5. For many countries, the data are complex and there are many factors to be taken into account. For example, Australia's population is supplemented with migrants each year. Many of these are at the stage in their lives when they are starting families, so their fertility rate is not necessarily the same as the fertility rate of the long-term resident population. This means that we need to be careful when using these data and ensure that we look at multiple sources to gain a clearer picture. During 2013–14, Australia's net overseas migration was 212 700 people, with the average age of new arrivals being 26.7 years. The new migrants were approximately 50% male, 50% female.

If Australia's population is being supplemented by migrants, the countries

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they are coming from decrease in population. Depending on the ages and skills of the migrants, this could have a negative effect on the country of origin. Imagine how a country would be impacted if a large number of specialists like doctors or lawyers left the country. Even if there is a spread of occupations, losing healthy, young people still has an impact.

The same happens if we change the scale of the issue. Consider a small agricultural town in rural Australia where the majority of young people have decided that they cannot remain in the town due to a range of factors including a lack of employment or opportunities. The town becomes socially poorer and has a further reduction of employment and social richness. In an extreme case, the businesses in the town may cease to remain viable, with the result being that the town 'dies' and the remaining residents become linked to a larger nearby town. The area becomes a locality and the small town loses its original identity.

There are many of these towns across Australia, but some of the notable ones are Silverton (NSW) which is now often used by the film industry, Walhalla (Victoria) which has become a tourist area, Cook (South Australia) which has a current permanent population of four, Betoota (Queensland) whose last permanent resident died in 2004 and Gwalia (Western Australia) which has been deserted since the gold mine closed in 1963.

The influence of income

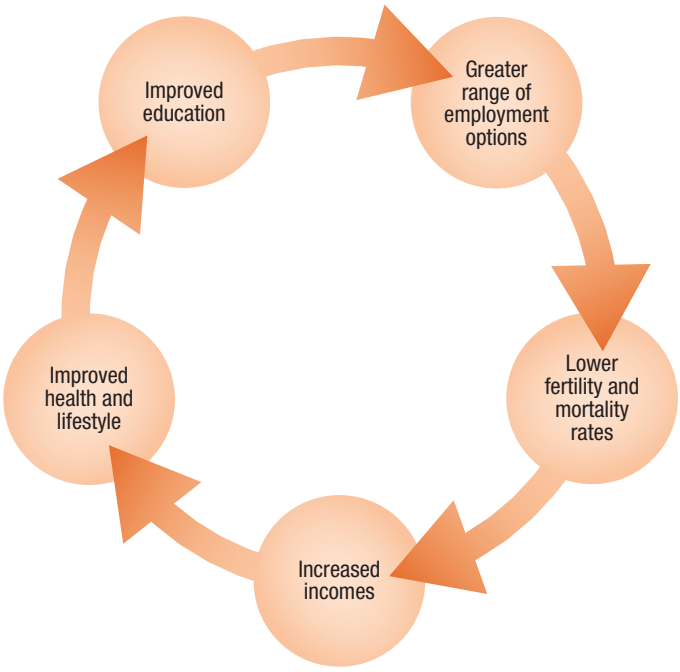
At first it may not seem as if there are links between income and fertility or mortality, but if we look at national income levels and compare them to the same nation's Demographic Transition Model stage, it becomes clear that there are patterns to be found. Higher income levels are consistent with higher education levels and, in general, higher education levels across both genders correspond to lower fertility and mortality rates. Increased literacy rates improve access to information on

Source 15.8 The gold mining ghost town of Gwalia, Western Australia

contraception, hygiene and health awareness. Better literacy also reduces superstition and the impact of cultural tradition, allowing better analysis of situations and options. It is a cycle that, once begun, can rapidly improve the life expectancy of individuals and the overall health of a community.

Gender equality in opportunity

The ability of increased education and opportunity to improve the quality of lives is stronger where both males and females have equity of access. Historically, not all cultures have delivered equality in this area; however, improved education for girls can significantly improve family and community health. Often it is women who run a home and provide care for the sick, making them pivotal in the community's health status. Ensuring equal education opportunities provides the community with more rapid reduction in fertility and mortality rates, supporting overall improvement in the health of each individual and better understanding of community health issues.



Source 15.9 The influence of income and gender equality on human wellbeing

Activity 15.2

1 What is the purpose of calculating fertility and mortality rates?
2 Discuss the reasons why economically developed countries tend to have a lower natural population growth than less developed countries.
3 What is the purpose of the Demographic Transition Model?
4 Explain the need for gender equality.

RESEARCH 15.1

Explore the website of the World Health Organization. Write a report that addresses the following:

- the role of the WHO
- current projects and campaigns of the WHO
- the health statistics of Australia compared with those of three other countries.

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15.2 Measuring and mapping human wellbeing and development to determine spatial trends

There are many dimensions of human wellbeing and many ways to measure it. It is important to be aware that any results obtained through such measurements are very dynamic and they can change each time an assessment is made. Therefore, researchers release rankings and classifications of countries and regions on a regular basis, and while there are some patterns that persist, others are prone to variations. Hence, any data we use to describe human wellbeing need to be referenced to the date when they were produced, the specific measurement(s) used and the organisation(s) which they originated from.

The where-to-be-born index

The where-to-be-born index, which links the results of subjective life-satisfaction surveys (that is, how happy people say they are) and objective determinants of quality of life (related to factors such as geography, demography, politics, income, crime, trust in public institutions and health of family life), was developed by The Economist Intelligence Unit to forecast how countries across the globe will be ranked in 2030. This will also be the year when a child born in 2013 will reach adulthood.

The last column in Source 15.10 shows the number of years a child born in 2013 is expected to live depending on the country where it is born. This is a very concise demographic indicator, which describes human presence on Earth. Prolonging human life is the ultimate goal in development, and countries like Australia have been successful in achieving this through advances in medicine, improvements in living conditions and increased health-related knowledge. However, human wellbeing is not only about living longer, it is also about living *healthier* (or disease- and injury-free) and *happier* lives.

Rank	Country	Score (out of 10)	Life expectancy at birth
1	Switzerland	8.22	82
2	Australia	8.12	82
3	Norway	8.09	80
4	Sweden	8.02	81
5	Denmark	8.01	79
6	Singapore	8.00	84
7	New Zealand	7.95	81
8	Netherlands	7.94	81
9	Canada	7.81	82
10	Hong Kong	7.80	82
71	Indonesia	5.54	72
72	Russia	5.31	70
73	Syria	5.29	75
74	Kazakhstan	5.16	70
75	Pakistan	5.17	67
76	Angola	5.09	55
77	Bangladesh	5.07	70
78	Ukraine	4.98	69
79	Kenya	4.91	63
80	Nigeria	4.74	52

Source 15.10 The where-to-be-born index, showing the top ten most and bottom ten least desirable countries to be born in and life expectancies at birth, The Economist Intelligence Unit, 2013

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Activity 15.3

1 Define the term 'life expectancy'.

2 Present the data in Source 15.10 in a graph so that it is visually appealing and yet accurately depicts the data. List the data from the top 10 countries only.

3 In order to try and map human wellbeing, use the data in Source 15.10 to annotate a map of the world. Use the BOLTSS method, and colour-code the top 10 and bottom 10 desirable countries to be born in. Explain what the colours mean in a key, and also include each country's name and their ranking in the where-to-be-born index.

The World Happiness Report

As we have seen, a variety of indexes have been developed to suit different purposes; they include different measurements. In terms of measuring happiness, the Happy Planet Index exists but has been widely criticised. A more successful measure is the World Happiness Report, which first launched at the United Nations in 2012, and ranks 157 countries according to the way their residents feel. In order to be able to assess this, different surveys are conducted. They ask respondents to answer questions such as:

- 'Taking all things together, how happy would you say you are (on a scale of 1 to 4)?' (European Values Survey)
- 'Taking all things together, would you say you are: Very happy, Quite happy, Not very happy, or Not at all happy?' (World Values Survey)
- 'On a scale of 0 to 10, how do you evaluate your quality of life?' (World Gallup Survey).

The analysis carried out in the *World Happiness Report* found out that in the last 30 years overall the world has become a little bit happier, but it also outlines significant regional differences in the level of life satisfaction experienced by people from various countries across the globe. Below is a summary of its findings:

prosperity having success, flourishing or thriving

- Happier countries tend to have greater economic **prosperity** – or wealth. However, more important for happiness than income are social factors, such as the strength of social support, the lack of corruption and the degree of personal freedom.
- Unemployment causes as much unhappiness as bereavement caused by the loss of loved ones or breakdown in family relationships. Work, job security and good relationships do more for job satisfaction than high pay and convenient hours.
- Behaving well makes people happier. This is a two-way relationship – people are happier when they experience kindness from other people but offering acts of kindness to other people also makes all of us happy. This seems to be a universal experience across the globe.
- Mental health is the biggest single factor affecting happiness in any country. However, only a quarter of mentally ill people get treatment for their condition in advanced countries, such as Australia, and

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Source 15.11 Dublin, Ireland, is one of the friendliest cities in the world and boasts an extremely popular nightlife.

treatment rates are even lower in poorer countries, such as India. Mental health is a very complex social, economic and environmental issue. Among the myriad of factors affecting people's mental state, recent research findings reveal evidence that the food we consume, and particularly the amount of fruit and vegetables, can influence how happy people feel on the day.

World Happiness Report: World Gallup Survey, 2005–2011 average (2012)	World Happiness Report: 2013–2015 average, update (2016)	Legatum Prosperity Index, 2015
1 Denmark	1 Denmark	1 Norway
2 Finland	2 Switzerland	2 Switzerland
3 Norway	3 Iceland	3 Denmark
4 Canada	4 Norway	4 New Zealand
5 Switzerland	5 Finland	5 Sweden
6 Sweden	6 Canada	6 Canada
7 New Zealand	7 Netherlands	7 Australia
8 Australia	8 New Zealand	8 Netherlands
9 Ireland	9 Australia	9 Finland
10 United States	10 Sweden	10 Ireland
–	–	–
94 India	83 China	52 China
112 China	118 India	99 India

Source 15.12 Happiness and prosperity ranking of countries

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- Stable family life and enduring marriages or de facto relationships are important for the happiness of parents and children. Again, this is universal across the globe.
- In advanced countries (Australia falls within this group), women are happier than men, while the position in poorer countries is mixed.
- Happiness is lowest in middle age. Unsurprisingly, this perhaps confirms the mid-life crisis theory developed by psychologists to describe the time when adults realise their mortality and start to question their satisfaction with life.
- Good physical and mental shape combined with a healthy environment and the availability of attractive opportunities and prospects can all increase people's happiness and satisfaction with life.

Legatum Prosperity Index

While the **happiness** surveys measure the subjective (or experienced day-to-day) side of human wellbeing, the Legatum Prosperity Index, developed by the independent London-based Legatum Institute, assesses objective conditions, such as the economy, entrepreneurship and opportunity, governance, education, health, safety and security, personal freedom and social capital. Ranked at 7th position, Australia is quite high on the index. Note that this index does not take into consideration environmental health conditions which are essential not only from a **sustainability** perspective but also for the physical and mental health of any country's population.

happiness a state of wellbeing and contentment

sustainability the ability to continue with minimal long-term effect on the environment

Activity 15.4

1 List what makes you feel happy and content.
2 Identify and discuss the biggest single factor affecting happiness in any country.
3 Why is happiness lowest in middle age?

RESEARCH 15.2

1 Research the Happy Planet Index. What factors does it include to measure happiness, and why has it been criticised?
2 Outline the differences between the World Happiness Report and the Legatum Prosperity Index country rankings.
3 Reflect on the problems societies around the world might face in the future if human wellbeing continues to rely heavily on economic prosperity.

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15.3 Contemporary trends in human wellbeing and development

A problem with using any system to categorise countries by levels of development is that statistics and measurements may indicate an unsatisfactory level and yet not illustrate how rich a culture might be. It is important when studying any place in geography to go beyond the quantitative information (i.e. the statistics) and search for qualitative information that can provide a realistic but fuller picture, such as including personal anecdotes, family heritage, cultural practices and celebrating the unique aspects of daily life.

Traditional measures of development

linear in a line or tracking along one path

Development has traditionally been thought of as a **linear** process whereby nations follow one path, moving from **agrarian** to industrial to post-industrial societies. Many assume that the processes of industrialisation and **modernisation** are beneficial, and that industrialised countries are more advanced and better than those countries that may not have experienced such things.

agrarian agricultural, farming-based activity

modernisation the process of society moving from traditional systems to other systems using technological efficiency, often linked to higher incomes and higher standards of living

Development usually entails a holistic improvement to society from which the whole population benefits. This might be a greater income, better health care, higher standards of education, environmental conservation, upholding of human rights, a just legal system, availability of employment and the preservation of cultural heritage. Two main methods of measuring development on a national scale include Gross National Product and Gross Domestic Product. Each has its own advantages and disadvantages, but a mix of indicators are used to create a picture of what a country is really like.

Source 15.13 Traditional path of development

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Gross National Product

Gross National Product (GNP) the measure of the value of all the goods and services a country produces in a year

Gross National Product (GNP) is the measure of the value of all the goods and services a country produces in a year. It is measured in dollar units and indicates the general direction of a country's economy.

Gross Domestic Product

Gross Domestic Product (GDP) is a commonly used measure of the wealth generated by all the output produced within a year by a country, whether the enterprises are owned locally or by foreign companies. It is an indicator of the health and size of the economy. GDP consists of consumer spending, investment by businesses and government spending. All the goods and services produced, government purchases, corporate investment plus net imports and exports are included in this measurement so the size of the economy can be determined.

Geographical fact

Luxembourg has the highest GDP per capita of over US$100 000 while Burundi has the lowest, US$315 (IMF, 2015).

A modern measure of development – the Human Development Index

Human Development Index (HDI) a tool to measure the wellbeing of a country, developed to overcome the shortfalls of other economic measurements and take into account aspects of life other than simply finances

The **Human Development Index (HDI)** is a tool to measure the wellbeing of a country. It was developed to overcome the shortfalls of other economic measurements and takes into account more aspects of life than simply finances.

The first Human Development Report was produced in 1990. It was the idea of a Pakistani economist who had previously worked for the World Bank. Since then the HDI has had a profound impact on global and domestic policy and has been refined to depict a more balanced view of wellbeing than other indicators. The human development approach to measuring development attempted to put people back at the centre of wellbeing, rather than simply focusing on economics.

composite made up of many things

The HDI is called a **composite** index because it comprises more than just one measurement. Other composite indicators are the gender equality index and the multidimensional poverty index. There are three dimensions to the HDI:

- Health – measured by life expectancy
- Education – measured by years of schooling
- Living standards – measured by GNP per capita.

Countries are given a score from zero to one. One is perfect and zero is the worst. Then, all the countries are ranked according to their scores. These are divided into four categories of human development – very high, high, medium and low. Countries that

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have consistently remained in the same four categories include:

- **Very high:** Australia, Norway, USA, Canada, Netherlands, Germany, Japan
- **High:** Russia, Cuba, Mexico, Saudi Arabia, Malaysia, Lebanon
- **Medium:** Fiji, China, Egypt, Philippines, South Africa, Samoa, Vietnam
- **Low:** Nigeria, Rwanda, Afghanistan, East Timor, Yemen, Pakistan, PNG, Zimbabwe.

Geographical fact

Norway has topped the HDI nine times since 1990 while Canada has been number one eight times.

Source 15.14 Alesund is a city in Norway, known for its Art Nouveau style buildings.

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Advantages and disadvantages of using the HDI	
Advantages	**Disadvantages**
• The three dimensions are weighted equally, meaning there is no overemphasis on economic wellbeing • Data for countries can be **disaggregated** to see differences in development for groups within a country • Highlights uneven development • Provides a good and useful summary of three different dimensions of a country • Used in conjunction with other measures it can provide an accurate picture of the wellbeing of a country • Promotes the idea that income is not the sum total of human life and cannot be the only measure • It has informed government policies and encourages countries to concentrate on the broader picture • It has changed the way resources are allocated and the distribution of resources, e.g. between upper and lower Egypt, and the provision of free anti-retroviral drugs for AIDS sufferers in Botswana • Has sparked a healthy competition between countries to improve their rankings • Has led to better monitoring and evaluation of programs • Has led to in-depth academic and **empirical** studies and refinements	• Cannot be used alone to determine a country's level of economic development • Does not show gender inequalities • Does not show political participation • Has been misused to represent the level of 'happiness' of people or the best place on Earth to live • The emphasis on those things that are measured can sometimes mean other things are not seen as important, e.g. infant mortality is not measured, but reducing this is very important • Human rights and non-discrimination are not included • Disregards qualitative methods assessments of wellbeing such as culture and political freedom

disaggregated separated or broken up into different parts

empirical information from observations and experiments

Source 15.15 Advantages and disadvantages of using the Human Development Index

Activity 15.5

1 What is the HDI?

2 How are nations categorised under the HDI?

3 To what extent is the HDI a more accurate measure of wellbeing and development than other measurements?

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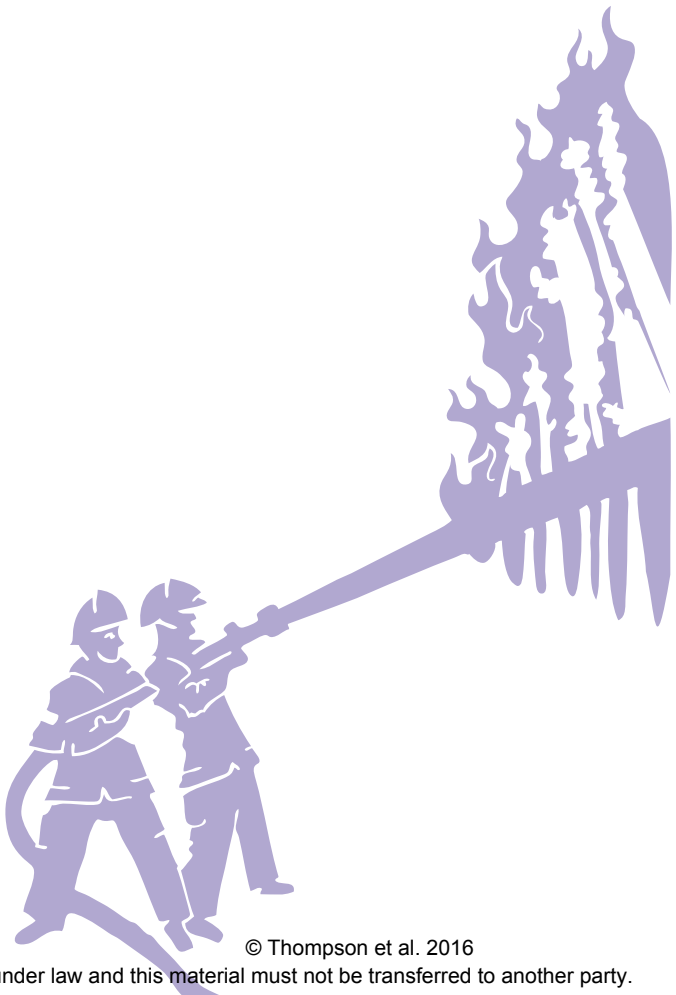
Note this down 15.1

Copy the graphic organiser below and complete the think, pair, share activity. (Think on your own, discuss as a pair and share ideas with the class.) If you were in charge of the HDI, what other indicators would you include and why?

Additional HDI indicators		
Think	Pair	Share

RESEARCH 15.3

Select four countries to investigate (one from each category of human development) and spend some time exploring the maps, statistics and reports for these countries available via the UNDP website. Comment on the trends evident over time.



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Chapter summary

- The concept of human wellbeing can be quite subjective and dependent on personal opinion.
- 'Development' refers to economic, social and political changes to a place that bring with them increased human wellbeing.
- There are many different ways to try to measure human wellbeing and development.
- Fertility, mortality and migration rates can be used to measure whether a population is stable and whether the environment can cater for a growing population. Higher education levels across both genders correspond to lower fertility and mortality rates.
- The Demographic Transition Model shows that populations change over time, with fertility and mortality rates generally decreasing. The ability of increased education and opportunity to improve the quality of lives is stronger where both males and females have equity of access.
- Improving human wellbeing is about making all people feel happy in the place where they live. Achieving this goal, however, is a complex task and involves satisfying many external conditions.
- Development can be measured in a variety of ways – two traditional methods are GNP and GDP.
- The HDI is a newer composite index, taking into account health, education and living standards, which ranks countries according to the level of wellbeing.

