

# PEARSON **geography** S.B.



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

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

A scientific base station  
in Antarctica.

Illustrator: Paolo Lim



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# PEARSON Australian Curriculum

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# PEARSON geography

## Built from the ground up

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

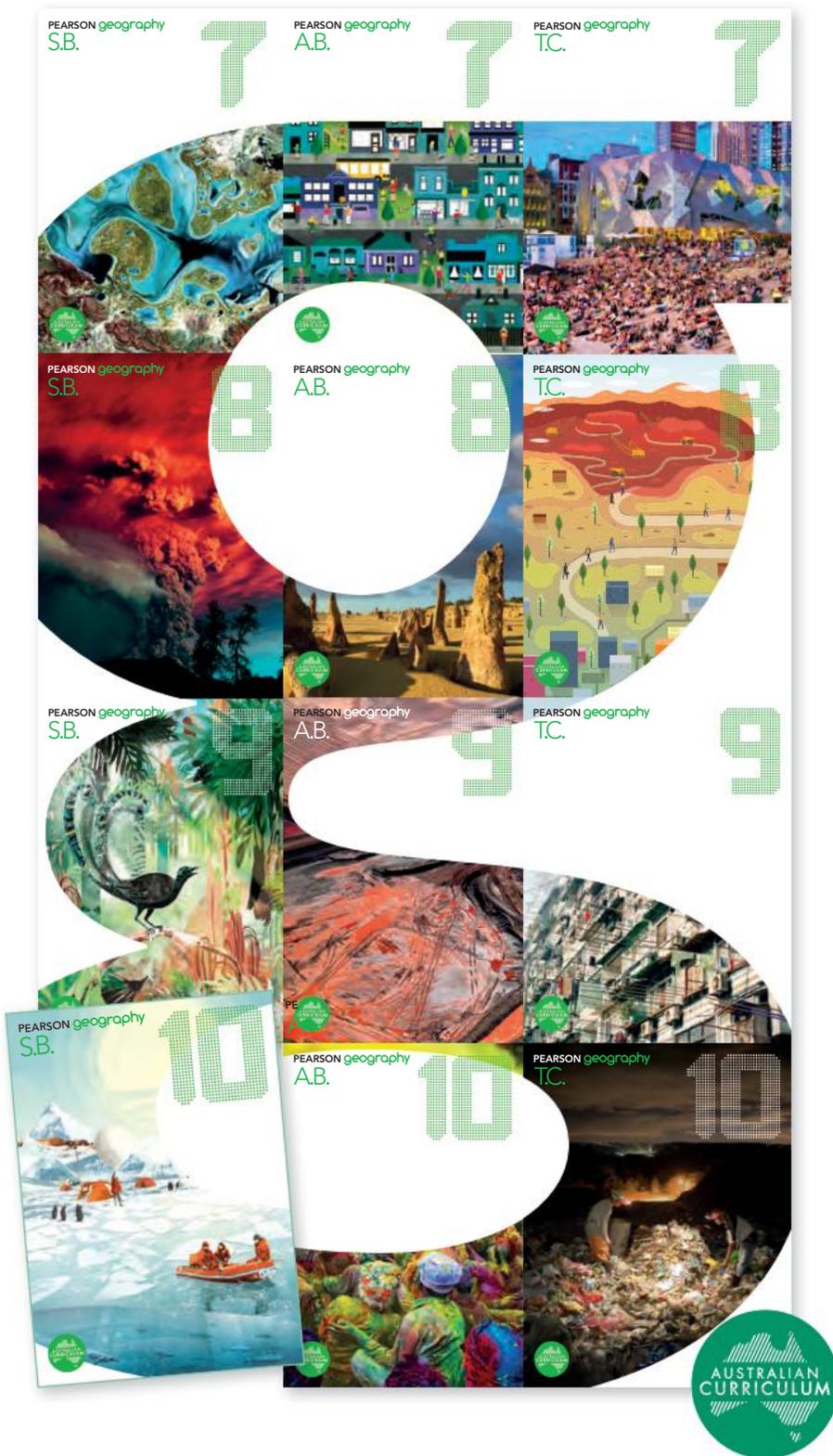
### Professional learning, training and development

Did you know that Pearson also offer teachers a diverse range of professional learning programs? We are dedicated to supporting your implementation of Pearson Geography, but it doesn't stop there. We offer specific training for the Australian Curriculum and beyond, in the form of workshops, conferences and seminars. Find out more about Pearson Professional Learning at [www.pearson.com.au/pl](http://www.pearson.com.au/pl).

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

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### Activity Book

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# How to use this book

Pearson Geography has been designed for the Australia Curriculum: Geography course. It includes content and activities that enhance the development of the Year 10 achievement standards within the two interrelated strands of Geographical Knowledge and Understanding and Geographical Inquiry and Skills.

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

## Units

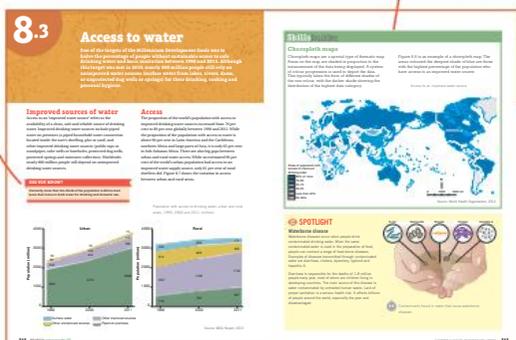
Each chapter of the Student Book is divided into units. Units have been written to develop students' knowledge and understanding of the concepts, skills and processes central to the study of Geography at this level. Units are written to ensure both strands—'Knowledge and Understanding' and 'Inquiry and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

## Did you know?

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

## Skills builder

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



## Chapter opener



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

## Spotlight

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

## Activity Book link

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

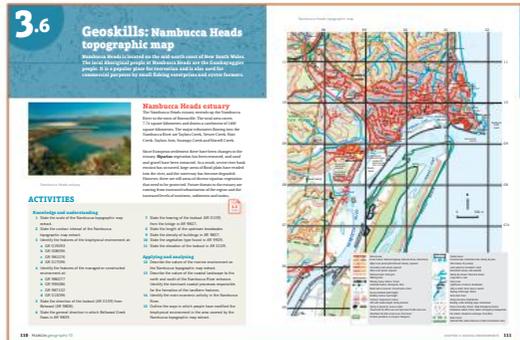


## Activities

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

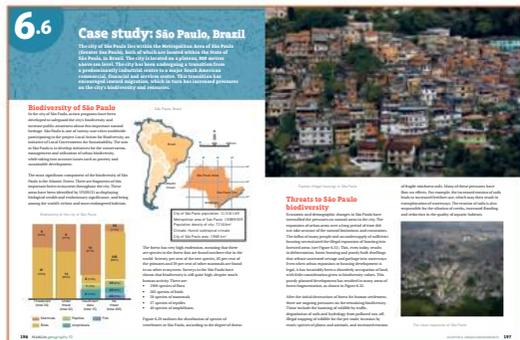
The activities include questions that guide students towards an understanding of the material covered and will extend them in a variety of learning experiences. The activities have been carefully selected to cater for the full range of students. The activities provide an opportunity for students to engage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

## Geoskills



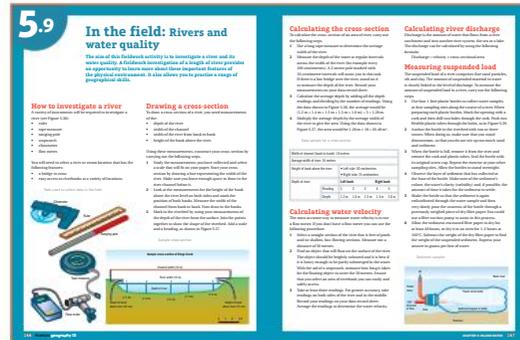
Geoskills units are designed to improve students' geographical skills: mapping, graphing, interpreting satellite images and using ABS data online. These skills relate to the Australian Curriculum: Geography Inquiry and Skills strand.

## Case studies



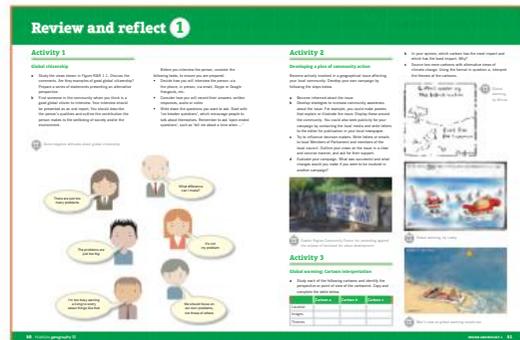
Case study units relate to a specific event or location. The units are written to extend students' knowledge and understanding. Case studies include examples from around Australia and world examples as specified in the Australian Curriculum: Geography.

## In the field



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

## Review and reflect



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

# Directive terms

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

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

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

CHAPTER

# 1

# ENVIRONMENTAL CHANGE AND HUMAN WELLBEING



**A**t the beginning of the twentieth century there were 1.6 billion people on earth. Pollution and environmental degradation were problems, but were mainly local. The world still seemed vast, and large areas remained virtually untouched by the activities of people.

Just over 100 years later, the world's population was heading towards 7 billion and the environmental problems that have resulted from this rapid growth now affect the whole planet. How we manage these environmental challenges and how we address the social and economic inequalities that exist between and within places are critical to our future wellbeing.

This chapter introduces the concept of environmental functions, the major challenges to their sustainability and the environmental worldviews that influence how people perceive and respond to these challenges, as well as the differences in human wellbeing between places.

## KEY IDEAS

- To understand human-environment systems thinking and how it assists us to understand the causes and consequences of environmental change
- To understand the environmental functions that support life
- To investigate the major challenges to environmental sustainability
- To compare the environmental worldviews that influence how people perceive and respond to these challenges
- To understand what is meant by the terms 'human wellbeing' and 'global citizenship'

## GLOSSARY

<b>absolute poverty</b>	lack of access to minimum necessities or essentials for living
<b>bioaccumulation</b>	the accumulation of substances such as pesticides in an organism
<b>biodiversity (biological diversity)</b>	the variety of all life forms: plants, animals and microorganisms; the genes they contain; the ecosystems of which they form a part; and the processes that link them
<b>carbon cycle</b>	the naturally occurring processes in which carbon is exchanged between organisms and the environment
<b>desertification</b>	the spread of deserts
<b>development</b>	changes that create a better quality of life for people
<b>ecological</b>	the relationship between living things (including people) and their physical environment
<b>empathy</b>	the ability to understand and share the feelings of another
<b>environment</b>	the totality of our surroundings
<b>extinct (species)</b>	a species of animal or plant that no longer exists
<b>fossil fuels</b>	a natural fuel such as coal or gas, formed in the geological past from the remains of living organisms
<b>global citizenship</b>	a recognition that we are all citizens of the one planet and behave in ways that demonstrate a respect for the earth and all its people
<b>global warming</b>	the gradual rise in average temperatures brought about by an increase in the heat-absorbing gases present in the atmosphere
<b>greenhouse effect</b>	the atmospheric processes that maintain an average surface temperature of 15°C
<b>habitat</b>	the physical environment in which a community of plants and animals lives
<b>human rights</b>	the rights to which all humans are entitled
<b>human wellbeing</b>	the quality of life experienced by people individually and collectively
<b>land degradation</b>	the downgrading of the productive capacity of land due to the activities of people
<b>non-governmental organisations (NGOs)</b>	non-profit, often volunteer-based groups of people seeking to achieve a collective goal locally, nationally or internationally
<b>pollution</b>	any hazardous, or potentially hazardous, substance released into the environment
<b>poverty</b>	the inability to meet the basic needs for food, clothing and shelter; the absence of money, goods or the means of subsistence
<b>relative poverty</b>	where some people are poorer than others in the community but still have access to necessities of life

# 1.1

## Geography's contribution

We are both the product of, and the creators of, places. We study geography so that we can appreciate why this world is like it is, what our role is in it and how we can sustain or change it. Geography gives us an understanding of the world that we live in.

### What is geography?

Geography is the study of places and the relationships between people and their environments. Geographers explore both the physical elements of the earth's surface and the human societies spread across it. They also examine how human culture interacts with the biophysical environment, and how locations and places can have an impact on people. Geographers seek to understand where

things are found, why they are there, and how they develop and change over time. Geography has traditionally been divided into two domains:

- **physical geography:** the study of earth's seasons, climate, atmosphere, soil, streams, landforms and oceans
- **human geography:** the study of the distribution of networks of people and cultures on the earth's surface.



1.1

Geography greatly enhances our aesthetic appreciation of the world in which we live.

These domains have their own subsets of related disciplines, each of which makes its own unique contribution. Geographers draw on the knowledge constructed by other related disciplines, apply geographical thinking and develop responses to problems.

## Key value of geography

Studying geography and gaining a knowledge about places and spaces greatly enhances our aesthetic appreciation of the world in which we live. We can have a sense of wonder, curiosity and respect about places such as Denali National Park in Alaska, shown in Figure 1.1.

The geographic knowledge, understandings and skills we develop through the study of geography provide us with a 'lens' through which to view the world around us. This can enrich our lives. Armed with geographical knowledge, understandings and skills we are better able to take on the responsibilities of **global citizenship**. These understandings and skills will, for example, enable us to make personal and collective contributions to addressing some of the great challenges facing humanity, such as global warming, inequality, rapid urbanisation, population growth, habitat loss and resource depletion.

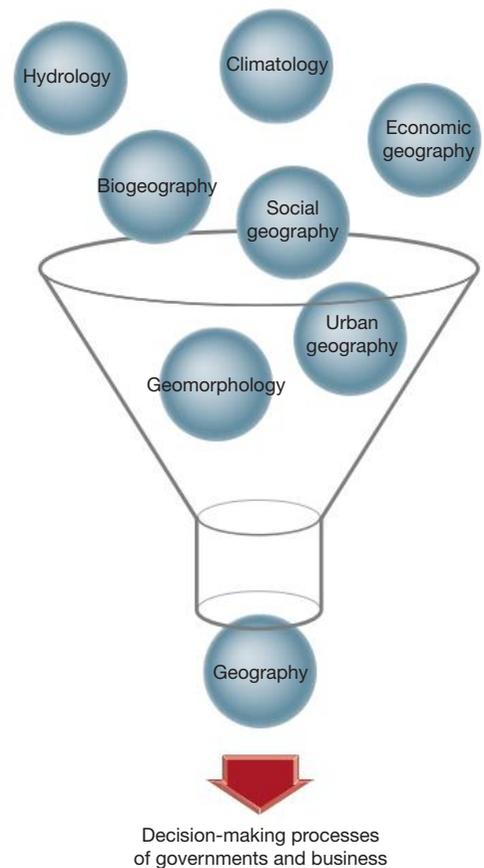
## Utilitarian value of geography

Geographical knowledge is of great value to planners, forecasters and decision makers in business and government. Whether the issue being addressed is the location of new public infrastructure such as a bridge or motorway, or the rehabilitation of a wetland, decision makers must consider such geographic issues as location, the relationship between processes on different scales, and the changing character of particular environments and landscapes (see Figure 1.2). Geographic expertise can be of great importance in helping organisations and individuals operate more efficiently and make well-informed decisions.

Geographers contribute to policy and decision making by:

- publishing their research findings—these works influence society's general understanding about issues, and society's opinions are transmitted to decision makers through a variety of channels, such as opinion polls, the media, letters and deputations to decision makers, protests and the ballot box
- providing expert advice in published reports and in presentations to decision-making bodies
- participating in the formal decision-making process through their interactions with decision makers. They might also be formally appointed to decision-making bodies, where their knowledge and professional judgement can inform the decision-making process.

1.2 Geography's contribution to the decision-making processes of governments and business



## ACTIVITIES

### Knowledge and understanding

- 1 Explain why we are all geographers.
- 2 Distinguish between physical and human geography.
- 3 Outline the intrinsic value of geography.
- 4 Outline the utilitarian value of geography.

### Applying and analysing

- 5 Study Figure 1.2. What does this diagram tell us about geography's contribution to the decision-making processes of business and government?

### Investigating

- 6 Study Figure 1.2. Select one of the fields of study shown in the diagram. Collect a minimum of five recent articles about one of these fields. Prepare a short report on how an understanding of geography contributes to the decision-making processes of business and government in this field.

# 1.2

## The environment: Life's support system

The environment is the totality of our surroundings and comprises the living and non-living features of the earth's surface. The term 'biophysical environment' refers to features that are altered or created by people, called the managed and constructed environments. People perceive, adapt to and use environments in different ways.

### People and the environment

Geographers are interested in the relationship between people and the **environment**. People depend on the environment for their survival and wellbeing. The environment supports and enriches our lives by providing raw materials and food, absorbing and recycling wastes, and being a source of enjoyment, inspiration and spiritual wellbeing. It also influences our lifestyles, our recreational activities and the ways in which we use the land.

### Environmental change

Environmental change is any alteration to an environment that disturbs natural **ecological** processes. Some environmental changes have beneficial outcomes for humans. The clearing of land for agriculture and the grazing of animals, especially when combined with irrigation, have increased food production; and mining and forestry have provided the resources necessary to construct water storage facilities, buildings, machines, vehicles and transport infrastructure. All these activities have promoted economic growth and employment. Some environmental changes can have negative effects, especially if they result in soil erosion, air and water pollution, or climate change.

### Challenges to sustainability

#### Population growth

Many of the challenges facing humanity are directly related to the surge in the world's population. Increasing numbers of human beings, combined with improved material standards of living (for some), have greatly increased the demands people place on the planet, its resources, ecosystems and environmental processes.

#### Energy use

The burning of **fossil fuels**, which are used to meet people's energy needs, has had a major impact on the earth's atmosphere. The **development** of alternative sources of energy, such as solar energy, wind power, tidal flow and hydroelectricity, is one way of reducing people's reliance on fossil fuels.

### Climate change

Over the last 200 years, the amount of carbon dioxide present in the atmosphere has increased by more than 25 per cent. The main cause of this increase is the burning of fossil fuels (oil, coal and natural gas) and the cutting down of trees, which convert carbon dioxide into oxygen. Increasing global temperatures, rising sea levels and the retreat of ice caps and glaciers have all been linked to this impact of people on the atmosphere.

### Pollution

**Pollution** is the release into the environment of any matter that has a harmful effect. Pollutants, many of which are the product of our demand for consumer goods, can reduce the ability of the biophysical environment to provide ecosystem services (clothing, food and shelter).

### Land degradation

The removal of natural vegetation (the result of deforestation, overgrazing and farming) is the main cause of **land degradation**. When trees are removed the land is exposed to the agents of erosion: wind and running water.

### Urbanisation

The migration of people from rural areas to large cities has created many problems. The rapid growth of cities, especially in developing countries, has overwhelmed the ability of authorities to meet the basic needs of the urban population. Overcrowding, pollution and the growth of squatter settlements are all results of rapid urbanisation.

### Exploited oceans

The world's oceans are an important natural resource. Of particular importance are the world's fisheries. These supply vast amounts of food. Unfortunately, the rate at which this resource is being exploited is unsustainable. Pollution is another major problem affecting oceans. If oceans are to be used sustainably, their use must be carefully managed and there needs to be international cooperation.



1.3 In the Tripa peat swamp forest of Indonesia, the Sumatran orang-utan population has declined by 80 per cent, as people have burnt forest to clear tracts of land for oil palm production.

### Habitat loss

A **habitat** is the physical environment in which a community of plants and animals lives. As habitats are destroyed, the communities of plants and animals that depend on them are displaced. Some of these face extinction, such as the orang-utan in Indonesia (see Figure 1.3).

## SPOTLIGHT

### Biosphere 2

In 1991, eight men and women moved into a US\$200 million purpose-built glass and steel replica of the earth's biomes in the Arizona desert. Known as Biosphere 2, the complex was designed to investigate whether the eight occupants could be self-sustaining in a sealed-off environment. It was hoped that a facility such as this could be used to colonise outer space.

The original idea was for the inhabitants to grow all their own food, and for the biomes, which included oceans with coral reefs, mangrove wetlands, tropical rainforest, savannah grasslands and a fog desert, to supply naturally recycled air and water. Despite the use of the latest technology, Biosphere 2 could not produce enough air, water or food to support the eight people. Significantly, the level of carbon dioxide could not be controlled. The experiment was abandoned after just three years. Today, the University of Arizona uses Biosphere 2 for scientific research.



1.4 Biosphere 2, a failed attempt to recreate the complex ecological processes of planet earth

## ACTIVITIES

### Knowledge and understanding

- 1 Define the term 'environment' and outline its importance.
- 2 Outline what 'environmental change' is and explain how it can be both beneficial and detrimental.
- 3 Outline the impacts of world population growth on the environment and how this affects the wellbeing of people.

### Applying and analysing

- 4 Study the Spotlight box: Biosphere 2. Describe what this example tells us about the complexity of the earth's environmental processes.
- 5 Construct an annotated mind map highlighting the key challenges to sustainability.

# 1.3

## Towards a sustainable future

Environments were once considered 'bottomless pits'—infinite stores of resources that could be exploited for the benefit of humans. Today, environments are seen as fragile, threatened systems in need of careful management. The concept of sustainability is at the centre of contemporary approaches to environmental management.

### Sustainability

Sustainability in an ecological context refers to the ability of biological systems to remain diverse and productive. For humans, sustainability is about maintaining the capacity of the environment to support life well into the future and the quality of life.

### Four functions of environments

The capacity of the earth to support life and human wellbeing depends on maintenance of the four functions of the environment, as outlined in Figure 1.5.

#### Source

The source function is the provision of the naturally occurring resources needed to sustain life and our material wellbeing. It includes the minerals and ores, timber and food—the plants we grow, the animals we graze and the seafood we harvest.

#### Sink

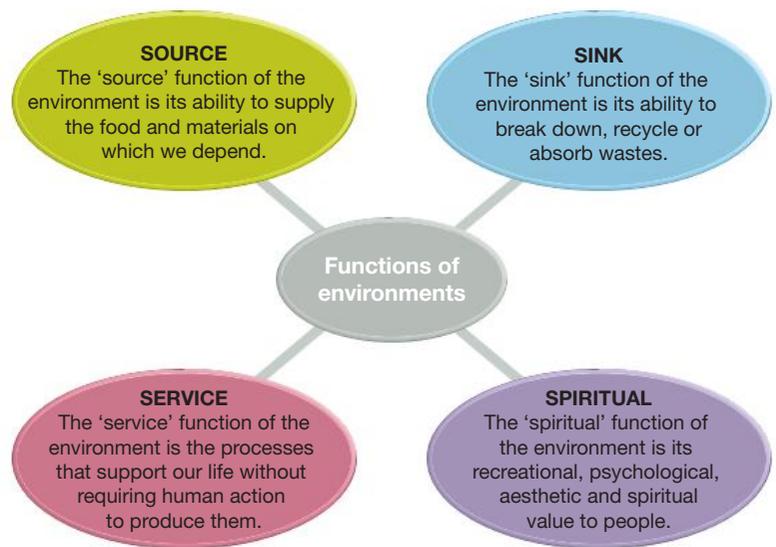
The sink function is the ability to break down, recycle or absorb and render harmless waste and pollution. The world's oceans, for example, are the largest active carbon sinks on earth. When waste output exceeds the limit of the sink function, long-term damage occurs.

#### Service

The earth's environmental service functions are all those things done for us by the biophysical environment; for example the absorption of carbon dioxide and production of oxygen by forests, and the filtering of water and recycling of nutrients via the process of decomposition by wetlands.

#### Spiritual

The spiritual functions of the environment include its cultural and recreational value to people and the ways in which it enriches the aesthetic experience of people.



1.5 The four functions of environments

### Sustainable development

Sustainable development is development that meets the needs of the present population without affecting the ability of future generations to meet their needs.

The aim of sustainable development is to achieve improvements in people's quality of life or wellbeing while protecting the environment. Sustainable development and good environmental management go hand in hand. If we are to put sustainable development into practice we must:

- use the earth's renewable resources in ways that do not reduce their usefulness for future generations
- involve people in making the decisions that affect their lives and their environment
- develop technologies that are cleaner, use less energy and require fewer natural resources
- reduce the waste we produce, and make products that last longer and are easy to recycle and repair
- reduce the amount of energy we use
- encourage the development and use of renewable energy from the sun, wind and flowing water.

## SPOTLIGHT

### The earth's carbon stores, sources and sinks

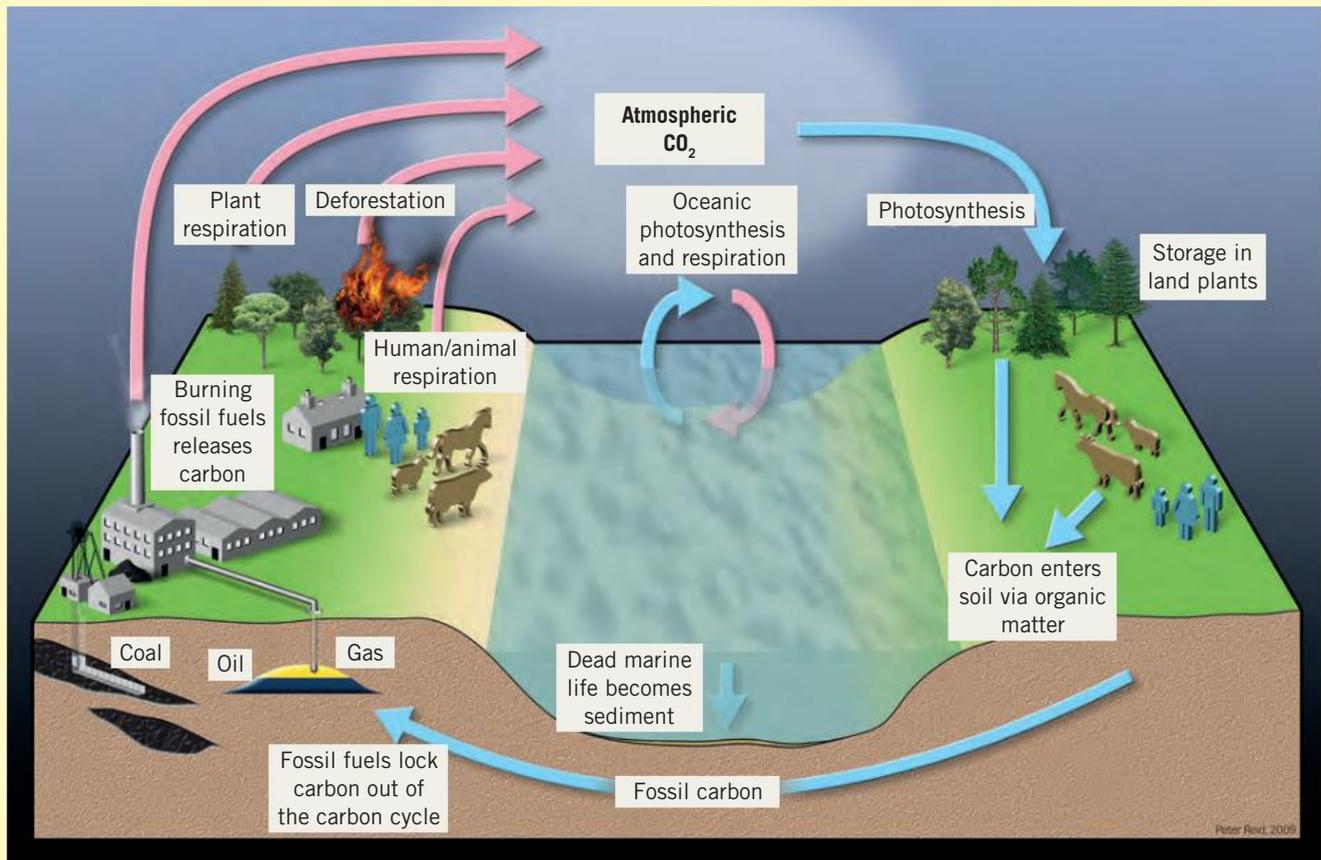
Carbon dioxide (CO<sub>2</sub>) is continually recycled on earth. The environmental processes by which CO<sub>2</sub> is released to the atmosphere are called carbon sources, while processes that absorb it are called carbon sinks. The atmosphere, fossil fuels and the earth's forests, soils and oceans are important stores of carbon. Carbon is constantly moving between these different stores. A carbon sink absorbs more carbon than it gives off, while a carbon source emits more than it absorbs.

Volcanoes, forest fires, decomposition, respiration and, under certain conditions, the world's oceans are all natural 'sources' of atmospheric CO<sub>2</sub>. When the oceans warm or are disturbed by storms they can release large amounts of dissolved CO<sub>2</sub>.

Photosynthesis, forests, oceans and freshwater bodies and fossil fuels are all natural 'sinks' for atmospheric CO<sub>2</sub>.

The amount of carbon in the atmosphere at any one time depends on the balance that exists between the various sources and sinks. This system of sinks and sources is referred to as the **carbon cycle**.

#### 1.6 The earth's carbon stores, sources and sinks



## ACTIVITIES

### Knowledge and understanding

- 1 State how our thinking about environments has changed over time.
- 2 Outline the four functions of the environment.
- 3 Explain what is meant by the term 'sustainable development'.

### Applying and analysing

- 4 Identify the source, sink, service or spirituality functions of the environment shown in Figure 1.6.

- 5 Which of these functions is of greatest value to humans? Justify your choice. What would be the impact if this environment was degraded or destroyed?
- 5 As a class, brainstorm the concept of 'sustainability'. Develop a mind map highlighting the main points raised in the discussion. Use the mind map to write your own definition and explanation of 'sustainability'.
- 6 Email the Australian Prime Minister with suggestions about how the government could promote sustainable development.

1.1

# 1.4

## World population growth

In 2014, 7.2 billion people inhabited planet earth. By 2050, there will be 9.6 billion of us. At the beginning of the last century there were just 1.6 billion people. This rapid rise in human numbers is unprecedented and threatens the wellbeing of the environmental systems on which all life depends.

### World population trends

Table 1.7 shows the growth in the world's population since 1000 AD. The highest rates of world population growth occurred during the 1950s and 1960s. They peaked at 2.2 per cent in 1963 before declining to just 1.05 per cent in 2014, as illustrated in Figure 1.8. Population growth is expected to decrease. Table 1.9 shows how long it has taken to add each additional billion to the world's population.

**1.7** World population growth rates, 1950–2100. Note that the 2100 population size is a medium prediction by the United Nations. The low prediction is 6 billion and the high prediction is 16 billion.

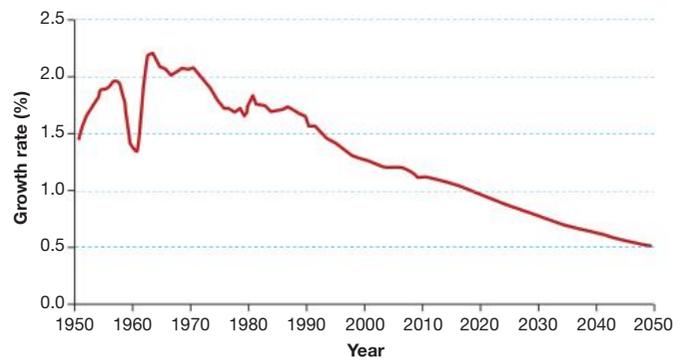
Year	Population (million)
1000	275
1100	306
1200	348
1300	384
1400	373
1500	429
1600	486
1700	635
1800	919
1900	1571
2000	6073
2100	10853*

\* UN estimate

#### DID YOU KNOW?

The total number of humans who have ever lived is estimated to be 107 billion.

**1.8** World population growth rates, 1950–2050



Source: US Census, 2011

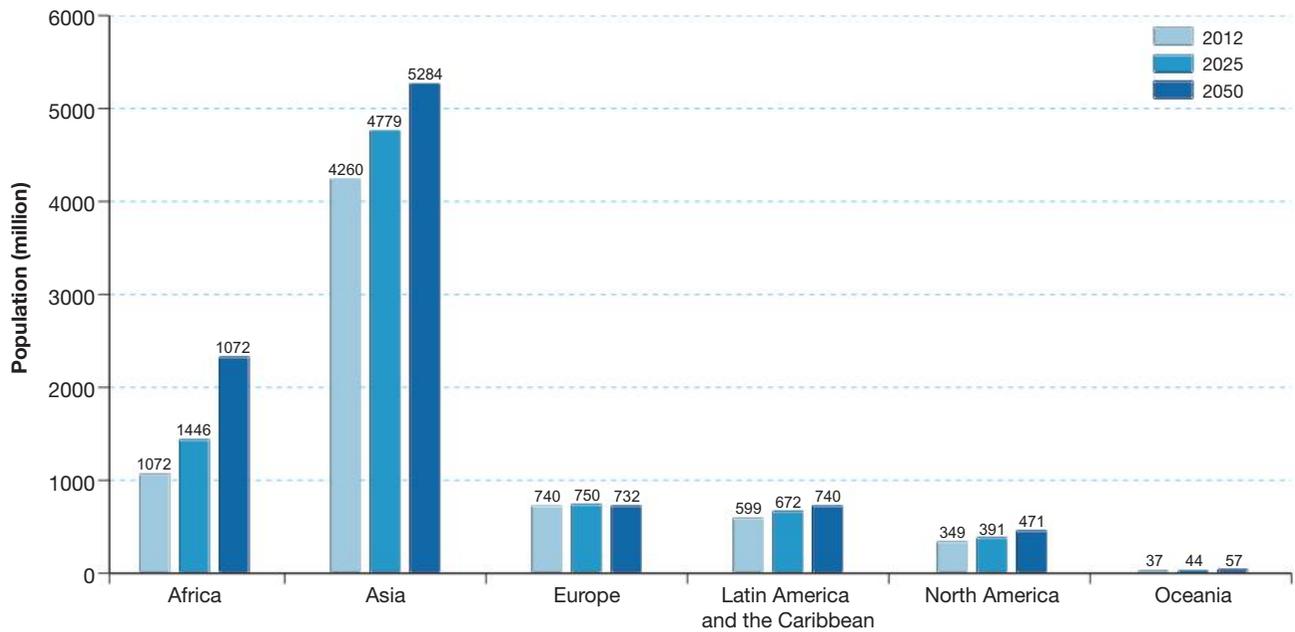
**1.9** Adding billions

World population	When reached	How long did it take?
1 billion	About 1800	Since the beginning of humanity (2 million years)
2 billion	1930	130 years
3 billion	1960	30 years
4 billion	1974	14 years
5 billion	1987	13 years
6 billion	1999	12 years
7 billion	2011	12 years

Source: Population Reference Bureau, 2012 World Population Data Sheet

The population of the world's developed regions will remain largely unchanged at around 1.3 billion between now and 2050. In contrast, the population of the 49 least developed countries is projected to double from around 900 million people in 2013 to 1.8 billion in 2050. Population growth will be greatest in Africa. Figure 1.10 shows projected world population growth by region in 2013, 2050 and 2010.

1.10 Current and projected world population growth by region, 2012, 2025 and 2050



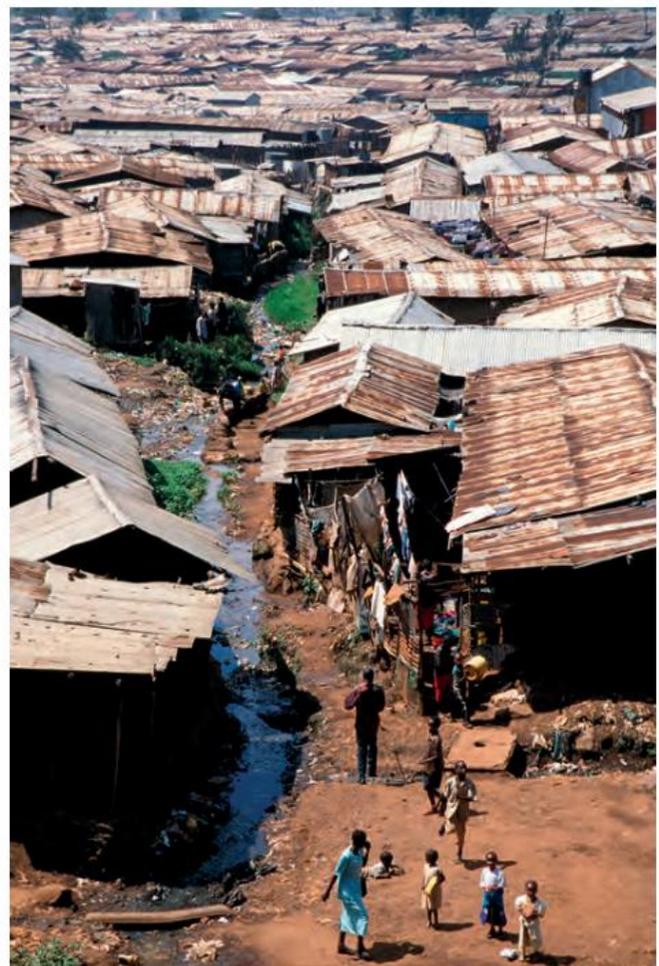
Source: Population Reference Bureau: 2012 World Population Data Sheet

Improving the wellbeing of people in developing countries is, not surprisingly, a major challenge facing humanity. Unless economic growth occurs at a rate faster than population growth, people will get a small share of the 'economic pie'.

## Consequences of rapid population growth

Many people around the world are inadequately fed, housed, educated and employed. Billions of people live in conditions that Australians would find intolerable, as shown in Figure 1.11. Demographers predict that the earth's population will grow until a fall in fertility rates brings about a gradual decline in population in the latter part of this century.

The problem with population growth is the material demands of the population, especially those living in the developed world. Over 1 billion people enjoy lifestyles that impose a disproportionate demand on our planetary ecosystems. This consumerism is powered by a sudden expansion in our technological capabilities that has enabled us to use (and sometimes misuse) natural resources. Our massive demand for the energy sourced from fossil fuels, for example, is altering the composition of the earth's atmosphere. The resulting climate change endangers whole ecosystems and perhaps humanity itself. Humanity has, however, confronted such challenges before. In recent times it has successfully addressed the issues of acid rain and ozone depletion. Collectively, we can reduce our environmental footprint by limiting our consumption of fossil fuels and by developing alternative (renewable) sources of energy. Humanity has the capacity to confront such issues. It also has the ability to address issues of global inequality.



1.11 Nairobi's Kibera slum. Meeting the needs of people living in the world's cities is a major challenge.

## The big shift

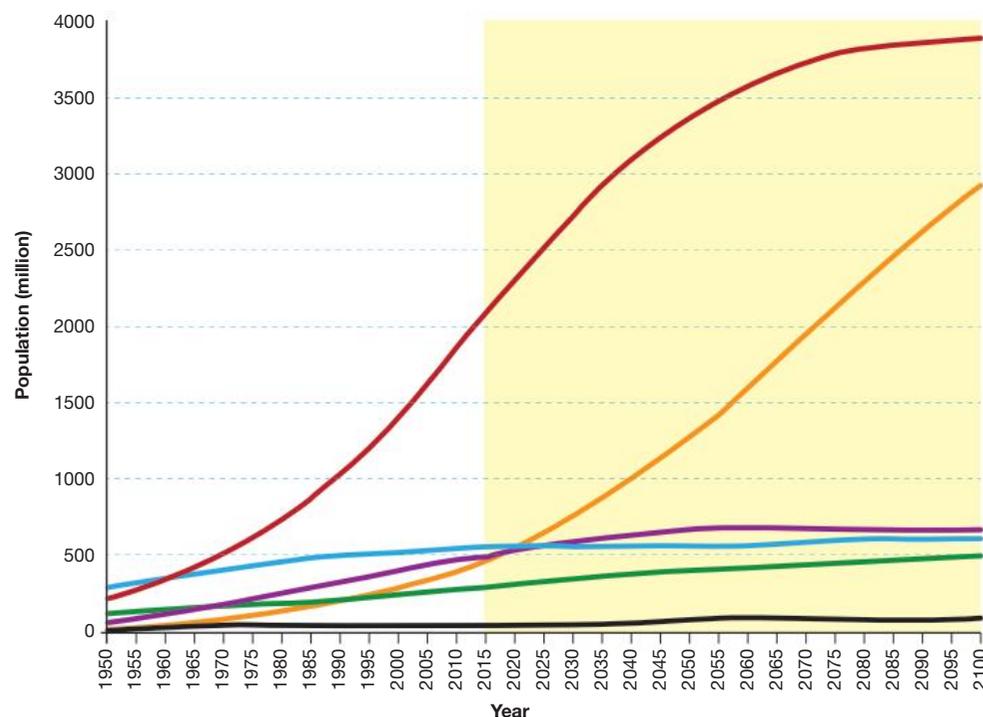
In 2007, the world reached an important milestone. For the first time in the planet's history, more than half the human population lived in urban areas. There are now 3.3 billion urban dwellers. Table 1.12 shows urban population distribution in 2011. By 2030, this number is expected to grow to almost 5 billion. Many of the new urban residents will be poor. Their future, in cities in developing countries, and the future of humanity itself depend on how increasing urbanisation is managed.

1.12 The proportion of people living in urban areas

	Urban population percentage, 2011
World	51
Developed	75
Less developed	46
Least developed	28
Africa	39
North America	80
South America	80
Asia	44
Europe	71
Oceania	66

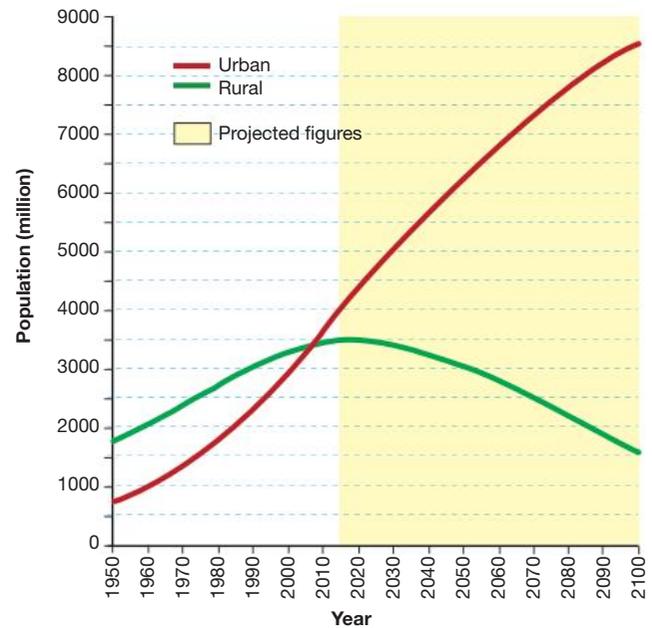
Source: Population Reference Bureau, World Population Data Sheet, 2011

1.13 Urban population by major regions, 1950–2100



Source: United Nations, Department of Economic and Social Affairs, Population Division (2012): World Urbanization Prospects, 2011 revision

1.14 Urban and rural populations, 1950–2100



Source: United Nations, Department of Economic and Social Affairs, Population Division (2012): World Urbanization Prospects, 2011 revision

There is, however, a positive side to this transformation. When people move to the cities, the fertility rate declines. Over time, this will help to stabilise the world's population.

The big issue is how the planet will cope with the ecological footprint of these additional consumers, especially if the material expectations of people in developing countries continue to increase.

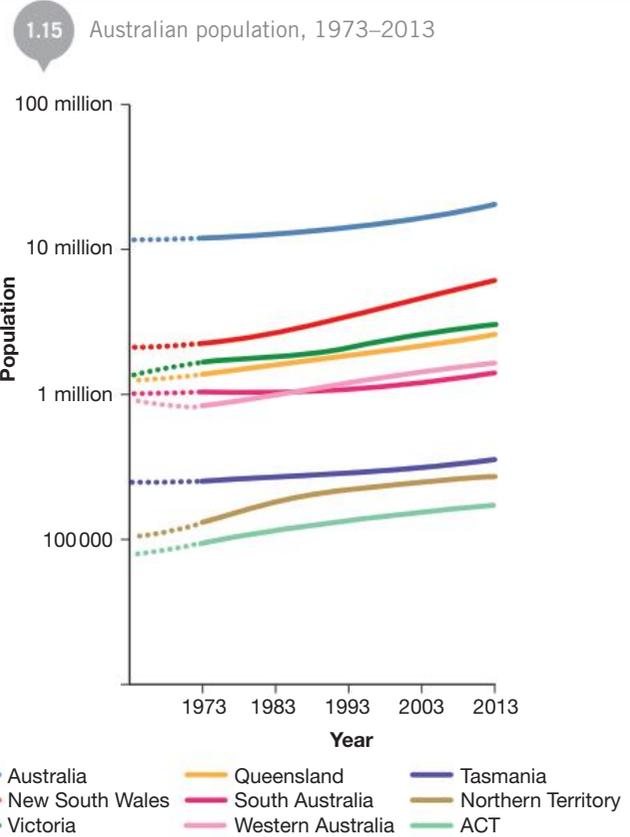
## Skillsbuilder

### Semi-logarithmic graphs

We use semi-logarithmic graphs when we need to graph a range of values that are difficult to fit on a standard graph. Semi-logarithmic graphs can accommodate data with a huge range of values. They also enable us to make judgements about the rate of change—the steeper the graph, the greater the rate of change.

Semi-logarithmic graphs have a vertical scale that is graduated in a semi-logarithmic progression. This means that equal intervals or cycles on the vertical scale increase geometrically, for example 1, 10, 100, 1000, 10 000. The horizontal scale has a normal arithmetical progression.

Figure 1.15 shows a semi-logarithmic graph for Australian population growth by state from 1973 to 2013.



## ACTIVITIES

### Knowledge and understanding

- 1 Explain why the increasing material demands of a growing world population are a problem.
- 2 Outline the trends in world population.
- 3 Explain why the 'big shift' from rural to urban living is seen as a positive development.

### Geographical skills

- 4 Study Table 1.7. Construct a semi-logarithmic graph showing the growth of the world's population (actual and projected) between 1000 and 2100. (Hint: use a scale of 10 million, 100 million, 1 billion, 10 billion and 100 billion.) In which period did the world's population grow most rapidly?
- 5 Study Figure 1.8. Using data from the graph, describe the trend in world population growth rates.
- 6 Study Table 1.9. Outline the trend apparent in the time it takes for the world to add each additional billion people to its population.
- 7 Study Figure 1.10. Identify the regions of the world projected to have the most rapid increases in population growth between 2012 and 2050. Which region will have the slowest growth? What are the implications of these trends?
- 8 Study Figure 1.13. Identify the regions that will experience the most rapid rise in urban population in the period 2010–2100.
- 9 Study Figure 1.14. Using data from the graph, describe the projected trends in the world's rural and urban populations.

# 1.5

## Pollution

Pollution is any hazardous or potentially hazardous substance released into the environment. It can affect people's wellbeing and the ability of the environment to provide environmental services.

### Air pollution

Air pollution is the contamination of the atmosphere by substances that can, either directly or indirectly, impact on human health and welfare. Sulfur dioxide, particulate matter, nitrogen oxides, carbon monoxide and lead are common atmospheric pollutants. Air pollution can irritate existing respiratory conditions, bring on an asthma attack, irritate people's eyes, produce unpleasant odours, damage property and reduce visibility. In the large cities of the developing world, air pollution is a major environmental problem.

### Water pollution

Water pollution occurs when pollutants are directly or indirectly released into oceans, rivers, lakes and aquifers without adequate treatment to remove harmful substances.

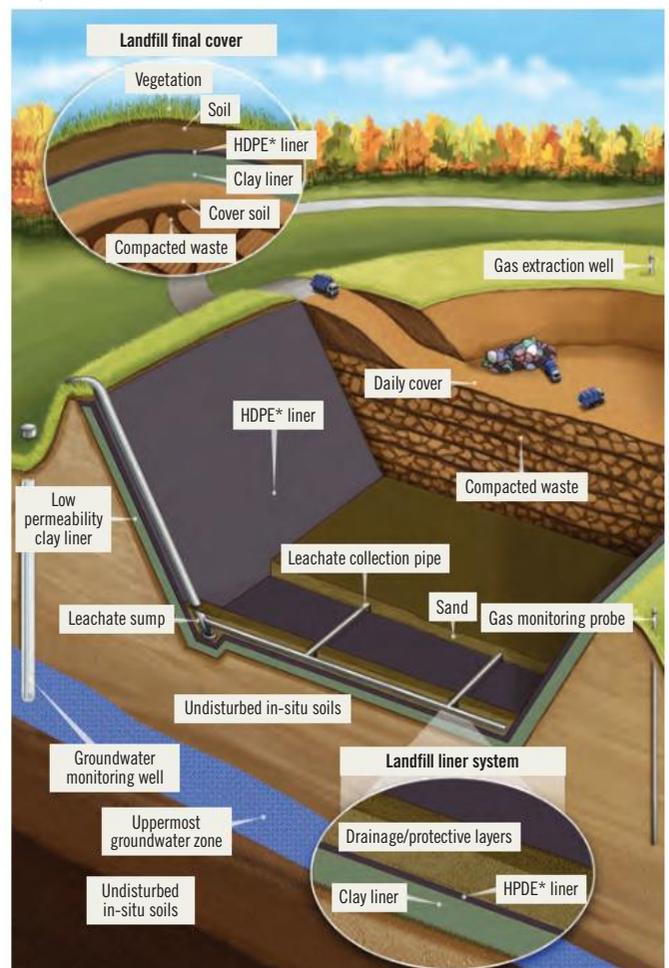
Dirty water is the world's biggest health risk, and continues to threaten both quality of life and public health. Many of our water resources lack basic protection, making them vulnerable to pollution from farms, industrial plants, and activities such as fracking. This can lead to drinking water contamination, habitat degradation and beach closures. Urban run-off is a particular concern. When water from rain runs off roofs and roads into waterways, it picks up toxic chemicals, dirt, litter and disease-carrying organisms.

### Solid wastes

Solid wastes include most of the rubbish we would normally throw into rubbish bins, plus many of the wastes produced by industrial plants and the building industry. As populations grow and standards of living increase, the amount of solid waste produced increases.

There are a number of environmental hazards associated with casual waste disposal. These include the contamination of groundwater by toxic substances; soil contamination; methane emissions; and dust, vermin and odour. These hazards can also occur in poorly managed landfill sites.

1.16 A well-managed landfill site



\*HDPE (high-density polyethelene) is a strong plastic.

The alternatives to casual waste disposal are recycling, re-use and waste reduction.

- **Recycling:** materials such as glass, plastic, aluminium, steel and paper can be reprocessed and used again.
- **Re-use:** re-using printer ink cartridges by having them refilled.
- **Waste reduction:** you can choose to buy goods without a lot of packaging and use re-usable bags instead of the disposable plastic bags provided by supermarkets.

In Australia, 54 per cent of waste ends up in landfill sites (this is down from 93 per cent in 1996–97). Wetlands and old quarries have, for many years, been sites for the disposal of this type of waste, but wetlands are now considered too important to use for waste disposal, and old quarries are in short supply. Figure 1.16 shows a well-managed landfill site.

## Types of waste

### E-waste

Obsolete electronic goods (known as e-waste) are one of the fastest-growing waste types, and their safe disposal is a major problem. In 2013, nearly 50 million tonnes of e-waste was generated worldwide—or about 7 kilograms for every person on the planet. Mobile phones, laptops, tablets, iPods and iPads, plasma and LCD televisions and electronic gaming machines are all constantly being updated and replaced. These products are made up of hundreds of different materials and contain toxic substances such as lead, mercury, cadmium, arsenic and flame retardants.

Much of the e-waste generated in developed countries ends up in processing plants in India, China and other parts of Asia. There are concerns about the working conditions in these plants as exposure to toxic substances can be hazardous to health.

### Plastic waste

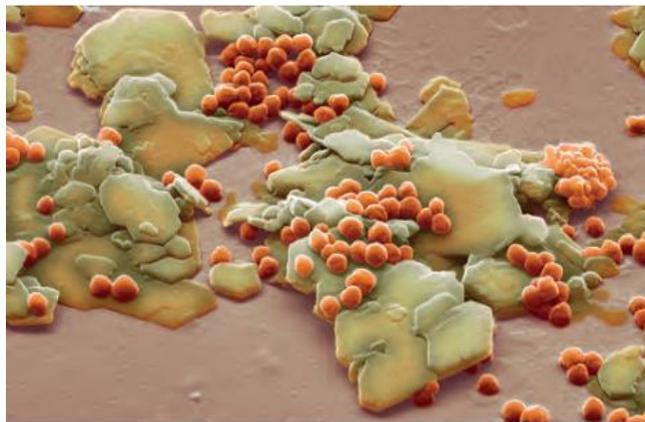
Plastic shopping bags are very damaging to the environment. Consider the following facts.

- Australians consume about 6.9 billion plastic bags every year. If these were tied together they would stretch around the world thirty-seven times.
- Every year, up to 80 million of these bags find their way onto our streets as rubbish.
- The World Wide Fund for Nature estimates that more than 100 000 whales, seals, turtles and birds die every year as a result of plastic bags.

Environmental groups advocate the imposition of a plastic bag levy. By imposing this added cost on retailers (and/or consumers), environmental groups hope to encourage the use of re-usable alternatives.

### Microplastics and microbeads

Microplastic pollution found in marine environments originates from either larger pieces of plastic broken into smaller pieces over time, or from cosmetic products (soaps, exfoliants and toothpastes) that contain microbeads made from polyethylene. These pieces of plastic, shown in Figure 1.17, are too small to be filtered during wastewater treatment and are discharged into the water cycle, making their way into freshwater and marine environments, then the food chain. There are efforts worldwide to lobby cosmetic companies to stop using microbeads in their products.



1.17

Facial scrub particles shown under an electron micrograph. It is thought that small marine animals ingest the microplastics and pass the pollutant up the food chain.

## Toxic wastes

Toxic wastes (sometimes referred to as hazardous wastes) are chemicals that can cause death or injury to living creatures. While toxic wastes are most often associated with industrial processes, they can also be found in the home and are widely used in agriculture, medical procedures and light industries such as dry-cleaning establishments. Toxic wastes can pose a long-term risk to people's health. They can enter the food chain, where they accumulate in the fatty tissues of animals (a process known as **bioaccumulation**). Some of these animals form part of the human food chain. Once they accumulate, these toxic substances can cause birth defects, cancer and developmental disorders. Abandoned industrial sites can be a major problem, especially when the site and/or adjacent waterways contain e-waste concentrations.

## ACTIVITIES

1.2

### Knowledge and understanding

- 1 Define the term 'pollution'.
- 2 Outline the impacts of air pollution.
- 3 Explain why water pollution is considered a health risk.
- 4 State why the disposal of solid wastes is increasingly problematic.
- 5 Outline the alternatives to the dumping of wastes.

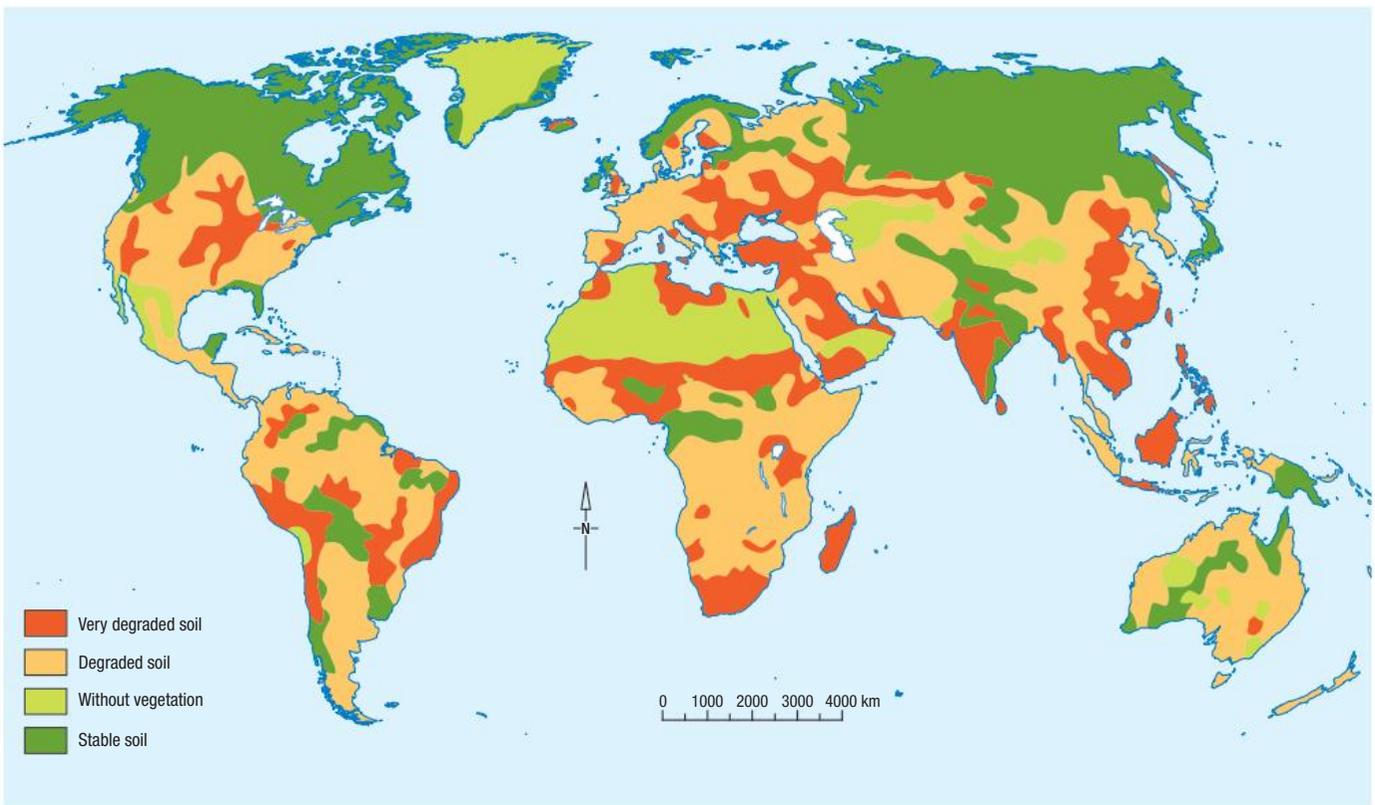
### Applying and analysing

- 6 Study Figure 1.16. Write a report highlighting how a landfill site can be managed in a way that protects the environment.
- 7 Develop an information campaign educating the public about one of the types of pollution: e-waste, plastic waste or toxic waste.

# 1.6

## Land degradation

Land degradation is the downgrading of land so that it is not as productive as it once was. If land is degraded, it loses its ability to produce the quality of vegetation or crops that it once did. Land degradation is one of the most important environmental problems in the world because it is so widespread and so difficult to reverse.

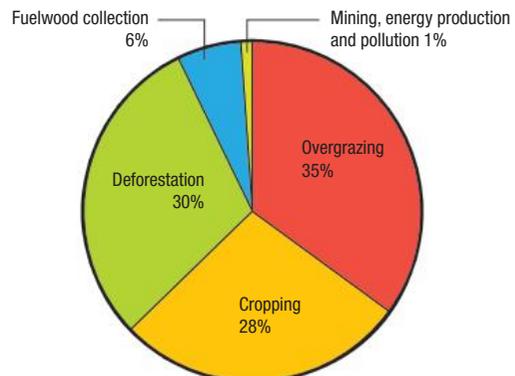


Source: UNEP

### Causes of land degradation

Land degradation is a worldwide problem, as is shown in Figure 1.18. The activities of people that contribute to land degradation include over-clearing of the natural vegetation (including deforestation)—a process that contributes to both soil salinity and erosion—and overgrazing by animals. When too many cattle or sheep are put onto an area of land, they eat all the grass and bushes, leaving nothing to hold the soil together. These heavy, hard-hoofed animals cause the soil to compact, and damage its surface. Elsewhere, overcropping of the land also exposes the land to erosion, as does the collection of fuelwood by people living in developing countries. These causes of land degradation are examples of poor land management. Usually this is unintentional, but it may be caused by greed. Figure 1.19 illustrates the main causes of land degradation.

1.18 Land degradation is a worldwide problem.



1.19 Overgrazing is the largest single cause of land degradation.



1.20 Salinity

## Soil degradation

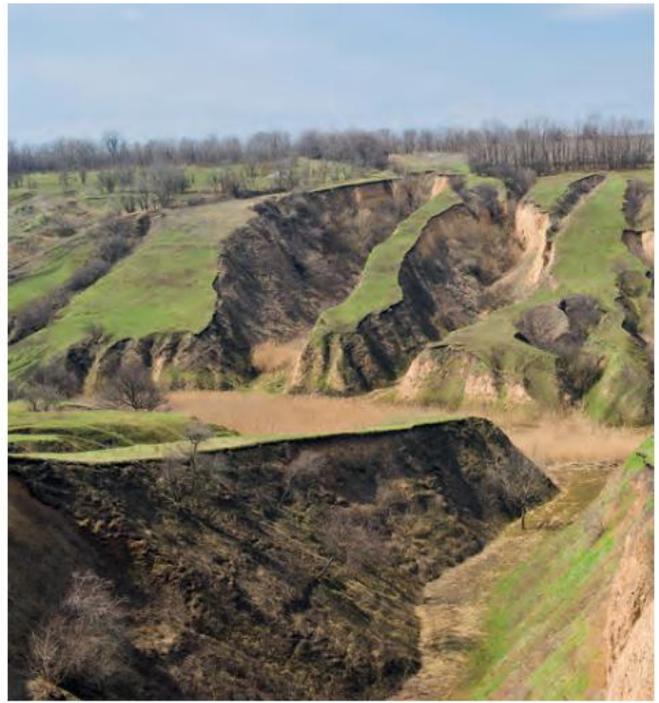
Soils can be damaged, or degraded, in four main ways: through salinity, erosion, compaction and acidification.

### Soil salinity

Increasing levels of salt in soils is common in some parts of the world, including Australia. It is caused by salty groundwater (water that is stored in rock and soil below the surface) reaching the surface of the soil. Normally, this water level is controlled by large trees, which pump water from the soil as they transpire. When trees are cut down, salty water may rise to the surface (see Figure 1.20). The water evaporates, leaving a salty crust.

### Soil erosion

Soil erosion is the removal of topsoil by water or wind. Erosion occurs wherever the soil is unprotected by plant cover. Once the original plant cover is removed, soil can be carried away easily by strong winds or heavy rain. Winds can strip the land of its topsoil and carry it hundreds of kilometres, and heavy rain and run-off can cut deep gullies in the soil (see Figure 1.21).



1.21 Gully erosion

### Soil compaction

Soil can be compacted by the weight of heavy machinery or the trampling of stock that are much heavier than native animals. The air spaces in the soil are compressed so that a hard layer develops on top. This reduces infiltration and makes it difficult to use the land for crops or pasture.

### Soil acidification

Soil can be made acidic by the overuse of chemical fertilisers. Often, fertilisers are essential to ensure that the soil keeps producing crops. When used over a long period of time, however, fertilisers can also harm the soil.

### Vegetation degradation

Natural vegetation can also be degraded. A natural ecosystem of plants can be changed in a number of ways. For example, vegetation can be affected by introduced plants. These can upset the natural balance of the ecosystem and spread uncontrollably.

Fires can also change the vegetation greatly. Although fire can be a natural part of the environment, it has a major effect on some species. It can remove some species, and encourage the growth of others.

Weed infestations often occur when vegetation is disturbed. Weeds are plants that have run wild (like animals gone feral) and have taken over from other species. Plants turn into weeds when they find conditions that are ideal, leading to their domination of an ecosystem.

## Desertification

One of the most serious forms of land degradation in the world is **desertification**, which means the creation of deserts (see Figure 1.23). Desertification is a problem in parts of Africa, where the desert is steadily advancing over what used to be good farming land.

Desertification in northern Africa has occurred on the edges of the Sahara. These marginal lands have variable rainfall and can only be used with great care. A mixture of overuse and periodic change in the rainfall has destroyed the productive ability of the land. The results are creeping desert sands and salty water holes.

## Role of poverty

Land degradation is both a cause and a result of **poverty**, with one contributing to the other. In subsistence economies, where people depend on the land for food, land degradation can result in greater poverty and human suffering. Developing countries often have high rates of population growth. This places increased demands on the land, as the land must be used more intensively to feed the growing numbers. This increased intensity of land use often exceeds the capacity of the land to cope.

As a result, it becomes degraded. This means less productive land per person, increased pressure on resources and even more land degradation.

## Coastal degradation

The coastline is under constant attack from the natural forces of wind and waves. Because of this, the coastline is constantly changing: beaches and sand dunes erode and are rebuilt in response to wind attack, and sand dunes can migrate inland. Human activities along the coastline can increase the rate at which these changes occur. Coastal degradation is caused by inappropriate development and land use management practices along the coastline. Coastal developments for tourism, residential, commercial and recreational purposes place pressure on coastal areas, and may cause degradation.

The extent of this degradation is often related to population density. The distribution of the earth's population and the extent to which coastlines have been altered by the activities of human are shown in Figure 1.23. The most extensively altered coastal environments tend to be found where population densities are greatest.

## SPOTLIGHT

### Fuelwood collection and the spread of deserts

The Food and Agriculture Organization (FAO) estimates that 40 per cent of the world's 2.7 billion people rely on fuelwood or charcoal (made from the partial burning of wood) as their primary source of energy for cooking and heating. This reliance is growing, as is the impact of its use on the environment. The consumption of fuelwood

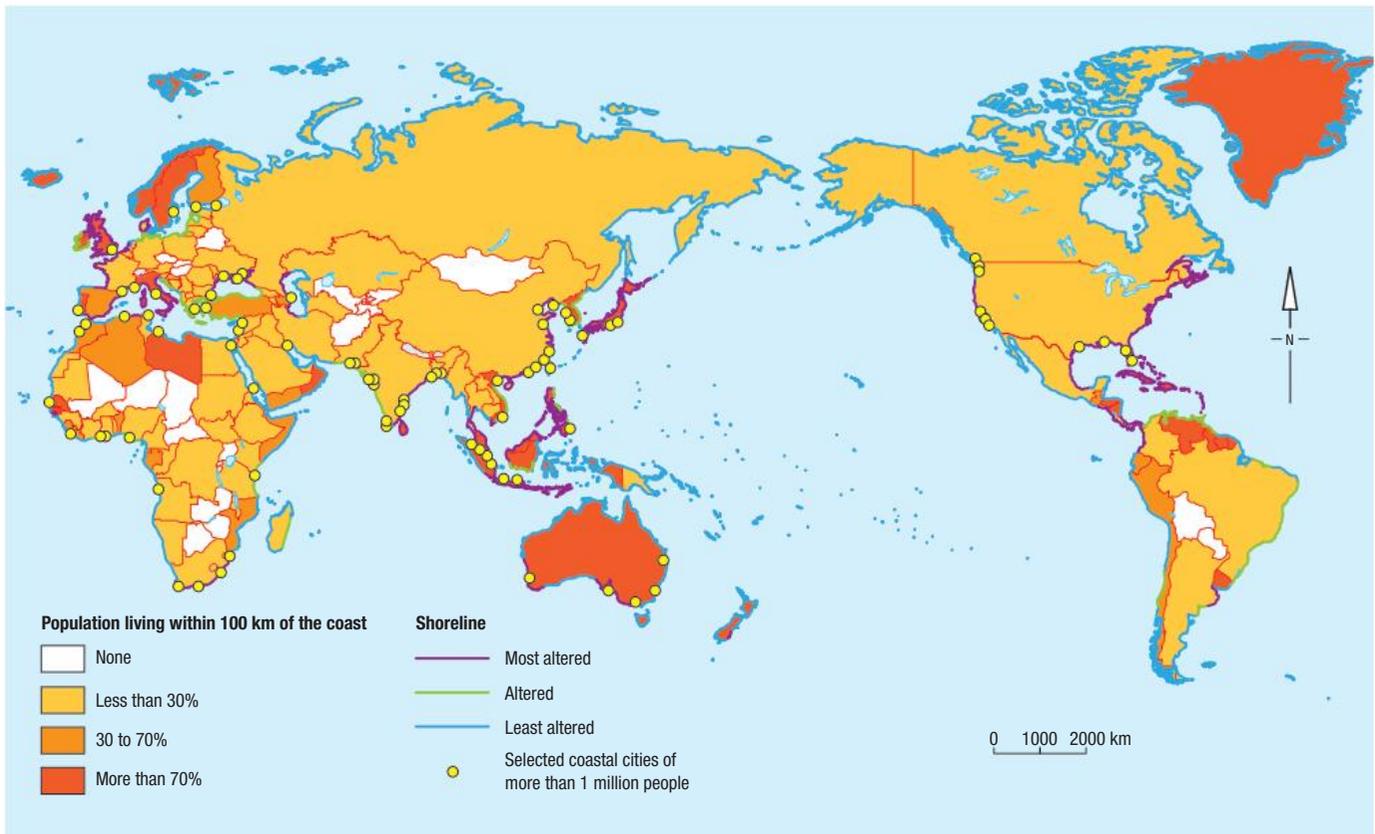
has increased 250 per cent since 1960, while the world's population has increased by only 90 per cent.

Because the collection of wood is time-consuming and often exhausting, people in developing countries tend to remove all suitable vegetation in increasingly wide areas around their villages. As a result, the collection of fuelwood and building materials is an important cause of deforestation, land degradation and desertification.



1.22 More than 90 per cent of Haiti is deforested, in large part because most of the 8 million people use charcoal to cook.

1.23 There is a close relationship between population density and the extent of human impact on coastlines.



Source: World Resources Institute

## ACTIVITIES



### Knowledge and understanding

- 1 Define the process of land degradation.
- 2 Outline the causes of soil and vegetation degradation.
- 3 Outline the various types of soil degradation.
- 4 Define the term 'desertification'.
- 5 Explain how the collection of fuelwood contributes to the problem of desertification.

### Geographical skills

- 6 Study Figure 1.18 then complete the following tasks.
  - a With the aid of an atlas, identify, in general terms, those parts of the world with very degraded soils.
  - b Which continent has the largest area of degraded land?
  - c Which continent has the smallest area of degraded land?
- 7 Study Figure 1.19. Identify the main causes of land degradation.
- 8 Study Figure 1.23. Identify the regions of the world where the coasts have been most altered. Note the relationship between the level of alteration and population density.

### Investigating

- 9 Investigate the strategies used to fight land degradation in a selected country and location. Present your findings as an annotated visual display. Include in your display a map of the location being investigated.
- 10 Conduct a survey of the school grounds or an area nearby to evaluate the amount of land degradation.
  - a Draw up a base map of the site.
  - b Look for evidence of damage to soil: erosion, compaction, waterlogging and salinity.
  - c Map the areas where nothing grows.
  - d Map the areas of plants. If possible, label them as native or introduced.
  - e Use this information to make a list of steps that could be taken to improve that particular area of land.

# 1.7

## Exploited oceans

The earth is sometimes referred to as the 'blue planet'. This is because two-thirds of its surface is covered by water: its four great oceans and the smaller seas. People have used these oceans and seas for centuries with little consideration of the long-term impact of their activities. Such indifference cannot continue. The wellbeing of the planet depends on the environmental functions performed by the oceans.

### Human impacts on oceans

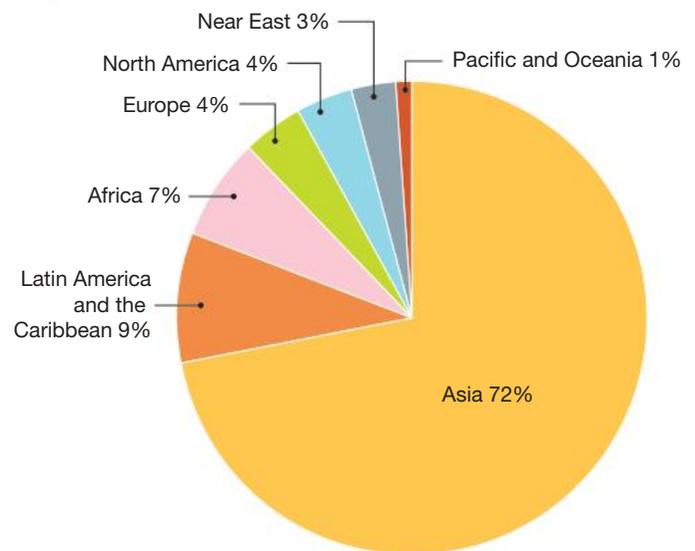
Some of the human impacts on oceans are:

- over-exploitation of the world's fisheries (see Figure 1.24)
- dumping of toxic pollutants and oil spills
- increased flow of nutrients (such as agricultural fertilisers and sewage)
- dumping of plastics and other solid wastes.

### Harvesting the world's oceans

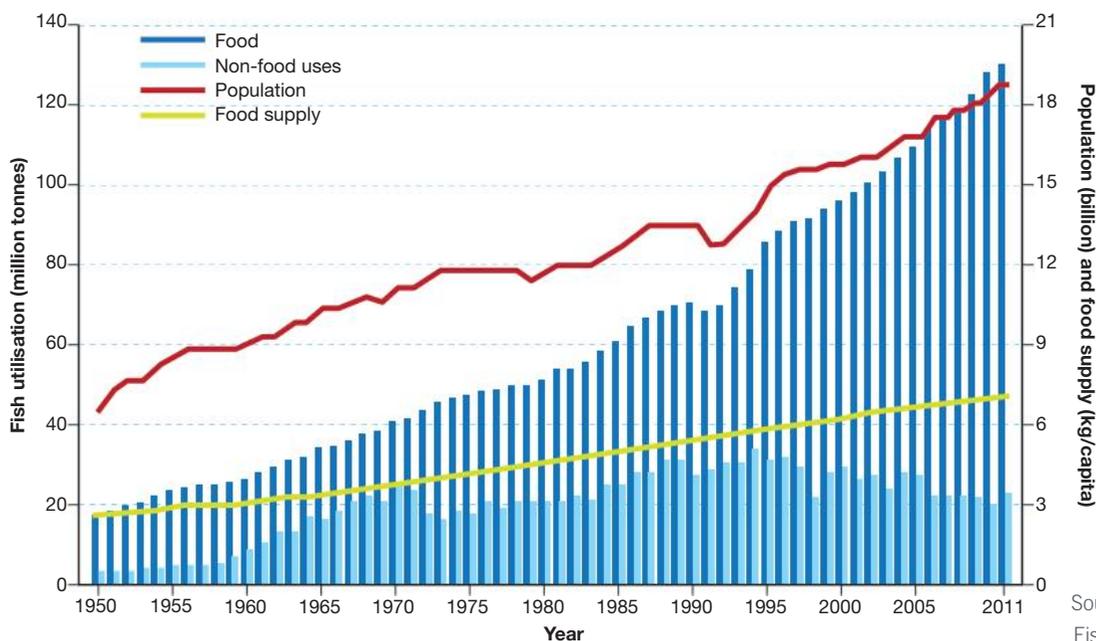
More than 3 million fishing vessels now sift the world's oceans for seafood. This is twice as many vessels as in 1970. The regional distribution of these vessels is shown in Figure 1.25. In 2010, wild capture fisheries and aquaculture supplied the world with about 148 million tonnes of fish, worth US\$217.5 billion. Of this, 59.9 million tonnes were produced on fish farms. This total catch equates to about 18.4 kilograms a year for the average person. Average fish consumption per country is shown in Figure 1.26.

1.25 Distribution of the world's fishing fleet



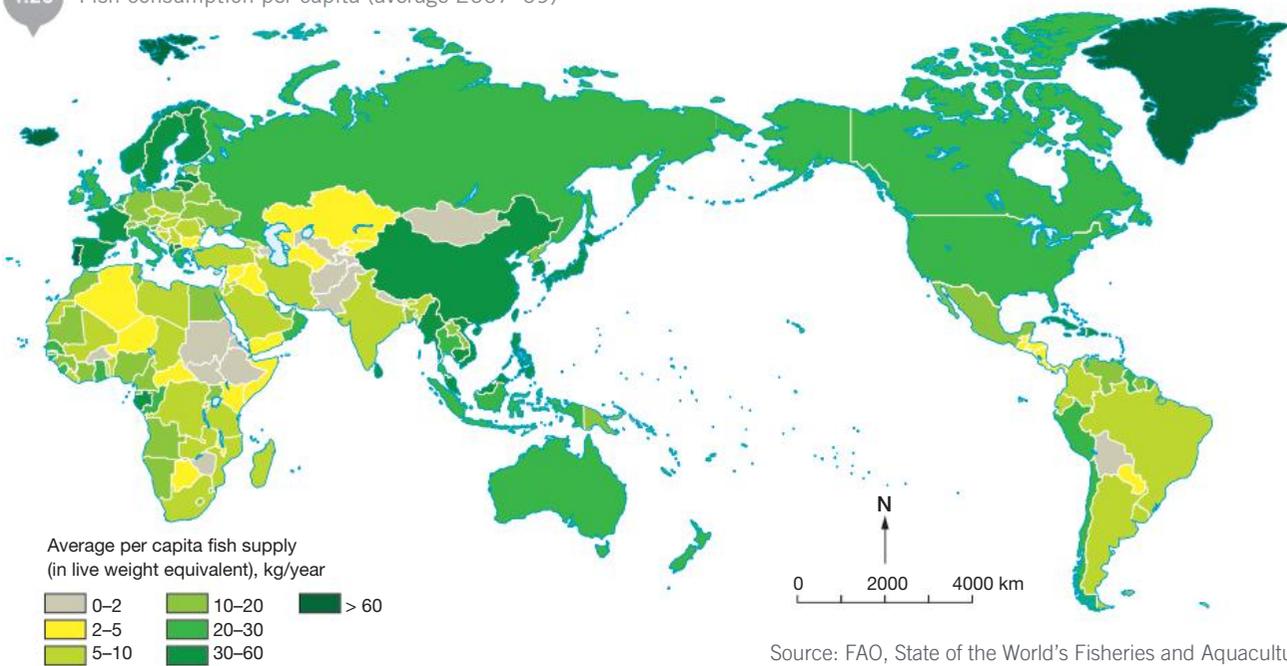
Source: FAO, State of the World's Fisheries and Aquaculture, 2012

1.24 World fish utilisation and supply



Source: FAO, State of the World's Fisheries and Aquaculture, 2012

1.26 Fish consumption per capita (average 2007–09)



Source: FAO, State of the World's Fisheries and Aquaculture, 2012

## Protection efforts

In an effort to protect their fishing grounds, many countries have extended their territorial control from 12 to 200 nautical miles (300 kilometres) beyond their coastline. As a result, nearly 40 per cent of the world's oceans have now been claimed as exclusive fishing zones by countries, which then restricts the access of foreign fleets to these waters.

In some regions, fish species have been exploited close to extinction. In other areas, fish yields are in serious decline. One such area is the Grand Banks of Newfoundland, Canada. In the mid-1990s, the Canadian Government became so concerned with the rate of decline that it ordered a stop to fishing in the region. The impact on local communities was dramatic—40 000 people were put out of work. Despite this, distant-water trawlers operating out of Spain, Portugal and other countries continued to fish the edges of the Grand Banks just outside Canada's territorial waters.

Having reduced fish numbers in their own waters, many rich countries are now buying access to the waters of poorer countries. This disadvantages local fishers, who are unable to afford the technology used by the larger foreign-owned factory ships, which process the catch on board. In the waters off Senegal in western Africa, for example, locals must now travel further and further to get the same catch. Large long-range trawlers from China, South Korea, Spain, Japan and France are depleting Senegal's local fish stocks.

International efforts to regulate the industry have not yet met with much success. As the oceans are so vast, it is difficult to make sure that operators comply with international agreements.

## Employment in fisheries

In 2010, there were 54.8 million people engaged in the primary sector of capture fisheries and aquaculture. More than 87 per cent of all people employed in the fisheries sector were in Asia, followed by Africa (more than 7 per cent) and Latin America and the Caribbean (3.6 per cent).

## ACTIVITIES

1.4

### Knowledge and understanding

- 1 Outline the actions countries have taken to protect their fishing zones.
- 2 Outline how people in developing countries have been affected by the growth of the fishing industry.
- 3 Explain why international efforts to regulate the industry have met with little success.

### Applying and analysing

- 4 Create a mind map on the impacts people have had on the world's oceans.
- 5 Study Figure 1.24. Describe the trend in fish utilisation for food and non-food uses, 1950–2011. Compare this to the trends in world population and total food production.
- 6 Study Figures 1.25 and 1.26.
  - a Identify the parts of the world where fish consumption exceeds 20 kilograms per person per year. Which regions have the lowest level of fish consumption?
  - b Compare the distribution of fishing fleet by region with average fish consumption.

# 1.8

## Habitat loss

A habitat is the biophysical environment in which a community of plants and animals lives. As habitats are destroyed, the communities of plants and animals that depend on them are displaced, resulting in some facing extinction.

### Pressures on biodiversity

As the world's population grows, so does the demand for food, clothing and shelter. As a result, whole habitats are lost and an area's **biodiversity** destroyed. While some species are already **extinct**, a growing number of species are classified as endangered, vulnerable or threatened.