End-of-chapter questions

Short answer

1 Discuss the links between income and fertility and mortality.

2 Provide examples for each of the key dimensions of human wellbeing that reflect on your life.

3 Discuss the advantages and disadvantages of using the HDI to measure wellbeing.

Extended response

Discuss why Norway has a high level of wellbeing. Include evidence to back up your claims. You may need to do further research via the internet to assist you with this response.

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16 Spatial variations in human wellbeing

Source 16.1 Xijiang Qianhu Miao Village, Guizhou Province, China – happiness enhances human wellbeing.

Before you start

Main focus

Human wellbeing and development varies across regions and locations, with some people having more opportunities and living happier lives than others. We will look at factors affecting wellbeing, and spatial patterns of both wellbeing and development.

Why it's relevant to us

People always strive to live better and longer lives, but this is influenced by the place where they live. There are large differences in human living conditions between different countries as well as between different communities within the same country. Understanding what contributes to people's happiness allows individuals and societies to improve human lives.

Inquiry questions

- What are some of the causes, issues and consequences of spatial variations in human wellbeing?
- What are the differences in human wellbeing and development between and within countries?
- What are some reasons for and consequences of spatial variations in human wellbeing and development?
- What are some issues affecting the development of places, and how do they impact on human wellbeing?

Key terms

- Developed/developing countries
- Development
- First/second/third world
- Happiness
- Human wellbeing
- Poverty
- Prosperity
- Spatial variation

Let's begin

How do we account for some of the spatial variations in human wellbeing and development between countries, and within countries? In this chapter we will investigate how Australia, China and India compare in terms of wellbeing and development. We will also examine whether spatial variations in human wellbeing exist within Australia, and look at ways people have mapped economic development to determine and account for spatial variations in human wellbeing.

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16.1 Spatial variations in human wellbeing and development between and within countries

Due to global development, overall human wellbeing has improved dramatically over the years. People now live longer than ever before and there have been significant achievements in education, health care and living conditions. However, there are still large differences and inequalities between different communities. Those who have better access to resources enjoy more opportunities; there is consequently a wide gap in wellbeing between them and the underprivileged. As we saw in the previous chapter, there are obvious spatial variations in human wellbeing between developed and developing countries and this is evident in the variations in their socio-economic development and governance. The term spatial variation relates to the differences in natural and human features over an area of our planet. Countries like Australia, India and China provide interesting examples that help in understanding these issues.

Source 16.2 San Jose in California has been named one of the world's happiest cities by the *National Geographic* due to the sunshine, warm climate and abundance of organic produce.

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Human wellbeing in Australia, China and India

Living in Australia, it is always of relevance to us to see how our country ranks among others. On the other hand, China and India are of interest as they are not only the world's most populous countries, but also emergent economic powers and important to Australia as trading partners.

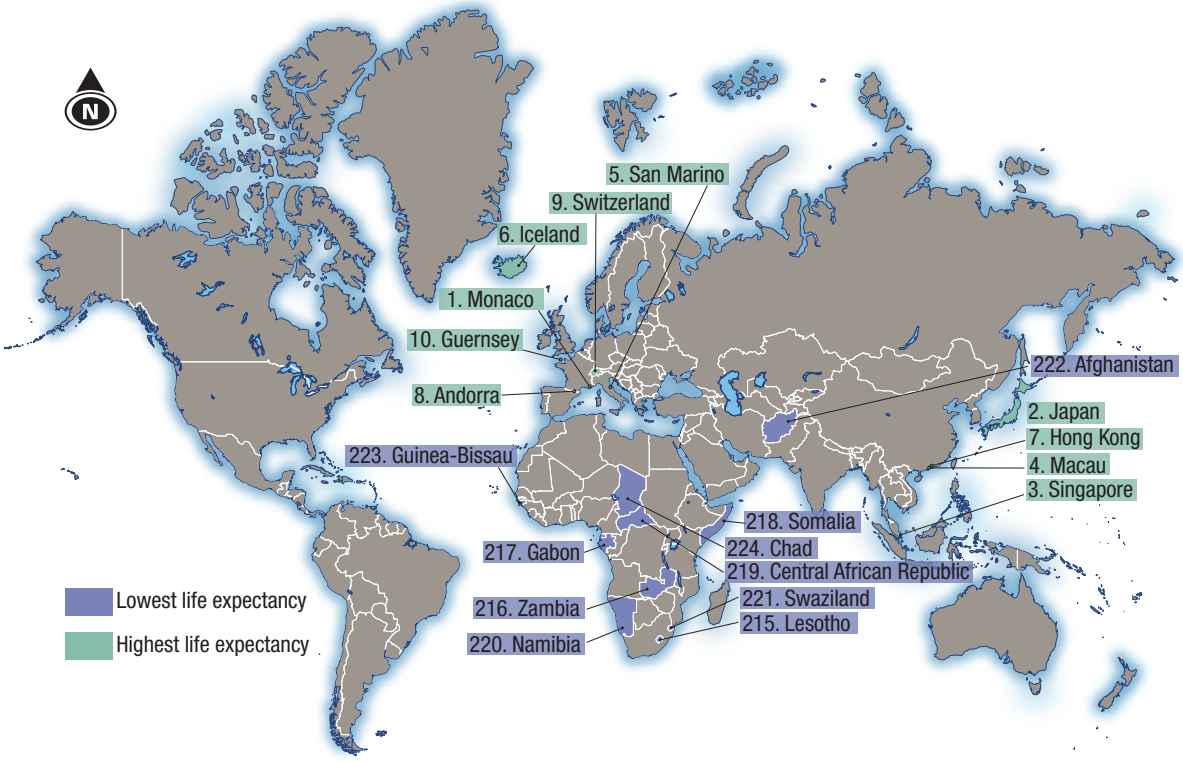
Extending human life is the ultimate goal in development. Therefore, let's start by examining spatial variations in life expectancy across the globe.

As you can see from Sources 16.3, Australia almost ranks within the top 10 countries for highest life expectancy, with an average lifespan of 82 years. The respective figures are 75 and 68 years for China and India. Source 16.4 shows the large disparities in the world with many African countries having the lowest numbers of healthy years (represented in purple on the map).

Rank	Country	Years
1	Monaco	89.52
2	Japan	84.74
3	Singapore	84.68
4	Macau	84.51
5	San Marino	83.24
6	Iceland	82.97
7	Hong Kong	82.86
8	Andorra	82.72
9	Switzerland	82.50
10	Guernsey	82.47
13	Australia	82.15
99	China	75.41
163	India	68.13

Source 16.3 Top 10 countries, and Australia, China and India's results by life expectancy in 2015

Source: The World Factbook



Source 16.4 Highest and lowest life expectancies across the globe in 2015. Adapted from The World Factbook data.

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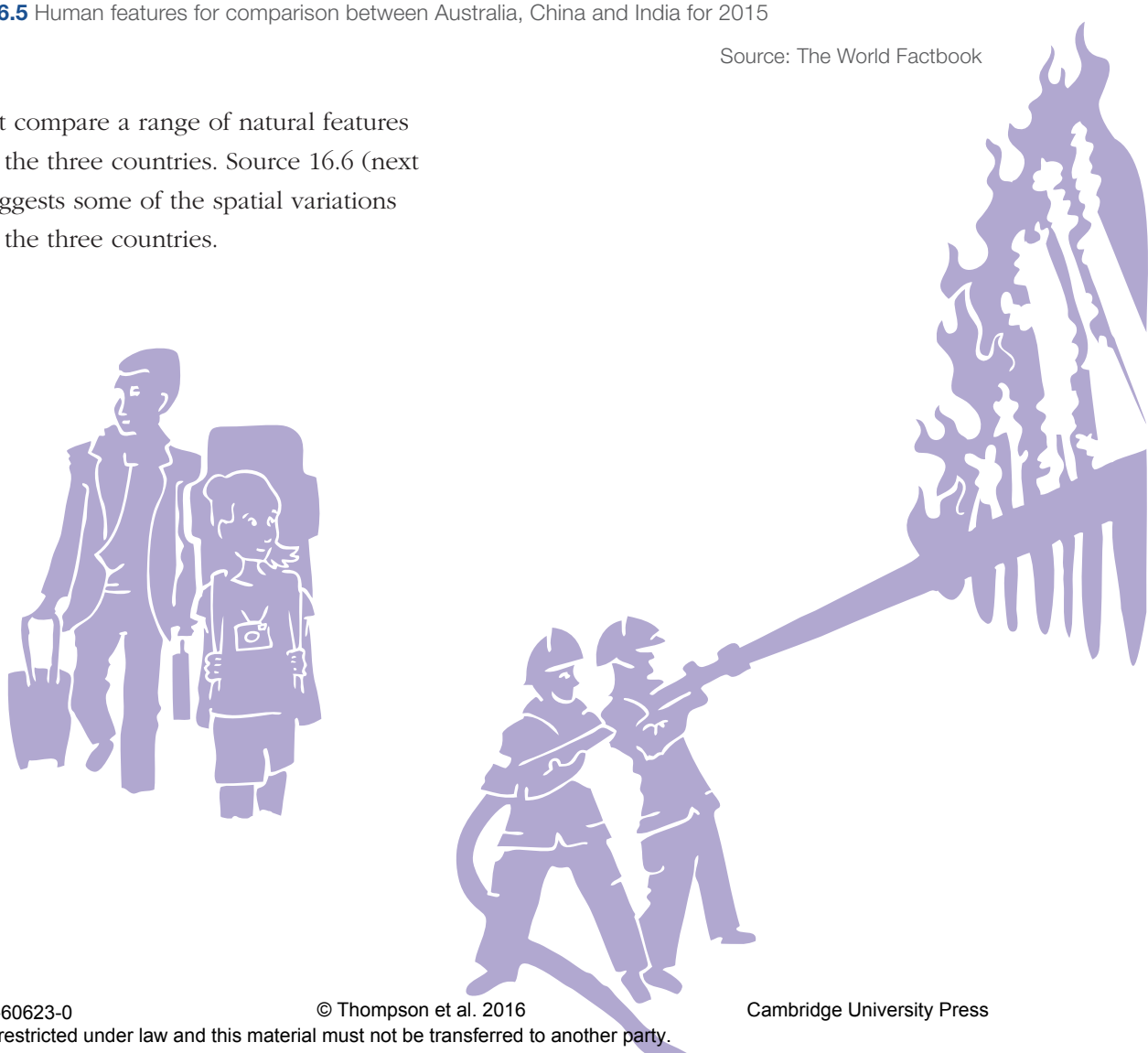
Let's next compare a range of human features between the three countries. These statistics reveal how Australia, China and India vary in terms of the number and location of their populations, and the relative health and wealth of those people. Global statistics are also included to indicate how each country ranks on a global scale.

	Population	Urban % of total population	Life expectancy at birth	Fertility rate (births per 1000 people per year)	Mortality rate (deaths per 1000 people per year)	Gross Domestic Product (GDP) in USD, billions
Australia	22 751 014 (July 2015 est.)	89.4%	82	12	7	1240.803
China	1 367 485 388 (July 2015 est.)	55.6%	75	12	7	11 384.763
India	1 251 695 584 (July 2015 est.)	32.7%	68	19	7	2182.577
World	7 256 490 011 (July 2015 est.)	54%	68	18	8	73 179.986

Source 16.5 Human features for comparison between Australia, China and India for 2015

Source: The World Factbook

Let's next compare a range of natural features between the three countries. Source 16.6 (next page) suggests some of the spatial variations between the three countries.



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	Location	Geographic coordinates	Total area	Climate	Terrain	Land use	Freshwater withdrawal total per capita (domestic/ industrial/ agricultural)
Australia	Oceania, continent between the Indian Ocean and the South Pacific Ocean	27 00 S, 133 00 E	7 741 220 sq km (Comparative area: Slightly smaller than the US contiguous 48 states)	Generally arid to semi-arid; temperate in south and east; tropical in north	Mostly low plateau with deserts; fertile plain in southeast	Agricultural land: 53.4% Forest: 19.3% Other: 27.3%	1152 cu m/ yr (2010)
China	Eastern Asia, bordering the East China Sea, Korea Bay, Yellow Sea, and South China Sea, between North Korea and Vietnam	35 00 N, 105 00 E	9 596 960 sq km (Comparative area: Slightly smaller than the US)	Extremely diverse; tropical in south to subarctic in north	Mostly mountains, high plateaus, deserts in west; plains, deltas, and hills in east	Agricultural land: 54.7% Forest: 22.3% Other: 23%	409.9 cu m/ yr (2005)
India	Southern Asia, bordering the Arabian Sea and the Bay of Bengal, between Burma and Pakistan	20 00 N, 77 00 E	3 287 263 sq km (Comparative area: Slightly more than one-third the size of the US)	Varies from tropical monsoon in south to temperate in north	Upland plain (Deccan Plateau) in south, flat to rolling plain along the Ganges, deserts in west, Himalayas in north	Agricultural land: 60.5% Forest: 23.1% Other: 16.4%	613 cu m/yr (2010)

Source 16.6 Natural features for comparison between Australia, China and India for 2015

Source: The World Factbook

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Activity 16.1

1 Define in your own words the geographic term 'spatial variation'.

2 Referring to Source 16.4, discuss the reasons for the concentration of lowest healthy life expectancy countries in one continent.

3 Refer to Sources 16.5 and 16.6 to answer the following questions:

- **a** Which is the largest country in terms of area?
- **b** Work out the percentage of global population for each country.
- **c** What do you think the differences in freshwater usage suggests about each country's infrastructure?
- **d** Each country's geographic coordinates give us their **absolute location**. Determine each country's **relative location** from each other.
- **e** What are some of the causes of spatial variations (natural and human-made) in human wellbeing?

absolute location the exact position of something. The address of a place can give this, as can latitude/longitude.

relative location location relative to other places e.g. the distance of a town from other towns. For example, Wollongong is approximately 85 km south of Sydney.

Wellbeing measurement results

spatial difference relating to difference in position, area and the size of things

Another way to compare **spatial differences** between Australia, China and India is through their various results in global wellbeing and development indexes. The rankings show us very different results in terms of happiness and economic security. In the where-to-be-born index, for example, out of 80 countries Australia ranked 2nd, China 49th and India 66th. Generally, Australia ranks highly in

Source 16.7 Australia consistently ranks highly in wellbeing measurements. Pictured is Sydney's central business district near Darling Harbour.

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wellbeing measurements, but India has fallen lower in recent years. A comparison between the 2012 and 2016 results in the World Happiness Report for China suggests rapid improvement. This perhaps in part reflects the recent rise of China as a world economic powerhouse – according to the International Monetary Fund (IMF) China has raised its share of GDP from 2 billion in 2005 to over 11 billion in a decade. In terms of purchasing power, China toppled the US in 2014 to become the world's biggest economy.

RESEARCH 16.1

1. Using wellbeing measurements introduced in Chapter 15 (such as Sources 15.10 & 15.12), account for the differences between wellbeing rankings in China/India and Australia. Make reference to some of the spatial variations in human and natural features of the countries.
2. Use the Human Development Index online to compare Australia, China and India.
3. Referring to the five stages of the Demographic Transition Model, try to determine where each of Australia, China and India currently sit. You may need to conduct online research to find the necessary statistics.

Human wellbeing within Australia

The high rankings in various wellbeing measurements are a very encouraging achievement for Australia as a country, but despite this there are significant differences between Australia's regions and suburbs as well as between Aboriginal and Torres Strait Islander peoples and non-Indigenous Australians (examined in detail in Chapter 17).

Australia is an island continent with much of the central and northern areas covered by arid desert. Most of the population lives on the eastern seaboard, where Australia's most populous cities are located. In Australian cities, wealthy suburbs, poorer suburbs and suburbs dominated by particular ethnic, cultural or religious groups have formed. Patterns of inequality are evident in data collection via the Census and academic research (spatial variations affecting wellbeing in Australia is examined in detail in Chapter 17). Spatial variation showing where these trends are taking place can then be mapped to provide a visual depiction of wellbeing.

For example, the following two sources depict New South Wales in thematic map form. Source 16.8 indicates where high-income households are located, while Source 16.9 highlights where low-income households tend to be located. While not exactly indicating human wellbeing, the two maps at least give us contrasting insights into spatial variation of wealth in NSW. The concentration of both wealth and poverty within a country are some of the issues and consequences of spatial variations in human wellbeing.

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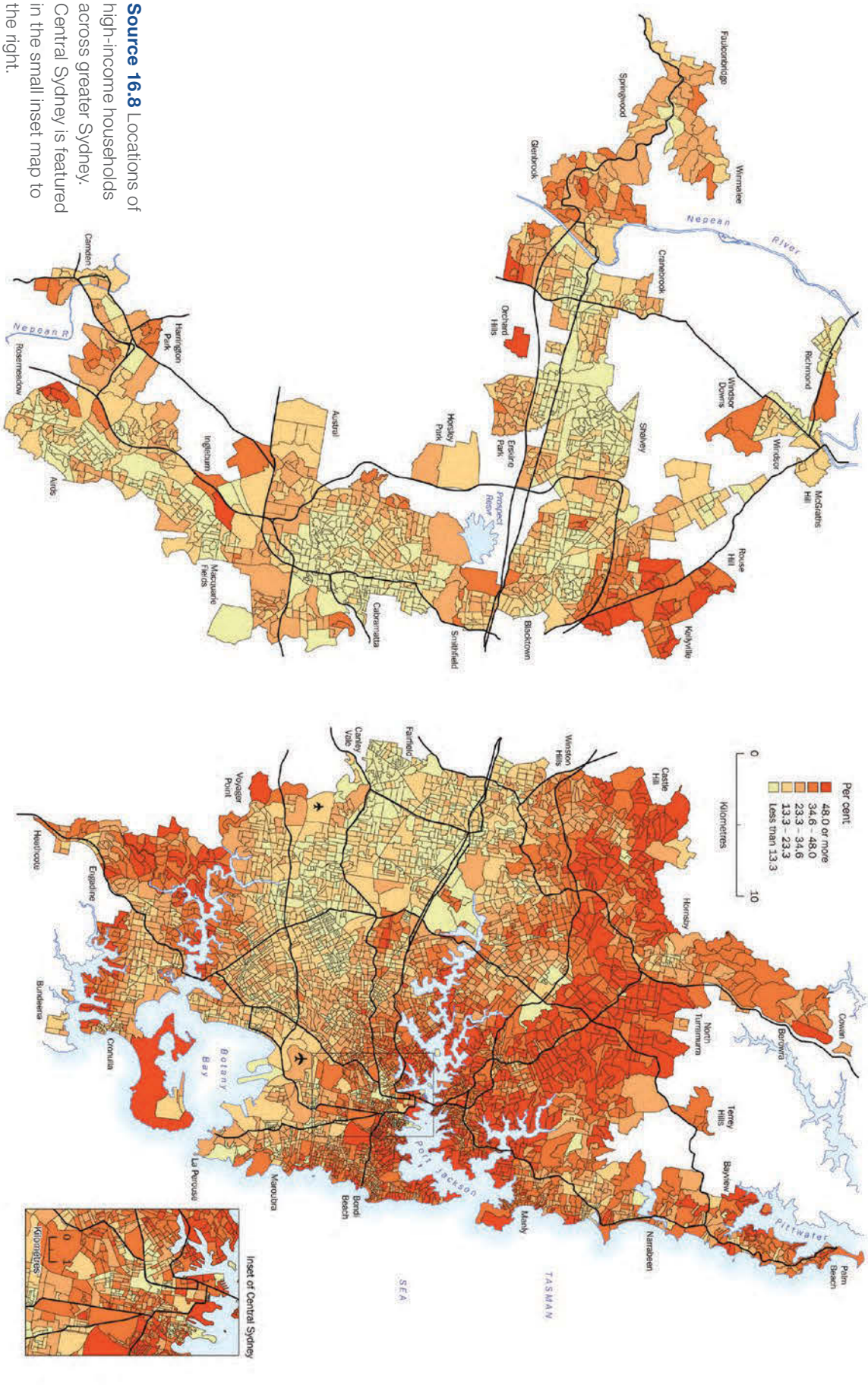

Source 16.8 Locations of high-income households across greater Sydney. Central Sydney is featured in the small inset map to the right.

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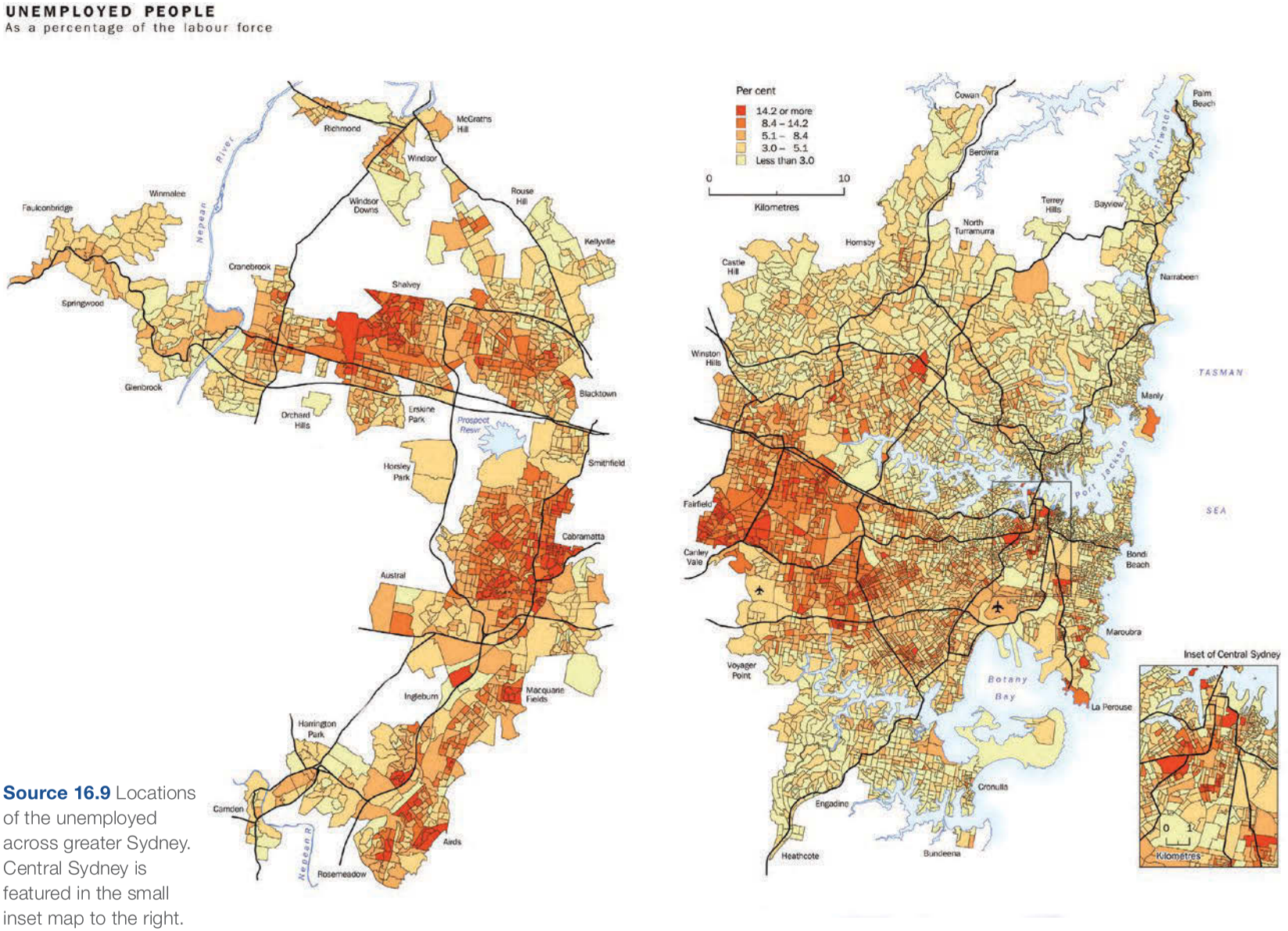

Source 16.9 Locations of the unemployed across greater Sydney. Central Sydney is featured in the small inset map to the right.

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Activity 16.2

1 Compare Sources 16.8 and 16.9. Can you see any correlation (or spatial variation) between where high-income earners live in comparison to where low-income or unemployed people live?

2 Explain how spatial variation can account for and affect human wellbeing and development within a country.

16.2 Reasons for and consequences of spatial variations in human wellbeing and development

As we saw by looking at Australia, China and India, there is a range of differences between nations in terms of human and natural features. As we also know, these features also vary within countries. One way to categorise these differences is through an economic approach. Let's next consider the issue of spatial variations in human wellbeing and development on a global scale.

Developed, developing and underdeveloped

The terms 'developed', 'developing' and 'underdeveloped' refer to a country's level of industrialisation. The IMF uses these terms or similar in their *World Economic Outlook* reports.

Developed countries are those that have undergone the process of industrialisation. Typically, this involves moving from an agrarian-based society to a manufacturing-based society where goods are mass produced and as such contribute to higher levels of GDP.

Industrialisation is also linked with other processes and characteristics such as

Source 16.10 Slums in Phnom Penh, Cambodia

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urbanisation and modernisation. For example, England experienced all the above in the eighteenth century, followed by France and Germany.

Developing countries are those that are in the process of becoming industrialised, such as Chile in South America.

The term 'underdeveloped' is not politically correct, but previously referred to economically poor countries, most of which are located in Africa and some parts of Asia. The more acceptable terms now are less developed countries (LDCs) or less economically developed countries (LEDCs).

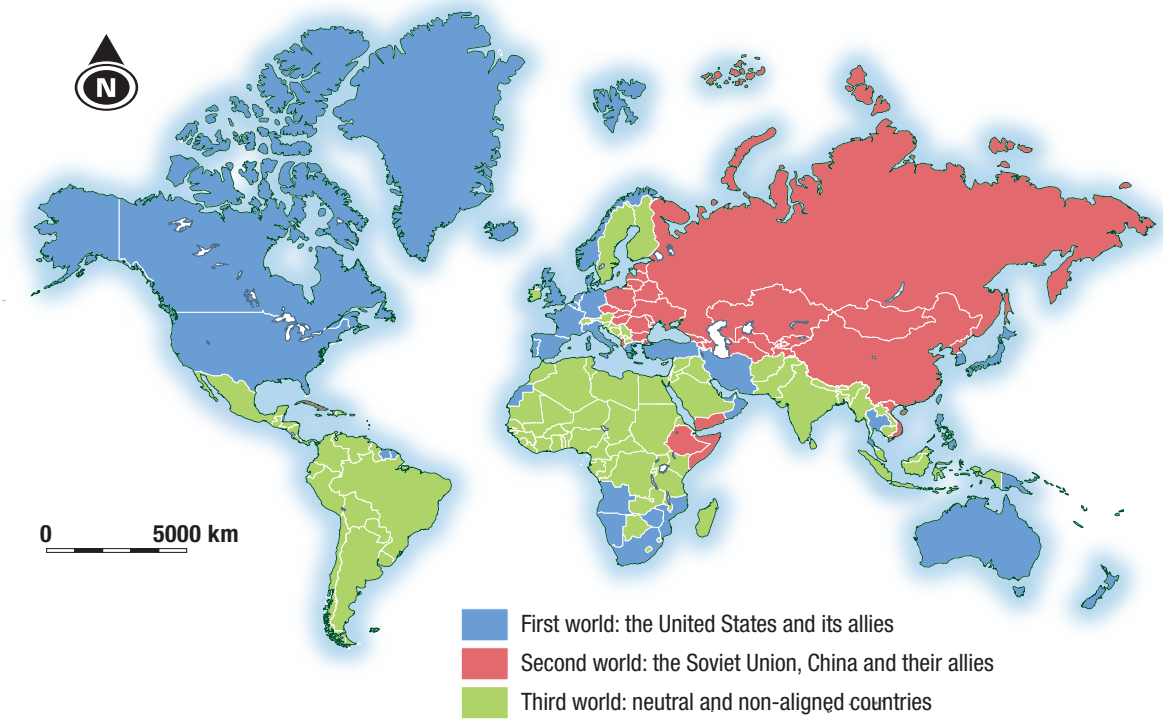
First world, second world and third world

During the period of the Cold War (1947–1991), the first world referred largely to the US and its allies. The second world referred to the communist Soviet Union, China and its allies, and the third world referred to those non-aligned countries who were not involved – most of Africa, Central and South America and Asia. Trends tended to indicate the democratic and capitalist nature of first world countries. Over time the term 'third world' came to describe poorer living conditions, lower levels of education, lower levels of income and worse health outcomes than those countries of the 'first world'.

Third-world countries were also associated with high population growth rates. Countries with categories in the 'first world' tended to be those with **western culture**, many of which were colonial powers and tended to have higher standards of living at the time.

western culture ideas, fashion, food and ways of life from the US, UK and Western Europe which are located in the Western Hemisphere

These terms are not used regularly nowadays due to other more appropriate terms being applied to countries.



Source 16.11 First-, second- and third-world countries

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Geographical fact

You may see or hear about 'first-world problems', particularly on Twitter where people comment on the frustrations associated with the luxuries of living in wealthy countries, all in good humour. For example, a Twitter search of #firstworldproblems revealed the following:

- I have so much food in my fridge, it's hard to get to the back of my fridge.
- One side of my bed has wifi and the other side doesn't.
- My shampoo and conditioner never run out at the same time.
- I hate it when iMessage goes down and you have to send regular text messages.
- The regular kitchen is being remodelled, so I have to eat in the basement kitchen now.

The terms have become defunct as lines are blurred and non-Western nations' levels of economic development have grown and may now be on par with the west.

Some limitations with this method of categorising nations have also arisen since the end of the Cold War. The Soviet Union does not exist anymore; it has been broken up into Russia and a plethora of other former 'Eastern Bloc' countries. This **dissolution** has created newer low-income countries that would have perhaps previously been considered part of the third world.

dissolution the action of ending an agreement and breaking up into separate parts

Source 16.12 The city of Petropavlovsk-Kamchatsky in the far east of Russia

Activity 16.3

1 List five countries that could all be categorised as developed and first-world countries, and five countries that could all be categorised as developing and third-world countries.
2 Explain why it is no longer appropriate to categorise nations as first-, second- or third-world countries.
3 Discuss the interrelationship between the development of a country (whether they are developed, developing or less economically developed) and the wellbeing of its people.

16.3 Issues affecting the development of places and their impact on human wellbeing

There are a number of factors that influence the development of a place, and subsequently impact the wellbeing of those who live there. In Australia, two factors that inhibit the development of places include poverty, and a resulting lack of social mobility.

Poverty

Poverty is one of the biggest factors influencing development and sadly is a reality for millions of people around the world. Therefore, trying to decrease poverty in countries tends to be the most effective way to improve wellbeing.

Nearly half of the world's population live on less than $2.50 a day. According to UNICEF, 29 000 children under the age of five die each day due to poverty – this is approximately 21 children per minute. Therefore, each year 11 million children die due to poverty-related issues.

Suburbanisation of poverty

Large working-class communities once dominated the centres of the major cities of Melbourne, Brisbane, Sydney, Perth, Adelaide and Hobart, but have now moved to the outer suburbs of these cities. Such a phenomenon is known as the suburbanisation of poverty. This trend has occurred for a number of reasons, including higher land prices and high rents close to central business districts (CBDs) forcing factories and residents to move out, and **economic restructuring** policies placing an emphasis on services rather than manufacturing.

economic restructuring an economy moving from a manufacturing base to a service base

The wellbeing of a city is dependent upon low levels of unemployment to ensure people are not living in poverty. Cities need to cater for those involved in the 'old economy' manufacturing jobs, who are more likely to be under housing stress – defined as more than 30% of income being dedicated to housing, either mortgage or renting. New economy jobs are those in service-based industries such

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as legal services, advertising, communication, entertainment and retail. They usually generate higher incomes than manufacturing-based jobs and this can create spatial patterns of economic wellbeing within a city. There are now over 3.5 million people in Australia living in poverty.

Source 16.13 There are over 3.5 million Australians living in poverty.

Social mobility

social mobility the ease of moving up 'levels' in society

strata layers or levels

Social mobility is the degree to which families or individuals can move up the social **strata** over a period of time, otherwise known as intergenerational mobility. It mostly is the result of a change in income. The new economy has provided millions of Australians with the means to 'better' their circumstances. For example, many stockbrokers, software developers, online retailers, merchant bankers, insurance underwriters, media owners and social media **entrepreneurs** have made millions in the new economy. Australia prides itself on being a classless or **egalitarian** society, but in reality it is not very easy to move up the social strata, despite Australia being one of the most socially and geographically mobile populations in the world. New wealth generated provides an increased level of economic wellbeing for some people.

egalitarian providing equality for everyone in terms of social, political, economic and civic rights

entrepreneur someone who takes a risk in owning or operating a business

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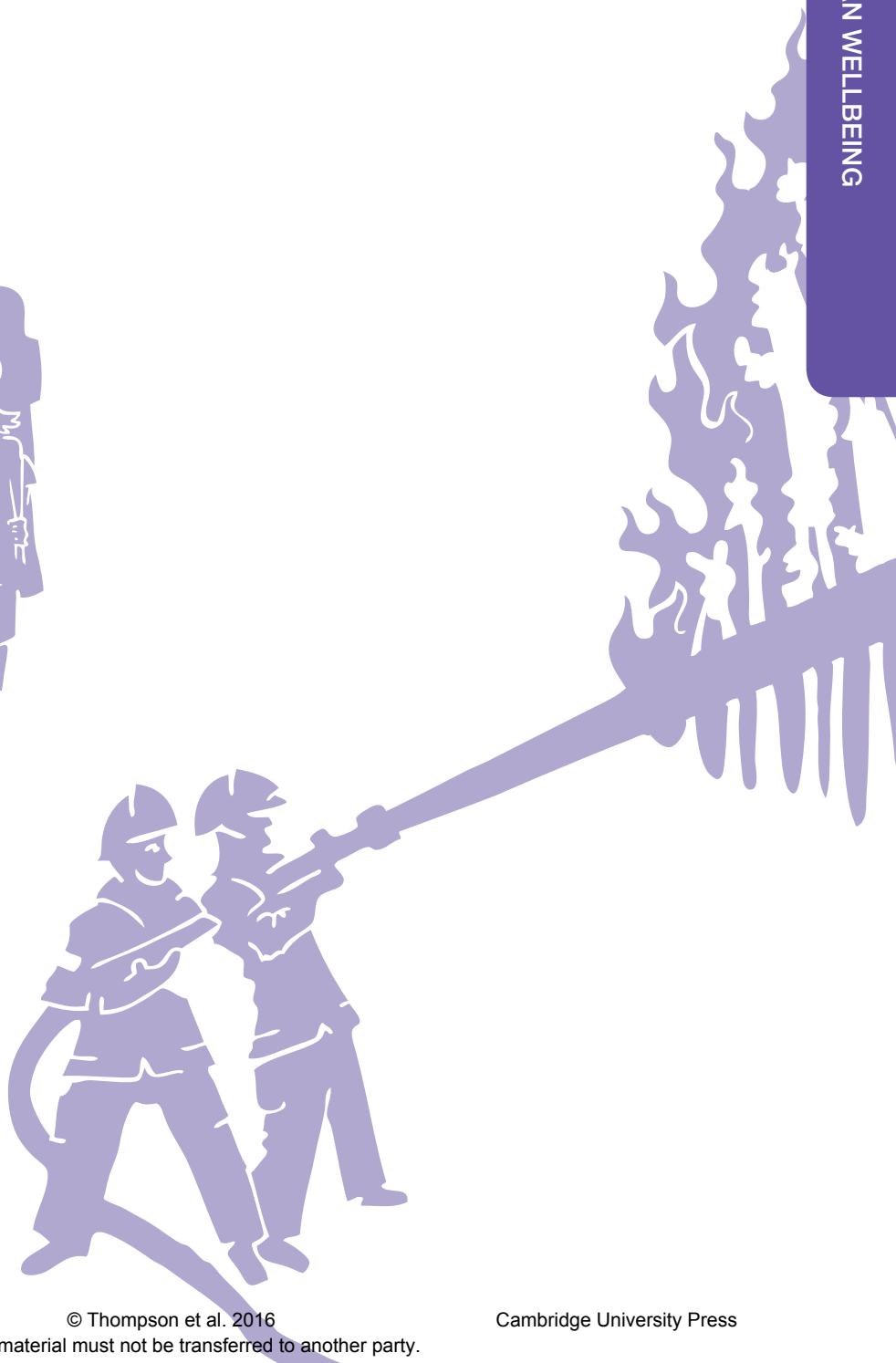
Activity 16.4

1 Explain why manufacturing-based jobs have moved out to the suburbs and away from the city centres.
2 Determine the reasons Australia is considered one of the most socially and geographically mobile countries in the world.
3 Describe how poverty and a lack of social mobility can affect the economic wellbeing and development of an area.



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Chapter summary

- Spatial variation is the difference or variation in natural and human features over an area of the Earth's surface.
- There are a range of spatial variations between Australia, China and India. These include human features like population level, GDP and natural features such as location, total area and access to freshwater.
- Australia ranks highly in many wellbeing measurements, while both China and India, with their growing economies, are constantly improving their results.
- Within Australia, spatial variation in wellbeing exists due to the sparseness of our island continent.
- Spatial variation in wellbeing can also be examined on a smaller scale by comparing maps of Sydney that show households with high and low incomes.
- Countries can be categorised according to their level of economic development in a number of ways, such as 'developed, developing or underdeveloped', or 'first-, second- or third-world' countries.
- As the world's countries change and develop it becomes harder to divide and categorise countries according to their development.
- Poverty and a lack of social mobility are some issues that can affect the development of an area and the wellbeing of its inhabitants.

End-of-chapter questions

Short answer

1 Explain why Australia is one of the top places in the world for a child to be born into today.

2 India is a vast country with the world's 2nd largest population. Analyse how human wellbeing can be improved in India.

3 3 Identify why the category 'underdeveloped' should no longer be used when referring to development.

Extended response

Compare and contrast the wellbeing of India and China. What are the similarities and differences between the countries? How might they each improve their populations' wellbeing? You may need to do further research via the internet to assist you with this response.

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17 Human wellbeing in Australia

Source 17.1 Australians have a high standard of happiness, development and wellbeing.

Before you start

Main focus

The wellbeing of people in our home country, Australia, is important to us all.

Why it's relevant to us

Our wellbeing as Australians is influenced by where we live, how we live, the choices we make, our standard of living, our education, our career options and our income levels.

Inquiry questions

- How does Australia compare to the rest of the world?
- Do Australians have a good sense of wellbeing and why?
- How do Aboriginal and Torres Strait Islander concepts of wellbeing compare to those of other Australians?

Key terms

- Census
- Indigenous
- Mortality rate
- OECD Better Life Index
- Segregation
- Social polarisation
- Spatial patterns
- Suburbanisation
- Vulnerability

Let's begin

Australia performs very well according to many human wellbeing measurements, with the exception of its environmental impact. It has a reputation of being a healthy and happy country with well-established educational and social security systems, and a beautiful, clean environmental landscape. This attracts large numbers of migrants from many countries around the world. Aboriginal and Torres Strait Islander peoples, however, have lower levels of wellbeing than non-Indigenous Australians.

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17.1 Differences in human wellbeing in Australia

Where we live can have a huge impact on our health and wellbeing. Australians have a reputation of being happy and healthy, and we are fortunate to live in a country where education and health care are available to all.

Source 17.2 Human wellbeing involves the state of happiness, and the feeling that our basic needs and wants have been met, and we are safe and well.

Human wellbeing involves the state of happiness, and the feeling that our basic needs and wants have been met, and we are safe and well. Where we live determines how we live; what our choices are in life; and our standard of living, level of education, career options and income.

The OECD Better Life Index is a global measure of wellbeing that compares countries across 11 areas. The Index does not rank countries, as it does not assign a relative importance to these topics. That is, it does not say whether the economy is more important than the natural environment, education more important than housing, and so on. The OECD Better Life Index uses an 11-petal flower design, where the length of each petal describes the score of the topic (from 0 to 10) and its width shows the importance assigned by respondents to this topic. Based on available data, the Better Life Index showed that in 2015 Australia was doing better than the average OECD indicators. This index is available as an interactive tool online for individuals or organisations to construct their own Better Life Indices.