### Levels of threat

The International Union for Conservation and Nature (IUCN) classifies the threat to species on a five-level scale, from threatened to extinct:

- **extinct:** not seen in the wild for the last 50 years
- **extinct in the wild:** found only in captivity (that is, in zoological gardens or seed banks)
- **critically endangered:** considered to be facing an extremely high risk of extinction in the wild
- **endangered:** considered to be facing a very high risk of extinction in the wild
- **vulnerable:** considered to be facing a high risk of extinction in the wild
- **threatened:** close to qualifying for the endangered or vulnerable categories in the near future.

The 2012 Red List, which sets out the status of 63 837 species, lists 19 817 at the highest levels of extinction threat, with 3947 described as critically endangered and 5766 as endangered; and more than 10 000 species are listed as vulnerable. At threat are 41 per cent of amphibian species, 33 per cent of reef-building corals, 30 per cent of conifers, 25 per cent of mammals and 13 per cent of birds.

#### DID YOU KNOW?

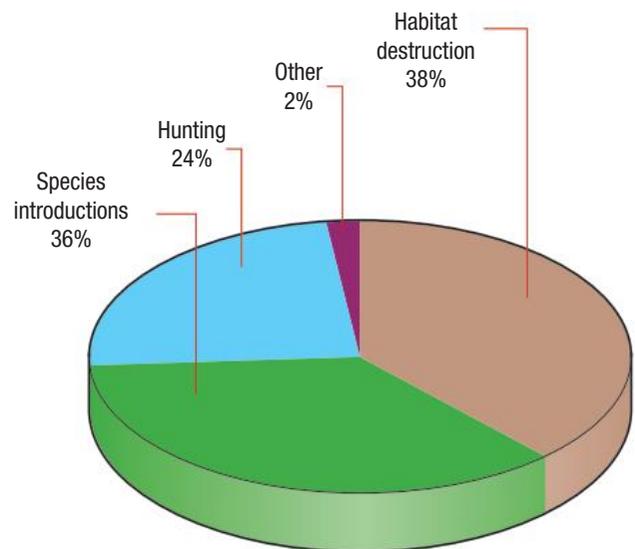
Only 1.9 million species have been identified out of an estimated 13 to 14 million species that are thought to exist.

### Causes of biodiversity loss

#### Habitat loss and degradation

The main reason that so many species have become endangered or extinct in the past hundred years is loss of habitat. The clearing of land for housing, logging and farming is the main cause of this habitat destruction. The known causes of animal extinctions are shown in Figure 1.27.

1.27 Known causes of animal extinctions. Habitat destruction is the main cause of species loss.



#### Introduced species

Introduced species of plants and animals can be an important factor in the decline of established native species. Rabbits, foxes, camels, goats, cane toads, cats, blackberry and prickly pear are some of the introduced species that have gone feral in Australia. They compete with native species and often eliminate them from wide areas. Many small species, such as the short-tailed hopping mouse and the numbat, have become endangered because of hunting by introduced species.

## Hunting (over-exploitation)

Over-exploitation is a significant cause of species loss and endangerment. Animals are hunted for food and skins. In the Caspian Sea, fishing for the highly valued beluga sturgeon's eggs, used to make caviar, has pushed the fish species close to extinction.

## Disease

The emergence of infectious diseases in free-living wild animals is a growing threat to biodiversity. It is likely that other factors (for example pollution) have increased the exposure of some species to disease. In Tasmania, the state's population of Tasmanian devils has, since the late 1990s, been affected by a facial tumour disease. This disease has reduced the devil population significantly and now threatens the survival of the species. The cancer's origin is a mystery, but studies indicate that the animals pass it on from one to another (it is contagious).

## Pollution

Many of the pollutants released into the environment by human activities have significant, large-scale impacts on the world's terrestrial and aquatic ecosystems. Acid precipitation, for example, has had a significant impact on the forests of Europe and North America, and industrial pollutants such as DDT are known to have caused significant declines in populations of many bird species, including the peregrine falcon and bald eagle. Toxic pollutants enter the food chain, causing birth defects and, in some cases, death.

## Climate change

Global warming has the potential to transform ecosystems. These transformations will affect the community of plants and animals within ecosystems. Rises in sea temperature and the acidification of oceans, for example, may cause whole reefs to die.

## Other causes

The impacts of tourism, natural disasters, urban development, tourism and the illegal trade in wildlife and animal-based products are also seen as threats to biodiversity.

## Wildlife trade

Wildlife trade is the second largest illegal trade-based activity. Only the trade in drugs is bigger. It is also the most serious threat to a number of endangered and vulnerable species. The items traded can be alive or dead. International law enforcement agencies estimate that the illegal trade of wildlife is valued at US\$10–\$20 billion per year. While the trade is global, with routes extending to every continent, conservationists say the problem is most serious in South-East Asia. Despite international and local laws that aim to eliminate the trade, live animals (see Figure 1.28) and animal parts—often sourced from endangered or threatened species—are openly sold in markets throughout Asia.

1.28

Geckos hidden in a hollowed-out book seized at the Cairns mail centre by Australian Customs Service officers. The geckos were destined for a European collector of exotic animals.



## SPOTLIGHT

### China acts to curb illegal ivory trade

In early 2014, Chinese authorities destroyed more than six tonnes of illegal imported ivory. The move was welcomed as an important signal that the country backs action to stop elephant poaching. The ivory came from more than 600 African elephants, killed by those keen to make money from the deadly trade. Conservationists say China is the world's largest consumer of trafficked ivory, most of which is used to make carved ornaments.

A global ban on the trade in ivory was imposed in 1989, in an effort to protect elephants from being hunted into extinction. Another strategy has been to sedate the elephants and to remove their tusks with saws, so denying the poachers the prize they seek.

1.29 Ivory being crushed by Chinese authorities



### Why species loss matters

All species are part of different ecosystems and a full variety of life forms—that is, biological diversity—in ecosystems allows these ecosystems to function better. They can purify water, maintain the quality of the air we breathe, recycle nutrients and waste, provide food and shelter for other species and keep the population of some species from dominating an area or environment.

Plants and animals also supply many of the medicines that are used to cure human diseases. The medical potential of many species is yet to be fully realised.

### Strategies for maintaining biodiversity

Attempts to protect habitats and biodiversity range from setting aside and protecting large areas of land to preserving species in zoos, botanical gardens and seed banks. None of the actions will, however, be sufficient to save many species from extinction.

#### DID YOU KNOW?

In the last 500 years, human activity is known to have forced 869 species to extinction.

## Protected areas

Protected areas are national parks, wilderness areas, nature reserves and World Heritage sites. According to the World Conservation Union, there are now 6555 national parks worldwide, covering more than 13 000 000 square kilometres. This land has been set aside to provide protection for threatened habitats and to maintain biodiversity. This area is roughly the size of India and China combined, or 8.8 per cent of the earth's surface. A much smaller area (just 1 per cent) of the world's seas is protected.

To be successful, protected areas need to:

- be large enough to protect whole ecosystems and allow evolutionary processes to continue into the future
- have boundaries that are based on environmental rather than political considerations; for example, taking in an entire catchment area that might span more than one country
- take into account the interests of the local people, for example by not banning traditional hunting practices, which would only encourage poaching
- be surrounded by a buffer zone, which is an area surrounding the protected area where human activity is carefully managed
- be well managed and adequately funded.

## Zoos, botanical gardens and seed banks

Zoos play an important role in captive breeding programs for endangered species, scientific research and public education. Animals bred in zoos are being used to repopulate their original homelands. Przewalski's horse, for example, has been reintroduced into northern China and Mongolia from animals reared at the San Diego Wild Animal Park in the United States of America. Seed banks have been established to store genetic material for future study and use.

## International agreements

International agreements between countries can make a great difference to the future of endangered species and threatened habitats.

### CITES

The Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES) aims to protect species by limiting or banning international trade in particular items. It has sought to ban the trade in ivory to protect African elephants from poachers. Helped by breeding programs, the number of African elephants has increased significantly in Namibia, Botswana and Zimbabwe.

A side-effect of trade bans has been the growth of illegal trade. Private zoos, for example, are willing to pay thousands of dollars for pairs of Australian parrots and lizards. Birds are usually drugged, put into narrow tubes and packed into suitcases. Sometimes dozens of birds die on their way to their overseas destinations.

## World Heritage Convention

The World Heritage Convention is an international agreement designed to protect important elements of our natural (and cultural) heritage. For a site to be included on the World Heritage List it must have important habitats for conservation of biodiversity and may contain threatened species with value to science or conservation.

## Convention on Biological Diversity

The Convention on Biological Diversity was adopted at the Earth Summit in Rio de Janeiro in 1992. The convention has three main goals: the conservation of biological diversity (or biodiversity); the sustainable use of its components; and a fair and equitable sharing of benefits arising from genetic resources.

# ACTIVITIES



### Knowledge and understanding

- 1 Define the terms 'habitat' and 'biodiversity'.
- 2 Outline the main causes of habitat destruction and species loss.
- 3 Outline the impact that introduced species can have on established native species.
- 4 Explain why we should be concerned about the loss of species.
- 5 Outline the conditions that need to be met if the protection of an area is to be successful.

### Applying and analysing

- 6 Create a PMI about the role of zoos. Divide the PMI into the following sections: past, present and future.
- 7 As a class, discuss the following question: 'Which is a more successful method of saving endangered species—habitat protection or a breeding program conducted in a zoo or animal park?'
- 8 Create a mind map outlining the main threats to biodiversity.

### Investigating

- 9 Investigate the ivory trade. Create an annotated world map showing the origin of the ivory and the destinations. Document on your map programs to stop the illegal killing of animals for ivory and to prevent people from purchasing ivory products.

# 1.9

## Our warming planet

Life has existed on earth for nearly 4 billion years. During this time, the climate of the planet has undergone great change, from ice ages lasting tens of thousands of years to long periods of steamy heat. With each change, some species of plants and animals flourished, others adapted and some became extinct.

### Climate change

During the past century, increasing levels of greenhouse gases such as carbon dioxide (CO<sub>2</sub>), shown in Table 1.30, have trapped enough heat in the atmosphere to raise the average temperatures by half a degree Celsius (see Figure 1.31). If present trends continue, the earth's climate could be significantly altered, with melting glaciers, rising sea levels, increasing rates of desertification and shifting vegetation zones.

1.30 Concentration of CO<sub>2</sub> in the atmosphere, 1960–2013

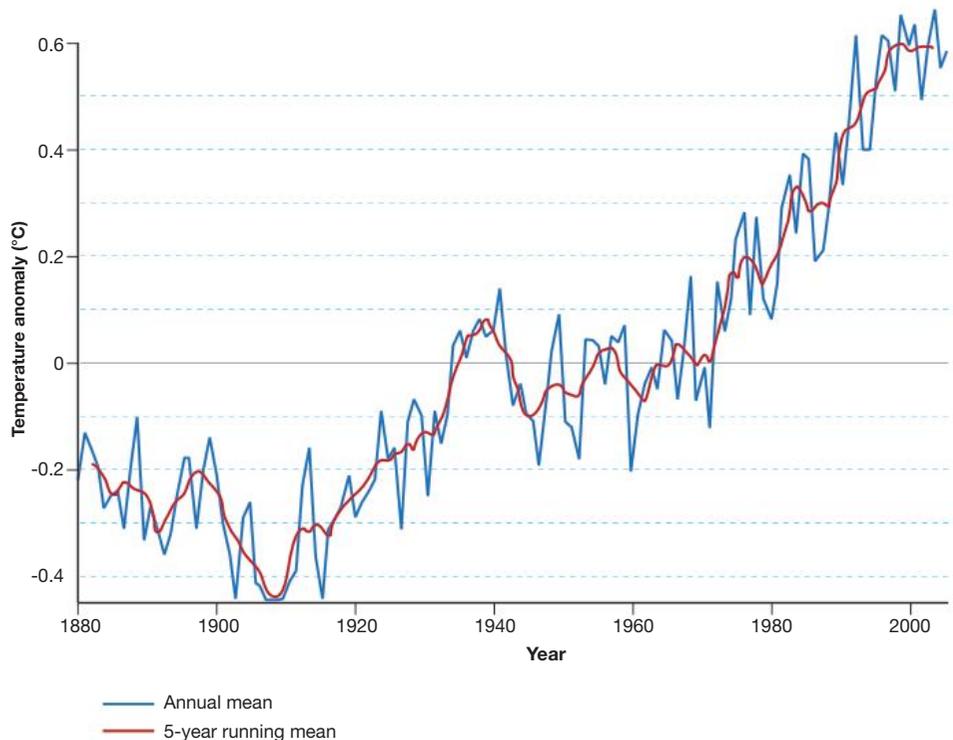
Year	Concentration (ppm*)
1960	316.91
1965	320.03
1970	325.68
1975	331.15
1980	338.67
1985	345.30
1990	353.83
1995	359.85
2000	368.77
2005	378.78
2006	380.91
2007	382.71
2008	382.71
2009	387.37
2010	389.85
2011	391.63
2012	393.82
2013	395.10

\* parts per million

### Global warming

The main cause of climate change is **global warming**: the gradual rise in average temperatures brought about by an increase in the heat-absorbing gases present in the atmosphere. The gases that make up the earth's atmosphere help trap and retain some of the heat radiated from the earth's surface. Without the atmosphere, the earth's surface temperature would average about  $-18^{\circ}\text{C}$  instead of the present  $15^{\circ}\text{C}$ .

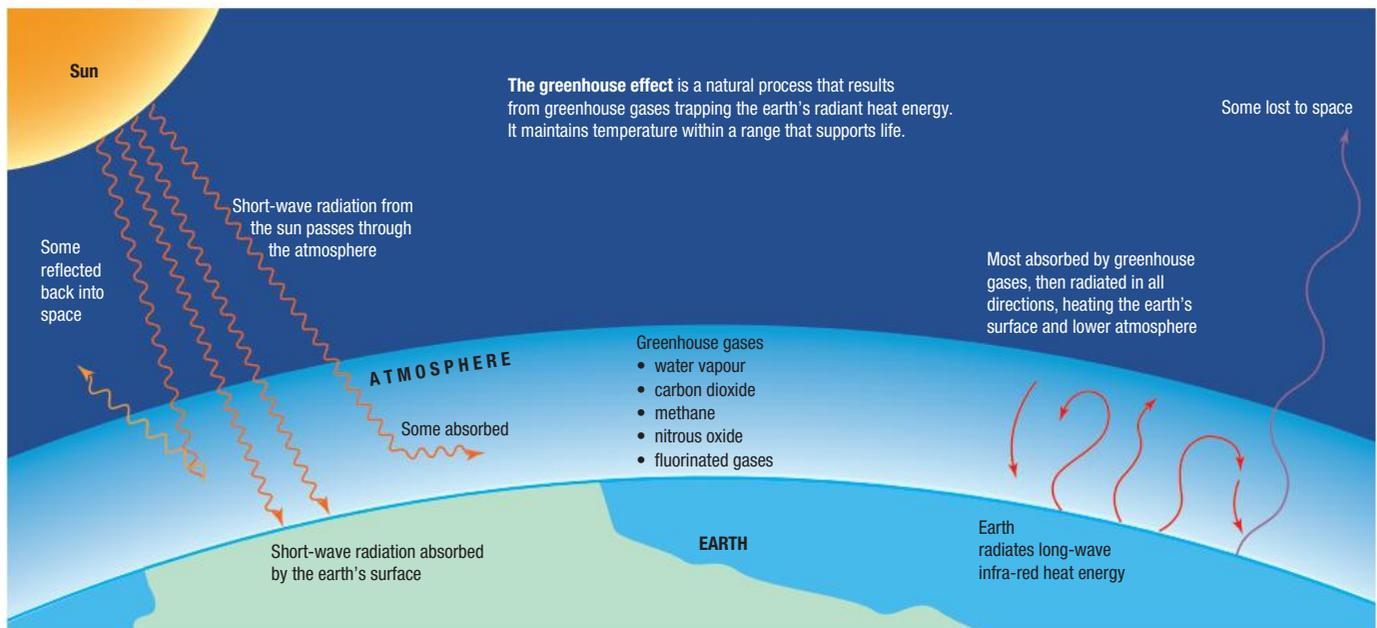
1.31 Global mean land–ocean temperature change from 1880 to 2012, compared to the 1951–80 mean. The black line is the annual mean and the red line is a 5-year running mean.



Source: NASA

The atmosphere lets only a fraction of the sun's energy (heat) make it directly back into space. The rest is trapped in the lower layers of the atmosphere, which contain various gases that absorb the heat and then radiate it back towards the earth's surface. This process is known as the natural **greenhouse effect** because it is similar to what happens in a greenhouse, or glasshouse, as shown in Figure 1.32. The natural greenhouse effect raises the average temperature of the earth by about 33°C (that is, from -18°C to +15°C).

1.32 The natural greenhouse effect



1.33 The enhanced greenhouse effect

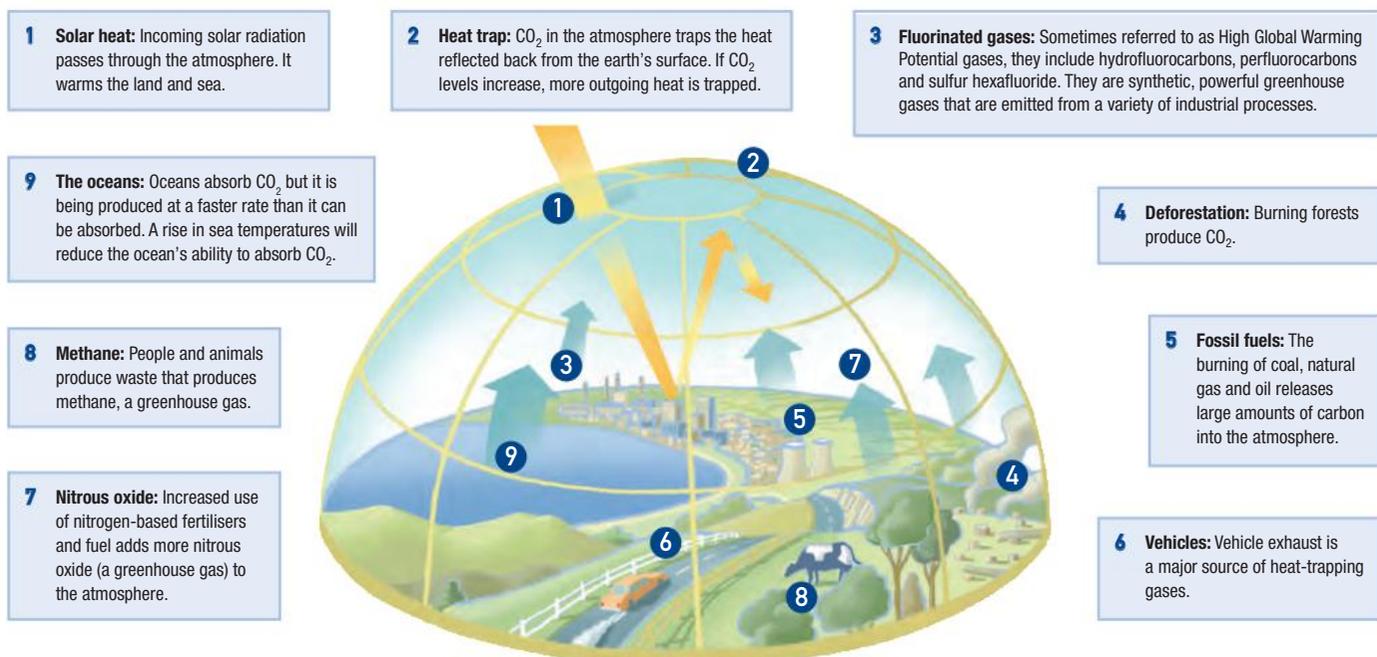


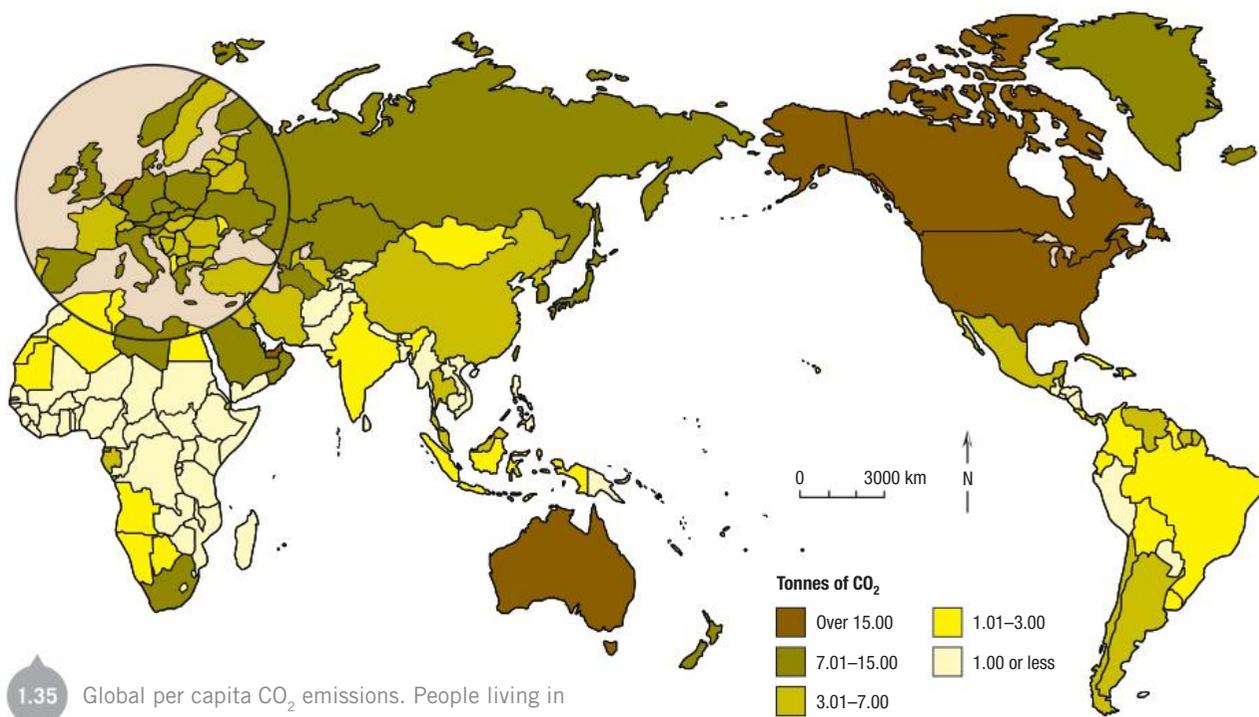
Table 1.34, which outlines the impacts of selected gases, shows that carbon dioxide is the largest contributor to the accelerated greenhouse effect. Figure 1.35 shows the amount of carbon dioxide per capita. Estimating the actual rate of global warming is made difficult by the natural variability of the climate from place to place and from time to time. There are also other unknown factors that might significantly influence global temperatures, such as the role of the oceans. The ability of a large body of water to retain its present temperature for a long time might slow the atmospheric temperature rise for some time. Because so little is known of this effect, it is difficult to predict accurately the rate at which temperatures will increase.

## Impacts of climate change

Now that scientists have accurately recorded the increasing concentrations of greenhouse gases in the atmosphere, they are turning their attention to the long-term impact of these gases on climate. Most scientists agree that the average temperature of the lower atmosphere will increase by between 1°C and 3.5°C over the next century. This increase is likely to affect environments and communities all over the world.

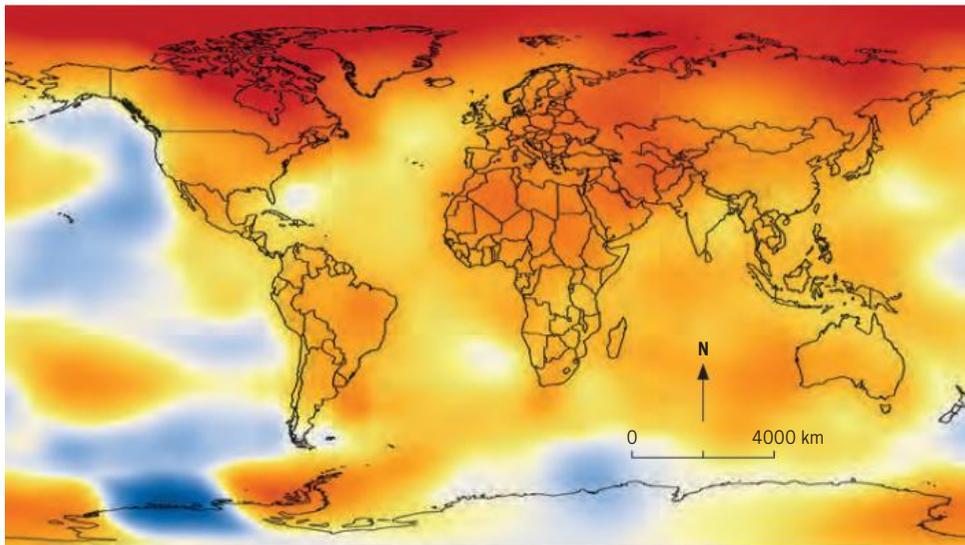
1.34 The contribution of selected gases to the greenhouse effect

Greenhouse gas	Natural origins	Human sources	Changes and impacts
Carbon dioxide 82%	<ul style="list-style-type: none"> <li>• Volcanic eruptions</li> <li>• Naturally occurring fires</li> <li>• Respiration by plants and animals</li> </ul>	<ul style="list-style-type: none"> <li>• Deforestation</li> <li>• Burning fossil fuels (coal, oil and natural gas)</li> </ul>	<ul style="list-style-type: none"> <li>• Current concentrations are more than 30 per cent greater than before the Industrial Revolution. Thought to account for 60 per cent of the warming observed since 1850</li> </ul>
Methane 9%	<ul style="list-style-type: none"> <li>• Decomposing plant and animal matter</li> <li>• Releases from geological deposits</li> <li>• Wetlands</li> </ul>	<ul style="list-style-type: none"> <li>• Ruminant animals, including cattle and sheep</li> <li>• Rice paddies</li> <li>• Landfill sites</li> <li>• Burning of fossil fuels</li> </ul>	<ul style="list-style-type: none"> <li>• There is now two and a half times more methane in the atmosphere than there was in the eighteenth century. Methane accounts for about 15 per cent of global warming.</li> </ul>
Nitrous oxide 6%	<ul style="list-style-type: none"> <li>• Natural atmospheric gas</li> </ul>	<ul style="list-style-type: none"> <li>• Burning vegetation</li> <li>• Chemical fertilisers</li> <li>• Burning fossil fuels</li> <li>• Industrial emissions</li> </ul>	<ul style="list-style-type: none"> <li>• The supply of nitrous oxides has increased by 15 per cent since 1800</li> </ul>
Fluorinated gases 3%	<ul style="list-style-type: none"> <li>• No natural sources</li> </ul>	<ul style="list-style-type: none"> <li>• Emissions from a range of industrial processes such as aluminium and semiconductor manufacturing</li> </ul>	<ul style="list-style-type: none"> <li>• Small atmospheric concentrations can have large effects on global temperatures. They are the most potent and long-lasting of the gases emitted by human activity.</li> </ul>

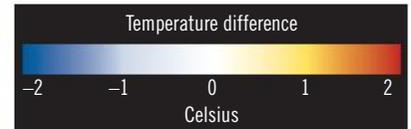


1.35 Global per capita CO<sub>2</sub> emissions. People living in developed countries are the main largest CO<sub>2</sub> emitters.

Source: World Bank, 2013



**1.36** Mean global temperatures in May 2010, compared with the May average for 1951–80. Parts of the planet show clear signs of warming.



Source: NASA

## Temperatures

The predicted increase will produce temperatures that were last experienced 100 000 years ago. Any increase will not be even across the globe (see Figure 1.36). Continental landmasses are likely to experience a greater temperature increase than ocean areas, because land absorbs heat faster than the sea. There is likely to be a greater temperature increase in regions in the high latitudes (that is, nearer to the poles) than near the Equator. Heatwaves are also likely to become more frequent and last longer.

## Rainfall

Higher temperatures will result in much more water vapour in the air: about 6 per cent more for every 1°C increase in temperature. In some places, this will mean more intense rainfall and flooding. Increases in sea and land temperatures will produce complex changes in wind patterns and precipitation patterns.

## Storm patterns

The combination of increased sea and air temperatures will affect the storm belts (areas of frequent storm activity) across the globe. At present, tropical cyclones are confined to latitudes 8–25° north and south of the Equator, where water temperatures are high enough to support the evaporation rate necessary for storms to form. With global warming, the storm belts will spread from the Equator. As a result, places on the same latitude as Brisbane (27°S) could regularly experience tropical cyclones, whereas they are presently out of range.

The warmer oceans will also create more intense storms.

## Melting ice sheets and glaciers

Scientists have recorded the retreat of the world's glaciers over the last century. There is growing evidence that the ice shelves surrounding Antarctica are beginning to break up and melt.

## SPOTLIGHT

### Australian bushfires to become more deadly

The devastating Victorian bushfires of 2009 and the Blue Mountain blazes of 2010 focused people's attention on the relationship between climate change and the frequency and severity of bushfires. Scientists have found that the most intense fire weather seasons have occurred since the 1990s. Adelaide, for example, experienced the three worst seasons on record in 2001, 2003 and 2007. This period coincided with one of Australia's worst and longest droughts. More frequent and severe droughts are predicted as a consequence of climate change. Scientists predict that the number of very high and extreme fire weather days could increase anywhere between 5 per cent and 65 per cent by 2020, depending on the rate of global warming, and by between 15 per cent and 300 per cent by 2050.



**1.37** The tragic fires in Victoria in 2009 claimed 173 lives and destroyed more than 2000 homes.

## Changes in sea levels

Rising sea levels could have an impact on coastal communities. It is predicted the polar regions will experience the greatest warming. If these predictions are correct, the melting of polar ice caps could be so great that it would add a significant amount of water to the oceans. In addition, as water expands as it warms, sea levels would be forced higher still. Average sea levels have risen by 10–25 centimetres during the twentieth century (see Figure 1.38).

## Causes of sea-level rise

There are three processes that contribute to sea-level rise.

### Thermal expansion

All bodies expand when they are heated, and that is true for the water that covers 70 per cent of the planet. The oceans are expanding—upwards. It is estimated that this expansion will raise levels by 10 to 40 centimetres over the course of the century.

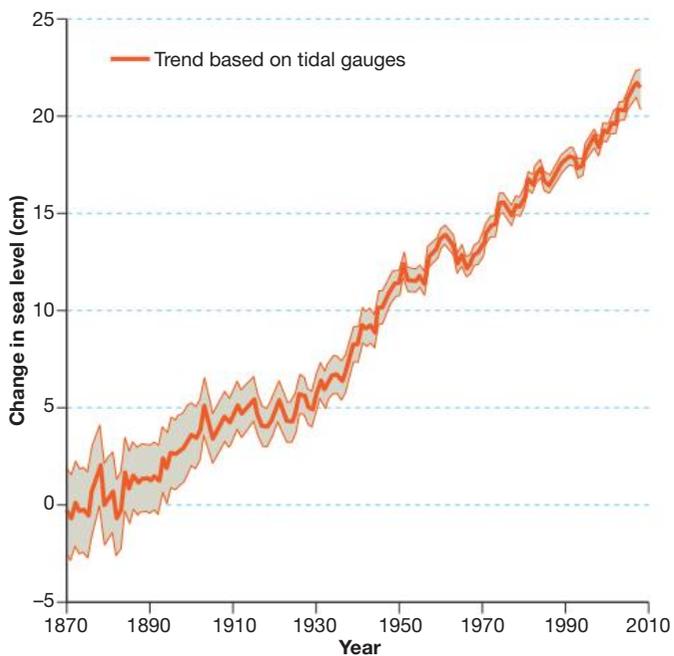
### Melting glaciers and mountain ice caps

Melting glaciers and mountain ice caps (outside Greenland and Antarctica) are adding water to rivers that flow to the oceans. However, these remain a modest source of sea-level rise—possibly around 10 centimetres.

### Melting ice sheets

The Greenland and Antarctic ice sheets represent vast reserves of frozen fresh water. The former would add 7 metres to sea levels if melted completely; the latter would bring a further 60-metre rise to the levels of the world's oceans.

1.38 Changes in sea level, 1870–2008. Sea levels have risen about 20 centimetres over the last 100 years.



Source: US EPA, 2010

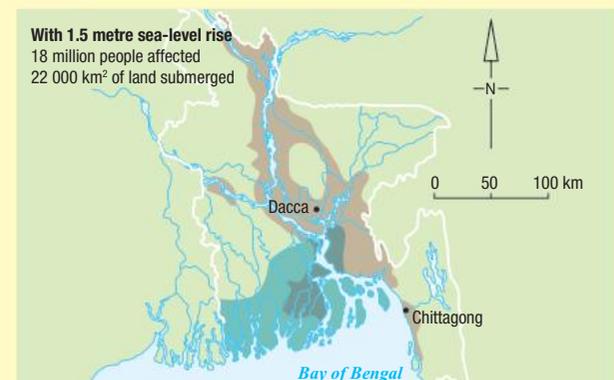
## SPOTLIGHT

### Bangladesh threatened by sea-level rise

Bangladesh is the seventh-most populous country in the world, one of the most densely populated countries, and among the poorest.

The country is located in the low-lying Ganges–Brahmaputra river delta. This delta is formed from the sediments deposited by the Brahmaputra and Ganges rivers and their various tributaries as they flow into the Bay of Bengal. The alluvial soil deposited by these rivers has created some of the most fertile plains in the world.

Most parts of Bangladesh are less than 12 metres above the sea level. It is believed that about 50 per cent of the land would be flooded if the sea level were to rise by a metre. If this happened, millions of people would become environmental refugees.



1.39 Large areas of Bangladesh will be flooded with even a modest rise in sea levels.

## Combating global warming

At the 1997 Climate Change Conference in Kyoto, Japan, the countries of the industrialised world agreed, in principle, to cut their emissions of greenhouse gases. In the face of worldwide demands to reduce emissions, developing countries are torn between going along with the plan and trying to lift the standard of living of their people. In the long run, the wellbeing of all the world's people will require greater cooperation between countries and a commitment by individuals to a more sustainable lifestyle. We will, for example, need to:

- reduce the amount of fossil fuels used
- use alternative sources of energy, such as wind and solar power
- stop cutting down forests, especially rainforests
- conserve energy.

Efforts to develop a global strategy for reducing humanity's CO<sub>2</sub> emissions are ongoing.

## Global warming deniers

Despite overwhelming scientific evidence that the planet is warming, there are still people who deny that this is occurring.

There is a range of views or perspectives, even among the sceptics. These range from outright denial that the earth is warming to a belief that climate change is real but the rate of warming and the predicted impacts of climate change have been greatly exaggerated. There is another view that global warming is due to natural processes, not human activity.

Groups opposed to any program aimed at reducing CO<sub>2</sub> emissions have focused on shaping the nature of the public debate about the issue.

In 2013, the *Guardian* newspaper reported that a small group of American billionaires, most of whom made their fortunes by exploiting fossil fuels, had donated more than US\$120 million to more than 100 anti-climate change groups and thinktanks working to discredit the work of climate scientists.

Many large fossil fuel-based industries have also tried to discredit the work of scientists. Exxon Mobil, the giant American oil company, has, for example, spent millions supporting organisations that cast doubt on the science on which the warnings about a warming climate have been based.

## ACTIVITIES

### Knowledge and understanding

- 1 Explain what global warming is.
- 2 Explain how human activity has increased the effectiveness or intensity of the greenhouse effect.
- 3 Outline the factors that make it difficult to estimate the actual rate of temperature increase.
- 4 Explain how global warming will affect the world's climate.
- 5 Explain why sea levels will rise.
- 6 Outline the actions taken by the international community to address the problem.

### Applying and analysing

- 7 Study Figures 1.32 and 1.33 and compare the natural greenhouse effect and the enhanced greenhouse effect.
- 8 Explain what is meant by the term 'climate change denier' and discuss the impact of these people.
- 9 In 2012, President Barak Obama said: 'We must respond to the threat of climate change, knowing that the failure to do so would betray our children and future generations. Some may still deny the overwhelming judgement of science, but none

can avoid the devastating impact of raging fires and crippling drought and more powerful storms.' Write a short response to his statement.

### Geographical skills

- 10 Using the data in Figure 1.30, construct a line graph showing the increase in atmospheric CO<sub>2</sub> concentrations since 1960.
- 11 Using data from Figure 1.31, describe the trends in global temperature over the course of the twentieth century.
- 12 Study Figure 1.35. With the aid of an atlas, do the following tasks.
  - a Identify the countries with CO<sub>2</sub> emissions greater than 15 tonnes per capita.
  - b Identify the regions of the world with annual CO<sub>2</sub> emissions of less than 1 tonne per capita.
  - c Using your knowledge of global inequalities, comment on the relationship between CO<sub>2</sub> emissions and level of economic development.
- 13 Study Figure 1.36. Identify the parts of the world that showed the greatest temperature anomaly (both positive and negative) in 2010 compared with the average for 1951–80.



# 1.10

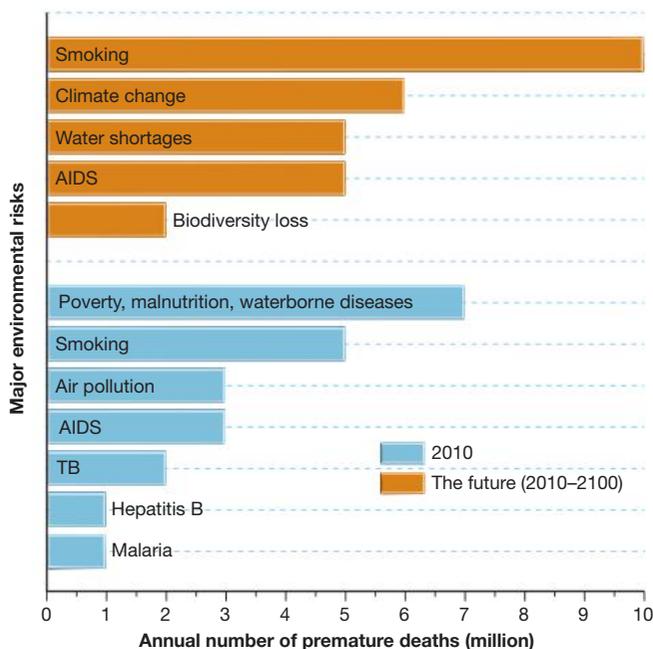
## Human environments

While environmental change is inevitable, the extent of the change and the pace at which it is occurring have accelerated in the last 50 years, largely because of human activities. As the fate of the earth becomes increasingly linked with that of the human race, it has become even more essential that we have a deeper understanding of the connection between environmental change and human activity. 'Human-environment systems thinking' is a technique that we can use to analyse the complex interactions between people and the environment.

### Scale of environmental change

Advances in technology have significantly increased the scale of the impact that humans have on the natural world. Human attempts to dominate nature have led to serious problems. There is now a growing appreciation of the challenges facing humanity. These include resource depletion, loss of biodiversity, pollution and climate change. Some scientists consider biodiversity loss and climate change the two most serious ecological risks to humans and other species. Estimates of human deaths from biodiversity loss and climate change 50 or more years into the future are difficult to make—they could be lower or higher than those shown in Figure 1.40.

1.40 Ranking of the major environmental risks in terms of the estimated number of people prematurely killed annually now and over the next 100 years.



Source: Data from UNFAO, UNEP, WB & US Centres for Disease Control and Prevention, and the World Bank

### A new way of thinking

Humans are not separate from nature. Continued human wellbeing relies on the life-support systems the earth provides. The changes needed to protect the natural world that sustains humans can only be achieved if there is a new awareness and understanding of the connections between humans and nature.

For too long, resources seemed limitless and nature was perceived as being separate, somewhere out there in a wilderness area. Now, as environmental issues are seen to threaten people's wellbeing, there is a realisation that these issues must be resolved in ways that balance the needs of both humans and the environment.

### Systems thinking

'Systems thinking' involves looking at a system as a whole, rather than focusing on its individual parts. All system parts are interdependent and they affect the performance of the whole system. Systems thinking provides a framework for looking at the interrelationships of these individual parts and how one can influence another. These interrelationships are known as feedback loops and they are the cause of the complexity within systems. These loops can bring about unintended consequences. Systems thinking also enables patterns of change over time to be detected, rather than providing a snapshot at one particular point in time.

### A system explained

In nature, a system is two or more parts interacting to operate as a whole within some boundary. The elements and processes of a system interact and affect one another, often in ways we cannot see. In a system, it is the nature of the relationships between the parts that is important—if elements or parts are added or taken away, the behaviour of the system changes.

## Human-environment systems thinking

The biophysical environment has a number of components, and human behaviour and decision making are shaped by many elements, as listed in Figure 1.41. Human-environment systems thinking is a useful approach to use when tackling the complexities of the relationships between humans and the environment, as it enables us to consider how one affects the other. It thus incorporates feedback loops. Ignoring feedback loops results in unintended consequences, as in the case of the introduction of the cane toad in Queensland.

1.41 Human elements shaping the biophysical environment

Components of the biophysical environment	Elements shaping human behaviour and decision making
Atmosphere	Economics
Hydrosphere	Technology
Lithosphere	Politics
Biosphere	Demography
Cryosphere	Religion
	Society
	Culture

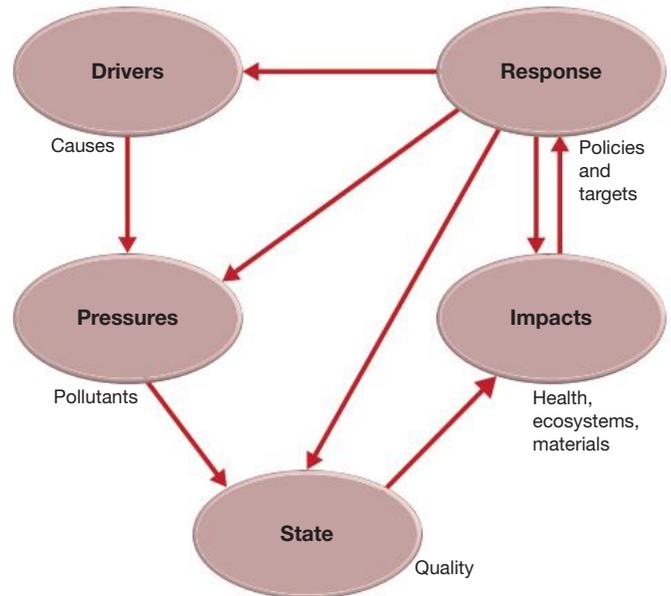
## DPSIR framework

An example of human-environment systems thinking is the DPSIR (drivers–pressures–state–impact–response) framework, which is used to assess and manage environmental problems. According to the DPSIR model, there is a chain of links from the driving forces to impacts and responses. The framework assumes cause–effect relationships between the various components of the DPSIR model as shown in Figure 1.42. These components are:

- 1 Drivers:** the forces that drive human activities that cause environmental change. They are the ultimate factors that cause change.  
*Example: agricultural production to provide food.*
- 2 Pressures:** human activities that place stress on the environment. They are the more immediate factors that affect environmental quality.  
*Example: clearing the land for cultivation and application of agrochemicals to boost yields.*
- 3 State:** the state or condition of the environment.  
*Example: land degradation and declining water quality from sediment, nutrients and toxic chemicals that wash into rivers and lakes and sink into groundwater.*

- 4 Impacts:** the effects of the environmental damage on the continued functioning of ecosystems and the earth's life support systems, which ultimately impact on human wellbeing.  
*Example: excessive and unsustainable agricultural practices that render the land unproductive and reduce food production; declining water quality from algal blooms and toxic contamination.*
- 5 Response:** the responses by policy makers or society to the undesired impact on the environment. Responses can be directed at any part of the chain, from the drivers to the impact.  
*Example: conservation farming practices and organic methods of pest control. Total catchment management that involves all the stakeholders in a catchment working towards protecting environmental quality.*

1.42 DPSIR assessment framework



## DPSIR at work

Initially, all the data and information on all of the various components are collected and collated. They are then examined to establish possible connections, before the DPSIR model is used to determine just how effective any responses may be. A strength of this model is that it considers the possible implications of changes in order to minimise uncertainty and unexpected problems.

The model can be extended to include elements such as values and beliefs. The attitudes of humans, both as producers and consumers, can have a bearing on environmental quality and public acceptance of new ways to protect the environment that may be proposed by policy makers.

## European Environment Agency

The DPSIR framework has gained international acceptance as a model for organising information about the state of the environment and addressing environmental issues. An early adopter of the framework was the European Environment Agency, which has used the DPSIR framework in its State of the Environment Reports, as shown in Figure 1.43.

## Reporting on Australia's environment

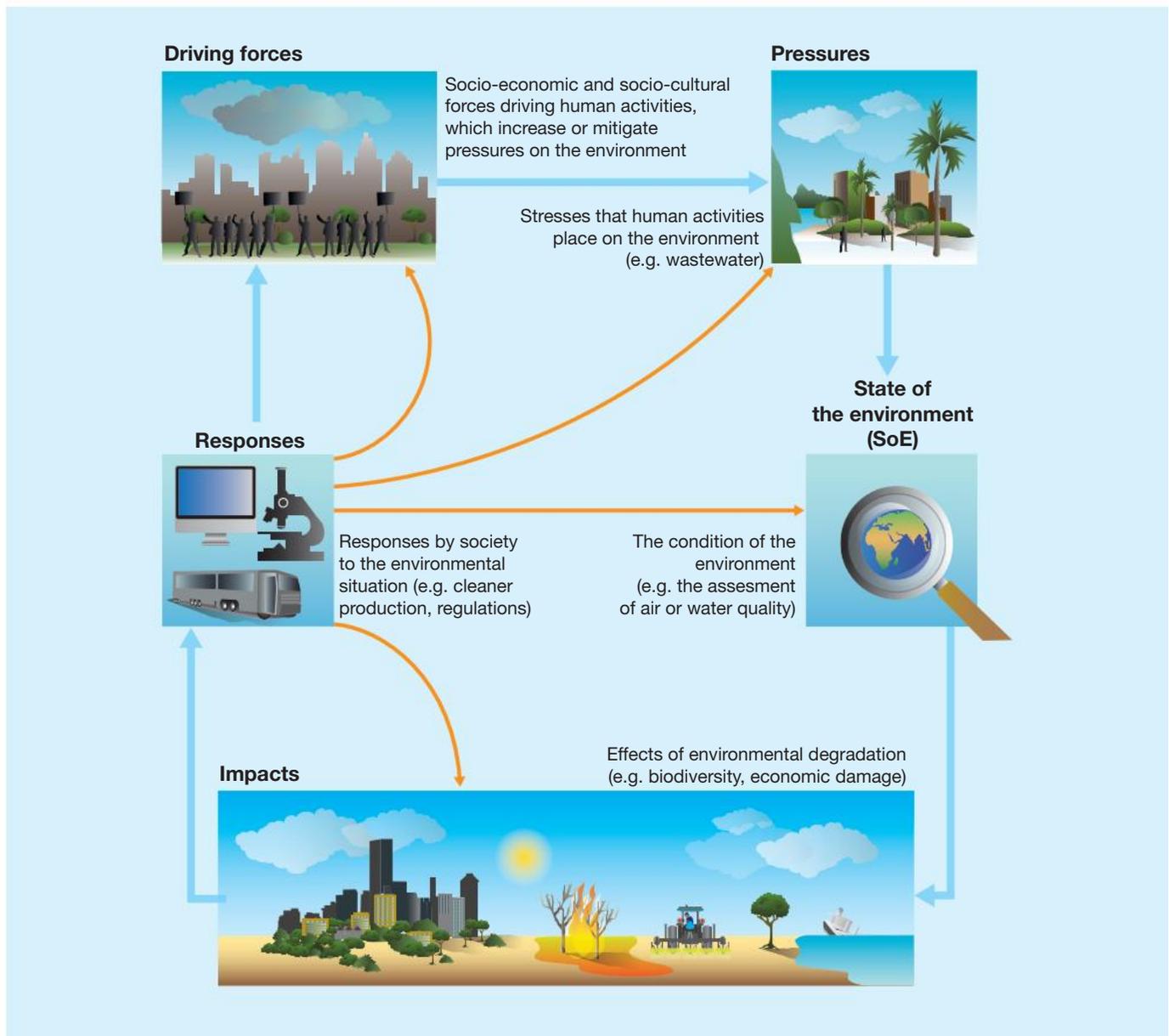
The Australian Government adopted the DPSIR model in the 2011 State of the Environment Report (SoE) (see Figure 1.44). This framework recognises the links from the drivers, such as economic development, through to the environmental impacts of human-induced pressures and management responses aimed at mitigating those pressures.

The report identified climate change as the direct driver of change. Population growth (with associated growth in the constructed environment) and economic growth (with associated increases in consumption of resources and generation of waste) are indirect drivers.

The 2011 SoE report aims to give Australians the best possible and clearest answers to three basic questions.

- 1 What is the current condition of the Australian environment (atmosphere, inland water, land, marine environment, Antarctic environment, biodiversity and coasts)?
- 2 What are the risks the Australian environment faces and are we doing enough to protect it?
- 3 Where is the Australian environment headed?

1.43 The DPSIR framework used by the European Environment Agency

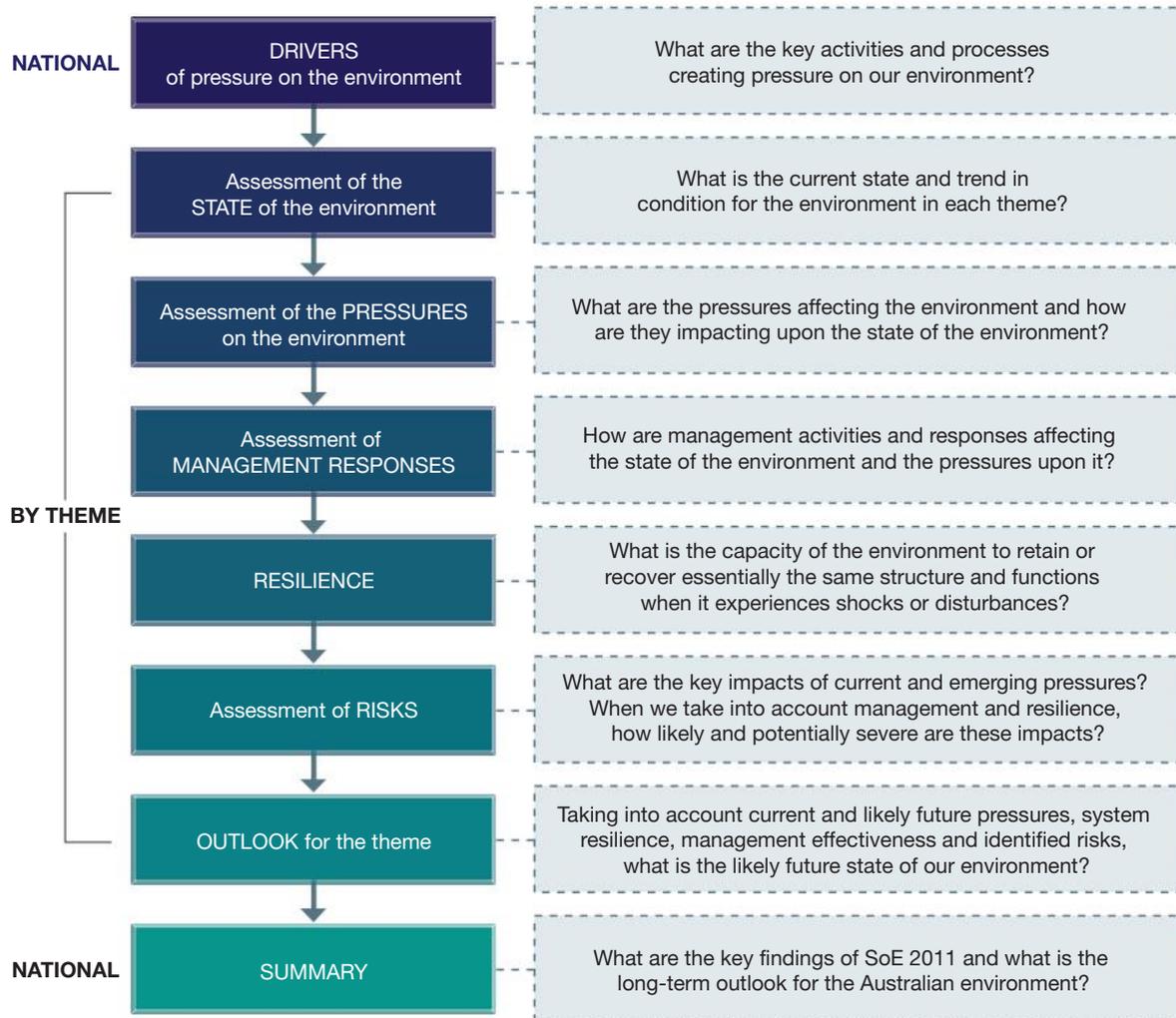


## Environment and development

Development is the main priority of most nations. While environmental considerations may initially have been seen as limiting economic growth and development, there is now a realisation that development and the environment should be mutually supportive. The links or connections between humans and their environment are complex, and in many

instances the environment is quite fragile. There has been an increased emphasis on ecological sustainability, and effective policies must be underpinned by a good understanding of the systems being managed. The framework of human-environment systems thinking enables this.

1.44 Approach to reporting on Australia's environment



## ACTIVITIES

### Knowledge and understanding

- 1 Describe systems thinking.
- 2 Assess the value of systems thinking in effectively addressing an environmental problem.
- 3 Describe the components of the DPSIR framework.

### Applying and analysing

- 4 Assess the scale of recent environmental change.
- 5 Study Figure 1.40 then answer the following questions.
  - a What was the biggest cause of premature deaths in 2010?

- b How many people are expected to die prematurely from smoking per year in the future (2010 - 2100)?
- c How many premature deaths each year are expected to be a result of environmental risks in the future (2010 - 2100)?
- 6 Study Figure 1.43 then answer the following questions.
  - a What are the two drivers of human activities?
  - b Analyse how the responses are connected to the other components of the DPSIR model.
  - c How might the use of this model in Europe improve the quality of the environment?



# 1.11

## Environmental worldviews

People disagree about the severity of environmental problems. As a result, they hold diverse attitudes and approaches towards environmental management. These differences arise mostly from conflicting environmental worldviews, as there are many ways of looking at nature and the relationship of humans to it. These worldviews often differ on the issue of what is more important, humans or nature.

### Role of environmental worldviews

A worldview is essentially a perspective or point of view held by an individual based on a set of values and assumptions. When it is accepted and shared by many, it becomes a belief system. An environmental worldview is concerned with nature and how the earth and all its species and resources are managed. It has an ethical dimension, as it shapes what individuals believe is right or wrong about their behaviour in relation to the environment.

A person's environmental worldview is shaped by their perceptions of:

- how the world works
- what an individual's role in the world should be
- what is correct environmental behaviour.

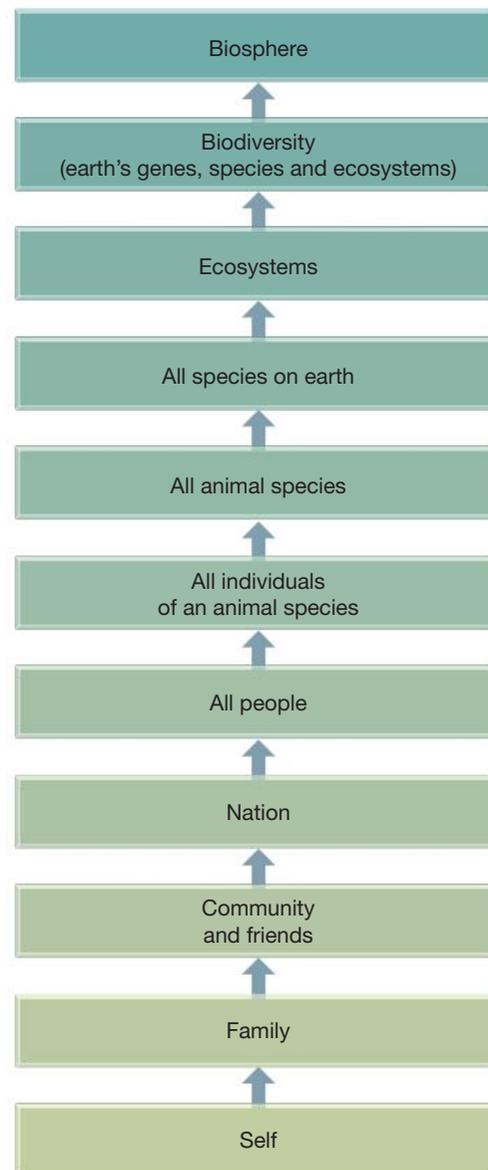
Figures 1.45 and 1.46 list ethical questions and concerns in relation to the environment that will help develop a person's worldview.

1.45 Some important ethical questions relating to the environment

- 1 Why should we care about the environment?
- 2 Are we the most important beings on the planet or are we just one of the earth's millions of different life forms?
- 3 Do we have an obligation to see that our activities do not cause the extinction of other species? Should we try to protect all species or only some? How do we decide which ones to protect?
- 4 Do we have an ethical obligation to pass the natural world onto future generations in at least as good a condition as we inherited?
- 5 Should every person be entitled to equal protection from environmental hazards regardless of race, gender, age, national origin, income, social class, or any other factor?
- 6 How do we promote sustainability?

Source: G. Tyler Miller & S. Spoolman, *Living in the Environment*, Brooks Cole, Belmont, 2012

1.46 Levels of ethical concern. People disagree about how far we should extend our level of ethical concern.



Source: G. Tyler Miller & S. Spoolman, *Living in the Environment*, Brooks Cole, Belmont, 2012

Taking the time to consider your environmental worldview enables you to have a deeper appreciation of your place in the environment and the implications of your decisions and actions. Your chosen environmental worldview shapes your behaviour and lifestyle choices. It also defines the boundaries of your actions and your readiness to take a stance on environmental issues.

## Conflicting environmental worldviews

There are different ways of looking at nature and how humans relate to it. It is not surprising that most people hold worldviews that are human-centred, as the focus of their world is their own wellbeing. Major environmental worldviews differ in what is more significant—providing for the human population or guarding the natural world from exploitation and degradation to ensure the health of ecosystems and the biosphere. Each worldview implies very different approaches to what are considered appropriate responsibilities towards the environment (see Figure 1.47).

### Human-centred worldview

According to this worldview, humans are superior and the most important species on earth. Humans are considered to be apart from the rest nature, and the value of other species and indeed the natural world is based on how useful they are to humans. As the dominant species, humans have unrestricted use of natural resources for their benefit alone. The belief underlying this worldview is that humans have an obligation only to themselves.

People with this worldview believe that what separates humans from other species is their intelligence. They have developed technologies to exploit resources and draw on the earth's life support systems for their own purposes. The human-centred worldview measures success in terms of how well humans control nature to meet their ever-increasing needs and wants. Such beliefs have long been evident in human civilisations and have driven the pursuit of economic growth in the western industrialised nations of the modern world. Through research and development, new technologies have evolved to exert even greater control over natural processes and extract resources to support ever-growing economies.

In the human-centred worldview, all economic growth is good and there is almost unlimited potential for it to continue. This is based on the assumption that human ingenuity and technology will ensure that any shortages or problems are overcome. The emphasis in modern economies has usually been on short-term efficiency and profits, disregarding any long-term costs associated with environmental damage.

### Stewardship worldview

This worldview has been held by indigenous peoples for thousands of years. Their strong spiritual connection with the natural world is ingrained in their daily lives. While they use resources to support themselves, they have an intimate knowledge and appreciation of their environment and act responsibly to ensure its continuing productivity. They are thoughtful managers or stewards of the natural world.

1.47 Comparison of three major environmental worldviews

Human-centred	Stewardship	Earth-centred
<ul style="list-style-type: none"> <li>We are apart from the rest of nature and can manage nature to meet our increasing needs and wants.</li> </ul>	<ul style="list-style-type: none"> <li>We have an ethical responsibility to be caring managers, or stewards, of the earth.</li> </ul>	<ul style="list-style-type: none"> <li>We are a part of and totally dependent on nature, and nature exists for all species.</li> </ul>
<ul style="list-style-type: none"> <li>Because of our ingenuity and technology, we will not run out of resources.</li> </ul>	<ul style="list-style-type: none"> <li>We will probably not run out of resources, but they should not be wasted.</li> </ul>	<ul style="list-style-type: none"> <li>Resources are limited and should not be wasted.</li> </ul>
<ul style="list-style-type: none"> <li>The potential for economic growth is essentially unlimited.</li> </ul>	<ul style="list-style-type: none"> <li>We should encourage environmentally beneficial forms of economic growth and discourage environmentally harmful forms.</li> </ul>	<ul style="list-style-type: none"> <li>We should encourage earth-sustaining forms of economic growth and discourage earth-degrading forms.</li> </ul>
<ul style="list-style-type: none"> <li>Our success depends on how well we manage the earth's life-support systems mostly for our own benefit.</li> </ul>	<ul style="list-style-type: none"> <li>Our success depends on how well we manage the earth's life-support systems for our benefit and for the rest of nature.</li> </ul>	<ul style="list-style-type: none"> <li>Our success depends on learning how nature sustains itself and integrating such lessons from nature into the ways we think and act.</li> </ul>

Source: G. Tyler Miller & S. Spoolman, *Living in the Environment*, Brooks Cole, Belmont, 2012

In modern times, individuals with a stewardship worldview accept the responsibility to be caring managers of the earth. They believe that they may use the available resources, but that this must be done in a sustainable way to ensure the availability of resources for future generations. Any form of economic growth and development that damages the environment is discouraged.

People with this worldview believe that they have an ethical responsibility to ensure that they leave the earth in a condition that is comparable to the one they inherited. This is because the earth and its resources are really being borrowed from future generations.

## Earth-centred worldview

People with this worldview believe that nature exists for all species on earth, not just humans, and that humans are equal to other species, not superior. All forms of life have a value, regardless of their actual or potential use to humans.

The extent to which people are prepared to protect the natural world depends on the depth of their beliefs. Individuals with an earth-centred worldview believe that protection should go well beyond species protection and encompass the entire natural world. They believe that humans are part of, and entirely dependent on, nature, and that nature exists for all species. So they advocate sustainability, which includes protecting the earth's biodiversity and the maintenance of its life support systems for all forms of life. Preventing the depletion of the natural world by ensuring ecological sustainability not only keeps other species alive but also ensures the survival of humans as a species.

The Deep Ecology movement goes even further. Supporters of this movement believe that present human intrusion into the natural world is excessive. This follows from a conviction that each life form is significant, and the fundamental interdependence of diverse life forms underpins the richness of the natural world. Supporters of the Deep Ecology movement claim that all forms of life have the right to exist. As humans are no different from any other species, they have no right to interfere with nature.

## Responding to environmental change

People have long held differing views on the environment. The stewardship worldview shaped the actions of indigenous people for thousands of years. With the emergence of civilisation and the voyages of exploration and subsequent colonisation, the human-centred worldview took over. As new frontiers were established, the wilderness was seen as something to be tamed and conquered so that

it could be of use to humans and yield valuable resources. Even then, though, there were individuals who cherished the natural world and worked to protect it.

It is clear that there are extremes in the environmental worldviews held today. While many people may not fully embrace particular environmental worldviews, it is evident that there are differences in people's views about the causes of environmental issues in Australia and across the world. Individuals' differing perceptions of the seriousness of environmental problems and what should be done about them present a challenge. With no consensus, it is difficult to develop and implement strategies to deal with the problems, which then become even worse and harder to solve.

## Different views on climate change

The issue of climate change provokes more argument than any other environmental issue, yet it could well have the most profound impacts on the quality of our life in the future. Despite the overwhelming majority of scientists stating that climate change is real and becoming significantly worse because of greenhouse gas emissions, there are people who deny the severity of the problem.

- Freeman Dyson, Professor at the Institute for Advanced Studies, Princeton University, United States, believes that:

Climate change is a real problem, partly caused by human activities, but its importance has been grossly exaggerated. We do not know whether the observed climate changes are on balance good or bad for the health of the biosphere. And the effects of atmospheric carbon dioxide as a fertiliser of plant growth are at least as important as its effects on climate.

- Jim Hansen, Director at NASA's Goddard Institute for Space Studies, United States, believes that:

The argument about whether or not there is global warming is over. It is now clear that we have been in a strong global warming trend at a rate of 0.3°C per decade for the past 30 years, meaning there has been a 0.56°C global warming in that period. The earth is now at its warmest level in the period of instrumental data; that is, since the late 1800s.

## Different views on solutions

Climate change is a global problem with global consequences and it needs a global solution and international cooperation. There are differences in the willingness of countries to reduce their emissions, as some consider that this might stifle their economic growth and development (see Figure 1.48). There are people who believe that carbon sequestration is the answer.

Carbon sequestration involves the capture and long-term storage of carbon dioxide. One way of doing this is geosequestration, whereby excessive carbon dioxide is buried deep beneath the earth in depleted gas or oil wells. There are concerns, though, that the carbon dioxide might leak out, especially if there is unexpected seismic activity.

Lowering greenhouse gas emissions is considered essential to mitigate human-induced climate change. Households and businesses should explore opportunities to increase their energy efficiency and reduce emissions. Governments and corporations need to invest in developing and commercialising clean energy technologies to reduce carbon pollution.

1.48 Cartoon by Justin Bilicki, illustrating that the findings of research are not always accepted and acted upon.



## ACTIVITIES

### Knowledge and understanding

- 1 Define the terms 'worldview' and 'environmental worldview'.
- 2 Explain why it is important for individuals to consider their own worldviews.
- 3 Describe what shapes an individual's worldview.
- 4 Identify three major environmental worldviews and consider how they differ in the relative importance placed on humans and the environment.
- 5 Define the term 'geosequestration'.
- 6 Explain why some nations are reluctant to reduce their emissions.

### Applying and analysing

- 7 Study Figure 1.46. How far up the scale would you extend your own ethical concern? Justify your choice.
- 8 Build your ecological identity or worldview by answering the following questions:
  - a Where do all the things I use and depend on come from?
  - b Where do all my waste products go?
  - c What do I know about the environment I live in?
  - d How am I connected to the natural world and other living organisms?
  - e What is my purpose in life?
  - f What is my responsibility as a human being living on this planet?
- 9 Study Figure 1.47. Which of the worldviews illustrated fits most closely with your thoughts? Which of these is the best fit with your parents' worldview?
- 10 Many consider applying the precautionary principle is especially important when tackling climate change. Justify this position.
- 11 'It is widely accepted that humans do have an ethical responsibility to avoid being the cause of the premature extinction of species through their actions.' To what extent do you agree with this statement? Discuss.

# Human wellbeing

The term 'human wellbeing' refers to the quality of life experienced by people individually and collectively. It can be measured using statistics such as life expectancy, educational attainment and income, and by the subjective judgements people make about their quality of their life.

## Global variations in human wellbeing

The quality of life experienced by people largely depends on whether they live in a developed or developing country. In Australia, a child born today can expect to live to about 81.85 years of age, but a child born in Ethiopia can expect to live to just 59 years.

Variations in **human wellbeing** can also be found within countries. A homeless person living on the streets of an Australian city or a disadvantaged Indigenous Australian living in a remote outback community may have much in common with people living in the squatter settlements of a developing world city. Similarly, a wealthy business owner living in Ethiopia may enjoy a quality of life as good as that experienced by people living in a developed country. Geographers call these differences 'inequalities'.

## Defining development

**Development** is a contested term. It can be viewed as simply the outcome of economic growth or it can be understood in terms of an ongoing, dynamic, socio-economic process, the aim of which is a sustained improvement in people's quality of life or wellbeing.

The process of development involves improving the quality of people's life through increasing per capita incomes, reducing poverty and enhancing individuals' economic opportunities and life choices. It is sometimes defined to include better education, improved health and nutrition, conservation of natural resources, a cleaner environment and a richer cultural life. It can also include relief from the factors that limit the life choices people are able to make. Development involves taking action—addressing issues such as poverty, child labour, malnutrition and starvation, tyranny and repression, **human rights**, the rights of women and minorities, the denial of economic opportunities, child labour and social deprivation.

## Defining wealth

A country's wealth is often measured using Gross Domestic Product (GDP): the total value of the goods and services produced each year. GDP per person, or per capita, is calculated by dividing the country's GDP by the number of people living in that country. Another commonly used measure is the Human Development Index (HDI), which takes into account income, life expectancy and education. The Inequality-adjusted Human Development Index (IHDI) measures the level of human development, taking inequality into account. In a country with no inequality, the IHDI is equal to the HDI, but falls below the HDI if inequality rises.

GDP per capita, or the HDI, tells us only part of the story. Other factors contribute to our sense of wellbeing. We often refer to these as qualitative factors. In other words, they cannot be easily measured. Examples are happiness, environmental quality, personal freedoms and lifestyle.

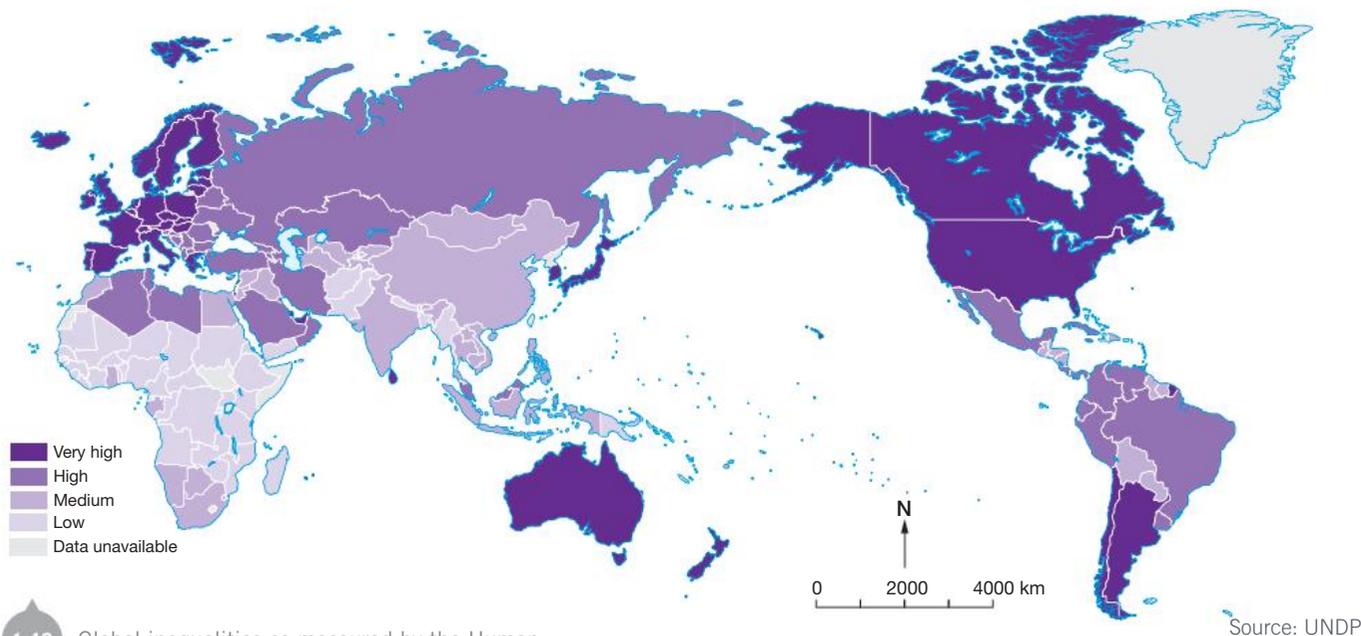
## Defining poverty

GDP can also be used to rank the world's poorest countries, but as with wealth, this gives you only part of the picture. Before you can make a judgement about the overall level of a country's development, you need more information about the way that people in that country live.

Poverty is often defined as either relative or absolute poverty. **Absolute poverty** is coping without the resources (food, clothing and shelter) necessary for life. People living in absolute poverty are barely surviving. **Relative poverty**, on the other hand, is the situation in which some people are poorer than others in the community but still have access to adequate food, clothing and shelter.

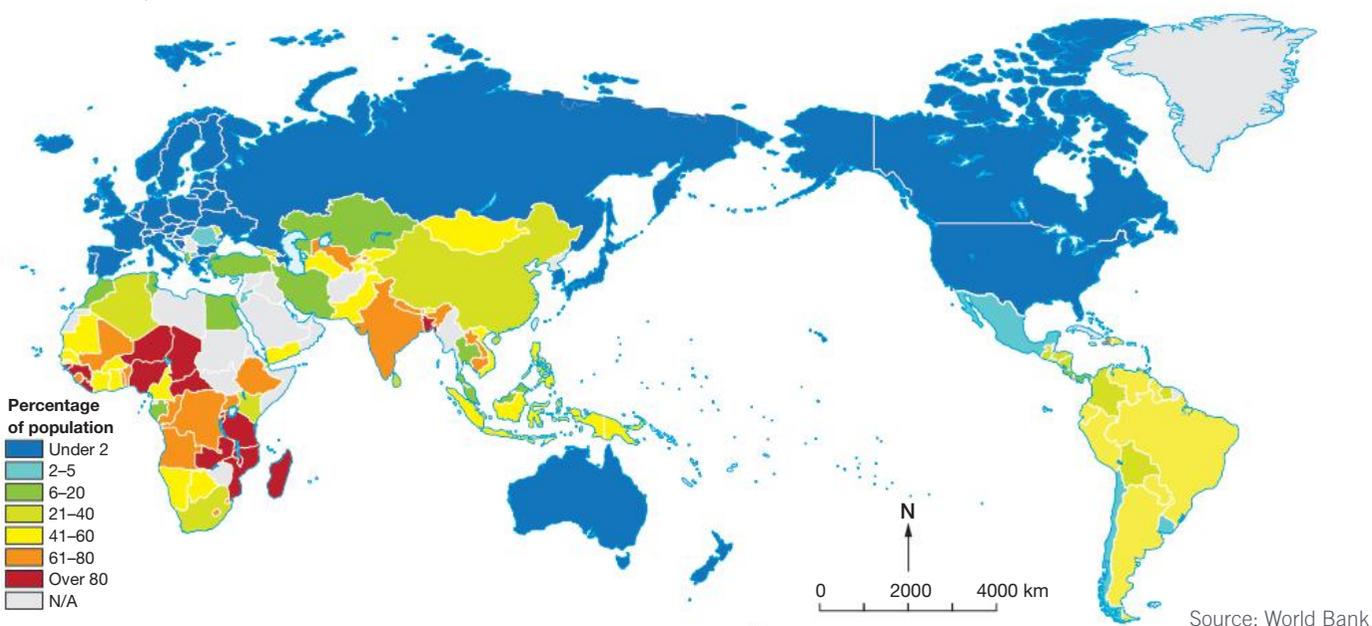
## Global patterns

The global distribution of rich and poor countries, based on the HDI, is shown in Figure 1.49. Global inequality, based on the IHDI, is shown in Figure 1.50.



1.49 Global inequalities as measured by the Human Development Index, 2013

Source: UNDP



1.50 Percentage of the population living under \$2 per day, 2009

Source: World Bank

## ACTIVITIES

### Knowledge and understanding

- 1 Define 'human wellbeing'. How can it be measured?
- 2 Identify the scales at which variations in human wellbeing occur.
- 3 Explain how the HDI differs from GDP.
- 4 Explain how the IHDI differs from the HDI.
- 5 Explain the difference between absolute and relative poverty.

### Applying and analysing

- 6 List the inequalities that exist in your own community.
- 7 In groups, discuss what you consider to be the basic minimum requirements for a person living in your

community. Consider food, education and health facilities. Draw up a list as a result of the discussion. See how much agreement there is between individuals and groups.

### Geographical skills

- 8 Study Figure 1.49. With the aid of an atlas, identify those parts of the world that have the lowest ranking on the HDI. Which countries have the highest HDI?
- 9 Study Figure 1.50. With the aid of an atlas, identify those countries with more than 61 per cent of the population living on less than \$2 a day.

# Aboriginal and Torres Strait Islander people: Environmental management

Indigenous Australians have held a custodial responsibility for their country for tens of thousands of years. Over this time they acquired and passed on to successive generations a wealth of knowledge about the natural world.

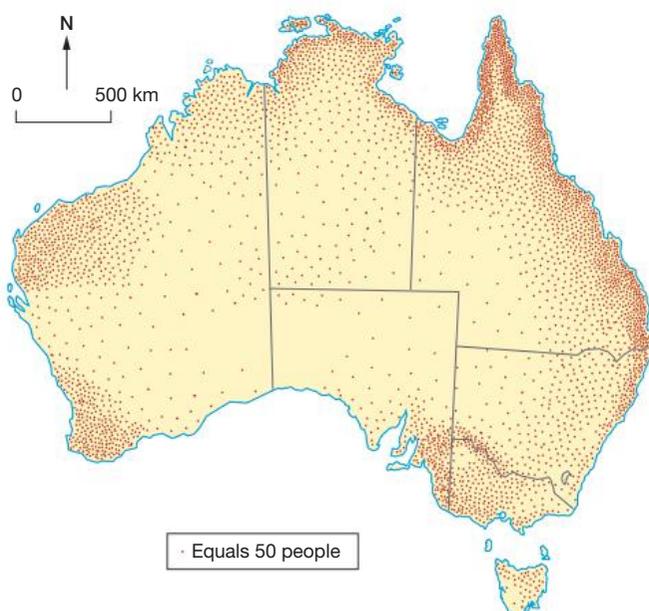
## Australia's Indigenous population

Australia's Indigenous population consists of Aboriginal people and Torres Strait Islander people. These two groups have their own characteristic identities, histories and cultural traditions, a product of adapting to quite different natural environments. They are still acknowledged as distinct populations within the Australian community today.

### Aboriginal people

Aboriginal people occupied the whole of the continent of Australia at the time of the European settlement in 1788, as is shown in Figure 1.51. Aboriginal people exploited all its environmental and climatic variations, as they possessed a detailed knowledge of the natural world and its resources.

1.51 Estimated number and distribution of Aboriginal people in 1788



They were able to live off the land in the vast dune systems of the arid interior, even though the resources were relatively scarce and they moved over a large area to hunt for food (see Figure 1.52). The population densities were much higher in the better-watered parts of the continent along the east coast, in the tropical north and in the Murray–Darling Basin.

### Torres Strait Islander people

Torres Strait Islander people come from the Torres Strait to the north of Cape York Peninsula in Queensland. There are 270 small islands between mainland Australia and Papua New Guinea. Of these, seventeen are inhabited. It is thought that they were occupied as people moved down from New Guinea (current-day Papua New Guinea and the Indonesian province of West Papua) at least 2500 years ago.

The Torres Strait Islander people have their own rich culture and traditions, which are quite distinct from those of the Aboriginal people. Being island communities, their lives are closely tied to the sea. This is reflected in the technology and material culture the Islanders developed, using materials such as fish bones, turtle shells and pearls. These were shaped and carved for tools such as fish hooks and spear tips, as well as highly prized decorative items used in ceremonies.

The Torres Strait Islander people relied heavily on trade with other islands in the region. For hundreds of years they had contact with visitors from Makassar (now part of Indonesia), who came to collect trepang or sea cucumbers. Trade continues with villages along the coast of New Guinea. Despite many of the Torres Strait islands being located just off the coast of New Guinea, they formally became part of Queensland in 1879. The majority of Torres Strait Islanders now live on the mainland in Queensland.

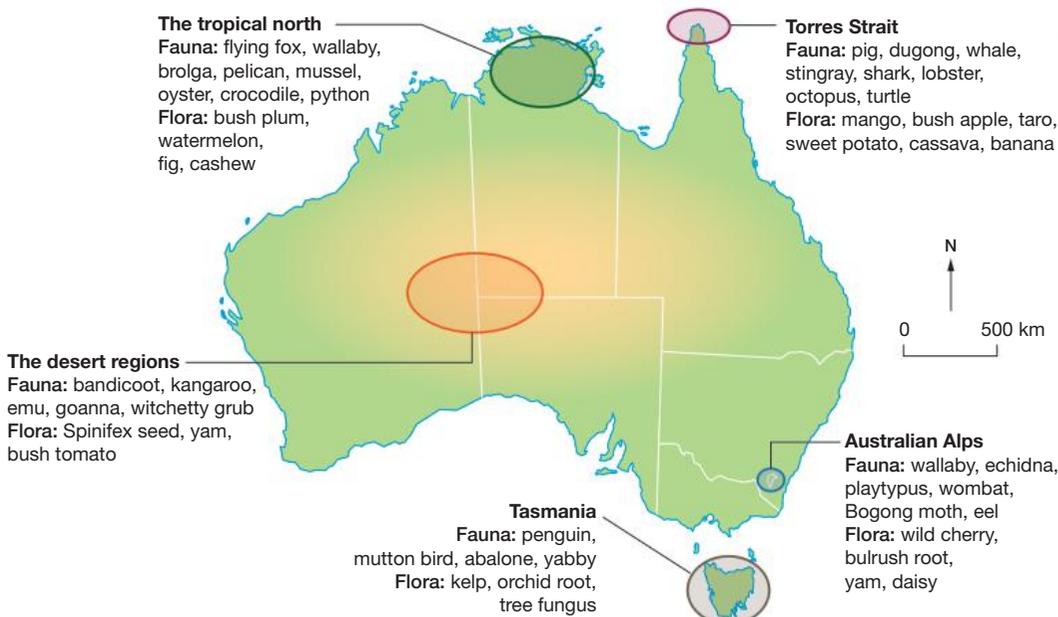


**1.52** Even in the seemingly inhospitable deserts of Australia, Aboriginal people were able to support themselves by hunting and gathering food.