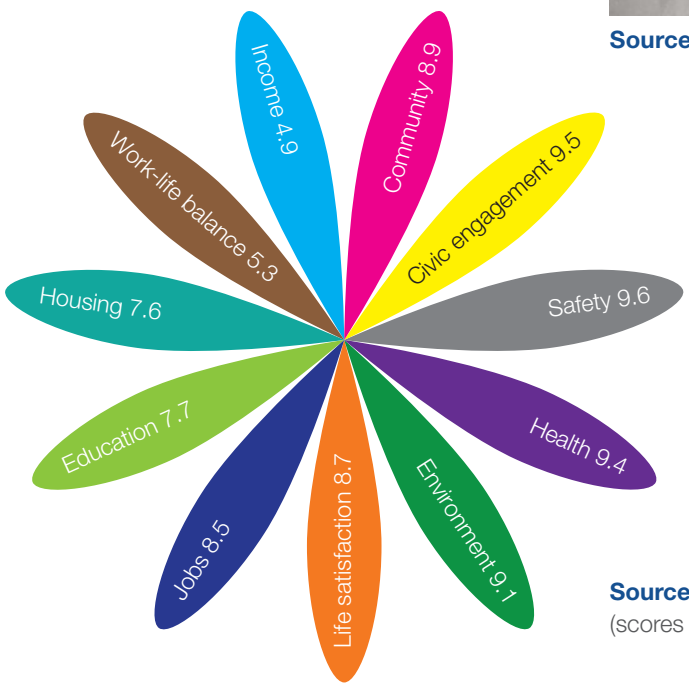
Source 17.3 Australians have sufficient access to education.

i Housing
ii Income
iii Jobs
iv Community
v Education
vi Environment
vii Civic engagement
viii Health
ix Life satisfaction
x Safety
xi Work–life balance

Source 17.4 The 11 topics of the OECD Better Life Index

It is important to note that the OECD Better Life Index does not clearly show the wellbeing of Indigenous Australians.

Source 17.6 The OECD sign outside its Berlin offices



Source 17.5 Australia's OECD Better Life Index results (scores out of 10)

Source: Better Life Index: Australia, 2015

RESEARCH 17.1

Use the OECD Better Life Index to create your own human wellbeing index. In groups, discuss with others what the width of the petal (that is, the importance of each area) should be. Use the website to explore in more detail:

- What exactly is the meaning of each of the 11 areas?
- How do countries that you (or your parents or friends) have visited perform according to this index?
- Compare Australia with a developed and developing country of your choice.
- Share your findings with the rest of the class.

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Spatial differences in Australia

The main government organisation in Australia which collects and makes available information about the state of the Australian population, society, environment and economy is the Australian Bureau of Statistics (ABS). At this time, the ABS does not provide data about spatial differences in human wellbeing within the states, regions, cities, towns, or suburbs of our country.

However, there are other studies that attempt to measure happiness and they often focus on a particular aspect, depending on the interests of the researchers. For example, in 2011 research conducted by psychologists from the University of Sydney pointed out that people in Tasmania, with a score of 61 (a score of 50 indicating that an individual is neither happy nor sad), feel the happiest in Australia. The differences in people's subjective assessment of their wellbeing were not very pronounced – Victorians had a score of 59, residents of New South Wales, South Australia and Western Australia 58, Queenslanders and residents of the Australian Capital Territory 57, and the Northern Territory 52.

In order to better understand the objective conditions that can impact on human wellbeing in Australia, researchers from Griffith University developed the VAMPIRE (Vulnerability Assessment for Mortgage, Petroleum and Inflation Risks and Expenditure) Index, which identifies the degree of socio-economic stress experienced across the suburbs of Australia's state capital cities of Adelaide, Brisbane, Melbourne, Perth and Sydney. The conditions that the researchers identified as having a strong impact on people's happiness are linked to housing affordability and transportation costs, particularly as most Australian cities are planned around the use of the car.

Source 17.7 presents some of the results from this study, which identifies large differences in **vulnerability** between richer central suburbs and those of the fringe. In general, suburbs within 10 km of the Central Business District (CBD) appear to be less vulnerable to oil price and mortgage rate increases, thus providing stable living conditions.

vulnerability the degree to which people, property, resources, systems and cultural, economic, environmental and social activity are susceptible to harm, degradation or destruction on being exposed to a hostile factor

On the other hand, however, these are also more expensive suburbs, often beyond the reach of people with lower socio-economic status. As the vulnerability of other Australian suburbs continues to increase (see Source 17.7, second column), this will have a negative impact on human wellbeing. Providing access to rail, tram, buses and other means of public transport is an important way to reduce exposure to higher petrol prices. Such services are very limited in many Australian suburbs, particularly in the outer metropolitan areas where cheaper house prices attract modest income earners and where transport is highly dependent on car travel.

Geographical fact

A 2015 study on happiness in Australia by the University of Melbourne found that people living in small towns with fewer than 1000 people were much happier than those who live in the major cities. Suggested reasons include the lack of traffic congestion and crime.

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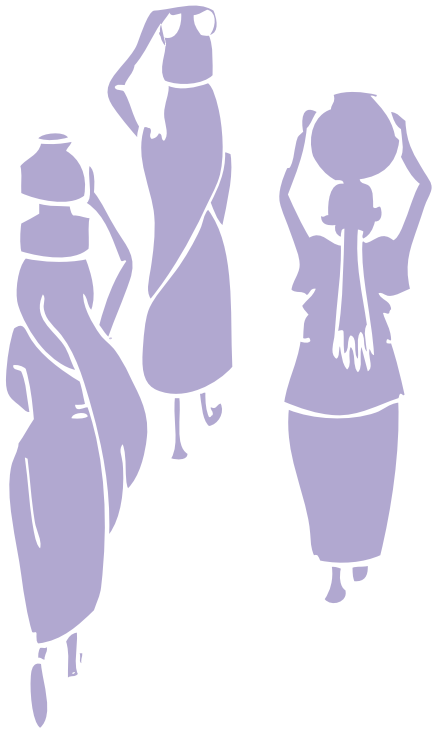
State capital	Changes since 2006
Adelaide	
Low vulnerability: Central Adelaide, North Adelaide, Hyde Park, Beaumont	17% of suburbs are less vulnerable
High vulnerability: Wingfield, Seaford, Parafield Gardens, Elizabeth	38% of suburbs are more vulnerable
Brisbane	
Low vulnerability: Indooroopilly, New Farm, Coorparoo, Bulimba	25% of suburbs are less vulnerable
High vulnerability: Browns Plains, Caboolture, Redcliffe, Capalaba	25% of suburbs are more vulnerable
Melbourne	
Low vulnerability: Port Melbourne, Brunswick, Camberwell, Bentleigh	24% of suburbs are less vulnerable
High vulnerability: Deer Park, Beaconsfield, Roxburgh Park, Knoxfield	42% of suburbs are more vulnerable
Perth	
Low vulnerability: Central Perth, Crawley, Claremont, Carine	22% of suburbs are less vulnerable
High vulnerability: Banksia Grove, Marangaroo, Huntingdale, Armadale	39% of suburbs are more vulnerable
Sydney	
Low vulnerability: North Sydney, Mosman, Potts Point, Pymble	18% of suburbs are less vulnerable
High vulnerability: Cabramatta, Parramatta, Hebersham, Fairfield East	41% of suburbs are more vulnerable

Source 17.7 Vulnerability of Australian suburbs, 2008

Activity 17.1

1. Outline the role of the Australian Bureau of Statistics (ABS).
2. What is vulnerability and how does it affect wellbeing?
3. Analyse Source 17.5 then discuss the possible reasons why Australia has low scores in income and work–life balance.



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Source 17.8 Sunset over view from Cremorne, Sydney, NSW

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Source 17.9 An oblique aerial view of Adelaide and surrounding suburbs

Aboriginal and Torres Strait Islander peoples' perspectives of wellbeing

The notion of wellbeing for Aboriginal and Torres Strait Islander peoples is quite different from that of non-Indigenous Australians. Aboriginal and Torres Strait Islander peoples' wellbeing is collective – it relates to the community, so the wellbeing of the community is of utmost importance. And of course **self-determination** and **reconciliation** are crucial. For non-Indigenous Australians, wellbeing is more about the individual and most likely to be associated with trying to increase their income and wealth as these then have flow-on effects to other forms of wellbeing.

self-determination the right to choose to act in a certain way. The term is most often associated with indigenous peoples around the world and their right to govern and make decisions for the betterment of their people as they see fit.

reconciliation a process of restoring respect and understanding for each other to create positive change in relationships

Aboriginal and Torres Strait Islander peoples' perspectives of wellbeing hinge upon identity and can include cultural attachment, understanding of the Dreaming, cultural continuities, sense of pride and identity,

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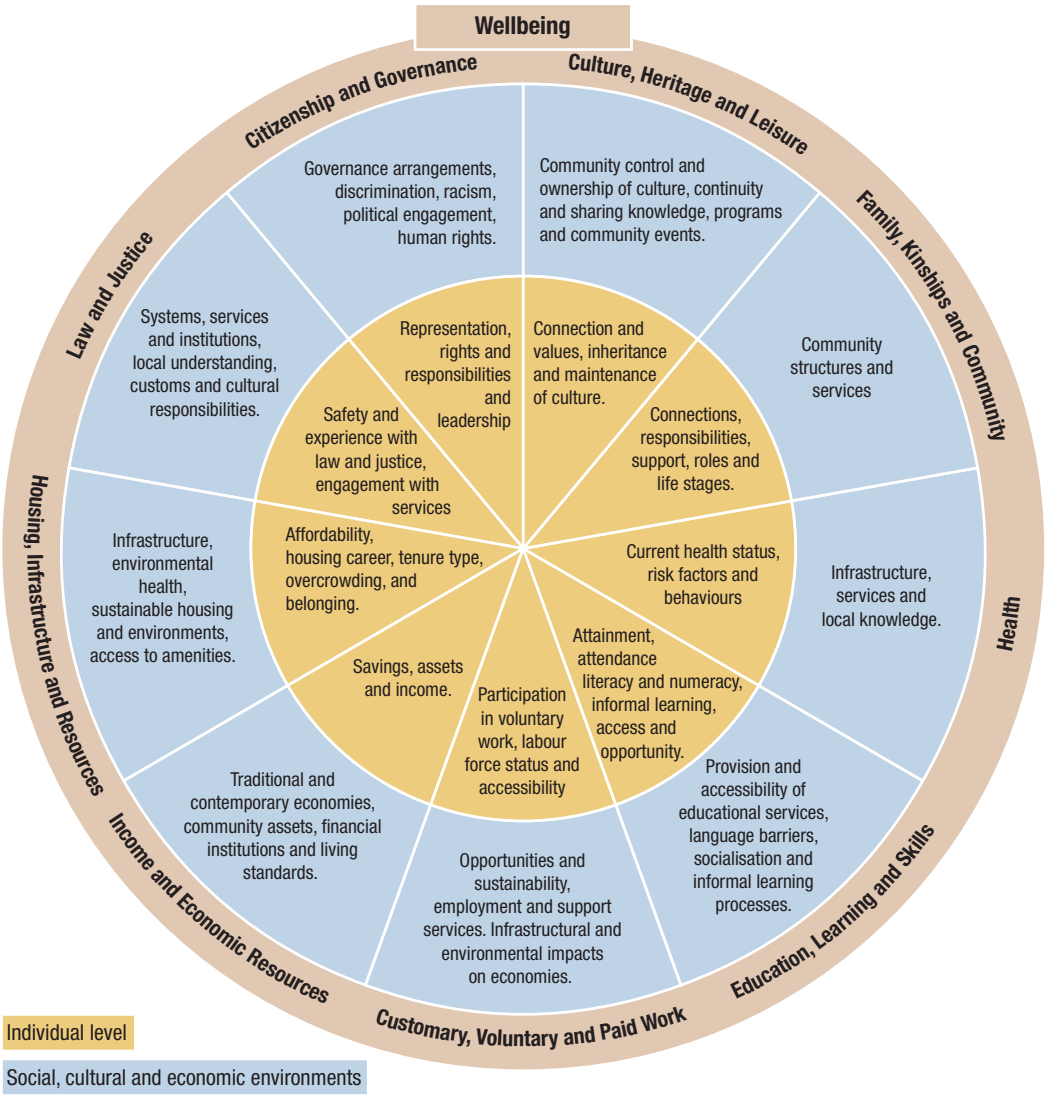

Source 17.10 Aboriginal and Torres Strait Islander peoples' wellbeing framework

control over ways of life and economic **developments**, security for the adequate supply of basic materials, and personal freedom. Together, all the elements combined provide a holistic view of Aboriginal and Torres Strait Islander peoples' wellbeing.

development economic, social and political changes that improve the wellbeing of people

contemporary referring to the current time; modern

Contemporary measures of Aboriginal and Torres Strait Islander peoples' wellbeing have been imposed by various institutions and include things such as social wellbeing, health, and other economic and legal indicators. Measurements are required in order to determine if improvements have been made.

Major attempts to reduce inequalities between Aboriginal and Torres Strait Islander peoples' and non-Indigenous Australians' wellbeing outcomes have been made in the last 15 years in particular – gaps still exist but some improvements have occurred. The Australian Human Rights Commission has reported significant inequalities between Aboriginal and Torres Strait Islander peoples' health outcomes and non-Indigenous health outcomes:

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- Between 2005 and 2007 life expectancy for Indigenous people was 11.5 years below the national Australian average.
- In 2007–09, Aboriginal and Torres Strait Islanders were up to twice as likely to be hospitalised for mental and behavioural disorders as other Australians.
- In 2011, babies with an Aboriginal or Torres Strait Islander mother were twice as likely to be low birth weight (weighing less than 2500 grams), compared to babies with a non-Indigenous mother.
- In 2013, the three leading causes of death for Aboriginal and Torres Strait Islander people in New South Wales, Queensland, South Australia, Western Australia and the Northern Territory were heart disease, cancer and diabetes.
- In 2013, notification rates among Aboriginal and Torres Strait Islander Australians for the majority of communicable diseases like chlamydia and syphilis were higher than among other Australians. Rates of gonorrhoeal infection among Aboriginal and Torres Strait Islander people were 14 times the rates among other Australians.

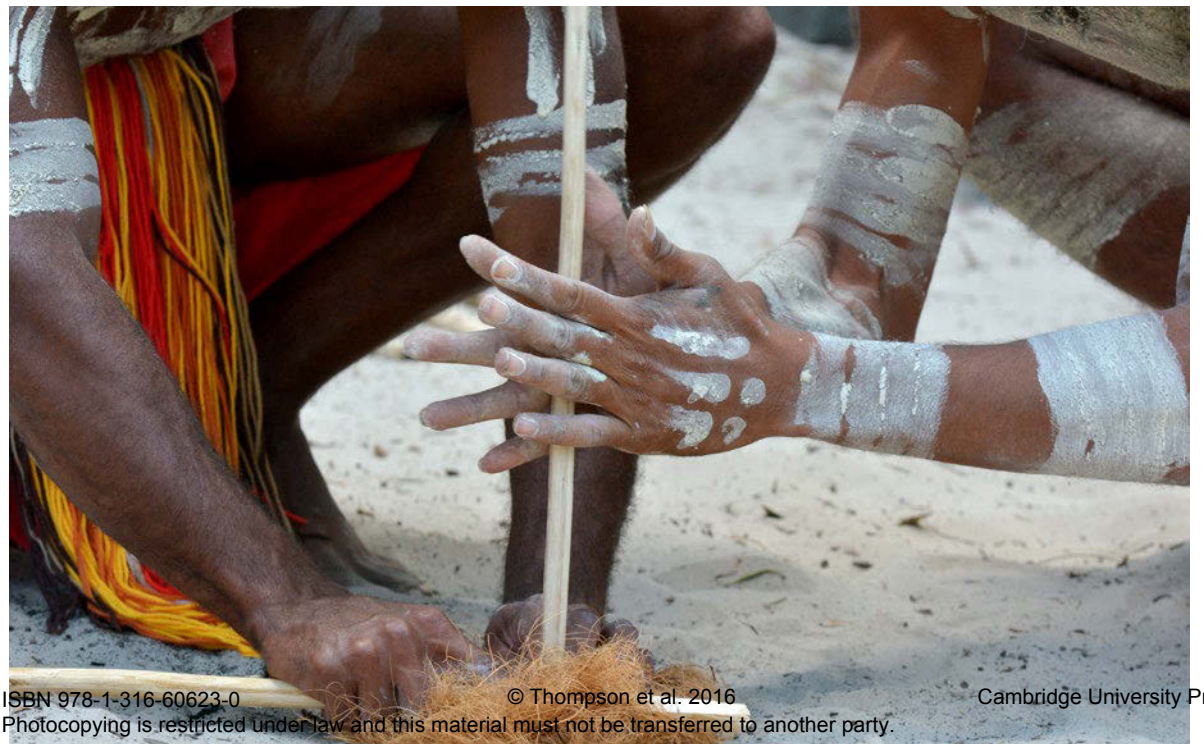
Activity 17.2

1 Describe the holistic approach to Aboriginal and Torres Strait Islander peoples' wellbeing.

2 Explain why self-determination, reconciliation and identity are crucial to Aboriginal and Torres Strait Islander peoples' wellbeing.

3 Compare the health and wellbeing of Aboriginal and Torres Strait Islander peoples and non-Indigenous people.

Source 17.11 Aboriginal warrior men of the Yugambeh people in Queensland demonstrate how to make fire.



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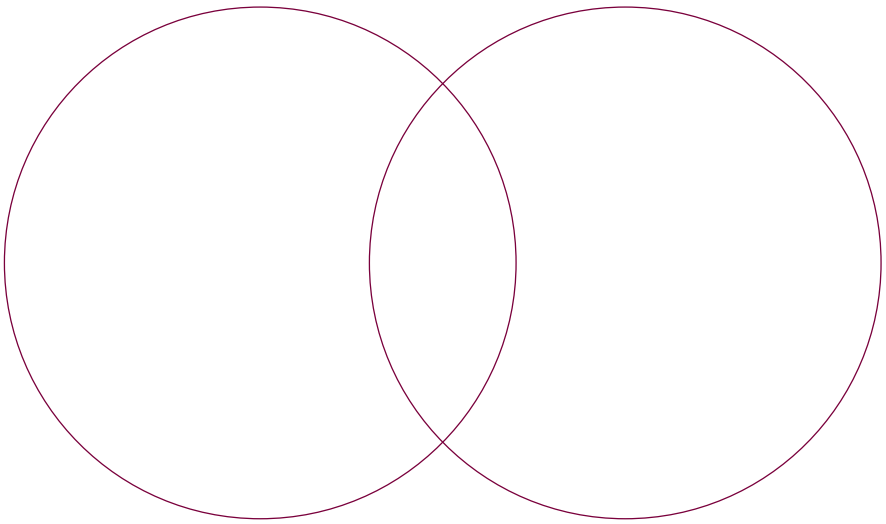
RESEARCH 17.2

Investigate the purpose, implementation and outcomes of the Northern Territory Intervention. Draw conclusions, based upon evidence you collect, to determine whether this strategy to improve the health and wellbeing of Aboriginal and Torres Strait Islander communities has been successful or not. Create a mini documentary of approximately 5 minutes to show your class group. For your documentary you must:

- first, read and research
- write your commentary
- record your commentary (you can download 'Audacity' for free)
- source relevant graphics, news reports and other clips to enhance your documentary
- add any titles, captions, credit and special effects.

Note this down 17.1

Copy the graphic organiser below and compare and contrast non-Indigenous concepts of wellbeing with those of Aboriginal and Torres Strait Islander peoples.



Wellbeing of Australian children and youth

The years of childhood and adolescence are a vital period for developing positive health and social behaviours. These years determine in many ways the future wellbeing of individuals. Improving the living conditions for Australian children and youth, including Aboriginal and Torres Strait Islander youth, recent migrants and those from socio-economically disadvantaged families, is very important in creating the prerequisites for happy lives as young people transition into adulthood.