## Models of sustainability

Underpinning all the interactions between Indigenous people and their environment were rules that imposed a strict discipline on the actions of each individual. This was reinforced by the Dreaming and the Dreaming Ancestors, who gave form to the landscape and bound people to their traditional country. The strong attachment to this country was not one of ownership, but rather a spiritual connection that carried with it many responsibilities.

Aboriginal and Torres Strait Islander people successfully adapted to live in many different and some very difficult environments, using a wide range of food sources, as shown in Figure 1.53. The items shown in each region are only a small selection of those used. The general pattern is similar everywhere, although there is regional variation according to the species available. For instance, seals were hunted in Tasmania and crocodiles and dugong in the north. People in Tasmania did not eat fish, a fact that researchers have not been fully able to explain. Torres Strait Islander people had gardens in which they cultivated species that were the same as those in neighbouring Melanesia.



**1.53** The fauna and flora used by Aboriginal and Torres Strait Islander people in different regions of Australia

## Knowing the land and seas

Aboriginal and Torres Strait Islander people knew the location and timing of a large number of significant natural events, as they were carefully attuned to predictable changes in the weather and the tides, as well as the seeding and fruiting times of plants and the breeding cycles and migration habits of the animals they relied on for food. Such detailed knowledge was recorded in early encounters with the Aboriginal people of Arnhem Land.

... as accurately as any ecologist, and they are able to state without hesitation what food supply, animal and vegetable, each association will yield ... The accuracy with which an Arnhem Land hunter could name and give an association according to its botanical composition, and the food supply, woods for spears and other purposes, as well as resins and fibre plants that would yield at any season of the year was astonishing.

Source: D.F. Thomson, 'Arnhem Land: Exploration among an unknown people', in *Geographical Journal*, 113, 1949, quoted in B. Gammage, *The Biggest Estate on Earth—How Aborigines Made Australia*, Allen & Unwin, Sydney, 2012

Most significantly, the natural world was much more important to the Indigenous people than just a means of survival; they saw themselves as its guardians or custodians. They felt a personal obligation to look after their country and ensure the natural world was kept in balance.

## Totems: Accepting individual responsibility

The foundation for sustainable management was the acceptance by each individual of their role in protecting the land and its totems. Indigenous people have a collection of totems that represent special plants, animals or places that they believe they are descended from. They cannot eat their particular totem and must ensure that its population is sustained. Each clan had a totem that linked it as a group. In addition, individuals had their own personal totem. This ensured the sustainability of food supplies that would otherwise not be available if the people ate everything they found.

## The value of traditional ecological knowledge

Aboriginal and Torres Strait Islander people had an intricate knowledge of the ecology of their environment and they were careful to make sure that ecosystems remained in balance. They were successful in doing this on a continent-wide basis for tens of thousands of years, over which time there was a great deal of climatic variability.

Indigenous people's specific knowledge about their environment is now being acknowledged. Given their holistic view of their environment, this knowledge extends to an understanding of ecosystem functioning and the interactions that occur within them. They are especially familiar with subtle yet important shifts that can occur in ecosystem relationships and know how to respond in order to restore the natural balance.

1.54

One of the Anindilyakwa Women Rangers, Groote Eylandt, Northern Territory. They work in the Anindilyakwa Indigenous Protected Area, which extends across the Groote Eylandt Archipelago. With relatively few introduced pests and no cane toads on the Eylandt, the Women Rangers are in a unique position to be strongly involved in biodiversity research and conservation activities.



## Caring for country

Given their vast knowledge and extensive experience, it is fitting that Indigenous Australians are having a growing, cooperative role in environmental management, as can be seen from the extract 'Indigenous land and sea management'.

# Indigenous land and sea management

Indigenous land and sea management, also referred to as ‘caring for country’, includes a wide range of environmental, natural resource and cultural heritage management activities undertaken by individuals, groups and organisations. In pre-colonial times, caring for country was undertaken by individuals and clan groups with inherited rights and responsibility for particular land and sea estates, under the guidance of initiated elders and other knowledge holders. These cultural rights and practices still underpin all contemporary land and sea management activities, but they have adapted and evolved over time and are delivered by a diversity of local, regional, state, territory and national institutional arrangements.

Contemporary caring for country embraces a combination of long-established cultural practices, such as species-specific ceremonies, seasonal use of traditional resources and use of fire to maintain desired environmental conditions, as well as contemporary practices such as feral animal and weed management, biodiversity surveys and satellite tracking of marine turtles.

There are now several hundred community-managed Indigenous land and sea management groups or organisations around Australia. Some of these comprise ranger groups employed by local community councils. Others are more fully developed Indigenous land and sea management agencies employing specialist planning and research staff as well as operational rangers, often with traditional owner governance arrangements that are separate from, or complementary to, local community councils. Although the majority of these groups and organisations are located in remote communities in northern and central Australia, Indigenous ranger groups and other Caring for Country initiatives occur throughout Australia, including the southern mainland states and Tasmania.

Indigenous ranger groups are generally engaged in patrolling, managing and monitoring areas of Aboriginal

land that have returned to Aboriginal or Torres Strait Islander ownership as a result of land claims or the recognition of continuing native title under the *Native Title Act 1993*. However, Indigenous ranger groups also increasingly engage in land and sea management activities in areas that may not be formally under Indigenous ownership, but lie within the traditional land and sea estates of the groups involved. This trend from tenure-based to country-based Indigenous engagement in land and sea management reflects a growing appreciation by government agencies and the wider community that Indigenous Caring for Country rights, interests and obligations are based on cultural connections to traditional estates—irrespective of their current tenure. This trend can be observed, for example, in increased Indigenous engagement in national park and marine park management, whether or not these protected areas have been returned to Indigenous ownership.

The continued growth in the capacity of Indigenous groups to undertake their own land and sea management is likely to be accompanied by new and diverse partnerships with government, research and nongovernment conservation agencies. This will lead to mutual benefits for all parties. Land and sea management may be a long-term propitious niche for Indigenous people in remote communities and elsewhere in Australia, particularly since these initiatives are grounded in Indigenous culture and have been driven by Indigenous groups and organisations, rather than by government policies. The challenge for governments is to respond positively to this momentum without overburdening the recipients of funding and other support with excessive reporting and compliance processes.

Source: Adapted from D. Smyth, *Indigenous Land and Sea Management—a Case Study*. Report prepared for the Australian Government Department of Sustainability, Environment, Water, Population and Communities on behalf of the State of the Environment 2011 Committee. Canberra: DSEWPac, 2011

## Working on Country

The Working on Country initiative was implemented by the Australian Labor Government in 2007. It recognises that protecting and conserving the environment is a shared responsibility. It is also designed to provide sustainable employment for Indigenous Australians.

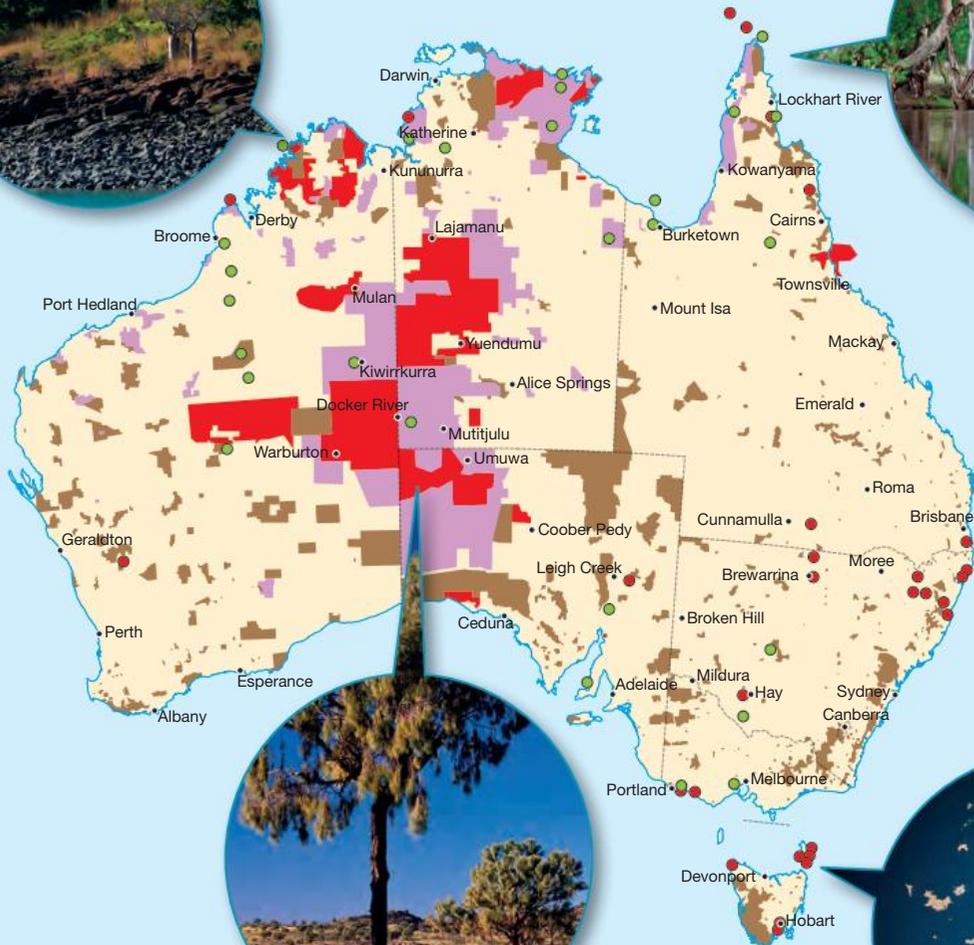
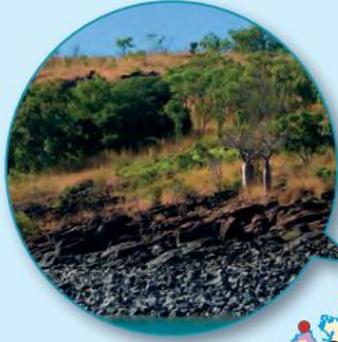
Indigenous people have long-held cultural and traditional responsibilities to protect and manage their land and sea country. They own an estimated 20 per cent of the Australian continent, upon which lie some of our most

environmentally precious natural assets and which, for Indigenous people, is rich in cultural and spiritual meaning.

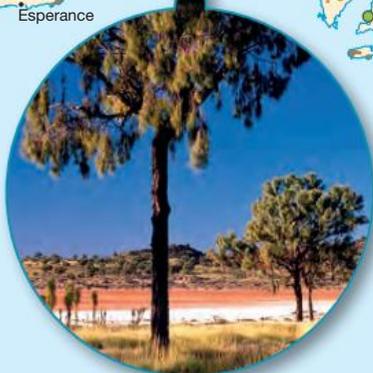
Working on Country builds on Indigenous traditional knowledge to protect and manage land and sea country. Almost 700 Indigenous rangers across ninety-nine teams are employed across Australia environmental projects, as shown in Figure 1.55. By June 2015, it is expected that around 730 rangers will have been trained and employed through Working on Country.

Western Australia: The Dambimangari Indigenous Protected Area is located on the rugged, dramatic Kimberley coast between Broome and Darwin. Situated north of Derby, it stretches east to the Prince Regent area, covering more than 1.4 million hectares. Dambimangari provides a refuge for animals that have disappeared from other parts of Australia. Endangered animals include the quoll and the brightly coloured Gouldian finch.

Queensland: The Kaanju Ngaachi Wenlock and Pascoe rivers area stretches across nearly 2000 square kilometres of wet tropical forest and sand ridge country between Lockhart River, Coen and Weipa on Cape York. The Chuulangun Aboriginal Corporation manages the area, which is a place of significant social, cultural, spiritual, historical and economic value for its traditional owners.



- Towns
- Other Protected Areas (2010)
- Aboriginal lands
- Declared Indigenous Protected Areas
- Indigenous Protected Area Consultation Projects



South Australia: The Kalka–Pipalyatjara Indigenous Protected Area stretches for more than 580 000 hectares across the north-west corner of South Australia. The Tomkinson and Mann ranges dominate the north-west landscape of the Anangu Pitjantjatjara Yankunytjatjara (APY) Lands, while in the south, sand-dune country with rocky outcrops provides habitat for a variety of plant and animal species.

Tasmania: Located in Bass Strait at the north-eastern tip of Tasmania, Mount Chappell Island and Badger Island form part of the Furneaux group of islands. These islands have long been regarded by Aboriginal people as an important part of the seasonal food-gathering cycle. The Tasmanian Government handed them back to the Aboriginal community in 1995.

## Indigenous Protected Areas

An Indigenous Protected Area is defined as an area of Indigenous-owned land or sea where traditional owners promote biodiversity and cultural resource conservation, according to an agreement with the Australian Government. Indigenous Protected Areas make a significant contribution to Australian biodiversity conservation. They make up almost 25 per cent of Australia's National Reserve System.

The goals of the Indigenous Protected Areas element of the Caring for our Country initiative are to:

- 1 support Indigenous land owners to develop, declare and manage Indigenous Protected Areas on their lands as part of Australia's National Reserve System
- 2 support Indigenous interests to develop cooperative management arrangements with government agencies managing protected areas
- 3 support the integration of Indigenous ecological and cultural knowledge with contemporary protected area management practices (source: Department of the Environment)

Indigenous Protected Areas produce more than just environmental benefits. They help Indigenous communities to protect their significant cultural values for future generations. There have been beneficial spin-offs in terms of health and education, as well as economic and social benefits.

There are now fifty declared Indigenous Protected Areas and over forty consultation projects across Australia, as shown in Figure 1.55. There are plans to increase Indigenous Protected Areas by at least 40 per cent—an increase of at least 8 million hectares.

## SPOTLIGHT

### The biggest estate on earth

Management was active, not passive, alert to season and circumstance, committed to a balance of life. The chief ally was fire. Today, almost everyone accepts that they burnt random patches to hunt or lure game. In fact, this was no haphazard mosaic making, but a planned, precise, fine-grained local caring.

What plants and animals flourished where related to their management. Detailed local knowledge was crucial. Each family cared for its own ground, and knew not merely which species fire or no fire might affect, but which individual plant and animal, and their totems and Dreaming links. They knew every yard intimately, and knew the ground of neighbours and clansmen, sharing larger-scale management or assuming responsibility for nearby ground if circumstance required.

They first managed country for plants. They knew which grew where, and which they must tend and transplant. They then managed for animals. Knowing which animals prefer let them burn to associate the sweetest feed, the best shelter, the safest scrub. They established a circuit of such places, activating the next as the last was exhausted or its animals fled. In this way they could predict where animals would be. They travelled to known resources, and made them not merely sustainable, but abundant, convenient and predictable ...

Three rules directed their management.

- Ensure that all life flourishes.
- Make plants and animals abundant, convenient and predictable.
- Think universal, act local.

These rules imposed a strict ecological discipline on every person.

Source: B. Gammage, *The Biggest Estate on Earth—How Aborigines Made Australia*, Allen & Unwin, Sydney, 2012

## ACTIVITIES

### Knowledge and understanding

- 1 Identify the two components of Australia's Indigenous population.
- 2 Describe the attachment of Indigenous people to their environment.
- 3 Explain how Aboriginal and Torres Strait Islander people were able to live successfully across the Australian continent.
- 4 Explain why the totem system ensured a sustainable food supply for Aboriginal people.
- 5 Outline the benefits of the Australian Government's Working on Country program and the establishment of Indigenous Protected Areas.

### Applying and analysing

- 6 Study the extract 'The biggest estate on earth'. Compare the management practices of the Aboriginal and Torres Strait Islander people with those of contemporary management in Australia. Assess the sustainability of each.

### Investigating

- 7 Investigate an Indigenous Protected Area in your state and prepare a report highlighting why the area is important and how it is being protected.

# 1.14

## Global citizenship

When you watch the television news you are often confronted with images of great human suffering and environmental decline. You may feel powerless to do anything about these problems, but there is much that you can do to make sure you leave a better world for the generations who will follow you. You can take individual responsibility for particular actions, or you can also join with other like-minded individuals to achieve collective goals.



### Global citizenship

It is not surprising that geographers should have an interest in global issues. One of the aims of the subject is to promote a greater understanding of the important issues humanity must deal with. By studying such issues you have the opportunity to demonstrate global citizenship. Global citizenship involves recognising that we are all citizens of the one planet and behaving in ways that demonstrate a respect for the earth.

A global citizen is someone who demonstrates **empathy**, a commitment to social justice and equity, a respect for diversity, a concern for the environment, a commitment to sustainable development and a belief that people can make a difference. One way of expressing the qualities of global citizenship is to become an active member of a **non-government organisation (NGO)** such as

1.56 Greenpeace activists practise global citizenship.

Amnesty International or Greenpeace (see Figure 1.56). People choose to join such groups because they believe that they can influence decision-making processes by engaging in collective, rather than just individual, action.

### Practising global citizenship

The term 'globalisation' describes the increasing economic and cultural links between countries in areas such as trade, aid, tourism, information and communications technology, finance, migration and employment. In this fast-changing and interconnected world it is important that you see that you are part of a global community, and that your actions can influence the lives of people in other countries and the state of the global environment.

Global citizenship involves people everywhere thinking about the impact of their activities on the world as a whole and then attempting to protect and improve the physical and human environment. Global citizens may decide to act as individuals or express their views with other like-minded people, perhaps through membership of an NGO, and aim to ensure the highest possible quality of life and availability of resources for the global population, today and in the future. As active global citizens you have two important responsibilities:

- to understand the social and environmental issues that have an impact on the world in which you live
- to take an active role in protecting the human rights of others and promoting sustainable practices in order to preserve the global environment for future generations. Some of the strategies for achieving this are discussed below.

## Strategies for active citizenship

While you may feel powerless when you think about the number of social and environmental problems facing the planet, it is important to remember that it is often the collective actions of individuals, working with their local communities that offer the best hope for the future. There are many possible solutions to the problems facing the earth and its people. Here are some things that you can do.

- Respect all life and learn as much as you can about global environmental and social issues.
- Respect the culture and beliefs of other people.
- Learn and care about and protect a part of your local environment.
- Work with others to improve your local environment and community.
- Consider the impact of your lifestyle on the environment and other people.

Taking the last suggestion as an example, you can make a difference by reducing the environmental impact of your consumption decisions. You can achieve this by living more simply and consuming fewer resources. Every year, Australians produce in excess of 22 million tonnes of solid waste, equal to about 1.156 tonnes per person, or 3.14 kilograms a each day. This level of consumption is not ecologically sustainable. To improve this situation, you need to consider the environmental impact of your purchases. As environmentally aware consumers, it is important to ask yourself the following questions.

- Does any part of the production or distribution process cause harm to the environment?
- Will the disposal of this product damage the environment?
- Is the product recyclable?

Here are some practical steps that you can take.

- Minimise the social impact of your consumption decisions by boycotting (refusing to buy) goods produced by companies that exploit people; for example, through the use of child labour.
- Write a letter or email to a newspaper editor or major political leader expressing your point of view about a social or environmental issue.
- Support political parties and interest groups that promote appropriate social and environmental values and policies.

Remember the following important tips.

- Don't expect immediate results; progress may be slow.
- Avoid the use of guilt or fear to change the behaviour of other people and do not allow others to do this to you. A more effective strategy is to lead by example so that you can demonstrate to others that they can also make a difference.
- Don't try to do everything. Focus on what you care about most.
- Behave responsibly. Violent protests, for example, are often counter-productive.
- Take time to enjoy life.

## ACTIVITIES

### Knowledge and understanding

- 1 Define the term 'global citizenship'.
- 2 Outline the responsibilities of global citizens.
- 3 Outline the steps consumers can take to minimise the environmental and social impact of their consumption decisions.

### Applying and analysing

- 4 Working in groups, complete the following tasks.
  - a Discuss the reasons why it is important to act as good global citizens. Present your top ten reasons to the class.
  - b Draw up a list of actions that you can take personal responsibility for.
  - c Select one of the actions from your list. Describe in detail how you could carry out this action and how it would make you a better global citizen.
- 5 Write a discussion on the following topic: 'As global citizens we should recognise that there is more that unites us than divides us.'

Consider the importance of this statement in your life and the lives of your friends. Use a 'think, pair, share' strategy to get you started.

# Review and reflect 1

## Activity 1

### Global citizenship

- a Study the views shown in Figure R&R 1.1. Discuss the comments. Are they examples of good global citizenship? Prepare a series of statements presenting an alternative perspective.
- b Find someone in the community whom you think is a good global citizen to interview. Your interview should be presented as an oral report. You should describe the person's qualities and outline the contribution the person makes to the wellbeing of society and/or the environment.

Before you interview the person, consider the following tasks, to ensure you are prepared.

- Decide how you will interview the person: via the phone, in person, via email, Skype or Google Hangouts, etc.
- Consider how you will record their answers: written responses, audio or video.
- Write down the questions you want to ask. Start with 'ice breaker questions', which encourage people to talk about themselves. Remember to ask 'open-ended questions', such as 'tell me about a time when ...'

R&R  
1.1

Some negative attitudes about global citizenship



## Activity 2

### Developing a plan of community action

Become actively involved in a geographical issue affecting your local community. Develop your own campaign by following the steps below.

- Become informed about the issue.
- Develop strategies to increase community awareness about the issue. For example, you could make posters that explain or illustrate the issue. Display these around the community. You could also seek publicity for your campaign by contacting the local media and writing letters to the editor for publication in your local newspaper.
- Try to influence decision makers. Write letters or emails to local Members of Parliament and members of the local council. Outline your views on the issue in a clear and concise manner, and ask for their support.
- Evaluate your campaign. What was successful and what changes would you make if you were to be involved in another campaign?



R&R  
1.2

A Gawler Region Community Forum Inc protest against the release of farmland for urban development

## Activity 3

### Global warming: Cartoon interpretation

- Study each of the following cartoons and identify the perspective or point of view of the cartoonist. Copy and complete the table below.

	Cartoon a	Cartoon b	Cartoon c
Location			
Images			
Themes			

- In your opinion, which cartoon has the most impact and which has the least impact. Why?
- Source two more cartoons with alternative views of climate change. Using the format in question a, interpret the themes of the cartoons.



R&R  
1.3

Global warming, by Wilcox



R&R  
1.4

Global warming, by Leahy



R&R  
1.5

Moir's view on global warming scepticism

## Activity 4

### Reflecting on the ideas of others

We live in a system that has severed or rendered invisible many of our connections to nature—such as the food we eat, or the people and ecosystems from which our consumer products are derived.

This has encouraged human beings to believe that they can manipulate and rearrange the material world any way they like, with few or no moral or ethical constraints, duties or obligations. Some also argue that the idea of material nature as a stockpile of inanimate resources lies at the centre of the modern consumerist worldview.

Further, we have obscured and hidden the natural origins of the ... products we use every day. The packaged chicken in the grocery store has been cleaned, sanitised and presented in a way that disguises the fact that it was once a living, breathing animal [see Figure R&R 1.6]. The [mobile] phone is an assemblage of literally hundreds of material elements, mined, milled and gathered from around the world, manufactured, assembled, distributed and disposed of by faceless people to unknown places, with unknown environmental consequences. This entire organisation of the global economic system is constructed upon the underlying worldview and accompanying detachment from natural origins.

Source: A.A. Leiserowitz & L.O. Fernandez, *Toward a New Consciousness: Values to Sustain Human and Natural Resources*, Yale School of Forestry and Environmental Studies, 2007

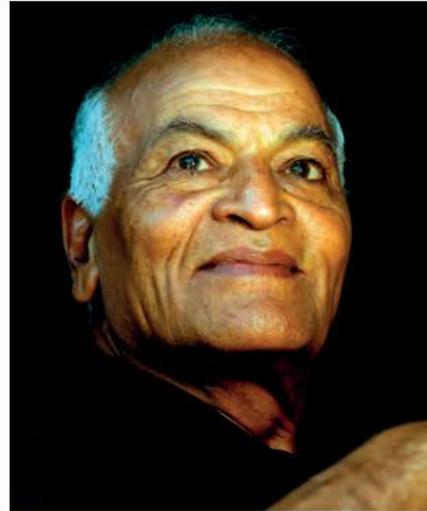
R&R  
1.6

Many people do not connect frozen chickens with living creatures



R&R  
1.7

Environmentalist and humanitarian, Satish Kumar



A tree has intrinsic value. That is, a tree is good not because it gives me an aesthetic pleasure when I see the beautiful cherry blossoms. No, the cherry tree is good in and of itself, even if nobody goes and looks at it, if nobody ever says: 'Wow, look at those beautiful cherry blossoms!' Even if no one ever sees it, the tree will still blossom. This is divine grace appearing on the earth. And it has an intrinsic value. Trees, animals, plants, rocks, mountains, rivers, worms, butterflies, honeybees—every creature upon this earth has intrinsic value and the right to be as they are, who they are, what they are. We talk about human rights, and that's fine. But nature also has rights. The trees have a right to exist. We have no right to cut them down without proper purpose. And when you understand this, when you recognise the rights of the trees, then you are truly an ecologist.

Satish Kumar



Chef Seattle (1786–1866) leader of the Squamish and Duwamish Native American tribes in what is now the US state of Washington



The earth does not need us managing it in order to go on, whereas we depend on the earth for our survival. From this perspective, it makes little sense to talk about saving the earth. It has been around for billions of years and doesn't need saving. What we need to save is the existence of our own species and cultures, which may have been around for less than an eye blink of the 3.5-billion-year history of life on earth, as well as the existence of other species that may become extinct because of our activities.

Source: Chief Seattle, quoted in G. Tyler Miller & E.S. Spoolman, *Environmental Science*, 14th edition, Cengage Learning, 2013

- a** Select one of the following options about the production of chickens.

Option 1: Undertake group research on the various methods of producing eggs as well as chickens for slaughter. Each group is to present their findings to the class in a multimedia format.

Option 2: Conduct a class debate on the following topic: 'All chickens should be raised and live in free-range conditions'.

- b** Assess the relevance of Chief Seattle's environmental perspective in the modern world.
- c** Undertake research on the intrinsic value of elements of the natural world. Prepare a collage of images or create an artwork to demonstrate the importance of intrinsic value. Include a definition of intrinsic value in your visual presentation.
- d** Conduct a class debate on the following topic: 'Species such as mosquitoes do not warrant any protection'.

## Activity 5

### Where does my dinner come from?

- a** As your dinner is being prepared at home
- record from the labelling where the food item is produced and packaged
  - record the origins of fresh fruit or vegetables
- b** Undertake internet research on the location and methods of production, water requirements and environmental impacts of each of the various items of food identified.
- c** Present your findings on an annotated poster (include a map).

## Activity 6

### Mobile phone production

Undertake internet research to find the following information.

- Which rare earth minerals are used in the manufacture of many of the features of your latest phone?
- Where they are extracted?
- Which country owns most of these minerals?
- What are the working conditions like for the miners?

Present your findings in the format of a newspaper article.

CHAPTER

# 2

# FORESTS

**E**ach year, approximately 16 million hectares of forests disappear. Only about 22 per cent of the world's original (old-growth) forest cover remains intact—most of this found is in three large areas: the Canadian and Alaskan boreal forest, the boreal forest of Russia, and the tropical forest of the north-western Amazon Basin.

Today, forests cover more than one-quarter of the world's total non-polar landmasses. Slightly more than 50 per cent of the forests are found in the tropics and the rest are temperate and boreal forest zones.

Forests are cleared, degraded and fragmented by forestry, cleared for agriculture and road building, and destroyed by fire. The exploitation of the earth's forests has been a constant in the human-based transformation of the earth. Deforestation has important implications for life on this planet. It is impossible to overstate the impact of the clearing of the forests by humans. The transformation of forested lands by human actions represents one of the great forces in global environmental change and one of the principal causes of habitat loss and decline in biodiversity.

In this chapter, we focus on environmental change and management using forest environments as an example. Of particular interest are the causes and consequences of the changes taking place and an evaluation of the strategies being used to manage these changes.

## KEY IDEAS

- To recognise the principal causes of environmental change in forest environments
- To explore the effects of the environmental changes taking place in forest environments
- To investigate the environmental management strategies that are being used and determine if these strategies are effective

## GLOSSARY

<b>adaptive management mechanisms</b>	a systematic process of continually improving management policies and practices by learning from the outcomes of previously employed policies and practices
<b>biodiversity (connectivity) corridors</b>	plant corridors that connect healthy ecosystems as a way of maintaining biodiversity
<b>biomass</b>	plant material derived from living, or recently living organisms; as an energy source, biomass can be used either directly via combustion to produce heat, or indirectly after converting it to various forms of biofuel
<b>biosphere reserve</b>	a zone-based approach to conservation whereby the inner core of high ecological value is protected
<b>carbon sink</b>	a forest, ocean or other natural environment viewed in terms of its ability to absorb carbon dioxide from the atmosphere
<b>clear-cutting</b>	the process by which all the trees in a forest area are cut down; this is the most efficient way for a logging operation to harvest timber
<b>connectivity conservation</b>	a corridor of protected forest lands that extend over hundreds, and in some cases, thousands of kilometres to protect biodiversity and critical ecological processes
<b>conservation reserves</b>	areas of land set aside to maintain biodiversity and/or natural or cultural heritage values
<b>deforestation</b>	the removal of large expanses of trees for their timber or to make way for other landuses
<b>emergent trees</b>	trees that tower above the forest canopy
<b>endemic</b>	native to a certain place
<b>environmental strategy</b>	a plan of action intended to accomplish a specific environmental objective
<b>hunter-gatherers</b>	people who survived by catching game, fishing and gathering plant food.
<b>overstory</b>	the upper tree layer or canopy of a forest, where the crowns of the trees spread their branches and foliage to capture light to photosynthesise
<b>population viability</b>	the ability of a population of a species to persist over time and avoid extinction
<b>shifting cultivators</b>	people who clear a small patch of forest to grow food in gardens that they then abandon when yields decline
<b>subsistence producers</b>	farmers who grow just enough food to feed themselves and their families
<b>transboundary pollution</b>	air and water pollution that travels from one jurisdiction to another, often crossing state or international boundaries
<b>understory</b>	the smaller plants adapted to the shady conditions of the forest floor

# 2.1

## Forests: The biophysical environment

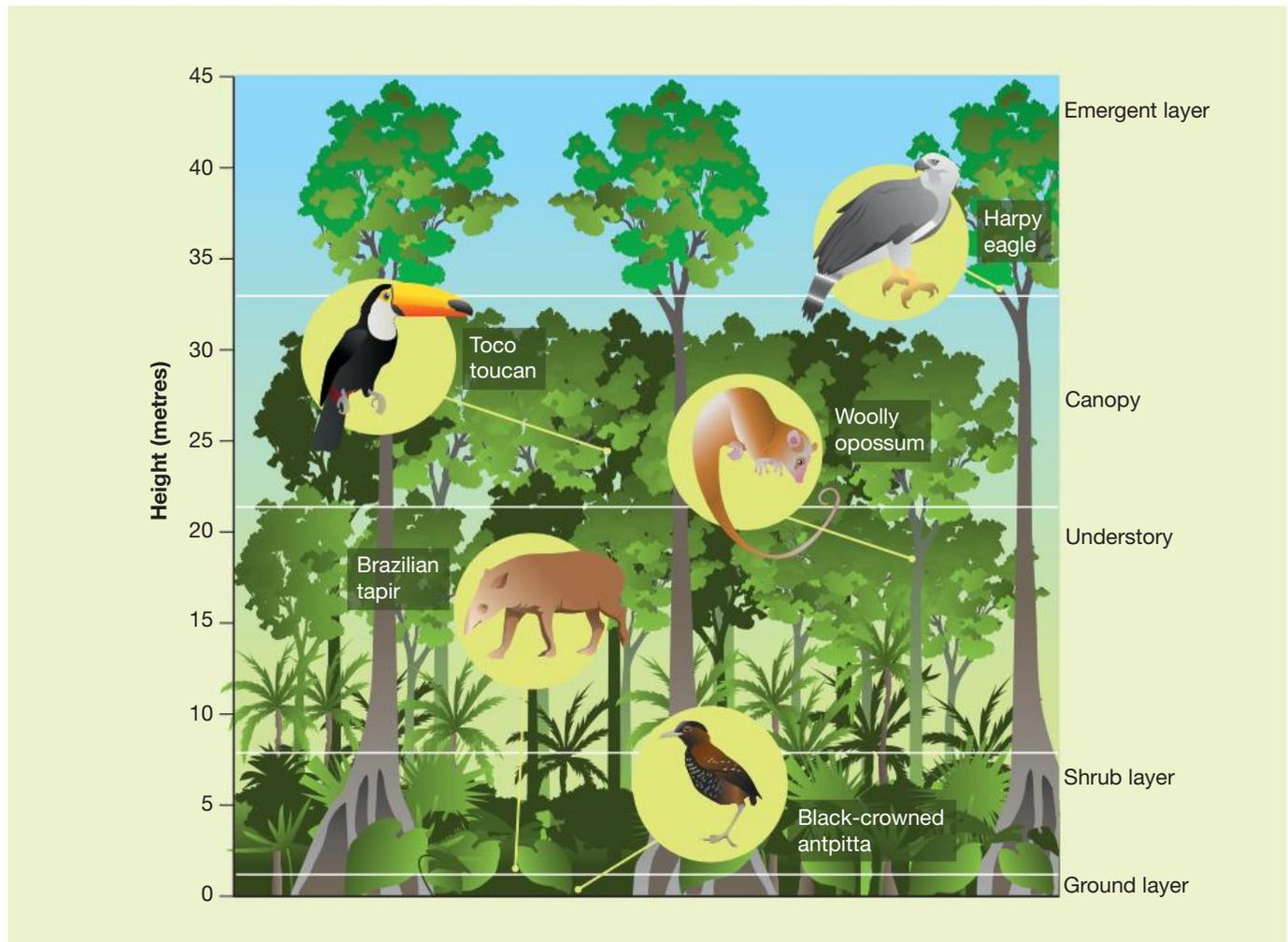
Forests are lands dominated by trees. Within them there are dynamic, relentlessly changing communities of living things interacting with the non-living components of the forest environment. Forests have long been considered special wild places representing nature untamed, but humans have exploited them and the damage is becoming increasingly evident.

### Elements and processes of the biophysical environment

To be classed as a forest, the trees that make up the forest must be more than 2 metres high and shade more than 20 per cent of the ground. To a person standing on the floor of the forest and looking upwards, more than 20 per cent of the sky would be covered by the foliage of the crowns of the trees.

A typical forest is composed of an **overstory** and an **understory**. The upper tree layer, or canopy, is made up of the crowns of the trees, where the branches and foliage spread to capture light to photosynthesise. Underneath is an understory of smaller plants. In complex forests such as tropical rainforests, the stratification of the forest layers forms five distinct layers, as illustrated in Figure 2.1.

2.1 Each of the five layers of a tropical rainforest has specialised niches of plant and animal species.



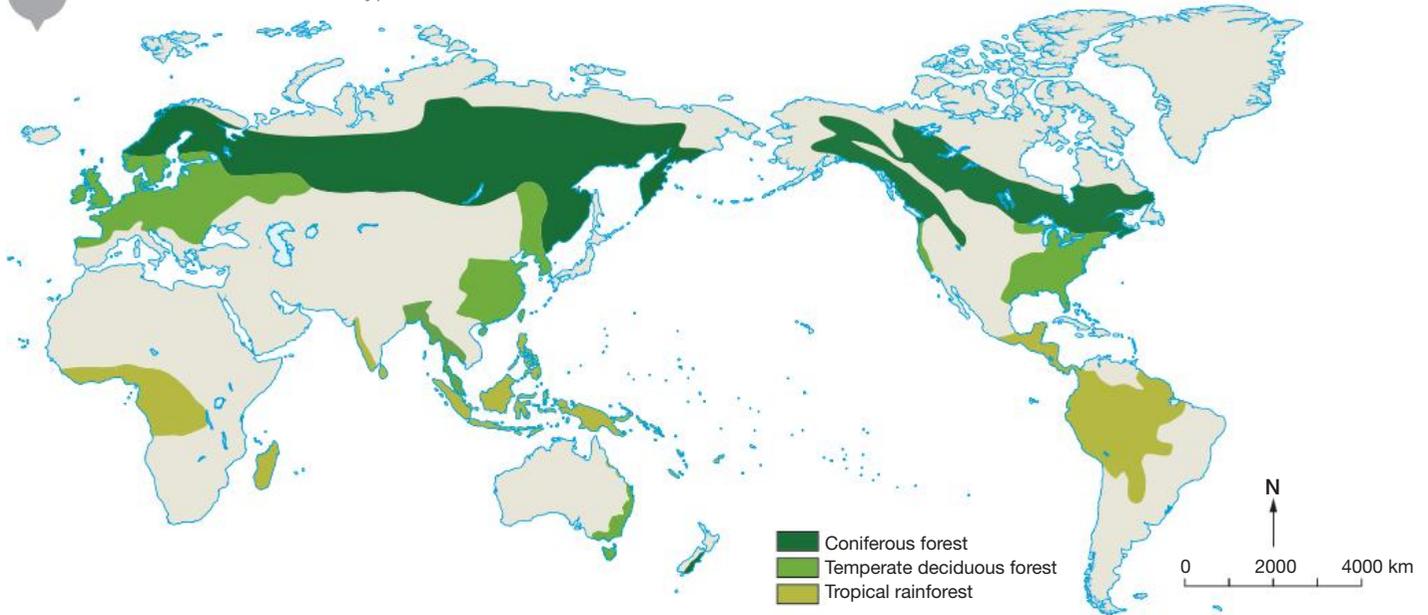
**Emergent trees** tower above the general leaf cover of the canopy, and an understory of smaller trees wait for their chance to fill a gap in the canopy when an old tree dies. Beneath them there are shrubs and ferns suited to the low light conditions, and a ground layer with little vegetation other than fallen leaves, seeds and fruit and decaying organic matter amid the massive roots and trunks of the trees.

Figure 2.1 also illustrates how rainforest species use the vertical dimension that a forest offers.

## Types of forests

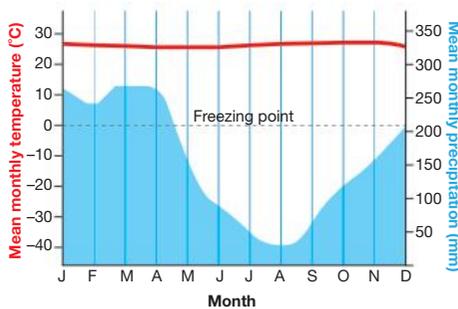
There are many types of forests, and they often merge almost invisibly with one another as the biophysical environment changes. There are three main types of forests: tropical, temperate and cold (northern coniferous, taiga or boreal). Figure 2.2 shows the location of these forests around the world. Forests are responses to particular combinations of varying temperature and precipitation levels that determine the processes operating within the biophysical environment (see Figure 2.3).

2.2 Global location of the main types of forests

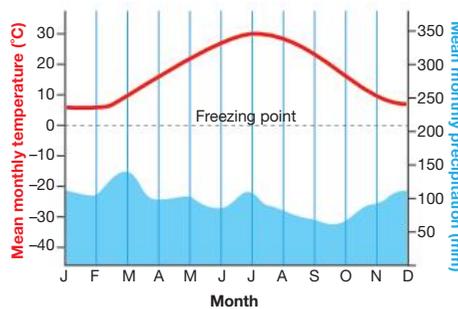


2.3 These climate graphs track the typical variations in annual temperature (red) and precipitation (blue) in (a) tropical, (b) temperate and (c) cold (northern coniferous, taiga or boreal) forests.

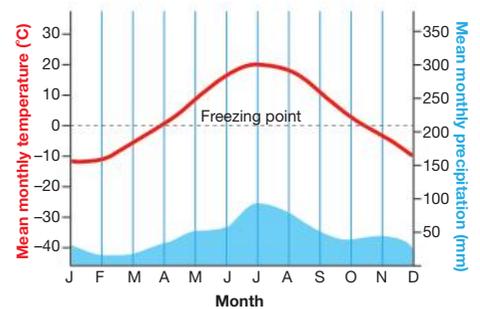
a Tropical forest



b Temperate (northern) forest



c Cold (northern) forest



2.4 The elements and processes of different types of forest environments

Type of forest	Location	Climate	Characteristics and processes
Tropical rainforests	<ul style="list-style-type: none"> <li>From 0° to 10° north and south of the Equator in areas such as the Amazon Basin, Central Africa, Central America, Papua New Guinea and the islands of South-East Asia and also extend down the east coasts of continents, e.g. Australia, where tropical rainforests are found in northern Queensland.</li> </ul>	<ul style="list-style-type: none"> <li>Optimal conditions for plant growth as it is constantly hot (24°C to 28°C) and continuously wet (&gt;1500 mm pa).</li> <li>Climate dominated by the unstable air of the low pressure systems (a product of the intense heating).</li> <li>Large volume of water readily available to the plants but presents the greatest threat—leaches out soluble nutrients.</li> </ul>	<ul style="list-style-type: none"> <li>The most luxuriant and dense of all forests.</li> <li>Dominated by broadleaf evergreen plants that keep their leaves all year, shedding only a few at a time as they become damaged, reducing their ability to capture light.</li> <li>Trees are draped with vines or lianas that spread their leaves out in the canopy to access sunlight.</li> <li>Very large biomass with immense biodiversity: many species; structurally dominated by trees; possesses many nutrient conserving mechanisms (e.g. drip tips on leaves; mycorrhizal fungi wrapped around plant roots to quickly mop up nutrients in the soil before they are leached out by the excessive water).</li> <li>The humus soils quickly become impoverished if the living rainforest is removed (as the biomass is the source of nutrients).</li> </ul>
Temperate deciduous forests	<ul style="list-style-type: none"> <li>Located primarily in the eastern half of the United States, Canada, Europe and parts of Russia, China, and Japan.</li> </ul>	<ul style="list-style-type: none"> <li>Moderate temperatures that change significantly with the seasons.</li> <li>Warm summers (20°C to 27°C) and cold winters (5°C to 10°C).</li> <li>Abundant precipitation evenly distributed throughout the year.</li> <li>Trees survive winter by going into dormancy by shedding leaves in autumn and replacing them in spring.</li> </ul>	<ul style="list-style-type: none"> <li>The forest has a simple structure dominated by a few species, e.g. oak, maple, beech.</li> <li>Most trees have broad leaves that are shed in winter to avoid damage from freezing.</li> <li>Deep, rich soils enriched by the thick layer of fallen leaves that accumulate in the autumn.</li> </ul>
Evergreen coniferous forests	<ul style="list-style-type: none"> <li>These cold forests are found just south of the Arctic tundra in a broad belt across the northern regions of North America, Asia and Europe.</li> <li>They also sit above certain altitudes in the Rocky Mountains and Sierra Nevada of the United States.</li> </ul>	<ul style="list-style-type: none"> <li>In the subarctic climate winters are long (only 6 to 8 hours of daylight), dry (cold air holds limited moisture) and extremely cold (&lt; -30°C).</li> <li>Summers are short and mild (short growing season).</li> </ul>	<ul style="list-style-type: none"> <li>Dominated by a few species of evergreen conifer trees (cone-bearing) such as spruce, fir, cedar and pine.</li> <li>The small, needle-leaved, waxy-coated leaves of these trees conserve water at all times, which is vital when the ground is frozen.</li> <li>The trees are evergreen and as they do not have to grow new needles; when the weather warms they can quickly take advantage of the brief summer.</li> <li>Plant diversity is low because few species can survive the winter when the soil moisture is frozen.</li> <li>Thin, nutrient-poor soils have a deep layer of partially decomposed pine needles (because of the low temperatures) which makes the soil acidic and prevents other plants growing on the forest floor.</li> <li>During the brief summer, the soil also becomes waterlogged in low-lying bogs.</li> </ul>

## Forest characteristics

Figure 2.4 illustrates the main characteristics of and processes in forests.

## Forest animals

Many of the larger animals of the world's forests are shy and unobtrusive. Quite often the only sign of those that live there may be a distant rustle of undergrowth or leaves as they make their escape. They are, however, fierce predators. The jaguars of the tropical rainforests of Central and South America have an exceptionally powerful bite that pierces the skull of their prey. The Bengal tigers of South-East Asia are well camouflaged in the rainforests by their stripes, which enable them to get very close to their prey. They have even been known to take down elephants.

The most noticeable animals in the forests are those that live among the branches of the trees. Birds, insects, squirrels and monkeys dart and glide from one tree to another, filling the rainforest with their calls and screeches. Yet it is the lives and habits of shyer and smaller creatures out of sight

that are vital elements of the forest environment.

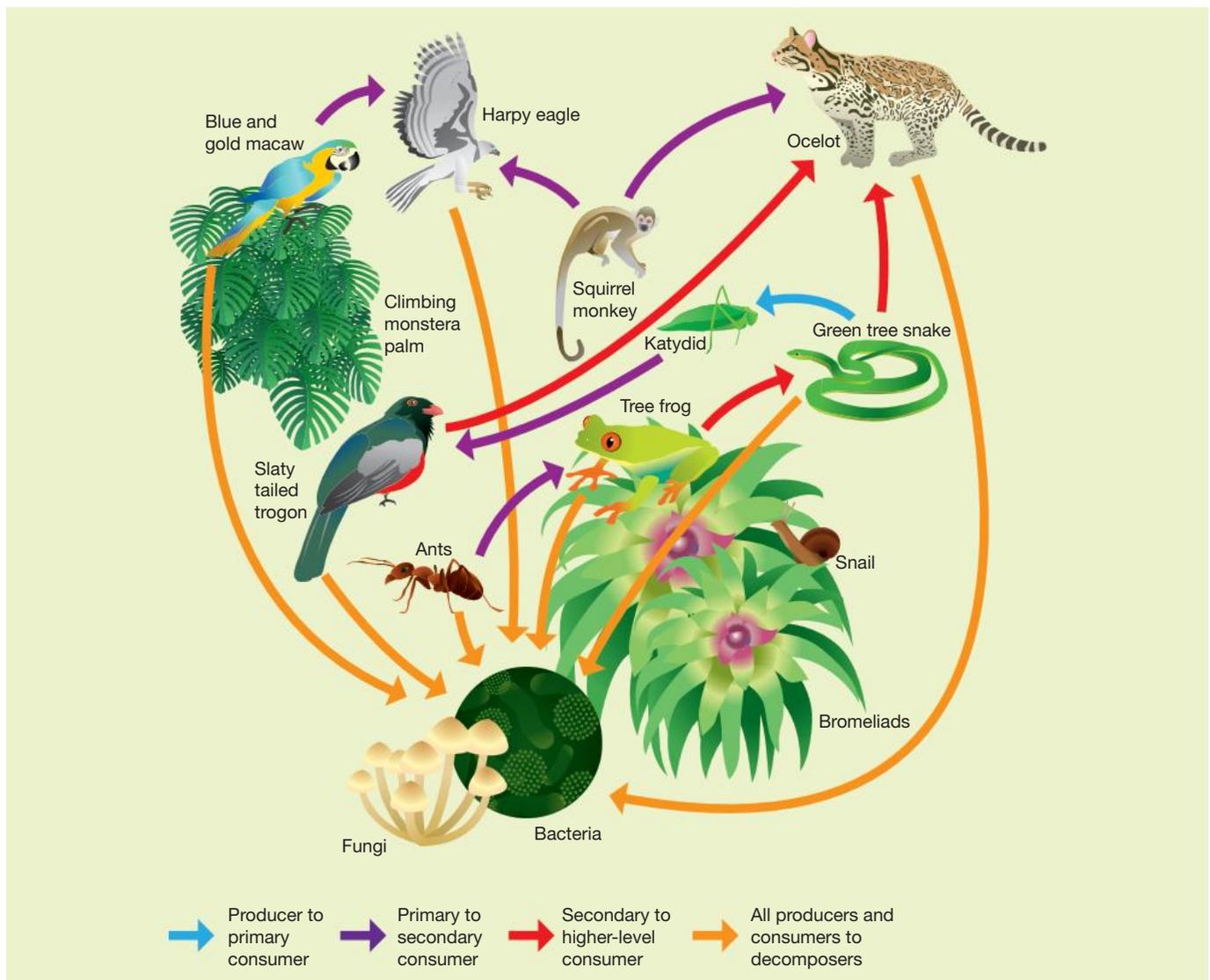
None are more important than those found in the dark world below ground, where hordes of decomposers rapidly recycle the scarce soil nutrients that support the ongoing growth of the life forms above.

## Interactions and natural balances

Forests offer many ways of living for a host of species of plants and animals. As a result, there is an immense **biomass** and biodiversity within forests. During the long course of evolution, animal and plant species have been shaped by the forest environments of which they are a part. Species, in turn, have had vital roles to play in maintaining natural balances that sustain life within those environments. Figure 2.5 shows some of the elements of and interactions in a tropical rainforest ecosystem.

2.5

The elements of and interactions in a tropical rainforest ecosystem (organisms are not drawn to scale)



## Importance of the forest environment

Forests fulfil a major role in supporting the livelihoods and welfare of vast numbers of people in both developed and developing countries. Increasingly, the significance of forests in maintaining natural balances is being recognised. Scientists warn that clearing and degrading the world's remaining forests is a serious global environmental threat.

## Economic services

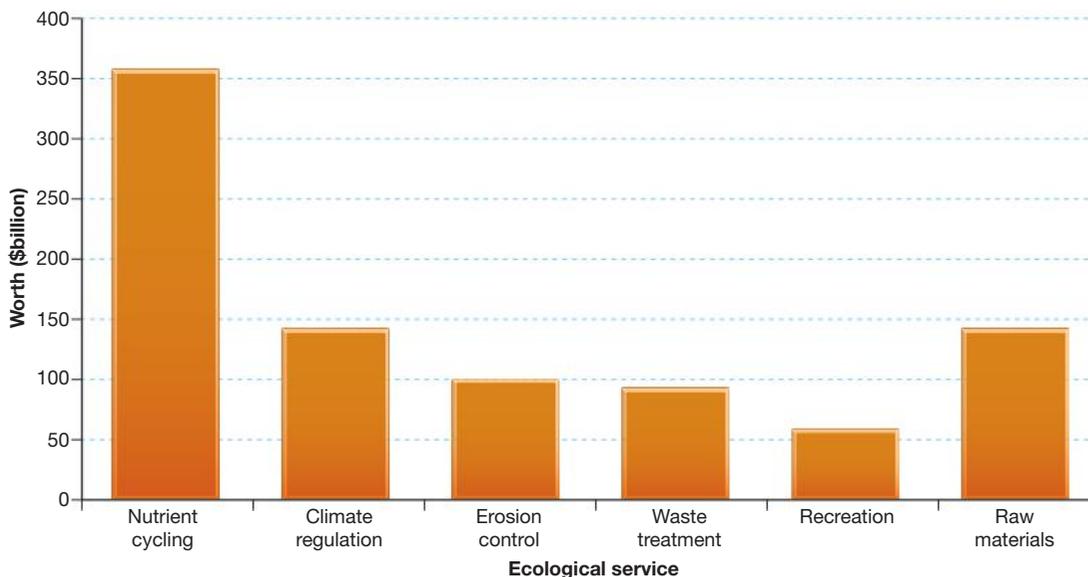
Forests are valued for the economic worth of the raw material they provide. More than 1.6 billion people around the world depend on forests for their livelihoods. Harvesting wood is one of the world's major industries; over half of the wood removed from the world's forests is used for fuelwood in cooking and heating, and the remainder is used in construction and papermaking. Global trade in non-wood forest products such as fruit, medicinal plants, fibre, gums and resins has recently been estimated at approximately US\$11 billion per year.

### SPOTLIGHT

#### Forests are carbon sinks

Forests affect climate change because they influence the amount of carbon dioxide held in the atmosphere. Through photosynthesis, trees remove carbon dioxide from the atmosphere and store it for long periods of time until the trees fall over and rot, or are burnt, when the carbon dioxide goes back into the atmosphere. So living forests act as **carbon sinks** and they help to stabilise average atmospheric temperatures and slow climate change.

2.6 Annual global economic values of some ecological services provided by forests, and the value of the raw materials they produce (in billions of dollars)



## Ecological services

Forests are of immense importance in sustaining life on earth. They:

- support energy flow and nutrient cycling
- provide natural habitat
- promote biodiversity
- reduce soil erosion and protect water catchments by holding the soil in place
- absorb and release water, and aid in flood control
- purify water and air
- decompose wastes
- store atmospheric carbon
- produce oxygen
- influence local and regional climate.

Scientists have estimated the value of such ecological services and, as illustrated in Figure 2.6, it far outweighs the monetary value derived from the raw materials extracted from rainforests.

## Spiritual functions

People value forests for many reasons. The social and cultural values of forests are intangible and so cannot be measured in monetary terms, but they can be profoundly important to people's sense of being and belonging. These values define worldviews and shape people's interactions with the natural world around them. Forests 'often bear a deep significance, inspire affection and respect, reinforce cultural identity and are vital for spiritual wellbeing', according to the International Institute for Environment and Development.

### DID YOU KNOW?

The world's forests hold more carbon than the entire atmosphere.

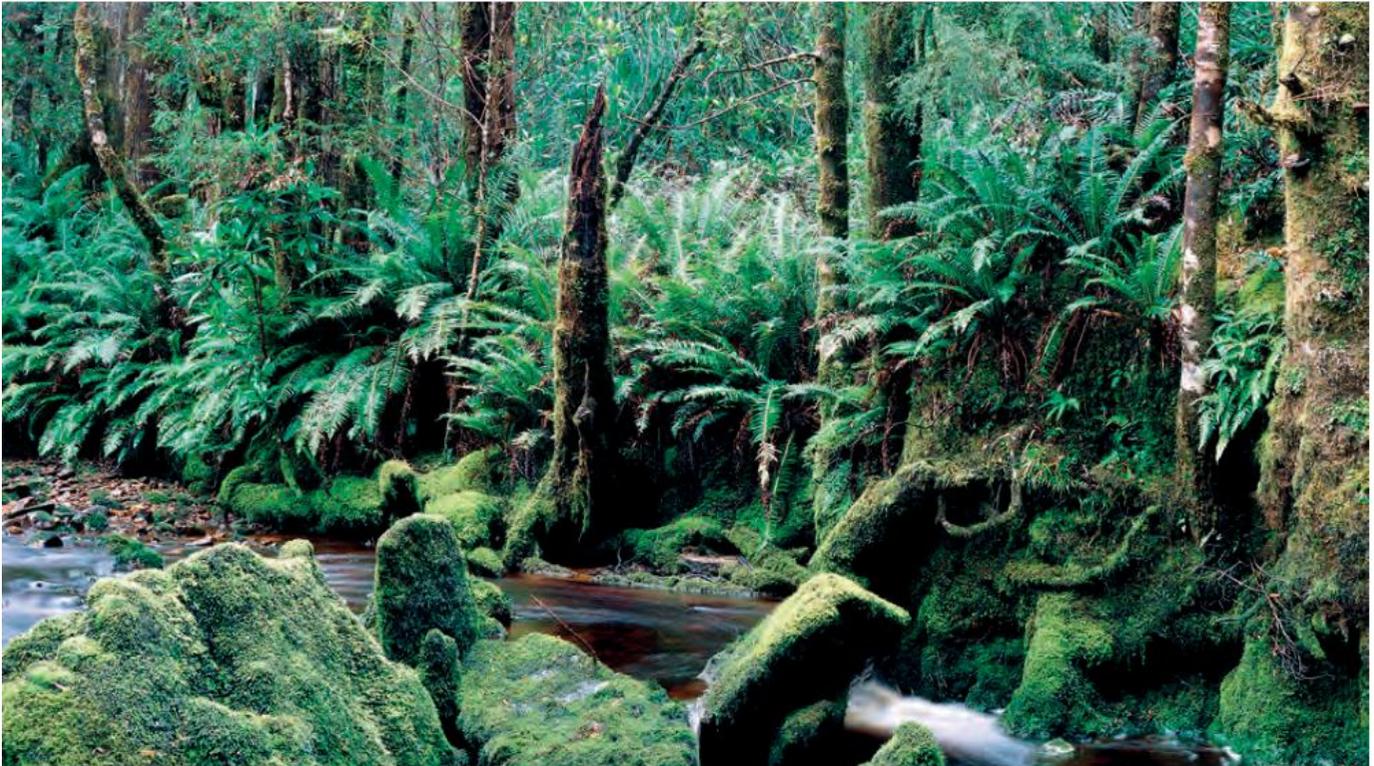
For indigenous people living in forests there is no separation between the spiritual and the physical worlds. They believe that spirits exist in the trees and the animals in the forest, and that they as humans are connected to them. The spiritual value of the forests is reflected in their traditions and folklore.

In European folklore and fairytales, forests—often referred to as the ‘woods’—are associated with mystery and lurking dangers. Powerful people have sought to have forests of their own. The Norman kings of England enclosed the forests around their castles for their own sport and pleasure. In today’s world this same desire to hold onto

forests can be seen in the creation of parks and reserves, which are now forests that ordinary people can enjoy. In an increasingly stressful world, making a connection with nature and experiencing the tranquillity of standing beneath towering trees has become especially appealing (see Figure 2.7).

#### DID YOU KNOW?

The total area of the world’s forest cover is 4 billion hectares, which represents nearly 30 per cent of the earth’s landmass. Approximately 56 per cent of these forests are located in tropical and subtropical areas.



2.7 South-west Tasmania’s Heritage-listed forest

## ACTIVITIES

### Knowledge and understanding

- 1 Identify the main features of a forest environment.
- 2 Differentiate between the two layers of a typical forest.
- 3 Describe and account for the variety of plants and animals that live in forests.
- 4 Outline the economic services provided by forests.
- 5 Explain how atmospheric carbon becomes stored carbon and why forests are such vital ‘carbon sinks’.

### Applying and analysing

- 6 Explain the spiritual values that forests hold for people.

- 7 Prepare a poster that captures the service, sink and spiritual functions of forest environments.

### Geographical skills

- 8 Study Figure 2.6 then answer the following questions.
  - a What is the value of raw materials gained from rainforests?
  - b What is the combined value of all the other ecological services?
  - c If extracting raw materials necessitates deforestation, what is the significance of this graph?



# 2.2

## Forests: Causes of environmental change

Meeting basic human needs and pursuing higher standards of living has largely been at the expense of the world's forests, past and present. For thousands of years, as settlement spread across Europe and North America, the temperate forests that once covered the land were cleared. The clearing of tropical rainforests escalated in the latter part of the twentieth century.

### Humans and forests

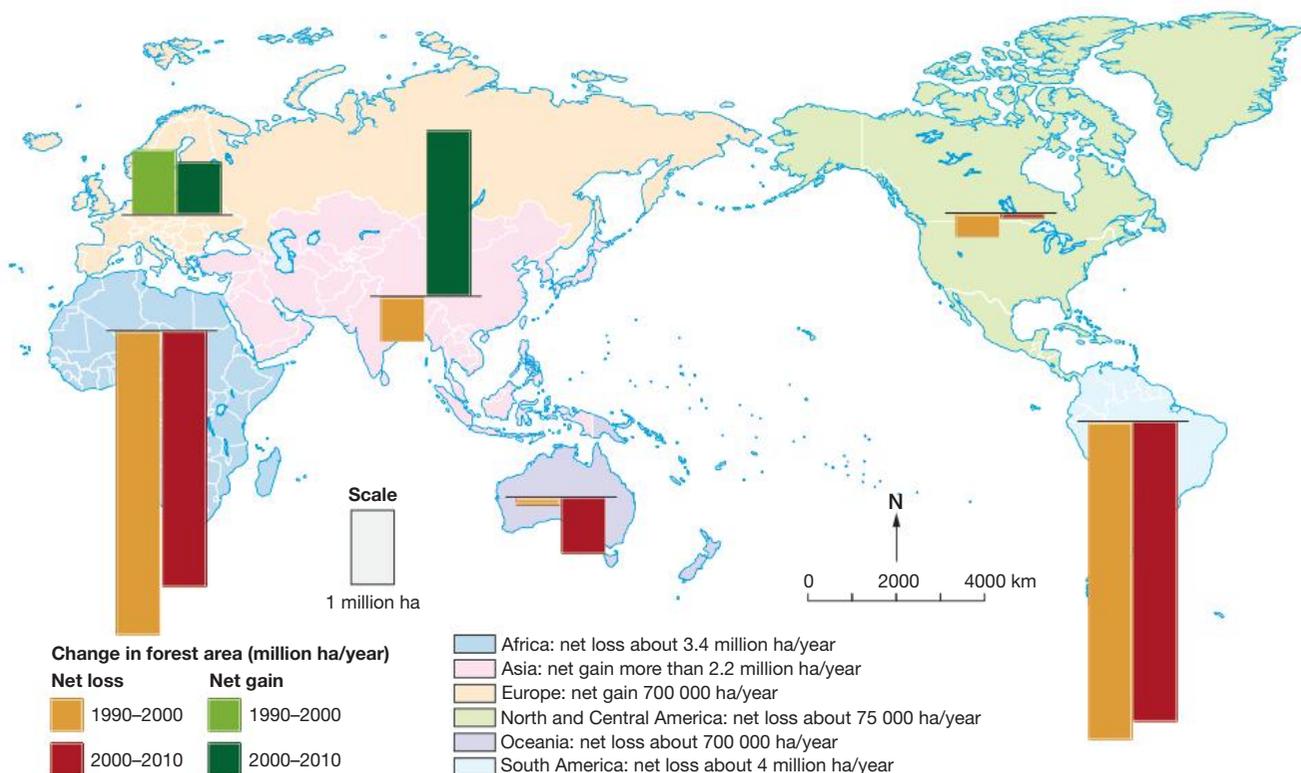
While humans have long considered forests to be special places, the products that they yield, or the ground on which they stand, is often valued above all else. Our ancestors felled trees for fuel and building materials, and cleared forests to grow crops and pastures for their stock. The trees were removed because they were obstacles to farming practices and they captured most of the available sunlight, leaving little for other types of vegetation underneath. Throughout Europe and North America, trees were associated with fertile land, which was highly favoured for agriculture.

The growth and spread of the world's population has been accompanied by increasing demands for land and forest resources.

With technological advancements, the scale of the extraction of resources and the accompanying environmental change have increased. Axes and crosscut saws have given way to chainsaws and modern electro-hydraulic harvesters, enabling whole slabs of forests to be clear-felled with greater speed. Areas of forest that were once spared because they were inaccessible or on slopes that were too steep are now being exploited.

**2.8** Annual change in forest area by region, 1990–2010. Losses are highest in South America and Africa. Australia had significant net losses in the period 2000–10 because of drought and fires.

Forest removal, or deforestation, is the most evident of the changes wrought by humans on forest environments. However, there other significant threats to forest environments that directly or indirectly arise from human activities.



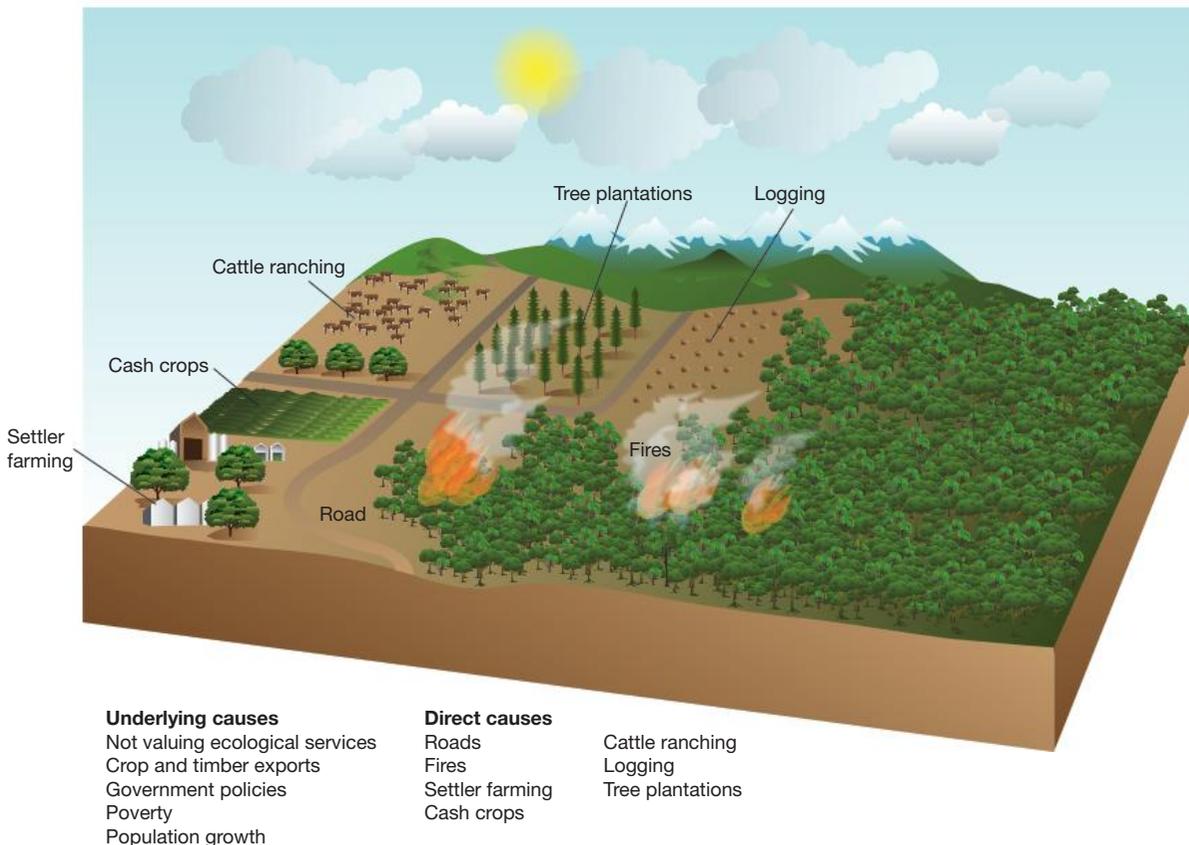
## Deforestation

**Deforestation** is the removal of large expanses of trees to provide agricultural land, timber and lumber products, and more recently, for energy and mineral extraction. According to the World Resources Institute (WRI), over the last 8000 years, human activities have reduced the earth's original forest cover by about 46 per cent, with most of the loss occurring in the last 60 years. The WRI estimates that about 40 per cent of the world's remaining intact forests will be logged or converted to other uses within two decades, if not sooner.

Current global concerns about deforestation are mainly about the conversion of tropical forests to agricultural land. Such losses are concentrated in areas of South America, Africa and Indonesia. Rates of deforestation were highest in the 1990s, when 16 million hectares of forest were converted to other uses or lost through natural causes each year. This eased to about 13 million hectares from 2000 to 2010. The rate of deforestation shows signs of decreasing, but it is still alarmingly high in several regions, as is shown in Figure 2.8.

Deforestation usually begins when a road is cut deep into a forest. This provides access to loggers and their equipment, and also settlers (see Figure 2.9). **Clear-cutting**, whereby

2.9 Major causes of the destruction and degradation of tropical forests



all the trees are uniformly cut down, is the most efficient way for a logging operation to harvest timber. Foreign companies do much of the logging in tropical rainforests. They are supported by concessions from governments. Once the timber has been removed, the land is sold to ranchers, settlers and plantation owners. Any remaining forests are usually burnt to clear the land. Such burning has been widely used to establish large plantations of soybeans in the Amazon Basin of Brazil and palm oil in Kalimantan and Sumatra in Indonesia.

## Acid deposition

Industrial emissions have increased the concentrations of oxides of sulfur and nitrogen within the atmosphere. These combine with atmospheric moisture to yield sulfuric and nitric acids. The acids may then be carried long distances from their source, drifting for thousands of kilometres before they fall on the forest biomass as acid rain, snow or fog, and dry deposits such as soot and ash.

The widespread damage of acid deposition on forests has become evident in recent decades. Most of the forests in Eastern Europe, extending from Poland northward into Scandinavia, have had acid deposition. Many areas in south-eastern Canada and the eastern United States of America have been affected, particularly in the high elevation forests of the Appalachian Mountains from Maine to Georgia, where the forests sit in acidic clouds and fog.

## Climate change, fire, disease and insects

Warmer and drier conditions are triggering rapid changes in the forests of North America. As trees are weakened by a lack of water they succumb to the ravages of diseases such as needle blight and intense insect attacks such as beetle infestations. Milder winters favour the survival of these invasive species, which multiply and kill more trees. The combination of drier forests and dead trees also increases the frequency and intensity of forest fires. As a result, millions of trees are being lost and the landscape is changing as tree species migrate (see Figure 2.10).

## Biophysical processes changing forests

Forest environments support an immense biomass and rich biodiversity. Such great assemblages of flora and fauna are a product of 400 million years of evolution. Over this time, natural change has been evident, but as it was gradual, species had time to adjust and balances were restored. Current concerns about the impact of humans on forests, notably with climate change, are that it is happening too fast for nature to keep up with, and mass extinctions may result.

The productivity and complexity of the different forest environments reflect the biophysical processes supporting them. Human action, whether intentional or inadvertent, can disturb these and even sever important links.

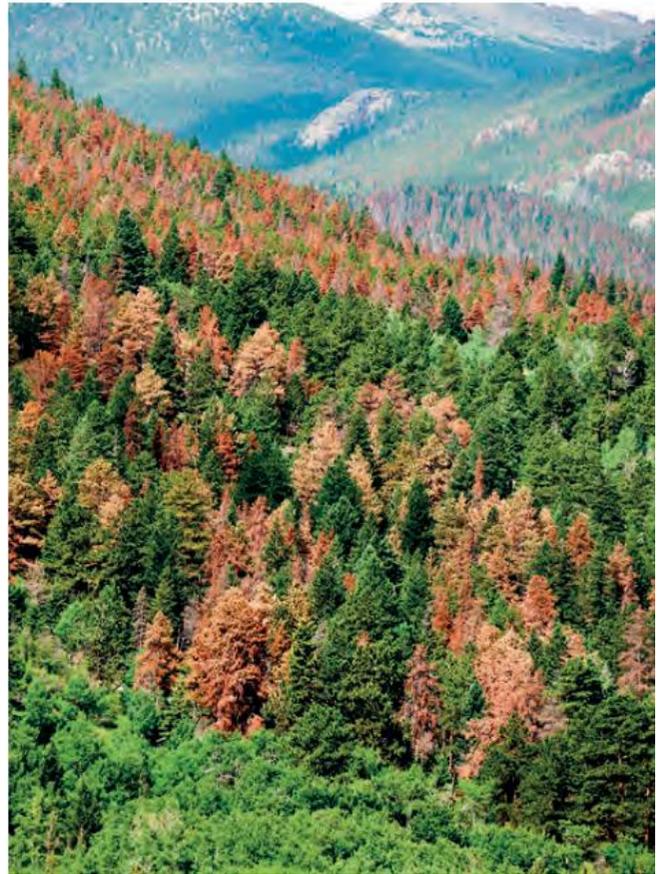
## Nutrient cycling in the Amazon Basin

The luxuriant growth of the rainforest is not a product of rich soils underneath. Rather, the rainforest supports itself by quickly and efficiently recycling the products of its own decay from debris that falls to the forest floor. This is especially important with the voluminous, almost daily downpours of rain that would otherwise leach the nutrients out of the soil and carry them away. A whole range of **adaptive management mechanisms** help retain nutrients.

The impact of deforestation and subsequent farming in the Amazon Basin is evident when the soil becomes unproductive and impoverished within a matter of years. Once the biomass of the forest has gone, the source of nutrients for the soil disappears too. As the crops are harvested and consumed, little is returned to the soil. The problem is compounded when the heavy rain washes away the topsoil, leaving a clay-rich subsoil to bake in the hot tropical sun, forming a lateritic crust on the ground that is as hard as bricks.

2.10

Dead, red lodgepole pines in Colorado are indicative of the landscape change underway.



## Forest soils changing from acid deposition

Acid deposition does not usually kill trees directly, but it does weaken them by changing the biophysical processes at work in the soil in which the trees stand. The acidic water dissolves the useful minerals the tree depends on and washes them from the soil before the tree roots can use them. It can also activate aluminium in the soil, which also inhibits tree growth.

## Consequences of environmental change Massive forest 'migrations'

A team of scientists from Oregon, Montana and British Columbia have documented huge migrations of tree species across North America. They describe the change as one that is occurring on a broad landscape level. In some cases, the mechanism of change is fire, or insect attack; in others it is simply drought. Some forests may be replaced by grass savanna or sagebrush desert. In central California, researchers have found that more than half the species now in existence would not be expected to survive in the climate conditions of the future.

## Peat fires in Indonesia

In Kalimantan, Indonesia, the peat that once lay protected in boggy soils below the forest dries out when the forests are cleared. Once this peat catches alight, the fires are very difficult to stop. Forest and land fires have caused **transboundary pollution** with smoke haze over South-East Asia for decades. The indices of air pollution

in Singapore, the southern Malaysia peninsula and elsewhere in Indonesia reached dangerous levels in 2013 (see Figure 2.11).

2.11 Forest and land fires caused choking smog and transboundary haze in South-East Asia in 2013.



## ACTIVITIES

### Knowledge and understanding

- 1 Define the term 'deforestation'.
- 2 Compare the rates of deforestation in the 1990s and early 2000s.
- 3 Explain why acid deposition has damaged forests.
- 4 Identify the major causes of landscape changes in the forests of North America.

### Applying and analysing

- 5 Explain why humans must be included in any investigation of environmental change in global forest environments.

### Geographical skills

- 6 Study Figure 2.8 then answer the following questions.

- a What was the approximate net forest loss for South America in 2000–10?
- b What was the approximate net forest loss for Africa in the two decades shown?
- c What was the approximate difference in the net forest loss for Oceania in the two decades shown?

### Investigating

- 7 Investigate nutrient cycling in a tropical rainforest. Present your findings on a poster annotated with textboxes outlining the nutrient-conserving processes that support the luxuriant forest growth.
- 8 Investigate deforestation and plantation agriculture in either the Amazon Basin or Kalimantan. Present your findings as a feature newspaper article.

# 2.3

## Forests: Managing environments

As environmental changes in the world's forests have become more evident and extensive, scientists have become concerned that the changes taking place are threatening the forests' survival. Human-environment systems thinking is being used to identify the causes of the changes taking place and to help develop effective strategies to manage them.

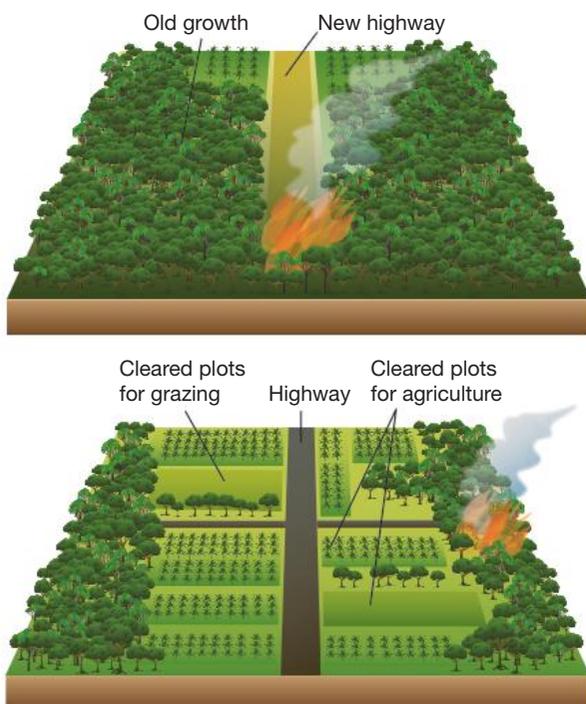
### People's worldviews and forest management

#### Human-centred worldviews

Today, many of the world's tropical rainforests support a mixed population of farmers, ranchers, rubber tappers, construction workers, and forestry and plantation workers. These workers and their families often originate from outside the forest and have a human-centred worldview of the rainforest and see it as a resource to be exploited.

Poverty is widespread in many tropical areas. Landless settlers gain access to the forest on the roads built by logging or mining companies (see Figure 2.12). For the most part,

**2.12** Building roads into previously inaccessible forests is the first step to harvesting timber, but it also paves the way for fragmentation, destruction and degradation of forest ecosystems.



these migrants have a human-centred worldview, driven by a desperate need to feed their families. They clear the forest using the slash-and burn method of production, but their practices are highly destructive. Not only are they armed with steel axes and chainsaws, but they also lack the skills of the original forest dwellers. The soil is quickly exhausted, the crops start to fail and the settlers simply clear more land.

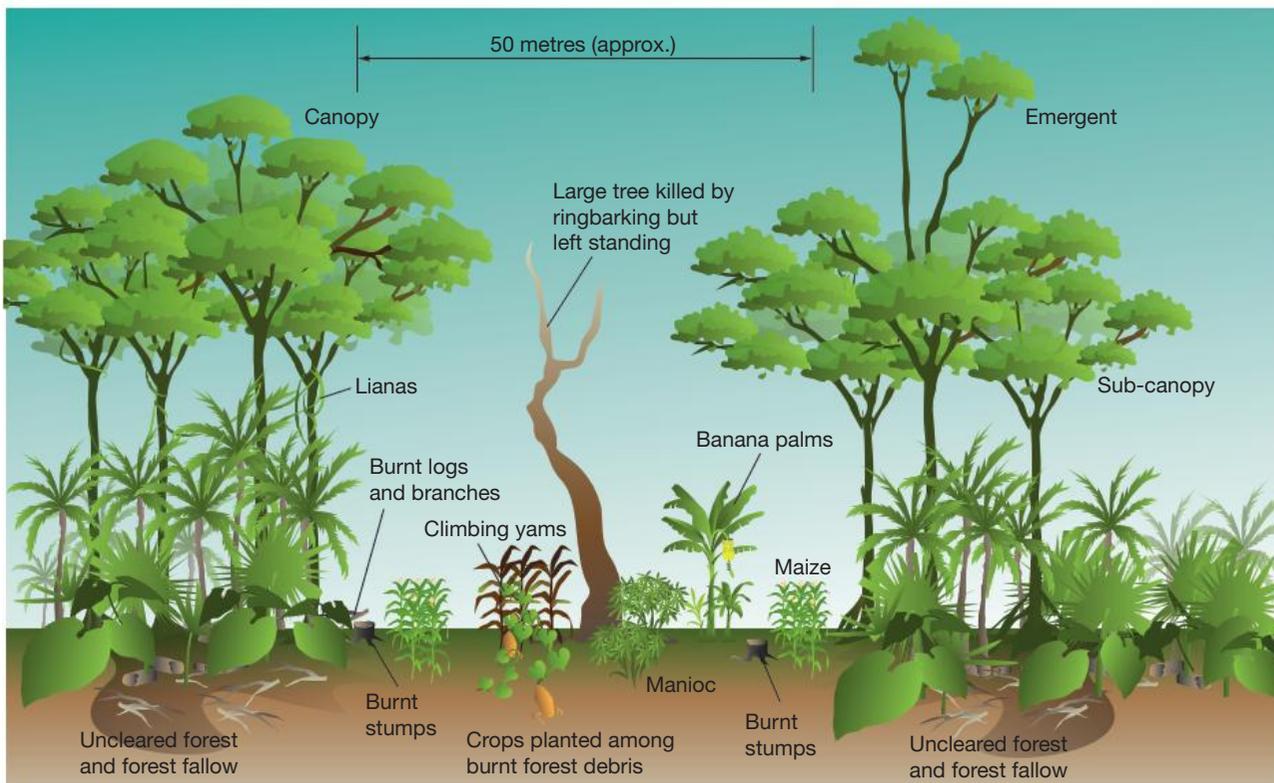
As a result, larger and larger areas of forest are cleared, creating large open tracts of land. This makes it harder for the forest to regenerate, as seeding trees are too distant from the cleared plots. Slash-and-burn agriculture is now the main cause of deforestation in Latin America and Africa and the second-most significant cause in Asia after plantation agriculture.

#### Stewardship worldviews

The first people to make a living within rainforests were probably **hunter-gatherers**, who ranged over huge territories in search of food. They had the ability to identify thousands of different types of plants and animals, and to recognise those that were edible or dangerous. The low population densities of tribes guarded against over-exploitation.

Early forest dwellers were also farmers. Traditional **shifting cultivators** cleared small patches of forest to grow food in gardens. Once a site was chosen, fruits and anything useful were harvested before the trees were ringbarked and the undergrowth hacked. When the undergrowth had dried out it was burnt to create a layer of ash that temporarily fertilised the soil (see Figure 2.13).

Initially, the yields from the garden plot were satisfactory, but they fell as the nutrients were used up and weeds invaded the garden. A plot would provide only a few good harvests before it was abandoned to be reclaimed by the forest. It could take up to 30 years for the site to regain its soil fertility and be ready for use again. Increasing population densities have inevitably resulted in increasing deforestation and made shifting cultivation unsustainable.



2.13 Cross-section through a typical garden of a shifting cultivator

### Earth-centred worldview

The first priority of the earth-centred worldview is the protection and restoration of forest ecosystems and their related species. Forest ecosystems are considered to be the most ancient ecosystems on earth and they hold immense biodiversity that must be valued and maintained. With the threats associated with climate change, the role of forests as global carbon sinks is considered especially important for the future. Recognising the natural values of forests is considered essential.

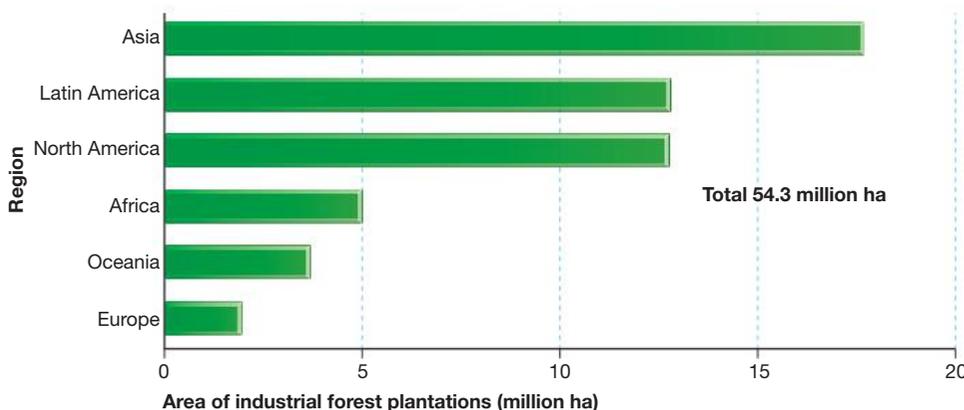
### Human-environment systems thinking

The human-environment systems thinking framework can help us to identify the drivers of deforestation.

### Globalisation

Global markets consume rainforest products such as hardwood timber, latex, natural oils and resins, fruit, nuts and spices, and compounds used in pharmaceuticals. The most important forest resource in economic terms is timber, used in construction and furniture, and for fibre for the pulp and paper industry. Fifty years ago, almost all industrial wood was harvested from natural forests, generally in the industrialised countries in the temperate regions of the Northern Hemisphere.

The globalisation of the timber industry is resulting in the establishment of fast-growing tree plantations in the tropical and subtropical zones in developing countries (see Figure 2.14). Corporations are investing in plantations in developing countries to take advantage of cheap land and labour. New technologies are being applied to generate rapidly growing trees that have all the desirable traits of industrial wood.



Source: Indufor Plantation Databank, 2012

2.14 Industrial forest plantations by region, 2012. The global area of industrial, fast-growing plantations is 54.3 million hectares. These forests are intensively managed productive plantations, mainly of exotic introduced species.

## Poverty

Population pressure and poverty are major drivers of deforestation. Many people who live in the tropics are desperate to survive in the short term. They attempt to grow food in the forest because it is only there that they can find land. Massive numbers of landless migrants from the poor regions of Brazil's north-east and central-west were encouraged to settle in the new frontier of the Amazon under government land-settlement schemes (see Figure 2.15).

## Conservation reserves and biodiversity corridors

**Conservation reserves** and **biodiversity corridors** are being established on a range of scales—from small areas set up by landholders to protect a patch of forest, through to large tracts of land. A major objective of establishing reserves and corridors is to protect the biodiversity of all the flora and fauna within a forest from threat or extinction.

### Conservation reserves

Conservation reserves are areas of land set aside to maintain biodiversity and/or natural or cultural heritage values. They are protected by legislation passed by a government or because of an international agreement that a government is signatory to. Any human use of conservation reserves is usually restricted to activities that are deemed compatible with the reserve's natural values.

### Biodiversity corridors

Land clearing has resulted in fragmented forests, with the result that plant and animal species cannot disperse or moving freely across the landscape. Being confined to smaller areas puts species at risk, as they may be weakened by inbreeding and their numbers can be decimated by disease or catastrophic events such as fire. Connectivity corridors link isolated blocks of native forest with strips of vegetation that imitate the structure and diversity of the original forest cover.



2.15

Poor migrant families have moved into the Amazon and cleared the forest to grow food.

Biodiversity corridors are an effective method of raising both the number and diversity of species by allowing dispersal and movement from one area of key habitat to another. Corridors vary in their size. A farmer may plant a corridor of native vegetation about 40 metres long following a boundary fence. This allows trees to seed and animals to move easily. Large-scale corridors connect habitats regionally and even internationally.

## Ecosystem-based management strategies

The ecosystems approach is an **environmental strategy** that integrates the management of land, water and living resources and emphasises that humans are an integral component of ecosystems. It recognises that management must be ecologically sustainable and for this to be assured, biodiversity must be protected, as biodiversity and healthy functioning ecosystems are vital for life on earth (see Figure 2.16).

## Addressing drivers of environmental change

The drivers of environmental change have been identified as globalisation and poverty.

Lowering the demand for wood-based products reduces the pressure on forests. This may be achieved by:

- cutting the wastage of timber resources: in the 1990s, Japan was criticised for using tropical timber panels for moulding concrete in public works projects, only to discard the timber when the concrete had set
- recycling timber: many cabinetmakers and renovators are using recycled timber, as many of the specialty timbers are becoming harder to source—they have been over-exploited in the past
- using wood substitutes: considerable potential exists for non-wood fibre alternatives such as cereal straw, hemp and flax to be used as raw materials for board and paper manufacture.

Raising people's standard of living will also take the pressure off forests. This could be done by:

- helping farmers to obtain formal title to their land, so they are encouraged to use it more efficiently rather than just move on to a clear more forest once soils become depleted
- involving farmers in producing new products from the natural forest that have potential as exports
- improving farming methods and promoting alternative cultivation techniques such as permaculture, whereby the structure of the forest is mimicked. Availability of cheap credit will assist farmers to implement the changes needed.

- 1 The objectives of management of land, water and living resources are a matter of societal choices.
- 2 Management should be decentralised to the lowest appropriate level.
- 3 Ecosystem managers should consider the effects (actual or potential) of their activities on adjacent and other ecosystems.
- 4 Recognising potential gains from management, there's usually a need to understand and manage the ecosystem in an economic context. Any such ecosystem-management program should:
  - a reduce those market distortions that adversely affect biological diversity
  - b align incentives to promote biodiversity conservation use
  - c internalise costs and benefits in the given ecosystem to the extent feasible.
- 5 Conservation of ecosystem structure and functioning, in order to maintain ecosystem services, should be a priority target of the ecosystem approach.
- 6 Ecosystems must be managed within the limits of their functioning.
- 7 The ecosystem approach should be undertaken at the appropriate spatial and temporal scales.
- 8 Recognising the varying temporal scales and lag-effects that characterise ecosystem processes, objectives for ecosystem management should be set for the long term.
- 9 Management must recognise that the change is inevitable.
- 10 The ecosystem approach should seek the appropriate balance between, and integration of, conservation and use of biotechnology.
- 11 The ecosystem approach should consider all forms of relevant information, including scientific, indigenous and local knowledge, innovations and practices.
- 12 The ecosystem approach should involve all relevant sectors of society and scientific disciplines.

Source: FAO

2.16 The twelve principles of the ecosystem approach

## ACTIVITIES

### Knowledge and understanding

- 1 Describe how the hunter-gatherers and traditional shifting cultivators survived in the forest.
- 2 Outline how forests have been exploited by those with a human-centred worldview.
- 3 Identify the priorities of forest management of those with an earth-centred worldview and justify such priorities.
- 4 Explain how both globalisation and poverty are driving deforestation.
- 5 Explain the benefits of ecosystem-based strategies.

### Applying and analysing

- 6 Analyse how addressing the underlying and immediate cause of environmental change may protect forest landscapes.
- 7 Write an extended response on the following topic: 'Explain how a system of agriculture that has worked well for thousands of years in tropical rainforests is breaking down under the pressure of human numbers.'



- 8 Study Figure 2.16 and select what you consider to be the three most important principles of the ecosystem approach. Justify your choice.

### Geographical skills

- 9 Study Figure 2.13 then answer the following questions.
  - a What crops are grown in the garden?
  - b Why are large trees that have been killed by ringbarking left standing and debris left strewn across the garden?
- 10 Study Figure 2.14 then answer the following questions.
  - a What region had the most industrial forest plantations in 2012?
  - b How many hectares were occupied by industrial plantations in both Latin America and North America?
  - c What percentage of the world's industrial forest plantations were in Africa in 2012?

# 2.4

## Case study: Canada's forests under threat

Canada's forests and their associated wetlands, which have been described as one of the world's great ecological treasures, cover 60 per cent of the country's 9.9 million square-kilometre landmass. Along with the Siberian boreal forest and the Amazon rainforest, they are the last significant stretches of forested land on earth that has never been touched by the large-scale footprint of human industrial activity.

### Coniferous forests

Canada's vast coniferous forests are dominated by cone-bearing trees such as the spruce, fir and pine. The leaves of these trees are usually needle-like and most stay green all year around (evergreen). The forests are able to survive cold temperatures and acidic soil. Coniferous forests are found mainly in the Northern Hemisphere. Figure 2.17 illustrates the distribution of Canada's forests.

### Threats

Forestry, mining and energy projects across Canada are transforming huge swathes of the coniferous frontier, destroying wildlife habitat, disrupting animal migration patterns, threatening water quality and compromising ecosystem services.

2.17 Distribution of forest types, Canada



Today, about one-eighth of Canada's total forest area is affected by infrastructure, including roads and hydroelectric dams. Species such as the woodland caribou have disappeared from the parts of the boreal forest and other wildlife, such as the wolverine, bear and wolf, are in trouble as the wave of development continues to push north.

There are now about 1400 human communities within Canada's boreal region. Many settlements were carved out of the forest to support a sawmill, pulp mill or mine, and in some cases, railway maintenance facilities. In total, boreal forestry activities support almost 400 000 direct and indirect jobs across Canada. Oil and gas exploration and development, forestry, pulp and papermaking and mining are the largest industries, along with tourism and other service-based activities.

Human activity is also contributing to infestation through the introduction of insect species. This infestation is a side-effect of international trade. Wood packaging from abroad is thought to be the source of the Asian longhorn beetle, which has no natural predators in Canada. The Asian longhorn has the potential to destroy a whole range of hardwoods by burrowing deep under the bark. An earlier alien invader was the gypsy moth, which attacks oaks and other broadleaf trees.

Canada's native species of insects can also cause enormous damage to the forests. One example is the mountain pine beetle, shown in Figure 2.18, which attacks many western Canadian pine species. A recent outbreak in numbers has devastated huge tracts of forest across British Columbia and parts of Alberta. Many experts believe this outbreak is linked to a series of warm, dry summers and milder winters—a result of global warming.

## Addressing forest degradation

To maintain ecological processes and the full complement of wildlife species, scientists argue that at least 50 per cent of Canada's forest ecosystem should be set aside as a permanent network of conservation areas free of disturbance. The rest should be carefully managed to preserve or restore its ecological wellbeing. Importantly, scientists also argue that these protected areas should accommodate the traditional uses of the land by First Nations people, and should be managed or co-managed by the First Nations in Canada.

## Triad approach to forest management

A management option being trialled in Canada is the triad approach, which is being tested on 0.86 million hectares of deciduous forest in Quebec. Under the triad approach, the forest is divided into three distinct zones, with very different management objectives.

- 1 The conservation zone: The main goal is conservation of biodiversity and ecological processes. Human activities that interfere with these processes are restricted.
- 2 The natural disturbance-based management zone: Human activity such as partial logging is permitted, but it must mimic what happens with natural disturbances in the forest (such as storm damage). The goal is to build the resilience of the forest to such an event.
- 3 The intensive silviculture zone: This is the intensive logging zone, where timber is extracted.

The triad approach holds the promise of balancing the exploitation of a valuable natural resource while meeting the needs of the many different stakeholders and interest groups.

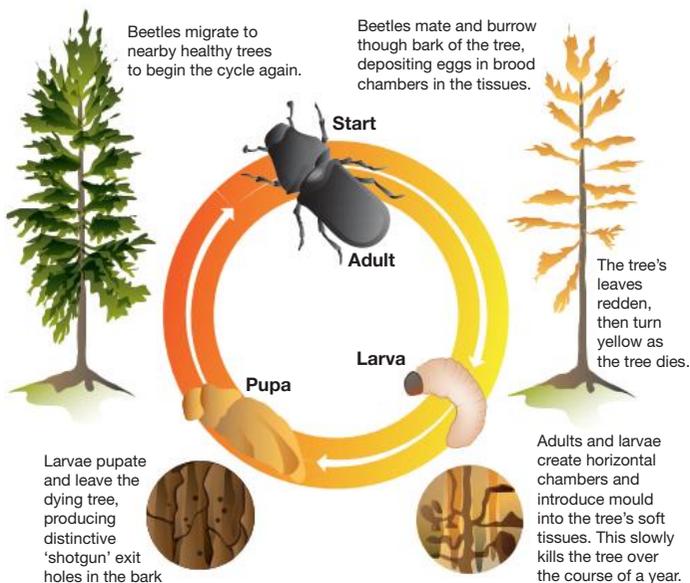
## ACTIVITIES

### Knowledge and understanding

- 1 State what is special about the Canadian forests.
- 2 Outline the features of the Canadian forests.
- 3 Outline the range of threats to the Canadian forests.
- 4 Explain what should be done to protect the Canadian forests.
- 5 Describe the triad approach to forest management that is being trialled in Canada.

### Geographical skills

- 6 Study Figure 2.17. With the aid of an atlas, describe the distribution of Canada's various forest types.
- 7 Study Figure 2.18. Write a report describing the life cycle of a pine beetle and its impacts on the forests.



2.18 The life cycle of a pine beetle and its impact on the tree

# 2.5

## Forests: Evaluating management responses

As both communities and governments tackle the environmental issues confronting them, they have to recognise the importance of monitoring the state of the forests and evaluating the management responses. For such evaluation to be effective, environmental, economic and social criteria must all be applied.

### Importance of evaluating management responses

Human wellbeing has long been connected with forests. Concern has been mounting over the threats to forests and the loss of important ecosystem services and renewable resources, species extinction and the reduction of carbon sinks. With only 10 per cent of the world's forests found in protected areas, it is evident the global forest cover is not being adequately conserved.

For too long management responses addressing the threats to forests relied on trial and error. All too often there was inadequate attention given to carefully collecting evidence on what had or had not worked in the past. Such systematic evaluation of management was surprisingly scarce relative to the work undertaken to protect forests.

There is now an increasing awareness of the importance of establishing a measure of what management responses have accomplished, and in doing so learning from past successes and mistakes. This is particularly important given the scale of environmental changes now affecting forests, especially those driven by climate change. Increasingly, monitoring and evaluation are being recognised as essential tools of forest management.

### Criteria for evaluation

There are many types of management responses and no single one is appropriate for all environmental changes. Having some vague notion that management will make a difference to environmental quality is not enough. When evaluating the effectiveness and appropriateness of management practices it is important to have a clear set of evaluation criteria.

#### Environmental criteria

The foundation for forest management is the maintenance or improvement of the condition of the forest environment. This includes the conservation of biodiversity, the maintenance

of ecological processes and the protection of all the natural features in the landscape, such as soil, air and water.

Proper forest management will ensure that the countless interrelationships between species that have evolved over time are maintained, and that intricate food chains will continue to enable the energy flows and nutrient cycling that support forests. Environmental criteria are used to judge the extent to which a policy or response meets its intended objectives.

#### Economic criteria

Planning and implementing management responses requires funding. This may be provided by individual landholders, community groups, governments at all levels (local, state and federal), non-governmental organisations (NGOs) and intergovernmental organisations (IGOs).

Whatever the source, it is important that the management undertaken is both:

- **efficient:** it achieves its intended objectives or positive outcomes in protecting or improving forest cover
- **cost-effective:** it can be done at minimum cost to the landholder or society. Any waste or additional costs because of poor financial decisions can draw a lot of criticism and jeopardise the continuation of environmental programs.

One of the biggest challenges faced by developing countries is their inability to access the funds required to respond to environmental changes. Their governments often find it difficult to raise funds, as many of their people are **subsistence producers** who do not pay taxes.

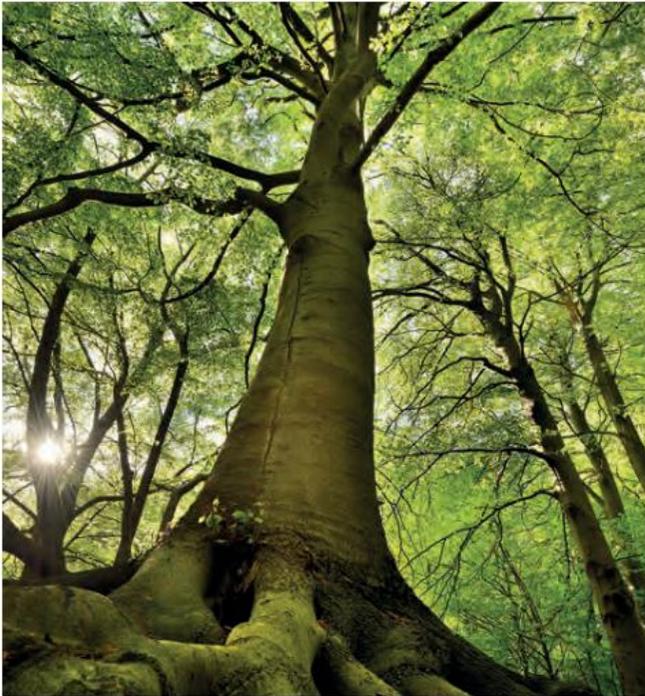
In recent times, developed nations have faced their own economic dilemmas as national debts have increased as a result of the global financial crisis. Environmental programs are often cut to reduce government spending. Similarly, donations to NGOs may fall, as individuals become more cautious about parting with their money.

## Social criteria

Fairness and equity are important, as success depends on community support. In reality, the costs and other impacts of management responses may not be spread evenly across a country. If they are thought to be inequitable, they will not be supported enthusiastically.

### 2.19 Services provided by healthy forest ecosystems

People can be made aware of how conservation and enhancement of forest ecosystems will improve their quality of life both now and in the future (see Figure 2.19). The extent to which local communities have been empowered to take ownership of the decision-making processes often determines the success or failure of management.



1 Storage of carbon in trees and soil



2 Pollination of plants/commercial crops



3 Decomposition of wastes



4 Provision of clean drinking water

## Trade-offs in decision making

Decision makers must attempt to balance environmental, economic and social criteria in environmental programs, and to determine the extent to which there can be trade-offs between them.

A trade-off is a loss incurred in return for a gain, and is made with an awareness of the consequences. Management that protects the forest may result in financial costs such as lost production or restrictions on the use of the forest that may affect the quality of life of the people living there. Similarly, management that ensures a reasonable degree of equity for the people may have to sacrifice efficiency and cost-effectiveness.

For an individual landholder considering revegetating part of their property to create a belt of trees to encourage biodiversity, as shown in Figure 2.20, the trade-offs might result in the following gains and losses:

**2.20** A landholder undertook revegetation of part of his property by creating a belt of trees. He was prepared to take land out of production for ecological benefits in the long term.

- gains: ecosystem services such as crop pollination, pest control, soil and catchment protection and carbon storage
- losses: land is taken out of production, thereby reducing the economic returns to the landholder. Costs are also incurred in purchasing tree seedlings and fencing off the area to keep stock out that may otherwise trample the seedlings.

The landholder has to weigh up short-term costs, which are mainly financial, against long-term environmental benefits that may guarantee the sustainability of production, both ecologically and economically.

Such choices about trade-offs must be made at every level of decision making. National governments and IGOs must debate the practical and ethical dilemmas of national and international conservation programs aimed at tackling environmental change. The challenge is to reduce poverty and provide a higher quality of life for those living in the forests of developing countries while safeguarding the environmental quality of those forests.



## Improving the evaluation framework

Properly conducted evaluations enable more effective decision making in managing forest landscapes. Increasingly, scientific research and monitoring are being recognised as essential tools for effective evaluation (see Figure 2.21). Research into the functioning of forest ecosystems and the interconnections within them helps managers to gauge the impact of their actions, both immediate and in the future. Research provides specific information about such processes, and monitoring shows if changes are occurring over time.

Conducting research and monitoring the condition of forest environments are crucial for determining the effectiveness of management responses and deciding if they need adjusting.

2.21 Scientific research and monitoring are essential evaluation tools.



## SPOTLIGHT

### The forests of Kosciuszko National Park

Kosciuszko National Park is renowned for its snow-covered alpine area where the climate is too cold for trees to grow. However, there are significant areas of forest at lower elevations within the park. In the steep country that falls away to the west, cool temperate rainforests are found in sheltered pockets, with drier sclerophyll forests on the lower slopes. Below the alpine area to the east, the snow gums of subalpine woodlands give way to expanses of tall forests of mountain gums and alpine ash.

In the 2006 Plan of Management for Kosciuszko National Park, the importance of monitoring, evaluation and reporting was emphasised:

Monitoring and evaluation are being recognised as essential components of park management. While research provides specific information on the park's values, monitoring is aimed at capturing **baseline data**, typically on the condition of these values, and charting the nature and rate of change in condition over time. When collected and analysed in a systematic way, this information can provide the basis for evaluating the effectiveness of management policies and actions in achieving stated objectives. Adjusting and refining park policies and actions on the basis of monitoring results and the outcomes of performance evaluation produces an adaptive or responsive approach to management.

Existing monitoring programs in the park are primarily directed at detecting changes in alpine and subalpine vegetation communities, populations of certain threatened animals and threatened species, vegetation responses to fire, and water quality'.

Source: Office of Environment and Heritage, New South Wales

## ACTIVITIES

### Knowledge and understanding

- 1 Identify what are now increasingly regarded as essential tools of forest management.
- 2 List and explain the criteria for evaluating management strategies.
- 3 Define a trade-off and outline some of the trade-offs that are made in the management of forests.
- 4 Explain why baseline data is important.
- 5 Explain how an adaptive or responsive approach to management can be achieved.

### Applying and analysing

- 6 Write a short paragraph discussion of the following statement: 'Managing environmental change in the world's forests can no longer be left to trial and error'.
- 7 Undertake a 'think, pair, share' activity to determine the most important evaluation criteria. What is the consensus of the class? Discuss the relative importance of each criterion and how decision makers must make trade-offs.

# 2.6

## Case study: Australia's east coast forests

Efforts to conserve the remaining forests along Australia's Great Dividing Range provide one model for managing the impacts of environmental change.

### Connectivity conservation

**Connectivity conservation** is based on the idea that a corridor of protected lands extending over hundreds, and in some cases, thousands of kilometres can protect biodiversity and critical ecological processes. Connectivity conservation is based on a number of key ideas.

- Largely intact areas of forests need to be formally conserved in conservation reserves in order to maintain their ecological integrity.
- The land around the reserves can be managed so that it can act as a buffer zone against any outside threats to biodiversity.

- Cleared land provides opportunities for large-scale restoration of natural vegetation to connect the reserves so that they are not left as isolated islands in which extinctions are likely.
- Conservation planning is done on a large scale to ensure that all the links and ecological processes essential for species to adapt to environmental change are in place.



2.22

The slopes of the Great Eastern Ranges include most of Australia's forests. Connectivity conservation is an approach now being used to manage environmental change within these forests.

To ensure the survival, health and resilience of all species—including humans—we need to look at how we can rehabilitate and 'reconnect' islands of vegetation on a large scale, so a mosaic of ecosystems can exist across the landscape and function more effectively.

Connectivity conservation is a holistic approach that uses science to identify where, why and how 'gaps' in the natural vegetation can be restored to provide more functional links in the ecosystem.

## A conservation corridor

A conservation corridor is a strategically located area of land that links key habitats for plants and animals. It may encompass a range of landuses, including agriculture, industry and human settlement, in addition to areas conserved as national parks or reserves.

## Great Eastern Ranges corridor

Seven large-scale connectivity conservation areas have been established to protect the integrity and resilience of Australian ecosystems. One of the largest is the Great Eastern Ranges corridor (GER corridor), shown in Figure 2.22. The GER corridor protects the forest landscape in the mountain ranges that run parallel to the east coast of Australia. The corridor extends from the Grampians in western Victoria to the Atherton Tablelands in far north Queensland and beyond, as shown in Figure 2.23.

### Key facts

The Great Eastern Ranges corridor:

- is 3 600 kilometres in length
- is 33 000 000 hectares in area
- goes across 14 bioregions
- contains three World Heritage Areas
- has the world's greatest concentration of primitive rainforest flowering plants
- has Australia's largest and tallest old-growth forests
- contains more than 8 000 species of plants of which 25 per cent are endemic
- contains the headwaters of 63 large rivers
- provides clean water to over 11 000 000 people.

## GER corridor's biodiversity assets

The biophysical environment in the GER corridor is one of the most biodiverse on the continent. Stretching over 28 degrees of latitude, the GER corridor includes significant areas of tropical, subtropical and temperate forests. It covers a number of climate zones, with major variations in temperature and rainfall. Along the ranges, tablelands and escarpments are Australia's least fragmented habitats, containing a rich diversity of flora and fauna, all of which have evolved over millions of years.

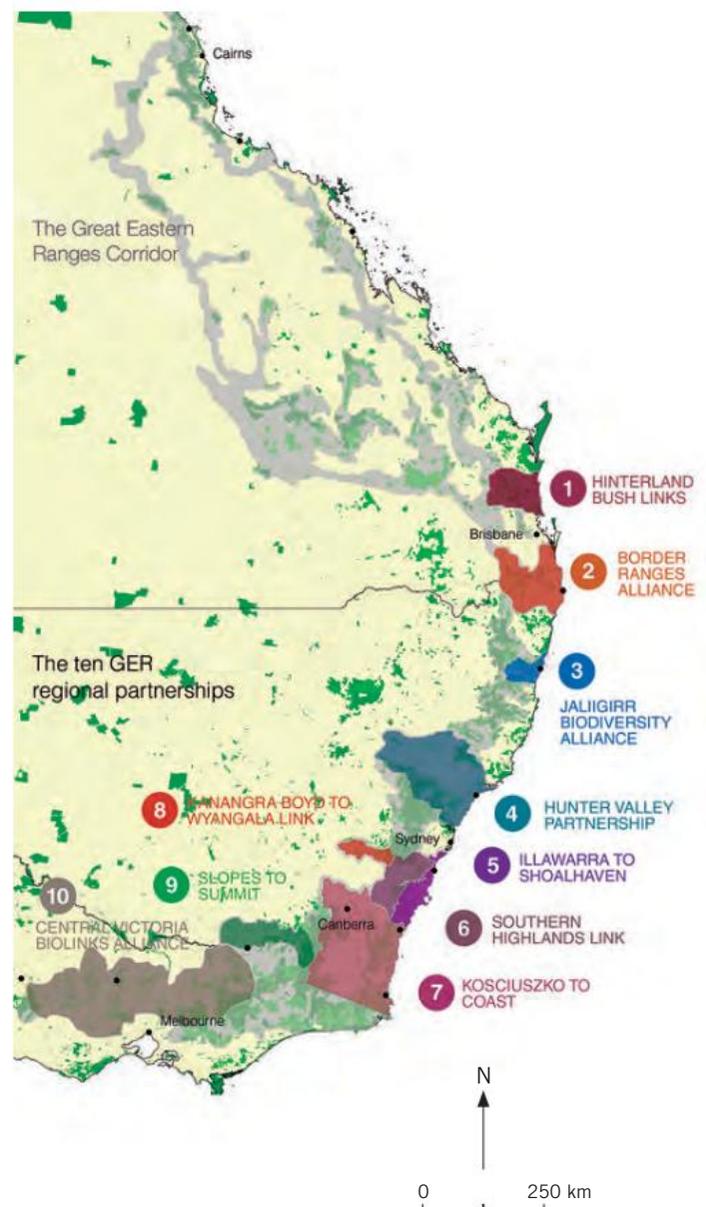
The three World Heritage areas (Wet Tropics, Central Eastern Rainforest Reserves and the Greater Blue Mountains) found in the GER corridor reflect the continent's evolutionary history. They provide evidence of the impacts of long-term global climate change, the long period of isolation since breaking clear of Antarctica (and Gondwanaland) some 60 million years ago, and adaptations to Australia's deeply weathered and infertile soils.

As a result, the region contains ancient and unique species of plants, the origins of which can be traced to Gondwanaland. The Wollemi pine is just one of these. There are many **endemic** plants and animals.

As the ranges receive high levels of precipitation, they support very productive ecosystems and thus have the largest amounts of biomass on the continent. The GER corridor contains most of Australia's rainforests and eucalypt forests and therefore the bulk of its forest-dependent flora and fauna.

2.23

The GER conservation corridor, which includes the Great Escarpment of eastern Australia and the Great Dividing Range and, in various places, large sections of intervening highlands



## Threats to biodiversity in the GER corridor

There are a number of environmental changes that threaten the rich biodiversity of the GER corridor:

- **Land clearing:** This has been the major contributor to the loss of biodiversity in Australia. The GER corridor is adjacent to the intensive agricultural zone along the east coast, where the major centres of population are also found. Habitat loss and fragmentation lead to the demise of species, as they are unable to maintain viable populations within increasingly smaller disconnected areas.
- **Invasive species:** The introduction of feral animals and weeds has had devastating consequences for many native species. Of particular concern is lantana, a shrub that grows along the edges of the forests of the ranges and penetrates any disturbed areas. It forms a dense thicket that excludes any native species from growing beneath.
- **Fire:** While Australia's vegetation evolved in the presence of fire, it is susceptible to considerable damage from very severe fires. For tens of thousands of years, there were frequent, low-intensity fires in the forests under traditional Aboriginal management. Since European settlement, fires have been deliberately prevented to protect people and property. As a result, the fuel load has built up in the forests and when fires do occur they can become large wildfires, the intense heat of which does severe ecological damage, even killing trees outright that would have normally regenerated.
- **Climate change:** Accelerating climate change is placing even more stress on forests. According to the New South Wales Department of Primary Industries, climate change is likely to increase wildfire risk, largely through its impact on climate extremes. Projections suggest that the frequency of very high and extreme fire danger days in south-eastern Australia may increase by 4–25 per cent by 2020, and by 15–70 per cent by 2050.

## Connecting nature

We need a better understanding of the complexity of the networks of interconnected systems within forest environments. The GER corridor initiative recognises that to fully understand a regional biodiversity asset (for example a particular forest), it is necessary to examine the continent-wide ecological processes that sustains it. The GER corridor uses science to identify the gaps in the forest cover and to determine how existing stands can be connected to restore the links and interactions that will protect biodiversity.

### The challenge

Although parts of the GER corridor are well protected by national parks and reserves, much of the rich biodiversity is found on private and public lands outside these protected areas. The GER recognises that nature's interconnected systems need to be supported across the whole environment, not just in the protected areas of the landscape. So we seek to integrate conservation efforts in the land adjacent to and interconnecting with the existing reserve systems. This will allow habitats for plants and animals to be managed better or rehabilitated and strengthened where needed.

### The approach

The GER is based on 'connectivity conservation', an approach that recognises the need for ecological processes to operate on a much larger scale than previously appreciated. By assessing these processes at local, regional and continental levels and harnessing the existing efforts of many landowners and organisations to respond strategically, we create the best conditions to preserve, restore and build resilience in our environment.

The key is simple—by creating stepping-stones between areas of native vegetation and managing and improving what is already in place, we reconnect to the landscape and improve the health of the environment on which we all depend. This approach will support our biodiversity by providing the best available opportunities for species to survive climate changes.

Source: Great Eastern Ranges Organisation

## Connecting people

The GER initiative brings together all the people and organisations working on improving native habitats and protecting biodiversity along the eastern ranges—researchers, landholders, community and Indigenous groups, conservation organisations, local councils and other government bodies. This approach provides a broad range of expertise to draw on and is coordinated and supported by the GER. Such cooperation means that the resources can be put to use to yield the best results on a large, landscape scale.

The approach taken in the GER initiative involves raising awareness about biodiversity conservation over the full extent of the GER corridor. Local communities can be galvanised into action that fits in with the strategic approach to protecting biodiversity in all the forests along the ranges.

## Management strategies

The GER initiative is an ambitious plan aimed at combating the threats to the biodiversity and ecosystem services of the forest landscapes of eastern Australia. For over a century, these landscapes have been under pressure from landuse intensification, invasion by introduced species and, more recently, rapid climate change. The GER corridor initiative is a large-scale, continent-wide approach to increasing the extent of forests and ecological connectivity within the landscape. Building such a continental lifeline will conserve biodiversity by supporting the survival of species.

## Environmental

Connectivity conservation involves identifying the gaps in forest cover and restoring the natural vegetation as can be seen in Figure 2.24. Connecting habitats and providing functional links between them is the key to achieving forest sustainability.

Conservation management in Australia has focused on species presence (snapshot data) rather than long-term viability and the need for connectivity conservation. This has been due to insufficient resources (time and talent) to fully implement **population viability** analyses for most corridor initiatives.

## Economic

Funding has not matched the scale of the initiative's vision and objectives. Delivering the aims of connectivity conservation is difficult when funding is limited. Much greater financial resources and human energy is required than has been invested to date in reducing continental scale pressures. One of the challenges for the Australian Government is to create conditions needed to attract far greater investment in time, talent and financial capital to match the scale of need and ambition to expand conservation corridor initiatives.

## Social

A real strength of the GER initiative is that it is socially inclusive. Local community networks have been involved in regional partnerships and people are working with an appreciation and understanding of how their efforts are contributing to the continental corridor initiative.

## The future

Connectivity conservation on a continental scale is the key to providing more functional links within the forest ecosystems and thereby conserving biodiversity. The GER has the backing of the people who at a local level are committed to regional partnerships, which are part of the vision of the initiative. In time, as research advances and funds flow more freely, there will be more progress.



2.24

Volunteers in locally organised groups can work within regional partnerships that improve the connectedness and resilience of forest landscapes.

## ACTIVITIES

### Knowledge and understanding

- 1 Explain how connectivity conservation protects forests.
- 2 Explain the purpose of the GER initiative.
- 3 Account for the rich biodiversity within the forests of the GER.
- 4 Identify the threats to this biodiversity.
- 5 Explain what is meant by the term 'population viability'.

### Applying and analysing

- 6 The GER provides clean water to over 11 million people. In a paragraph, explain why protecting the forests along the ranges of the GER is vitally important to this role.
- 7 As a class, debate the effectiveness of the GER initiative.
- 8 Study the photograph of the GER in Figure 2.24. What evidence is there of connecting nature in this landscape?
- 9 Evaluate the GER initiative against environmental, economic and social criteria.

# 2.7

## Case study: Yucatán Peninsula, Mexico

South-eastern Mexico has significant areas of tropical rainforests that have come under threat as agriculture and eco-archaeo-tourism have expanded. The southern Yucatán Peninsula illustrates how these drivers of environmental change are reshaping the forest ecosystems. It also illustrates how vulnerable the remaining tropical rainforests are to such change.

### Threats to the rainforests

#### Poverty and population growth

In the late 1960s, the Mexican Government promoted development in the Yucatán by providing land for poor farmers to grow food on communal farms known as *ejidos*, shown in Figure 2.25. This encouraged landless migrants to move into the region, many of them illegally squatting on the land. The population increased tenfold by the year 2000 to 39 000 people, resulting in extensive clearing of almost 1000 square kilometres of rainforest. The region became one of the global 'hotspots' of tropical deforestation.



2.25 Forests have become fragmented as the land has been cleared for *ejidos*.

Most of the farmers were subsistence producers. They grew corn, beans and squash, or ran livestock to provide food for their families. They also used the forest to hunt and poach animals. By the mid-1990s more than half the farming households were also growing commercial chilli for the national market. Chilli is a very sensitive crop and susceptible to pest, diseases and water shortages. As farmers battled to make money, they intensified their land use and cultivated the land more frequently. As soil fertility was lost, they cleared more forest to plant chillies.

#### Invasive species

The increasing number of *ejidos* in the region led to the fragmentation of the forest landscape, making it more vulnerable. As the forest became fragmented, more forest edges were created. Fires used to clear the land destroy near-edge trees and the rainforest became more exposed to the severe winds of hurricanes. As trees fell, they took with them the tangle of clinging vines and lianas, creating more gaps within the forest. Bracken fern invaded the open tracts of land and quickly covered the area. This invasive species blocked forest regeneration by preventing other plants from growing.

Large-scale burning to clear land for farming also accelerated the spread of bracken fern across disturbed land. Once it became established, the land was lost to cropping and rather than combat the spread of the fern, farmers just cleared more rainforest.

#### Increasing numbers of tourists

Tourism increased as the southern Yucatán Peninsula gained international recognition for its ancient Mayan ruins. The popularity of this cultural heritage and archaeological sites necessitated the construction of tourism-related infrastructure. Roads, including a paved federal highway, were cut through the rainforest to provide access to the ruins. This caused significant loss of rainforest habitat. Increasing numbers of tourists have also led to water shortages in the dry season (November to April). Most of the water is reserved for tourists, creating a shortage in the local *ejidos*.

#### Revaluing the region

In the late 1980s, Mexico determined to realise the economic value of the region's forests and archaeological heritage. In doing so, the government established the Calakmul Biosphere Reserve (CBR), El Mundo Maya (EMM) and the Mesoamerican Biological Corridor program (MBC). Efforts have since been made to reconcile the different interests of the main stakeholders in the region.

## Calakmul Biosphere Reserve

Covering more than 7231 square kilometres, the CBR was established in the centre of the southern Yucatán Peninsula to protect the immense biodiversity found within the rainforest (see Figure 2.26). There are also many ancient Mayan ruins within the limits of the reserve. Mexico currently has forty **biosphere reserves**.

The CBR is noted for its small but healthy population of jaguars, as well as other big cats such as ocelots and pumas. It also has howler and spider monkeys, tapirs, toucans, parrots and over 400 species of butterflies. In all, the CBR has eighty-six different species of mammals, many of which are rare, threatened or in danger of extinction.

In 1993, the CBR was recognised by UNESCO as a biosphere reserve and became part an international network of sites.

The CBR has three functions:

- conservation of the mature forest cover, its species and genetic diversity, and its carbon stock (stored carbon)
- appropriate development that is both socially and economically sustainable to protect the livelihoods of the people living there, as well as the environment
- monitoring and research to track the state of the rainforest and understand how it functions.

2.26

The Calakmul Biosphere Reserve is located on the southern Yucatán Peninsula, Mexico.



## SPOTLIGHT

### Biosphere reserve zones

Biosphere reserves are organised into three interrelated zones:

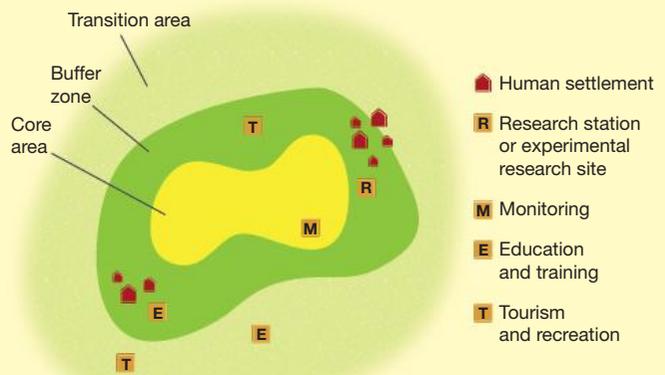
- a core area, which is legally protected to conserve biodiversity; it is carefully monitored to track environmental change
- a buffer zone, which surrounds the core area and provides for scientific research and experimentation, education and training as well as tourism
- a transition area beyond the buffer zone, where local communities have a hand in managing the resources of the area through farming and agroforestry.

In 2014, UNESCO approved the extension of the CBR and the area is now recognised as an important 'mixed natural and cultural property'.

The guiding principle of biosphere reserves is that the local community is not displaced, but rather actively involved in all aspects of management, research and monitoring. The goal is to conserve the forest while improving the income from forest activities. Tourism-based livelihoods, such as guided tours to the Mayan ruins or bird-watching hotspots, are being encouraged.

Workshops have also been held to bring together several communities in the CBR to share their experiences of

practices that lift production levels without damaging the rainforest. Those involved in tapping resin from the chico zapote tree have managed to improve their productivity so that now fewer trees are tapped than in the past. Farmers have also been given funding to assist them to become self-sufficient by using their land more intensively, rather than clearing additional forest.



2.27

Biosphere reserves have a research-intensive core area or core areas at their heart, surrounded by a buffer zone, where sustainable development is fostered, before gradually transitioning into the surrounding region.

## El Mundo Maya

The Yucatán Peninsula is known for the Mayan ruins found in the heart of the forest. Mexico joined with Belize, Honduras, Guatemala and El Salvador in a regional plan to develop eco-archaeo-tourism throughout the Maya lowlands. The organisation El Mundo Maya now develops and promotes environmentally sensitive tours of ruins, historical sites and rural areas within all five countries.

## Mesoamerican Biological Corridor

Mexico is one of seven countries that have agreed to coordinate their efforts to stem the loss of biodiversity in one of the world's biologically richest regions. The Mesoamerican hotspot holds a disproportionately high percentage of the earth's biota: more than 7 per cent of global species are found here, in less than 0.5 per cent of global land area. The species diversity in the rainforests is threatened by poverty and population pressure.

The MBC is an ambitious effort to connect large existing parks and reserves with new protected areas using a network of habitat corridors. Five such corridors are located within south-east Mexico to enable the sustained movement, migration and dispersal of species over long distances. The MBC links North America to South America. It was initiated in 1997 to keep 106 critically endangered species from becoming extinct and follows an earlier proposal called *Paseo Pantera*—the Panther's Path.

The MBC also addresses the needs of the local people living within the region. It includes multiple-use areas where low-impact human activities such as agriculture, fisheries and agroforestry are permitted. The MBC represents a holistic approach involving human environment systems. It seeks to address the relationship between human-impacted land and the expanses of mature rainforest in the region.

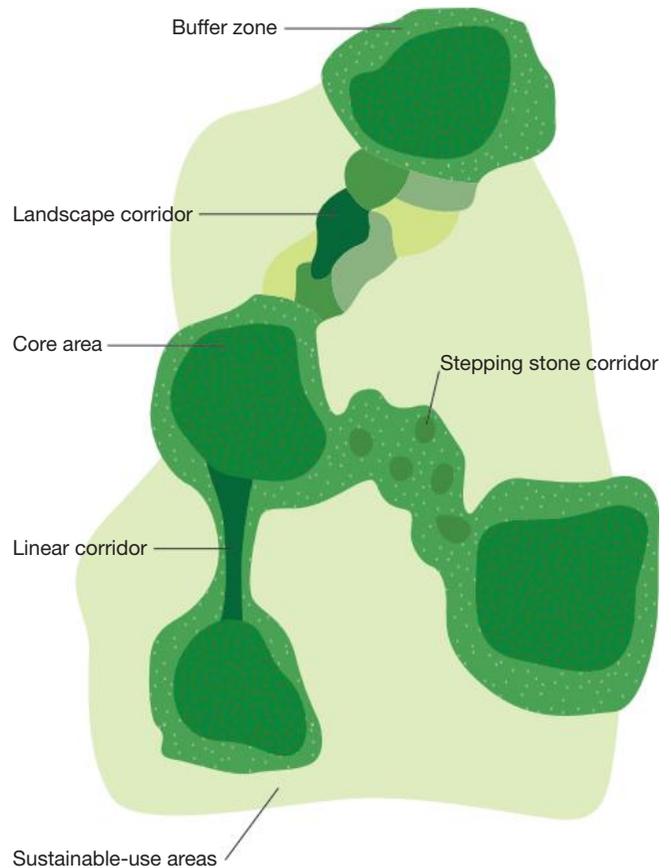
## Exploring solutions

There are a number of management options for addressing the challenges of environmental change in forest landscapes.

### Ecological networks

Ecological networks consist of core areas, corridors and buffer zones (see Figure 2.28). Corridors create a permanent connection between core areas. The core areas and connecting corridors are surrounded by buffer zones, which serve as a protection from possible disruptive external influences. Beyond the core areas and connecting corridors lies another area with land selected for sustainable use with preservation of several ecosystem functions.

2.28 An ecological network



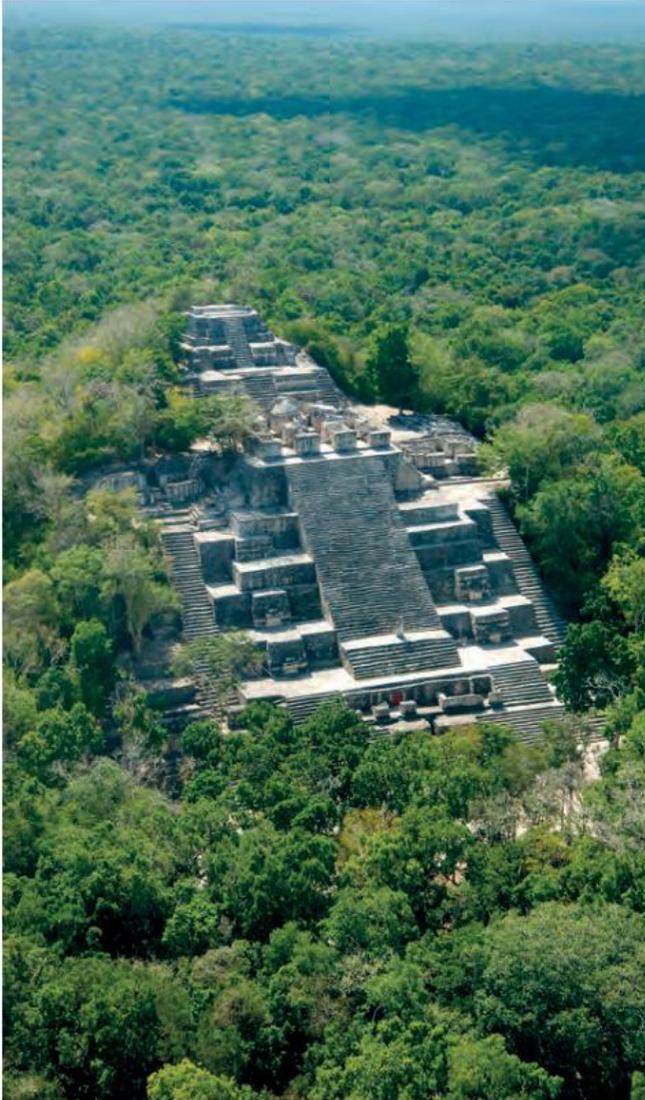
## Management strategies

Since the 1980s, the Mexican Government has made a determined effort to develop the southern Yucatán Peninsula by increasing food production and incomes while maintaining a mature forest cover. The Calakmul Biosphere Reserve, shown in Figure 2.29, and El Mundo Maya were established to facilitate this.

The success of these efforts can be judged by considering the criteria used for evaluation.

### Environmental

The increasing number of landless peasants within the region has placed added pressure on the land, fragmenting and opening the forest landscape. Large-scale burning and the invasion of bracken fern, particularly along the edge of the CBR are hazards. After a forest has been cut for cultivation, if it is able to regenerate naturally, it takes 25 years for the species abundance to return, but more than a century for the forest biomass to build up. With population pressure in the region, such regeneration does not occur; rather, further clearing occurs, with dire environmental consequences.



## Economic

The implementation of El Mundo Maya has brought revenue from tourism, although most poor migrants who have moved into the region rely on agriculture for a livelihood. They have been supported by the government-led development of *ejidos* and non-government initiatives promoting agroforestry.

Many of the rules and programs that were designed to make agriculture compatible with protecting the forest cover in reality run counter to it. The Mexican Government's efforts to transform the region into a green economy have faltered. In an attempt to curb deforestation, the government provided households with payments to intensify their landuse. However, as the farmers encountered economic difficulties, they used the payments to clear additional forest for grazing, which was an unforeseen outcome of the program.

## Social

Involving the local communities in managing, researching and monitoring the CBR has been a successful, socially inclusive, management response. As the people have not been displaced, and have been able to supplement their income by supporting tourism in the CBR, they recognise the importance of protecting its natural values. There is some resentment that the tourists' needs are prioritised above their own when it comes to allocating water.

The pressures on the southern Yucatán Peninsula are magnified by poverty. Desperate people feel they have no choice but to proceed with landuses that may damage forests. What is evident is the need to address such poverty and reconcile the very different objectives of the various stakeholders.

## ACTIVITIES

2.6

### Knowledge and understanding

- 1 Outline the pressures on the tropical rainforests of the southern Yucatán Peninsula of Mexico.
- 2 Describe how these forests in Mexico are being managed.
- 3 Explain why such a lengthy wildlife corridor was considered necessary to protect biodiversity in Central America.

### Applying and analysing

- 4 Write a report evaluating the effectiveness of the management of the southern Yucatán Peninsula, using environmental, economic and social criteria.
- 5 Draw a Venn diagram to compare the effectiveness of management responses in the Great Eastern Ranges Conservation Corridor (see Unit 2.6) and the southern Yucatán Peninsula.

### Geographical skills

- 6 Study the photograph of the *ejidos* in Figure 2.25. Draw a photo sketch, labelling important features of both the biophysical and constructed environments.

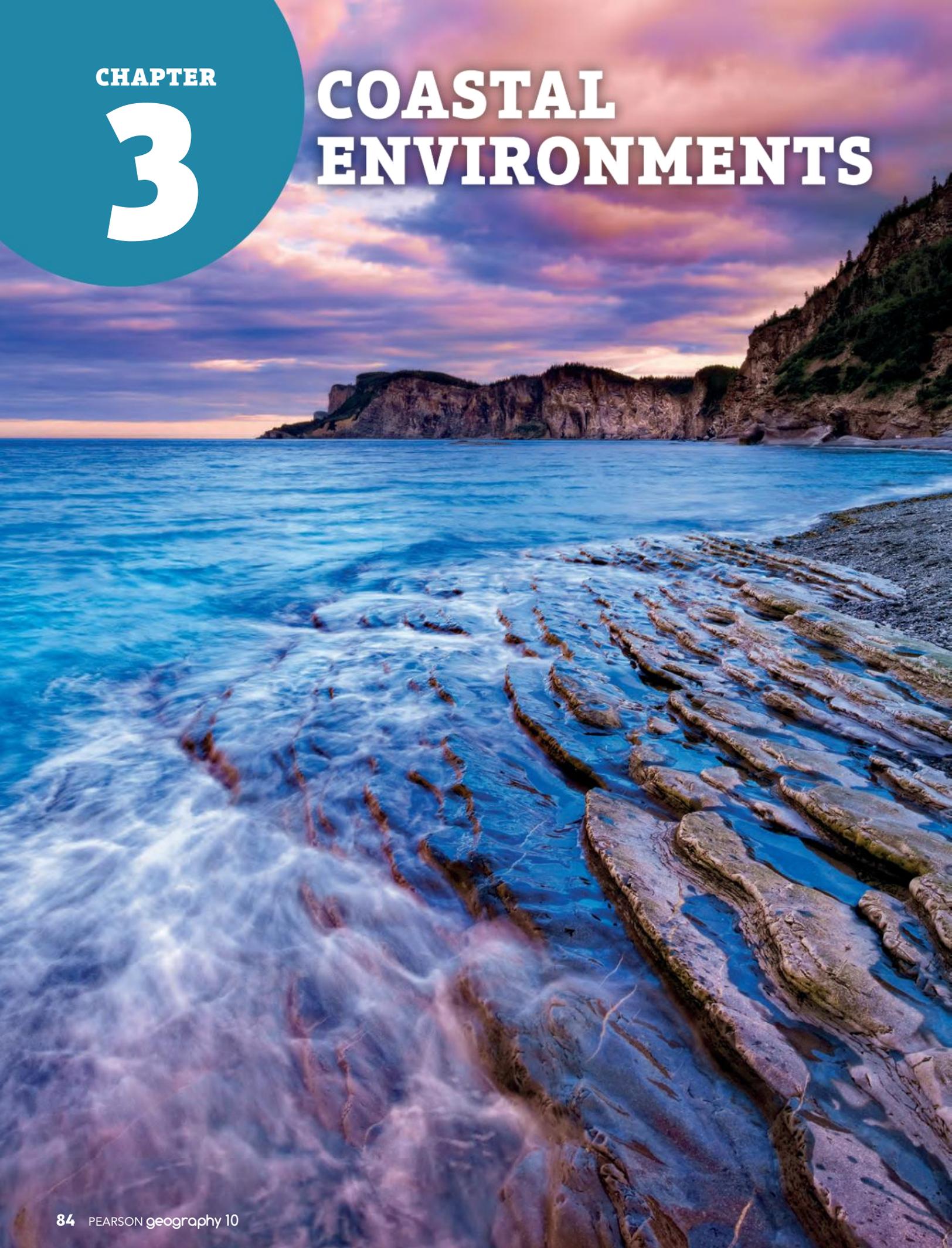
### Investigating

- 7 Investigate the countries that are part of the Mesoamerican Biological Corridor. Prepare a brochure to appeal to ecotourists that highlights the biodiversity found within the rainforests of this corridor.

CHAPTER

# 3

# COASTAL ENVIRONMENTS



**T**he coastline is the area where the land meets the sea. The exact point at which this occurs is difficult to determine because of the dynamic nature of tides. As a result, the term **coastal zone** is often used instead. This is the zone in which the interaction between the sea and land processes occur. The coastal zone includes many types of environments: coral reefs, the continental shelf, **coastal barrier islands**, estuaries, salt marshes and mangroves.

Many of the planet's coastal environments are under threat. Fifty per cent of world's population live within 10 kilometres of the sea and fourteen of the fifteen largest megacities are located on the coast. Given the scale of this human impact, and the ecological importance of these environments, it is critically important that they are effectively managed.

In this chapter, we focus on environmental change and management using coastal environments as an example. Of particular interest are the causes and consequences of the changes taking place and an evaluation of the strategies being used to manage these changes.

## KEY IDEAS

- To identify the main causes of environmental change in coastal environments
- To recognise the effects of environmental change in coastal environments
- To investigate environmental management strategies that are being used in coastal environments

## GLOSSARY

<b>coastal barrier</b>	long sand island parallel to the coast
<b>coastal zone</b>	the area in which the interaction between the sea and land processes occurs
<b>coastline</b>	the area where land meets the sea
<b>continuous resource</b>	a renewable resource, the availability of which is not affected by human activity; for example the energy of the sun
<b>ecotourism</b>	responsible travel to natural areas that conserves the environment and improves the wellbeing of the local people
<b>hard engineering</b>	the controlled disruption of natural processes through the use of human-made structures
<b>landuse zoning</b>	plans outlining how land can be used in an area
<b>longshore drift</b>	the process by which sand moves along a beach shoreline as a result of waves approaching the shore at an angle
<b>resonance</b>	process whereby an outgoing low tide collides with the incoming high tide, causing a wave of water to be pushed into a bay
<b>riparian</b>	related to or situated on the banks of a river
<b>sand dunes</b>	long hills of sand formed by the wind
<b>soft engineering</b>	the use of vegetation and other materials to soften land–sea interactions
<b>turbidity</b>	the amount of suspended sediment in water
<b>upwelling</b>	upward movement of water from deep in the ocean

# 3.1

## The importance of coastal environments

Every time a wave crashes into a headland, energy is transferred from the wave to the rock, and slowly breaks the rock down. Coasts are often referred to as 'boundary environments'. This is because they are found at the edge of marine (water-based) and terrestrial (land-based) environments. This interaction between the sea and land is at the centre of the coastal ecosystem.

### Biophysical interactions and natural balances

All ecosystems are the result of biophysical interactions. The biophysical environment is made up of four parts, known as the four spheres. These spheres are:

- **the hydrosphere:** water and its movement
- **the atmosphere:** the gaseous layer that surrounds the earth
- **the lithosphere:** the earth's solid outer shells, including soils and rocks
- **the biosphere:** flora and fauna.

The interaction of these spheres helps to determine the nature of the ecosystem that is found at any particular location.

### Importance of the coastal environment

#### Buffer zone

A coastal environment is a little like a bumper bar on a car. In a collision, the bumper bar bears the shock of the impact and absorbs much of the energy of the collision, helping to reduce damage to other parts of the car. Similarly, the coastal environment takes the full force of the waves and tides from the sea. This helps to minimise the impact to areas further inland. When humans begin to change the coastal environment by removing **sand dunes**, clearing coastal wetlands and dredging, this protective buffer is lost.

#### Breeding grounds

Coastal environments play a very important role in the broader marine environment. Many of the world's marine species, even those that spend most of their time in the deep oceans, use coastal areas as breeding grounds as well as food sources. From a human perspective, most of the fish species that are harvested for human consumption come from coastal waters (see Figure 3.1).

These coastal waters are the most productive. This is because they are rich in nutrients, which are brought to the coastal waters by river systems and the process of **upwelling**. Upwelling is a process whereby nutrient-rich waters from the deep ocean are pushed upwards towards the surface. Shallower coastal waters also have greater penetration of sunlight, which provides energy for aquatic plants (through photosynthesis). These plants are an important source of food for many species.

#### Cultural importance

For many indigenous cultures, coastal areas have great spiritual and cultural significance. For example, in Australia, Aboriginal and Torres Strait Islander people have important creation stories that link directly to coastal waters. Coastal waters have always been an important source of food for traditional owners. Traditional hunting in indigenous communities around the world is practised as part of the management of coastal environments.



3.1

Most of the world's fish are caught in coastal waters.

## Coral reefs

Coral reef systems, such as Australia's Great Barrier Reef, are among the most complex and diverse ecosystems in the world. These very important environments are found in the warm, shallow coastal waters of the tropics. They require very specific conditions to grow, and coastal areas where reefs exist require special management to ensure that they are not destroyed.

## Waves

Waves are one of the most important features of any coastal system. A wave is created when energy is transferred from the atmosphere to the surface of the water in the form of wind. This energy can be carried vast distances until it is released at the shoreline as the wave breaks. At this point, the energy is transferred to the land.

In the open ocean, waves move as swell, with the energy moving in an orbital motion. When in deep water, the waves do not change their shape. These types of waves are known as waves of oscillation. Once the waves enter the shallow waters of the **coastline**, they are transformed into waves of translation. This takes place because the waves begins to interact with the seabed, which gradually slows the base of the waves, but not the crest. Consequently, the waves increase in height until they break. Figure 3.2 illustrates this.

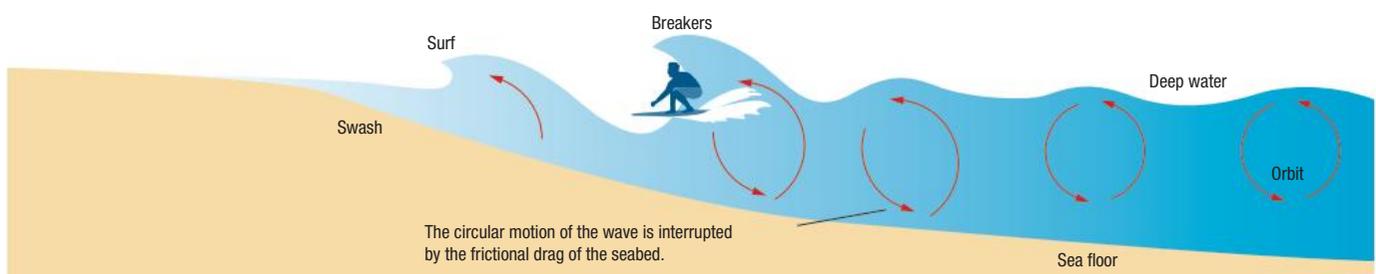
Waves demonstrate interactions between the spheres at the coast. The wind that provides the waves energy comes from the atmosphere. The energy is then transferred into the water of the hydrosphere. The wave then breaks because its orbital motion is interrupted by the sea floor, which is part of the lithosphere.

Waves may be constructive or destructive.

## Constructive waves

Constructive waves tend to be less powerful and are usually created by lighter winds. They bring sediment such as sand onto the beach and so gradually construct the beach and other coastal features.

3.2 How a wave breaks



## Destructive waves

Destructive waves are more powerful waves and are usually associated with large storm events. These waves strike the beach with so much power that they pull sand back with them as the swash retreats back into the sea. During very big storms it is possible for waves to take huge quantities of sand from beaches.

## SPOTLIGHT

### Beaches washed away

In June 2013, beaches along the coasts of southern Queensland and northern New South Wales were extensively eroded by huge waves, as shown in Figure 3.3. The waves were created by a weather pattern called an east coast low. This is a very unstable weather cell that creates strong winds, which cause the very destructive waves. In 2013, a series of these low-pressure systems over a number of weeks brought flooding rains and high winds.

An easy way to tell constructive and destructive waves apart is to look at the colour of the water as the wave breaks. With a constructive wave you will see the sediment caught up in the water as the wave breaks. Destructive waves on the other hand will look clear and glassy.

3.3 During the winter of 2013 powerful destructive waves eroded vast quantities of sand from beaches, including here at Surfers Paradise on Queensland's Gold Coast.



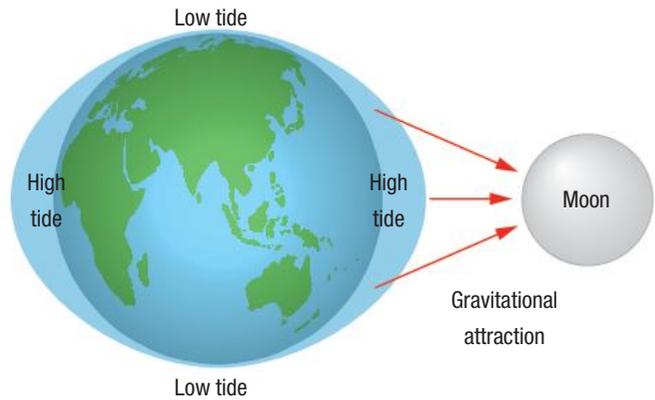
## Tides

Tides rise and fall twice a day, due to gravitational forces. The most significant of these is the gravitational pull created by the moon. The pull of the sun and the rotation of the earth itself also contribute to the tides.

Figure 3.4 shows that the moon pulls water to the side of the earth closest to it. This creates a bulge or high tide. A similar bulge is then created on the opposite side to compensate. Between the bulges, water is repelled to create a low tide. Every fourteen days the moon and sun are in alignment. This creates an extra-strong gravitational pull that results in a particularly high tide, known as a king tide.

When a king tide and a storm occur at the same time, the effects of the high tide and destructive waves often lead to a storm surge. Storm surges are caused by very low-pressure cells, such as tropical cyclones. These severe storms form over the ocean and the low pressure causes the air to rise, pulling the sea surface up with it. Storm surges can do tremendous damage.

3.4 The gravitational pull of the moon is the main cause of tides.



## Functions of coasts

Table 3.5 outlines the different functions of coastal environments.

3.5 Functions of coasts

Function	Coastal environments
Source function	<ul style="list-style-type: none"> <li>About 15 per cent of all protein consumed by humans is in the form of seafood. Most of this is taken from coastal waters, making this a crucial environment for feeding the world's growing human population.</li> <li>Coastal areas are crucial habitats for many animal species that rely on the coast for both food and shelter. For example, the iconic dugongs of Hervey Bay rely entirely on the coastal seagrass beds for their food.</li> </ul>
Sink function	<ul style="list-style-type: none"> <li>The value of coastal areas as important carbon sinks is becoming more recognised.</li> <li>Sometimes referred to as 'blue sinks', coastal ecosystems such as intertidal wetlands and seagrass beds are important in absorbing carbon dioxide, as well as adding vital oxygen to the water. Recent research has found that 'blue sinks' are far more effective at capturing and storing carbon dioxide from the environment than so-called green sinks, such as rainforests.</li> <li>Coastal environments have been used for centuries as places to 'dump' waste. In more recent times this has become more regulated, but most coastal communities still use coastal waters to disperse treated sewerage and other waste.</li> </ul>
Service function	<ul style="list-style-type: none"> <li>Coasts are important 'zones of transition' from the marine to the terrestrial (land)-based environment.</li> <li>One of the most important service functions of the coast is to act as a barrier to the sea. For example, dune systems absorb the energy of storm waves, reducing impacts such as potential flooding from storm surges.</li> <li>Coastal environments play a crucial role in the movement of sediment. Wave action not only erodes the coast, creating sediment, but it also moves it on and off the shoreline. Currents then move this sediment, often very long distances. These processes allow for the creation of new landforms elsewhere, for example barrier systems and sand islands.</li> <li>Coastal ecosystems, such as intertidal wetlands, mudflats and estuaries (coastal rivers), are very important breeding and nursery grounds for a vast number of marine species. Many species, such as prawns, that are very important to commercial fishing begin life in the coastal ecosystems.</li> </ul>
Spiritual function	<ul style="list-style-type: none"> <li>For many indigenous cultures, coastal environments have an important spiritual value.</li> <li>Aboriginal and Torres Strait Islander people, whose traditional lands include coastal areas, have strong links through their Dreaming stories to the coastal environment.</li> <li>For non-indigenous people, coasts have an important aesthetic and psychological value. Coastal-based tourism is worth billions of dollars annually, as people enjoy spending time in coastal settings.</li> </ul>

## SPOTLIGHT

### Superstorm Sandy

In October 2012, a powerful hurricane called Sandy developed in the Caribbean Sea. The storm caused considerable damage throughout the Caribbean, killing fifty-four people on the island nation of Haiti and leaving a trail of destruction across Jamaica and the Bahamas. The storm then headed northwards up the east coast of the United States of America.

On the evening of 29 October, the storm struck the coast near Atlantic City in New Jersey. A king tide had increased the high tide by a further 20 per cent, making the storm surge created by the hurricane even more intense. As the storm continued, sea water surged over the sea walls in Lower Manhattan in New York City. The water flowed into tunnels and even the city's famous subway was flooded. The strong winds caused a massive construction crane, seventy-four stories up on a skyscraper, to collapse, and a large tanker ran aground on Staten Island. Waves were measured at more than 10 metres in New York Harbour.

By the time the storm blew itself out, 149 people had been killed, more than 8.5 million people were left with no electricity, at least US\$20 billion in damage had been caused to private property and about US\$19 billion worth of damage had been caused to public infrastructure, including the subways, bridges and other important assets. Even the Statue of Liberty was badly damaged by huge waves and was not re-opened until July 2013, more than eight months after the storm.



3.6

The impact of Superstorm Sandy can be seen in these photos. The same location is shown before and after the storm.

## ACTIVITIES

### Knowledge and understanding

- 1 Explain why coasts are considered boundary environments.
- 2 Outline the four spheres of the biophysical environment.
- 3 Explain the importance of coastal areas as buffer zones.
- 4 Outline the role of coastal environments in the broader marine ecosystem.
- 5 Describe why coastal waters are more productive than the open ocean.
- 6 Outline the spiritual importance of coastal environments to traditional cultures.
- 7 Describe the process of wave formation.
- 8 What are waves of translation?
- 9 Compare destructive and constructive waves.
- 10 Define a tide.
- 11 Outline the factors that lead to a storm surge.

### Applying and analysing

- 12 Using a flow chart, describe the processes of a wave breaking onto the beach. In your flow chart show how the different spheres are involved.
- 13 Examine Figure 3.3. Describe the impact that the destructive waves have had on this part of the Queensland coast.
- 14 Read the Spotlight box 'Superstorm Sandy' then complete the following tasks.
  - a Outline the nature of the storm.
  - b Explain why Sandy was such a damaging storm.
  - c With the aid of Figure 3.6, describe the damage done by the storm.
- 15 Take on the role of an environmental leader. Prepare a letter to the Australian Government, encouraging them to place greater protections on an area of coast. In your letter, outline the importance of the coast.

3.1

# 3.2

## Causes of environmental change

About half the world's population live within 10 kilometres of the coast and fourteen of the fifteen largest cities on earth are located on the coast. This places considerable pressure on our coastlines.

### People's impact on coasts

As the human population along the coastline continues to grow, so do the environmental changes that humans cause. For centuries, humans have viewed the oceans as a **continuous resource**, a place that could be exploited and used without concern. This view has led to coastal areas being extensively developed and changed. They are often seen as convenient places to dispose of rubbish, sewage and other contaminants, leading to widespread pollution and environmental damage.

### Pollution

It is estimated that about 80 million tonnes of plastic are produced each year. Much of this plastic is disposed of, with a significant amount making its way into the world's oceans and coastal areas, as shown in Figure 3.7. Plastics have a long life span, taking about 500 years to fully decompose in the oceans. Their buoyancy means that plastic rubbish can travel vast distances.

Once in the oceans, plastics enter the food chain when marine animals mistakenly eat them. More than 200 species of animals, including whales, seals, crabs, sharks and dugongs, are known to be affected by plastics. A build-up of plastics releases toxins into the blood stream, organs and tissues of these animals. Many are also killed by being entangled in the rubbish.

### Ghost nets

About 640 000 tonnes of fishing equipment is lost at sea every year. Much of this is lost in coastal waters. Lost fishing nets, known as ghost nets, kill marine life long after they have been lost.

The coast of the Gulf of Carpentaria, in the far north of Australia, is one of the most isolated and least populated places on earth. Yet there is a major problem with ghost nets there, even though there is very little fishing in the area. The nets are believed to come from fishing grounds in Asia, washed into the Gulf of Carpentaria by ocean currents.

3.7

The Indian city of Mumbai has a population of more than 18 million. There is considerable pollution to the environment of the extensive coastal mangrove forests that grow around the city.



3.8 Ghost nets continue to kill marine life long after they have been lost.



Ghost Nets Australia is an environmental group established in 2004 by twenty-two Indigenous communities. Its task is to remove ghost nets from beaches in northern Australia. Since it started work, more than 7500 nets, each capable of killing thousands of marine animals, have been removed from beaches, as shown in Figure 3.8. Turtles are the most common species found in the nets. Turtles need to rise to the surface to breathe, but the nets trap them, causing them to drown. When Indigenous rangers and environmental volunteers remove the nets from the beaches they stop them from being washed back out to sea to start a cycle of death again, saving countless animals in the process.

### Development

Most of the world's human population lives on or near the coast and the demand for more and more development has seen coastal environments placed under great stress. Coastal landforms, such as intertidal wetlands and coastal dunes, are often destroyed to make way for canal housing estates, tourist facilities and other developments, as in Mandurah, shown in Figure 3.9.

3.9 Large-scale urban development has dramatically changed the coastal environment in Mandurah, south of Perth.



### Dubai's island building

Dubai is one of the seven emirates that make up the United Arab Emirates. It is a large city, and hugs the coastline of the Persian Gulf. Made wealthy from its rich oil reserves, Dubai has a reputation for huge construction projects. One of these projects was the construction of huge islands off the coastline for housing and resort developments, as shown in Figure 3.10. At present there are four main developments, three in the shape of enormous palm trees and the fourth in the shape of the world's landmasses.

The islands are made from sand dredged from the bottom of the Persian Gulf and then moulded using special sand-spraying ships. Research by environmental scientists has found that construction of the islands has had considerable environmental impact. During construction, the sand buried wildlife and increased **turbidity** (cloudiness of the water), which, in turn, reduced the amount of sunlight in the water, killing aquatic plants. Another major impact is the disruption that the new islands cause to the flow of currents in this part of the Persian Gulf. This also affects the movement of sand and other sediments.

### Destroying buffer zones

Coasts are home to very important infrastructure and commercial structures. Almost all the world's trade is done using ships, which require the construction of huge port facilities. These facilities are often built on reclaimed land, which is land that is created by filling in coastal areas, or by destroying important coastal environments, such as wetlands, mudflats and sand barriers.

Ships are also increasing in size and this has meant that deeper and wider harbours are needed. Dredging the sea floor is now very common in many large ports. This involves removing mud and other sediment from the sea floor, changing the environment dramatically.

3.10

Taken in 2009, this image from an orbiting spacecraft shows some of the artificial islands off the coast of Dubai. Since then, more islands have been added.



## SPOTLIGHT

### Community protests over Gladstone Harbour redevelopment

Gladstone is located about 550 kilometres north of Brisbane, close to the southern end of the Great Barrier Reef. With its large harbour, Gladstone is the perfect location for port facilities for the export of billions of tonnes of mined coal and gas to the west in central Queensland.

Gladstone Harbour has been dredged to make it deeper for the massive bulk carriers that will use the port. Many environmentalists are concerned that the dredging will

affect the environment of the harbour as well as that there will be a big increase in shipping through the Great Barrier Reef to access the port. This increased shipping could lead to devastating oil spills. Community groups such as Save the Reef have implemented a major campaign to highlight the risks. The emergence of such groups over the last few decades highlights the changing attitudes towards the coastal environment and the need to protect it.

**3.11** Greenpeace and other environmental groups have joined community groups to protect Queensland's coastal environment.



## ACTIVITIES

### Knowledge and understanding

- 1 Explain how past attitudes towards the coastal environment have led to its degradation.
- 2 Outline the problem of plastics in the world's coastal and marine environments.
- 3 Explain what a 'ghost net' is. Describe the environmental impacts of the nets.
- 4 Describe the construction methods used to create islands in Dubai and the impacts they have on the coastal environment.
- 5 Outline the concerns of environmentalists about the Gladstone Harbour development.

### Applying and analysing

- 6 Working in small groups, take the perspective of environmental leaders and research and prepare a presentation to be delivered to an upcoming United Nations conference on environmental pollution caused by plastics.

### Investigating

- 7 Study Figures 3.9 and 3.10. Using the aerial photograph as a source, brainstorm a list of the ways this type of development affects the coastal environment.
- 8 Visit the Ghost Nets Australia website and summarise the work being done by the organisation to reduce the hazards of ghost nets.

3.2

# 3.3

## Managing coastal environments

Serious environmental management is a relatively recent phenomenon. In the second half of the twentieth century it became clear that the environment was not an inexhaustible resource and the environmental movement began to become more significant.

### Coastal protection

Although much of the world's population lives near the coast there has been little attention paid to the protection of coastal environments. This lack of concern has seen coastal environments destroyed to make way for urban development, infrastructure such as ports, and unsustainable tourism.

Whenever humans want to live near the sea there will be a tension between the need to protect the coastal environment and the interests of humans. An increasing number of people see the value of the coastal environment and its need for protection and there are many community-based organisations actively engaged in the protection of the coastal environment. Over recent years, much tougher environmental restrictions have been placed on new coastal developments in many countries, including Australia. These restrictions are often the result of community pressure and protests.

Coastcare, which was formed in the 1990s, is one such organisation. Across Australia there are about 2000 separate Coastcare groups working to protect stretches of the Australian coastline. Coastcare groups are made up of individuals who volunteer some of their time to undertake environmental works. For example, Coastcare groups are often involved in coastal sand dune revegetation. This is a labour-intensive task. The free labour of volunteers enables local councils to undertake this important work, which might otherwise be too expensive for them to do.

### Strategies for managing the coast

Environmental management strategies can be divided into two types:

1 **protective:** used to protect coastal environments from damage in locations where human impact has been minimal, or where the environment has already been repaired

2 **restorative:** used to repair damage already done by human activities.

In order to be successful in the long term, restorative strategies need to be followed up by protective strategies.

### Protective strategies

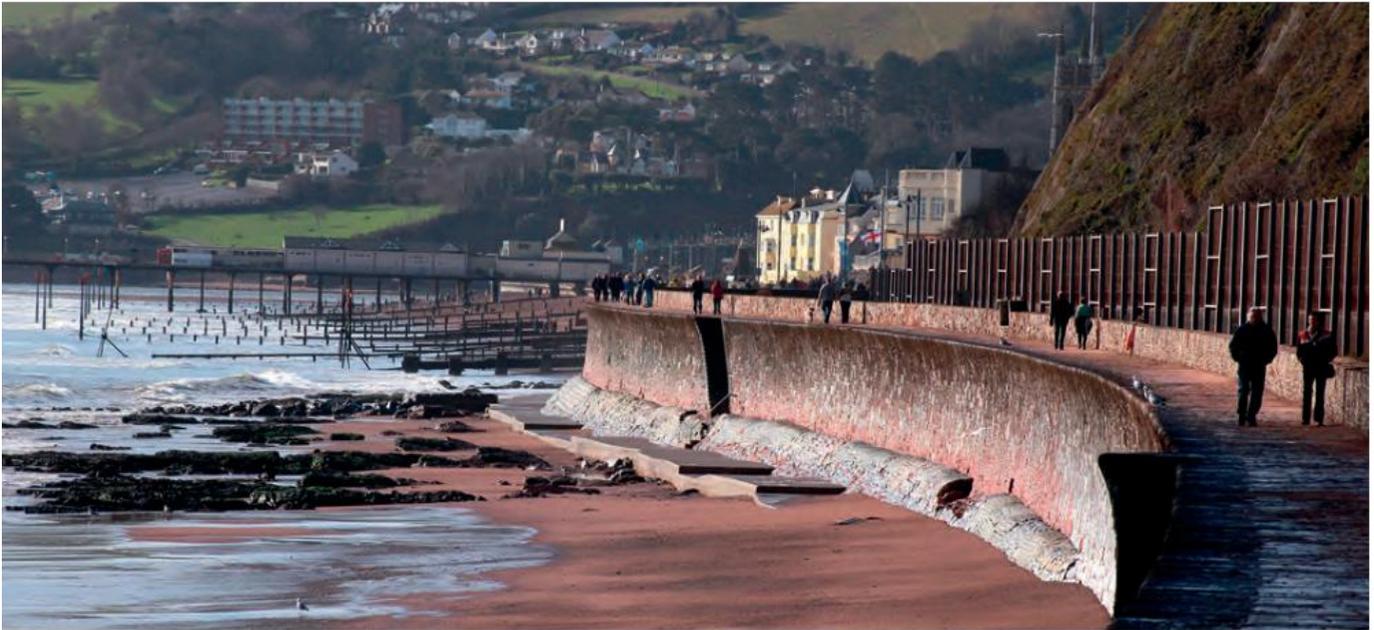
While a large proportion of the world's coastal environment has been altered by human activity, there remain large areas that are relatively intact. Protective strategies are crucial for ensuring that these areas remain safe from human impacts.

Restricting development along coastlines is one of the most effective strategies for protecting them. Determining the type of activities allowed in an area is known as **landuse zoning**. Through careful zoning, coastal environments can be protected from large-scale urban developments that can destroy the entire ecosystem.

Sometimes zoning can also be used to enable more appropriate developments. For example, zoning can be used to ensure that development does not take place on the most active parts of beaches, such as in the dunes. By keeping buildings away from this area there is less need to construct sea walls and other sea defences. In many coastal communities, there is pressure on local authorities to build environmentally damaging sea defences to protect homes and developments from erosion from the sea.

### Sea walls

Sea walls are commonly built along stretches of coastline where there is erosion that threatens property. They are usually built from concrete or large stones, to absorb the power of the waves. In nature, dune systems, which are large accumulations of sand, usually absorb the power of the waves. However, in many places the dunes have been flattened to make way for development, and the sea walls are needed.



When a wave smashes into a sand dune, much of the energy is able to pass out of the wave and into the sand. However, when a wave hits a sea wall, the energy is unable to pass through the solid surface, and is reflected back. This reflected energy is often powerful enough to erode sand from in front of the sea wall, a process known as scour. Scour in turn causes the beach in front of the wall to be eroded, as shown in Figure 3.12.

### Fencing

A simple but highly effective protective strategy is fencing. Dunes play a crucial role in the functioning of many coastal areas. Dunes are created by winds causing sand to pile up into huge mounds, over which vegetation eventually begins to grow. The vegetation is critical to stabilising dunes and preventing them from blowing away.

As people cross sand dunes to access beaches, they walk on the vegetation and gradually kill it. This is known as trampling. Trampling exposes the sand and the dune begins to be eroded by the wind. By installing fencing around the dunes and some educative signage, trampling can be substantially reduced.

Fencing works best when the pathways through the dunes, known as access ways, are provided (see Figure 3.13). For example, providing access ways linking car parks to popular beaches help to ensure that people stay off the dune vegetation. A board and chain walk—narrow strips of wood connected by a flexible chain—can be used to cover the sand and reduce erosion in the access way. Dune vegetation is very susceptible to fire, so installing bins at either end of the access ways helps to reduce the risk of fire from cigarettes and glass.

3.12

This sea wall at Teignmouth in the south of England has caused so much erosion that its foundations are now visible at the base of the wall.



3.13

Fencing dunes and funnelling people into access ways helps to reduce the impact of beach goers on the dunes.

### Restorative strategies

When the coastal environment has been degraded by human activity, restorative strategies are needed to repair the damage. These strategies are often time-consuming and can be expensive, but they can be highly effective at undoing the damage. Restorative strategies are effective only if the restored environment is then protected from any future harm.