For example, a healthy family life and maintaining contact with parents in cases of separation (around half of all divorces in

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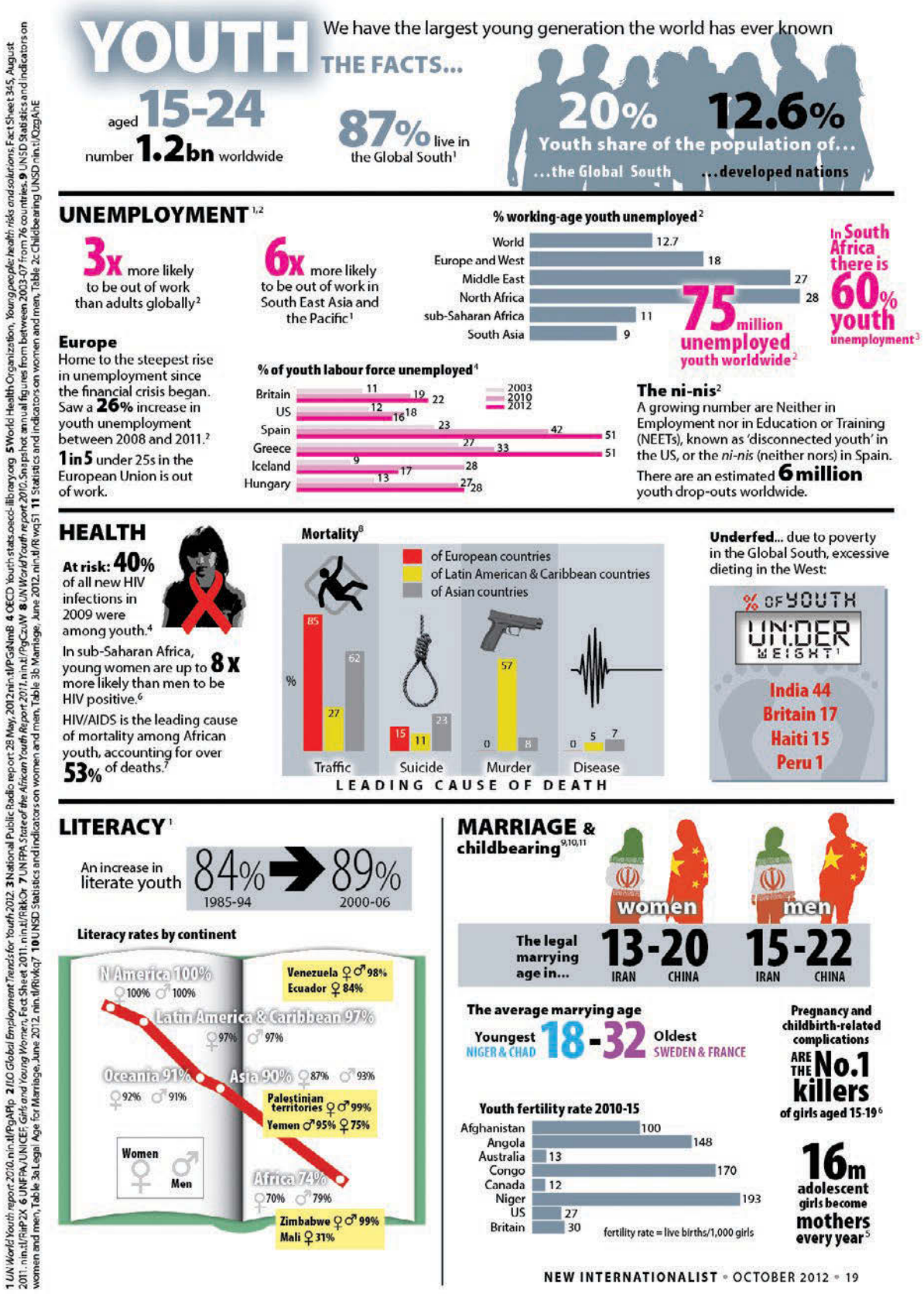

Source 17.12 Youth and wellbeing infographic from *New Internationalist* magazine

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Australia involve children under 18) create a positive social environment for growing adolescents, help prevent mental health problems and provide the best possible start in life. A nutritious and healthy diet within the dietary guidelines for Australians combined with exercise and other physical activities are essential in maintaining good health. These things can help prevent and reduce problems such as obesity and related diseases, maintain physical and emotional wellbeing and, most importantly, set up children, youth and young adults on a happy trajectory allowing them to reach their full potential.

Geographical fact

Australia was the 2nd most desirable country in the world for a child to be born into in 2013.

Source 17.13 Physical activities are essential for everyone including children and young adults.

17.2 Reasons for and consequences of differences in human wellbeing in Australia

There are a variety of social, legal, political and historical forces that have contributed to differences in wellbeing in Australia.

Differences between Aboriginal and Torres Strait Islander peoples and non-Indigenous Australians

The resilience of Aboriginal and Torres Strait Islander peoples is manifested in their capacity to maintain themselves and their culture in a historically imposed foreign culture following

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the European settlement of the continent. Despite being culturally and linguistically diverse, Aboriginal and Torres Strait Islander communities share a culture very different from that of non-Indigenous Australians. Considerations related to conceptions of family structure and community obligation, language, obligations to country and continuation of traditional knowledge are highly important to their wellbeing.

The Australian Bureau of Statistics (ABS) is yet to produce a publication dedicated to Aboriginal and Torres Strait Islander peoples' wellbeing. Instead it uses a long list of issues that cover individual aspects or indicators within a framework of nine domains of Aboriginal and Torres Strait Islander peoples' wellbeing, conceptualised by Aboriginal and Torres Strait Islander peoples' researchers and other stakeholders:

1 Culture, heritage and leisure
2 Family, kinship and community
3 Health
4 Education, learning and skills
5 Customary, voluntary and paid work
6 Income and economic resources
7 Housing, infrastructure and services
8 Law and justice
9 Citizenship and governance.

There is evidence that Aboriginal and Torres Strait Islander communities have poorer levels of emotional, social, economic and health wellbeing than the rest of the Australian population. Below are some examples:

- 25% of Aboriginal and Torres Strait Islander people over 15 live in overcrowded housing; the overcrowding is even higher in remote areas where it reaches 48%.
- The retention rate of Year 7/8 to Year 12 at school is only 49% for Aboriginal and

Source 17.14 Aboriginal and Torres Strait Islander peoples have lower levels of wellbeing than non-Indigenous Australians. Pictured is Arnhem Land artist Glen Namundja busy at work.

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Torres Strait Islander peoples compared to 76% for other students.

- Poverty rates among Indigenous Australians are also much higher; income levels are much lower.
- The rate of community mental services contact for Aboriginal and Torres Strait Islander peoples is often twice as high as that for non-Indigenous Australians.
- Aboriginal and Torres Strait Islander peoples are twice as likely to be hospitalised for intentional self-harm than non-Indigenous people.
- Aboriginal and Torres Strait Islander peoples' children under five are three times more likely to die than non-Indigenous children.
- Aboriginal and Torres Strait Islander people are 12 times more likely to be in prison than other Australians; Aboriginal and Torres Strait Islander youth are 28 times more likely to be in prison than non-Indigenous youth.

Given these alarming indicators, it is not surprising that Indigenous people experience poorer physical and mental health and live shorter lives, approximately 10 years less than the overall Australian population according to the ABS. (The Australian Institute of Health and Welfare claims this difference to be 16–17 years.) They experience higher infant mortality rates and a higher incidence of diseases such as diabetes, respiratory disorders, some cancers, ear and eye disorders, and alcohol-related problems.

According to an ABS study, *National Aboriginal and Torres Strait Islander Survey, 2004–05*, Aboriginal and Torres Strait Islander peoples recorded higher rates of mental health problems:

- 27% of Aboriginal and Torres Strait Islander peoples reported high or very high levels of psychological distress.
- Aboriginal and Torres Strait Islander peoples were twice as likely as non-Indigenous

Source 17.15 The resilience of Aboriginal and Torres Strait Islander peoples is shown in their ability to uphold themselves and their culture.

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Australians to report high or very high levels of psychological distress.

- One in 10 Aboriginal and Torres Strait Islander peoples had visited a doctor or health professional in the four weeks prior to the interview due to feelings of psychological distress.
- Four in 10 Aboriginal and Torres Strait Islander adults indicated that they, their family, or a friend had experienced the death of a family member or a close friend in the previous year.

Despite the significantly poor objective measures of Aboriginal and Torres Strait Islander peoples' wellbeing in Australia, the subjective experiences and life satisfaction of Aboriginal and Torres Strait Islander peoples are less pessimistic. The *2004–05 National Aboriginal and Torres Strait Islander Health Survey* (NATSIHS) reported that 51% of Indigenous adults felt calm and peaceful and 71% had been happy in the previous four weeks.

Note this down 17.2

Copy the graphic organiser below and summarise what you have learned about spatial differences in human wellbeing in Australia.

Vulnerability		
Suburban Australians	**Aboriginal and Torres Strait Islander peoples**	**General**
People living in outer metropolitan areas (where house prices are cheaper but there is limited public transport) are most vulnerable to increases in petrol prices and mortgage interest rates.	Aboriginal and Torres Strait Islander peoples feel vulnerable because they experience high levels of psychological distress.	The majority of Australians are dissatisfied with their level of income despite the country's average income being relatively high. Most people feel vulnerable as there is a large difference between those who earn a lot and the rest.

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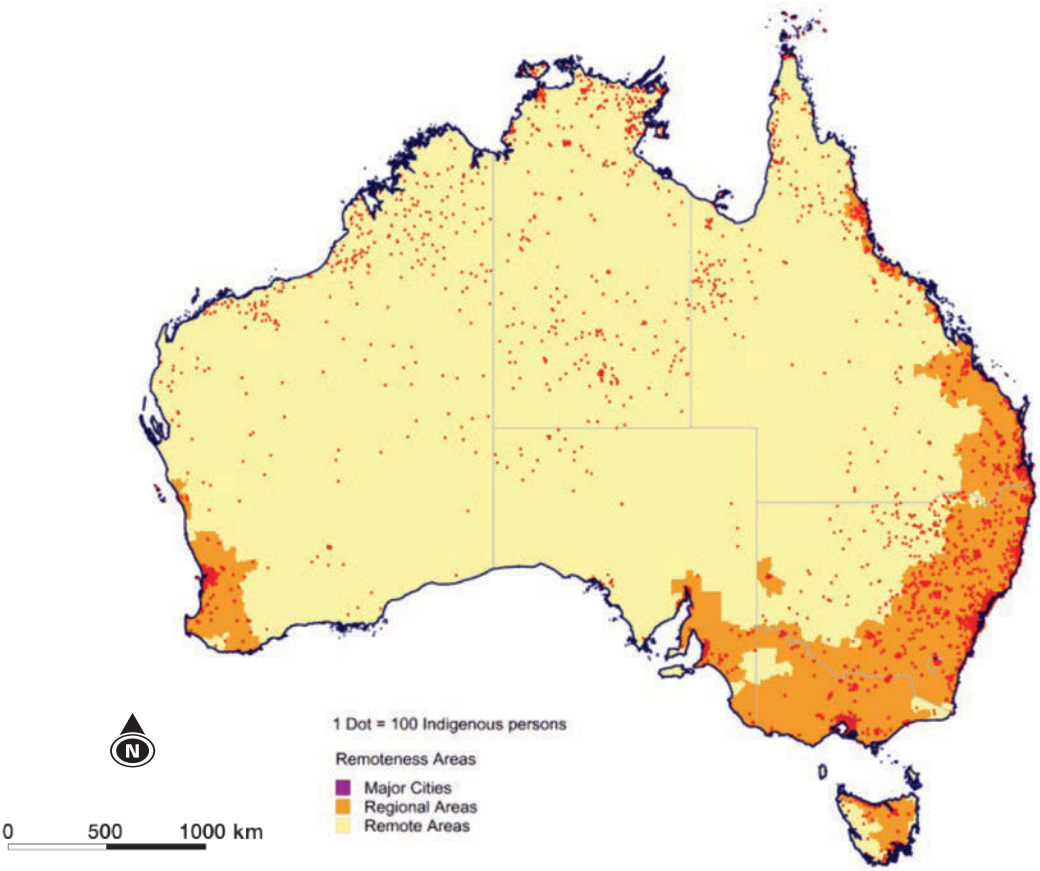
The Australian Bureau of Statistics has found stark differences between the wellbeing of Aboriginal and Torres Strait Islander peoples in remote areas compared to those living in major cities. People in remote areas:

- are more likely to have more children than in other areas; 24% of Aboriginal and Torres Strait Islander women over 40 have five or more children compared to 13% in major cities
- are more likely to report having higher levels of cultural attachment (e.g. speak an Indigenous language at home, participate in cultural activities and identify with a language group)
- experience a high income disparity compared to people in regional areas or major cities
- are more likely to live in overcrowded conditions; 52% of people live in households without a sufficient number of bedrooms
- overall have a greater sense of positive wellbeing than their urban counterparts.



Source 17.16 Population distribution of Aboriginal and Torres Strait Islander peoples

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Activity 17.3

1 List three disadvantages that Aboriginal and Torres Strait Islander peoples in remote areas may face in regard to wellbeing.

2 'Use and occupancy' maps are a type of map that documents how indigenous groups are connected to and use the land. Suggest how these maps can contribute to Aboriginal and Torres Strait Islander peoples' wellbeing.

3 How can the differences in wellbeing between Aboriginal and Torres Strait Islander peoples and non-Indigenous Australians be reduced? What contribution can you personally make?

Remote communities and wellbeing

Where we live can have a huge impact on our wellbeing and also on our health. Across the globe there are huge differences in the location of resources. These are not restricted to physical resources like gold, oil or building materials, but include less obvious resources like clean drinking water and unpolluted fresh air. They include living in a community that has a variety of specialists and services that can improve our health and lifestyles: teachers, farmers, reliable transport systems and health care. A key indicator for the health and wellbeing of any nation is the ratio of doctors to population.

Number of doctors per 10 000 people, 2005–10	
World	8
Mali	less than 1
Madagascar	2
Pakistan	8
Mexico	20
United States of America	24
United Kingdom	27
Australia	30
Austria	49

Source 17.17 Number of doctors per 10 000 people in certain countries

Greater access to quality medical care and information is a primary factor in decreasing mortality, which can take a country from Stage 1 to Stage 2. It is just as important as a country moves towards Stages 4 and 5, as it supports better survival rates of babies through pregnancy and childbirth as well as improved knowledge of contraception. Both of these will help to reduce the fertility rate: the first because greater survival rates mean fewer pregnancies are required to build the family; and the second as it improves the ability to regulate how many pregnancies are wanted by the family.

Access to medical treatment when needed provides not only physical wellbeing but also emotional wellbeing, as there is comfort in the knowledge that the services are available if required. Services are not equally distributed across the globe and these statistics are an effective measure of human wellbeing. It is easy to see how these data could also be used to support fertility and mortality measures of wellbeing.

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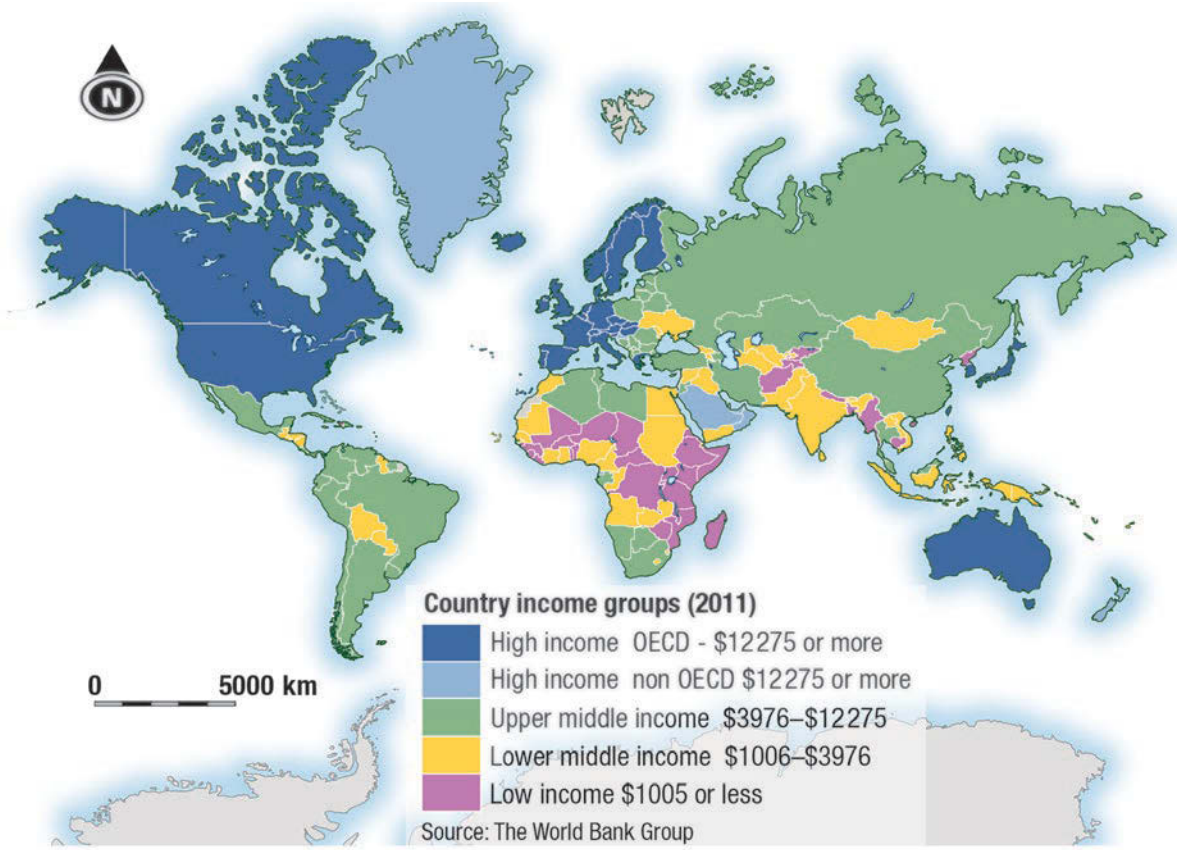

Source 17.18 Map of global incomes

Source 17.19 An ambulance in Eden, NSW

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State/Territory	Number of doctors per 10 000 people, 2011
New South Wales	31
Victoria	33
Queensland	33
South Australia	35
Western Australia	34
Tasmania	37
Northern Territory	44
Australian Capital Territory	47

Source 17.20 Number of doctors per 10 000 people by state/territory, 2011

Region	Number of doctors per 10 000 people, 2011
Major cities	36
Inner regional areas	17
Outer regional areas	19
Remote areas	17

Source 17.21 Number of doctors per 10 000 people by type of region, 2011

The data provide a picture of the current situation, but can also be used to plan where services need to be located in order to achieve a more balanced and equitable distribution of medical services in the country.

RESEARCH 17.3

Many countries have tried to manage their population growth through intervention focused on fertility. Copy the graphic organiser below and use the internet to investigate and compare China's One Child Policy (1970s–2016) and Australia's Newborn Payments scheme (consisting of the Newborn Upfront Payment and the Newborn Supplement), filling in the table with the information you find.