One of the most widely used restorative strategies in coastal ecosystems is revegetation. Coastal sand dunes are an important part of many coastal environments, and vegetation is essential for their stabilisation. Replanting of dune systems is often undertaken by volunteers, such as Coastcare.



### Hard engineering

For centuries, humans have been trying to tame the coastal environment. By their nature, coasts are highly dynamic places, meaning that they are constantly changing. This does not suit human developments that require stability. To overcome the dynamism of the coast, humans have used complex engineering to try to control the power of the sea. This is often referred to as 'hard engineering'.

One of the best examples of **hard engineering** is the Italian city of Venice, which has literally been built out of the sea. Venice lies at the north-eastern end of the Adriatic Sea within a very large lagoon. The coastal environment once consisted of 118 small islands surrounded by marshes and shallow lagoon waters. From the thirteenth century onwards, the lagoon was slowly transformed by creating 160 canals between islands, criss-crossed by about 400 bridges. Wooden pilings were driven into the soft mud of the marshes and the city was built on top. Today, Venice is one of the most visited cities on earth. However, it requires constant maintenance and is slowly sinking into the mud.

3.14

Maeslant storm surge barrier

The people of the Netherlands have been using hard engineering to protect themselves from the sea for more than a thousand years. About 20 per cent of its landmass, on which about 20 per cent of its population live, is below sea level. As levels rise as a result of climate change, hard engineering projects in the Netherlands are becoming bigger, more complex and much more expensive. One of the most impressive is the huge Maeslant storm surge barrier, shown in Figure 3.14, which protects the huge port of Rotterdam from flooding. The barrier has two huge doors, each 240 metres long, that can be closed within 90 minutes to stop the sea from flooding into the Nieuwe Waterweg (New Waterway) Canal, which connects Rotterdam to the North Sea. During big storms, the gates close to protect the port and surrounding land.

## Soft engineering

**Soft engineering** is a very different technique for managing the coastal environment, and is becoming more popular. Instead of being used to change and control the coast, soft engineering is aimed at working with nature and changing how people interact with coasts. One example of soft engineering is the restoration of old dune systems so that the dunes can absorb the power of storm waves. This in turn means that expensive and damaging sea walls can be removed.

Soft engineering is usually cheaper in the long run because there is no ongoing maintenance. However, soft engineering projects are often undertaken at the expense of development projects. For example, land has to be put

aside for dune restoration instead of being developed and sometimes this can be seen as ‘wasting’ the resource. People with this view generally see the ecosystem in terms of its value for human use rather than its ecological value.

Figure 3.15 shows a soft engineering project off the coast of Louisiana. The US National Oceanic and Atmospheric Administration (NOAA), with other partners, has constructed earthen terraces and barrier islands to create wetlands, which will trap sediment and create new land over time. It has been estimated that Louisiana lost approximately 0.5 million hectares of land during the twentieth century and continues to lose 65 square kilometres of coastal wetlands every year.



3.15 NOAA restoration project, Louisiana. This photograph, taken three months after the hurricanes Katrina and Rita, shows new land being built between the terraces.

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the changing attitude towards coastal environments.
- 2 State the tension between the interests of humans and the protection of the coastal environment.
- 3 Describe the role of the community in protecting the coastal environment.
- 4 Explain the difference between protective and restorative strategies for environmental management.
- 5 Outline the concept of zoning and explain how it can be used to protect the coastal environment.
- 6 Describe the role of fencing dunes in protecting coasts.
- 7 Explain the value of access ways.
- 8 Outline the importance of replanting dunes as a restorative strategy.

- 9 Explain the difference between hard and soft engineering.
- 10 Outline the advantages of soft engineering over hard.

### Applying and analysing

- 11 Examine the information in the text on sea walls and complete the following activities.
  - a Explain why sea walls are built.
  - b Outline the environmental consequences of sea walls.
  - c Taking the perspective of an environmental manager for a local council on the coast, prepare a presentation to give to residents about why the council should look for alternatives to building a sea wall that residents want.



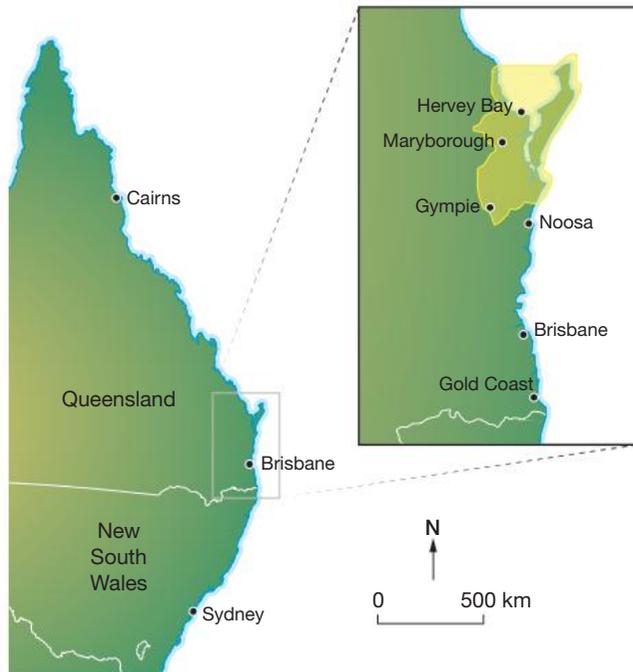
# 3.4

## Case study: The Great Sandy Region

The Great Sandy Region is one of Australia's most unique and valuable environments. It is also an area that is of important economic and social value to human communities. Thousands of people live within the region and many hundreds of thousands more visit the region every year as tourists. For this reason, careful management of the environment is essential.

### Location

The Great Sandy Region is located to the north of Queensland's Sunshine Coast, stretching northwards from Noosa to the Burnett River north of Bundaberg (see Figure 3.16).



3.16 Location of the Great Sandy Region

### Biodiversity of the Great Sandy Region

The Great Sandy Region is one of the most biologically diverse places in Australia. Its waters contain more fish species than the Great Barrier Reef and it provides a habitat for half of Australia's bird species. The sand there is the key geological feature of the region, which contains some of the most ancient sand dune systems found anywhere on earth. Fraser Island, shown in Figure 3.17, is the largest sand island in the world.

3.17 Fraser Island



The sand that makes up the landform features of the Great Sandy Region has been accumulating for millions of years. The vast sandstone mountain ranges of eastern Australia have been gradually worn down by running water and the sand swept out to sea by coastal river systems. Powerful currents, moving parallel to the shoreline, have carried the sand northwards in a process known as **longshore drift**. At Hervey Bay, at the top of the Great Sandy Region, rocky headlands have trapped the sediment in a basin.

Over thousands of years, sea levels have risen and fallen. At times of low sea level, the sand has been exposed, enabling the wind to shape the sand into the huge sand dunes that are found throughout the region today.

### Human impacts

In the decade 2001–11, the population of the Fraser Coast Regional Council—the Local Government Area or LGA, which is located over much of the Great Sandy Region, grew 31 per cent, adding more than 23 000 permanent residents to the area. Much of this growth took place in Hervey Bay, where the population increased by 43 per cent.



3.18 Mangrove forest in the Great Sandy Region

Three major rivers flow into Hervey Bay—the Mary, Burnett and Burrum. The Paradise Dam on the Burnett River was opened in 2005 and there have been plans to build a new dam on the Mary River at Traveston Crossing.

As the region's population grows, the amount of water used by humans increases. The amount of fresh water being taken out of these important river systems is beginning to change the chemical make-up of the waters of the Great Sandy Region. During dry years, the flow of water down the rivers and into Hervey Bay declines considerably. Marine scientists have found evidence of hyper-salinity in parts of Hervey Bay. Many marine species within the Great Sandy Region are very sensitive to changes to salinity. Mangrove forests (see Figure 3.18), found throughout the region, are also very sensitive to increases in salinity. These forests are critical to the health of the whole ecosystem of the Great Sandy Region, as many of the marine species breed and hatch their young in mangrove forests.

## Tourism

Each year, close to 750 000 people, including 120 000 international tourists, visit the Fraser Coast region. Fraser Island and Hervey Bay (see Figure 3.19) are the most popular destinations. About 3 million people holiday on the Sunshine Coast, which is located on the southernmost part of the Great Sandy Region.

The tourism industry is vital for the economies of the towns in the region. Significant parts of the coast have been extensively developed to provide resorts and hotels. This has resulted in land clearing and the loss of important habitats, including mangrove forests. The development of a large marina and hotel complex on the shore of Hervey Bay opposite Fraser Island has altered the structure of the coastline. Tourism developments affect water quality because of increased urban run-off, sewage, rubbish and other pollutants.

3.19 Large-scale tourist developments have taken place in Hervey Bay.



## SPOTLIGHT

### Managing Fraser Island's dingo population

One of the most iconic species of Fraser Island is the dingo. The dingo is the apex species on the island, meaning that it is at the top of the food chain and it helps to keep the island ecosystem in balance. As the number of people visiting the island has grown, the number of interactions between dingoes and people has also grown. In some cases, this has resulted in death and injury to people. In 2011, a 3-year-old girl was mauled by dingoes.

After each attack on a person, there have been calls to reduce the number of dingoes by culling them. After the 2011 attack, rangers shot and killed the two dingoes thought to be responsible. Part of the problem is that some campers and visitors have been feeding the dingoes and they are beginning to lose their fear of humans.

A dingo management plan was released in July 2013 by the Queensland Government. The plan aims to reduce the risk of dingo attack by reducing human interactions with the dingoes. This is to be achieved by:

- temporarily closing camping grounds where the behaviour of dingoes has been modified due to human interactions
- tagging more of the animals to track their movements
- installing more signage and improving public education programs about the dingoes and the importance of not feeding them.



3.20 The management of Fraser Island's dingo population is challenging.

### False water rat

The false water rat, or water mouse as it is commonly known, lives in the intertidal zone along the eastern coast of Queensland. This tiny creature, shown in Figure 3.21, weighs less than 70 grams. It lives in the mangrove forests and salt marshes that fringe the coast. It is currently listed as vulnerable and suffers from unsustainable human activities. Feral pigs and red foxes, which are introduced species, hunt the water rat.

### Fens

Fens are saturated environments in which ridges of peat, which is undecomposed vegetation, lie between pools of water, creating a patterned formation (see Figure 3.22). They are common in wet and cold environments. The fens of Fraser Island, which began to form about 6000 years ago, are the only fens found in subtropical areas. The soils within fens are devoid of oxygen, which is why vegetation does not decompose.

The fens on Fraser Island are important to the island's overall environment because they are one of the few areas on the island that is open; the rest is covered by thick rainforest. The fens are an important habitat for several species of birds, such as the threatened ground parrot; mammals, such as the false water rat; and amphibians, including several species of endangered frog.



3.21 False water rat



3.22 The unique patterned fens environment of Fraser Island

## Managing threatened ecosystems

The Great Sandy Region contains a wide variety of ecosystems. Each of these requires specific management strategies.

### National Park

The Great Sandy Region National Park was established in 1971. Covering a total area of almost 75 000 hectares, the park covers a large part of the Great Sandy Region. In 1992, Fraser Island, which is within the Great Sandy Region National Park, was also made a UNESCO World Heritage site. This inclusion was made in recognition of the island's unique natural features, including complex dune systems, dune lakes and rainforests. The inclusion of Fraser Island on the World Heritage list means that there is an extra level of protection of this important environment.

### Ramsar Convention

The Ramsar Convention is an important international law that helps to protect habitats used by migratory birds. As several species of migratory birds, some of which fly from as far away as China and Siberia, spend time in the fens, they are considered to be an important site for global bird migration.

Another important ecosystem in the Great Sandy Region that is part of the Ramsar site is the region's intertidal wetlands. This unique ecosystem includes extensive mangrove forests, which line much of the region's coastline and estuaries. Salt water moves up the tidal rivers at high tide and fresh water flows down from inland at low tide. In total, the Ramsar site covers more than 93 000 hectares, including open water, channels and creeks.

## Impacts and strategies

The main environmental impacts that require management within the wetlands are:

- feral introduced animals, including pigs, which dig up the ground; foxes, which prey on wading birds and water rats
- weeds, which take over the native vegetation—very often these weeds come from domestic sources; for example, people living in urban areas close to the wetlands have garden plants, including grass, such as kikuyu, which then invade the wetlands
- human interactions, especially the swash from boats, which cause erosion; off-road vehicles, which cause damage; overfishing; and abandoned fishing equipment such as lines and nets, which entangle turtles and birds
- pollution, including rubbish and water pollution from stormwater drains, which eventually release water and the pollution into the wetlands.

Strategies to manage these impacts include the following.

- Feral animals are tracked, in order to collect data about them. Traps and culling are used to reduce their numbers.
- Weeds are carefully monitored in order to contain weed outbreaks before they can get out of control.
- Human interactions are managed through education of visitors about their impacts. Signage throughout the region helps to remind people to act responsibly, for example signs at popular fishing spots about not leaving equipment. Controls are also important, for example speed zones for boats to minimise swash from motors, and restrictions on 4WD access to confine vehicles to areas where their impacts are reduced. These controls are reinforced by education programs as well as rangers.
- The flow of rubbish into the waters of the region is reduced by simple strategies such as installing bins at popular tourist spots and using rubbish traps across stormwater pipes.

As the area is so popular with visitors, careful management of visitor numbers is crucial to protecting the region.

## Introduced species

### Bitou

Bitou, shown in Figure 3.23, is a highly aggressive weed that grows rapidly across sand dunes, eliminating native flora. It produces huge quantities of seed, giving it advantages over other species. The bush is native to South Africa and was introduced to Australia to help stabilise dunes after sand mining.

Bitou is a major problem in New South Wales, where it is present in 60 per cent of dune systems and 80 per cent of headlands. Within the Great Sandy Region, including Fraser Island, it is a small but growing problem. Without careful management, the species could easily get out of control. Monitoring across the region is important to keep track of outbreaks of the weed. Hand pulling—literally pulling out the plants by hand—is very effective but quite expensive, as it uses so much labour. Coastcare volunteers do much of this work across the region.



3.23 Bitou bush

### Gambusia

Gambusia, shown in Figure 3.24, is a small fish introduced from California to help control mosquitoes. Gambusia competes with native species and since its introduction it has had a huge impact on native species numbers. Dealing with the gambusia is proving challenging but the use of biological controls has had some success in other parts of Australia.



3.24 The tiny introduced gambusia, sometimes called the mosquito fish, has devastated native small fish populations.

## SPOTLIGHT

### Fire management

Managing for fire is also an important strategy for protecting the Great Sandy Region's ecosystems. Some of the region's environments are very vulnerable to fire, for example the patterned fens and dune systems of Fraser Island. The peat ridges of the fens are composed of undecomposed vegetation, which is very flammable—so flammable that in many parts of the world it is used as the main fuel source. In the dune system, vegetation is critical for holding the dune together. Without vegetation cover, the exposed sand is easily eroded by wind. Therefore fires in the dunes can have a devastating impact on the whole ecosystem.

The main source of fire in both the dunes and the fens is human activity. For example, campfires lit in the dunes can easily get out of control and burn the woody plants that make up the dune vegetation. Discarded rubbish, especially glass and cigarettes, can be a source of ignition. Throughout the region, signage alerts visitors to the risk of fire. Rubbish bins have been installed and camping is confined to designated areas where the fires can be built in pre-dug pits to minimise risk. Rangers patrol regularly to enforce these rules.



3.25 Signs such as this are used across Fraser Island to help manage the risk of fire.

## ACTIVITIES

### Knowledge and understanding

- 1 Describe the location of the Great Sandy Region.
- 2 Describe the processes that have led to the creation of the Great Sandy Region.
- 3 Explain how vast dune systems such as those on Fraser Island have been formed.
- 4 Outline the population growth in the Great Sandy Region.
- 5 Describe the impact of tourism on the environment of the region.
- 6 Describe the environment of the patterned fens.
- 7 Why are the patterned fens such an important habitat on Fraser Island?
- 8 Explain the purpose of the Ramsar Convention.

### Applying and analysing

- 9 Copy and complete the following table to summarise the environmental issues facing the Great Sandy Region and the environmental management strategies used to deal with them.

Environment issue	Management strategy

- 10 Examine Figure 3.19. Describe the impacts on the environment that are evident from this development.
- 11 In a small group, design a poster or a digital presentation for visitors to Fraser Island about management of dingoes. You may wish to visit the Fraser Island National Park website.
- 12 As a class, discuss the dangers of fire to the environments of the Great Sandy Region. Brainstorm strategies for managing this risk and record your ideas in a mind map.

### Investigating

- 13 Write a short report explaining the consequences of dam building along the rivers that feed fresh water into the Great Sandy Region.
- 14 Prepare an extended response on the following topic: 'The wetlands of the Great Sandy Region are an important ecosystem that needs careful management.'

# 3.5

## Case study: Bay of Fundy, Canada

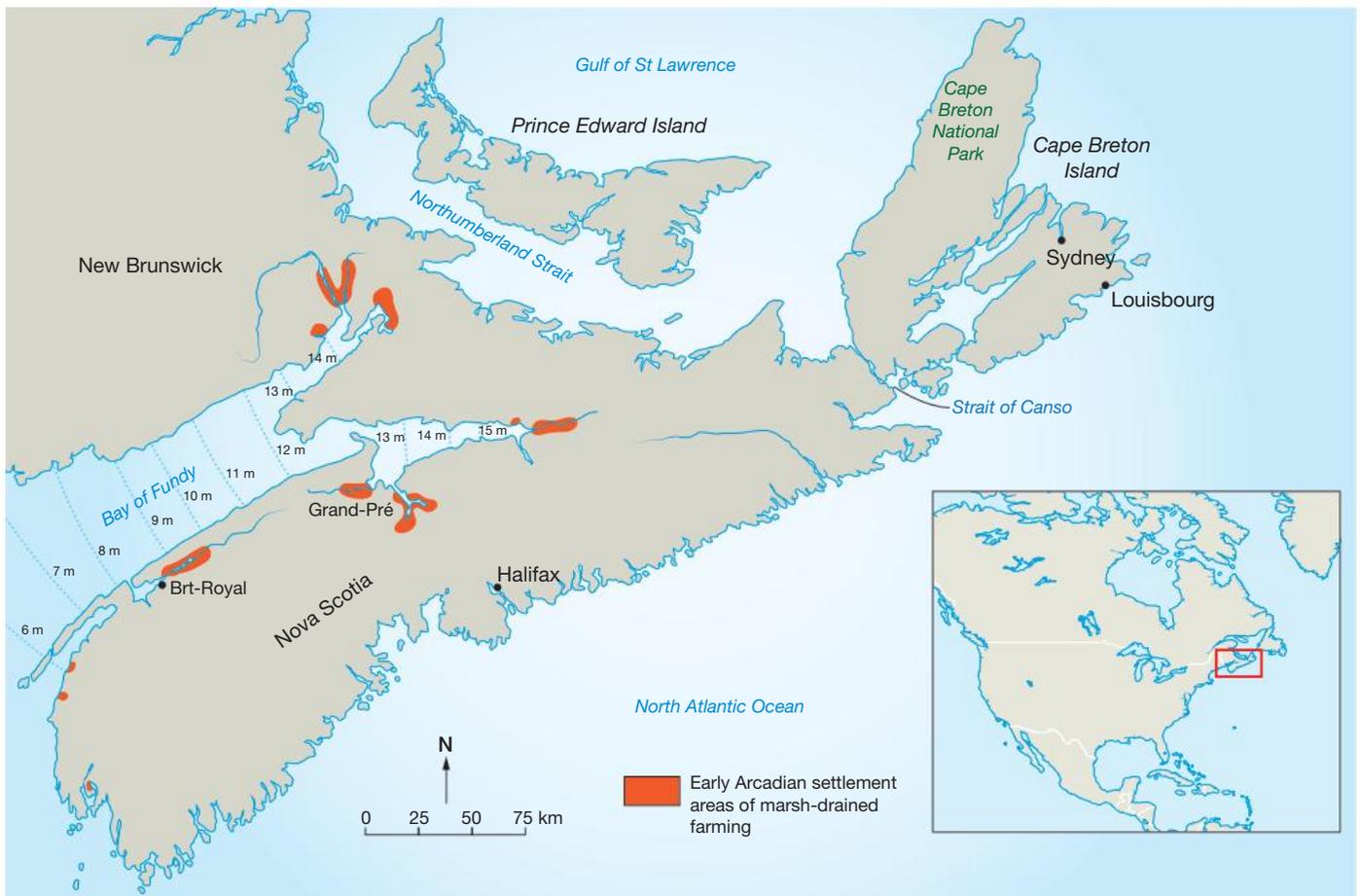
Like ecosystems around the world, the Bay of Fundy faces many challenges. Commercial activity associated with tourism has expanded substantially, as has the tidal power industry. Both need monitoring and management. In addition, the traditional industries of fishing and agriculture place stress on the environment and there are concerns over the impact of climate change.

### Location

The Bay of Fundy is a large bay off the Atlantic Ocean on Canada's east coast. The bay covers a total area of more than 9000 square kilometres, stretches more than 150 kilometres and at its entrance is 52 kilometres wide. It is renowned for its enormous tidal range, which is the difference in height between low and high tides. Every 12 hours and 25 minutes the tide rises as high as 21 metres (16 metres is the norm across the whole bay), the highest tide in the world (see Figure 3.26).

The huge tides of the Bay of Fundy, shown in Figure 3.27, are the result of the unique shape of the bay. High cliffs surround it, reaching upwards of 60 metres in some parts. The shape of these cliffs creates narrow inlets within the bay, which act as funnels for the incoming and outgoing tides. When the tides enter the bay at its mouth they are normal, but as they push up the ever-narrowing bay they are 'squeezed' by the surrounding cliffs and the increasingly shallow base, causing the water to rise. The outgoing low tide collides with the incoming high tide, causing a wave of water to be pushed into the bay, a process called **resonance**.

3.26 Location of the Bay of Fundy





3.27 The Hopewell Rocks in the Bay of Fundy at high and low tides

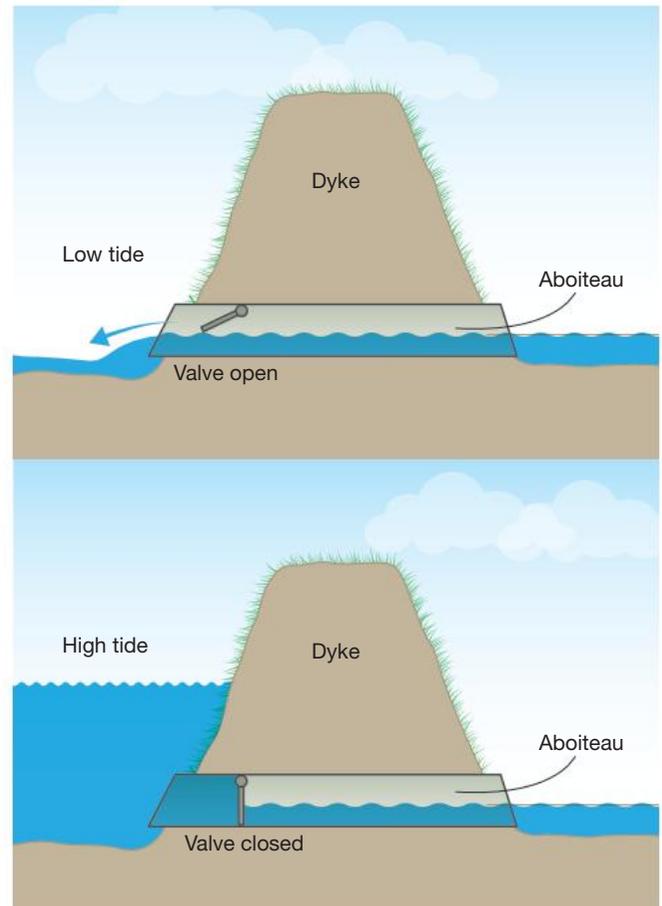
## Human impacts

### Draining the marshes

The salt marshes lining Nova Scotia's Bay of Fundy have been drained for agriculture since the early 1600s. The Arcadian people—French settlers who first claimed Nova Scotia as their home—employed their dyke-building skills to drain salt marshes, reclaiming thousands of hectares of productive farmland.

The Arcadians built the dykes along the outer marsh areas. Their construction required an enormous amount of work due to the great tidal range experienced in the bay. Sometimes these structures were constructed by driving five or six rows of logs into the ground, laying other logs, one on top of the other, between these rows, filling all the spaces between the logs with well-packed clay and then covering everything over with sods cut from the marsh itself. Sometimes dykes were built by simply laying marsh sods over mounds of earth.

The Arcadians also devised a system of drainage ditches with an ingenious one-way water gate called an aboiteau. The aboiteau (see Figure 3.28) was a hinged valve in the dyke that allowed fresh water to run off the marshes at low tide but prevented salt water from flowing onto the farmland as the tide rose. After letting rain (and snow) wash away the salt from the marshes over a period of 2–4 years, the Arcadians were left with fertile soil that yielded abundant crops.



3.28 The ingenious one-way water gate, called an aboiteau, used to drain Nova Scotia's marshlands

Building and maintaining the complex system of dykes and valves demanded required a high level of cooperation. Everyone had to be vigilant and ready at all times to repair breaches that could be caused by storm waves or simply by soil erosion.

## Impacts of tourism

As far back as the nineteenth century the Bay of Fundy was a popular tourist destination. With the growth in **ecotourism** and nature-based tourism in the last 20 years tourism in the region has boomed, and now more than 1.2 million people visit the region annually.

Tourism needs to be well managed to bring substantial economic benefits to the local community without causing significant harm to the environment. Tourism has a number of impacts on the bay's environment.

- Many migratory bird species stop in the Bay of Fundy on their annual migrations. Sand pipers feeding on the exposed mudflats at low tide are disturbed by large numbers of tourists and the time they have to feed is reduced.
- There are more than twenty whale-watching businesses in the bay, and careful management is needed to ensure that the whales are not stressed by too much human interaction.
- About 200 000 people now visit the Bay of Fundy on cruise ships. The ships coming into the bay are getting larger and there are concerns that the wake of the large ships will increase erosion of both the bay floor and the surrounding cliffs.

## Tidal power

The huge tides in the Bay of Fundy make it an ideal location for the development of a tidal power industry, but there some serious environment concerns about tidal power. The large turbines (see Figure 3.29) and associated equipment can alter the flow of currents and sediments in the bay. The blades of the turbines can hit animals and the noise they create interferes with animal movements in the bay. One of the least understood but most significant concerns relates to the electromagnetic fields created by the turbines. Many species, such as rays, sharks and many shorebirds, use the earth's natural electromagnetic fields to navigate. The huge turbines create their own fields and this can confuse the species and lead to navigational errors as well as cause distress.

## Climate change

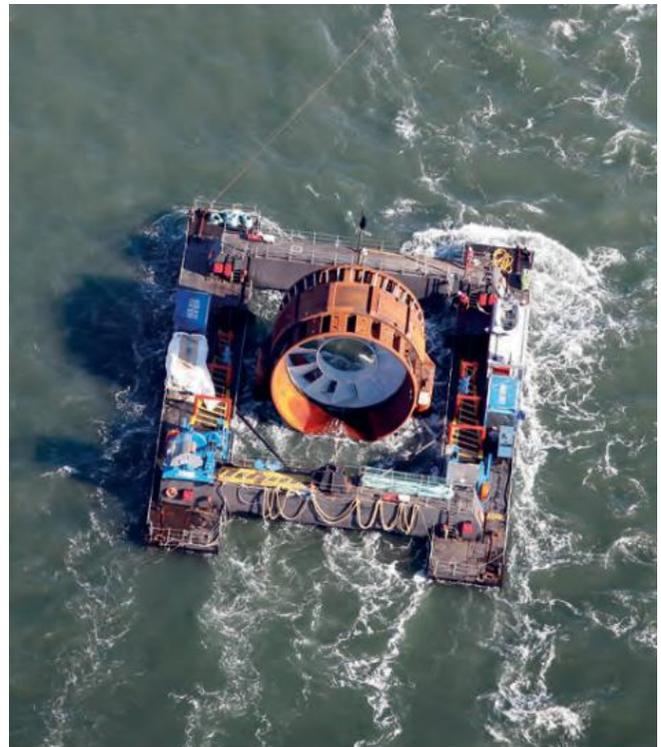
The high tidal range in the Bay of Fundy means that the area is subject to very high levels of erosion. Studies conducted by scientists working for the State of Nova Scotia have found that tides may rise by as much as 10 per cent in the Bay of Fundy as a result of climate change. Of particular concern is the impact of this on salt marshes (see Figure 3.30) and mudflats.

The flora and fauna located in the mudflats and salt marshes have adapted to the inundation from the incoming tides twice a day. As sea levels rise, less and less of the salt marshes and mudflats are exposed at low tide, destroying the ecosystem that the plants, animals and microorganisms have adapted to. Climate change will also cause an increase in storm activity, which will lead to more erosion.

Local authorities are planning to put in place management strategies for reducing the impact of climate change on the delicate ecosystem of the Bay of Fundy. One of the most important strategies is to closely monitor the effects of rising sea levels on the shoreline environment. This includes gathering data on wave energy and its impacts on erosion, and undertaking detailed studies of threatened species. With a bank of data, better management strategies can then be devised to help protect the bay from climate change.

Some of the strategies being planned for the bay include:

- construction of sea walls and other sea defences
- soft engineering
- revegetating salt marshes further inland
- beach nourishment, which involves dumping additional sand onto beaches after erosion by storms and high tides
- construction of vegetation strips using plants such as seagrasses to reduce the speed of waves as they approach the shoreline.



3.29

Part of a huge wave energy turbine being transported to a site in the Bay of Fundy



**3.30** Salt marshes, like these at Fox River, in the Bay of Fundy, are at risk from climate change.

### Introduced species

Foreign species are most commonly introduced into the bay by ships. As ships move around the world, species attach themselves to the hull and ‘hitch’ a ride to new areas. Ballast water can also contain unwanted species. Ships take on ballast to weigh them down when they have light loads and release the water once they take on heavier loads. When pumping in the ballast, foreign species can be taken on board and then discharged elsewhere.

### Common periwinkle

The common periwinkle is believed to have been introduced into the bay in the early 1800s, possibly intentionally to provide a source of food. This snail-like mollusc lives in large numbers on the rocks and mudflats of the intertidal zone. The periwinkle’s success has come at the expense of native molluscs, several of which have disappeared from the bay.

### European green crab

The European green crab competes with native oysters, molluscs, crabs, scallops and a range of other species in the bay. It has a wide diet and its numbers have increased significantly.

### Aquatic plants

Codium, shown in Figure 3.31, is not yet well established in the Bay of Fundy but scientists are very concerned about it. Sometimes called green sea fingers, it grows very densely and chokes out native species. It also reduces sunlight penetration, so that the sea floor often becomes barren. This disrupts the food chain, affecting many species.



**3.31** Codium is an introduced seaweed that has the potential to cause great damage in the Bay of Fundy.



**3.32** The dyke lands are an important part of the Bay of Fundy. Restoration work is beginning to return parts of them to their natural state.

## Local and international protection

The importance of the Bay of Fundy is recognised at a global level through the Ramsar Convention. Four specific areas within the bay are protected under the Ramsar Convention, which requires the Canadian Government to ensure their protection and management. There are also many other areas of the Bay of Fundy that are protected by federal, state and local governments. These include large areas such as national parks through to small conservation areas that are managed by local authorities.

## Managing introduced species

Management of introduced species is complex, but the most effective strategy is to intercept them before they arrive. Strict regulation of commercial shipping is important for the Bay of Fundy; for example, the hulls of ships must be painted with anti-fouling paint. This special paint is applied to the bottom of a ship to stop molluscs and aquatic plants from attaching themselves. Without anti-fouling paint, species can 'catch a free ride' on the hulls of ships and travel into new waters, where they compete with local species.

Controls over the discharge of ballast water have also been introduced. Ballast water is used by ships to weigh them down when they have little cargo on board. The water is

taken in by the ship at one port and then discharged as it takes on cargo at a different port. As the ship takes in the water, small aquatic animals and plants can also be sucked into the ballast tanks and these can then be released when the ballast is discharged elsewhere. Ships entering the Bay of Fundy must now discharge their ballast well out to sea, and nets must be installed over ballast intakes.

## Restoration management strategies

The environmental importance of the marshes is now recognised, and a number of projects to restore this environment are now underway. In the Upper Bay of Fundy, a number of dykes have been removed, along with some dams that blocked waterways. As a result of these actions, fresh water is beginning to move back across the low-lying areas and the tidal flow is being restored.

Studies have shown that salt marshes and other wetlands can quite quickly reinhabit the restored areas. At a 13-hectare test site on St Croix River, when a dyke was removed, former farmland began to return to a wetland habitat within a year. Plants began colonising the area once the tidal flows returned and soon after, birds and other species began to return.

## Managing aquaculture

There is a growing aquaculture industry in the Bay of Fundy. Most of the farms produce salmon in large cages in parts of the bay. One of the consequences of the salmon farming is that large amounts of nitrogen and phosphorus

are produced by uneaten fish food and the digestive systems of the fish. These chemicals can interrupt the normal food chain and cause the growth of algae, which can produce an imbalance in the environment. Scientists from the University of New Brunswick and elsewhere have been working on solutions for reducing the environmental impacts of aquaculture on the bay.



**3.33** Aquaculture in the Bay of Fundy requires careful management.

One strategy is to use the by-products of the fish and the uneaten food as a source of food for other commercial species. For example, kelp and mussels are grown on ropes around the cages. They use the nutrients added by the fish farms to grow, using it before it enters the broader environment. Ultimately, it is expected that the kelp and mussels can then be harvested and sold for food and other commercial purposes.

## SPOTLIGHT

### Learning from the First Nations

Canada has a significant indigenous population. In the north are the traditional lands of the Inuit people. In the rest of Canada, the indigenous people are known as the First Nations. In the Bay of Fundy region, the Mi'kmaq people are the traditional owners. They have a strong cultural and religious connection to the land and waters of the region, and have developed an intimate knowledge of the environment over the centuries.

The knowledge of the Mi'kmaq people is now being recognised and utilised to assist in the management of the Bay of Fundy. Before major projects take place in the region, the Mi'kmaq people are consulted and a special study known as a Mi'kmaq Ecological Study (MEKS) is undertaken. These special studies incorporate the unique knowledge and perspective of the indigenous traditional owners into broader environmental assessments.

## ACTIVITIES

### Knowledge and understanding

- 1 Explain the reason for the massive tides in the Bay of Fundy.
- 2 Describe the impact of tourism on Sand pipers.
- 3 Describe the impact of climate change on the Bay of Fundy.
- 4 Outline the strategies being developed to manage climate change in the Bay of Fundy.
- 5 Describe the role of shipping in introducing foreign species into the Bay of Fundy.
- 6 Explain the impact of codium on the environment of the Bay of Fundy.
- 7 Explain how the peoples of the First Nations of the Bay of Fundy are helping to manage its environment.
- 8 Outline the impacts of aquaculture and the strategies used for managing these impacts.

### Applying and analysing

- 9 Take on the role of environmental scientist for the state of Nova Scotia. You have been appointed to conduct community briefings on the impacts of climate change and how communities can better

manage these impacts. Using the information in the text and research from the internet, prepare a digital presentation and present it to the class.

- 10 In a small group, design an educational campaign about the risk of codium to the Bay of Fundy. Your campaign should be targeted at local people and outline the problem as well as how locals can help deal with the threat. You may wish to design a digital campaign, posters or radio or television advertisements.
- 11 Prepare a short report on how the dyke lands of the Bay of Fundy are being rehabilitated.
- 12 As a class, discuss whether the benefits of tidal power outweigh the impact on the environment. Justify your response.

### Investigating

- 13 Using the internet, conduct research into tourism in the Bay of Fundy. Make a list of the type of activities that can be done in the bay. Share your list with a partner and together brainstorm the potential impacts of the activities on the environment. Record this in a mind map or list.

# 3.6

## Geoskills: Nambucca Heads topographic map

Nambucca Heads is located on the mid-north coast of New South Wales. The local Aboriginal people at Nambucca Heads are the Gumbaynggirr people. It is a popular place for recreation and is also used for commercial purposes by small fishing enterprises and oyster farmers.



3.34 Nambucca Heads estuary

### Nambucca Heads estuary

The Nambucca Heads estuary extends up the Nambucca River to the town of Bowraville. The total area covers 7.74 square kilometres and drains a catchment of 1460 square kilometres. The major tributaries flowing into the Nambucca River are Taylors Creek, Newee Creek, Watt Creek, Taylors Arm, Swampy Creek and Warrell Creek.

Since European settlement there have been changes to the estuary. **Riparian** vegetation has been removed, and sand and gravel have been extracted. As a result, severe river bank erosion has occurred, large areas of flood plain have eroded into the river, and the waterway has become degraded. However, there are still areas of diverse riparian vegetation that need to be protected. Future threats to the estuary are coming from increased urbanisation of the region and the increased levels of nutrients, sediments and toxins.

## ACTIVITIES

### Knowledge and understanding

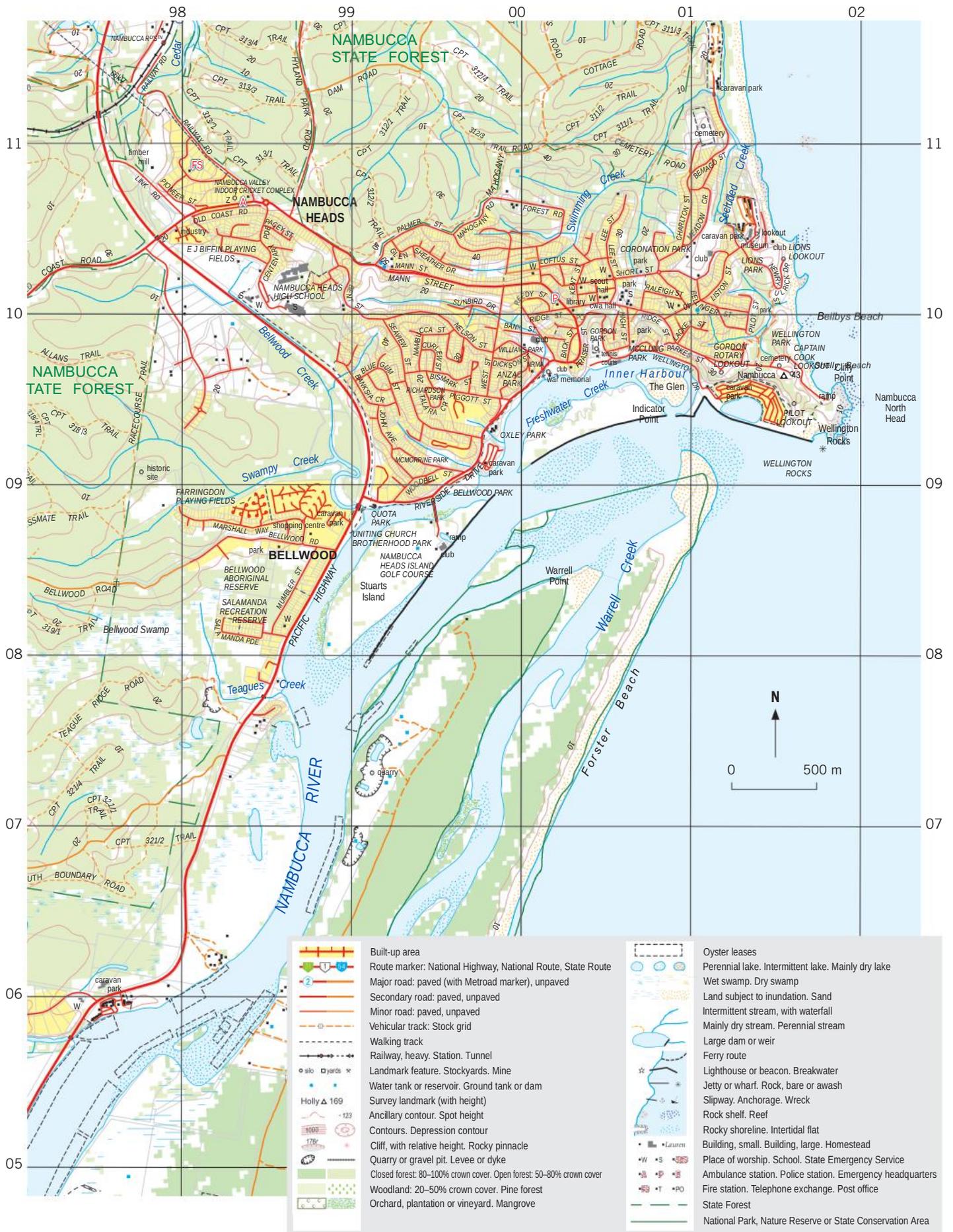
- 1 State the scale of the Nambucca topographic map extract.
- 2 State the contour interval of the Nambucca topographic map extract.
- 3 Identify the features of the biophysical environment at:
  - a GR 019093
  - b GR 008096
  - c GR 981076
  - d GR 017096
- 4 Identify the features of the managed or constructed environment at:
  - a GR 986077
  - b GR 995086
  - c GR 987102
  - d GR 013096
- 5 State the direction of the lookout (AR 0109) from Belwood (AR 9808).
- 6 State the general direction in which Bellwood Creek flows in AR 9809.

- 7 State the bearing of the lookout (AR 0109) from the bridge in AR 9807.
- 8 State the length of the upstream breakwater.
- 9 State the density of buildings in AR 9807.
- 10 State the vegetation type found in AR 9909.
- 11 State the elevation of the lookout in AR 0109.

### Applying and analysing

- 12 Describe the nature of the riverine environment on the Nambucca topographic map extract.
- 13 Describe the nature of the coastal landscape to the north and south of the Nambucca River entrance. Identify the dominant coastal processes responsible for the formation of the landform features.
- 14 Identify the main economic activity in the Nambucca River.
- 15 Outline the ways in which people have modified the biophysical environment in the area covered by the Nambucca topographic map extract.

3.5



CHAPTER

# 4

# MARINE ENVIRONMENTS



**M**arine environments cover a vast area of the earth's surface and extend from the shallows surrounding the continental landmasses to the depths of the ocean—the deepest point of which is just over 10.9 kilometres below the surface of the western Pacific in the Marianas Trench.

The diverse ecosystems that make up the marine environment are facing unprecedented pressure from an increasing number of potentially competing uses. These include oil and gas extraction, fisheries, aquaculture, shipping, port expansion, coastal development, waste disposal, recreation, tourism and conservation. Extensive science-based knowledge of our marine environments is critical if we are to protect these critically important ecosystems.

In this chapter, we focus on environmental change and management, using marine environments as an example. Of particular interest are the causes and consequences of the changes taking place and an evaluation of the strategies used to manage these changes.

## KEY IDEAS

- To understand the principal causes of environmental change in marine environments
- To examine the effects of the environmental changes taking place in marine environments
- To investigate the environmental management strategies being used in marine environments and to determine their effectiveness

## GLOSSARY

acidification	an increase in the acidity of ocean water as a result of the uptake of carbon dioxide from the atmosphere. An estimated 30–40 per cent of carbon dioxide released by humans into the atmosphere dissolves into oceans, rivers and lakes
atmosphere	the blanket of air surrounding earth
by-catch	fish caught unintentionally while catching targeted fish species
carbon cycle	a series of naturally occurring processes in which carbon is exchanged between organisms and the environment
heat budget	the balance between the incoming and outgoing heat
hypoxic water	a water body in which oxygen levels are extremely low
marine debris	human-created waste that has deliberately or accidentally been released in a lake, sea, ocean or waterway
thermal expansion	the tendency of water (and other matter) to change in volume in response to a change in temperature

4.0 Small fish called sweepers swim around soft coral in the Red Sea, Egypt.

# 4.1

## The marine environment

Earth is often referred to as the 'blue planet'. More than 70 per cent of the earth's surface is covered by oceans, and they account for 96.5 per cent of all the water found on the planet. The marine ecosystem is, therefore, the largest of all the environments, but it is also one of the least explored and known.



### Salt water

Salt water is the defining feature of all marine environments. It is composed of about 96.5 per cent liquid water, in which chloride and sodium are dissolved. The salt in sea water arrives in the sea via rivers that carry huge quantities of dissolved chemicals because of the weathering of rocks inland. Chemical reactions cause salt that has been held in a solid state in rocks on land to become dissolved and then transported by rivers to the sea, where it remains dissolved in the water and mud of the oceans.

Chemical analysis shows that the salinity of the world's oceans has been fairly constant for the last 1.5 billion years. This indicates that equal amounts of salt are removed from and deposited in the oceans.

A considerable amount of salt is lost due to evaporation. The wind also blows a large amount of salt onshore each year. Some salt is also lost as it reacts with hot basalt lava spewed onto the ocean floor by underwater volcanoes.

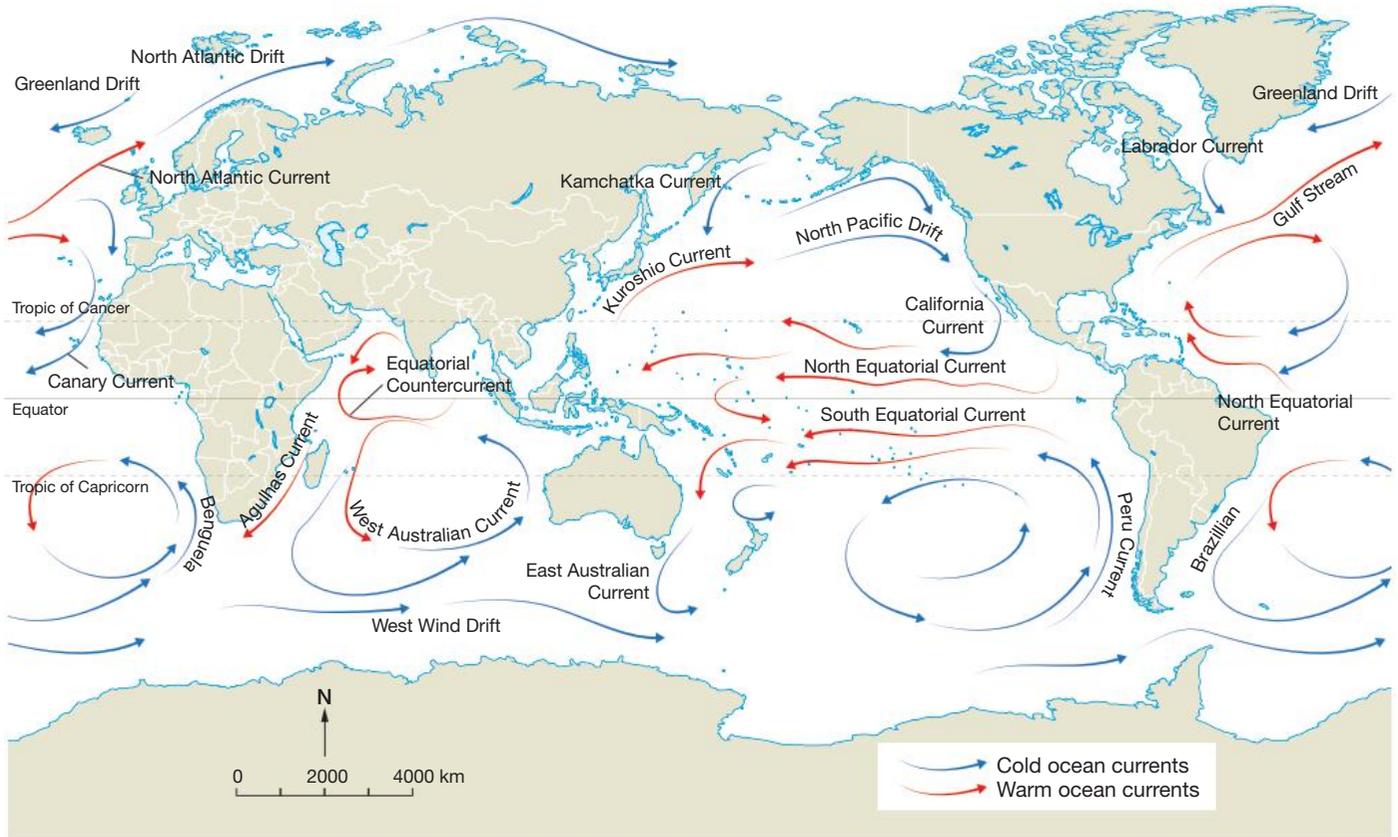
4.1

Salt fields in La Pama in the Canary Islands off the north-west coast of Africa. Sea water is collected in ponds and evaporated, leaving pure salt.

Salt is consumed by sea creatures, especially tiny diatoms that have a silica-based shell. Humans have collected salt throughout history using the method shown in Figure 4.1.

### Currents

Currents are critical to all life on earth. Currents are very complex and many factors affect the direction in which they flow. Generally, currents move huge volumes of water around the globe, helping to regulate temperatures (see Figure 4.2). Warm water and air that form around the Equator, where the sun is at its strongest, move towards the poles, making the areas north and south of the Equator warmer. Conversely, the cooler air and water of the poles move towards the Equator, reducing temperatures. Currents are therefore crucial in creating what scientists call the global **heat budget**.



4.2 Main surface currents in the world's oceans

Ocean currents are divided into two types.

- **Surface currents:** These are usually driven by the wind. They affect only about 10 per cent of the oceans' volume. However, these currents are better understood because they affect the top layers of the oceans. For example, it is these surface currents that sailors have used for centuries to help propel their ships around the globe.
- **Sub-surface currents:** These are density-driven currents. They form because dense water sinks due to gravity, displacing less dense water; in other words, dense water pushes less dense water out of the way. The density of the water is determined by its temperature and salinity (the amount of salt it contains).

As water temperature rises, its density decreases. Consequently, waters close to the Equator tend to have lower densities. As salinity levels rise, water density decreases. Salinity levels are affected by how much fresh water is deposited into the ocean area. For example, rainfall, run-off from rivers, and melting ice all add freshwater and this in turn reduces the salinity.

### The Humboldt Current

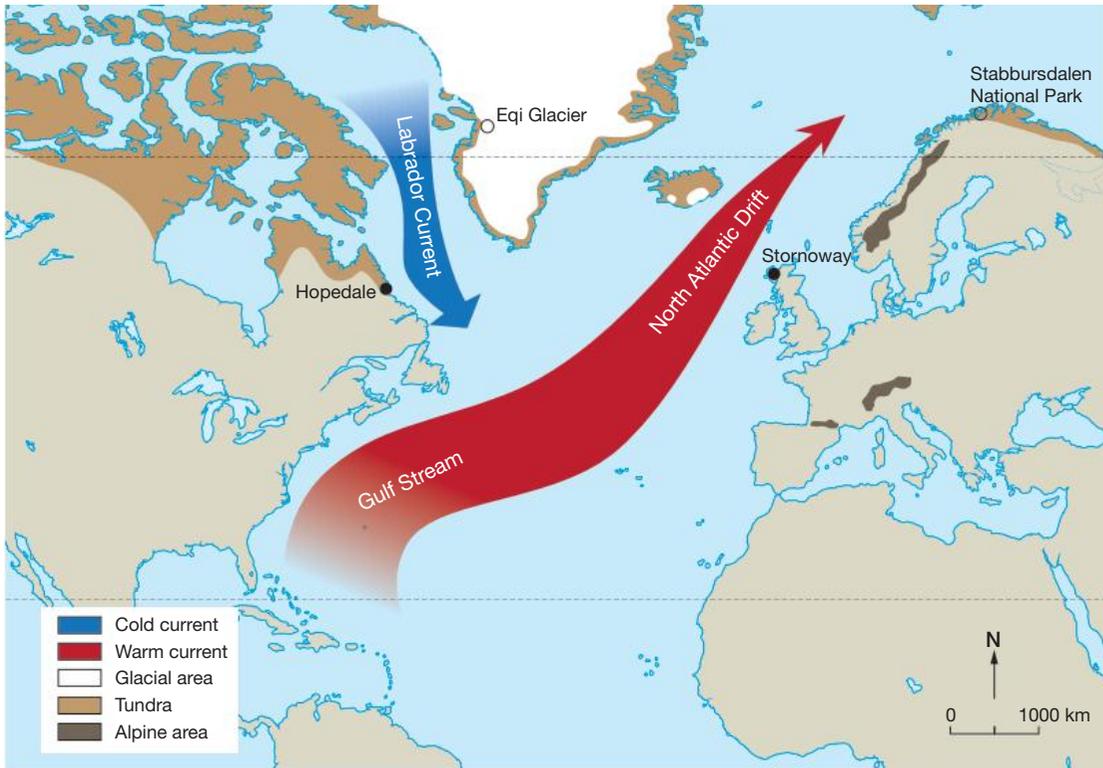
Sometimes called the Peru Current, the Humboldt Current is a very slow-moving current that brings cold water northwards from Antarctica up the western coastline of

South America. Its cold, slow-moving waters allow for very little evaporation, creating the arid and extremely dry landscape of the west coast of the continent (see Figure 4.3).

While the Humboldt produces an arid and desolate environment on land, in the ocean it has the opposite effect. As it runs into the continental shelf along the coast, it brings to the surface water full of nutrients from the ocean floor. These nutrients form the base of a complex food chain that supports the great diversity of sea life found in the eastern Pacific.

4.3 The Humboldt Current has a considerable cooling influence on the climate of Paracas in Peru, one of the driest places on earth.





4.4 The Gulf Stream is one of the most important sea surface currents in the world.

## The Gulf Stream

The Gulf Stream is one of the best known ocean currents. It is a surface current that forms in the Gulf of Mexico. Warm water flows into the Gulf from the Caribbean Sea, where the hot tropical sun creates an average sea surface temperature of 27°C. Southerly winds blowing northwards from the Equator towards the North Pole then push the warm current up the east coast of the United States of America and Canada. Ultimately, the Gulf Stream continues to flow into the North Atlantic Ocean as the North Atlantic Current.

The warm waters of the Gulf Stream moderate the temperatures, keeping them much warmer than they otherwise would be. The Gulf Stream therefore plays a critical role in enabling human life in North America and northern Europe.

Figure 4.4 shows that North America's tundra and glacial areas are located next to the cold Labrador Current that flows south from the polar region. These environments support low levels of life and are constantly frozen. In areas nearer the warm waters of the Gulf Stream these harsh environments give way to more hospitable places such as the forests of Scandinavia. Therefore, even though Norway and Greenland are the same distance from the Equator, they have very different environments because of the influence of the Gulf Stream (see Figure 4.5).



4.5 Grasses and shrubs grow in Stabbursdalen National Park, in Finnmark, Norway (top) under the warming influence of the North Atlantic Drift, a warm ocean current, while, at a similar latitude, the Eqi Glacier of Greenland is found where the currents are cold.

# Marine environments: Functions

Table 4.6 outlines the source, sink, service and spiritual functions of marine environments.

## 4.6 Functions of marine environments

Function	Marine environments
Source function	<ul style="list-style-type: none"> <li>Ninety per cent of the world is ocean. With so much of the marine world unexplored, it is difficult to determine the number of marine species, but it is estimated that between 50 and 80 per cent of all life on earth is found in the marine environment.</li> <li>About 80 million tonnes of seafood is taken out of the world's oceans each year. This accounts for about 15 per cent of all the protein eaten by humans.</li> <li>Marine environments are sources of many important minerals and fuels. About 26 per cent of the world's current oil supplies comes from deep ocean wells. It is expected that much of the world's future oil and gas will come from the deep ocean.</li> </ul>
Sink function	<ul style="list-style-type: none"> <li>The marine environment is the world's biggest carbon sink. It absorbs about 90 thousand million tonnes of carbon annually and releases about 88 thousand million tonnes, meaning it is an important store of carbon dioxide, which is critical for dealing with global warming.</li> <li>For decades, humans have used the marine environment to dump wastes. This has included deep-sea disposal of nuclear waste and other highly toxic chemicals. Today there are international laws regulating this but it is still a problem.</li> </ul>
Service function	<ul style="list-style-type: none"> <li>Fifty per cent of all the oxygen on earth comes from the ocean's phytoplankton.</li> <li>The marine environment is critical for supporting life on earth. Ocean currents, along with air currents, control the global heat budget. They transport warmth away from the Equator toward the poles, warming these regions, while transporting cooler water towards the Equator, moderating temperatures there.</li> </ul>
Spiritual function	<ul style="list-style-type: none"> <li>For many cultures, the sea is a crucial element of their spiritual life. For example, for traditional cultures throughout the Pacific, the ocean and its animals are worshipped as gods bringing life to the island peoples.</li> </ul>

## ACTIVITIES



### Knowledge and understanding

- Describe the composition of salt water.
- Outline the role of currents in the global heat budget.
- Explain why waters close to the Equator have lower densities.

### Applying and analysing

- Construct a flow diagram showing how surface and sub-surface currents form.
- Copy and complete the following table comparing the Gulf Stream and the Humboldt Current.

### Geographical skills

- Study Figure 4.2.
  - Compare the currents that circulate around Australia and Antarctica.
  - Using your knowledge of climate in Australia and Antarctica, explain how these currents influence the climate of each region.

	Gulf Stream	Humboldt Current
Location		
Impact on climate		
Impact on environment		
Other		

# 4.2

## Importance of marine environments

The marine environment is the largest of all of earth's ecosystems. It includes the oceans, salt marshes, intertidal wetlands, mangrove forests, estuaries, lagoons, coral reefs, ocean depths and sea floor.

### The oceans

The earth's oceans cover 71 per cent of the planet's surface area. Deep oceans, where ocean depths are greater than 200 metres, make up 87 per cent of this. The deep ocean is an environment we know very little about, yet it is critical to all life on earth. Figure 4.7 shows the angler fish, a species that lives in the deep oceans.

The marine environment accounts for about two-thirds of the world's ecosystem services. These are the services that environments provide in order to keep the world functioning: providing the oxygen we breathe and moderating temperature extremes. Phytoplankton, tiny photosynthesising plants found in the world's oceans, provide 50 per cent of all the oxygen on earth.

### Oceans—the benefits

#### Carbon cycle

One of the most important service functions of the marine environment is the role it plays in the carbon cycle: moving and storing carbon. In recent decades, with growing knowledge of the impact of human activities on the **carbon cycle** through the burning of fossil fuels, the importance of the oceans in the cycle has become more apparent. Rising levels of carbon dioxide in the **atmosphere** are the main cause of climate change, leading to global warming. Marine organisms, ranging from microscopic

4.7

The angler fish lives 1000 metres below the surface of the water.



phytoplankton through to large marine mammals such as whales, take carbon from the atmosphere and deposit it in the deep oceans. Without the oceans taking carbon out of the atmosphere, there would be no life on earth. Increasing levels of atmospheric carbon, due to human activities, are causing an increase in the acidity of the water. This process, known as **acidification**, is affecting the ocean biosphere (fauna and flora). Figure 4.8 shows the effect on sea urchins of the oceans becoming more acidic.

### DID YOU KNOW?

A 2010 study published in *Nature* reported that the number of marine phytoplankton has declined by 40 per cent since 1950, at a rate of about 1 per cent per year, possibly in response to ocean warming.

4.8 Acidification as a result of high levels of CO<sub>2</sub> causes a sea urchin's spines to dissolve (left). Compare this with a sea urchin under normal CO<sub>2</sub> conditions (right).



## ACTIVITIES

### Knowledge and understanding

- 1 Outline the role of the marine environment in terms of ecosystem services.
- 2 Explain the role played by the oceans in the carbon cycle.
- 3 Describe the benefits humans receive from the oceans.

### Applying and analysing

- 4 Assume the perspective of an environmentalist. You have been asked to prepare a presentation to the United Nations on why the world needs to take better care of the oceans. Prepare a short digital presentation and oral report, and present in the class. You may wish to do this activity in a small group.

## Economic benefits

In a typical year, more than 80 million tonnes of wild fish are caught in the world's oceans. The global fishing industry employs about 35 million people directly and a further 300 million people indirectly, and is worth at least US\$80 billion a year. Seafood is the major source of protein for millions of people. Additionally, the world's oceans are major trade highways. Ships transport virtually all the world's raw materials, from coal and oil to wheat and rice. More than 100 million containers of goods containing everything from T-shirts to mobile phones are moved across the oceans every year.

## Social benefits

The marine environment has an important spiritual and cultural value. Many people feel joy when they see whales in the wild or hear waves crashing onto the beach. The indigenous people of Hawaii, like many other Pacific peoples, have a strong spiritual bond to the marine environment. The ocean is referred to as *ke kai popolohua mea a Kane* (the deep dark ocean of Kane) and has great religious importance. For the Hawaiians, the ocean provided everything that they needed and therefore was worshipped and honoured.

# 4.3

## Human impacts on marine environments

Vast areas of the marine environment have been subject to great change as a result of human activity. Unlike land environments, much of the world's oceans is beyond the control of individual nations. The oceans are largely left unmanaged and their use is unregulated. This has resulted in unsustainable fishing and dumping of wastes and toxins.

### Marine pollutants

**Marine debris**, or marine litter, is defined as any persistent, manufactured or processed solid material discarded or abandoned in the marine or coastal environment. Marine debris is harmful to marine life, especially to protected species of birds, sharks, turtles and marine mammals. Marine debris may cause injuries or death through drowning, injury through entanglement and internal

injuries or starvation following ingestion. Discarded fishing nets and hooked lines are among the most dangerous of all marine debris. They kill marine life long after they have ceased to be used by humans.

Other marine pollutants include chemical discharges from factories and farms, such as fertilisers and pesticides, sewage, urban run-off and discharges from ocean-going vessels.

### SPOTLIGHT

#### The Great Pacific Garbage Patch

The Great Pacific Garbage Patch is an enormous collection of rubbish that has accumulated in the eastern Pacific Ocean between Japan and North America, in the North Pacific Gyre. A gyre is a circular ocean surface current created by wind movements and the rotation of the planet. The centre of a gyre tends to have very stable and calm waters. Rubbish from across the Pacific has accumulated and become trapped in the North Pacific Gyre. A similar, smaller rubbish accumulation is found in the North Atlantic Gyre. The North Pacific Gyre contains a huge array of materials. Much of it is tiny particles of plastics that enter the food chain, slowly poisoning marine life. Sea turtles, mistaking plastic bags for jelly fish, ingest them and die.

Scientists visiting the remote part of the Pacific have collected up to 750 000 pieces of plastic in a single square kilometre. The rubbish is so dense in some parts that the whole food chain is disrupted. Sunlight cannot penetrate through the surface, which leads to the collapse of the phytoplankton that form the basis of the food web and rely on sunlight.

Dealing with this vast rubbish patch has been very challenging. As no country has control over the waters in which it is found, action has been slow. At present, much of the work is limited to research and alerting the public to the nature of the issue. In 2010, a group of activists sailed *Plastiki*, a raft made entirely from plastic rubbish, across the Pacific from San Francisco to Sydney to highlight the damage that plastic is doing to the marine environment.



4.9

Found in one of the most isolated places on earth, the Great Pacific Garbage Patch is a vast accumulation of plastics and other rubbish.



## Oil and gas exploration

Oil and gas are the world's most widely used energy sources. Known as fossil fuels, oil and gas deposits (coal is also a fossil fuel) were formed millions of years ago when plants and animals sank to the seabed and were covered by layers of mud and sand, which were eventually compressed into rock.

Land-based reserves of oil and gas have been exploited for decades and offshore deposits are now being identified and exploited. Huge rigs are constructed to drill through the sea floor and pump out the oil and gas under pressure. These are then transferred to processing plants, often offshore floating factories, and then sent ashore. Technological advances have made oil and gas exploration possible in areas previously too hard to exploit, for example deep-ocean drilling and drilling in the inhospitable Arctic Ocean. As near-shore reserves continue to dwindle, more and more drilling is likely to take place in deep oceans.

**4.10** In 1979, the *Atlantic Empress* collided with another ship off the African coast, releasing 287 000 tonnes of oil.

The world's oil and gas are not evenly distributed. Huge reserves are found in the Middle East, Central and South America and in the North and Arctic seas. To move the fuels to where they are consumed, massive oil tankers and pipelines have been constructed. The tankers are the largest machines ever built by humans and have the capacity to move more than a billion tonnes of fuel around the world each year. While accidents are quite rare, due to improvements in safety standards, the environmental impacts of oil spills can be devastating. In July 1979, the *Atlantic Empress* collided with another tanker, the *Aegean Captain*, off Tobago in the Caribbean Sea (see Figure 4.10). The accident led to the spill of 287 000 tonnes of oil into the Caribbean Sea and the Atlantic Ocean, and was the biggest tanker spill in history. Oil is highly toxic to marine species and its effects linger for decades.

## Climate change

The impact of climate change on the marine environment is extreme. One of the most obvious consequences is sea-level rise. As the world's climate warms, a process of **thermal expansion** takes place. When water warms, the particles in water expand; therefore water rises as it warms. Scientists believe that sea levels may rise by as much as 1 metre. Rising sea levels are already leading to flooding of low-lying islands and coastal areas. The world's oceans absorb huge quantities of carbon, and as atmospheric carbon increases so does the carbon stored in the oceans. This increase in carbon is slowly turning the oceans more acidic. This acidification is having an impact on the biosphere. For example, some animals can no longer make strong shells.

As temperatures rise, ecosystems around the world are being affected. Fragile coral reefs that require very specific temperature ranges are disappearing. There are also grave concerns for the future of the huge ice sheets that lock away most of the world's fresh water. The Greenland ice cap beyond the Arctic Circle is already beginning to shrink, as shown in Figure 4.11. The fresh water that is added to the oceans as a result of the melting changes the chemical composition of the sea water. This in turn affects the movement of ocean currents, which are driven by changes in water density, associated with how saline (salty) the water is.

Scientists fear that changes to the density of waters around Greenland could affect the Gulf Stream, which regulates temperatures across the eastern part of North America and the north-west of Europe. Ironically, the world becoming warmer may cause the Gulf Stream to stop flowing, bringing freezing temperatures to a large part of the world.

## SPOTLIGHT

### Polar bears

Polar bears are found in the Arctic Circle. They rely on the sea ice to hunt seals, their main source of food. Global warming is reducing the Arctic sea ice level, affecting the ability of polar bears to hunt for food. As a result, female polar bears do not obtain enough food to store sufficient energy for pregnancy, and so are having fewer or no cubs.



4.12 A polar bear nurses her two cubs.



4.11 The extent of the Greenland ice cap, 1992 and 2005

Source: Cooperative Institute for Research in Environmental Sciences (CIRES), University of Colorado Boulder, 2005



4.13 Cod fishing, circa 1980s

## Fishing

More than 15 per cent of the world's population rely on seafood for their main source of protein. As the world's human population has increased, the strain on the world's fish stocks has grown markedly. Since the 1970s, about twenty of the world's most important fishing grounds have disappeared as a result of unsustainable fishing practices. The collapse of the Grand Banks cod fishery (see Figure 4.12) in the North Atlantic Ocean is one of the best known examples. This once vast and seemingly endless fishing ground had disappeared by the 1990s, due to overfishing.

In addition to declining fish stocks, large-scale commercial fishing has other consequences for the marine environment. The heavy gear that trawlers drag across the sea floor kills species that cannot move. Large nets catch many non-commercial species that are simply thrown away—this is known as **by-catch**. Driftnets can be up to 65 kilometres long and are dragged through the water for a number of days, trapping fish indiscriminately. Some nets now have special escape routes for dolphins and turtles, but they are not used in most parts of the world.

## ACTIVITIES

4.2

### Knowledge and understanding

- 1 What is the Great Pacific Garbage Patch?
- 2 Explain why there has been so little attention paid to the garbage gyre.
- 3 Outline the main causes of climate change.
- 4 Explain the impact of climate change on the marine environment.
- 5 Outline the impacts of commercial fishing on the marine environment.

### Applying and analysing

- 6 Write a short report on the risks to the marine environment posed by oil and gas exploration.
- 7 Work in small groups. Using the text, internet and other sources, produce a digital presentation on the impact of human activities on marine environments. Share your presentation with the class.

# 4.4

## Managing marine environments

The marine environment is among the least managed environments on earth. A key reason for this is a lack of real understanding of the world's oceans, their processes and the ecosystems they support. More of the moon has been mapped and researched than the ocean depths.

### Agreements and cooperation

Environmental management is usually the responsibility of governments, but much of the world's marine environment lies beyond the territorial limits of individual nations, in an area known as the high seas. Individual governments do not have the power to manage this environment. Consequently, international cooperation is critical for its effective management.

Until the late twentieth century, there was very little cooperation or agreement between nations regarding environmental management. Today, a growing number of international agreements deal with the protection of the marine environment.

International agreements can only be successful in protecting the environment when a significant number of nations are prepared to follow the rules set out in the agreements. Sometimes nations act in their own interests rather than in the broader global interest, and this limits the success of international cooperation.

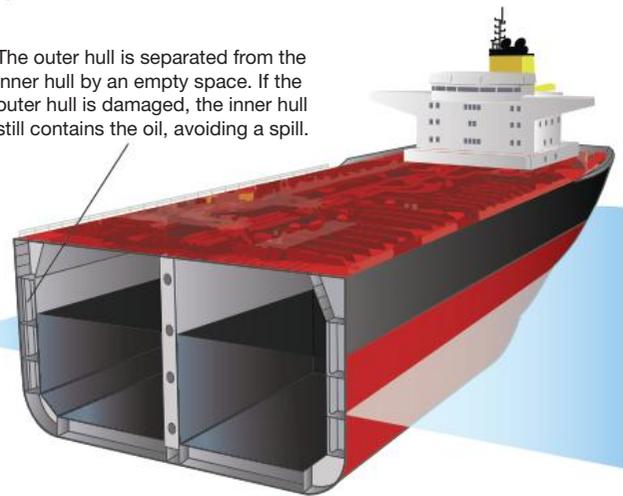
### Convention for the Prevention of Pollution from Ships

One of the first attempts to create an international agreement regarding the marine environment was the International Convention for the Prevention of Pollution from Ships in 1973. Most countries were not interested in the agreement until a series of tanker accidents in 1976 and 1977. These accidents highlighted the danger to the environment posed by oil tankers. In 1978, Regulations for the Prevention of Pollution by Oil were added to the Convention now known as MARPOL.

The Convention requires all new tankers to have double hulls: an outer and an inner hull with a gap between them, as shown in Figure 4.14. If the outer hull is damaged by a collision, the inner hull should remain intact and stop oil from flowing out.

4.14 Cross-section of a double-hulled oil tanker

The outer hull is separated from the inner hull by an empty space. If the outer hull is damaged, the inner hull still contains the oil, avoiding a spill.



Other parts of the Convention control the movement of dangerous substances, such as radioactive materials. There are also restrictions on the dumping of toxic chemicals, rubbish and sewage from ships.

### Wellington Convention

The Wellington Convention is an international agreement to protect the marine environment in the South Pacific region. Its full title is the Convention for the Prohibition of Fishing with Long Driftnets in the South Pacific. It was agreed to in 1989. This convention protects fishery resources throughout the South Pacific Ocean by banning fishing with driftnets over 2.5 metres long.

Driftnets are sometimes called 'walls of death'. The nets are strung out to drift near the surface and capture fish by entangling them around their gills. Traditionally, driftnets were small, but modern commercial driftnet boats use very large nets. These nets are equipped with floats to keep them on the surface and weights that attach to the sea floor, creating a curtain to trap anything that swims into the net.

As the nets do not discriminate, they create very large by-catches. These are species that are not meant to be caught and they are often thrown back, already dead. Turtles are particularly vulnerable, as are dolphins and many shark species. Driftnets become even more dangerous if they are lost at sea. The nets are made of nylon, and can float around for decades, entangling animals. The success of the Wellington Convention has led to the protection of other marine environments outside the South Pacific. Authorities in the United States have banned driftnetting along parts of the western US coast.

### Whaling in the Southern Ocean

In 1982, the International Whaling Commission (IWC) placed an indefinite moratorium on the commercial hunting of most whale species. A huge whale sanctuary was declared in the Southern Ocean in 1994. Known as the Southern Ocean Whale Sanctuary, the sanctuary protects the important feeding grounds for many whale species around Antarctica. Since the introduction of the moratorium, whale numbers have increased.

Although a member of the IWC, Japan has continued its whaling program, arguing that their program is for scientific research. Environmental groups and whale experts argue that this is a lie. They say that the program is purely for commercial whaling, and the whale meat is sold in fish markets in Japan. They also point out that almost no scientific papers about the program have been written by Japanese researchers, while scientists studying whales in other countries produce excellent research without harming any whales at all.

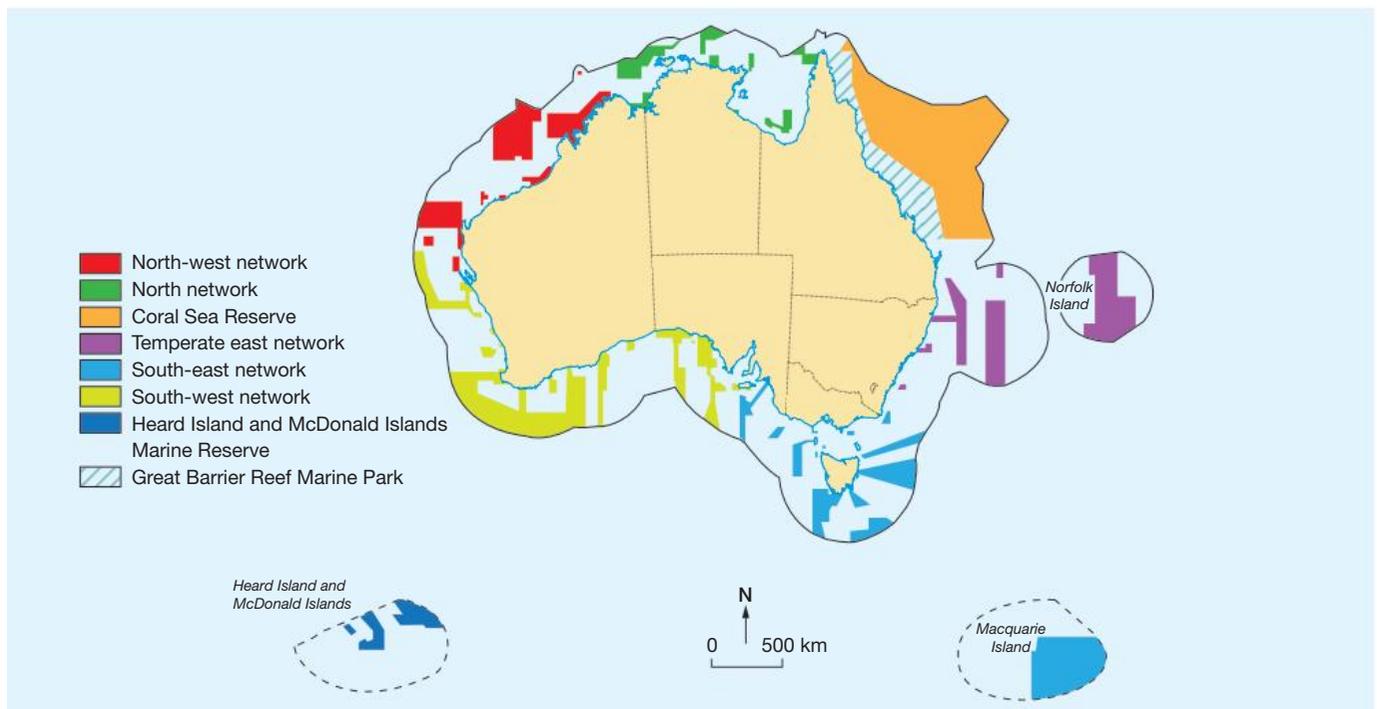
Japan had been exploiting a loophole in the international agreements that regulate whaling for scientific hunting. Other countries have argued that Japan is not acting in the best interest of the environment and is not fulfilling its obligations under the agreement. Environmental groups have taken more dramatic action. Sea Shepherd is one of the most vocal critics of the Japanese program. It sends ships to harass the Japanese whaling fleet. Groups such as Sea Shepherd rely on individuals to support them and apply pressure to the Japanese Government to abandon their whaling program.

In 2014, the International Court of Justice in The Hague ordered Japan to cease whaling in the Antarctic. The ICJ ruling stated that Japanese whaling was commercial and not for scientific purposes. This was in violation of the IWC moratorium.

### Marine management in Australia

Australia has become a world leader in managing its marine environment. The fishing industry is heavily regulated, with strict quotas used to maintain sustainable fisheries. Extensive marine parks have also been established along large areas of the Australian coast, as shown in Figure 4.15. Some people have been critical of these parks as they limit commercial fishing.

4.15 Australia's extensive network of protected marine environments. Note that Macquarie Island, Heard Island and McDonald Islands are not shown on the map in their correct location according to the scale.



© Commonwealth of Australia 2014

With the Australian demand for seafood growing every year, it has been argued that Australia is protecting its marine environment at the expense of environments elsewhere. Well over a \$1 billion worth of seafood is imported into Australia annually, much of it from South-East Asia. There are concerns that Australian consumers are fuelling the destruction of the marine environment throughout the region.

## The role of the individual

The everyday actions of individuals can have a very significant impact on the marine environment.

### Everyday actions

When individuals drop rubbish on the ground, it makes its way into stormwater systems and eventually floats out to sea.

This is how the rubbish collected in North Pacific Gyre. Individuals taking greater responsibility for their rubbish is more effective than the installation of rubbish traps over stormwater outlets.

### Direct action

Environmental organisations such as Greenpeace and Sea Shepherd rely on individuals for support.

In 2013, oil companies began drilling deep-sea wells well above the Arctic Circle. Environmentalists fear that the pristine environment here will be destroyed by a spill. In 2013, thirty Greenpeace activists boarded an oil rig and attempted to unfurl a banner highlighting the dangers of drilling. They were arrested by Russian police, as shown in Figure 4.17.

## SPOTLIGHT

### Managing the Great Barrier Reef

Covering an area of 348 000 square kilometres, the Great Barrier Reef (GBR) is the largest coral reef system in the world.

In 1981, the importance of the GBR to the entire world was recognised by the United Nations Education, Scientific and Cultural Organization (UNESCO) when they listed the reef as a World Heritage site. This recognition was based on the enormous biodiversity found on the reef. Fifteen hundred of the world's 13 000 fish species are found there, along with six of the seven turtle species, more than 200 species of birds, 500 species of seaweed, 600 species of echinoderm, 125 species of shark and rays and about 360 species of hard coral.

Managing a large-scale environment with such an amazing diversity of species is challenging. Being a marine environment adds further complications. Hundreds of large

ships navigate through the reef every year, travelling to and from the huge coal ports on the Queensland coast, and up to 2 million tourists visit the region every year. An increasing number of visitors arrive on cruise ships.

The Great Barrier Reef Marine Park Authority (GBRMPA) is responsible for balancing the interests of humans and the need to protect the environment. They have established different management zones in which activities are controlled. About 85 per cent of tourism activity is confined to just 7 per cent of the reef system, minimising the impact, and commercial fishing is limited to certain areas. The GBRMPA also conducts reef and marine research to learn more about how to manage the reef. Warmer water can cause corals to expel the algae (zooxanthellae) which gives them their colour, causing them to become completely white. This is called coral bleaching, shown in Figure 4.16. Most corals struggle to feed themselves without their zooxanthellae.



4.16 Coral bleaching in the Great Barrier Reef

4.17 Greenpeace activists attempting to board a Russian oil rig



## Consumer choice

Consumers are increasingly aware that the decisions that they make about products can have a significant impact on the environment. Much of the canned tuna sold in Australian supermarkets now is labelled as dolphin friendly. This means that the tuna has been caught by methods that protect dolphins from being accidentally caught. This growth in dolphin-friendly tuna developed at the late twentieth century as a result of consumer demand.

An awareness of the damage that large-scale commercial fishing causes to the environment has led to a rise in demand for sustainable seafood. The Marine Stewardship Council now provides certification that companies can use to indicate to consumers that they have met rigorous standards for harvesting seafood in a sustainable fashion.

## Consumer boycott

The Brent Spar, a 4000-tonne facility located in the North Sea, was constructed in 1976 to temporarily store oil from oil rigs until it was taken ashore by tankers.

In 1997, energy company Royal Dutch Shell, which owned Brent Spar, announced it was planning to sink the storage facility, as it was no longer in use. Environmentalists feared that sinking the facility would cause huge environmental damage, as it was contaminated with toxins. Greenpeace called on consumers to boycott Shell petrol stations throughout Europe. This boycott proved so successful that Shell backed down and agreed to tow Brent Spar to Norway to be thoroughly cleaned, dismantled and recycled.

## ACTIVITIES

4.3

### Knowledge and understanding

- 1 Explain why managing the marine environment in the area known as the high seas is challenging.
- 2 Outline the importance of international agreements for managing the marine environment.
- 3 Describe how the MARPOL Convention protects the marine environment.
- 4 Outline the purpose of the Wellington Convention.
- 5 Assess the justifications given by Japan for whaling in the Southern Ocean.
- 6 Outline why the Great Barrier Reef was given World Heritage status.
- 7 Describe the role of environmental organisations in protecting the marine environment.

### Applying and analysing

- 8 Create a PMI chart on marine parks in Australia.
- 9 Design an advertising campaign to encourage individuals to take action to protect the marine environment.

### Investigating

- 10 Assume the role of a fisheries manager. You have been asked to give a presentation to the Environment Minister of a developing nation that allows large driftnets to be used in their waters. Prepare a digital presentation to convince the Minister to agree to the Wellington Convention.

# 4.5

## Case study: Bass Strait

Bass Strait is a wide channel separating mainland Australia from Tasmania. At its widest point, it is 240 kilometres wide. Close inshore, its depth is often less than 20 metres, but at its deepest it exceeds 120 metres. The shallowness of Bass Strait creates a perfect environment for large swells and waves, and consequently the Strait is famous for its rough seas.

### Location

The vast Southern Ocean lies to the west of Bass Strait and the Tasman Sea to the east (see Figure 4.18). Low-pressure weather cells, which form in the Southern Ocean, sweep up from Antarctica towards Australia. These cells bring with them large storms and seas, creating strong south-westerly winds in the Indian Ocean, which are funnelled into the eastern part of Bass Strait. These winds create the legendary storms characteristic of the Strait. During these storms, the waves regularly reach 4 metres and can exceed 7 metres.

### Biodiversity of Bass Strait

The cool waters of Bass Strait are highly productive and support a wide diversity of marine life. In the coastal waters, mammals such as seals are found and extensive kelp forests provide an important habitat for many creatures.

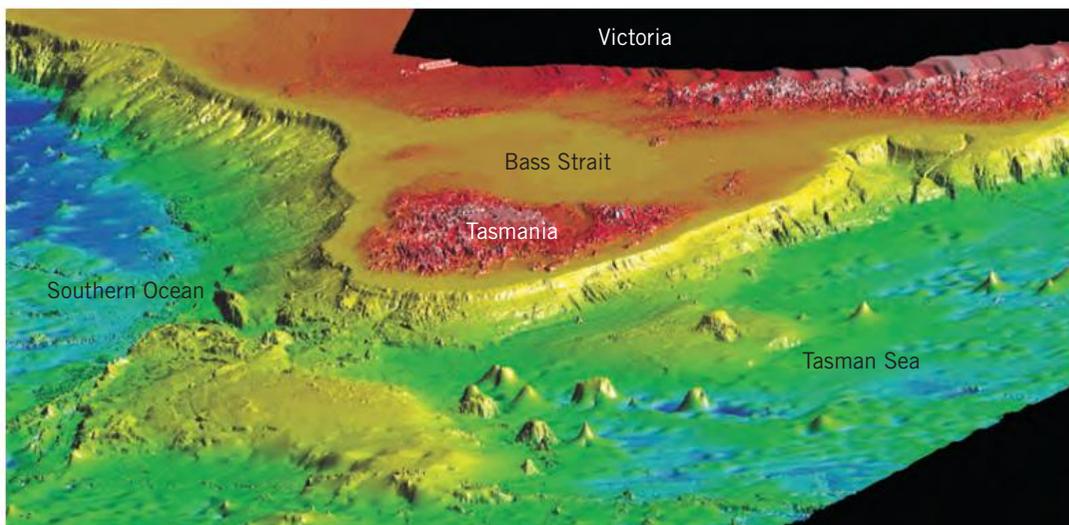
The giant cuttlefish is found in these forests. These beautiful creatures, which grow to more than 1 metre in length, have a life span of only two years. The short life span means that disturbances to the breeding cycle can have a dramatic impact on the species. Giant cuttlefish are commonly caught as by-catch by commercial fishing operations.

### Human impacts

Bass Strait is a busy and important shipping route. Threats of oil spills from shipping accidents are ever-present but fortunately large oil spill accidents have been rare. Since the 1960s, oil and gas exploration and drilling have been undertaken in the Strait.

The Strait's oil reserves are declining and some experts predict that the fields will cease production within the next decade or two. Energy companies are now turning their attention to gas, which is considered to be a cleaner energy source than oil. The demand for gas is growing in Australia and around the world. Several large companies are now actively drilling for gas reserves in the Strait.

The huge oil rigs that dot the north-eastern part of Bass Strait (see Figure 4.19), off the Victorian coast, pose one of the greatest risks to the environment. In October 2013, 750 litres leaked from the Cobia pipeline into Bass Strait. Although only a small leak, environmentalists have pointed to the spill as evidence that the oil infrastructure in the Strait is ageing. Some of it is more than 30 years old and it is feared that more serious spills may occur in the future.



4.18

The continental shelf, showing Bass Strait, located between mainland Australia and Tasmania



## Managing the Bass Strait

Although now in decline, the oil industry is important in meeting Australia's energy needs. Bass Strait is also important to the shipping and the fishing industries. This human activity takes a toll on the environment of Bass Strait. The Strait is now extensively managed.

## Dealing with pollution

The coastline of Bass Strait is quite heavily populated, especially the Victorian coastline, which takes in Port Phillip Bay. The urban areas abutting Bass Strait have long been a source of pollution. Toxins from industry, sewage, plastics and other rubbish all take a toll on the marine environment.

Algal blooms have become a feature of Bass Strait coastal waters in recent years. The blooms can grow very large and have a great impact on the environment. The algae are toxic and take oxygen out of the water, which leads to the deaths of fish and other marine life. In 2013, the emergence of toxic blooms in the north of Tasmania, shown in Figure 4.20, resulted in a ban on shellfish harvesting in much of Bass Strait. The algae are caused by run-off from inland areas that are rich in nutrients, such as fertiliser, and also by the release of untreated sewage. Management and treatment of stormwater is essential for reducing the impact of the algal blooms.

Research conducted by La Trobe University into seabirds in Bass Strait has revealed the impact of plastics. One study on Phillip Island into fledgling (very young) mutton birds found that they have on average seven pieces of plastic in their stomachs. These plastics are toxic and can gradually kill the birds. Researchers found that the nest-bound chicks have been fed regurgitated fish containing plastics by their parents.

4.19 Oil rigs dot the Victorian side of Bass Strait.

Authorities are beginning to deal with this issue through education programs to alert the public that the rubbish they drop into drains and gutters makes its way into the marine environment. Traps installed over stormwater pipes and booms that are strung across waterways also capture rubbish. These are effective but require regular emptying and maintenance.



4.20 This 2004 algal bloom in Bass Strait was so large that satellites were used to track it.

## SPOTLIGHT

### Tamar Valley pulp mill

Forestry is one of the most significant and controversial industries in Tasmania. A large pulp mill to make paper has been planned for Bell Bay in northern Tasmania since 2004. The mill has been approved and in 2013 the original owners of the site, Gunns, went bankrupt, and the approval for the mill was offered for sale.

Some local residents and environmentalists have always opposed the mill, claiming that it will have a huge impact on the environment, including Bass Strait. They have been led by the Friends of the Tamar Valley group. The group uses community action and protests to highlight the dangers of the mill.

If built, the mill is expected to dump about 640 000 tonnes of waste water into Bass Strait daily. This waste will contain a mixture of chemicals, including highly toxic dioxins and furans (a type of dioxin). Both these toxins remain in the environment for decades and gradually affect the entire food chain.



4.21 Community and environmental groups protesting against the construction of a pulp mill in Bell Bay on the coast of northern Tasmania

### Managing the oil and gas industry

Oil and gas drilling poses one of the greatest risks to the marine environment of Bass Strait. Fortunately, there has not been a major spill of oil in Bass Strait but the environmental impact of a major rig incident could be catastrophic.

The National Offshore Petroleum Safety and Environmental Management Agency (NOPSEMA) is an Australian Government agency that has responsibility for regulating oil and gas exploration offshore. NOPSEMA conducts environmental assessments into drilling applications and is responsible for monitoring the environmental impacts of offshore gas and oil operations. The agency also coordinates responses to oil spills, and works with the industry to develop contingency plans to ensure that spills are dealt with quickly and correctly.

### Managing the fishing industry

Bass Strait has an important commercial fishing industry. Throughout much of the twentieth century this industry was unrestricted, and unsustainable catches led to a decline in important commercial species. Today, like other fishing zones in Australia, Bass Strait fishing is subject to quotas and strict licences to ensure that fishing is sustainable.

One of the most significant seafood industries in Bass Strait is the scallop industry. In the 1980s, more than 300 boats harvested about 40 000 tonnes of scallops annually from the Strait. In December 2005, the Australian Fisheries

Management Authority (AFMA), which manages commercial fishing throughout Australia, closed the Bass Strait scallop fishery. This was to allow the vast scallop beds to replenish after many years of unsustainable harvesting. In May 2009, scallop harvesting in Bass Strait was allowed again (see Figure 4.22), but AFMA imposed extensive restrictions. This included reducing the number of boats from 120 to just 17. Strict quotas for each boat are developed each year, based on detailed surveys.



4.22 Harvesting scallops in Bass Strait

# Evaluating management

Table 4.23 provides an outline and evaluation of the management strategies of selected industries in Bass Strait.

4.23

Evaluation of the management of Bass Strait

Management strategy	Environmental criteria	Economic criteria	Social criteria
Rubbish and nutrient management	<ul style="list-style-type: none"> <li>Plastics and other rubbish and toxins from urban areas need to be dealt with</li> <li>High levels of nutrients lead to algal blooms; better water management and treatment helps to reduce this</li> </ul>	<ul style="list-style-type: none"> <li>Education programs and rubbish traps to reduce pollution are cheap to implement</li> </ul>	<ul style="list-style-type: none"> <li>Education programs allow the community to be involved in caring for the environment</li> </ul>
<p>Evaluation: Urban pollution has a significant impact on the marine environment. Rubbish traps and education programs are cost-effective and provide opportunities for the community to take action.</p>			
Scallop fishing	<ul style="list-style-type: none"> <li>Reduction in the number of boats allowed to harvest scallops</li> <li>Tight quotas imposed on boats</li> <li>'No fish' areas created</li> </ul>	<ul style="list-style-type: none"> <li>Ban on scallop fishing between December 2005 and May 2009 damaged the industry</li> </ul>	<ul style="list-style-type: none"> <li>Reduction in the industry has created job losses and affected fishing communities</li> </ul>
<p>Evaluation: The scallop industry has had to become more sustainable in order to survive in the long term. There have been negative social and economic consequences of the restrictions on the industry but the restrictions are allowing the scallop population to rebound.</p>			
Oil and gas industry	<ul style="list-style-type: none"> <li>Regulations by NOPSEMA that require environmental assessments</li> <li>NOPSEMA coordinate responses to spills to minimise impact</li> </ul>	<ul style="list-style-type: none"> <li>Oil and gas drilling allowed within Bass Strait, providing jobs and economic growth</li> </ul>	<ul style="list-style-type: none"> <li>Oil and gas drilling brings jobs and contributes to the national economy</li> </ul>
<p>Evaluation: The industry provides significant economic benefits and the regulations of NOPSEMA help to minimise the environmental impacts. However, drilling for oil and gas represents a very significant threat to the environment in the case of a spill.</p>			

## ACTIVITIES

### Knowledge and understanding

- 1 Explain why the waters of Bass Strait are typically so rough.
- 2 Describe the impact of human activities on the environment of Bass Strait.
- 3 Outline the sources of pollution in Bass Strait.
- 4 Describe the causes and impact of algal blooms on Bass Strait.
- 5 Describe the management strategies used for rescuing plastic pollutants.
- 6 Explain the potential impact of the Tamar Valley pulp mill on Bass Strait.

### Applying and analysing

- 7 Construct a mind map to summarise the main impacts of human activities on Bass Strait and the management strategies used to reduce this impact.

### Investigating

- 8 Using the internet, conduct research into the Tamar Valley pulp mill. Prepare a summary of the current status of the mill.
- 9 Write a short report outlining how the Bass Strait scallop industry is being managed to make it more sustainable.

# 4.6

## Case study: Gulf of Mexico

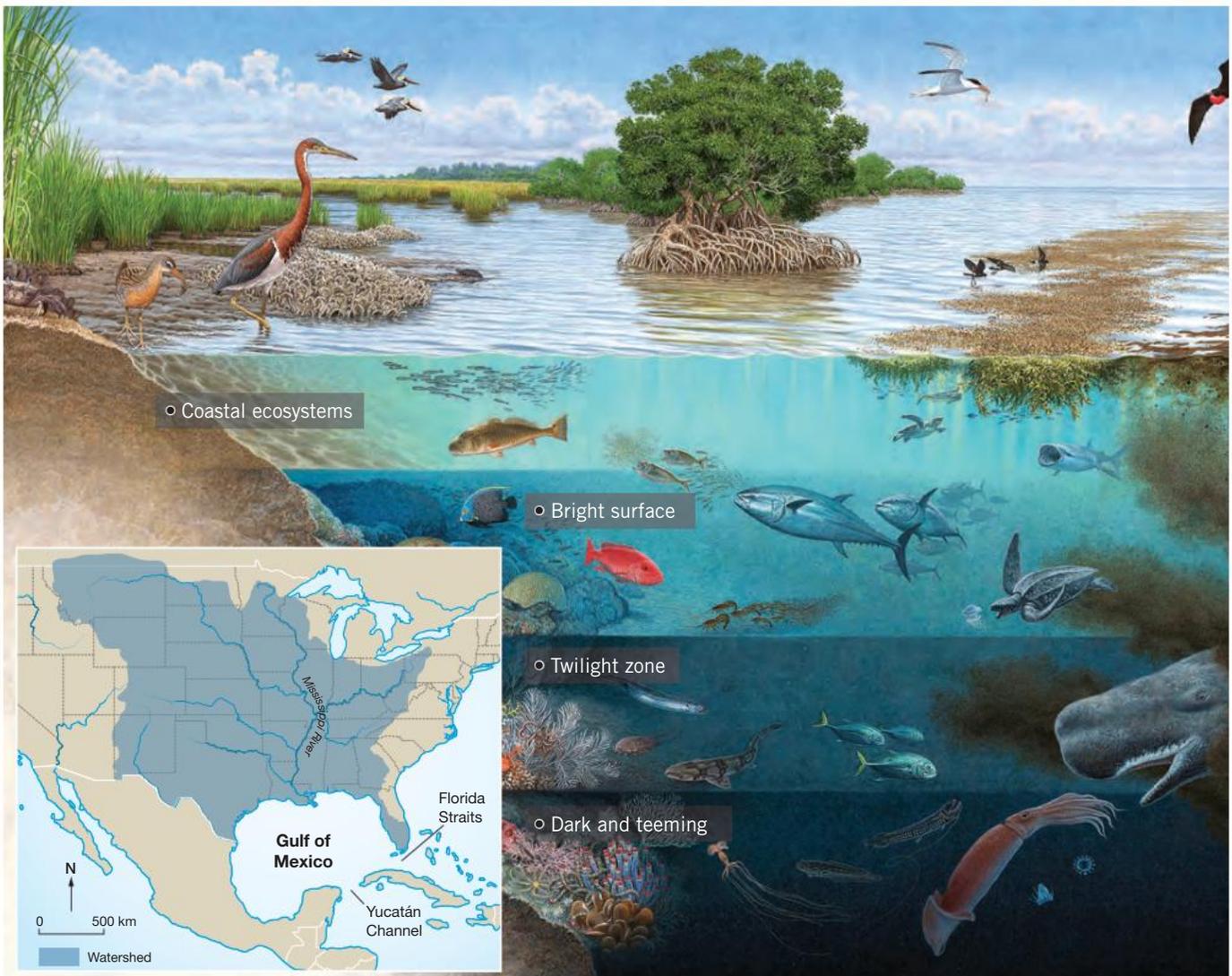
The Gulf of Mexico's diversity of habitats makes it one of the most ecologically and economically productive bodies of water on earth. It is also one of the most intensively used marine environments. As a result, many of its habitats are threatened.

### Geography of the Gulf

The Gulf of Mexico is the ninth largest body of water on earth, measuring 1 550 000 square kilometres. Land surrounds much of the Gulf, with only the narrow Florida Straits in the east forming a passage to the Atlantic Ocean, and the Yucatán Channel in the south allowing waters from the very warm Caribbean Sea to enter (see Figure 4.24, inset).

The Gulf is deep, with waters in the centre plunging to more than 5000 metres. Many large rivers flow into the Gulf, which means that the water closer to the coast is far less saline than the water in the centre. These different water conditions result in diverse environments.

4.24 The Gulf of Mexico's watershed (inset map) and coastal and marine habitats



## Human impacts

### Oil and gas

Human activity has had an enormous impact on the Gulf of Mexico's environment. Deep below the sea floor, huge reserves of oil and gas are being exploited. When accidents occur, oil spills have a dramatic and long-lasting impact on the environment.

### Deepwater Horizon

*Deepwater Horizon* was a huge oil rig owned by UK energy company British Petroleum (BP). On 20 April 2010, while drilling in the Gulf, the rig caught fire after an explosion caused by a build-up of methane gas. The explosion killed eleven crew members and injured seventeen. On the sea floor, the well head was damaged and began leaking oil, which spread horizontally at a depth of about 1 kilometre.

As millions of litres of oil spewed into the Gulf of Mexico, killing marine life, BP used Corexit, sprayed on the surface by aircraft, to break up the oil. Corexit is highly toxic and is banned in many parts of the world. It was only after 2 500 000 litres was sprayed that BP was ordered by the US Environmental Protection Agency to stop. By early May, the waters of the northern Gulf of Mexico were so polluted that the National Oceanic and Atmospheric Agency ordered that all commercial and recreational fishing be stopped. It took about three months to stop the leak.

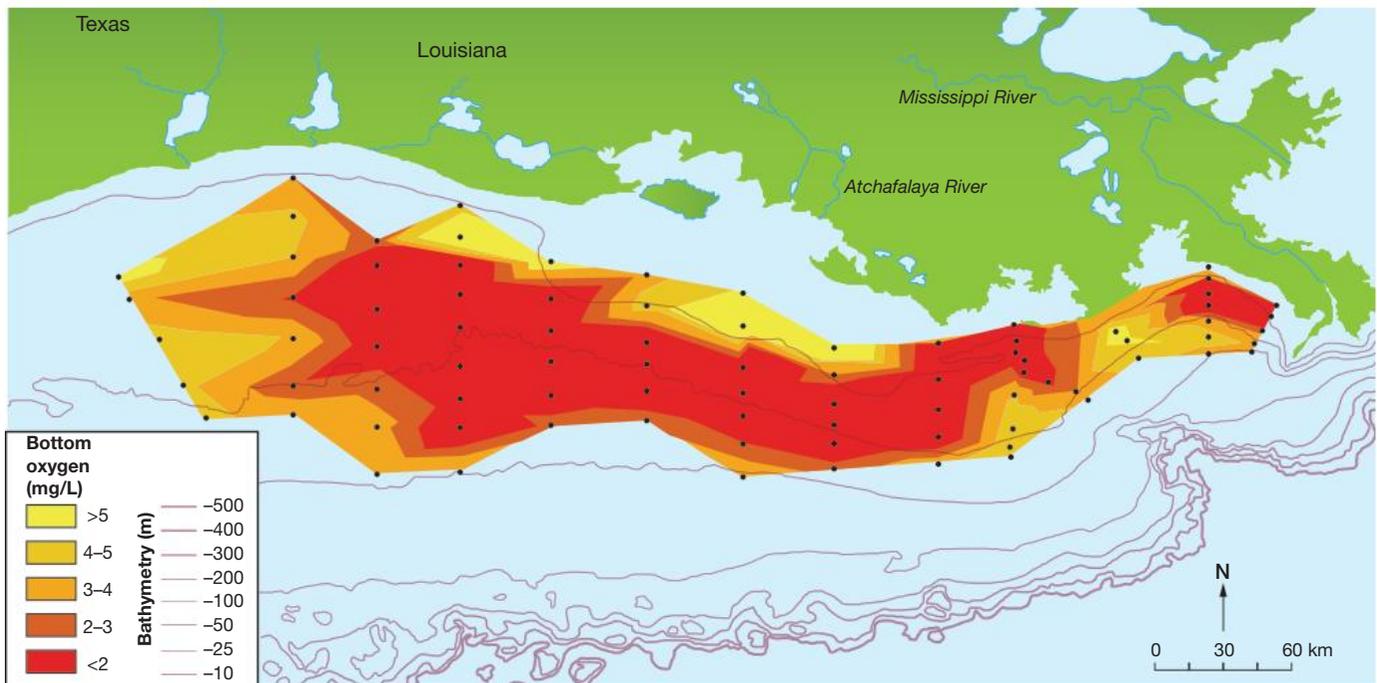
The spill has had a huge impact on the environment. Because the oil leaked at the sea floor, many deep-sea creatures were affected, including deep-water rock reef systems, which have a rich diversity of anemones, sea lilies and whip corals. As the oil rose to the surface, seabirds and surface animals were also affected. The build-up of oil and the toxic Corexit will remain in the Gulf of Mexico environment for decades.

### Agriculture

Human activities on land are also taking a significant toll on the Gulf environment. Scientists have discovered an extensive 'dead zone' in the Gulf's marine environment (see Figure 4.25). The **hypoxic water** in this zone is a result of extremely low levels of oxygen in the water. Located off the coast of Louisiana and Texas, the zone covers an area of more than 20 500 square kilometres. The dead zone appears at the onset of spring, when huge amounts of water flow into the Gulf from the Mississippi River.

The cause of the dead zone is the use of nitrogen-based fertilisers in agriculture, manure from animals and the burning of fossil fuels. About 1.6 million tonnes of nitrogen enters the Gulf of Mexico from the Mississippi River each year from farmland throughout central United States. The excess nutrients promote the growth of algae, which take the oxygen out of the water, leading to the destruction of the food chain.

4.25 The Gulf of Mexico dead zone, where dissolved oxygen levels fall below 2 mg/L



## Managing the Gulf of Mexico

Management of the Gulf of Mexico presents many challenges. The Gulf is one of the largest bodies of water in the world and is under the control of multiple governments. Its waters contain vast oil and fishing industries that are economically very important. The Gulf coast is home to millions of people, and the waters that flow into the Gulf from the many rivers drain a huge area of land.

## Integrated management

In order to manage the Gulf of Mexico effectively, an integrated approach has been adopted. It deals not just with the marine environment but also with the huge landmass that drains into the Gulf. The northern Gulf of Mexico watershed (or water basin) is one of the largest on earth. It is over 5 million square kilometres in area and covers thirty-one of the fifty states of the United States.

The water that enters the rivers and makes its way into the Gulf of Mexico flows across farmland, urban areas and natural landscapes. This water contains contaminants such as nitrogen-rich fertilisers, which are a major contributor to the Gulf of Mexico 'dead zone'. Environmental management of this issue sometimes takes place thousands of kilometres from the Gulf, and requires integrated approaches from many different agencies, as well as extensive education programs.

## SPOTLIGHT

### The Gulf of Mexico Program

The Gulf of Mexico Program was developed in 1988 by the United States Environmental Protection Authority to provide a coordinated approach to management of the Gulf. The program is based on undertaking extensive scientific research into the problems facing the Gulf and then bringing together many different agencies, volunteers and non-governmental organisations to work together to solve those problems.

The program has identified five major areas that require attention.

- improved water quality
- habitat conservation and restoration
- ecosystem research
- reduced nutrient flows into the Gulf
- environmental education programs.

Since its establishment, the Gulf of Mexico Program has had a number of important environmental successes. These include substantially improving the water quality of 109 rivers whose waters eventually find their way into the Gulf, and developing education centres and programs.

### 4.26 Evaluation of the management of the Gulf of Mexico

Management strategy	Environmental	Economic	Social
Integrated management	<ul style="list-style-type: none"> <li>• A broad approach, such as the management of watershed, maximises the management of the entire environment</li> </ul>	<ul style="list-style-type: none"> <li>• Strategies help to balance the environmental and economic values of the Gulf</li> </ul>	<ul style="list-style-type: none"> <li>• Programs allow the involvement of community groups and education programs involve individuals</li> </ul>
Evaluation: The Gulf of Mexico is so vast it requires management of many different aspects of the environment. It also requires cooperation between many different governments and agencies.			
Fishing industry management	<ul style="list-style-type: none"> <li>• Licence buybacks reduce the number of longline boats</li> <li>• Watershed management reduces risks of hypoxia</li> <li>• 'No-fish' areas created</li> </ul>	<ul style="list-style-type: none"> <li>• Watershed management reduces risks of hypoxia, which can devastate the industry</li> <li>• Need to balance the needs of the oil and fishing industries</li> </ul>	<ul style="list-style-type: none"> <li>• Policies to regulate recreational fishing are in place and need to be maintained</li> <li>• Many Gulf communities rely on the fishing industry for employment</li> </ul>
Evaluation: The Gulf fishing industry is very significant. Policies are in the place to improve the sustainability of the industry. The oil industry represents a significant threat, as does hypoxia. Both of these need constant management and attention.			
Oil and gas industry	<ul style="list-style-type: none"> <li>• Enhanced regulations requiring tougher environment standards introduced following <i>Deepwater Horizon</i> explosion</li> <li>• Scientific research prompted by <i>Deepwater Horizon</i> is improving knowledge and reactions to oil spills</li> </ul>	<ul style="list-style-type: none"> <li>• Oil industry adds huge economic growth to the area and provides energy for further economic growth</li> </ul>	<ul style="list-style-type: none"> <li>• Oil and gas drilling brings jobs and contributes to the national economies of the US and Mexico</li> </ul>
Evaluation: The industry provides significant economic benefits. However, as shown by the <i>Deepwater Horizon</i> tragedy, the environmental risks are enormous. Better regulations and more research are now in place to manage the industry more effectively.			

In recent years, there has been increasing cooperation between Mexico and the United States in managing the Gulf. The Gulf of Mexico Large Marine Ecosystem Project brings scientists, environmental managers and government officials from both countries to coordinate their management of the Gulf.

## Managing fishing in the Gulf of Mexico

Extensive fishing industries are found on both the US and the Mexican Gulf coasts. The US Gulf fishing industry is estimated to be worth more than US\$650 million. Shrimp (prawns) are the most important commercial species, with about 80 million kilograms being removed from US Gulf waters every year.

The Gulf of Mexico fishing industry is under threat from unsustainable fishing, damage from oil spills and the effects of hypoxia. Fishing throughout the Gulf is now regulated and restrictions are placed on the size of catches. Mexican authorities have instituted closed seasons for shrimp fishing periodically. During these seasons, commercial shrimp boats are not allowed to take any shrimp at all, in order to allow the population to recover.

There are also concerns over the sustainability of fishing of other species, including the iconic groupers. There are concerns that grouper numbers are in decline and that longline fishing, a method of fishing using fishing lines with thousands of hooks, creates a huge by-catch.

Management approaches have included extensive scientific research into grouper populations and the impact of fishing. An education program for commercial and recreational fishers, as well as fish buyers, aims to encourage more sustainable fishing approaches. A licence buyback program has also been implemented, whereby licences for longline fishing are bought back from commercial fishers to reduce the number of boats. These strategies are beginning to prove effective and the number of groupers in the Gulf is growing.

## Managing the Gulf's oil industry

The oil and gas industry represents one of the most significant human uses of the Gulf of Mexico. There are about 4000 wells in the US waters of the Gulf, and more in Mexican waters. These operations provide extensive employment and economic development throughout communities along the Gulf coast. However, they also represent a real and ever-present threat to the environment of the Gulf.

The environmental risks created by oil drilling were dramatically demonstrated by 2010 explosion of the *Deepwater Horizon* rig. This tragedy has led to the implementation of new environmental management strategies. The Offshore Drilling Safety Reforms were introduced after the explosion and require more thorough environmental risk assessments and more thorough planning for oil spills.

There has also been a significant increase in scientific research into oil spills. Government agencies and environmental groups have undertaken studies throughout the Gulf to assess the impact of the *Deepwater Horizon* spill. The Gulf of Mexico Research Initiative (GoMRI) brings together scientists from several universities and non-governmental agencies. GoMRI is now developing better strategies to detect and reduce the impact of oil spills, as well as better remediation strategies for areas affected by oil spills.

## ACTIVITIES



### Knowledge and understanding

- 1 Define the term 'hypoxic water'.
- 2 Outline the causes of the Gulf of Mexico dead zone.
- 3 Outline the role of the Gulf of Mexico Program.
- 4 List some of the success of the Gulf of Mexico Program.
- 5 Explain why the Gulf of Mexico Large Marine Ecosystem Project is important.
- 6 Describe the importance of the fishing industry in the Gulf of Mexico to the United States.
- 7 Explain how the *Deepwater Horizon* disaster has affected the management of the oil industry in the Gulf of Mexico.

### Applying and analysing

- 8 Construct a table to summarise the challenges facing managers of the Gulf of Mexico. Add the strategies used to overcome these challenges to your table.
- 9 Prepare a short report explaining the strategies used to manage the Gulf of Mexico more effectively.

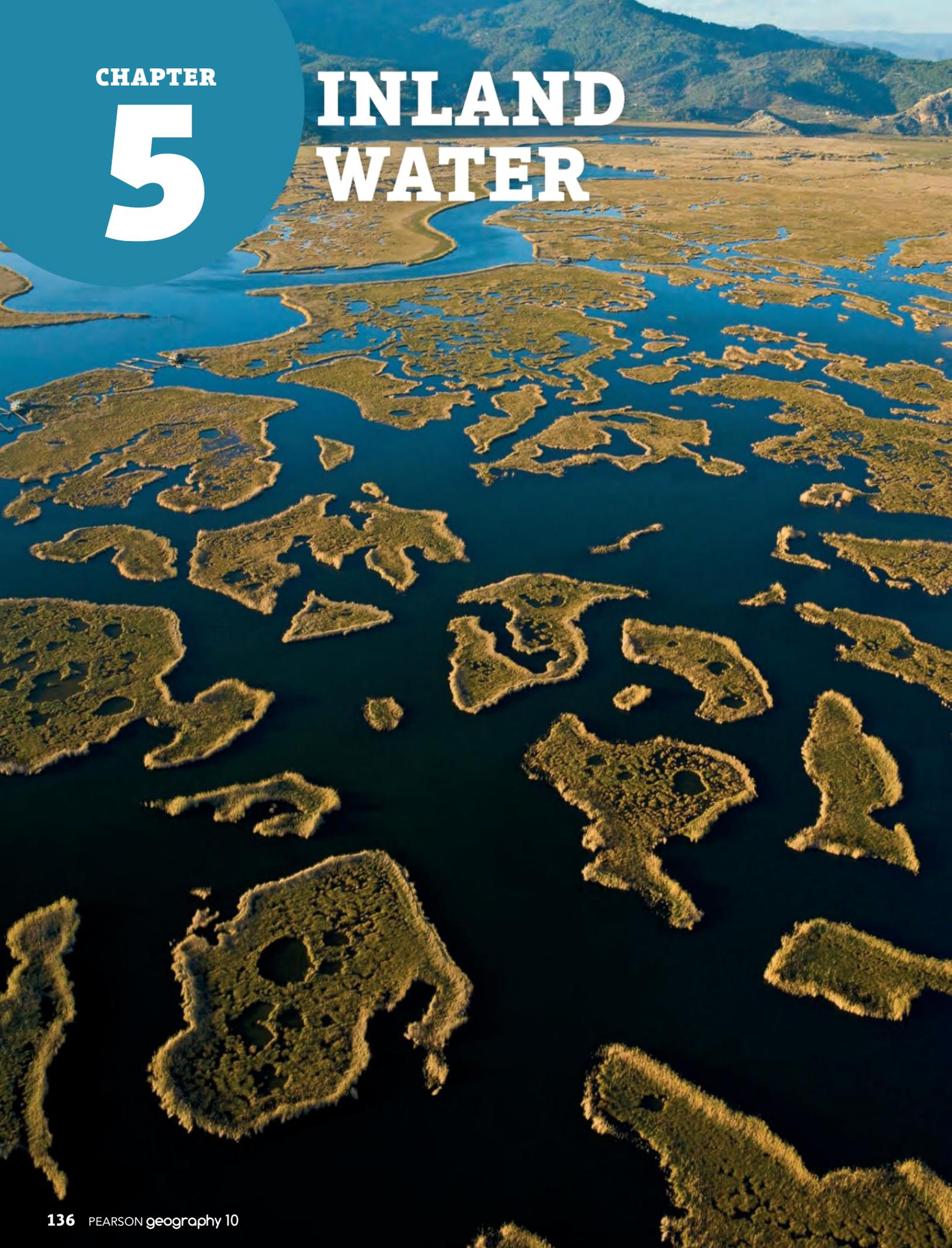
### Geographical skills

- 10 Study Figure 4.24.
  - a Describe the location and extent of the Gulf of Mexico and the extent of landmass drained by rivers flowing into the Gulf.
  - b Briefly describe each of the Gulf marine habitats.
- 11 Create a dot point summary of the impact of the *Deepwater Horizon* disaster on the marine environment.

CHAPTER

# 5

# INLAND WATER



**L**ife on earth depends on the waters of inland aquatic environments. These include flowing waters such as groundwater, creeks, streams and rivers; and standing waters such as lakes and wetlands. These bodies of water can be permanent or ephemeral, such as intermittently flooded wetlands.

Inland waters and wetlands not only meet the needs of humans, they also provide habitat for a variety of plant and animal species. Some animal species, such as fish and frogs, require water throughout their life cycle. Some may use aquatic areas for a specific stage of their life cycle, for example birds and amphibians. Still others may depend on aquatic ecosystems for resources such as food or as a corridor for movement. Under the right conditions, these environments can support large and spectacular breeding colonies.

While water is the driving force in nature, we often take it for granted. It is only when it is in short supply or rendered unusable that we really appreciate its worth.

In this chapter, we focus on environmental change and management using inland water environments as an example. Of particular interest are the causes and consequences of the changes taking place and evaluation of the strategies being used to manage these changes.

## KEY IDEAS

- To describe the main causes of environmental change in inland water environments
- To understand the effects of the environmental changes taking place in inland water environments
- To investigate the environmental management strategies in use and determine if these strategies are effective

5.0 Dalyan Delta, near Mulga, Turkey, where silting has created a warren of reed-covered streams

## GLOSSARY

aquiclude	an impermeable body of rock or stratum of sediment that acts as a barrier to the flow of groundwater
aquifer	an underground layer of water-bearing permeable rock or unconsolidated materials from which groundwater can be extracted
base flow	the portion of stream flow that comes from deep sub-surface flows, as distinct from groundwater flows; the flow that is largely independent of short-term variation in precipitation
ecosystem approach	a management approach that integrates the management of land, water and living resources in ways that promote conservation and sustainable use in an equitable way
eutrophication	a process where water bodies receive excess nutrients that stimulate excessive plant growth
fracking	the process of creating fractures in rock strata by injecting fluid into cracks to force them further open; the process allows more oil and gas to flow out of the rock strata and into a bore, from where they can be extracted
freshes	the sudden overflowing of a river caused by heavy rain or melting snow
groundwater	water held underground in the soil or in pores and crevices in rock
hydrologic cycle	the circulation of water between the earth's oceans, atmosphere and land, involving precipitation as rain and snow, drainage in streams and rivers, and a return to the atmosphere through evaporation and transpiration
overland flow	the water flow that occurs when the soil is infiltrated to full capacity and excess water flows over the land
sequestering	removing or withdrawing
stream flow	the flow of water in streams, rivers and other channels; a major element of the water cycle
transboundary	crossing at least one political border, either a border within a country or an international boundary
watertable	the level below which the ground is saturated with water

# 5.1

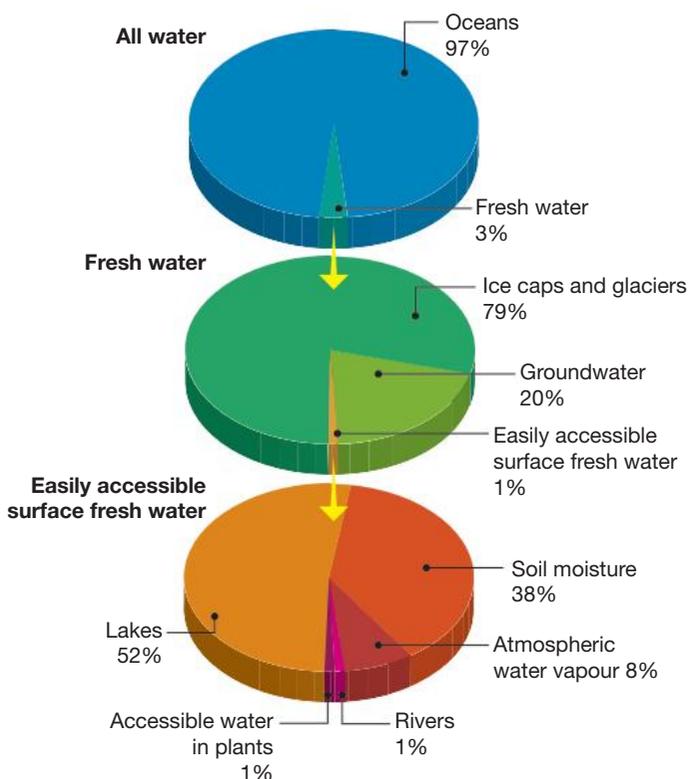
## The inland water environment

Inland waters are critical to life on land. They are part of wider landscapes that are rich in biodiversity and provide many services that sustain the earth's continuing productivity. Humans need water for their survival and use it extensively, withdrawing water from surface and ground-based sources, and as a means of disposing of pollutants. A decline in the health of inland waters is evident and must be addressed.

### Elements and processes of the biophysical environment

Inland waters include springs, streams, rivers, ponds, lakes, floodplains, groundwater, cave waters and swamps and marshes. They are mostly fresh water, but in some areas are saline or a mixture of the two (brackish). All inland waters are part of the endless global circulation of water in the **hydrologic cycle**. Only 3 per cent of the world's water is found on land, and most of this is locked up in glaciers and ice caps, so the availability of fresh water is limited, as is shown in Figure 5.1.

5.1 Global water distribution

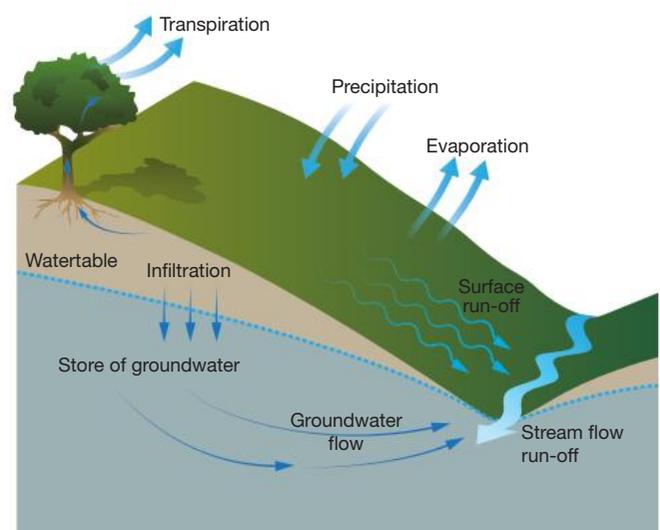


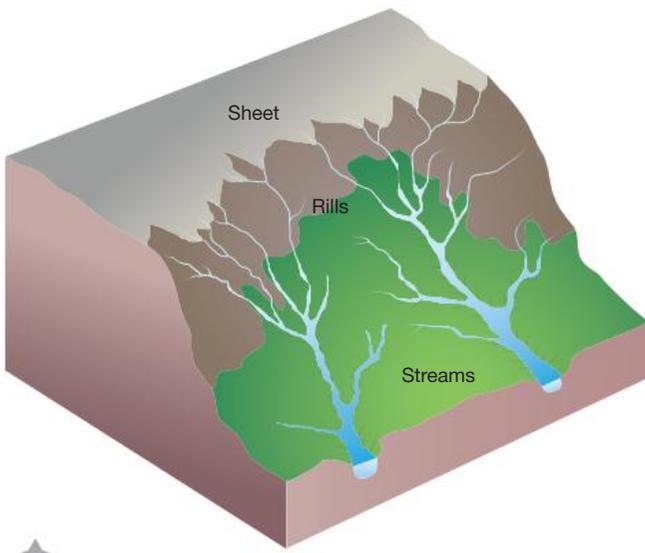
### Types of inland waters

Inland waters are quite distinctive, especially in terms of where they are found in the landscape, and the manner and speed with which the water moves. Inland waters accumulate, either permanently or seasonally, in water storages above and below the land surface. Flowing water and still water are very different, as is the water that trickles through underground.

The water that falls as precipitation returns quickly to the atmosphere through evaporation, or is transpired by plants. Some disappears under the land to become **groundwater**, while the remainder flows or accumulates as surface water, as shown in Figure 5.2. Both groundwater and surface water are closely interrelated. Water that runs across the land surface or collects upon it is the most visible and the most accessible to humans, and is considered the most important as a resource.

5.2 Portion of the global water cycle showing water involved in the circulation over land areas





5.3 Movement of running water down a slope

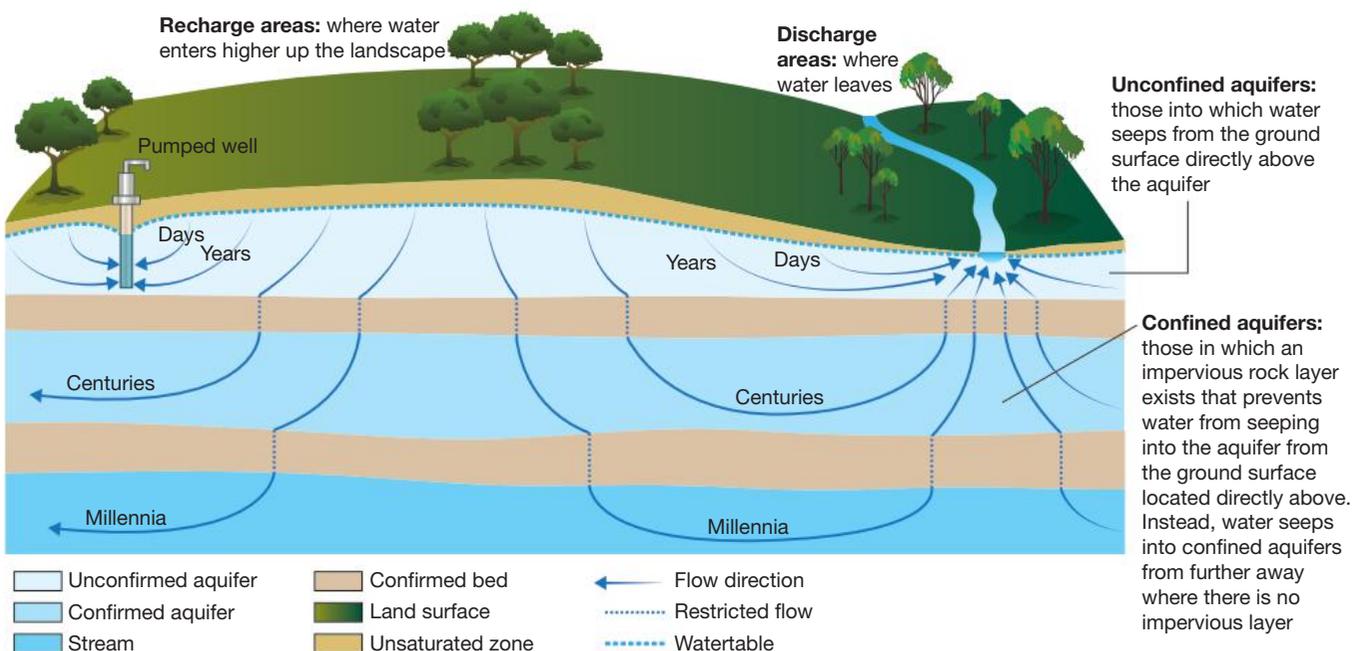
## Surface water

### Running water

Surface water flow is called run-off. It may take one of two paths downslope—**overland flow** or **stream flow**. On a fairly smooth surface, overland flow can be seen as a sheet of water, but on steeper and rougher slopes the flow can be interrupted or broken, with the water concentrating in rills or rivulets, as shown in Figure 5.3.

Further downslope, the water concentrates in long, narrow channels or streams. The channel is the easiest path for the rapid flow of water and the load of sediment it carries. These channels or streams, which usually begin high up in hills or mountains, form the tributaries of rivers. Streams can vary enormously in width and length.

5.4 Cross-section of two types of aquifers. An unconfined aquifer below the watertable flows into a stream and is also drawn down in a well. Below that, two confined aquifers are renewed over much longer time scales.



### Standing water

When surface water flows into natural dips on the land surface it can collect as still water in small shallow ponds or large bodies of deeper water known as lakes. Some lakes are the sources of rivers and other rivers end in lakes. Australia is a continent with a sunken centre, and inland rivers such as the Barcoo and Diamantina drain towards Lake Eyre, which is 15 metres below sea level. When rivers break their banks during a flood and spill out onto their adjacent flood plain, water can fill any depressions and sit there until it evaporates.

### Wetlands

When shallow water permanently or temporarily covers any area of flat land, wetlands are created. The water in a wetland may be still or flowing, and fresh, saline or brackish. Wetlands such as swamps and marshes are found adjacent to rivers and lakes, and are characterised by water-saturated soils and aquatic plants.

### Groundwater

When precipitation falls, it seeps into, or infiltrates, the soil and disappears below the ground. As gravity continues to pull the water downwards, it percolates or moves through the cracks and holes in porous rocks until it reaches impervious rock that stops any further downward percolation. Groundwater builds up in porous water-bearing rocks, forming an **aquifer**. Typically, water sits in tiny pores or spaces between the smallest rock particles in the aquifer. Its upper surface is called the **watertable**.

Groundwater is recharged or replenished slowly when infiltrating rainfall or floodwaters seep down into the aquifers, in time scales ranging from years to millennia. Figure 5.4 illustrates groundwater flows. Eventually, all groundwater discharges back to the surface or the ocean.

## Interactions and natural balances

Most of the water flowing down rivers comes from groundwater seeping into riverbeds. This is most visible in small streams higher up in the hills that are 'spring fed' as the watertable reaches the surface. The most compelling evidence of this is that permanent rivers flow all the time, when months have gone by without a drop of rain or any overland flow into them. It is the constant, slow discharge of groundwater that sustains constant river flow. In many places where groundwater discharges naturally to the surface, bubbling into natural springs, it not only sustains these streams and rivers but also supports many other ecosystems, such as wetlands.

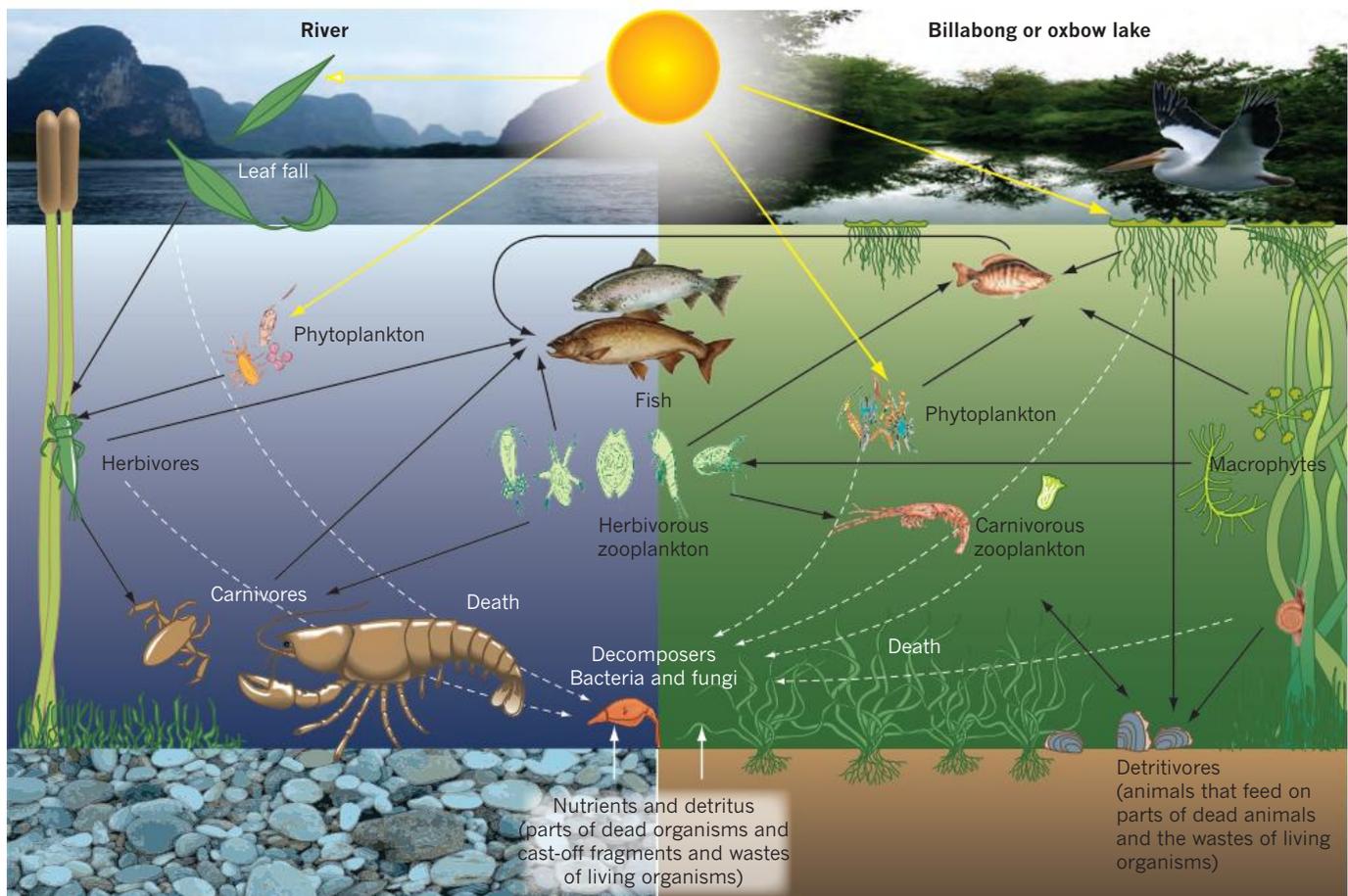
Rivers, lakes and wetlands are rich and diverse habitats. Even big rivers have quiet pools within them, and seemingly calm lakes have turbulent currents under the surface. Flowing water feeds into and moves out of bodies of still water. Inland waters are directly nourished from the land. As they move over the land they collect nutrients from fertile soil, as well as any leaf fall or organic debris that settles on the water surface. The nutrients are used by aquatic plants and continue to be recycled within the ecosystem. The shallow waters of wetlands are very conducive to life and are especially rich in biodiversity. They have complex, interrelated food webs, as can be seen in Figure 5.5.

## Distribution and extent of inland waters

The planet's fresh water supply is virtually limitless in the sense that it is continuously recycled by the hydrologic cycle. However, it is unevenly distributed, with some regions being well watered and others having very little water. Australia is described as a continent with a wet rim and a dry interior.

Precipitation and run-off levels influence the distribution of river networks. Australasia only contributes 2 per cent of the world's fresh water discharged into the ocean, whereas over 30 per cent pours in from each of Asia and Latin America. There are estimated to be 5 to 15 million lakes across the world, over 10 000 of them larger than a square kilometre. A disproportionate share of the larger lakes is found in North America, especially Canada, where glacial scouring created many depressions that have subsequently filled with water.

5.5 A billabong food web



## Inland water biodiversity

Water and biodiversity are interdependent. A disruption in either means a disruption to both. This is because all life depends on water. The hydrologic cycle not only drives the functioning of the biophysical environment, it also sustains life. Quite apart from the various processes of the cycle itself (such as precipitation, infiltration, surface run-off), water is fundamental to the physical and chemical processes upon which life depends. In turn, the storage, movement and transfer of the water are driven by physical attributes of the environment, which is a product of biodiversity.

Such interdependence can be seen in the following examples:

- Vegetation cover directly affects the rates of transpiration, evaporation, infiltration and run-off in a drainage basin. Slopes covered by forests readily absorb and capture water and maintain water quality by protecting soils from erosion.
- The flora, fauna and microorganisms in inland waters play a significant role in purifying the water itself, by removing high levels of nutrients and contaminants.

## Importance of inland waters

The major concentrations of the world's population demonstrate the importance of inland waters to humans. Fresh water is used in households, agriculture and industry. It is essential to our way of life and our economy. Water resources are an input in the production of almost all goods. Inland waters also support fisheries and tourism. Australia exports most of its agricultural produce and effectively supports a population of 67 million people globally.

Water environments have long held a deep spiritual value for Indigenous Australians. In a continent as dry as Australia, rivers, lakes and estuaries are also valued for their recreation opportunities and have become part of the national identity. Some people have a strong sense of place and quite an emotional attachment to iconic water environments, such as the Murray River.

Globally, inland waters are critically important for poverty reduction and the achievement of human development targets. Inland water biodiversity, especially inland fisheries, provides food security for millions of the world's poor. It is estimated that groundwater supplies drinking water for an estimated 1.5 to 3 billion people and, in most areas, groundwater is recharged through functioning wetlands. The rest of the world's population relies on the surface water provided by functioning freshwater ecosystems.

## Ecological services

There are many important benefits derived from the ecological services provided by inland waters. These include:

- habitats for terrestrial and aquatic species
- an extraordinarily high level of biodiversity, which includes not only life within the waters, but life that depends on inland water habitats.
- processing waste and absorbing nutrients, which keeps water clean
- flood management, as wetlands in particular absorb enormous amounts of water after extreme rain events
- climate regulation and carbon sinks.

### SPOTLIGHT

#### Climate regulation and carbon sinks

One of the most important functions of wetlands is their role in the mitigation of global climate change through **sequestering** and releasing a major proportion of fixed carbon in the biosphere. Although peatlands cover only an estimated 3 to 4 per cent of the world's land area, they are estimated to hold 540 gigatonnes of carbon, representing 25 to 30 per cent of the carbon contained in terrestrial vegetation and soils.

## ACTIVITIES



### Knowledge and understanding

- 1 Describe inland waters.
- 2 Identify the paths that water may take after it falls on land as precipitation.
- 3 Describe a wetland.
- 4 Explain why rivers continue to flow long after rain has fallen.

### Applying and analysing

- 5 Study Figure 5.3 and describe how water flows down a slope to a river in a drainage basin.
- 6 Study Figure 5.4 then answer the following questions.
  - a Which type of aquifer is in more danger of contamination? Give reasons for your answer.
  - b Which aquifer is safer to drill into for a drinking water well?

### Investigating

- 7 Research carbon sequestrations in peatlands to determine why peatlands are so effective in storing carbon. Prepare a poster promoting the protection of peatlands.

# 5.2

## Causes of environmental change

Humans change almost all aspects of inland waters and the landscape they are part of—shifting water around for different uses, overusing and polluting it, and degrading the environment that supplies it. Globally, inland waters are being modified by human activities and they are in serious decline due largely to the pressures placed on them by their various users.

### The condition of inland waters

Over half the world's largest river systems have been moderately or extensively modified by dam construction, flow regulation and water extraction. Over half the world's wetlands have been lost. Freshwater populations of vertebrate species were reduced by 50 per cent between 1970 and 2005. This is a sharper decline than has been observed in marine or terrestrial ecosystems.

Australia does not have a comprehensive account of the distribution or condition of its freshwater ecosystems. Major loss of habitat has been observed, but the exact loss of ecosystem values and species cannot be accurately reported. We do know that in the 40 per cent of the continent that has been most intensively used, over 85 per cent of the rivers have been degraded by human activity.

In the Murray–Darling Basin, twenty of the twenty-three rivers have been rated as being in poor or very poor

ecological condition (see Figure 5.6). Populations of native fish have declined significantly over the past five decades, with fish communities currently reduced to about 10 per cent of their pre-European levels. More than half of the thirty-five native fish species in the basin are considered threatened or rare. Exotic (introduced) species make up 56 per cent of the total fish biomass in the lower catchment.

According to the Commonwealth Scientific and Industrial Research Organisation, approximately 50 per cent of Australia's wetlands have been lost to other uses, including 90 per cent of the flood-plain wetlands of the Murray–Darling Basin, 50 per cent of coastal wetlands in New South Wales and 75 per cent of wetlands on the Swan Coastal Plain in the south-west of Western Australia.

5.6

Monoman Creek, Chowilla flood plain, South Australia, during the millennium drought (circa 2000s), with dying red gums and a blue green algae bloom





5.7 Woronora Dam, Sydney. The concrete barrier of the dam has been built across the river to impound its water.

#### DID YOU KNOW?

A drop of oil can make 25 litres of water unfit for drinking.

## Humans and inland waters

### Disturbance and regulation of water flows

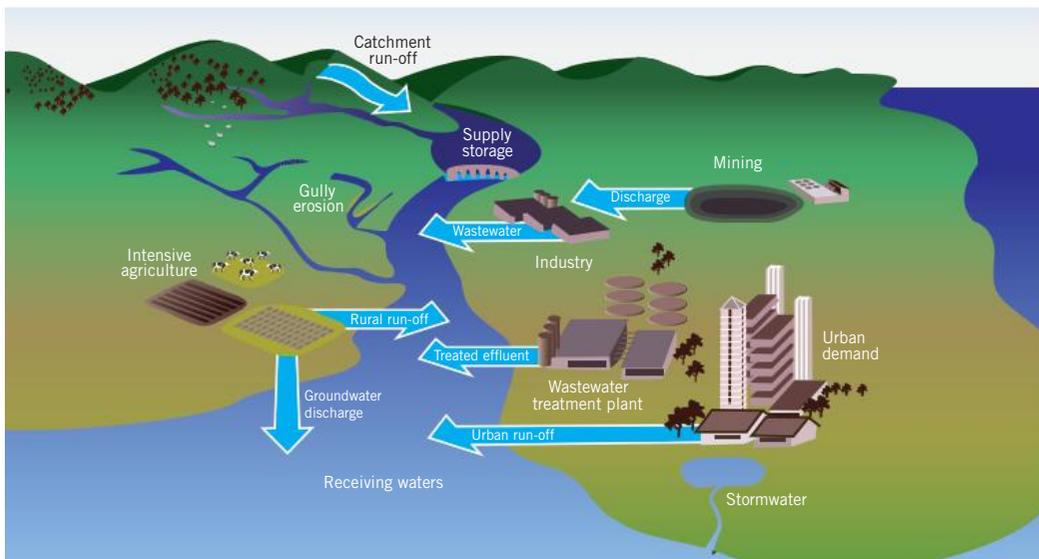
The demand for water has exploded over the last century, and the extraction, storage and diversion of water have significantly changed the distribution and movement of both surface and groundwater. Rivers have been altered for thousands of years, but the scale of modifications has escalated. Most of the world's major river systems have been regulated; that is, they have dams, weirs, inter-basin diversions, canals and irrigation channels.

Dams are the most significant form of river regulation. They capture and store river water and hold it until it is released to downstream users, giving water security to those in urban centres (drinking water and industry) and on the land (irrigation and stock water—see Figure 5.7).

Dams safeguard against extremes of both drought and flood in regions susceptible to unreliable rainfall. Dams also have the capacity to catch and hold back excessive run-off that would otherwise cause severe flooding problems downstream. Levees are constructed along the banks of rivers to contain floodwaters within river channels so they do not inundate flood plains. Embankments have also been built along rivers to improve navigation, as rivers are a major means of transportation.

### Deterioration of water quality

Over the past four decades, the contamination of water by toxic chemicals and the excessive loading of nutrients have contributed to the degradation of inland waters, as shown in Figure 5.8.



5.8 There are many potential sources and pathways of pollutants in water bodies.

Source: *Water: Science and Solutions for Australia*, CSIRO, 2011

## Toxic chemicals

Over 200 000 human-made industrial and household chemicals are commonly used in Australia. They can enter waterways in run-off from cities and agricultural areas, wastewater discharge from industry and sewage works, and even settle on the water surface from the air above (see Figure 5.9). Pesticides, herbicides, insecticides, polychlorinated biphenyls and petroleum hydrocarbons are all found in waterways. At worst, industrial accidents such as major chemical spills can have devastating consequences.

Another concern is the seepage of chemicals into aquifers. Contaminated rivers may be flushed clean after a big rain event, but aquifers are not, because groundwater movement is so slow and there is no dilution of the contaminants.



5.9

Aerial spraying in Virginia, South Australia. Fertilisers and agrochemicals are applied in this manner and can end up in both surface water and groundwater.

## Nutrient loading

Sewage is the largest and most common cause of poor water quality in inland waters. Up to 90 per cent of sewage in the urban areas of poor developing countries flows untreated into waterways. Not only does sewage add excess nutrients to waterways, but it may also carry dangerous pathogens or disease-causing organisms such as bacteria and viruses. The rivers downstream of the largest cities are often little cleaner than an open sewer.

The excess application of fertilisers can load run-off with concentrations of phosphorus and nitrogen. Nutrient loading is projected to become an increasingly severe problem for inland waters.

## Sediment

Deforestation, overgrazing and ploughing have caused a massive acceleration of erosion in many catchments. Overland flow has carried the sediment into waterways. Nutrients are attached to the soil particles, compounding the problem of nutrient loading.

## Pests and invasive species

The introduction of exotic species rates second to habitat degradation in causing freshwater species extinction, as the invasive species can become the dominant life form in an inland water environment. The water hyacinth was found in the upper reaches of the Amazon in the mid-nineteenth century and taken all over the world as an ornamental plant. It is now considered one of the worst aquatic weeds on the planet, infesting rivers, lakes, dams and channels on all continents apart from Antarctica. It quickly extends its range, choking waterways and reducing the availability of light and oxygen to other organisms (see Figure 5.10).

The global spread of exotic species has increased with the expansion of global commerce, shipping and aquaculture. Exotic fish introductions have eliminated or reduced the populations of native fish. Carp is a large freshwater fish native to central Asia. Introductions in many countries have helped to make carp the most widely distributed freshwater fish in the world. It is extensively farmed in Europe, Asia and the Middle East, and is a popular angling fish in Europe. However, in North America, Canada and Australia, carp is considered a significant pest.

## Climate change

Climate change and, in particular, reduced rainfall, increased drought, more intense rainfall events, sea-level rise and warming of the water column will have an impact on inland waterways and wetlands in many ways. They will cause:

- reduced river flows and changes in seasonality of flows
- changes in species composition and community structure (such as loss of cool-adapted aquatic species)
- reduced availability of areas for waterbird breeding
- saltwater intrusion into freshwater bodies (through sea-level rise)
- changes in water quality, **eutrophication** levels and the incidence of blue-green algae outbreaks.



5.10

Water hyacinth is a weed that floats in a mass, covering waterways and causing the water underneath to putrify.

## Changing inland water environments

Inland water environments have been sustained by the cycling of water in the hydrological cycle. Altering the flow regimes of both surface and groundwater, as well as changing the physical and chemical properties of the water, have affected the biophysical processes that sustain these environments.

### Altered flow regimes in rivers

If the functions of inland water ecosystems rely on the availability of water, then moving water away from them will affect their biophysical processes. The construction of dams and weirs to control river flow interrupts the downstream movement of water and sediment.

- Dams change the pattern of the flow of a river, both lowering its overall volume and altering its seasonal variations. A more regular flow of water replaces the peak and low flows associated with normal variations in the climate. This can cause the ecological web in a river system to unravel, as species cannot adapt.
- All parts of inland water landscapes can be affected by changes to flow regimes. Flood-plain ecosystems such as wetlands are closely tied to a river's flooding cycle, as the river replenishes them with water and nutrients. Many aquatic species depend on the variations in flow for reproduction, hatching, migration and other important life-cycle stages.
- Above the dam wall, the free-flowing river ecosystem is transformed into an artificial slack-water reservoir habitat. This alters many of the physical and chemical properties of the water held there, such as temperature and dissolved oxygen levels. These new conditions may not suit the native species that evolved in the river and they suffer.
- The dam wall itself blocks fish migrations, so fish downstream can no longer reach their spawning areas.
- The dam wall holds back sediments that would naturally replenish ecosystems downstream.

### Excessive extraction of groundwater

Some aquifers are replenished after rain when water seeps through soils or leaks out of gravelly riverbeds. However, most of the largest groundwater storages hold ancient water from wetter times, millions of years ago. They are hidden deep below the ground and have complex geological patterns that are not well understood. It is especially difficult to measure or even estimate the amount of recharge and yet knowledge of this is what should guide extraction rates.

Aquifers are being depleted, resulting in falling watertables and lower aquifer pressures. The problem is that there

can be considerable time lags, even running into decades, before the consequences of over-pumping are realised. Given that many inland water environments depend on groundwater, their needs play a key part in determining sustainable groundwater extraction rates.

Irrigated agriculture is now the largest consumer of groundwater, with 40 per cent of all cultivated land dependent on wells and bores. The countries with the biggest groundwater-use are India (39 million hectares) and China (19 million hectares). Where aquifers lie under deserts, the groundwater has often been pumped to the surface and transformed the landscape, as in the case of Israel and California.

## SPOTLIGHT

### Do rivers all reach the sea now?

Some of the world's greatest rivers no longer reach the sea for much of the year. The Nile flows out of the Mountains of the Moon in East Africa, recharges in Lake Victoria, and crosses the Sahara through Sudan and Egypt via the High Aswan Dam before giving up the last of its water just short of the Mediterranean Sea. Even in the monsoon season, every last drop of water is usually extracted before the Nile has the opportunity to pass through its delta.

The Yellow River in China, having watered the cities and fields of half a billion people, is a trickle by the time it encounters sandbars at its mouth.

The Indus in Pakistan, the Euphrates in Iraq, the Rio Grande on the border of the United States and Mexico, and the ancient, once mighty Oxus of Central Asia all appear on maps as flowing into the sea. But the maps are one thing; the reality is often quite different.

## ACTIVITIES



### Knowledge and understanding

- 1 Assess the condition of Australia's inland waters.
- 2 Describe how surface water flows are disturbed and regulated.
- 3 Identify the sources of pollution in inland waters.
- 4 Explain how exotic species change aquatic ecosystems.
- 5 Describe the impact of dams on rivers.

### Applying and analysing

- 6 Complete the following task: 'I used to think that there would always be plenty of fresh water available. Now I think ...'
- 7 Conduct a class debate on the following topic: 'Big dams are appropriate for Australia.'

# 5.3

## Water flow and environmental health

The sustainability of inland waters depends on habitats supporting a stable and diverse mix of species. Altering the water flow changes the population of the producers (water plants and algae), which then affects the population of dependent species higher up the food chain. All these species need to maintain viable suitably dispersed populations, or they are at risk of extinction.

### Water needs of rivers

The distinctive flow patterns of rivers create a variety of habitats: **base flows** are slow and steady; **freshes** are rises of water level with faster currents, but with flows contained within the channel; flood peaks spread beyond the riverbanks to recharge flood plains and wetlands and reconnect them with the river. These are illustrated in Figure 5.11.

### Water needs of flood plains and wetlands

Floods that spill out over flood plains bring with them a nourishing load of sediment. They also recharge shallow, unconfined aquifers, which can continue to feed into wetlands. This connection between the river and its flood plain is vital for life to continue in these watery habitats.

Different species are adapted to different flooding frequencies and depths. In the Murray–Darling Basin, for example, river red gum forests are found where floods occur typically every 1 to 5 years. If flooding does not occur at regular intervals, the red gum forests suffer extreme stress.

### SPOTLIGHT

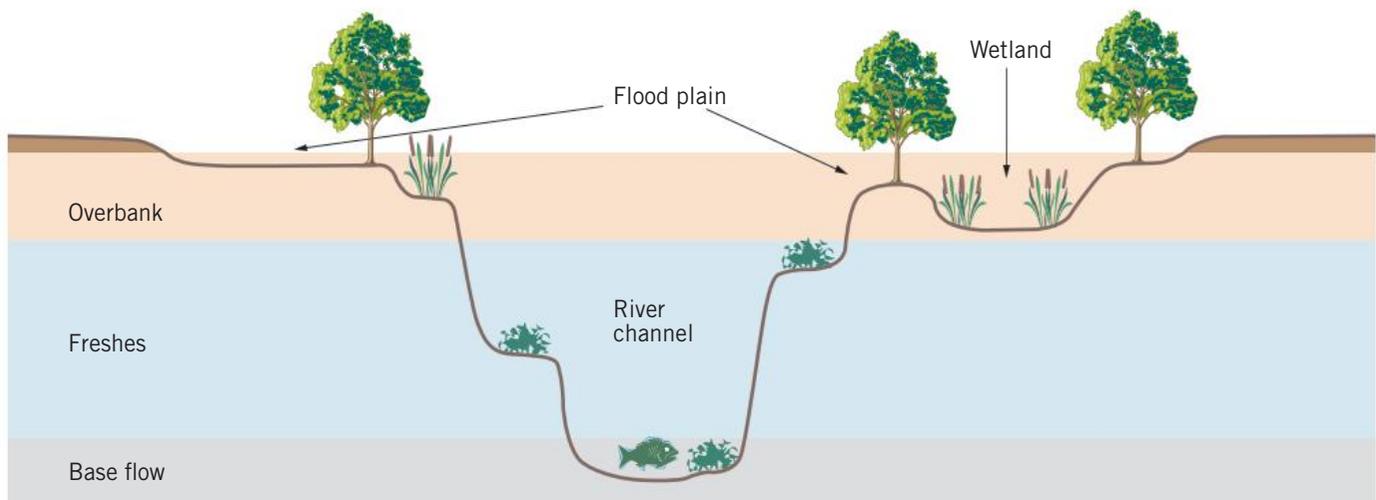
#### Ngurunderi's story

One of the main Dreaming stories telling of the creation of the River Murray is that of Ngurunderi, the all-powerful ancestor of the Ngarrindjeri people. Ngurunderi's long journey to the Coorong created the Murray and its landscape.

While there are several different recounts of Ngurunderi's story, the common theme is his long chase of the Murray Cod (Ponde), towards the Murray mouth. As Ponde swam to escape Ngurunderi's spear, the wide sweeps of his tail widened the river and created its bends and turns. At last the giant fish arrived at Lake Alexandrina, where it foundered in the shallows.

With the help of Nepele (the brother of Ngurunderi's wives), Ponde was speared in the Lake. Ngurunderi divided the fish with his stone knife and created a new species of fish from each piece.

5.11 Different river features are inundated at different levels of flow. Overbank flows inundate flood plains and wetlands, and freshes fill much of the river channel with fast-flowing water.



Source: *Water: Science and Solutions for Australia*, CSIRO, 2011

## Water quality and ecosystem functioning

Changes in flow regimes are often accompanied by more pollution and sedimentation, which can lead to a significant loss in ecological functioning, such as the following.

- **Eutrophication:** Algae occur naturally in inland waters and play an important role as producers. However, when the water becomes enriched with nutrients such as nitrogen and phosphorus, the algae grow rapidly in blooms and disrupt ecosystem functioning by covering water surfaces; prevent light penetration by using up the oxygen in the water; and excrete toxins. Blue-green algae, or cyanobacteria, are especially poisonous when their cell walls rupture (see Figure 5.12).
- **Sedimentation:** Sediments are transported by surface flow in rain events and are deposited when the flow wanes. They can cover and smother aquatic plants, preventing them from photosynthesising, which affects the food chain. Even while the sediments are in suspension in the water, they have an impact on ecosystem functioning, as they absorb heat. This increases the temperature of the water and, as it warms, the water loses its ability to hold dissolved oxygen. Deposited sediment can also become stirred up and re-suspend, releasing both nutrients and contaminants into the water.
- **Biomagnification:** Biomagnification is a problem in aquatic ecosystems that are polluted by toxic substances such as heavy metals. At successively higher levels of the food chain, these substances become more concentrated. As a result, organisms at the top of the food chain generally suffer greater harm from a persistent toxin than the levels below.

5.12 Blue-green algae at Chaffey Reservoir near Tamworth, New South Wales



## SPOTLIGHT

### Tarmgaeddon

As conventional sources of oil are limited, the tar sands in the Canadian wilderness are being exploited. The tar sands, which now produce more than 1.3 million barrels of oil a day, are located in the largely untouched boreal forest of Alberta, and cover 140 000 square kilometres.

Tar sands are sludgy deposits of oily soil. To extract the oil requires enormous quantities of energy and several stages of industrial processing, which creates poisonous tailings ponds. Recently, 1600 ducks accidentally landed on one of these and all died instantly. As this mining activity occurs above Canada's biggest aquifer, there is no guarantee that there will be no contamination.



5.13 Alberta tar sands

## ACTIVITIES

### Knowledge and understanding

- 1 Identify the various types of flows within rivers.
- 2 Explain why it is vital to maintain the link between a river and its flood plain.
- 3 Define the terms 'eutrophication' and 'biomagnification'.
- 4 Explain how high levels of sediment in surface flows have an impact on inland water environments.

### Applying and analysing

- 5 Create a KWL chart about tar sand extraction in Canada.

# 5.4

## Managing inland waters

Humans must work towards a better understanding of how water can be managed, so that it will continue to meet both the needs of humans and the ecosystems on which they depend. Securing adequate fresh water has always been at the forefront of people's interactions with the environment, because without water they cannot exist. Yet there have been very different approaches to such interactions, reflecting the worldviews of those involved.

### Worldviews and environmental management

#### Human-centred worldview

For people with a human-centred worldview, water has become a commodity. It is to be extracted, exploited and traded. Gone is the spiritual connection with water and an appreciation that it is an ongoing giver of life. Water is an input into the vast range of economic activities to produce the food and all the commodities people want in order to secure what they believe to be higher standards of living.

The demands on inland waters include household drinking water and water for cooking; personal hygiene and sanitation; irrigation and other agricultural uses, such as watering stock; industrial production for such purposes as fabricating, processing, washing, diluting, cooling and being incorporated into products; fisheries

and aquaculture; waste disposal, whereby waterways carry away residuals from processes of human production and consumption; and recreational uses such as swimming, boating, waterskiing and angling.

As populations and economies grow, national governments invest heavily in water infrastructure to increase the availability of water. For more than 4000 years, dams and reservoirs have been constructed across rivers to collect and store vast amounts of water and then manage releases into rivers to meet the ongoing needs of people. Many of these dams are still in operation today. A human-centred worldview is exemplified in river basin diversion projects, when water is moved from one river basin to another for better utilisation by humans.

5.14 San Juan-Chama Project, New Mexico and Colorado, USA



## San Juan–Chama Project

The San Juan–Chama Project (Figure 5.14) consists of a series of tunnels and diversions that take water from the drainage basin of the San Juan River—a tributary of the Colorado River—to supplement water resources in the Rio Grande watershed. The project delivers water for irrigation and municipal water supply to cities along the Rio Grande, including Albuquerque and Santa Fe. Such schemes divert

vast amounts of water, taking much of the natural flow away from one basin purely to meet the demand for water of people living in another.

Where countries share river basins, **transboundary** issues of water quantity and quality may arise and conflicts can occur. Future wars could well be fought over control of this critical resource, just as they were over Gulf oil last century.

## SPOTLIGHT

### The Bontoc people of the Philippines

The Mountain Province is a landlocked region on the island of Luzon in the north of the Philippines. It is characterised by a belt of volcanoes from which arose a large mountain range known as the Central Cordillera. The region is dissected by a number of swift-flowing streams that carry the heavy rains of the summer monsoon. The Bontoc are a highland tribal group that have lived on the banks of the Chico River for centuries.

The Bontoc are agriculturalists and support themselves by growing rice, corn, coconut, sugarcane, bananas, pineapple, coffee, mangoes, tobacco and abaca (a banana-like plant). Securing their food supplies is only possible with careful management of water resources. They are fortunate to live in a tropical climate with constant high temperatures that are favourable to plant growth. The soils are also particularly fertile, as they are derived from volcanic rock and have a rich mix of nutrients. There is little flat land available, as 83 per cent of the region is mountainous, but the Bontoc overcome this by cutting terraces into the hillsides, creating level fields to cultivate. While plenty of rain is brought by the summer monsoon, the Bontoc have had to cope with a dry season from December to February.

The Bontoc's stewardship worldview guides their water management practices; they believe that humans are at one with nature and can never be above it. Nature is viewed as the source of all life and as such it is respected and nurtured.

The Bontoc live by the principle of communal ownership, whereby equity and cooperation are a priority. A foremost consideration in their water management is ensuring that water is equally distributed to all rice-field owners in the dry season. Through a cultural irrigation practice known as *oblis*, they take turns in watering their rice fields in the dry season.

Water sites (springs, rivers and lakes) are considered sacred places, and rituals and ceremonies are performed to express respect for and devotion to the spirits that guard their water. In return, the spirits bestow abundant and clean water on the people. There are also myths that warn of conflict over water.

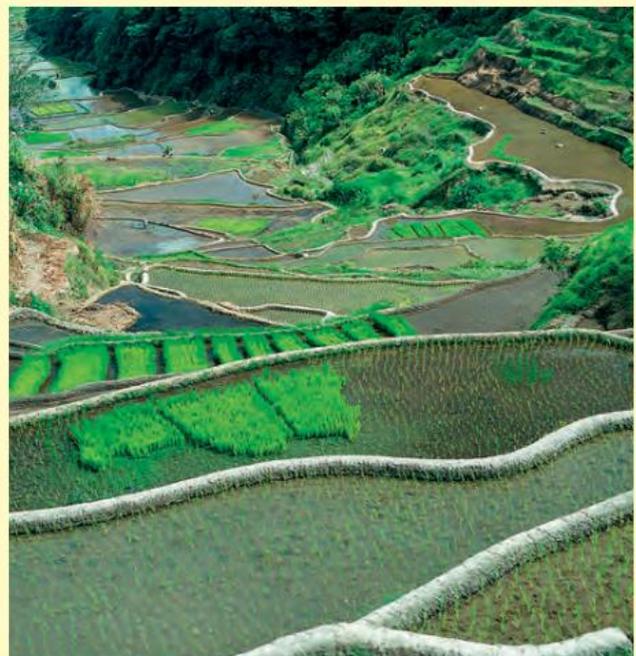
The Bontoc's approach to water management is holistic, linking the forests and the mountains with their water. The very old practice of terracing prevents soil erosion and maintains the forest watersheds. The Bontoc mastered the ancient stone walling techniques, using stones they hauled up from Chico River. The stone walls hold back water, and

so the terraced fields act as reservoirs, which are used to water crops in the dry season. The standing water has altered the microclimate in the area, as more evaporation results in more local rainfall. The Bontoc also have taboos forbidding disturbance of any springs or forests in catchment areas.

Today, the Bontoc have by choice retained most of their traditional culture. The Bontoc society possesses a wealth of traditional knowledge that sustained their water resources through centuries. The Bontoc municipal government has a more human-centred worldview and has adopted a modern bureaucratic approach to managing the water resources of the Central Cordillera. Officials are concerned that the once clean and reliable supply of water is becoming murky and depleted and there is a potential water crisis.

There are other pressures on the mountains, as the Central Cordillera not only has mineral resources, but the region also holds enormous potential for hydroelectric production. At least 5 million kilowatts of power could be generated if its rivers were dammed, which would provide over half of all of the electrical needs of the Philippines. If the rivers are dammed, the Bontoc lands would be flooded and the people displaced.

5.15 The Bontoc are particularly adept at rice terrace farming.



## Stewardship worldview

Water is central to the cultural and spiritual values of many indigenous communities. In many instances, indigenous people regard water not merely as being essential for human survival, but as an important part of their spiritual wellbeing. Water is an important part of the Australian Indigenous Dreamtime narratives used to explain the creation of the world and natural features of the environment. Significantly, indigenous knowledge systems are based on the principles and practices that balance their immediate needs and the needs of the environment, people and other living things, as well as the needs of future generations.

In Australia, inland waters not only provided Indigenous people with drinking water, they were also a particularly bountiful source of food, not just fish, but also the animals that were drawn to waterholes and streams to drink. Water was also taken from wells and rivers to irrigate crops.

Indigenous people developed successful systems of water management. Underlying this was the acceptance of a communal need to be at one with nature, and a recognition that water resource management was the responsibility of every person. As a consequence, they employed the principles of sustainable management, ensuring the ongoing supply and quality of water.

5.16

Low stone-walled fish traps once used by Aboriginal people for catching fish in the bed of the Barwon–Darling River



## Aboriginal people of the Murray–Darling Basin

The traditional owners of the lands in the Murray–Darling Basin have deep cultural, social, environmental, economic and spiritual connection to their lands and waters.

Aboriginal people have lived in the basin for thousands of years and there are at least 10 000 known water-related Aboriginal sites in the basin. The rivers and flood plains are of particular importance. Today there are over forty Aboriginal Nations in the Murray–Darling Basin.

The lands of the Murray–Darling Basin provided the region's Aboriginal people with a diverse and abundant source of food, water and shelter (see Figure 5.16). Shell middens of freshwater mussel shells, together with bone remnants of wallabies, yabbies, lizards, fish and birds, give us an insight into the diet of Aboriginal people.