	China – One Child Policy	Australia – Newborn Payments Scheme
What was the government trying to achieve?		
Why was the government trying to change the fertility rate of the country?		
What measures did they put into place?		
How is/was the program implemented/managed?		
Was the program successful?		
Any other information		

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Activity 17.4

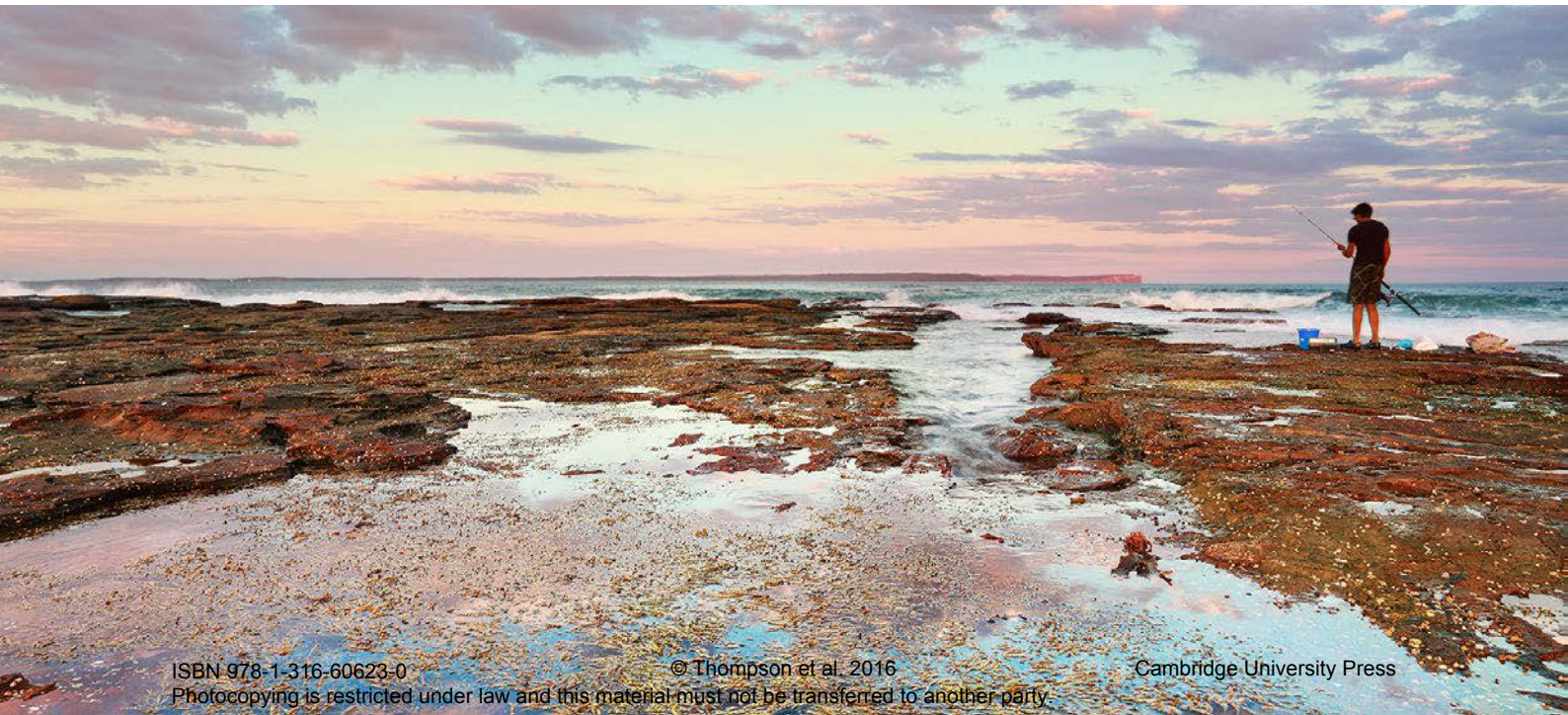
1 Explain how the ratio of doctors to population is an important measure of human wellbeing.
2 Analyse the Australian data on the number of doctors in inner regional areas and remote areas.
3 Present your ideas on why these two very different areas would have the same ratio of doctors to population.

17.3 How human wellbeing is influenced by where people live in Australia

Wealthy suburbs, poorer suburbs and suburbs dominated by particular ethnic, cultural or religious groups have formed in Australian cities. This has occurred for a variety of reasons. People tend to congregate towards like-minded people, but a prime factor in these suburbs is income. Income was once closely linked to family history and education. Those who could afford university went, and those who completed university attained higher paying jobs. But with the rise of information technology, social media and skills shortages in trades, the old-fashioned paradigm has been challenged as to who the wealthy people are.

There are prolonged trends, though, of where the advantaged and disadvantaged people live. Facilities and support have become structured in ways to suit the clientele in a specific area. For example, the retail shops and charities operating in various suburbs can be an indication of the relative wealth of the population there.

Source 17.22 A local fishing off Plantation Point in Vincentia, NSW



census initially the ancient Roman registration of citizens and their property to calculate tax, it is now a count of the population with additional details such as age, sex, occupation, residence, transportation and religion

spatial patterns patterns and trends in where things are located

Patterns of inequality are evident in data collection via the **Census** and academic research. Research by Griffith University's Urban Research Program revealed interesting trends regarding segregation, coexistence, social inclusion, social exclusion and social polarisation in Australian cities. **Spatial patterns** showing where these trends are taking place can then be mapped to provide a visual depiction of wellbeing.

Segregation and coexistence

segregation a division or parting of something

Segregation refers to the separating of people or groups in society. In the past, this has occurred largely to migrants with an ethnic, religious or cultural background different to that of the majority of Australians.

Segregation can lead to a decline in the wellbeing of a city because it is not a positive outcome of government policy or social practice. Segregation can be the result of restriction of activities due to income or language spoken. Segregation may have

Source 17.23 Central Tilba in NSW

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stemmed from the White Australia Policy, where non-Caucasians were not permitted entry into Australia. However, following this, the government pursued a policy of multiculturalism and Australia is now one of the most culturally diverse countries in the world.

coexistence when two or more things or people live together in the same space or place

enclave a pocket of land or territory surrounded by another territory

Such **coexistence** of a range of groups provides Australia with a unique identity and a rich multicultural heritage. Despite this, over time a number of **enclaves**, or pockets within cities, have developed, where people of similar background are concentrated, usually due to familial ties, support structures and sense of comfort settling in. However, now segregation is based more along economic lines, and depending on where you live you may see just one end of the spectrum or anywhere in between – you may see evidence of segregation or different groups coexisting in harmony.

Social inclusion and social exclusion: the elderly and homeless

Cities are complex and dynamic places where life happens at a fast pace. Continual changes mean that some people can be 'left behind', feeling like society is changing rapidly and they have very little involvement or control over events. Social exclusion is about people not feeling connected to society. Their perception is subjective to some extent. The elderly and the homeless are two groups who can feel socially excluded because they may

Source 17.24 Sydney's Lower North Shore

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not be involved in paid work (although many wish to be), they may not have the means or capacity to manage their own affairs due to illness or loss of skills, and they may not be aware of community events or changes.

The wellbeing of society must take into account all people, not just those who can keep pace with rapid change. Social inclusion refers to the opportunity to connect with the community, family and friends, participate in society through avenues such as employment and access to services and be heard. The first person appointed as the Minister for Social Inclusion was Julia Gillard, when she was Deputy Prime Minister to Kevin Rudd.

Social polarisation

polarisation a widening gap between two things, creating stark differences, almost opposite each other

Social **polarisation** refers to the disparity between rich and poor. It is about income inequality. Spatial patterns are evident in Australian cities based upon households with high, middle or low incomes. All Australian state capitals have experienced social polarisation. For example, in Sydney, high-income households tend to be located on the north shore and eastern suburbs.

Spatial patterns tracking income of households build a picture of wellbeing in cities. In the late 1990s Australia underwent significant economic growth, from which the upper and middle classes, many of whom were engaged in the 'new economy', seemed to benefit greatly. However, there was also a growth in poverty, creating a widening gap between rich and poor. In Sydney the outcomes of economic restructuring during the late 1970s and early 1980s resulted in localities on the northern and southern fringes of the metropolitan area becoming more unequal in terms of income and access to viable employment opportunities.

Activity 17.5

1 Describe an enclave.
2 Discuss how it may be possible to have a segregated yet coexisting society.
3 Distinguish between social inclusion and social exclusion.

RESEARCH 17.4

Use the Australian Bureau of Statistics Social Atlases to critically analyse spatial patterns of wellbeing in your state or territory's capital city. In your report you must include the following:

- information on population, cultural diversity, education, labour force, income and housing
- relevant maps
- significant statistics
- reference to specific suburbs or regions within the city.

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Chapter summary

- The OECD Better Life Index is a global measure of wellbeing for countries across 11 areas including education, income, jobs, civic engagement and safety.
- It is important to note that the OECD Better Life Index does not clearly show the wellbeing of Indigenous Australians.
- Aboriginal and Torres Strait Islander Australians tend to have lower levels of wellbeing than non-Indigenous Australians.
- Aboriginal and Torres Strait Islander peoples' perspectives of wellbeing centre upon identity.
- The years of childhood and adolescence are a vital period for developing positive health and social behaviours. These years determine in many ways the future wellbeing of individuals.
- A key indicator for the health and wellbeing of any nation is the ratio of doctors to population.
- There are prolonged trends of where the advantaged and disadvantaged people live in Australia.
- Segregation, the separating of people or groups within society, can lead to a decline in the wellbeing of a city.
- The wellbeing of society must take into account all people, not just those who can keep pace with rapid change.
- Social polarisation, the disparity between rich and poor, is quite pronounced in some parts of Australia.

End-of-chapter questions

Short answer

1 Should social polarisation be used as an indicator of wellbeing? Provide reasons for your answer.

2 Compare and contrast the different perspectives of wellbeing among Aboriginal and Torres Strait Islander peoples and non-Indigenous Australians.

3 Analyse the data on the number of doctors in each state/territory and region in Australia to identify the area that is most likely to need more doctors. Explain your response.

Extended response

Discuss the issue of spatial differences in human wellbeing in your capital city.

- Identify literature sources that discuss human wellbeing for your city.
- Analyse what measurements are used to describe wellbeing and what the outcomes are from this analysis.
- Critically examine the findings from the literature and suggest policies and other measures that could improve the level of human wellbeing.

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18 Improving human wellbeing

Source 18.1 A traffic jam in Karachi, Pakistan. Traffic congestion is often cited as a factor that negatively affects human wellbeing.

Before you start

Main focus

To explore the role of international and national government and non-government organisations (NGOs) in improving human wellbeing in relation to the environment and conflict.

Why it's relevant to us

International and national government organisations play an important role in improving wellbeing. However, not all important issues are dealt with by government organisations, which is why NGOs also work towards improving the impact of conflict and environmental matters.

Inquiry questions

- Which organisations are working to reduce spatial variations in human wellbeing?
- How do conflicts negatively affect human wellbeing around the world?
- What role do individuals play in improving human wellbeing?
- How can different organisations act to improve the wellbeing of Aboriginal and Torres Strait Islander peoples in Australia?

Key terms

- Environmentalism
- Mission
- Non-government organisation (NGO)
- Objective
- Wellbeing

Let's begin

Different types of organisations and initiatives around the world aim to improve human wellbeing. Conflicts around the world have led to individuals and groups fleeing their homelands, sometimes only to find they face dangerous and unliveable conditions elsewhere. Environmental factors are one of the causes of conflict, proving that initiatives targeting environmental sustainability and conflict resolution are important in improving human wellbeing.

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18.1 Initiatives to reduce spatial variations in human wellbeing

It is the goal of every government to improve wellbeing for their citizens. Initiatives aimed at improving wellbeing can be affected by a number of factors.

How Australians' wellbeing can be improved

Despite the relatively good scores Australia has in the OECD Better Life Index, there are still areas that can be improved, for example, income and work–life balance. The average annual income per person in Australia in 2015 was A$40 248. This is 23% better than the average OECD citizen, but the income component of Australia's Better Life Index is only 4.9 (out of 10). The main reasons for this are the big disparities between those who have large earnings and those who don't. In fact, in Australia the top 20% of the population earn almost six times as much as the bottom 20%. Even if the average figures look satisfactory, the actual wellbeing of Australia's population is affected by these stark contrasts in the earning levels of its people.

Another area affecting the wellbeing of Australians is work–life balance. Australians spend a lot of time working. According to the OECD data, 14% of Australian employees work very long hours (that is, more than 50 working hours per week), compared to the 9% OECD average, but Australia's country average of 1728 hours per year is below the OECD average of 1765. The Australia Institute, however, estimates that Australians work the highest number of hours in the developed world.

Long working hours can have many negative consequences for individuals and their families, including high levels of stress; impaired health; jeopardised safety; and

Source 18.2 The Australia Institute estimates that Australians work the highest number of hours in the developed world.

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less time spent on personal care, household activities, cooking and meal preparation, leisure, hobbies, and activities with family and friends. While the health score for Australians is still relatively high, there are a range of health problems that are directly or indirectly linked to the unsatisfactory work–life balance. For example, 60% of adult Australians are overweight or obese; by 2031 it is expected that more than 3 million Australians will have the lifestyle and food-related Type 2 diabetes.

The OECD Better Life Index is a combination of 10 objective measurements and one subjective personal experience, namely life satisfaction. Overall, Australians appear to be quite content with their life but there are some differences and people with a lower socio-economic status generally report lower levels of happiness.

Australia	OECD average
The average Australian earns US$31 197 a year	The OECD average earnings per person is US$23 938 a year
Over 72% of Australians aged 15–64 have a paid job.	The average OECD employment rate for the 15–64 age group is 66%.
The average Australian student scored 512 in reading literacy, mathematics and science in the OECD's Program for International Student Assessment (PISA).	The OECD PISA average is 497.
Australia's life expectancy at birth is 82 years.	The average OECD life expectancy at birth is 80 years.
93% of Australians believe that they know someone on whom they could rely in a time of need.	The OECD average of people who know somebody on whom they can rely in a time of need is 89%.
The level of atmospheric PM10 (tiny air pollutant particles which can enter and cause damage to human lungs) is 13.1 micrograms per cubic metre.	The OECD PM10 average is 20.1 micrograms per cubic metre.
83% of Australians say that in an average day they have more positive experiences (such as feelings of rest, pride in accomplishment and enjoyment) than negative ones (such as pain, worry, sadness and boredom).	The OECD average for people who have more positive than negative experiences in an average day is 76%.

Source 18.3 Australia and OECD Better Life Index, 2014 comparison

Activity 18.1

1 Consider human wellbeing studies like Source 18.3. List some ways such a study can reveal information about human wellbeing, and also some limitations.

2 Discuss some reasons why 14% of Australian employees work very long hours.

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How global wellbeing can be improved

non-government organisations (NGOs) not-for-profit groups that work outside of government control

One of the most important roles of governments and **non-government organisations (NGOs)** like Oxfam or the Red Cross in improving wellbeing is how they help support those suffering from conflict. Generally speaking, the countries with the greatest wellbeing tend to be those with less conflict. Conflicts around the world have led to individuals and groups fleeing their homelands, sometimes only to find they face dangerous and unliveable conditions elsewhere.

Source 18.4 Red Cross workers in action

The impact of conflict

armed conflict severe conflict involving weapons and firepower such as tanks, guns, bombs, air strikes etc

inter-state conflict combat between two different nation-states

Conflict can take many different forms; some of the most common **armed conflicts** are defined below. These severe types of conflict often result in injury and death with obvious impacts on human wellbeing.

- **Inter-state conflict** – between two nation-states
- Intra-state conflict – within a **nation-state**, otherwise known as **civil war**; a rebellion to overthrow the government
- Extra-state conflict – reprisal against **colonisation**. Anti-colonial conflicts tended to end in the 1970s
- **Coup d'état** – violent and undemocratic change by the military. Eighty such violent

nation-state a group of people (nation) governed within a certain area (state). Also known as a country.

civil war a war involving conflict between regions of the same country

colonisation the establishing and development of colonies in a country

coup d'état a sudden and violent appropriation of leadership

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changes of government have occurred in Sub-Saharan Africa during the last 4 decades.

- Urban violence – tends to be intermittent rather than ongoing. There may be a spate of shop looting or attacking houses of the wealthy; for example, in Zimbabwe, white famers were attacked. Now it is more about reacting to poverty and struggles between supporters of political parties.

New forms of conflict have developed since World War II involving warlords, gangs and terrorist and **guerrilla groups**. There are also different methods of fighting, such as targeting tourist sites and civilians rather than the more traditional fighting documented as having taken place on battlefields.

guerrilla group different from a traditional army; people are involved in a style of warfare that is smaller in scale but aims to affect the enemy all the same. It often includes sabotage and surprise attacks (ambushes).

Source 18.5 (Left) Thai Army officers patrol the city of Bangkok, Thailand after the Thai Royal Army coup d'état against the government on 23 May 2014. (Right) This event caused many people in the country to protest at the undemocratic takeover, and greatly affected the wellbeing of the Thai people.

Geographical fact

Between 1987 and 2007 Fiji averaged one coup every 5 years.

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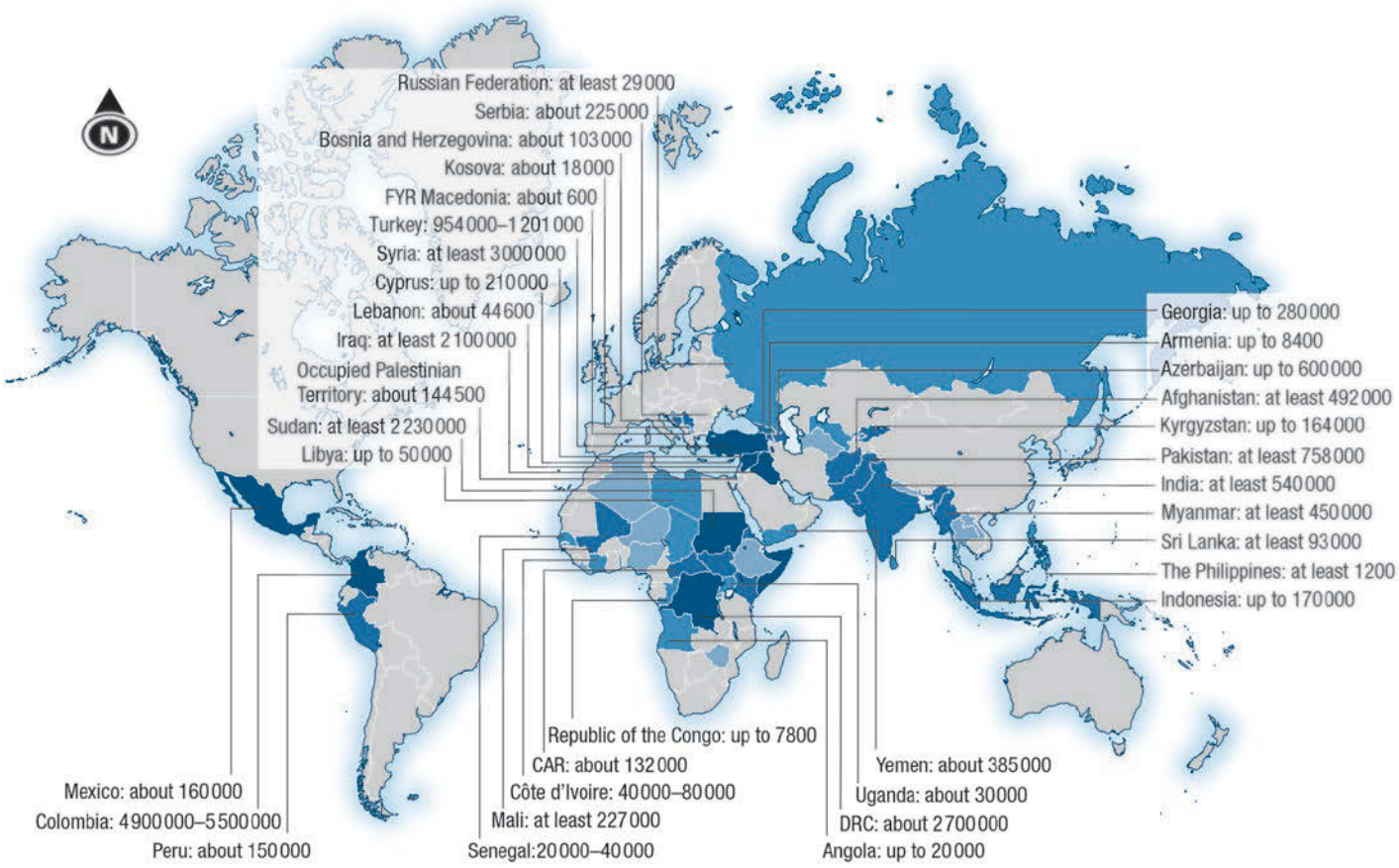
The United Nations

The devastating impacts of World War II on human wellbeing largely led to the formation of the United Nations (UN). Its specific purposes are to:

- Maintain international peace and security – prevent and remove violence, settle international disputes
- Help develop friendly relations between countries – via respect, equality and self-determination
- Achieve international cooperation – solve humanitarian issues; promote human rights and freedoms, including freedom from discrimination for all people
- Be a place where the above activities can take place.

Developing countries experience more war than developed countries like Australia because there is usually a lower level of access to socially valued resources such as adequate housing, education, health and employment; in addition, there is a lower level of wealth due to a range of factors such as colonisation, government mismanagement and lack of productive environmental resources. As a result of diminished access and opportunity, fierce competition can arise due to individuals and groups seeking to improve their own level of wellbeing. Such competition means many



Source 18.6 World map showing the countries with the highest numbers of people internally displaced through conflict

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countries experience violence, the formation of rebel groups or militia, political controversy and injustice.

Civil wars often cause people to flee their home countries in search of a better life. Refugees may be fleeing because their political, environmental, economic or religious rights have been curtailed and they seek to improve their level of wellbeing in another location.

Geographical fact

According to the UNHCR, developing countries host over 86% of the world's refugees today, compared to 70% a decade ago.

RESEARCH 18.1

Scenario: The UN wish to undergo a review of their current practices and policies in order to become more effective. They have selected your class to provide an independent and unbiased report to the General Assembly later this year. In groups, you will evaluate the effectiveness of the United Nations in improving wellbeing at a global scale and provide related recommendations.