The Aboriginal people still talk about how the waters of the basin sustain their life and identity. They view themselves as an integral part of the river system, and as a result they feel a responsibility to ensure the health of rivers.

## Earth-centred worldview

Inland waters and the sediments they carry are integral to the processes that support ongoing life on land. Exploitive extraction or pollution of these waters compromises these processes and the resulting environmental changes can be disastrous. People with an earth-centred worldview have been more active in protecting inland waters than other environments. The importance of maintaining the supply



of fresh water is evident, but it may well be that lakes and rivers evoke strong feelings in those who believe that the integrity of such natural places must be protected.

One of most direct interventions by an individual with an earth-centred worldview was the purchase by former businessman Douglas Tomkins of 32 000 square kilometres of land in Chile to protect the lakes, forests and mountains from exploitation for power generation, industry and agriculture. He established Pumalin Park, which is now recognised by the Chilean Government as a nature sanctuary, despite the government's early efforts to promote the development of the region.

Most people with an earth-centred worldview do not have the financial resources to accomplish what Douglas Tomkins did, but they can bring about change that provides protection for inland waters at risk. They can pressure governments to be more mindful of the natural values of inland waters and the importance of these values in sustaining those waters. Protection can be sought under the intergovernmental Ramsar Convention.

## Ramsar Convention

The Convention on Wetlands of International Importance, called the Ramsar Convention, is an intergovernmental treaty that provides the framework for national action and international cooperation for the conservation and wise use of wetlands and their resources. The Ramsar Convention is the only global environmental treaty that deals with a particular ecosystem. The convention uses a broad definition of wetlands, including lakes and rivers, swamps and marshes, wet grasslands and peatlands.

5.17 Lake Barombi Mbo, south-west Cameroon

The convention's mission is 'the conservation and wise use of all wetlands through local and national actions and international cooperation, as a contribution towards achieving sustainable development throughout the world'. Lake Barombi Mbo (see Figure 5.17) is a small crater lake in Cameroon, Africa. It is especially important because it is an area where speciation (the process of evolutionary adaption) has been proven to take place. It is at risk from pollution, overfishing and sedimentation, and it has been nominated as a Ramsar site so that it can be protected.

## ACTIVITIES



### Knowledge and understanding

- 1 Describe how many indigenous people view inland waters.
- 2 Explain how the Bontoc people managed their water resources in a sustainable manner.
- 3 Outline the demands on inland water by people with a human-centred worldview.
- 4 State the mission of the Ramsar Convention.

### Geographical skills

- 5 Refer to Figure 5.15. Construct a photo sketch and label the main features. Explain how terracing is carried out and how it benefits the mountainous environment.

# 5.5

## Human-environment systems thinking

The aim of managing water resources is to safeguard human access to quality fresh water while maintaining sustainable aquatic and associated terrestrial ecosystems. Human-environment systems thinking provides a useful framework for developing effective and sustainable water management practices.

### Assessing the state of an environment

To manage inland waters it is important to assess the current state of the environment and how it has changed over time. In assessing the state of an environment, it is useful to use the following questions to frame the inquiry.

- 1 State of water
  - What is the water quality? (An assessment based on the ecological quality of the water and levels of nutrients, pesticides and heavy metals)
  - How much water is there? (An assessment based on data on run-off, availability, demands and any evidence of water stress)
- 2 Time-based trends
  - Is water quality getting better or worse?
  - Is the amount of water increasing or decreasing over time?
- 3 Is there a problem, and if there is, what is causing the problem?
  - Humans and their domestic-based uses?
  - Industry?
  - Agricultural uses?
- 4 Are there policies in place to work on solutions?
  - Have aims and targets been decided upon?
  - Who has been employed to work on solutions?
  - Has a time frame been implemented?

The state (type, quality and quantity) of water is determined by natural factors such as geology and climate and also by the pressures exerted by human activities. For example, geology will influence the amount of mineral material in water, while agriculture is a significant driver in terms of ecological quality, nutrient and organic pollution, hazardous substances and water quantity.

The European Environment Agency (EEA) applies human-environment systems thinking, acknowledging that humans have an impact on the biophysical environment,

and applies the DPSIR framework to water issues. The analytical DPSIR framework allows a comprehensive assessment of the issues through examination of the relevant driving forces and pressures on the environment. The use of this framework to assess water quantity and quality is illustrated in Figures 5.18 and 5.19.

### Management strategies

Much of the pressure on inland water environments is a legacy of the past and a human-centred worldview: the impounding of rivers, the drainage of wetlands, the clearing of native vegetation in catchments and the introduction of pests and invasive species. Given the magnitude of such changes, and the recognition that they cannot be reversed, these pressures remain. This makes the choices made now even more important if inland water landscapes are to be managed more sustainably and restored.

The challenge ahead is to rehabilitate and protect inland water environments while enabling sustainable use of water resources. Humans cannot do without water, and with their increasing numbers they are going to want more of it. This comes at a time when it is clear that more water needs to be given back to the environment to restore natural balances—otherwise the quantity and quality of water in the future will be compromised, not just for humans, but for all life. The biodiversity of inland waters is the evolutionary capital for continued productivity. This is especially important given the threats associated with climate change.

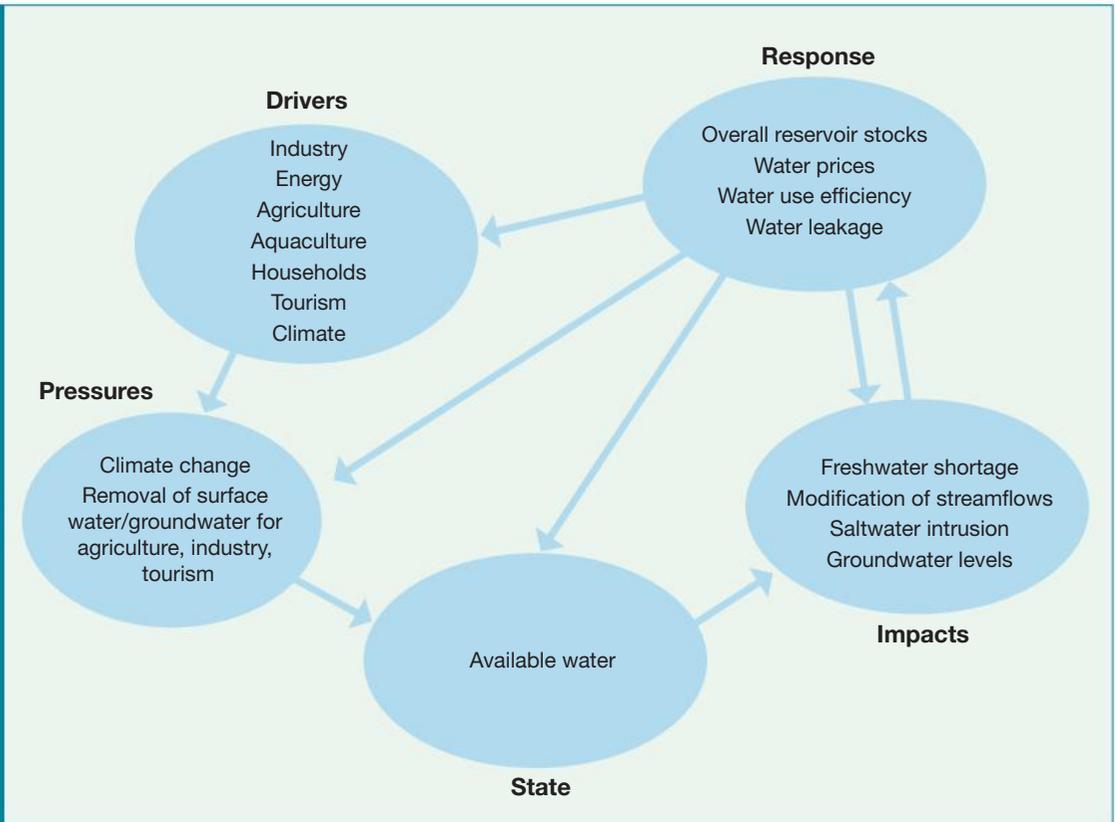
### Ecosystem approach

The **ecosystem approach** to inland water management integrates the management of land, water and living resources in ways that promote conservation and equitable sustainable use. The ecosystem approach calls for the focus to be on the ecosystem: its components, structure, processes and functions and all the interactions that occur among its organisms and their environment.

5.18 A DPSIR framework for managing water quantity

**Water quantity**

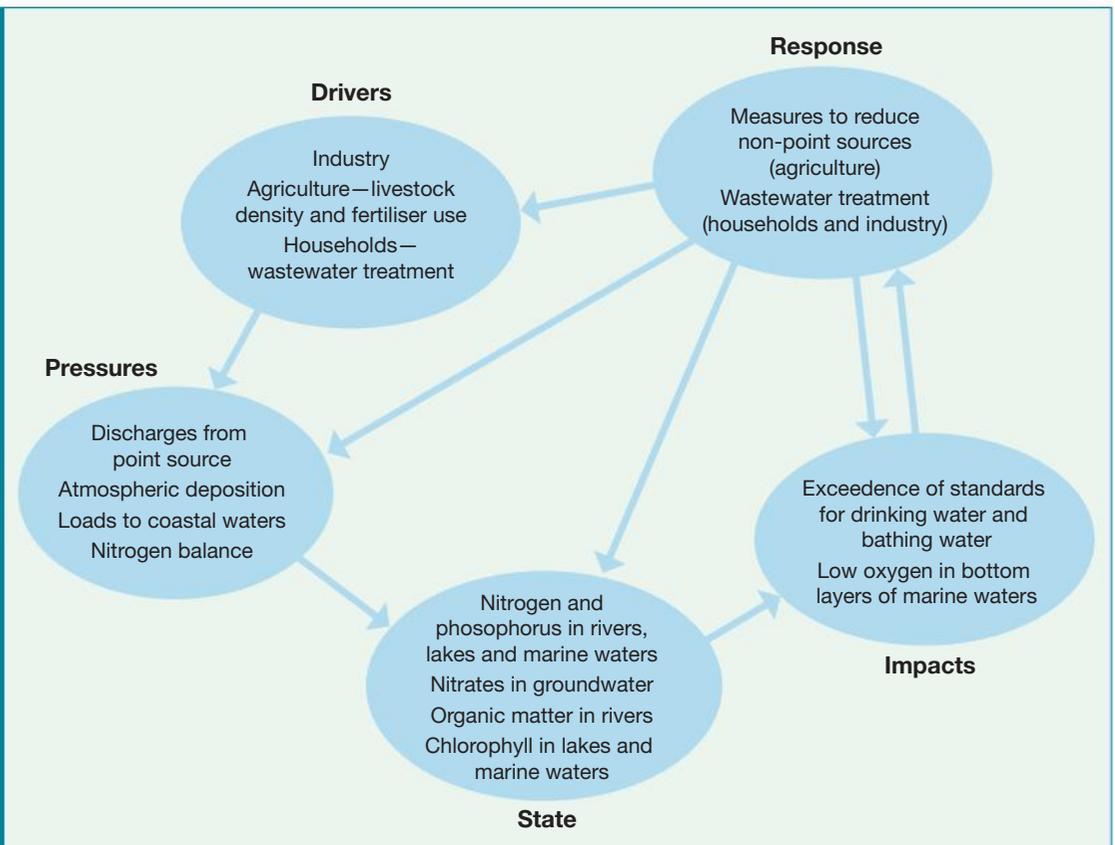
Water availability problems occur when the demand for water exceeds the amount available during a certain period. Fresh water shortages occur frequently in areas with low rainfall and high population density and in areas with intensive agricultural or industrial activity.



5.19 A DPSIR framework for assessing water quality—organic pollution and eutrophication

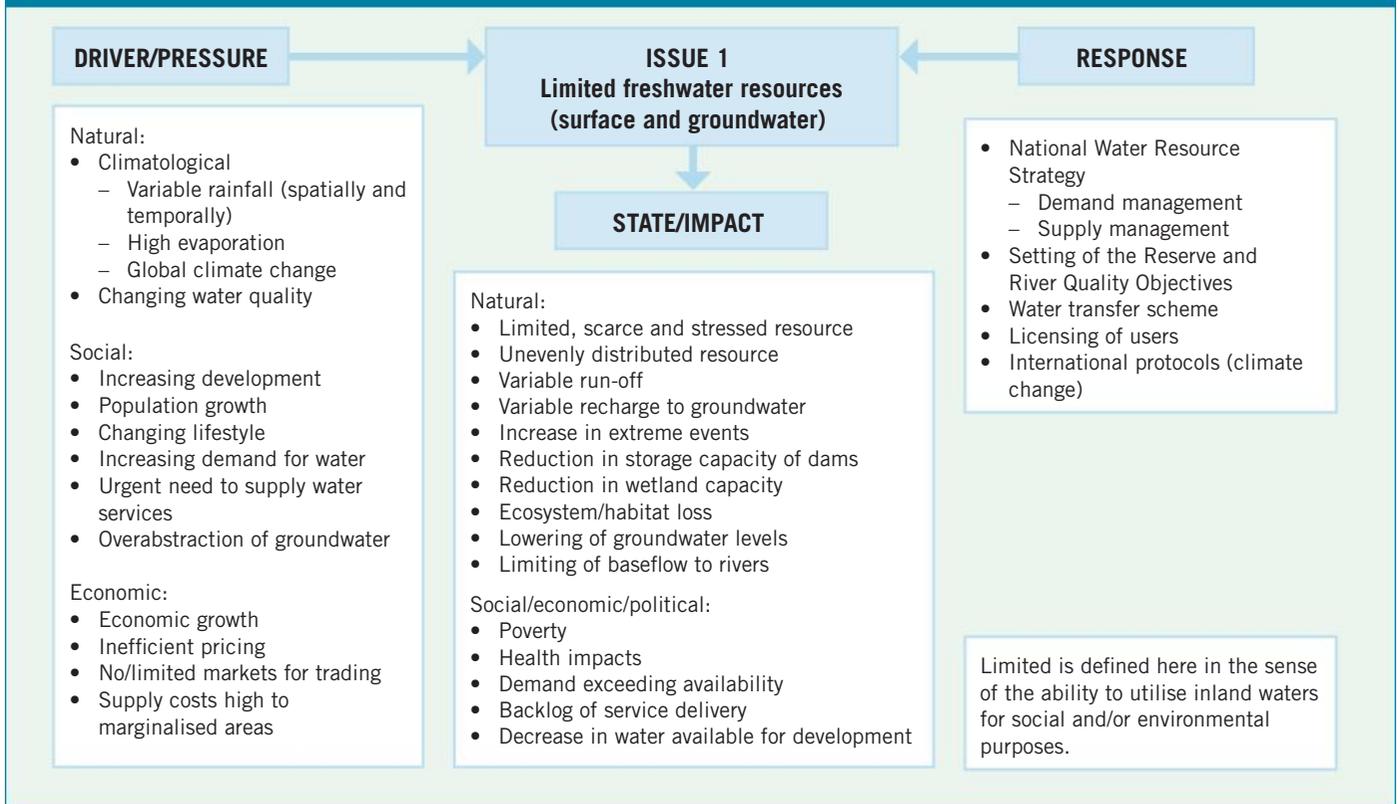
**Water quality—organic pollution and eutrophication**

The effects on the aquatic environment of organic pollution, caused by discharges from wastewater treatment, plants, industrial effluents and agricultural run-off, include reduced river-water chemical and biological quality, as well as impaired biodiversity of aquatic communities.



## Drivers affecting South Africa's inland water resources

Inland water systems are affected by two main drivers, natural (e.g. climate) and human-related (e.g. development). These drivers cause certain pressures on inland waters, which result in impacts on freshwater resources, by changing the quantity of ground/surface water and/or by changing the quality of ground and/or surface water. The DPSIR framework for managing limited freshwater resources in South Africa is shown below.



5.20

A DPSIR framework for managing limited freshwater resources in Africa

### Adapting the DPSIR model

The approach includes humans in the mix. Given the complexity and the dynamic nature of ecosystems, there is recognition that management must be adaptive as shown in the DPSIR model for South Africa in Figure 5.20.

## UN Watercourses Convention

The UN Watercourses Convention (UNWC) was established to govern the management and protection of international watercourses. It deals specifically with international water law and policy. The Convention applies to surface and underground water systems that cross international borders, and includes all major rivers, their tributaries, and connected lakes and aquifers. The UNWC takes into account and promotes the ecosystem approach in the use of such watercourses by considering transboundary environmental effects. This enables cooperation between nation states in:

- arriving at a reasonable and equitable use of shared water resources
- undertaking measures to rehabilitate and restore degraded ecosystems.

Following the ecosystem approach, the UNWC makes it clear that environmental concerns and ecosystem protection are just as much within their area of responsibility as the amount of water used. Thus both water quantity and quality are scrutinised. A priority is also the rehabilitation and restoration of degraded inland water ecosystems.

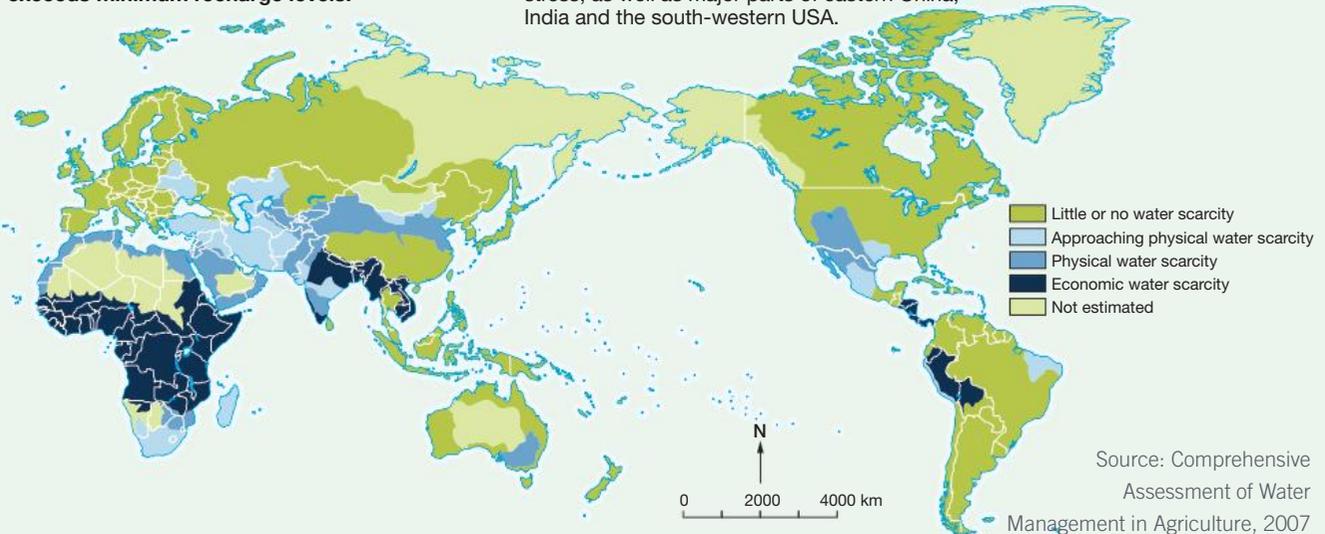
## Integrated Water Resource Management

The increasing need for a more holistic approach to environmental management has led to the development of Integrated Water Resource Management (IWRM), now considered to be the most effective means of managing inland waters. In the IWRM approach, water is viewed as less of a commodity and more of a resource that needs to be equitably shared by all users, including nature. The IWRM approach involves all stakeholders working together to identify the costs and benefits of various water uses and finding an appropriate balance between development and sustaining ecosystems.

An estimated 1.4 billion people live in river basin areas where water use exceeds minimum recharge levels.

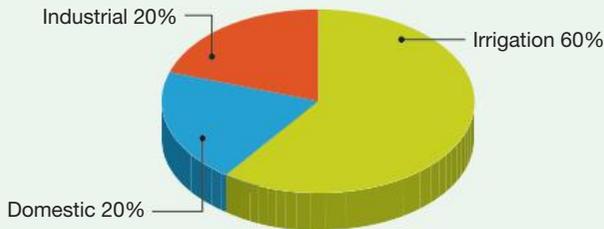
### GLOBAL WATER STRESS

Arab region countries have high levels of water stress, as well as major parts of eastern China, India and the south-western USA.



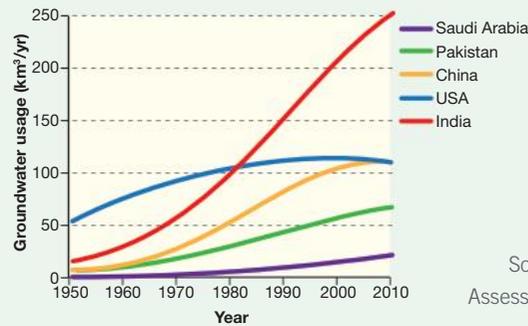
### DEMAND FOR GROUNDWATER

As of 2010, the world's aggregated groundwater abstraction is estimated at up to 1000 km<sup>3</sup> per year



Source: National Groundwater Association, 2013

### Trends in selected countries



Source: World Water Assessment Programme, UNESCO, 2012

5.21

All the world's inhabited continents are experiencing water stress as consumption levels rise.

## Addressing the causes of environmental change

The current state of inland waters—that is, declining water quantity and quality—is a result of too much water being extracted, too many pollutants being added, and little concern about inland water environments (see Figure 5.21). In order to address the causes of environmental change, all users must be more aware and responsible in their water usage. People must realise that they are all downstream or across the shore from someone else.

There needs to be a universal appreciation that:

Water is unique amongst our natural resources because whilst it is renewable, it is not replaceable. We have various substitutes for energy resources and most commodities, but there is no substitute for water. Once it is gone or degraded through overuse or pollution, it cannot be substituted.

Convention on Biological Diversity, Drinking water, Biodiversity and Development, 2010, UN Water

## ACTIVITIES

### Knowledge and understanding

- 1 Describe Integrated Water Resource Management.

### Geographical skills

- 2 Refer to Figure 5.21 then do the following tasks.
  - a Identify the parts of the world that experience the greatest water stress.
  - b Suggest reasons why water stress is an issue in these regions.
  - c What was the approximate consumption of water by Saudi Arabia in 1990?
  - d What was the approximate increase in consumption by the USA from 1950 to 2010?
  - e Which country had the biggest increase in consumption from 1950 to 2010? What do you think this is a result of?

# 5.6

## Case study: The Great Artesian Basin

The inland water of the Great Artesian Basin is a resource of national importance. Historically, artesian water was vital for the development of northern Australia but viability of flows must be ensured for the future wellbeing of the region and its communities.

### Australia's fabled inland sea

From the early 1800s, European explorers went in search of the fabled inland sea of Australia, thought to be west of the Blue Mountains. As no major rivers were seen to be entering the sea, it was believed that the rivers must flow to an inland sea. The first expedition to find the inland sea was led by John Oxley, NSW surveyor-general, in 1817. Later expeditions were undertaken by Charles Sturt in 1828, who mapped the Macquarie River and reached the Darling River. There was no inland sea to be found above ground, but underground was the Great Artesian Basin (GAB).

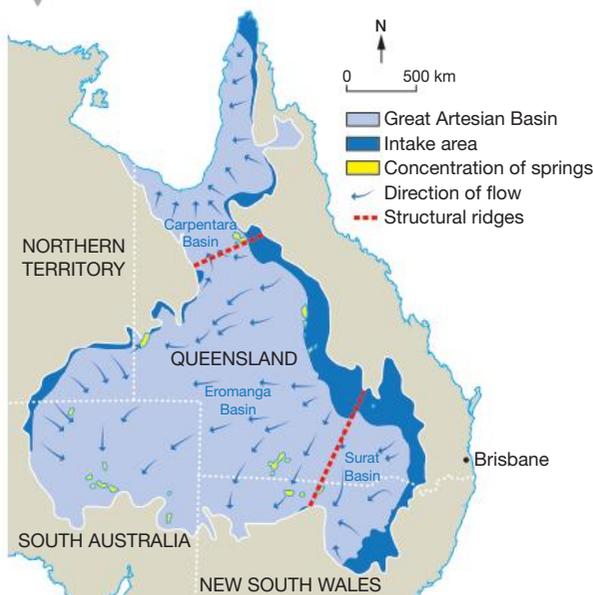
The GAB is Australia's largest freshwater resource. It underlies one-fifth of the continent, including parts of Queensland, New South Wales, South Australia and the Northern Territory—an area of more than 1.7 million square kilometres. The GAB is composed of many different layers of rock. Some layers, such as sandstone, are aquifers, while others are impermeable, as rocks such as mudstone

and siltstone will not allow water through them. These impermeable layers are called **aquicludes**.

Figures 5.22 and 5.23 show that the GAB aquifers fill, or recharge, on the edges of the basin, where the sandstones are exposed. Water moves through the aquifer very slowly at a rate of only 1 to 5 metres a year. The GAB is bowl-shaped and the aquifer is sealed by aquicludes. The water at the lowest part of the basin is stored under pressure. When a bore is sunk, it rises to the surface.

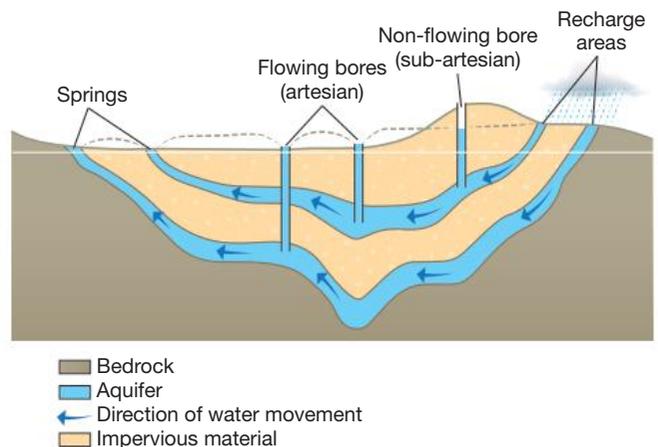
Water can naturally discharge at the surface in springs where the watertable is intersected because the aquifer slopes upwards towards the surface, or where there is a fault line. There are numerous springs on the basin's fringes. As they are permanent sources of water in an otherwise dry environment, they support rare flora and endemic invertebrates and fish. They support luxuriant growth of sedges, bulrushes and reeds as high as 3 metres (see Figure 5.24). They are also referred to as 'mound springs', as they look like miniature volcanoes.

5.22 Location of the GAB



5.23

If the water in a bore reaches the surface unassisted, it is known as a flowing or artesian bore. If it has to be pumped up, it is called a sub-artesian bore.





5.24 A mound spring in the desert

## SPOTLIGHT

### Indigenous people's connection with *kwatye* (water)

*Dean An Chee of the Southern Arrente people, Senior Ranger, Witjira National Parks and Wildlife Service South Australia:*

Witjira National Park is located on the western edge of the Simpson Desert in the far north of South Australia. The responsibility to care for this country belongs to my people, the Indigenous Southern Arrente people, and the Irrwanyere Aboriginal Corporation. We have cared for this country for a long, long time.

Located in this area are many mound springs, which are central to our Tjukurpa. Tjukurpa contains our spiritual connection, our law, our culture, our heritage and the stories associated with the land. *Kwatye* is an Arrente word for water within the Great Artesian Basin. Well before my elders' time it provided more than just a source of water for Indigenous people. For it was and remains a travel path, which connects many Indigenous groups.

This water is a source of healing when we are sick, and it provides us with many spiritual and cultural interests. For it is our lifeblood, which we need to survive. It allows us to continue our ceremonies, which incorporate our rich and unique culture that is still strong today. For it is these sources of water that provide an adequate and valuable food source rich in fish and other foods for my people. As one of the traditional elders of this country, Mr Bigey Lowe, says: 'We are in the middle of *kwatye* (water), it is all around us, we have to look after this place.'

Source: Adapted from Dean An Chee, 'Indigenous People's connection with *Kwatye* (Water) in the Great Artesian Basin', Great Artesian Basin Coordinating Committee, 2002

## Precious water in a parched land

The fresh water of the GAB is the only reliable source of water in many arid and semi-arid regions of Australia. It supports pastoralism, industry, mining and tourism in the region.

For tens of thousands of years the mound springs and their pools provided Australia's Aboriginal people with permanent water supplies and food. Knowing where to find the springs was a matter of survival as they moved through the desert. Their use of this inland water was sustainable, as they only collected what they needed and what was naturally replenished.

When Europeans arrived and discovered these large pools of water, they set up pastoral properties. In 1878, a shallow bore was sunk near Burke, New South Wales. It produced flowing water. Within a decade, more than 500 bores had been sunk around the margins of the basin. Because the water was held under pressure, most of just flowed freely into open drains to water stock. Initially, some of the bores would shoot water 100 metres into the air and supply up to 455 megalitres in a day.

Within just a decade, there were concerns about the decline in flow from bores. Despite this, more were drilled and thousands of kilometres of open drains were dug for over a century. In that time, an amount of water equal to 100 times the volume of Sydney Harbour was extracted—and more than 90 per cent of it was wasted. It was wrongly assumed that rainwater would seep through quickly into the sandstone in the east and recharge the basin. Scientists now know it will take millions of years.



5.25 A coal seam gas well

## Coal seam gas

Coal seam gas (CSG) is a type of natural gas extracted from underground coal seams at depths of 300 to 1000 metres. CSG can be captured and used for generating energy, or processed into liquefied natural gas and exported. The extraction of CSG has raised many issues, including fears about damage to the aquifers and the contamination of the water.

Water must be removed from the coal seam to enable the CSG to move up to the surface. There is a fear that this will alter groundwater levels, thereby damaging the aquifer. In some coal seams, it is necessary to create fractures to provide pathways through which the gas can flow. This is done using a technique known as hydraulic fracturing, or **fracking**. This technique involves injecting a fluid made of water, sand and chemicals into the well under high pressure (see Figure 5.25). The fluid is then pumped back to the surface, where it has to be disposed of. There are concerns that some gas could escape and that the chemicals used could contaminate both ground and surface water.

## Strategic Management Plan

The Strategic Management Plan was launched in 2000 to provide a framework for responsible groundwater and related natural resource management in the GAB. It guides governments, water users and other stakeholders on policies, programs and actions required to achieve optimum economic, environmental and social benefits from GAB groundwater resources. The aspirations of basin-wide management for the future are listed in Figure 5.26.

The Great Artesian Basin Sustainability Initiative has assisted with the implementation of the SMP by providing finance to landholders to rehabilitate bores and replace bore drains with piped systems, as shown in Figure 5.27.

## Evaluation of the Strategic Management Plan

The plan has been assisting land managers to achieve more sustainable property and stock management. The success of such efforts can be judged by considering the criteria used in evaluation.

### Environmental criteria

The water savings are substantial and in many places the water pressure is on the rise. Some springs have started flowing again, restoring the aquatic habitat and ecosystem functioning. However, the rate of recovery in the western side of the basin is slow.

### Economic criteria

The financial assistance provided by the government has helped landholders to attend to their bores and reduce waste. This is an expensive process and they would have been unlikely to have done so otherwise. Funding from the government is dependent on the state of the economy and political priorities.

### Social criteria

The plan is supportive of landholders and they are receptive to the framework being a basin-wide management plan. The greatest conflict relates to the relatively new practice of coal seam gas extraction.

# Aspirations for basin-wide management

Key elements of the vision for the state of the Great Artesian Basin in 50 years:

- The GAB is widely recognised and cooperatively managed as a resource of national importance.
- Water managers have a sound understanding of the dynamic hydrological functioning of the GAB resource.
- Recognising the benefits for all Australians, judicious management of GAB water:
  - maximises productivity within limits of sustainability, based on scientific evidence
  - retains options to allocate water for uses which may not yet have been conceived, for the benefit of future generations
  - enhances biodiversity and cultural values associated with GAB water
  - is integrated effectively with management of land and management of other water resources.

Improvements in the state of the Great Artesian Basin from judicious management of water are evident in the following Key Outcomes (20 years):

- Basin pressure continues to be restored to the levels required to meet balanced biophysical, cultural and socio-economic objectives in state/territory plans, and this pressure can be sustained.
- Wastage of water is reduced to negligible levels.
- Improved productivity is enabled and sustained.
- Land degradation from water-use practices is reduced to negligible levels.
- The 'natural' condition of biodiversity is enhanced by improved water distribution.
- The health of GAB springs and groundwater-dependent ecosystems is enhanced and sustained.
- Cultural heritage assets associated with the GAB are recognised and protected.

These aspirations form the basis for Resource Condition Targets in the GAB Strategic Management Plan Assessment and Reporting Framework.

Source: GAB Consultative Council

## 5.26 Aspirations for basin-wide management

## 5.27 Before: a free-flowing bore drain; after: a capped bore



## ACTIVITIES

### Knowledge and understanding

- 1 List the states in which the GAB is located.
- 2 Explain how groundwater moves through the GAB.
- 3 Describe the process of fracking.
- 4 Assess the significance of the GAB to Aboriginal people.
- 5 What has been the impact of Europeans on the GAB?

### Applying and analysing

- 6 Why will it take millions of years for the GAB to be replenished?
- 7 **a** Complete a KWL chart about coal seam gas extraction.  
**b** Conduct a class debate on the following topic: 'Coal seam gas extraction should be banned from northern Australia.'

### Investigating

- 8 Refer to Figure 5.23. Using the internet, research groundwater movement in the GAB. Redraw the diagram and replace the labels with textboxes providing more detailed explanations.

# 5.7

## Case study: The Pangani River Basin

The Pangani River Basin is one of the most productive areas of Tanzania. It is fed by snowmelt from Africa's highest mountain, Mt Kilimanjaro, and, just like the mountain, it is feeling the adverse impacts of climate change. There is currently not enough water to meet demands in the basin and conflicts are emerging between various water users.

### The Pangani River Basin

The Pangani River Basin drains a large area in north-eastern Tanzania along the border with Kenya (see Figure 5.28). The source of water is rainfall on the mountains and snowmelt from Mt Kilimanjaro. The major threats to water security are environmental degradation, climate change and increased usage.

### Water usage in the Pangani River Basin

The Pangani River Basin has a population of 3.7 million people. Eighty per cent rely on agriculture for their livelihood. Most live in the highlands and foothills, where rainfall is higher. There is large-scale production of sugar, coffee and flowers, as well as small-scale growing of corn and rice. All these crops are, for the most part, irrigated. A large proportion of the farmers believe that they do not have enough access to water.

There are also many nomadic pastoralists who depend on livestock and are forced to move from place to place in search of water (see Figure 5.29). The river provides a livelihood for some of the poorest people, who turn to fishing when crops fail (see Figure 5.30). In addition, the basin also has four hydroelectric power facilities that supply 17 per cent of Tanzania's power needs.

Considerable conflict has arisen over water resources in Tanzania, the extent of which is evident in Figure 5.31. Some conflicts have been quite violent, with farmers accusing pastoralists of destroying their livelihood, as herds of cattle eat and trample crops when heading to the river to drink.

Inland waters are already clearly over-allocated and this is without allowing for the vital needs of the basin's aquatic ecosystems and inland water environments.



5.28 Location of the Pangani River Basin



#### DID YOU KNOW?

Almost 90 per cent of the surface flow from the Pangani River is used for irrigation and hydroelectric power generation.

5.29 Pastoralists and their cattle on the move, seeking water



5.30 Fishing is very important for the survival of the poorest people in Tanzania.



5.31 Conflicts in the Pangani River Basin

- 1 Communities and conservationists:** In the highlands, conservationists conflict with the community. The establishment of national parks to conserve catchment areas and increase tourism has generated revenue. The farmers would like to use the conservation areas for farming and gathering fuelwood. The pastoralists would like to graze or move their livestock there.
- 2 Upstream and downstream users:** Conflict is caused by higher allocation of water for highlands users, hence inadequate water for small farmers in the lowlands. There are complaints that the share for downstream users is not adequate.
- 3 Hydroelectricity producers and other users:** Since the establishment of three hydroelectric power stations along the Pangani River, small-scale irrigators have complained that water rights were introduced to protect the power-generating plants.
- 4 Communities and donor agencies:** The competition between donor agencies in the basin generates confusion in the community. They exacerbate water problems in the basin because they compete for the same resources.
- 5 Farmers and pastoralists:** Conflict between these two groups is a result of an increase in the number of livestock in the basin. Cattle destroy natural vegetation and crops.
- 6 Rural-urban competition:** Water pollution increases as the urban areas grow and as farmers use more chemical inputs to grow enough food to feed the fast-growing population.
- 7 Communities and river basin authorities:** Communities are not satisfied, as they are not involved in making decisions when it comes to policy formulation.

## Key challenges

Several studies have shown that the Pangani River Basin is already water-stressed. The river's flow has decreased dramatically in recent years and water demand is expected to double within a decade. The Pangani River Basin Management Project (PRBMP) identifies a number of challenges that need to be addressed. These include:

- frequent cycles of droughts and floods
- population and economic growth
- conflicts over access to water resources
- environmental degradation.

## Deterioration of inland water environments

The rivers in the highlands of the basin are no longer perennial (that is, flowing all year). The Kirua swamp has, as a result, been reduced to a fraction of its original size due the over-extraction of water, which has prevented its flooding.

## Impact of climate change

The overstretched water resources of the Pangani River Basin are also being adversely affected by climate change. The most visible effect is the diminishing snow on Mt Kilimanjaro. An increase in temperature of 1.8 to 3.6°C, increasing evaporation and decreasing rainfall would also result in a 6–10 per cent reduction in annual flow in the drainage basin. Meteorologists have already noted that the climate patterns are changing and the trend towards shorter rainy seasons is set to continue. The more frequent and severe droughts associated with climate change are affecting Tanzania.

## Development and implementation of the project

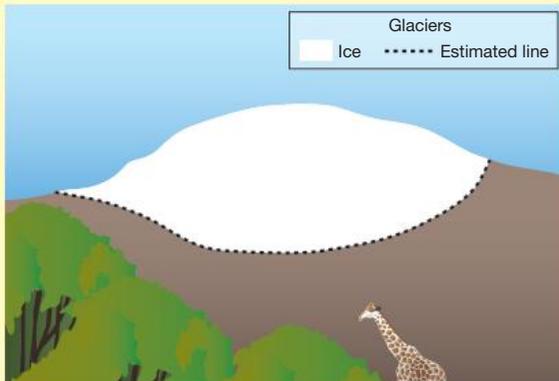
In 2002, the PRBMP was established to manage the basin's water resources. As Tanzania is a developing country, it could only undertake such a project with financial support and technical expertise from a number of sources. These include the United Nations Development Programme (UNDP), the European Union, the Netherlands Development Organisation, and the International Union for Conservation of Nature (IUCN).

### SPOTLIGHT

#### Melting ice on Kilimanjaro

Mt Kilimanjaro is an important water source for the Pangani River Basin. With its famous glacial ice cap rapidly melting, Kilimanjaro has become an international symbol for climate change. It is predicted that its ice cap will be completely gone by 2025.

1912



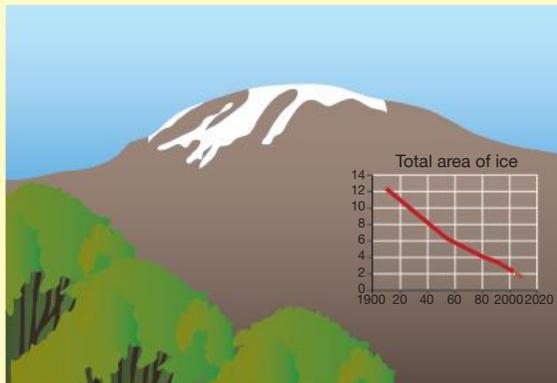
2000



1993



2002



5.32 Melting ice on Kilimanjaro

The project promotes Integrated Water Resource Management (IWRM), which involves the coordinated development and management of water, land and related resources, in order to support the equitable provision and wise governance of fresh water for livelihoods and to protect the environment for current and future generations. The maintenance of aquatic ecosystems is accorded the second-highest priority in water allocation over allocation of water for basic human needs.

The emphasis is on the sustainable use of water and achievement of this requires people to consider the needs of other potential water users and take into account the overall distribution and scarcity of water across the entire river basin.

The PRMBP has undertaken to:

- generate technical information: an Integrated Flow Assessment has been implemented to build an understanding of the hydrology of the river basin and the flow-related nature and functioning of the river ecosystem
- develop participatory forums: the establishment of catchment associations and community-led projects will enhance conflict resolution in the basin, as people are being consulted and participating in decision making.

The full development and implementation of the plans for the project goes beyond simply allocating to one or more water-use sectors (see Figure 5.33). To truly move towards sustainability is far more complex and will occur over a considerable time span. The timeline of implementation may be one to two decades, even though the political will, funds and technical skills exist.

## Evaluation of the project

The success can be judged by considering the criteria used in evaluations.

### Environmental criteria

Tanzania is the first nation in East Africa to raise awareness about climate change impacts. It has also given priority to the maintenance of aquatic ecosystems and has undertaken extensive field assessment of the quality of these systems. However, there is currently not enough water in the basin to meet demands for the people, let alone allow for environmental flows.

### Economic criteria

The PRBMP is fortunate to receive substantial international funding to undertake field investigations and generate important technical information about the basin. However, the high level of poverty in the region puts a lot of pressure on people desperate to support themselves. Their actions can have a negative impact on inland waters.

## Social criteria

The PRBMP is certainly socially inclusive; it has, for example, developed participatory community forums. However, conflict is still rife in some areas, which again is driven by poverty. There have been a number of deaths in the struggle between the small farmers and the pastoralists.

### 5.33 Changes in the Pangani River Basin

#### BEFORE

Over-exploitation of water resources  
Ineffective management  
Limited knowledge about the basin's ecosystem  
Conflict

#### AFTER

Participatory governance—IWRM Plan drafted  
Increased institutional capacity at basin level  
Increased knowledge about water resources  
Empowered water users  
Conflict resolution  
Platforms for stakeholder dialogue

## ACTIVITIES

### Knowledge and understanding

- 1 Describe the drainage of the river basin.
- 2 Explain why the highlands are favoured for agriculture.
- 3 Identify the challenges being faced.
- 4 Explain the impact of climate change on river flows.

### Applying and analysing

- 5 Study Figure 5.31. List the conflicts in the Pangani River Basin and decide whether or not each conflict has a social, economic or environmental impact. Note that some conflicts will have more than one impact.

### Investigating

- 6 Study Figure 5.28. Describe the location of the Pangani River Basin. Find out what Mount Kilimanjaro's elevation and altitude are, and explain why it has snow on its summit.
- 7 Study Figure 5.31. Research the various conflicts identified. Show where these conflicts are occurring on an annotated visual display based on a map of Tanzania.

# 5.8

## Geoskills: Murray Valley National Park topographic map

The Murray Valley National Park is located in the Riverina region of New South Wales. The national park was created in 2011 with the amalgamation of separate state forests. The park is 41 601 hectares in size. The aim of the national park is to protect the majestic river red gum forests of the Riverina's Ramsar-listed wetland. The local Aboriginal people are the Ulupna and Bangerang, of the Yorta Yorta people.

### Boomanoomana

Figure 5.35 shows a section of the Murray Valley National Park that was once known as the Boomanoomana State Forest. The area forms part of the Murray River flood plain. The area is known for the river red gum forests and box woodlands with grasslands and marshes located on the flood plains. The national park is an internationally significant breeding habitat for eighteen migratory bird species, including the vulnerable pied honeyeater. Over sixty native animals and forty plant species listed as threatened call the region home. Since European settlement river regulation, irrigation practices and levee bank construction have reduced flood frequency. These changes to river flow have reduced vegetation health and the diversity of flora and fauna. The region is a Ramsar-listed wetland.

5.34

The River Murray wetlands



## ACTIVITIES

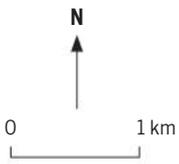
### Knowledge and understanding

- 1 State the scale of the Tocumwal topographic map extract.
- 2 State the contour interval of the Tocumwal topographic map extract.
- 3 Identify the features of the biophysical environment at:
  - a GR 025205
  - b GR 024197
  - c GR 000254
  - d GR 999202
- 4 Identify the features of the managed or constructed environment at:
  - a GR 984253
  - b GR 977252
  - c GR 027168
  - d GR 038207

- 5 State the direction of Gwynne Hill (AR9925) from the intersection of Yarrowonga Road and Mulwala–Barooga Road (AR 0222).
- 6 State the bearing of the horizontal control point at GR 000253 from the bridge at GR 025230.
- 7 State the width of the River Murray flood plain from GR 990185 to GR 990228.
- 8 Estimate the distance along the Mulwala Canal from the bridge at GR 052212 to the bridge at GR 984253.
- 9 State the elevation of the River Murray in AR 0019.
- 10 State the types of vegetation occupying the River Murray.

### Applying and analysing

- 11 Describe the nature of the riverine environment on the Tocumwal topographic map extract.
- 12 Create a KWL on the impacts of forestry on the riverine environment.



	Built-up area		Orchard, plantation or vineyard. Mangrove
	Route marker: national highway, national route, state route		Power transmission line (33kv and above)
	Major road: paved (with Metroad marker), unpaved		Cableway
	Secondary road: paved, unpaved		Pipeline, water. Pipeline, other
	Minor road: paved, unpaved		Perennial lake. Intermittent lake. Mainly dry lake
	Vehicular track: stock grid		Wet swamp. Dry swamp
	Four-wheel drive track: gate		Land subject to inundation. Sand
	Walking track		Intermittent stream, with waterfall
	Landmark feature. Stockyards. Mine		Mainly dry stream. Perennial stream
	Water tank or reservoir. Ground tank or dam		Large dam or weir
	Survey landmark (with height)		Building, small. Building, large. Homestead
	Ancillary contour. Spot height	<b>BOUNDARIES</b>	
	Contours. Depression contour		State forest
	Cliff, with relative height. Rocky pinnacle		National Park, Nature Reserve or State Conservation Area
	Closed forest: 80-100% crown cover. Open forest: 50-80% crown cover		Local government
	Woodland: 20-50% crown cover. Pine forest		State

# In the field: Rivers and water quality

The aim of this fieldwork activity is to investigate a river and its water quality. A fieldwork investigation of a length of river provides an opportunity to learn more about these important features of the physical environment. It also allows you to practise a range of geographical skills.

## How to investigate a river

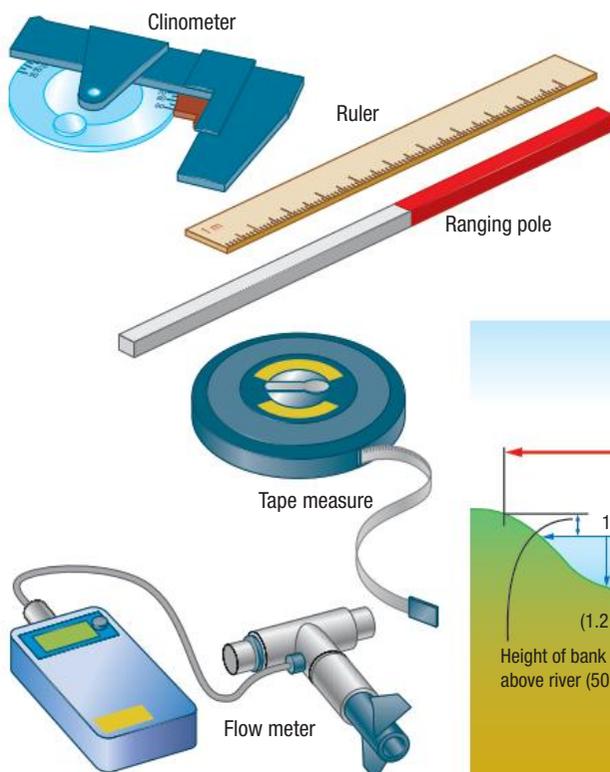
A variety of instruments will be required to investigate a river (see Figure 5.36):

- clinometer
- ruler
- ranging pole
- tape measure
- stopwatch
- flow meter.

You will need to select a river or stream location that has the following features:

- a bridge to cross
- easy access to riverbanks at a variety of locations.

5.36 Tools used to collect data in the field



## Drawing a cross-section

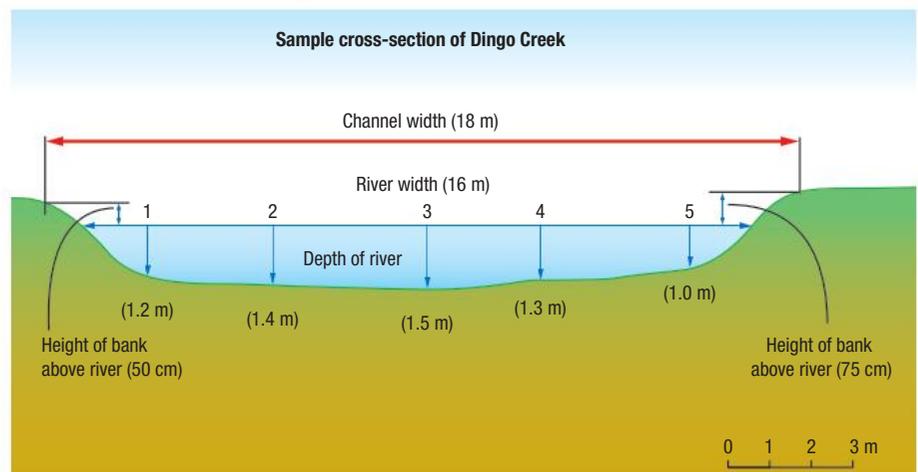
To draw a cross-section of a river, you need measurements of the:

- depth of the river
- width of the channel
- width of the river from bank to bank
- height of the bank above the river.

Using these measurements, construct your cross-section by carrying out the following steps.

- 1 Study the measurements you have collected and select a scale that will fit on your paper. Start your cross-section by drawing a line representing the width of the river. Make sure you leave enough space to draw in the river channel below it.
- 2 Look at the measurements for the height of the bank above the river level on both sides and mark the position of both banks. Measure the width of the channel from bank to bank. Now draw in the banks.
- 3 Mark in the riverbed by using your measurements of the depth of the river from the surface. Join the points together to show the shape of the riverbed. Add a scale and a heading, as shown in Figure 5.37.

5.37 Sample cross-section



## Calculating the cross-section

To calculate the cross-section of an area of river, carry out the following steps.

- 1 Use a long tape measure to determine the average width of the river.
- 2 Measure the depth of the water at regular intervals across the width of the river (for example every 100 centimetres). A 2-metre pole marked with 10-centimetre intervals will assist you in this task. If there is a low bridge over the river, stand on it to measure the depth of the river. Record your measurements on your data record sheet.
- 3 Calculate the average depth by adding all the depth readings and dividing by the number of readings. Using the data shown in Figure 5.38, the average would be  $(1.2 \text{ m} + 1.4 \text{ m} + 1.5 \text{ m} + 1.3 \text{ m} + 1.0 \text{ m}) \div 5 = 1.28 \text{ m}$ .
- 4 Multiply the average depth by the average width of the river to give the area. Using the data shown in Figure 5.37, the area would be  $1.28 \text{ m} \times 16 = 20.48 \text{ m}^2$ .

5.38 Data sample for a cross-section

Width of channel (bank to bank): 18 metres						
Average width of river: 16 metres						
Height of bank above the river:		<ul style="list-style-type: none"> <li>• Left side: 50 centimetres</li> <li>• Right side: 75 centimetres</li> </ul>				
Depth of river:		Left bank		Right bank		
Reading		1	2	3	4	5
Depth		1.2 m	1.4 m	1.5 m	1.3 m	1.0 m

## Calculating water velocity

The most accurate way to measure water velocity is to use a flow meter. If you don't have a flow meter you can use the following procedure.

- 1 Select a straight section of the river that is free of pools and/or shallow, fast-flowing sections. Measure out a distance of 50 metres.
- 2 Find an object that will float on the surface of the river. The object should be brightly coloured and it is best if it is heavy enough to be partly submerged in the water. With the aid of a stopwatch, measure how long it takes for the floating object to cover the 50 metres. Ensure that you select an area of riverbank you can easily and safely access.
- 3 Take at least three readings. For greater accuracy, take readings on both sides of the river and in the middle. Record your readings on your data record sheet. Average the readings to determine the water velocity.

## Calculating river discharge

Discharge is the amount of water that flows from a river catchment and into another river system, the sea or a lake. The discharge can be calculated by using the following formula:

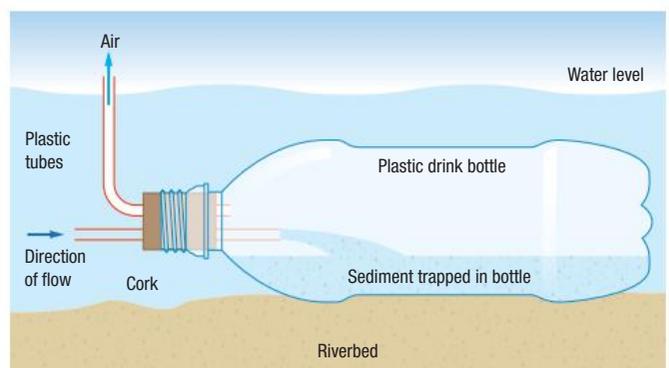
$$\text{Discharge} = \text{velocity} \times \text{cross-sectional area}$$

## Measuring suspended load

The suspended load of a river comprises fine sand particles, silt and clay. The amount of suspended material in water is closely linked to the level of discharge. To measure the amount of suspended load in a river, carry out the following steps.

- 1 Use four 1-litre plastic bottles to collect water samples at four sampling sites along the course of a river. When preparing each plastic bottle, block the opening with a cork and then drill two holes through the cork. Push two flexible plastic tubes through the holes, as in Figure 5.39.
- 2 Anchor the bottle to the riverbed with two or three stones. When doing so, make sure that you stand downstream, so that you do not stir up too much sand and sediment.
- 3 When the bottle is full, remove it from the river and remove the cork and plastic tubes. Seal the bottle with its original screw cap. Repeat the exercise at your other sampling sites. Allow the bottles to stand overnight.
- 4 Observe the layer of sediment that has collected at the base of the bottle. Make note of the sediment's colour, the water's clarity (turbidity) and, if possible, the amount of time it takes for the sediment to settle.
- 5 Shake the bottle so that the sediment is again redistributed through the water sample and then very slowly pour the contents of the bottle through a previously weighed piece of dry filter paper. You could use a filter suction pump to assist in this process.
- 6 Allow the sediment-encrusted filter paper to dry for at least 48 hours, or dry it in an oven for 1–2 hours at  $100^\circ\text{C}$ . Subtract the weight of the dry filter paper to find the weight of the suspended sediment. Express your answer in grams per litre of water.

5.39 Sediment sampler



## Measuring turbidity

Turbidity refers to the cloudiness of water, which is caused by suspended sediment. To measure the turbidity of a river, carry out the following steps.

- 1 Collect a 1-litre sample of water at a number of sites along the course of a river.
- 2 Transfer the samples into separate glass containers. Allow the water to stand for at least 24 hours so the sediment will settle.
- 3 Using a ruler, measure the depth of sediment at the bottom of each container. Record your data in a spreadsheet file and present your data as a graph.

## Measuring water quality

You can measure how clean river water is without having to use expensive equipment. One simple method involves looking at the kinds of animals that are found in creeks and rivers. The health of a river ecosystem can be measured by the variety of animal species present. If the water is polluted, many species find it almost impossible to survive. To assess water quality, carry out the following steps.

### 1 Select a suitable site

You can approach the task in one of two ways. You can:

- compare pollution levels in two or more rivers or creeks
- measure how pollution levels change down the course of one river or creek.

### 2 Equipment

You will need the following equipment:

- a white dish or tray
- a magnifying glass
- bottles and jars for water samples
- a pond dipping net
- turmeric paper (which turns brown in ammonia)
- pH paper (which measures acidity)
- a clipboard, pencil and recording sheet for drawing up a results sheet, as shown in Figure 5.40.

### 3 Take measurements and make observations

At each of the selected sites, complete the following experiments. Repeat each experiment three times at each site to make sure the results are reliable.

#### Turbidity

Fill your jar with water. Is the water clear or is it muddy? Allow the water to stand for 10 minutes. How clear is the water now? How much sediment has settled on the bottom of the jar?

Filter another sample of the same water through some filter paper or blotting paper. Observe what remains on the paper.

#### Smell

Using the same jar of water, smell the contents. Does the water smell? Record your observations on the results sheet.

#### pH test

Fill your dish with water taken from the river or creek. Place a piece of indicator paper in the water. Estimate the pH by comparing the test strip with the indicator chart (see Figure 5.41). Significant variation in recordings taken at different sites may indicate pollution.

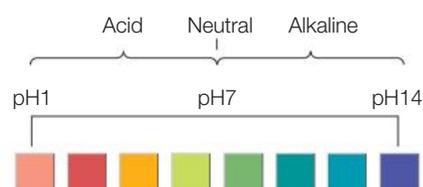
#### Ammonia test

Use the turmeric paper to test a sample of water taken from the creek or river. If the paper turns brown, ammonia is present in the water. Ammonia is a poisonous chemical that builds up in water when it is polluted by sewage, rotting vegetation and carbon-based chemicals.

5.40 Water quality results sheet

Water quality results					
Name of waterway:	_____			Date:	_____
Location:	_____				
Site number:	<input type="text"/>				
Test	1	2	3	Comments	
Turbidity					
Smell					
pH					
Ammonia					
Organisms					
Site observations					

5.41 A pH chart



## Organism survey

Scientists have found that the number and variety of water bugs found in a stream can indicate the amount of pollution present. By sampling the water bugs in a local stream, you will get an idea of the quality of the water.

Water bugs live in many different parts of the stream. Some live on the water's surface, others at the bottom of the river or creek, in the surrounding vegetation or among the rocks.

Scoop your net through the weeds growing on the riverbed, through the plants growing on the water's edge, and through the water at various depths. Wash off the excess mud by dunking the base of the net into the water. Empty the contents of the net into your white tray and, with the aid of a magnifying glass, look for bugs similar to those shown in Figure 5.42. List the organisms present in your sample.

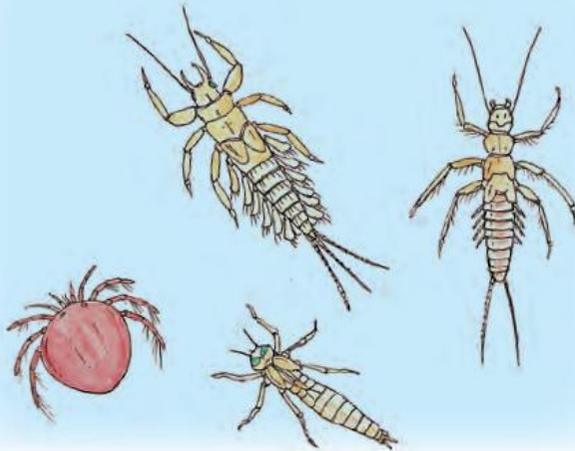
If you can identify bugs from groups one and two, the quality of the water is quite good. If bugs from only groups three and four are present, the creek or river probably has quite high levels of pollution.

## Site observations

Record any additional observations about the sites selected. Identify any possible sources of pollution. Use photography to illustrate your notes.

5.42 Some of the small aquatic animals found in rivers and creeks

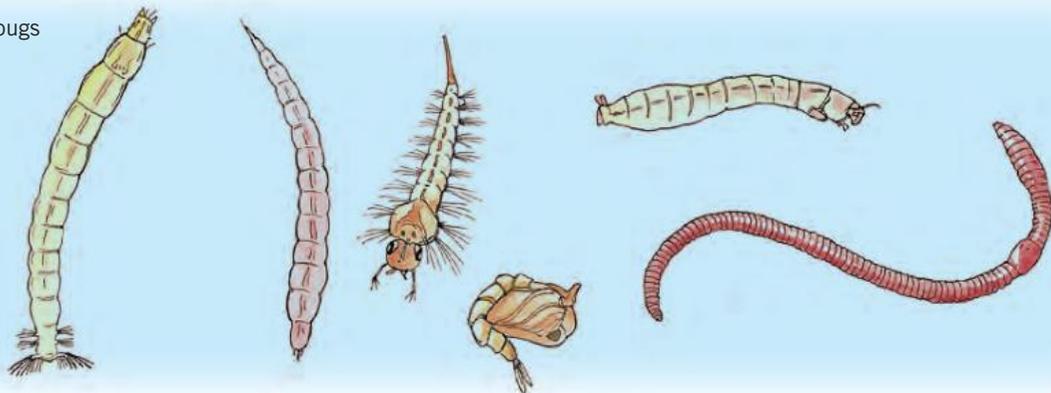
Very sensitive water bugs



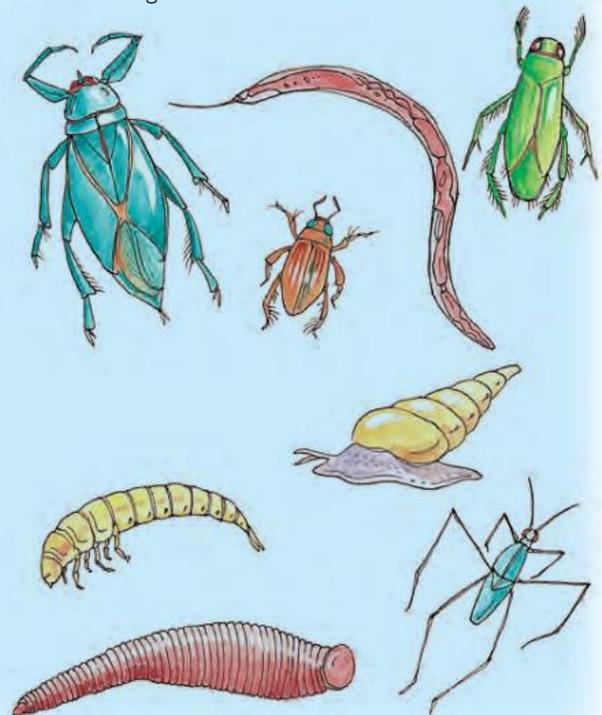
Sensitive water bugs



Very tolerant water bugs



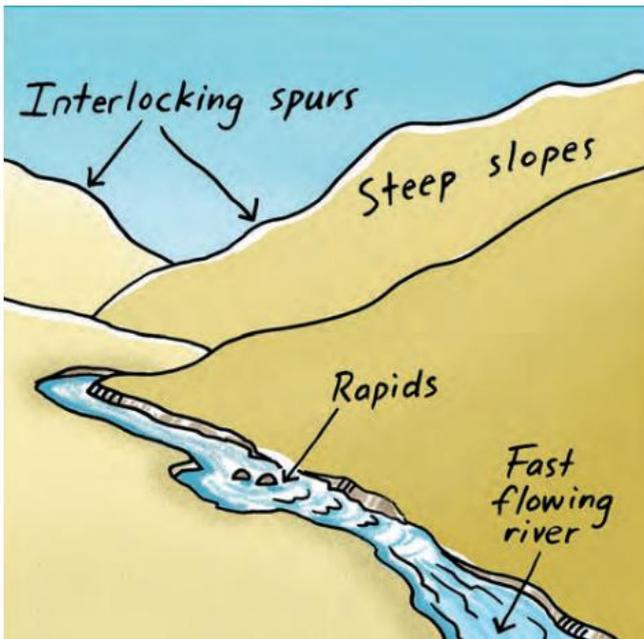
Tolerant water bugs



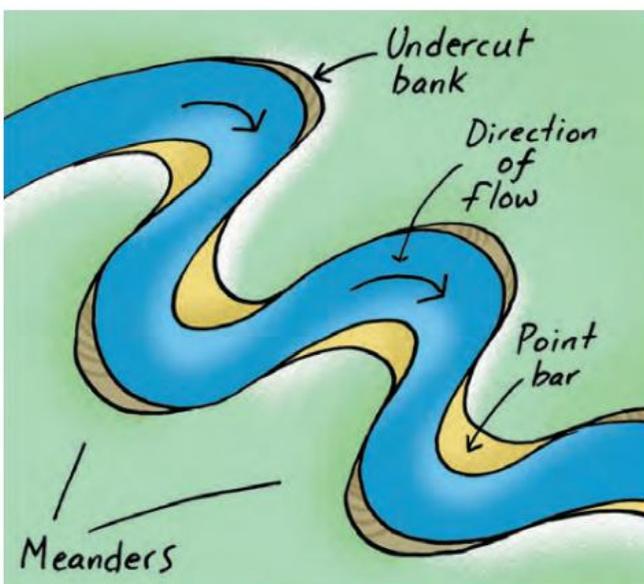
## Drawing a field sketch

To draw a field sketch of the river being studied, use Figures 5.43 and 5.44 as a guide.

5.43 Annotated field sketch of the upper reach of the river being studied



5.44 Sketch plan of the mid-reach of the river being studied



## ACTIVITIES



### Aim

To investigate the physical features of a river and water quality

### Instructions

- 1 Select a suitable river to investigate and include a map of the area investigated.
- 2 Draw a cross-section.
- 3 Calculate the cross-section of the river. Collect data and record it in a data record sheet similar to the sample below.

River: *Sandy Creek* Location: *Site 1* Date: *23 May 2014*

#### A. Cross-sectional area

Average width of the river *15 metres*

Channel depth at various points (in centimetres)

Point 1: *20*

Point 2: *25*

Point 3: *35*

Point 4: *45*

Point 5: *30*

Point 6: *20*

Average depth:  *$175/6 = 29$  centimetres*

Cross-sectional area: average river width  $\times$  average depth

*$15 \times 0.29 = 4.35$  square metres (ii)*

- 4 Calculate water velocity.

a Collect data and record it on a data record sheet similar to the sample below.

b Select data from two different locations and follow the steps above.

River: *Sandy Creek* Location: *Site 1* Date: *23 May 2014*

#### B. Water velocity

Length of river section: *50 metres*

Measurement 1: *75 seconds*

Measurement 2: *90 seconds*

Measurement 3: *85 seconds*

Average: *83.3 seconds*

Average velocity:  *$50/83.3 = 0.6$  metres per second (i)*

- 5 Calculate river discharge.

River: *Sandy Creek*    Location: *Site 1*    Date: *23 May 2014*

C. Discharge

Velocity (i)  $\times$  cross-sectional area (ii)

*0.6 metres per second  $\times$  4.35 square metres*

*= 2.61 cubic metres per second*

- 6 Measure turbidity. Collect data and record it in a data record sheet similar to the sample provided.
- 7 Measure suspended load.
- 8 Measure water quality. Collect data and record it in a data record sheet similar to the sample provided.
- 9 Draw a field sketch of the river area being studied.

### Option 1

Create an annotated visual display of the area investigated.

- a Take images of the river channel, upstream and downstream, and land on either side of the river channel.
- b Explain how each has or might influence the river channel.
- c Annotate the photos and explanations around the map of the area of river investigated.

### Option 2

Investigate the river from its source to the mouth of the river. Include the following information:

- topography, vegetation and landuse
- how the river water is being used (agriculture, irrigation, recreational, household use, etc.)
- problems associated with the river (pollution, reduced water flow, etc.).

Present your findings in a multimedia presentation and/or oral presentation.

### Evaluation

- 9 Once you have collected enough data, display the results and comment on your findings. Include the following in your commentary:
- a a description of the features of section of river that you investigated
- b information about changes in speed flow along the river
- c information about levels of turbidity and suspended load—was there a correlation between the two?
- d information about water quality—was there a correlation between the two?

### Option 3: Taking action

If you find that your local creek or river is polluted, you might like to do something about it. In small groups, discuss the actions you could take. You might consider:

- writing to the Environment Protection Authority and your local council
- mounting a public information campaign using posters and leaflets warning of the dangers of water pollution.

### Conclusion

- 10 Describe what you have learnt about river profiles.

### Fieldwork reflection

- 11 Write a short report outlining:
- a the way you gathered your data
- b what worked well and what did not
- c how you would improve the effectiveness of the fieldwork if you were to repeat it.
- 12 As a group, list the skills you have developed when undertaking the fieldwork activity. Share your findings with other groups. What were the most commonly cited skills? Which skills did other groups identify that differed from your group's list?

CHAPTER

# 6

# URBAN ENVIRONMENTS



**B**y 2008, half of the world's population lived in urban areas. By 2050, it is predicted that 64.1 per cent and 85.9 per cent of the populations of the developing and developed world respectively will be urbanised. As cities expand, they transform the landscape, a largely constructed (or built) environment replacing the biophysical environment. Furthermore, the environmental 'footprint' of a city extends well beyond its physical boundaries. Meeting the needs of city dwellers, especially their demand for food, results in the expansion of agriculture into areas once dominated by the biophysical environment.

It can be argued, however, that the effects of urbanisation are largely positive for the environment. The birth rate of new urban dwellers falls to replacement rate, and keeps falling. This, over time, reduces environmental pressures resulting from population growth. Also, the movement of people from rural areas reduces the impact of destructive subsistence farming techniques, such as improperly implemented slash-and-burn agriculture.

Cities do, nevertheless, have an impact on biodiversity. Generally, the richness of plant species increases in cities due to introduction of exotic species, whereas the diversity of animal species declines. The abundances of some groups, especially birds and arthropods, often disguises the more general declines in species diversity. What remains of urban biodiversity requires careful management. Understanding the human-controlled and natural processes that alter biodiversity is essential if we are to conserve urban biodiversity.

## KEY IDEAS

- To understand the main causes of environmental change in urban environments
- To describe the effects of the environmental changes taking place in urban environments
- To investigate the effectiveness of environmental management strategies being used in urban environments

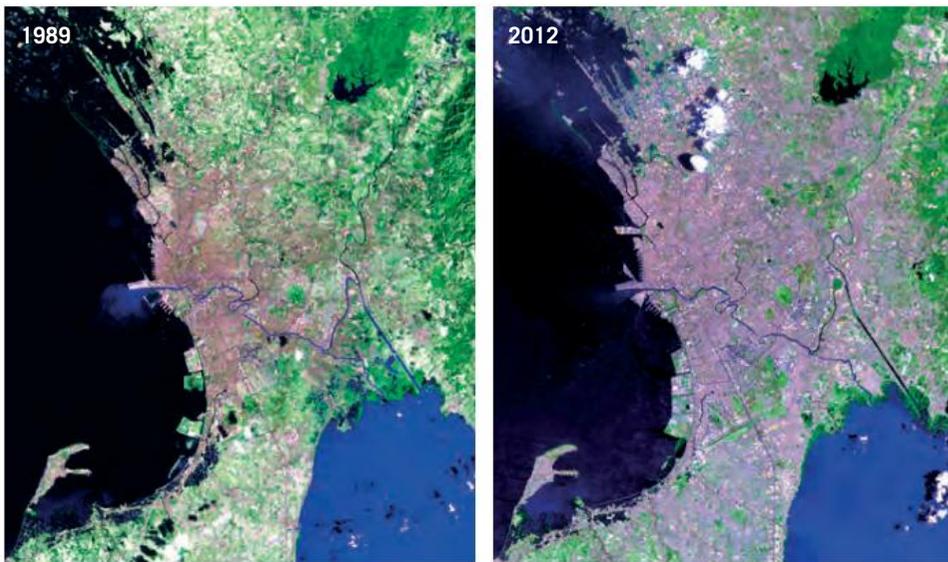
## GLOSSARY

bioregion	a region defined by a distinctive mix of characteristics of the biophysical environment rather than by human-made divisions
common	a piece of land that the community has the right to use and enjoy
habitat degradation	the decrease in the quality of the habitat
habitat fragmentation	the transformation of a large and continuous habitat into many smaller, isolated habitats
ruderal	a plant species that is first to colonise disturbed lands after a natural event such as a bushfire, or as a consequence of human activity such as road building or abandonment of agricultural land
service function	the capacity of an environment to provide the habitat for all living beings, including humans
sink function	the capacity of the environment to safely break down, recycle or remove pollution
source function	the capacity of an environment to provide the natural resources on which an urban environment depends, such as soil, water and air
spiritual function	the capacity of an environment to provide intrinsic recreational, psychological, aesthetic and spiritual benefits
sustainability	using the earth's resources in ways that meet the needs of the present generation without affecting the ability of future generations to meet their needs

# 6.1

## Environmental change in urban areas

Urban environments are constantly undergoing change. Change can occur when urban environments expand into the surrounding countryside, or are damaged or neglected. Change may also result from significant improvements through processes such as urban renewal. The composition of the urban environment may alter, or people may move throughout the city in different ways.



6.1 Satellite image of Manila, Philippines in 1989 and 2012, showing the growth in the urban area

This satellite image uses pseudo-natural colours:

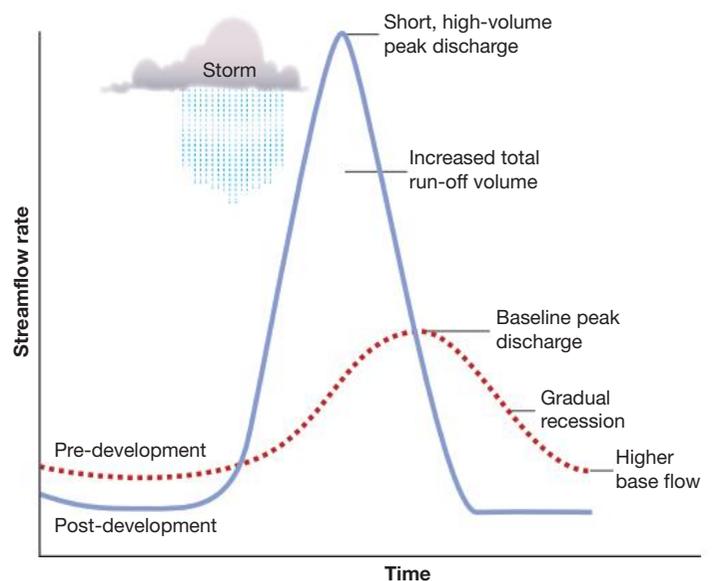
- urban industrial areas; the depth of mauve colour increases with greater density
- healthy growing vegetation (rainforest and mangroves)

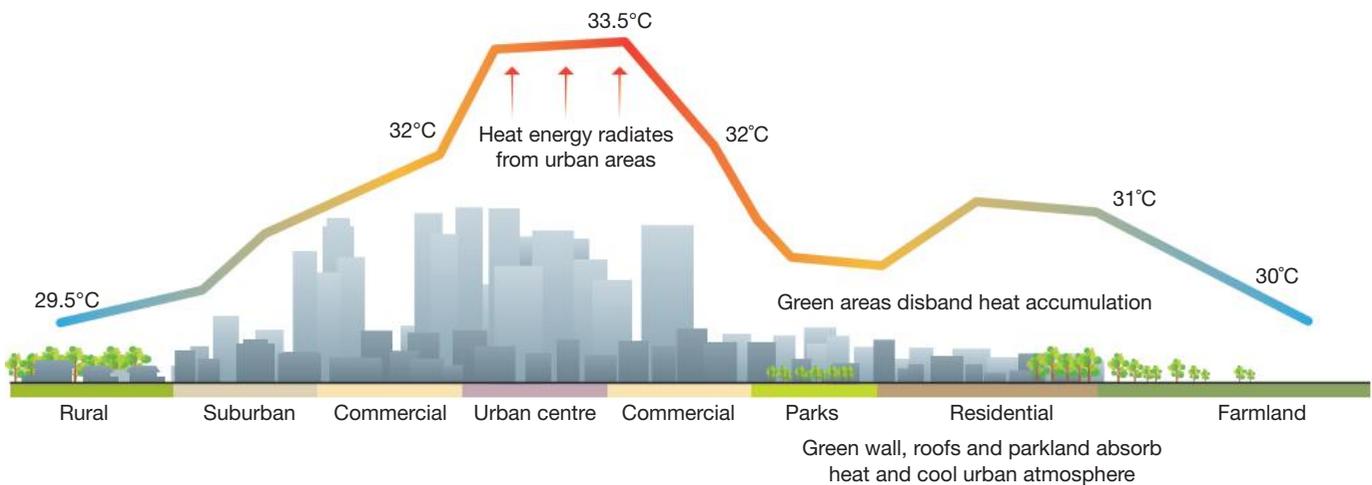
### Environmental change

Inevitably, urban development results in environmental change. The best example of this change is the alteration of the land cover from a vegetated to a built surface in Manila, Philippines, as illustrated in the satellite image in Figure 6.1. Sometimes, the alteration can involve the conversion of aquatic environments to urban environments. For example, part of the Port of Brisbane is built on land that was once wetlands and waterways. Changes include the loss of significant areas of mangroves and salt marshes, while dredging of the river has removed large seagrass meadows.

In urban places, air quality can be reduced through the release of pollutants such as carbon monoxide. The release of pollutants can also affect the quality of water and soil. Air pollutants can increase the acidity of precipitation, which collects in soil and rivers, changing the acidity of those environments. As vegetated areas are replaced with impervious built and paved areas, infiltration decreases. This results in an increase in run-off, as illustrated in Figure 6.2. This means that not only is flooding more frequent and more severe, but natural waterways and groundwater in urban environments are also degraded.

6.2 Impacts of urbanisation on stream flow





6.3

Urban heat island effect, showing how temperature varies from farmland to the urban centre

In urban places, habitats, both aquatic and terrestrial, become smaller and more vulnerable, while biodiversity generally decreases. The nature of the urban surface also affects the microclimate of the city. Figure 6.3 illustrates the urban heat island effect.

## Ecosystem functions

The environment of an urban place can be considered in terms of a series of interlinked functions; that is, source, sink, service and spiritual functions.

The **source function** refers to the supply of the natural resources of an urban environment, such as soil, water and air.

Urban environments also provide a **sink function**, whereby the environment safely breaks down, recycles or removes pollution such as waste, gas emissions, fertilisers and run-off.

The urban environment may also have a **service function**, such as the rock cycle; photosynthesis; the ozone layer; water filtration by wetlands; and the natural greenhouse effect, by which we are able to have a suitable climate.

The **spiritual function** of urban environments include those intrinsic recreational, psychological, aesthetic and spiritual benefits gained from the environment.

## Changes in urban biodiversity

One of the most significant environmental changes in urban places is the loss of **biodiversity**. Recognition of the importance of preserving biodiversity in urban environments has increased as research into the impacts of biodiversity loss emerges and the benefits of its preservation are identified.

## What is urban biodiversity

Urban biodiversity is increasingly understood to be more than just the variety of living species. It is now considered to include the diversity of all aspects of nature. This means that biodiversity includes not only plants and animals in the constructed environment but also the patches of land that have survived the city's expansion.

Urban biodiversity includes urban and suburban parks and gardens, as well as remnant vegetation communities such as wetlands, coastal sand dunes and forest stands. Increasingly, urban biodiversity is considered to include private gardens, roadside planting, bio-retention basins and the urban forest. The urban forest refers to all trees and vegetation, regardless of origin, location and ownership. For example, the urban forest includes the trees and shrubs that line streets, grow in public parks or in the suburban backyard.

Biodiversity has value for human populations, providing:

- mitigation of air pollution
- climate amelioration
- noise reduction
- habitat
- place for recreation
- contact with nature
- aesthetic and psychological benefits
- reduction in UV radiation
- temperature moderation
- wind speed moderation
- carbon sequestration
- reduction of flow and nutrients in stormwater.



6.4 Oblique aerial photograph of Cape Town, South Africa

### **Biodiversity of Cape Town, South Africa**

The South African city of Cape Town (see Figure 6.4) lies at the convergence of a number of different soil types and microclimates, and within a major biodiversity hotspot. The city of approximately 2460 square kilometres, has a population of 3.7 million and is increasing by 55 000 people each year. This is placing immense pressure on the remnants of biodiversity. The city and surrounding waters' biodiversity consists of:

- 23 different vegetation types
- 3000 indigenous plant species, 190 of which are endemic
- 83 mammal species, such as the leopard, hippopotamus and killer whale
- 27 amphibian species
- 57 reptile species
- 361 bird species.

### **Biodiversity of Sydney Harbour**

The city of Sydney has developed around a harbour, which is 30 kilometres long and has a surface area of 50 square kilometres. Almost all of the harbour is under tidal influence. At the entrance to the harbour, between North and South Heads, the harbour is 3 kilometres wide and

30 metres deep. This harbour is home to a huge array of biodiversity, due in part to the variety of aquatic habitats. Over 3000 species are to be found, including 586 fish species, 672 crustacean species, 1375 mollusc species. Many of the species are filter feeders, which are important for keeping the water clear and removing excess nutrients and pollutants. Thus, the biodiversity helps to reduce ecosystem stress and maintain good water quality.

### **How biodiversity is changing**

As urban environments change to accommodate growing numbers of people and changes in their lifestyle, urban biodiversity has, with very few exceptions, decreased significantly.