Each group will investigate a different aspect of the UN and present their findings to the class or broader audience. Remember, that 'evaluate' means to make a judgement based on criteria.

Group 1 – The state of the world's children (UNICEF)	**Group 2** – The UN Refugee Agency (UNHCR)	**Group 3** – International Court of Justice (ICJ)
Group 4 – World Food Program (WFP)	**Group 5** – World Health Organization (WHO)	**Group 6** – International Monetary Fund (IMF)

In your presentation you will need to include:

- a brief overview of your allocated branch of the UN
- current practices and programs and how they seek to improve wellbeing
- international commentary/critique of practices
- case study/illustrative example
- recommendations
- relevant statistics, facts, graphics or video clips to engage the audience.

18.2 Role individuals play in improving human wellbeing

Many conflicts around the world are a result of environmental issues and competitiveness for natural resources. The condition of the environment also contributes to human wellbeing; for example, healthy landscapes, pristine areas and precincts set aside for production or agriculture actually help to improve the health of the population. This is why, like groups resolving conflict, there are many government organisations and

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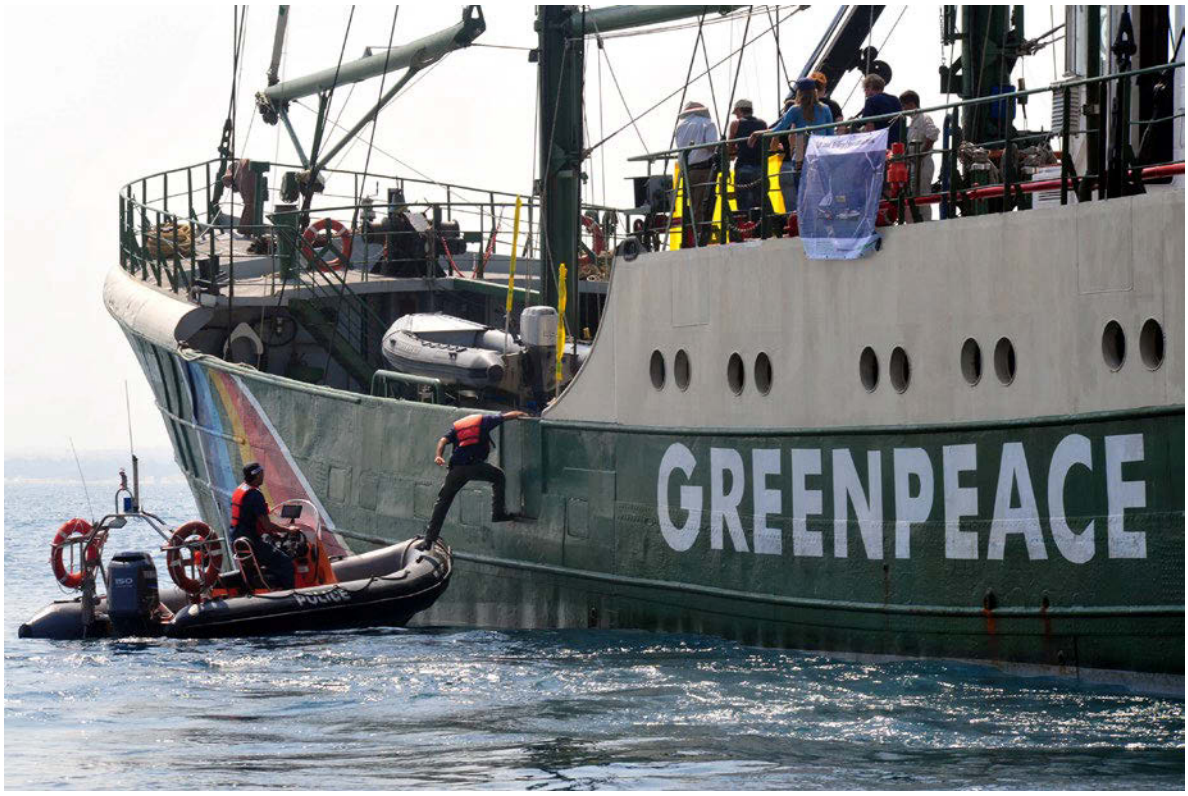
NGOs dedicated to improving environmental sustainability.

There are also many things we can do as individuals such as signing a petition; participating in reconciliation day activities at school; volunteering for Clean Up Australia day; donating to the Red Shield Appeal; writing letters for Amnesty International; starting a small action group at school or becoming part of the SRC; making small changes in and around the home and community to improve wellbeing in the local area; or helping an elderly or disabled person in need. Individuals can also form groups, which can be very effective and improve the wellbeing of members and those they support. An example of such a group is Greenpeace.



Source 18.7 Greenpeace is an example of how individuals can group together to take action in an effort to improve overall wellbeing.

The emergence of environmentalism

environmentalism advocacy for the protection of the environment from destruction and/or pollution

The industrialisation of Europe and the USA triggered the emergence of modern **environmentalism**. During the eighteenth century, communities and prominent members of society in the USA lobbied to stop industry from dumping waste into waterways. In the nineteenth century, a conservation movement gained momentum in the USA and lobbied against the over-exploitation of forests and other natural resources. In the late nineteenth century British intellectuals objected to the industrialisation of England and lobbied for social reforms and a return to a simpler lifestyle and activities that did not harm the natural environment. This pressure group is considered an early version of the

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'Back to Nature' movement that became well established across the world in the twentieth century and a cultural phenomenon that persists today. The belief that humans are capable of de-materialising and living sustainably in harmony with nature was widely embraced in the twentieth century and fuelled the growth of environmentalism.

Increased environmental activism and a change in attitudes towards development and its impacts on the environment fostered the establishment of groups such as Greenpeace and Friends of the Earth. The first Earth Day was observed in San Francisco in March 1970 and is now celebrated by over 175 countries. Earth Day raises awareness of the importance of managing the environment for all living things.

Earth Day events are run by both global and local groups and can include activities like tree planting, clean-ups, education sessions and concerts.

The increase in environmental activism in the 1960s and 1970s encouraged governments to establish departments and agencies with the primary responsibility of managing development and the natural environment. Environmental laws were also enacted in many countries to protect endangered species and reduce or prevent the impact of development on the environment.

Environmentalism in Australia

Environmentalism in Australia grew rapidly after World War II, by which time the effects of land degradation were felt throughout the nation. The post-war boom in development, fuelled by an increase in manufacturing, the construction of new infrastructure and increased urbanisation, sparked more concern for the environment. Insecticides and other toxic chemicals were widely used in the 1960s and 1970s. Lessons were learned from experiences in other developed nations and stricter controls were introduced to minimise impacts.

Source 18.8 An environmental activist holding the proposed flag for Earth Day during the International Day of Climate Action 2009 in Washington

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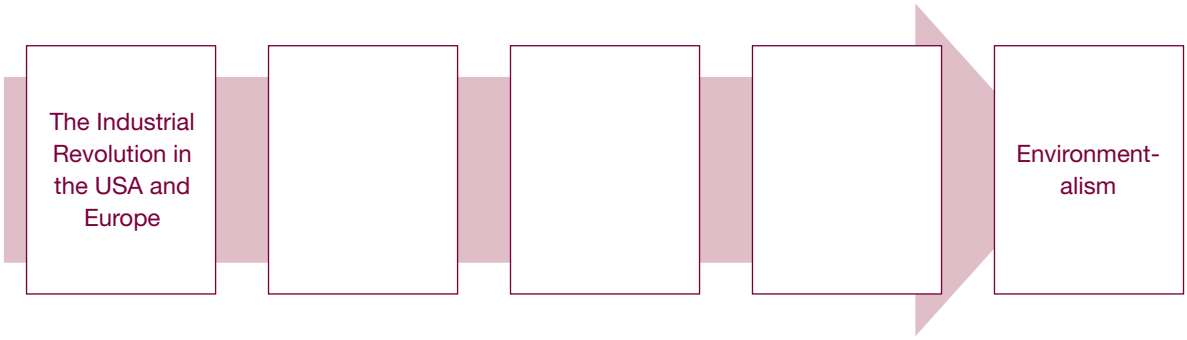
Australia's first minister in charge of environmental affairs was appointed in 1970. State Ministers for the Environment were also appointed and Australia embarked on a new era of environmental management that included the creation of environmental laws and the establishment of various government agencies that are involved with environmental management and sustainability.

Note this down 18.1

Copy the graphic organiser below and use the flow chart to summarise the emergence of environmentalism. The first point has been completed for you. Add more boxes as needed.



Activity 18.2

1 Why is Earth Day a significant annual event?
2 Is environmentalism still influencing our attitudes towards development and its impacts on the environment? Provide one example from your local area.
3 In what ways have you been influenced to think about sustainability?

18.3 Action to improve wellbeing

Many organisations aim to improve wellbeing at different scales.

International and national government responses to conflict

The United Nations Security Council and the North Atlantic Treaty Organization (NATO) are powerful bodies comprising a number of nations that make decisions about intervention in conflicts; for example, whether to use drone strikes and other methods. Some decisions are highly sensitive in nature because differences in judgement arise due to different socio-cultural and economic perspectives and political alliances between countries. This certainly affects the decision making process, as one nation may see intervention as good and morally worthwhile, while another may see it as an attack on their sovereignty.

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Some people claim that intervention does not necessarily end or reduce the conflict. Early intervention by the UN has been found to significantly reduce conflict, but intervention by international bodies such as NATO is not a significant factor in reducing conflict. If there is to be intervention, it must be appropriate, empowering for locals and sustainable. Intervention and the deployment of thorough peacekeeping/peacebuilding **missions** have helped improve opportunities for peace.

mission an important assignment carried out due to wishes of the government or an important organisation

Source 18.9 Peaceful demonstration in Munich, protesting NATO and depicting the organisation as an octopus in Europe. The banner reads 'No friendship with NATO'.

Improving the state of conflict

objective a set goal

The United Nations have established a number of bodies with the **objective** of improving the state of conflict throughout the world. These bodies include the Security Council, General Assemblies, Peacebuilding Commission, Disarmament Commission, Conference on Disarmament and Committee on the Peaceful Uses of Outer Space. These bodies approach many issues, including

Geographical fact

Every 21 September, the UN hold the International Day of Peace, a day devoted to strengthening the ideals of peace. It is a chance for world leaders to meet to work towards a goal of sustainable peace.

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disarmament, terrorism, peacekeeping, organised crime, women, peace and security. Different strategies are adopted by these bodies to aid with improving human wellbeing for countries in need. The UN carries out missions to many countries.

Non-government organisation responses to conflict

Although government organisations strive to improve human wellbeing and close the chapter on conflict nationally and internationally, efforts from non-government organisations (NGOs) are also important. NGOs possess the strengths of being able to reach the most vulnerable and rely on public support and voluntary contributions. NGOs cover a range of sectors including development, human rights, the environment and peacebuilding. They provide active local, national and international support and can focus on sensitive areas government organisations may miss.

Source 18.10 The Ikea Foundation is an NGO that has partnered with the UNHCR to improve wellbeing for children in developing countries, like this child in Nepal.

RESEARCH 18.2

Use the internet to research NGOs in Australia (e.g. Oxfam, MSF, Amnesty International). Select one that supports a cause you feel passionate about. With the information you gather on the organisation, prepare a presentation for the class explaining who they are, what they do and any success stories they have. Finish the presentation by identifying why you feel strongly about this organisation.

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Improving wellbeing in Australia: fostering relationships between land managers and Traditional owners

Tension between Traditional landowners and land managers had been evident in Australia since the arrival of the European settlers. After decades of conflict and disagreements, organisations have put in place projects to improve relationships with Traditional Owners, for the benefit of the environment and for members of communities and all-round wellbeing.

NGO Landcare Australia uses locally based community groups to care for the natural resources of Australia. In 2011 Landcare Australia completed the project titled 'Building relationships between land managers and Traditional Owners' with success.

The project

Through the 'Building relationships between land managers and Traditional Owners' project, the Merri Creek Management Committee (MCMC) further developed their relationship with the local Indigenous community, the Wurundjeri People, through a range of community projects and activities. Previously, they had focused on arts and culture to engage with the Wurundjeri People; however, this project extended the relationship to encompass the cultural context of the landscape including vegetation management. The Be Natural funding supported the two organisations to develop a wide-ranging partnership which enabled Wurundjeri people to play an active role in natural resource management.

The Merri Creek flows about 60 km from the Great Dividing Range through Melbourne's

Source 18.11 The Merri Creek has long been an important natural source of life and wellbeing to the traditional owners of the land, the Wurundjeri People. *Aboriginal people fishing and camping on Merri Creek*, painting by Charles Troedel, 1864.

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northern suburbs to the Yarra River. Tributaries of the Merri Creek include Edgars, Merlynston, Central, Curly Sedge, Aitken and Malcolm Creeks.

The Merri Creek is an environmental, heritage and recreation area that draws its significance from its role as a continuous habitat corridor. All areas of the creek are important because they contribute to the linking of areas of environmental, heritage and recreational value. The Merri Creek and its immediate surrounds are host to some of the most threatened ecosystems in Australia. The creek has a unique role to play in the preservation of threatened flora and fauna and the maintenance of vegetation communities that in other places have been almost totally destroyed, including native grasslands and native grassy woodlands of the Victorian Volcanic Plains.

Source 18.12 A pedestrian footbridge over the Merri Creek in Melbourne

MCMC worked with Wurundjeri Tribe Land and Compensation Cultural Heritage Council and Traditional Owners to plan and implement a range of land management and cultural activities, including participation in traditional grassland burns, two Indigenous digging activities and an information exchange day. MCMC's Parkland Team also increased their awareness and respect for the cultural context of their land management work. Wurundjeri people along with MCMC attended Kalkallo Common on 25 November 2011 as the site for the information exchange day. Kalkallo Common contains native grassland where the yam daisy, once a staple Wurundjeri food, still survives today. MCMC hosted the day and shared information about the grassland area.

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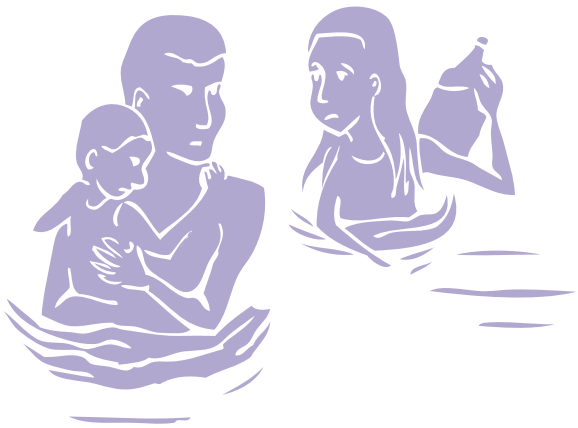
Source 18.13 Traditional grassland burning

Activity 18.3

1. Suggest how projects like the 'Building relationships between land managers and Traditional Owners' project improves relationships between land managers and the Traditional owners.
2. Identify how this project improves human wellbeing.
3. Describe the role the Merri Creek plays in the preservation of the ecosystem.
4. Explain why Aboriginal and Torres Strait Islander peoples' land management activities are so suitable for Australian land.



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Chapter summary

- Despite the relatively good scores Australia has in the OECD Better Life Index, there are still areas that can be improved, such as income and work–life balance.
- The countries with the greatest wellbeing tend to be those with less conflict. Conflicts around the world have led to individuals and groups fleeing their homelands, sometimes only to find they face dangerous and unliveable conditions elsewhere.
- One of the most important roles of governments and non-government organisations (NGOs – not-for-profit groups that work outside of government control) in improving wellbeing is how they help support those suffering from conflict.
- The condition of the environment contributes to human wellbeing.
- There are many things we can do as individuals to help improve wellbeing, such as signing a petition, or volunteering time and effort or financially. Individuals formed the environmentalism movement in Australia after World War II.
- The United Nations Security Council and the North Atlantic Treaty Organization (NATO) are powerful bodies comprising a number of nations that make decisions about intervention in conflicts, to improve wellbeing.
- Government organisations utilise the strengths of NGOs by often partnering with them to improve wellbeing.
- In Australia, after decades of conflict and disagreements, organisations have put in place projects to improve relationships with Traditional Owners, for the benefit of the environment and for members of communities and all-round wellbeing.

End-of-chapter questions

Short answer

1 Describe how an NGO works alongside government organisations to improve human wellbeing.

2 Examine how the environmentalism movement in Australia is an example of ways that individuals can contribute to improving human wellbeing.

3 Analyse the extent to which conflict impacts wellbeing. Use examples to support your answer.

Extended response

Try to imagine a world without environmentalism. Research all the benefits of the emergence of environmentalism in Australia. Consider these benefits and prepare an essay describing what Australia would be like without environmentalism. Consider human wellbeing, Aboriginal and Torres Strait Islander peoples and sustainability.

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Glossary

This glossary includes terms and definitions from the digital versions of the textbook.

abiotic relating to non-living organisms such as air, light and water

Aboriginal law beliefs and expectations recognised by Aboriginal peoples

absolute location the exact position of something. The address of a place can give this, as can latitude/longitude.

accrete to make larger or greater, as by increased growth

aerial photograph image taken from the air showing characteristics of an area. It may be at an oblique angle (slanting angle) or a vertical angle (straight down).

aesthetics the value or appreciation of something due to its beauty

agrarian agricultural, farming-based activity

agrochemicals any synthetic materials such as fertilisers or pesticides that are used to support or improve agricultural practices

air pollution when the air contains gases, dust, fumes or odours in harmful amounts

alkali a substance with a basic pH (opposite to acid)

alluvial sediment deposited by flowing water, as in a riverbed, flood plain, or delta

alms food, money or other goods given to the needy as charity

animal husbandry the agricultural practice of breeding and raising livestock

anthropogenic human-made

aquaculture the cultivation of aquatic animals or plants in a natural or controlled environment

arable land used or suitable for growing crops

archipelago a group of islands

arid dry; characterised by severe lack of water

armed conflict severe conflict involving weapons and firepower such as tanks, guns, bombs, air strikes, etc.

artisanal made by a skilled manual worker; using low technology

aspect the direction a slope faces

asylum seeker a person whose claim for refugee status has not yet been approved

ballast waters water that is pumped in and out of ballast tanks on board a vessel to increase the draft, change the trim, regulate the stability or to maintain stress loads

bauxite aluminium ore; the rock from which aluminium powder is extracted

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

bioaccumulation the accumulation of a substance, such as a toxic chemical, in the tissues of different organisms in a food chain

biodiesel a type of biofuel used as a substitute for diesel and manufactured from animal waste products, such as tallow

biodiversity the variety of living organisms and the environments they form

biofuel fuel produced using plant material, e.g. ethanol, biogas

biomass the mass of organisms per unit area

biome a major terrestrial vegetation community, e.g. a tropical forest, a temperate grassland or a desert

biomimetics the study of the structure and function of biological systems to create models for the design and engineering of materials and buildings

biosphere all the life forms and environments on or near Earth's surface that are capable of sustaining life

biotic relating to living organisms such as animals and plants

borough a subdivision of certain cities

cadastral a public record, survey, or map of the value, extent and ownership of land as a basis of taxation

caldera a large crater formed by the collapse of land following a volcanic eruption – often as a result of magma being expelled and the resultant reservoir having the land above it collapse

canal estates any development that requires a constructed waterway, canal or water body that is then inundated by or drains to a natural water body

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cartographic conventions accepted practices associated with constructing and interpreting maps, e.g. using a border, orientation or compass point, legend or key, title, scale, giving latitude readings before longitude

caste any group or class of people who have exclusive privileges or are perceived as socially distinct

catchment area the area drained by a river or water body. Also known as a river basin.

census initially the ancient Roman registration of citizens and their property to calculate tax, it is now a count of the population with additional details such as age, sex, occupation, residence, transportation and religion

civil war a war involving conflict between regions of the same country

climate the average types of weather, including seasonal variations, experienced by a place or region over a long period of time

coast a much wider area of land and water beyond the shoreline where terrestrial and marine processes interact

coastal erosion the gradual loss of material from a coast by the action of wind and waves

coastal lowlands an area of low-lying ground close to estuarine and marine environments

coastal stakeholders individuals, organisations, community groups or government agencies that have an interest in, or are affected by, use of coastal resources

coastal system interconnected components which interact to form coastal processes

coexistence when two or more things or people live together in the same space or place

colonisation (human societies) the establishing and development of colonies in a country

colonisation (plant or animal) the process by which a species enters a new area and dominates it

commodity a product that can be bought and sold

composite made up of many things

coniferous tree an evergreen tree that grows cones

conservation the protection of plants and animals, natural areas, and interesting and important structures and buildings, especially from the damaging effects of human activity

contemporary referring to the current time; modern

contingency plan a plan designed to help an organisation respond to a future event or uncertain situation

cormorant fishing a fishing method long used in China and Japan in which fishermen use trained birds – cormorants – to fish in rivers. Today the method is mainly used to entertain tourists.

Country/Place Country is a space mapped out by physical or intangible boundaries that individuals or groups of Aboriginal peoples occupy and regard as their own. It is a space with varying degrees of spirituality. Place is a space mapped out by physical or intangible boundaries that individuals or groups of Torres Strait Islander peoples occupy and regard as their own. It is a space with varying degrees of spirituality.

coup d'état a sudden and violent appropriation of leadership

cross-shore sand transport the process that moves sand perpendicular to a beach or coastline

cultural integration the process of drawing together various elements of a cultural system, such as ethnic groups, into a wider community

custodians people given the responsibility for keeping a sacred site safe; usually the custodian(s) will 'belong' to the site

dam a barrier constructed to hold back water and raise its level, forming a reservoir used to generate electricity or as a water supply

deciduous refers to trees and shrubs that lose their leaves seasonally, usually during autumn

degradation a loss of quality

demographer a person who works with statistics to examine populations

depressions hollowed-out areas in the sea floor, often the result of local currents

desert an area that receives less than 250 mm rainfall per year

development economic, social and political changes that improve the wellbeing of people

disaggregated separated or broken up into different parts

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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

dissolution the action of ending an agreement and breaking up into separate parts

drainage diverting or removing excess water from land or soil

drainage basin an area drained by a river system which includes all areas that gather precipitation water and direct it to a body of standing or streaming water

dredging the use of any of various machines equipped with scooping or suction devices, used to deepen harbours and waterways and in underwater mining

dryland agriculture farming that depends only on natural rainfall and soil moisture to water crops

ecological footprint the measure of human demands on the Earth's ecosystems

ecologically sustainable development (ESD) the environmental component of sustainability that is embedded in environmental decision making in Australia. It also considers the need to meet economic and social development goals.

ecology the way in which everything living interacts with the world around it

economic restructuring an economy moving from a manufacturing base to a service base

egalitarian providing equality for everyone in terms of social, political, economic and civic rights

El Niño (Spanish for 'the boy child') during an El Niño pattern, pressure at sea level is lower in the eastern Pacific and higher in the western Pacific. The opposite happens with a La Niña pattern.

emigrants people who leave their country to permanently live in another

empirical information from observations and experiments

enclave a pocket of land or territory surrounded by another territory

entrepreneur someone who takes a risk in owning or operating a business

environment the living and non-living elements of the Earth's surface and atmosphere. Where unqualified, it includes human changes to the Earth's surface, e.g. croplands, planted forests, buildings and roads.

environmental degradation a change or disturbance to the environment perceived as harmful or undesirable

environmental functions processes of an ecosystem that support human life and economic activity

environmental impact assessment an assessment of positive and negative impacts an action or project will have on the environment

Environmental Impact Statement (EIS) a document that outlines the main activities of a development, predicts the potential impacts and describes strategies to minimise or prevent environmental impacts

environmental management an attempt to control human impact on and interaction with the environment in order to conserve the 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

environmentalism advocacy for the protection of the environment from destruction and/or pollution

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

ephemeral lasting for a very short time

epilimnion the upper, warm layer of water

epiphyte a plant that grows on another plant but tends not to be parasitic; instead it survives on nutrients from the rain, air and debris around it rather than the plant it is attached to

erosion a natural process that gradually wears down a surface area

estuaries the wide lower course of a river where fresh and marine water mix

estuarine relating to the wide lower course of a river where it nears the sea and there is typically a mix of fresh and salt water

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ethanol an alcohol as well as a type of biofuel that is derived from fermentation of sugars or starch

ethical protocols the application of fundamental ethical principles when undertaking research and collecting information, e.g. confidentiality, informed consent, citation and integrity of data

eutrophication an environmental response to high nutrient concentrations. Algal blooms and bacteria can deplete oxygen and degrade habitat.

extensive agriculture crop or livestock production over large areas of land which requires fewer inputs such as labour, e.g. wool production

external migration migration to another country

extraction stripping away vegetation and removing topsoil in dunes, in order to mine the sands

favela highly populated urban slum areas in Brazil

features the tangible elements of a place or environment

feedback change in one factor causing a change in a second which then changes the first

fertilisers organic or inorganic substances that contain chemical elements that provide one or more essential nutrients to plants to help them grow

fertility rate or birth rate; the number of live births in a population, usually shown as a ratio of births per woman per lifetime, or births per 1000 people per year

field sketches annotated line drawings created to record features of an environment during fieldwork activities

fishery a place where fish are harvested for commercial purposes

flow regulation when humans control river flows to ensure access to water when it is required and to supply water where it is most needed

food security when all people at all times have physical and economic access to sufficient, safe, nutritious food to maintain healthy and active lives

forced migration movement of people somewhere else because they have to leave

fossil fuels natural fuels such as coal or gas, formed in the geological past from the remains of living organisms

free trade no trade barriers, no tariffs to be paid; international trade left to its own natural course

gentrification the renovation and growth in social and economic status of previously run-down areas

geographical challenges issues and problems arising from interactions between people, places and environments that threaten sustainability, e.g. biodiversity loss, food insecurity, inequality

geographical data quantitative or qualitative information about people, places and environments

geographical processes the physical and human forces that work in combination to form and transform the world, e.g. erosion, the water cycle, migration and urbanisation. Geographical processes can operate within and between places.

geographical questions questions that inquire into the spatial and environmental dimensions of places and environments

geology the study of the Earth: the materials of which it is made and their structure as well as the processes acting upon them. It also studies organisms of our planet and the study of how Earth's materials, structures, processes and organisms have changed over time.

geomorphology the study of the physical features of the surface of the earth and their relation to its geological structures

germination the process by which a plant grows from a seed

global positioning systems (GPS) navigation systems that provide location and time information anywhere there is a line of sight to GPS satellites

global warming rise in the average temperature of the Earth's atmosphere

Green Revolution a period beginning in the 1940s when new agricultural techniques brought great increases in production and greatly decreased the incidence of hunger worldwide

Greenhouse Effect the retention of the Earth's heat by atmospheric gases

Gross Domestic Product (GDP) the monetary value of all goods and services produced by a country

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Gross National Product (GNP) the measure of the value of all the goods and services a country produces in a year

groundwater bodies of water that can occur beneath the land surface

groyne a wall or similar structure built out from the seashore or riverbank to control erosion

guerrilla group different from a traditional army; people are involved in a style of warfare that is smaller in scale but aims to affect the enemy all the same. It often includes sabotage and surprise attacks (ambushes).

habitat the natural home or environment of an animal, plant or other organism

haemoglobin the part of red blood cells that carries oxygen from the lungs to the body's organs and tissues

happiness a state of wellbeing and contentment

hard engineering a controlled disruption of natural processes by using artificial structures such as concrete breakwalls

heat island effect increase in temperature in an urban area due to the buildings and asphalt

hectare (ha) 10 000 square metres

heritage features belonging to the culture of a particular society, such as traditions, languages, or buildings that were created in the past and still have historical importance

hibernating sleeping or staying inactive during winter in order to survive extreme weather conditions

high-yielding varieties (HYVs) varieties developed by selective breeding and cross-breeding to achieve faster growth and to produce more seeds

holistic the importance of the entire or whole of something but recognising the interdependence of inner parts

horticulture the science of plant cultivation and management of fruit, vegetables, nuts and other crops

hukou a record of household registration required by law in China

Human Development Index (HDI) a tool to measure the wellbeing of a country, developed to overcome the shortfalls of other economic measurements and take into account aspects of life other than simply finances

human wellbeing people's quality of life and happiness that can be measured by health, income, life expectancy, literacy rates, women's participation in public life, infant mortality and many other indicators

humus layer the dark, nutrient-rich top layer of soil formed when plant and animal matter decays

hypolimnion the deeper, colder layer of water

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

impervious incapable of being penetrated

industrialisation the process of a society moving from being largely agriculturally based to manufacturing based, often characterised by mass production

infiltration the process by which water on the ground surface enters the soil

infrastructure the basic systems and services, such as transport and power supplies, that a country or organisation uses in order to work effectively

initiation a rite of passage symbolising the acceptance of an individual into a group or into adulthood

Integrated Catchment Management (ICM) a management strategy that takes into consideration that catchments are made up of different terrestrial and aquatic ecosystems that are interconnected through physical and biological factors

Integrated Coastal Zone Management (ICZM) an approach to coastal zone management that fosters intergovernmental cooperation, the involvement of other stakeholders, and recognition of the co-dependence of economic growth, social needs and protection of environmental assets

intensive agriculture farming a small area with a crop that has a high monetary value

interbasin diversion transferring water from one catchment to another

intergenerational equity the responsible use of natural resources to enable fair access to the same resources by future generations of humans

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interglacial warmer period between ice ages

internal migration the movement of people from living in one defined area to living in another within a country, e.g. movement from cities to non-metropolitan coastal locations, or between states and territories

international migration the voluntary or forced movement of people between countries

inter-state conflict combat between two different nation-states

interstate migration movement of a person to another state

intrastate migration movement of a person within their own state

irrigation applying water to land or soil

La Niña (Spanish for 'the girl child') during a La Niña pattern, pressure at sea level is higher in the eastern Pacific and lower in the western Pacific

land clearing the direct human-induced removal of vegetation cover from forested areas, in order to allow the land to be used for other purposes such as agriculture

land degradation degradation of the health of land resources through human actions in ways that threaten their ability to maintain their environmental functions, e.g. salinity, accelerated soil erosion, loss of biodiversity and habitats

land management the process of managing the use and development of land resources

landward tending toward the land and away from the coast

latitude distance from the Equator measured in degrees north or south

legume a type of plant, such as clover, soybeans and lupins, that carries nodules on its roots; working with certain bacteria, legumes are responsible for the fixing of nitrogen in the soil

lentic (of surface waters) standing; not flowing – the classification of lakes and wetlands

lichen a slow-growing plant which characteristically grows like a crust over rocks, walls and trees

linear in a line or tracking along one path

literacy rate the percentage of people who can read and write

littoral forests occur within the influence of the sea, or a large coastal water body such as a lake or estuary

liveability an assessment of what a place is like to live in, using particular criteria such as environmental quality, safety, access to shops and services, and cultural activities

longitude degrees east or west of Greenwich

longshore sand transport the process that moves sand parallel along a beach or coastline

lotic (of surface waters) permanently or intermittently flowing

lucerne alfalfa

mangroves trees that have managed to adapt to growing in the harsh and difficult tidal zone between the land and estuarine waters

map a diagrammatic representation of particular features of a place, usually drawn on a flat surface

marine environments oceans, seas, bays, estuaries and other major water bodies, including their surface

maritime relating to or involving ships or shipping

mass migration large numbers of people moving somewhere else for similar reasons

meander a winding curve or bend of a river

megacities cities with a population greater than 10 million

metalimnion (thermocline) a transitional layer of water where temperature decreases

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

millet an ancient cereal or grain that can be used to make flour and grows well in warm countries with poor soil

mission an important assignment carried out due to wishes of the government or an important organisation

modernisation the process of society moving from traditional systems to other systems using technological efficiency, often linked to higher incomes and higher standards of living

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mortality rate the number of deaths per 1000 head of population, often expressed as a ratio

multiculturalism an ideology that different cultures can coexist successfully within a country (rather than conform to one national culture)

nation-state a group of people (nation) governed within a certain area (state). Also known as a country.

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

new urbanism an urban design movement that promotes walkable neighbourhoods that contain a range of housing and job types

nomadic herding moving one's cattle or other animals, such as goats or yaks

non-government organisations (NGOs) not-for-profit groups that work outside of government control

objective a set goal

orographic rainfall rainfall produced when rain-bearing winds are forced upwards by mountain ranges

osmoregulation a process of regulating water potential in order to keep fluid and electrolyte balance within a cell or organism

ozone gas formed when oxides and nitrogen react with sunlight. In the upper atmosphere it absorbs UV rays, preventing them from reaching the earth. At lower levels, ozone is a pollutant caused by vehicle and industrial emissions, the main component of smog.

pathogen an agent that causes disease, especially a living microorganism, such as a bacterium or fungus

perpetual frost an area that is constantly covered in ice, such as the polar caps

persecution unfair or cruel treatment over a long period of time because of race, religion or political beliefs

pesticides substances used to destroy insects and other organisms that can harm or damage plants or animals

photosynthesis a process by which a plant produces its food using energy from sunlight, carbon dioxide from the air and water from the soil

polarisation a widening gap between two things, creating stark differences, almost opposite each other

population distribution where people live in a given area

primary data original materials collected by someone, e.g. field notes, measurements, responses to a survey or questionnaire

productivity the total economic output compared with the input of resources

propaganda information used to promote a political view or perspective; tends to be misleading or biased in nature

proponent a person who is in favour of or advocating a theory, proposal or action

prosperity having success, flourishing or thriving

province an area within a country or state

pull factors reasons why a person would want to move to a particular area

push factors reasons that force a person to leave their place of residence

qualitative methods explanatory and interpretive methods, e.g. participant observation, focus group discussion or interviews, which are used to gather qualitative data

quantitative methods statistical and other methods used to analyse quantitative data

quota a specific number that must be achieved or not exceeded

rainforest a tropical forest environment with a large amount of rainfall

reconciliation a process of restoring respect and understanding for each other to create positive change in relationships

recreation activities for the purpose of relaxation during leisure time

refugee a person who has left their own country because of fear for their safety and wellbeing

regenerative able to regenerate (be reborn or renewed)

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relative location location relative to other places e.g. the distance of a town from other towns. For example, Wollongong is approximately 85 km south of Sydney.

resilient able to recover strongly and quickly from misfortune

respiration a process living organisms need – inhaling air, particularly oxygen, and exhaling carbon dioxide

riparian living or located on the bank of a natural watercourse such as a river or a lake

river basin the area of land drained by a river and its tributaries

run-off the draining away of water from the surface of an area of land or structure

sacred sites areas or places with culturally significant meaning to particular people

salinity the measure of salt levels in water and soil

saltmarsh a coastal wetland that is flooded and drained by salt water brought in by the tides

SARs Special Administrative Regions of the People's Republic of China. Territories such as Hong Kong or Macau fall under the sovereignty of China but are not on the Chinese mainland.

satellite altimeter an instrument for determining elevation, especially an aneroid barometer used in aircraft that senses pressure changes accompanying changes in altitude

satellite city a smaller metropolitan area that is located near a major city, which may be economically and politically independent

savanna a grassy plain with scattered trees and shrubs

seagrasses flowering plants that can live under water

seaward tending toward the sea and away from land

secondary information sources sources of information that have been collected, processed, interpreted and published by others, e.g. census data, newspaper articles, and images or information in a published report

sediment material broken down by natural processes such as erosion which are transported by wind, water and other means

segregation a division or parting of something

self-determination the right to choose to act in a certain way. The term is most often associated with indigenous peoples around the world and their right to govern and make decisions for the betterment of their people as they see fit.

service function the environment's provision of balance and stability through the atmosphere, biodiversity, ecological integrity and the climate

shifting cultivators people who farm a section of land for 2 to 3 years, then move on to another section to allow the original plot to revitalise itself

silage grass or other green fodder compacted and stored in airtight conditions, typically in a silo, without first being dried, and used as animal feed in the winter. Hay is the dry version of silage.

sink function the environment's ability to absorb, break down and recycle wastes including pollution

smog a mixture of smoke and fog that has come to mean human-made pollution that can be seen in the atmosphere

social mobility the ease of moving up 'levels' in society

soft engineering the use of ecological principles and practices to reduce erosion and achieve the stabilisation and safety of shorelines, while enhancing the habitat, improving aesthetics and saving money by using vegetation and other materials

sorghum an ancient grain used as a food source in Africa and parts of Asia, and often used as livestock feed in the United States and Australia

source function the environment's provision of raw materials and natural resources

Southern Oscillation Index (SOI) atmospheric pressure differences at sea level between Tahiti and Darwin. Sustained negative values of the SOI are associated with El Niño events, and positive values with La Niña events. As El Niño and the Southern Oscillation are related, the two terms are often combined with the abbreviation of ENSO.

spatial difference relating to difference in position, area and the size of things

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spatial patterns patterns and trends in where things are located

spatial scale the extent, size and location of something being studied; for example, the climate of a large area such as central Australia versus the microclimate of a small area such as a westward-facing slope

spatial variation the difference or variation in natural and human features over an area of the Earth's surface, e.g. water, population, Gross Domestic Product (GDP), life expectancy

spiritual function the cultural, recreational or psychological value of the environment for people

stakeholder a party or person with an interest or concern in an organisation and its actions

stewardship the responsible planning and management of resources

storm surge local and temporary rise in sea level that is primarily caused by a low-pressure system

strata layers or levels

stratification the process of waters with different properties forming layers to act as barriers to water mixing

subjective regarding personal views and feelings associated with a topic. Opposite to 'objective' which is factual information.

subsistence (agriculture) producing just enough for the family to survive

substrate surface or material on or from which an organism lives, grows, or obtains its nourishment

suburbanisation a process whereby people, businesses and warehouses move from the inner city out to the suburbs, usually due to cheaper land, accessibility to major transport routes and labour supply

surface water water found on the surface of continents and islands

surplus excess; extra

sustainability the ability to continue with minimal long-term effect on the environment

sustainable agriculture farming that is conducted in a way that preserves resources

sustainably when a resource is used in such a way as to preserve the resource and its surrounds

swales a low tract of land, in between sand dunes or ridges, that may be moist or marshy

taiga coniferous forest that is found in colder climates in the Northern Hemisphere. Largest biome in the world.

tallow a hard fatty waste product from animal fat usually used to make soap and candles

tangible can be touched

teff a native Ethiopian grain that is a very resilient crop and grows well in both dry and wet conditions, as well as low and high altitude. Eaten as a grain and the flour used to make the traditional bread *injera*. There are now some crops of teff being grown in Australia.

terms of trade the price farmers receive for their products divided by the price paid for inputs such as fuel, labour and/or fertiliser

terracing a type of farming that involves clearing vegetation then building a series of levelled sections or steps into a steep slope

terrestrial ecosystem a system of plants, animals, nutrients and elements, and the interactions between them, that is only found on land

theory an idea or a group of ideas intended to explain something

tide gauges installations that measure relative sea level at a specific point along the shoreline. They are usually secured on piers or on platforms a few metres off.

tillage the activity or process of preparing land for growing crops

topographic map a detailed, large-scale map of part of the Earth's surface which illustrates the shape of the land and selected natural and human features from the surrounding environment

topography the relief and configuration of a landscape, including its natural and human features

trace element a chemical element required in only minute amounts by living organisms for normal growth

Traditional Owner Indigenous person recognised as having primary spiritual responsibility for the land

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trawling a method of fishing that involves pulling a fishing net through the water behind one or more boats

tundra an area where plant growth is limited by low temperatures and a short growing season; usually found at high latitudes or high altitude

turbidity cloudiness in the water due to the presence of extremely fine particles of matter that are held in suspension

UNEP United Nations Environment Programme

UNHCR United Nations High Commissioner for Refugees – basically the UN's refugee agency

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 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 environment the human-made areas that allow human activities to take place

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 of economic and social change in which an increasing proportion of the population of a country or region live in urban areas

visa a document allowing a person to enter and stay in a particular country for a specified time period

voluntary migration when people move somewhere else by their own choice

vulnerability the degree to which people, property, resources, systems and cultural, economic, environmental and social activity are susceptible to harm, degradation or destruction on being exposed to a hostile factor

water quality the physical, chemical and biological characteristics of water

water scarcity the lack of sufficient available water resources to meet demand

weirs low dams that are built across rivers to regulate flow or raise the water level

western culture ideas, fashion, food and ways of life from the US, UK and Western Europe which are located in the Western Hemisphere

wetlands land consisting of marshes or swamps

zonation variation in plant life due to differing environmental conditions

zoning government restrictions about the types of buildings and services allowed in an area

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