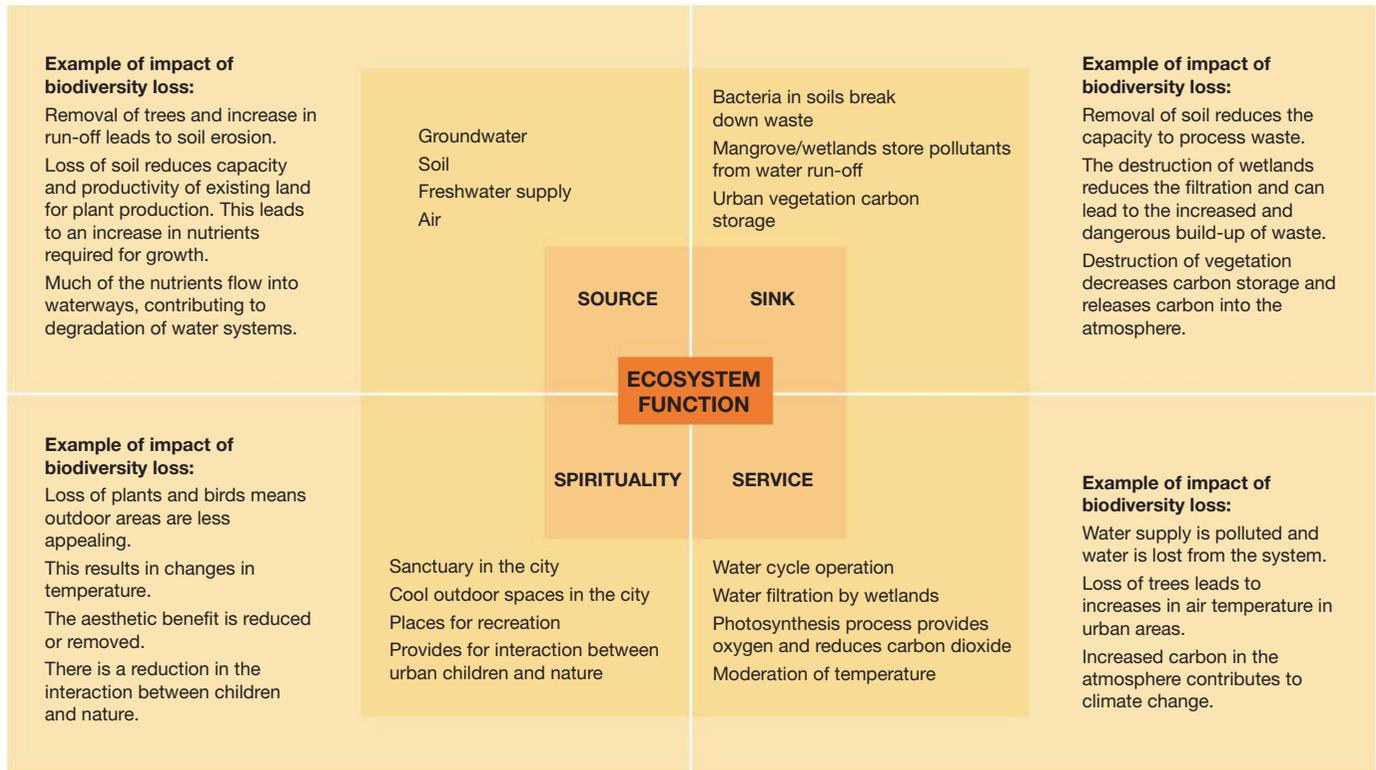
### **Measuring biodiversity**

Measuring how much biodiversity has been lost is difficult, since urban settlement began well before concerns about the loss of biodiversity and so accurate records have not been kept. To get some idea, within the Melbourne metropolitan area, it is estimated that 18 per cent of the total vegetation remains, with six species thought to be extinct, while there are at least 120 endangered plants and animals. These include the legless lizard, orange-bellied parrot and golden sun moth.

## The impact of biodiversity loss

The sustainability of the urban environment can be considered in terms of its capacity to provide source, sink, service and spiritual functions. The ways in which each of these functions is affected indicate the impact of changes in biodiversity.

### 6.5 Ecosystem functions in an urban environment



The loss of biodiversity is a detrimental aspect of urban change. This is detrimental to the point that it reduces the **sustainability** of the environment. The significance of this loss of biodiversity on sustainability is demonstrated by a study of the impact on the functions of the urban environment, as described in Figure 6.5.

Sustainability is about ensuring that the source and services functions are maintained. The filling up of sinks beyond capacity or the depletion of sources results in unsustainability.

## ACTIVITIES

6.1

### Knowledge and understanding

- 1 Describe how urban places result in environmental change.
- 2 Outline the main ecosystem functions.
- 3 Outline the benefits of urban biodiversity to humans.

### Applying and analysing

- 4 With reference to ecosystem functioning and Figure 6.5, analyse the impact of the loss of urban biodiversity.
- 5 **a** Compare the biodiversity of Cape Town and Sydney using a Venn diagram.  
**b** Are there any similarities? Explain.

### Geographical skills

- 6 Study Figure 6.1 then do the following tasks.
  - a** Study the pattern of urban development in Manila in 1989.
  - b** What was most likely determinant of the pattern evident on the image in 1989?
  - c** How did this pattern change by 2012?
  - d** Describe the changes to vegetated (green) areas between 1989 and 2012.
  - e** Despite the massive urban expansion, not all vegetated areas had disappeared from Manila by 2012. Suggest some possible reasons for this.
- 7 Study Figure 6.2 then describe the changes to stream flow rate after development. In your answer, refer to volume and peak discharge.

# 6.2

## Biodiversity loss in urban environments

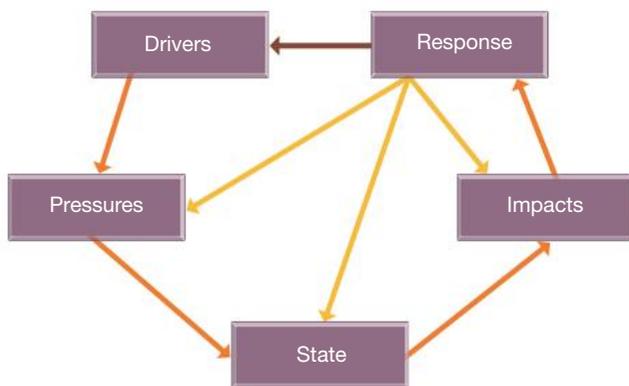
**Biodiversity loss in urban environments occurs due to the combination of three main factors: expansion of urban areas, introduced species and pollution. Although each of these has significant individual impacts, the impacts are magnified when these factors occur in combination.**

### Environment as a system

A system is a group of interacting objects, materials or processes that form an integrated whole. The environment can be considered as a system. Defining the environment as a system allows us to investigate the impact of changes within the ecosystems. This enables us to focus on the nature of each component of the system and how it interacts with other components.

The environment, including the human activity within it, can be investigated as if it were a system, for example using the DPSIR model shown in Figure 6.6. Developed by the European Environment Agency, the main focus is on the links between each of the components. The DPSIR model has been adopted by many other organisations, such as the United Nations Environment Programme and the Australian Government's Department of the Environment.

6.6 Simplified DPSIR model



The more complex DPSIR model shown in Figure 6.7 illustrates how the relationships between each of the drivers (D), pressures (P), state (S), impacts (I) and response (R) are used to assess environmental problems. The drivers are the social, cultural and economic forces that drive human activity. These result in increases in or mitigation of pressures on the environment. For example,

the driver of population growth results in pressures such as production of waste and atmospheric emissions. The pressures directly influence the state of the environment, which is the combination of the physical, chemical and biological conditions such as air and water quality. A change in the state of the environment may affect the quality of ecosystems and the welfare of human beings. These are the 'impacts' referred to in the model. Finally, responses are what society or governments do in order to address the impacts, such as placing strict controls on and monitoring the release of industrial waste into natural waterways.

### Expansion of urban areas

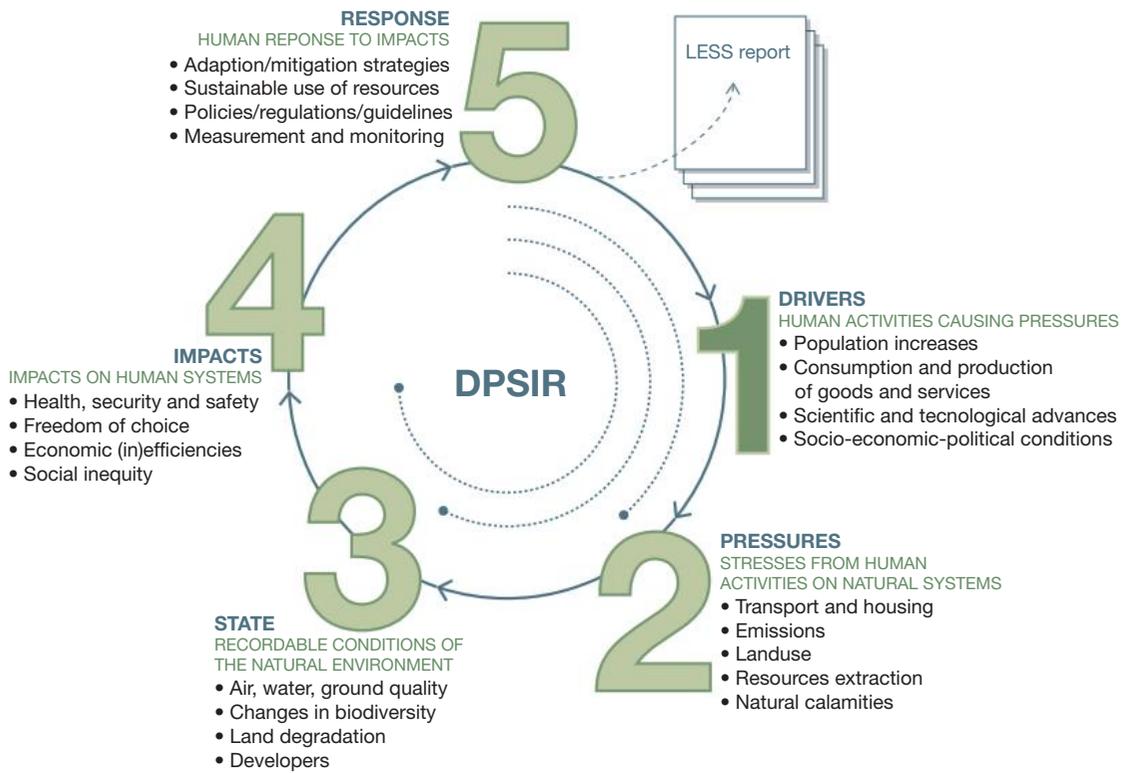
Urban growth is responsible for the destruction and fragmentation of the natural environment. Habitat destruction results in the loss of organisms that once inhabited that part of the environment. **Ruderal** or new plant species not native to the area then take over the disturbed habitats. In a broader sense, it also reduces the richness of native species of plants and animals. Figure 6.8 shows the relationship between the type of species, number of species and distance from the centre of an urban area.

**Habitat fragmentation** is the transformation of a large and continuous habitat into many smaller, isolated habitats. This can occur due to the construction of roads, housing estates or industrial centres. The impact of fragmentation of habitat is significant; isolated habitats make it more difficult for species to move to different areas, and invasive species can penetrate further into a smaller habitat. Similarly, the fragmentation of habitats reduces the functioning of ecosystems and their services.

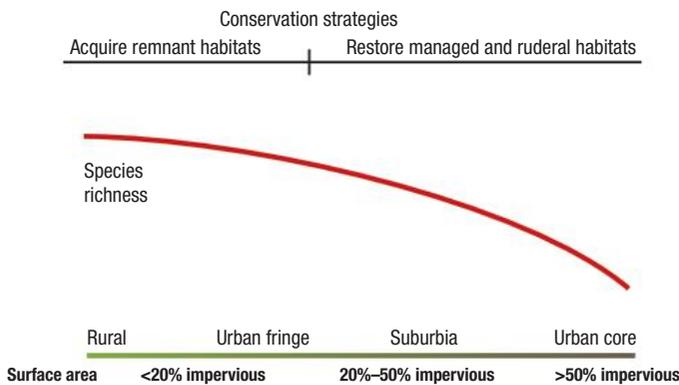
### Introduced species

Human activity in urban areas results in the deliberate or inadvertent introduction of non-native species of plants and animals into the environment. These introduced species are often much better adapted to the urban context than native species. They may kill or successfully compete with the native species.

6.7 Complex DPSIR model



6.8 A generalised pattern of changes in biodiversity



## Pollution

Human activity results in wastes. When the sink environmental function is not able to process this waste effectively, the resultant pollution can have adverse impacts on biodiversity. There are two major types of pollution: air and water. Table 6.9 outlines the three main causes of water pollution and the impacts on biodiversity.

6.9 Causes of pollution and their impact on biodiversity

Cause of pollution	Impact on biodiversity
Toxic discharge	Dangerous chemicals may be released into the soil or water bodies. This can weaken or even kill plants and animals. These chemicals include pesticides used in horticulture and arsenic contamination. Pesticides may enter soil and water in concentrated amounts through run-off.
Bacterial contamination	Bacteria enter the environment from leaking sewers and overflowing septic tanks, and are removed from the urban landscape by water run-off into stormwater pipes that discharge into waterways. Animals as well as humans may contract diseases from these bacteria.
Nutrient build-up	Nutrients, especially phosphorus and nitrogen, may be discharged into rivers, causing eutrophication. The nutrient-rich water encourages the rapid growth of algae and aquatic plants. Some of these release toxic substances into the water. When the amounts of plant and algae in the water become too high, the oxygen and carbon dioxide properties of the water change, making it an unsuitable habitat for many aquatic plants and animals.

## Impact of biodiversity loss

The loss of biodiversity has many consequences for both the natural environment and human society.

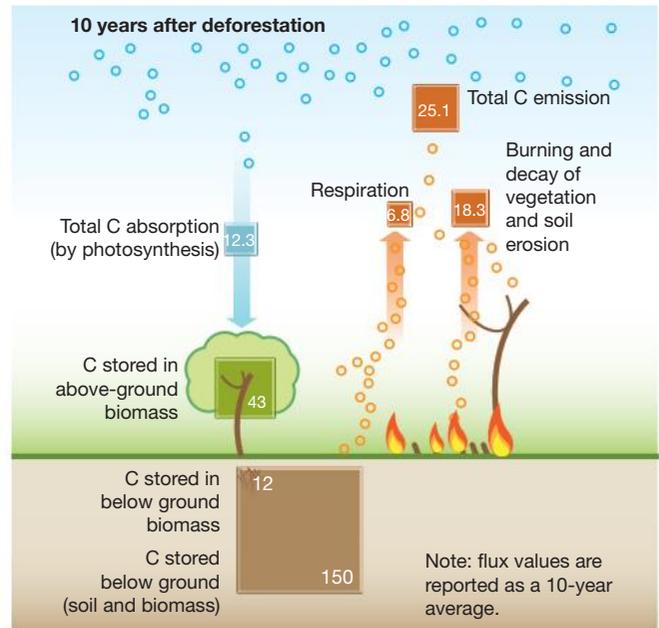
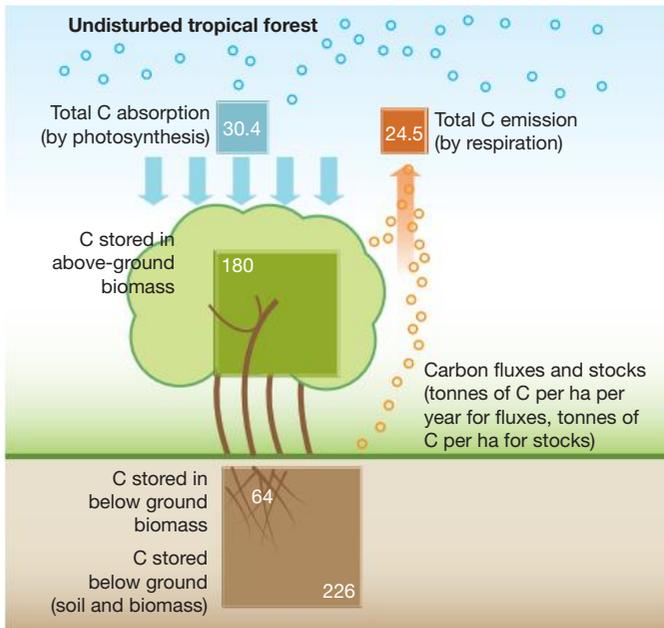
### Consequences for ecosystem services

The reduction of biodiversity reduces soil formation and protection. This decreases the capacity of soil to decompose harmful waste, as well as its ability to act as a carbon sink.

6.10 A bee village or apiary on a rooftop at Melbourne's Federation Square

The loss of insect and bird pollinators, such as bees and honeyeaters, has consequences for a variety of urban ecosystem services. Pollination has been found to affect food production, the regulation of hydrology and climate, and even soil formation. For instance, the pollination of fruit plants is required for the production of fruit. Figure 6.10 shows an apiary on a rooftop at Melbourne's Federation Square. It is one of over forty rooftop bee villages in Melbourne's CBD and inner-city suburbs. The aim of urban bee keeping is not just to collect honey, but also to promote pollination—it is estimated that 65 per cent of all the food we eat is dependent on honey-bee pollination.





6.11 Impact of deforestation on the carbon cycle

## Consequences for human society

Biodiversity loss can have specific social and economic impacts on humans. The removal of large vegetated areas reduces the capacity of the urban environment to store carbon. This loss of biodiversity, in some cases, reduces the opportunities that ‘urbanites’ have to interact with nature.

In addition, the process of burning the vegetated areas releases carbon into the atmosphere. This is believed to contribute to climate change.

## Waterway degradation

Biodiversity loss, such as the removal of vegetation that provide water filtration, can make water resources more polluted and more turbid. This has the potential to reduce fish breeding sites and thereby result in an economic loss to local fishing industries.

## Economic impacts

Unconverted wetlands, or wetlands that have not been significantly altered by human activity, have an economic value. For example, the That Luang Marsh, located on the eastern edge of Vientiane (Laos) supports livelihoods based on agriculture and fishing by providing services such as flood prevention and water purification. Estimates of the value of this wetland take into account the market price of goods; the cost of services such as water purification, if provided by industry; and the cost of preventing damage to property. Excluding cultural and aesthetic values, a study in 2004 found the marsh to be worth US\$5 million annually. In a less developed nation, this is a significant recurring amount.

## The carbon cycle

Figure 6.11 shows the impact of deforestation in the carbon cycle; in an undisturbed state the forest is a carbon sink and this cycle is destroyed by deforestation. In an undisturbed forest the carbon flux ratio (the calculation of the annual net difference between carbon respiration and storage) is neutral. The process of removing and burning vegetated areas alters the carbon flux ratio and it is believed that this contribute to climate change.

## ACTIVITIES

6.2

### Knowledge and understanding

- 1 Outline the causes of urban biodiversity loss.
- 2 Discuss the environmental, economic and social impacts of the loss of wetlands.

### Applying and analysing

- 3 Study Figures 6.6 and 6.7. Redraw the diagram of DPSIR to apply to your own local area. Identify the drivers, pressures and states based on your own understanding. Predict the impacts and suggest appropriate responses.
- 4 Study Figure 6.8 then do the following tasks.
  - a Describe the trend in species richness from rural to the urban core.
  - b Account for this trend in terms of the causes of biodiversity loss.
- 5 Study Figure 6.11 then do the following tasks.
  - a Describe how carbon is stored in a disturbed tropical forest.
  - b Identify three key changes to carbon storage as a result of deforestation.

# 6.3

## Managing urban biodiversity

**Managing urban biodiversity is the responsibility of all those with an interest in the sustainability of urban areas. Urban environments may be managed with a view to biodiversity in a variety of ways. There are some common approaches among many very complex management plans.**

### Organisations managing urban diversity

#### International

The United Nations has taken the lead in the initiation of programs to protect diversity. In 1993, 168 countries signed the Convention on Biological Diversity. In 2010, the countries that had signed the agreement met in Japan to produce a revised and updated plan for biodiversity. The plan committed signatory countries to reducing biodiversity loss by 2020. This is known as the Strategic Plan for Biodiversity 2011–2020.

Other groups are:

- the United Nations Environment Programme (UNEP), which launched the Global Partnership on Cities and Biodiversity in 2008
- the International Council for Local Environmental Initiatives, an association of local governments and government organisations that have made a commitment to sustainable development
- the International Union for Conservation of Nature (IUCN), or the World Conservation Union, which is a composite of many groups. Among their members are over 200 governments, 900 non-government organisations and 11 000 voluntary scientists and experts. Their role is to initiate conservation projects, provide published research and influence government.

#### National

The Australian Biodiversity Conservation Strategy 2010–2020 identifies short-term and long-term actions for the management of biodiversity. The strategy involves all levels of government and sees collaboration as an integral part of successful management. Not only are governments represented, but there is also a strong involvement of community members, Indigenous Australians and business people.

#### Local

The success of urban biodiversity management lies in the degree to which local communities are consulted and involved in the process. When the local community is not involved in the management, projects with the best of intentions and expertise can still fail. Countless numbers of small groups of volunteers and local residents are involved in a variety of ways to preserve, protect and manage biodiversity.

#### Barnes Common, London

Barnes Common is a 50-hectare site of valuable metropolitan open land in London. The **common** is dissected by numerous roads, paths and a railway. The acid grassland ecosystem, a significant natural feature of the common, is a carpet of fine grasses that grow in acidic soil. The Friends of Barnes Common is a not-for-profit organisation that is concerned about protecting the acid grasslands. Their challenge is to strike a balance between the conflicting uses of the community common—between biodiversity management and the demands for more sporting fields, paths for dog walkers, community vegetable gardens and a cemetery.

#### Urban Barcode Project, New York

The Urban Barcode Project involves high-school students in New York City. The students explore the city's outdoors and community venues to gather biological samples as part of their own scientific investigations. The students return to a laboratory, and, with the assistance of the Rockefeller University, they extract DNA and match the DNA to known DNA samples. In many cases, new DNA has been identified, increasing the pool of knowledge about New York's urban biodiversity.

## SPOTLIGHT

### Perth's urban bushlands

Perth is an urban area with a number of significant sections of relatively undisturbed bushland. Due to the development and change in the urban environment, the urban bushland is constantly at risk from developers, climate change, fire, receding watertables and weed infestation.

The Western Australian Urban Bushland Council is an association of seventy community conservation groups concerned about the decline in urban bushland. A voluntary, non-government organisation, it lobbies governments for the protection of bushland.

An example of this integration is evident in the Local Biodiversity Program of Perth. A local government initiative, its aim is to support local governments to protect and manage local natural environments. One of the projects is Bush Links, which aims to link efforts of local governments, professional bush regenerators, residents and local school children in local biodiversity conservation projects.



6.12 Aerial photograph of Wilson Wetlands, showing Wilson Wetlands Action Group project sites

## Worldviews and biodiversity management

Environmental worldviews influence the management biodiversity. Figure 6.13 outlines environmental worldviews in an urban environment.

6.13 Environmental worldviews on urban biodiversity

### Human-centred

Management of urban biodiversity serves, first and foremost, the use of urban spaces by humans.

Examples: Sports fields, botanic gardens



Cranbourne Botanical Gardens, Victoria

### Stewardship

Management of urban biodiversity serves to balance social, economic and environmental needs, even at the expense of the quality of meeting one of these needs.

Example: Wetlands kept as tourism sites



Roebuck Bay, Western Australia

### Earth-centred

Areas of ecosystems are protected and excluded from human access.

Examples: Fenced bird sanctuaries, prohibited islands in urban harbours



A colony of northern gannets on Bonaventure Island, in the Gulf of St Lawrence, Canada

## Urban biodiversity management strategies

Figure 6.14 identifies specific strategies used in the management of urban biodiversity.

### Conflict in urban biodiversity management

#### Social and economic conflict

The reality for many urban environments in the world is the perception that immediate economic and social needs outweigh those of biodiversity. To some extent,

this is understandable. Population and economic growth result in greater demands for housing and building infrastructure. Infrastructure such as roads, public spaces, water supply and sanitation services must be provided in growing communities. These place large demands on the natural environment and existing open space. Natural land is transformed into human landscapes, typically with impermeable and vegetation-free surfaces.

6.14 Strategies of urban biodiversity management



a Restoration and revegetation



b Information signs



c Encourage responsible pet ownership



d Engage local residents in projects



e Control development



f Implement water-sensitive urban design



g Address disease



h Remove introduced species



**6.15** An unauthorised settlement at the fringes of the Sanjay Gandhi National Park, India. A leopard killed a 5-year-old girl here in July 2012.

### Mumbai, India

The Sanjay Gandhi National Park (SGNP) is one of the largest metropolitan parks in the world. Its dense forest with great diversity of flora and fauna covers 103 square kilometres in the northern part of Mumbai. The park's flora function as a significant carbon sink, and two lakes provide water for the Indian city.

Since 1990, there has been an acceleration in the construction of illegal dwellings for Mumbai's urban poor. Between 1995 and 1996, 27 hectares were lost as a result of this unchecked urban expansion. In 2003, middle-class environmental activists brought about a court order to evict residents from the SGNP. The residents, 33 000 of whom were legal residents and 24 000 illegal residents, were relocated to a village far away from their homes and places of work.

### Transport

In many urban ports, the preservation of harbour biodiversity is difficult. Ships use water as ballast, taking on vast amounts of water, which can include aquatic species, at one location and discharging it at another.

### Introduced species: Zebra mussels

The European zebra mussel is believed to have been introduced to the Great Lakes of North America in ships' ballasts, invading the harbours of cities such as Cleveland, Chicago and Toronto. The introduced mussel has a significant impact on the biodiversity of the harbour ecosystem.

The zebra mussel filters about 1 litre of water a day. It consumes food such as microscopic plants and animals, but any material that it takes in is excreted and dies. Thus it removes large amounts of plants and animals that other small fish would have eaten. As the other fish have less food, their populations decline, which has flow-on effects further up the food chain. Zebra mussels can grow on top of native mussels, reducing their capacity to survive.

### Cultural values

Protecting biodiversity is not important in many societies. Consequently, it can be difficult to gain support for biodiversity projects. When biodiversity needs conflict with cultural values, it can be difficult to carry out management strategies to protect biodiversity.

### Cultivated gardens, Tokyo

Cultural values can offer an opportunity, rather than conflict. In Tokyo, 8000 hectares of cultivated land and 14 000 agricultural households supply 680 000 people with vegetables and fruit. Market gardens in urban environments have many social and ecological benefits. Many local farmers continue to farm in traditional ways, growing produce with plants sown over generations. Urban market gardens also reduce pollution and related impacts such as chemical waste. One district, Musashino, set up a local waste management scheme, taking organic domestic waste and using it for farm compost.

## ACTIVITIES

### Knowledge and understanding

- 1 Define the term 'common'.
- 2 Explain why there is conflict in urban diversity management.
- 3 Describe the impact of the zebra mussel.

### Applying and analysing

- 4 Analyse the social challenges in managing urban biodiversity in the following scenario: 'A patch of bushland on the fringes of a large city currently provides local residents with many benefits.

However, the area is needed for urban expansion and the development of much-needed housing and community facilities. Consequently, the government plans to destroy this bushland in the next year.'

Complete the following tasks:

- a List the advantages and disadvantages of such a change.
- b Discuss the potential conflict in terms of social, political, economic and environmental factors.
- c Suggest how you would manage the situation.

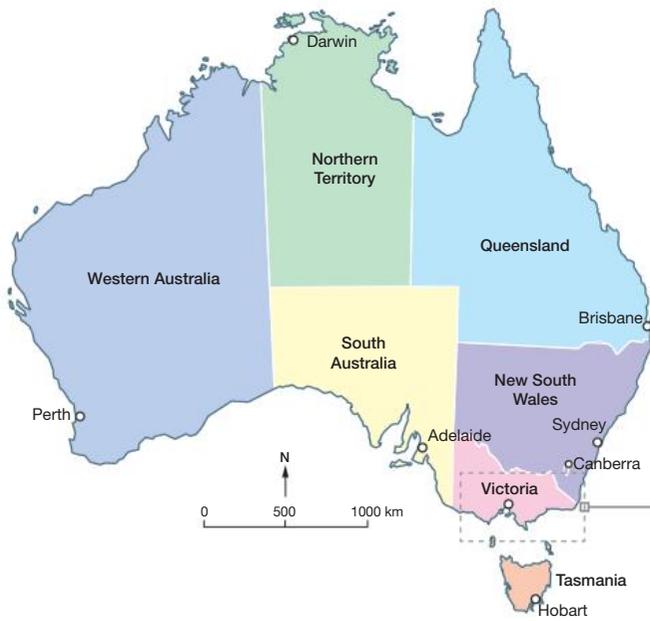


# 6.4

## Case study: Melbourne's biodiversity

Melbourne covers an area that was once a rich tapestry of ecosystems and landscapes. Most of the original vegetation has been removed. Some pockets of natural habitat remain, totalling 146 000 hectares. The protection of Melbourne's biodiversity is important, not just because of the variety of ecosystems represented, but also because studies show that green spaces provide people with long-lasting health benefits.

6.16 Location of Melbourne, Australia

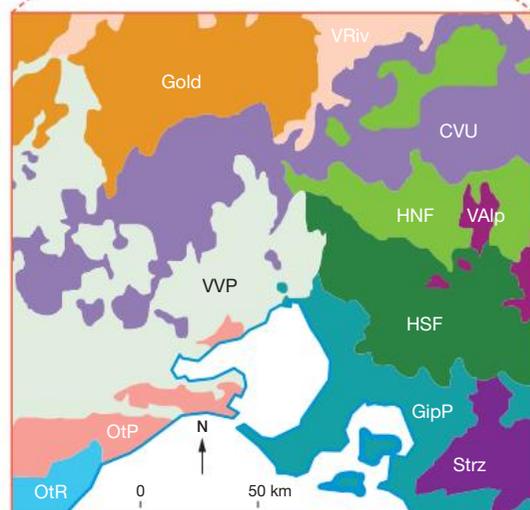


Melbourne, Australia

- Population: 4 246 345 (2013)
- Population density: 1567 per km<sup>2</sup>
- Area: 9990 km<sup>2</sup>
- Climate: Oceanic climate

### Melbourne's biodiversity

Melbourne is located at the junction of three distinct **bioregions**, as shown in Figure 6.16. At this location there is great diversity of natural environments, such as forest, woodland, heathland, wetlands and grassland. Within this diversity of ecosystems are found 1864 species of indigenous flora, 178 of which are threatened, and 52 species of indigenous fauna, 136 of which are threatened.



- VVP Victorian Volcanic Plain
- VRiv Victorian Riverina
- GipP Gippsland Plain
- OtP Otway Plain
- Gold Goldfields
- CVU Central Victorian Uplands
- HSF Highlands—Southern Fall
- HNF Highlands—Northern Fall
- OtR Otway Ranges
- Strz Strzelecki Ranges
- VAIp Victorian Alps



## Pressures on Melbourne's biodiversity

Like all urban areas, Melbourne's biodiversity is under pressure because of competing landuses. Some of the main pressures on Melbourne's biodiversity are habitat loss, habitat fragmentation, **habitat degradation**, altered fire regimes and climate change.

### Habitat loss

There was a great amount of vegetation clearance following settlement and, more recently, as a result of the spread of housing and industry and the construction of infrastructure (see Figure 6.17). In the past, landuse decisions were often made on a case-by-case basis, which did not take into consideration the public's views about the environment. Past habitat loss has ongoing impacts. Specifically, habitat loss has led to a reduction in the area that populations of species need to live successfully.

### Habitat fragmentation

Most of Melbourne's remaining natural habitats are fragmented areas. These small isolated patches are less able to support viable populations of flora and fauna. They also offer reduced protection from other pressures.

### Habitat degradation

**Habitat degradation** refers to the decrease in the quality of the habitat. Habitat degradation means that the ability of the habitat to support species is increasingly limited. This degradation comes about because of a reduction in forest density or the impact of invasive species. Invasive species compete directly with native species for resources, change habitat conditions, and can result in hybridisation and predation.

6.17 Urban growth brings Melbourne's biodiversity 'close to home'.

### Altered fire regimes

The term 'fire regime' refers to the pattern, frequency and intensity of fires. Urban natural habitats are prone to changes in fire regimes due to the likelihood of accidental ignition, arson and increased fuel loads, as regular burning is less likely to occur (see Figure 6.18). How habitats respond to fire is very complex as each responds slightly differently to differences in intensity and frequency. Nevertheless, bushfires do play a part in the loss of plant and animal species that rely on very specific patterns of fire.

### Climate change

Changes in precipitation and temperature patterns will have an impact on the distribution and viability of plants and animals.



6.18 Human interaction with the environment can result in more frequent fires.

## Management of Melbourne's biodiversity

The management of biodiversity in Melbourne is largely a function of the relationship between laws made by government (legislation), the directions and plans of government (government policy) and the establishment of conservation areas and specific interventions. Generally, in Melbourne, laws about diversity flow from the international level to national level to state level and then to regional and local levels.

### Legislation

National, state and local government legislation provides legal guidelines and the boundaries for activity. Much of the key legislation affecting Melbourne's biodiversity is driven by agreements between nations, such as treaties and conventions. These provide the impetus for national and state legislation.

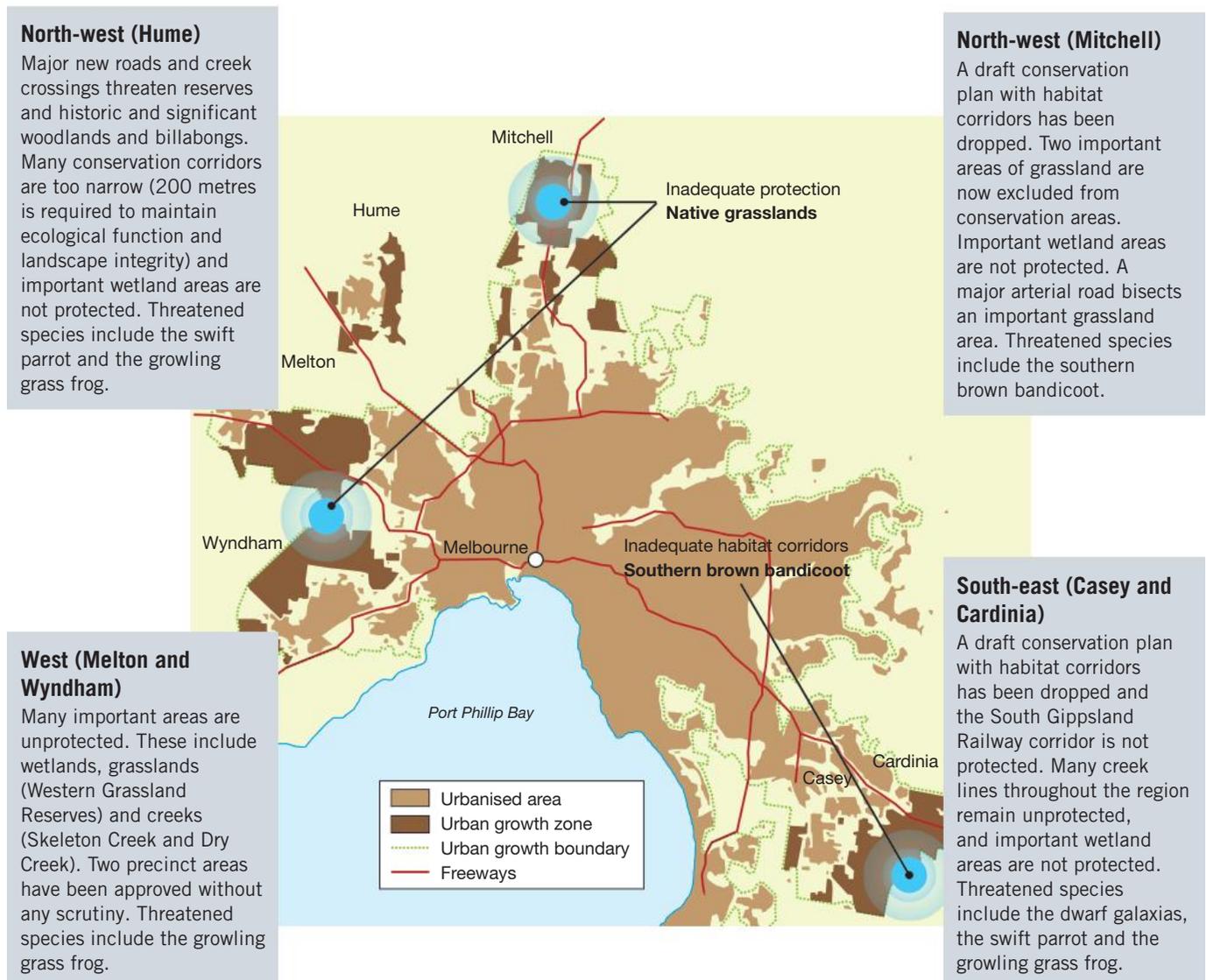
## Government policy and planning instruments

Government policy and planning is extremely significant in the management of biodiversity. For example, the Victorian Planning Provisions require a permit for the removal, destruction or lopping of native vegetation. At the local level, local councils can apply Vegetation Protection Overlays on areas deemed environmentally significant, such as the Yarra River frontage.

Victorian Native Vegetation Management: A Framework for Action is a statewide policy aimed at reducing the loss of native vegetation in Victoria. The policy directs human activity to avoid the removal of native vegetation, minimise the removal of native vegetation through appropriate plans and designs, and offset the loss of native vegetation appropriately.

6.19

Melbourne's urban growth corridors and impacts on biodiversity



## Conservation strategy for growth corridors

The Victorian State Government Department of Environment and Primary Industry has developed a strategy to protect Melbourne's biodiversity. This was developed under the Commonwealth *Environment Protection and Biodiversity Conservation Act 1999*. The Biodiversity Conservation Strategy for Melbourne Growth Corridors (BCS) was established in order to address the potential impacts of Melbourne's overarching urban development plans such as Melbourne 2030 and Melbourne@5million in outer areas of Melbourne. The BCS is the overarching strategy for the protection of biodiversity in the growth corridors, as shown in Figure 6.19. The BCS outlines the conservation measures for thirty-six conservation areas. These are:

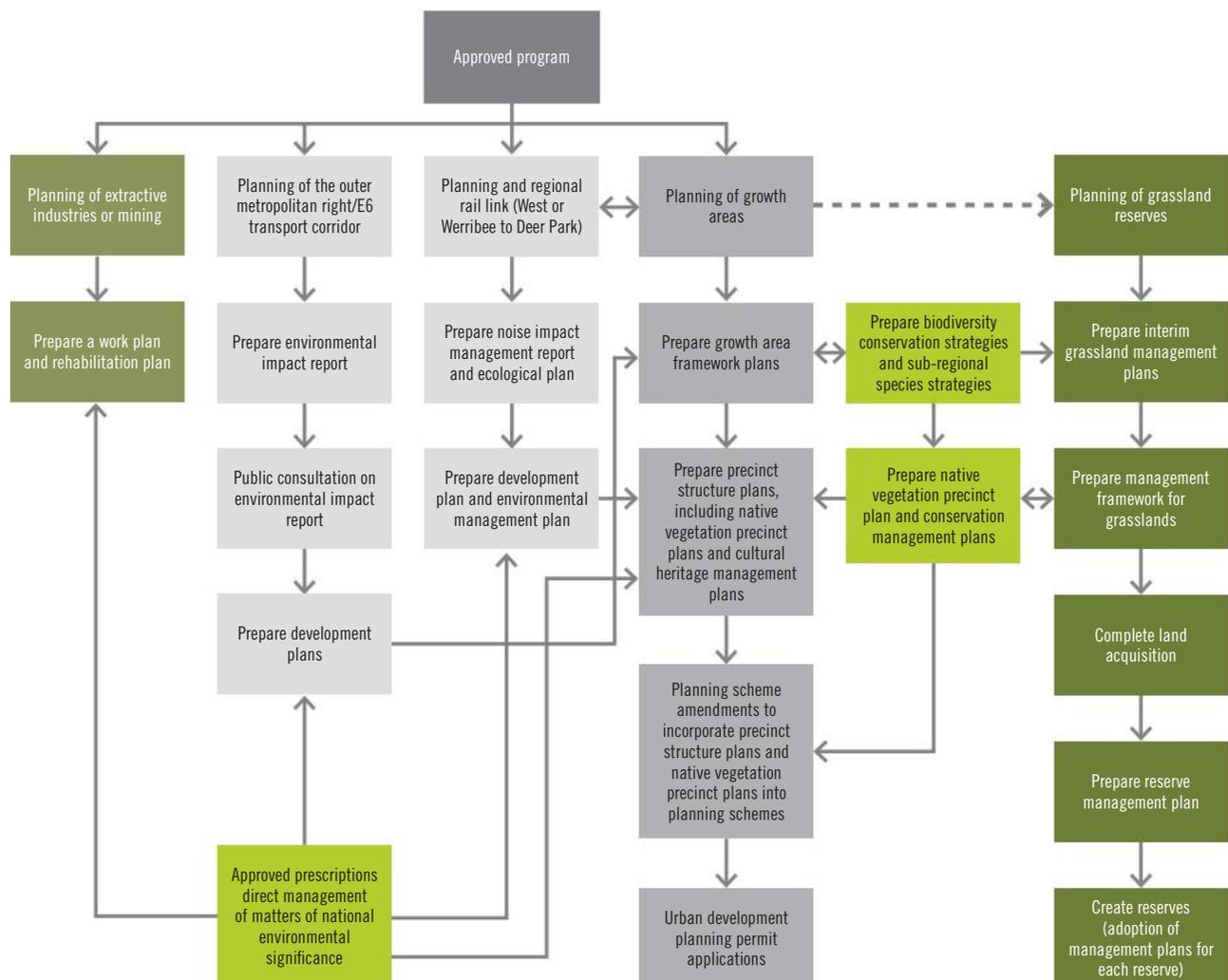
- protection and management of land of high biodiversity value within defined conservation areas, as well as areas outside the urban growth boundary
- requirements to provide offsets for the removal of natural vegetation and threatened species' habitat on land suitable for urban development
- requirements to salvage and translocate threatened species prior to the removal of habitats on land for urban development.

To achieve the BCS, the following plans are being implemented.

- Precinct structure plans set out the future structure of suburbs in the growth corridors. For example, they designate areas for the location of housing and local transport networks. There are sixteen separate precincts in the growth area.
- Planning permits, which are legal documents, give permission for a specific use or development of land, such as the removal of native vegetation.
- Native vegetation precinct plans set out the requirements for the renewal and protection of native vegetation within a precinct.
- Conservation management plans outline how matters of national significance will be managed.

The management of biodiversity in the BCS will be funded using the cost-recovery method; that is, sufficient fees will be collected from developers and other users of the area. Figure 6.20 outlines the processes for biodiversity conservation.

6.20 Implementation of the Biodiversity Conservation Strategy for Melbourne Growth Corridors



## Conservation areas

Setting aside areas for conservation of ecosystems is an effective way of maintaining biodiversity. Melbourne Conservation Areas comes under the umbrella of the state-based Protected Area System. One of the criticisms of the National Reserve System is that it does not provide protection for many areas outside the reserve system, such as crown land, which has important biodiversity habitats. A lot of crown land provides narrow links between reserves, such as stream frontages and roads. The links allow the movement of genetic material of a species from one

population to another, as well as enable individual animals to search for food or breeding opportunities outside their possibly small, protected areas.

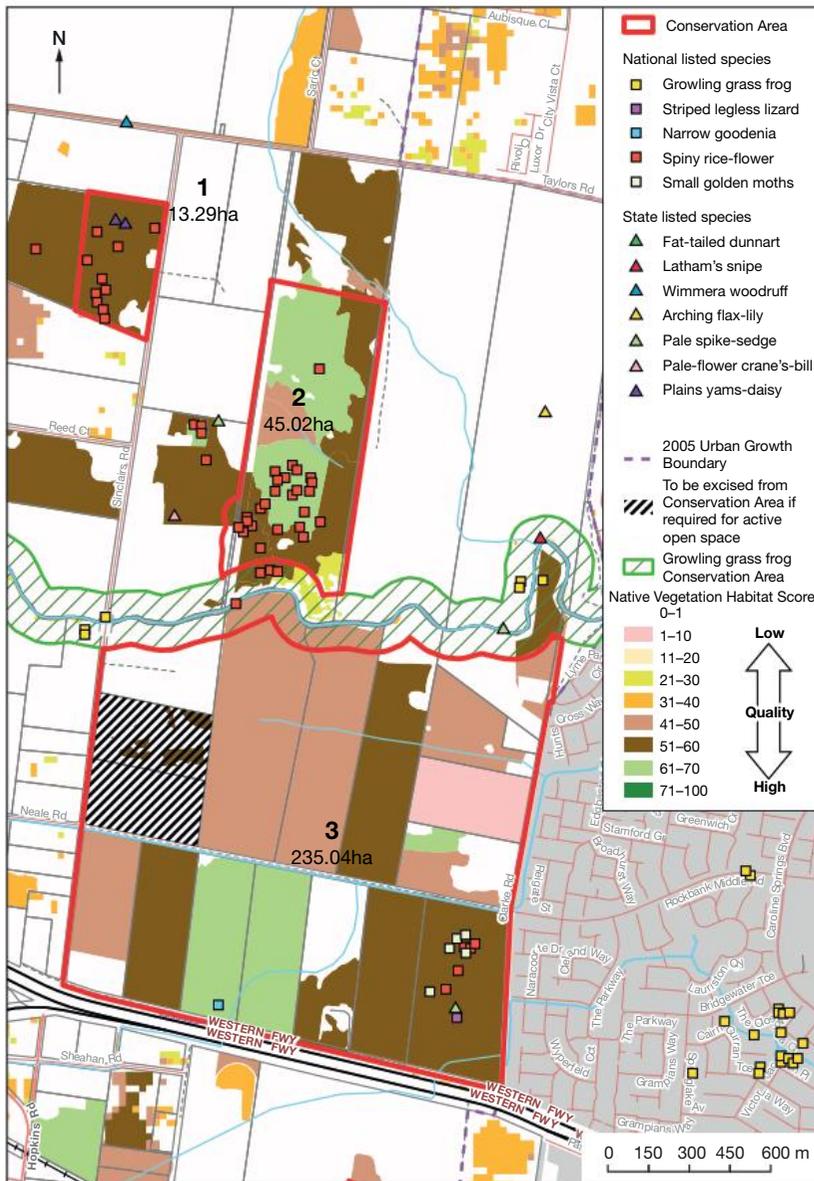
### Western growth corridor

Melbourne's Growth Corridor Plans are high-level integrated landuse and transport plans for Melbourne's new suburbs. The plans focus on housing, jobs, transport, town centres, open space and key infrastructure. Table 6.21 outlines the biodiversity conservation strategy for the Western Growth Corridor.

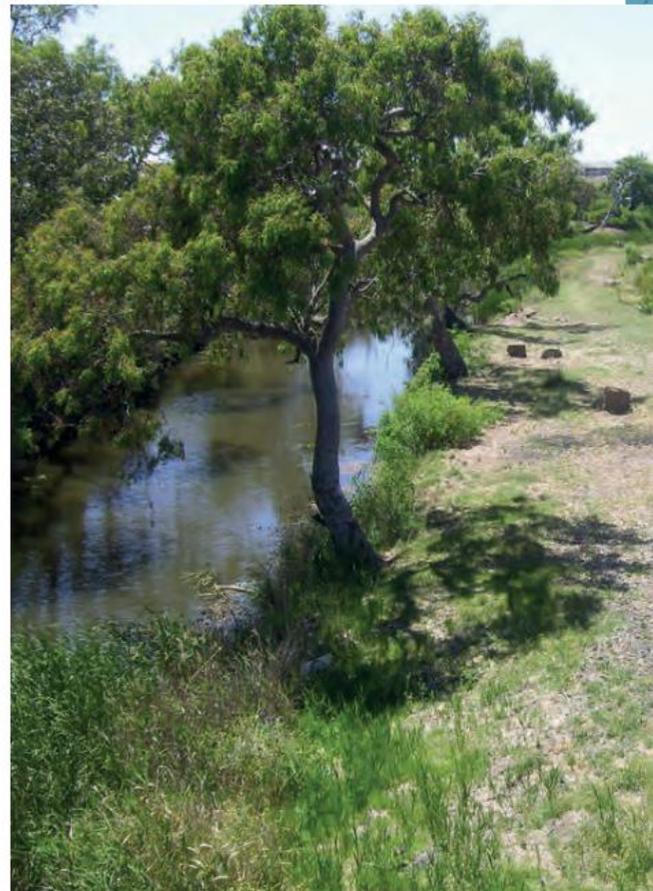
6.21 Conservation Areas 1, 2 and 3

	Conservation Area 1 Western Growth Corridor: Kororoit Creek North Herb-rich grasslands, Plumpton	Conservation Area 2 Western Growth Corridor: Kororoit Creek North Herb-rich grasslands, Ravenhall	Conservation Area 3 Western Growth Corridor: Clarke's Road Grassland, Rockbank
Total area	13.29 hectares	45.02 hectares	235.04 hectares
Management category	Nature conservation	Nature conservation	Regional park (part only)
Key rationale for protection of area	Protects high-quality, herb-rich native grassland that contains a significant population of spiny rice-flower within a manageable area	Protects high-quality, herb-rich native grassland that contains a significant population of spiny rice-flower within a manageable area	Protects high-quality, herb-rich native grassland that contains a range of biodiversity values of national and state significance within a manageable area, including the most significant population of small golden moths orchid in Victoria
Biodiversity values	High-quality, herb-rich natural temperate grassland Spiny rice-flower population (greater than 50) within high-persistence habitat High-persistence habitat for golden sun moth Habitat for striped legless lizard	High-quality, herb-rich natural temperate grassland Spiny rice-flower population (greater than 20) within high-persistence habitat High-persistence habitat for golden sun moth Habitat for striped legless lizard Likely population of small golden moths orchid	High-quality, herb-rich natural temperate grassland Small golden moths orchid (population greater than 400, only wild population in Victoria out of three populations in total) Spiny rice-flower population within high-persistence habitat Growling grass frog population A number of sun orchid species High-persistence habitat for golden sun moth Habitat for striped legless lizard
Further actions	Prepare planning provisions Prepare conservation management plan Ensure funding in place for management Establish management agreements with landowners under Section 69 of the <i>Conservation Forests and Lands Act 1987</i> Transfer land to the Crown where needed	Prepare planning provisions Prepare conservation management plan Ensure funding in place for management Acquire land and incorporate within Kororoit Creek Regional Park Establish management agreements with landowners under Section 69 of the <i>Conservation Forests and Lands Act 1987</i> Transfer land to the Crown where needed	Prepare planning provisions Prepare conservation management plan Ensure funding in place for management Acquire land and incorporate within Kororoit Creek Regional Park Establish management agreements with landowners under Section 69 of the <i>Conservation Forests and Lands Act 1987</i> Transfer land to the Crown where needed

Source: Department of Environment and Primary Industries Victoria



6.22 Conservation Areas in Melbourne's Western Growth Corridor



6.23 Kororoit Creek

## ACTIVITIES

### Knowledge and understanding

- 1 Describe the biodiversity of Melbourne.
- 2 Explain how Melbourne's biodiversity has been affected by urban development.
- 3 Outline the strategies in place to protect Melbourne's remaining biodiversity.

### Applying and analysing

- 4 In your view, what is the most important component of Melbourne's management of urban biodiversity? Why?

### Geographical skills

- 5 Study Figure 6.19. Describe the pattern of urban growth in Melbourne.

- 6 Study the table in Figure 6.21. If the parcel of land can't be built on, who is most likely to purchase the land? What should the land be used for?
- 7 Study Figure 6.22. Investigate the management of biodiversity in Melbourne's Western Growth Corridor.
  - a Discuss why Conservation Areas 2 and 3 do not extend to the creek.
  - b Explain the factors that determined the location of each of Conservation Areas 1, 2 and 3.
  - c Which of the criteria in the table in Figure 6.21 are best addressed by this management plan? What could be done to address other criteria?
  - d Research the typical habitat for either growing grass frog, spiny rice-flower or small golden moths orchid. Use this to recommend the best way to manage these conservation areas.

6.4

# In the field: Urban biodiversity

**The aim of this fieldwork activity is to investigate the biodiversity in your local neighbourhood. You will need to undertake research online and in the field. After you collect your data, you will assess management strategies to protect biodiversity.**

## Landuse map

A landuse map is a thematic map showing the distribution of different landuses. The steps below explain how to construct a landuse map of the biophysical environment in your local government area or neighbourhood.

### Step 1

Decide if you are going to investigate your local government area or your local neighbourhood. Then access an outline map of the area you are going to investigate. Your local council websites can usually provide a map. You can also use an online digital map service such as Google Maps. Download and/or print a copy.

### Step 2

Using your outline map, conduct a landuse survey of the biophysical environment in the area you are investigating. Make a legend for your map that contains the following landuse categories. Colour-code these landuses on your map. Use Figure 6.24 as a guide.

- Parks, gardens
- Waterways: rivers, creeks, streams, lakes
- Coasts
- Bushland, forests
- Swamps, estuaries

### Step 3

Take photographs to show the diversity of the biophysical environment in your local neighbourhood. Link these images to your landuse map. Include a caption with your photo, noting any specific points about the biophysical environment and its surrounds, as shown in Figure 6.25.

## Change over time

### Step 1

Gather historical resources such as maps, photographs or paintings of the area you are investigating (see Figure 6.26). You can start your research with Trove, the National Library of Australia's search site, or your state library. You can also try your local council library or historical society.

### Step 2

Depending on the resources you collect, undertake one or more of the following tasks.

- Annotate your map with the collected resources.
- Link an image or photo to the right location and take a photo of the similar location.
- Compare your landuse map and present-day images with the historical resources, noting any changes you observe.

## Urban biodiversity and conservation

### Step 1

Discover areas of significant biodiversity or conservation in your local area. Your local council website is the best place to start your research.

### Step 2

Take photographs of all or a selection of significant biodiversity or conservation areas. Link these images to your landuse map and include in your annotations the reasons why these areas are important biodiversity and conservation areas—for both flora and fauna.

## Community groups

### Step 1

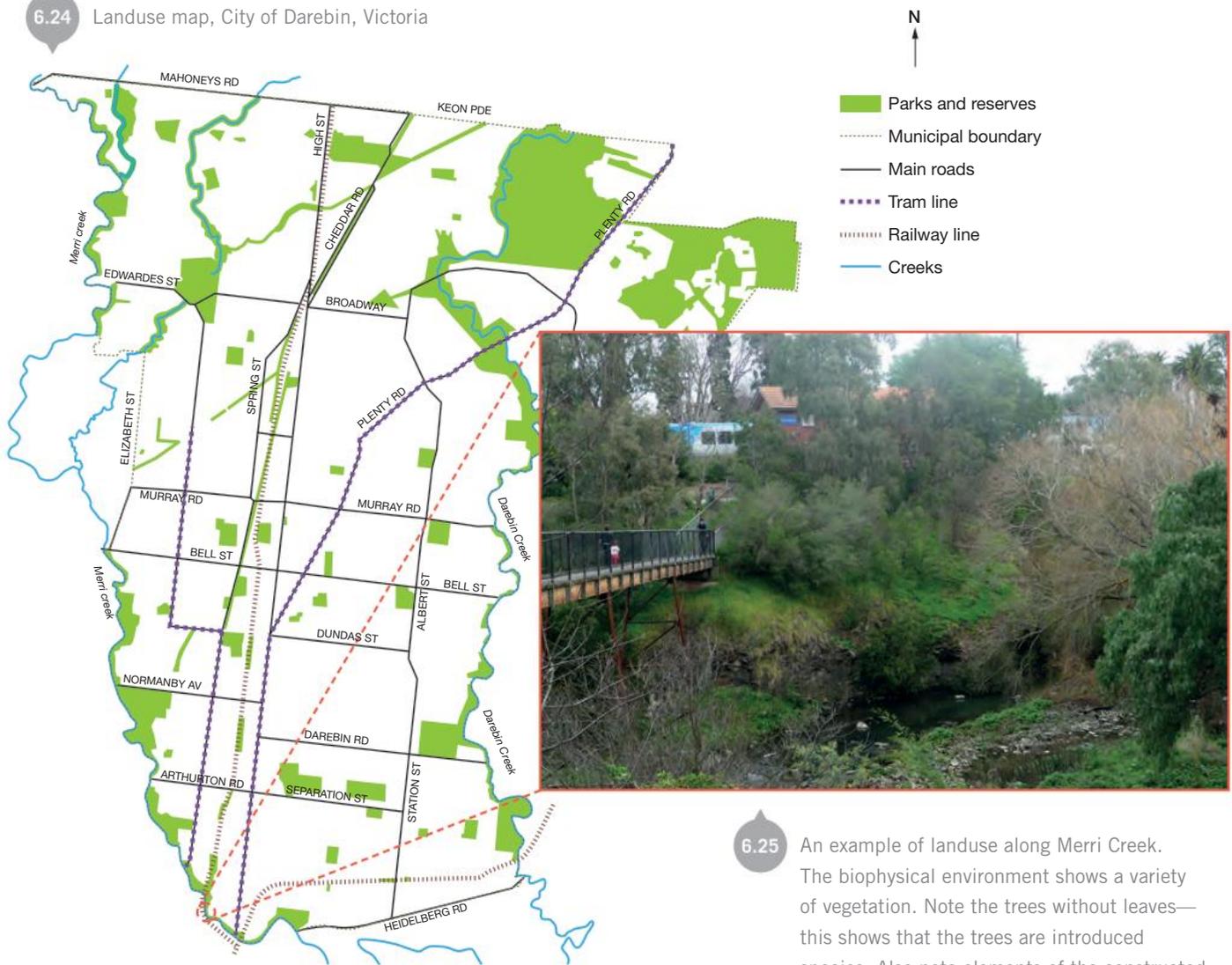
List and investigate the community groups involved in protection of biodiversity in your area of investigation.

### Step 2

Select one community group to investigate. Include in your response the following information:

- the aims of the group
- the membership of the group
- current, past and future projects
- collaboration with the local council and/or other community groups
- funding of their projects.

6.24 Landuse map, City of Darebin, Victoria



6.25 An example of landuse along Merri Creek. The biophysical environment shows a variety of vegetation. Note the trees without leaves—this shows that the trees are introduced species. Also note elements of the constructed environment—the small bridge across the creek and a railway station on the opposite bank



6.26 Aboriginal people fishing and camping on Merri Creek. Tinted lithograph by Charles Troedel, 1864, from *Souvenir Views of Melbourne and Victorian Scenery*, Melbourne, 1865. Held in the La Trobe Collection, State Library of Victoria. Note: the exact location of the painting is unknown.

# Urban biodiversity management

Protecting urban biodiversity is important. A range of strategies are used to protect urban biodiversity. The ability to assess the effectiveness of these strategies is an important skill. It enables biodiversity to be maintained in the most effective and efficient manner.

6.27 Management strategies

## Step 1

Select one of the biodiversity or conservation areas in your local area to visit and investigate. Find examples of the biodiversity management strategies being used to protect biodiversity in this area.

## Step 2

Investigate strategies of urban biodiversity management. Figure 6.27 illustrates some of these management strategies you might investigate.

### a Restoration and revegetation



Tree planting and stabilisation works

### b Information/education signs



A community noticeboard providing information about the local flora and fauna and community news

### c Responsible pet ownership



Ensuring pet owners clean up after their pets. Registration of pets and pet curfews are also aimed at encouraging responsible pet ownership.

### d Engaging local residents in projects



Many local councils encourage residents to plant native species in their gardens to support local wildlife.

### e Control of development



Fences and paths separate and protect areas. Councils can also zone areas for protection and determine the type of development in an area.

### f Water-sensitive urban design



Restoration of native vegetation is important for protecting waterways. Rain and water gardens are also being constructed in many areas to prevent wastes from entering rivers and creeks.

### g Addressing introduced species and disease



Blackberry is regarded as one of the worst weeds in Australia. Eradication of introduced species among plants and animals

### h Protection



Governments and local councils can create laws to protect significant areas for biodiversity.

## Evaluation of biodiversity management

Evaluation is the determination of whether management has achieved its objectives and what accounts for its level of performance. Table 6.28 provides a possible set of criteria for evaluating urban biodiversity and lists indicators that allow measurement of the degree to which those criteria have been met.

6.28 Criteria for evaluating urban biodiversity management

Measures: Enhances, maintains, minor reduction, major reduction		
Criteria		
Environmental	Economic	Social
<ul style="list-style-type: none"> <li>Diversity of species</li> <li>Diversity of ecosystems</li> <li>Ecosystems services</li> <li>Ecosystem stability</li> <li>Ecosystem resilience</li> </ul>	<ul style="list-style-type: none"> <li>Economic profitability of urban area</li> <li>Ongoing financial support for management</li> <li>Encourages business activity</li> <li>Urban place's links with other areas</li> </ul>	<ul style="list-style-type: none"> <li>Local community</li> <li>Encourages active interaction between people and biodiversity</li> <li>Promotes local ownership of urban biodiversity management</li> <li>Enhances quality of life for local residents</li> <li>Considers social justice</li> </ul>

Evaluating the effectiveness of biodiversity management:

- leads to better management
- assists in effective resource allocation
- promotes accountability and transparency
- helps to involve the community, builds constituency and promotes protected area values.

## ACTIVITIES



### Aim

Undertake a study of biodiversity in your local area and evaluate the effectiveness of the strategies being implemented to protect it using the criteria in Table 6.29.

### Method

- 1 Construct a landuse map of your local area, highlighting the distribution of the biophysical elements of the environment.
- 2 Use annotations and photographs to illustrate your landuse map.
- 3 Compare your landuse map with maps compiled in the past in order to identify possible changes in biodiversity over time.
- 4 Identify the management strategies being used to protect the remaining biodiversity.
- 5 Use criteria to assess the effectiveness of these strategies.

### Option 1

Select one of the following: urban expansion, pollution or introduced species. Explain its impact on biodiversity in your local area.

### Option 2

Choose one native species (flora or fauna) traditionally found in your local area to investigate in detail.

### Evaluation

Outline the findings of your investigation.

- 6 Describe the nature and extent of biodiversity in your local area.
- 7 Outline how the biodiversity of your local area has changed over time.
- 8 Describe the range of strategies used to protect biodiversity and assess the effectiveness of each. Identify the most effective strategy.
- 9 Evaluate the effectiveness of the methods used to investigate the issue of biodiversity in your local area.

### Conclusion

- 10 If you could, would you make any changes to the way the remaining biodiversity in your local area is being protected? Are there any ways in which biodiversity in your local area could be increased?

# 6.6

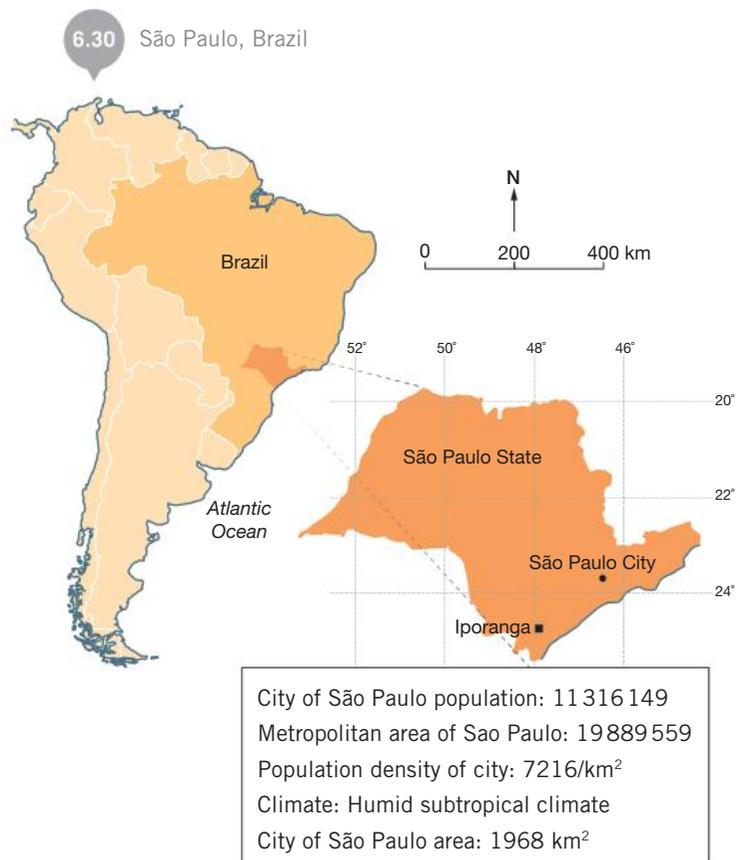
## Case study: São Paulo, Brazil

The city of São Paulo lies within the Metropolitan Area of São Paulo (Greater Sao Paulo), both of which are located within the State of São Paulo, in Brazil. The city is located on a plateau, 800 metres above sea level. The city has been undergoing a transition from a predominantly industrial centre to a major South American commercial, financial and services centre. This transition has encouraged inward migration, which in turn has increased pressures on the city's biodiversity and resources.

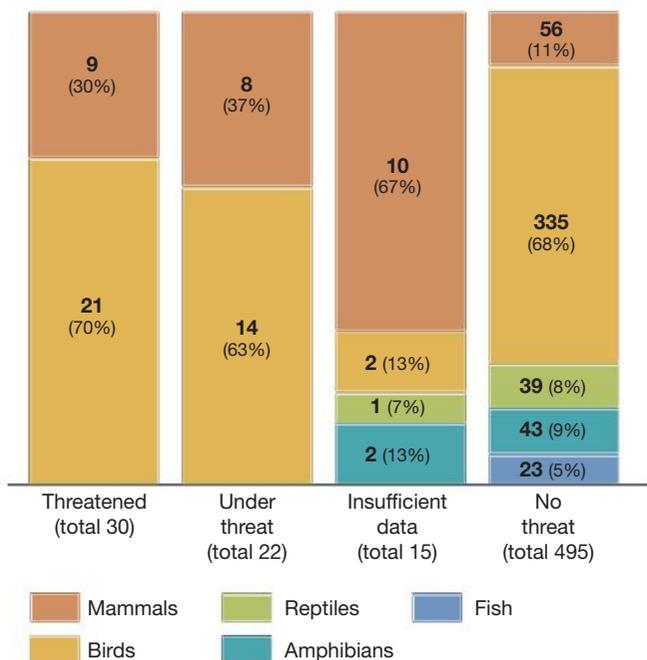
### Biodiversity of São Paulo

In the city of São Paulo, action programs have been developed to safeguard the city's biodiversity and increase public awareness about this important natural heritage. São Paulo is one of twenty-one cities worldwide participating in the project Local Action for Biodiversity, an initiative of Local Governments for Sustainability. The aim in São Paulo is to develop initiatives for the conservation, management and utilisation of urban biodiversity, while taking into account issues such as poverty and sustainable development.

The most significant component of the biodiversity of São Paulo is the Atlantic Forest. There are fragments of this important forest ecosystem throughout the city. These areas have been identified by UNESCO as displaying biological wealth and evolutionary significance, and being among the world's richest and most endangered habitats.



6.29 Biodiversity of the city of São Paulo



The forest has very high endemism, meaning that there are species in the forest that are found nowhere else in the world. Seventy per cent of the tree species, 85 per cent of the primates and 39 per cent of other mammals are found in no other ecosystem. Surveys in the São Paulo have shown that biodiversity is still quite high, despite much human activity. There are:

- 1909 species of flora
- 285 species of birds
- 58 species of mammals
- 37 species of reptiles
- 40 species of amphibians.

Figure 6.29 outlines the distribution of species of vertebrates in São Paulo, according to the degree of threat.



6.31 Favelas (illegal housing) in São Paulo

## Threats to São Paulo biodiversity

Economic and demographic changes in São Paulo have intensified the pressures on natural areas in the city. The expansion of urban areas over a long period of time did not take account of the natural limitations and constraints. The influx of many people and an undersupply of sufficient housing necessitated the illegal expansion of housing into forested areas (see Figure 6.31). This, even today, results in deforestation, forest burning and poorly built dwellings that release untreated sewage and garbage into waterways. Even when urban expansion or housing development is legal, it has invariably been a disorderly occupation of land, with little consideration given to biodiversity values. This poorly planned development has resulted in many areas of forest fragmentation, as shown in Figure 6.32.

After the initial destruction of forest for human settlement, there are ongoing pressures on the remaining biodiversity. These include the harming of wildlife by traffic, degradation of soils and hydrology from polluted run-off, illegal trapping of wildlife for the pet trade, invasion by exotic species of plants and animals, and increased erosion

of fragile rainforest soils. Many of these pressures have flow-on effects. For example, the increased erosion of soils leads to increased fertiliser use, which may then result in eutrophication of waterways. The erosion of soils is also responsible for the siltation of creeks, increased flooding and reduction in the quality of aquatic habitats.



6.32 The urban expansion of São Paulo

## Management of biodiversity

Although there has been some biodiversity protection for at least a couple of decades, urban biodiversity loss continues. As a result, the city of São Paulo has implemented a number of measures. The Municipal Secretariat for Environment and the Municipal Council on the Environment and Sustainable Development were formed in 1993. They oversee environmental matters such as conservation of biodiversity. A special fund set up in 2001, the special Environment and Sustainable Development Fund, provides financial support to environmental plans, programs and projects.

## The Strategic Management Plan 2002

The Strategic Management Plan 2002 is a legal document that regulates urban, economic and social development policies. The advantage of the plan is that it incorporates an environmental protection theme. The plan recognises two zones (environmental protection and urban infrastructure), which determine the type of activity and development suitable for that location.

## Municipal parks

Municipal parks include:

- urban parks accommodating a wide range of activities from leisure to preservation. These comprise about 1.13 per cent of the total city land area.
- environmental protection areas, of which the city has two. They are areas that contain mostly unmodified natural systems. One is 251 square kilometres in area and the other is 90 square kilometres, and both contain remnants of Atlantic Forest.
- other parks such as state parks, conservation units and municipal nature parks. These are locations identified as containing remnant Atlantic Forest or significant biodiversity.

## Municipal environmental police

Established in March 2007, the Municipal Environmental Police Department's 300 guards enforce environmental protection, particularly irregular land occupation.

## Inventory of flora and fauna

The fauna inventory began in 1993 and the last update was in 2006. Forty-eight areas were surveyed and 432 animal species recorded. In 1998, São Paulo Municipal Herbarium was registered with the Index Herbarium, an international herbarium publication.

## Flora management

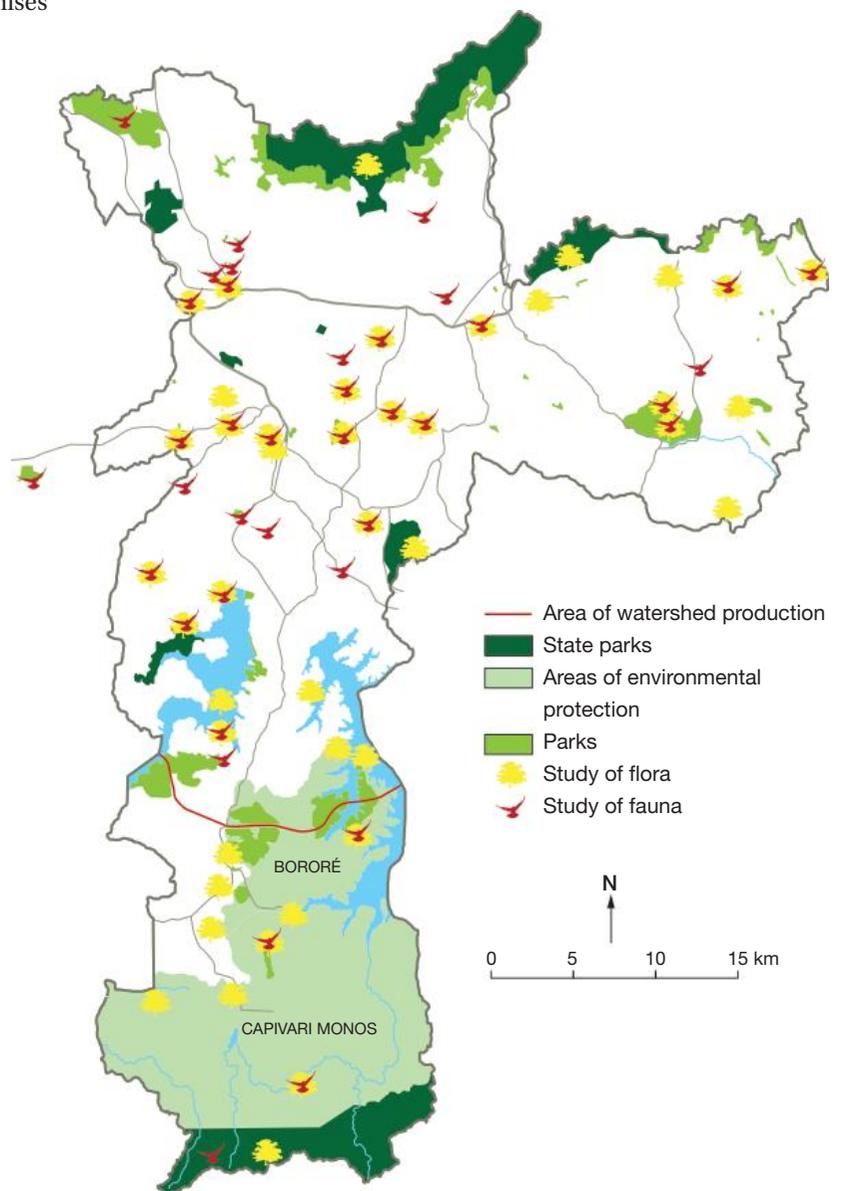
A tree-planting program was established in 2006 to increase the number of trees in the city, especially in areas with very few. Since the start, 9000 trees have been planted per month.

## Wildlife rehabilitation

The Technical Department of Veterinary Medicine and Care for Wild Fauna, established in 1993, provides veterinary care for wild animals in the city of São Paulo. If suitable recovery is made, the animal is returned to its natural habitat in the city.

## Operation Defense of the Waters

With the goal of protecting springs, and revitalising creeks and other waterways, this policy addresses impacts caused by irregular housing, slums and waste disposal.



6.33 Public parks and protected areas of São Paulo



**6.34** Ibirapuera Park, which was part of the program 100 Parques, includes several species of fish and over 100 species of birds. This park also provides a popular area for leisure, jogging and walking.

## ACTIVITIES

### Knowledge and understanding

- 1 Describe the biodiversity of São Paulo.
- 2 State the threats to São Paulo's biodiversity.
- 3 Outline how the issue of biodiversity loss is being addressed in São Paulo.

### Applying and analysing

- 4 Study Figure 6.34. Discuss the value of this urban parkland in terms of its benefits to the community and its contribution to biodiversity.
- 5 Conduct a class debate on the following topic: 'It is easier to manage urban biodiversity in places where biodiversity is extremely high, such as a city in a tropical rainforest, than a city such as São Paulo'.

# Review and reflect **2**

## Activity 1

### Home: Documentary study

The producers of the film *Home* argue that we are living in exceptional times. Scientists tell us that we have little more than a decade to change the way we live if we are to avert the depletion of natural resources and catastrophic climate change. The stakes are high for us, and our children.

*Home* focuses on the diversity of life on earth and depicts how humanity is threatening the ecological balance of the planet.

- a Watch *Home* on YouTube then read the following extracts from the film's narration.

#### Life as a miracle

Life, a miracle in the universe, appeared around 4 billion years ago, and we humans only 200 000 years ago.

... a cloud of agglutinated dust particles, similar to so many similar clusters in the universe. Yet this is where the miracle of life occurred. Today, life, our life, is just a link in a chain of innumerable living beings that have succeeded one another on earth.

#### Life as a whole

The engine of life is linkage. Everything is linked. Nothing is self-sufficient. Water and air are inseparable, united in life and for our life on earth. Sharing is everything.

The earth counts time in billions of years. It took more than 4 billion years for it to make trees. In the chain of species, trees are a pinnacle, a perfect living sculpture. Trees defy gravity. They are the only natural element in perpetual movement towards the sky. They grow unhurriedly towards the sun that nourishes their foliage. They have inherited from those minuscule cyanobacteria the power to capture light's energy. They store it and feed off it, turning it into wood and leaves, which then decompose into a mixture of water, mineral, vegetable and living matter. And so, gradually, soils are formed.

In the great adventure of life on earth, every species has its role to play; every species has its place. Not one is useless or harmful. They all balance out.

#### Enter humans

And that's where you, *Homo sapiens* (wise human), enter the story. You benefit from an amazing, 4 billion-year-old legacy bequeathed by the earth. You are only 200 000 years old, but you have changed the face of the world. Despite your vulnerability, you have taken possession of every habitat and conquered swathes of territory like no other species before you.

The invention of agriculture turned our history upside down. It was less than 10 000 years ago. Agriculture was our first great revolution.

We have created phenomena we cannot control. Since our origins, water, air and forms of life have been intimately linked. But, recently, we have broken those links.

Let's face facts ... We have shaped earth in our image.

#### There is hope

It's too late to be a pessimist ... [but we] have very little time to change. How can this century carry the burden of 9 billion human beings if we refuse to be called to account for everything we alone have done?

It's time to come together. What's important is not what's gone but what remains. We still have half the world's forests, thousands of rivers, lakes and glaciers and thousands of thriving species. We know that the solutions are there today. We all have the power to change. So what are we waiting for?

It's up to us to write what happens next.

- b As a class:
- Discuss the nature of humankind's relationship to the environment presented in this series of quotes and the film.
  - Explain the reference to a 'chain of species'. How can we describe the relationship of the human species to the rest of life on earth? What place are humans given among living things?
  - Reflect on the use of the tree to highlight the relationship between trees and humanity.
  - Discuss the meaning of the statement: 'Let's face facts ... We have shaped earth in our image'.
  - Identify the point in the film when 'everything shifts'. What effects are used to dramatise the change?
  - It is important that the film ends on a positive note. What challenge does it present?

## Activity 2

R&R  
2.1

Humanity and the natural world

### Cartoon interpretation

- Study Figure R&R2.1. Write a paragraph or two outlining the message the illustrator is seeking to convey. What is the dominant worldview underpinning the relationship portrayed?
- Study Figure R&R2.2. Drawing on your knowledge of ecosystem functioning and food chains, explain the point the cartoonist is seeking to make. What are the consequences of the actions depicted?
- Study Figure R&R2.3. Drawing on your knowledge, explain the point the cartoonist is seeking to make.
- Hold a class debate on the following topic: 'It is no longer possible to hold a human-centred worldview. Humanity must embrace a more earth-centred worldview'.



Suppe Wikimedia 2002 / Steppa.net



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R&R  
2.2

Upsetting the balance



## Activity 3

### Music and the environment

Using the internet, compile a list of ten songs about the environment by artists with whom you are familiar. Select one of these songs for closer analysis then answer the following questions.

- What is the message conveyed by the song's lyrics?
- Develop a pictorial multimedia presentation featuring relevant images of the environment. Add your song as a soundtrack.
- Share your work with the rest of the class.

## Activity 4

### Alternative futures

Study Figure R&R 2.4. Reflect on how your view of the relationship between people and the environment has changed since you commenced your studies of secondary school geography in Year 7. Which of the photos now best fits your view of the relationship between people and their environment? Write a paragraph about each photo, indicating whether you agree with the view presented. Explain why.

R&R  
2.4

Alternative futures



## Activity 5

### River red gums

Research the river red gum forests of the River Murray. Write an illustrated article for a geographic magazine highlighting the importance of these forests and explaining why they are at risk. Your article should include the following:

- a map showing the location of river red gum forests
- an outline of the environmental, economic and social importance of these forests
- a description of the risks facing the forests and how these impact upon the people and animals
- solutions being implemented to minimise the risk to river red gum forests.

R&R  
2.5

Most of the river red gums along the Murray, from Victoria to South Australia, are stressed, dying or dead from salinity and lack of water.



CHAPTER

# 7

# HUMAN WELLBEING



**E**nhancing the wellbeing of people living in the world's poorest countries is one of the great challenges facing humanity. In Geography, you study 'development' to identify the ways in which developing countries can improve wellbeing and eliminate absolute poverty.

In the period since World War II, and the subsequent decolonisation process in Africa, Asia and other parts of the world, the peoples and governments of the most developed countries have acknowledged that they have a responsibility to assist the world's poorest countries to improve the lives of their people. At one level, this is a simple matter of self-interest—if people in poorer countries have a greater income, they have more purchasing power and can generate more international trade, creating greater wealth for all. At another level, it is the moral responsibility of those living in the developed world to assist the poor. It is a simple matter of social justice.

This section of the text focuses on the geographies of human wellbeing. In this chapter we examine the global pattern of human wellbeing and how it is measured. We also investigate causes of the global differences in these measures among countries. India is used as a case study.

## KEY IDEAS

- To explain to what extent human wellbeing varies between and within countries
- To understand how human wellbeing is measured
- To explain the reasons for spatial variations in human wellbeing

## GLOSSARY

<b>cash crops</b>	crops grown for sale rather than consumption
<b>colonialism</b>	the practice of acquiring full or partial political control over another country, occupying it and exploiting it economically
<b>developed world</b>	rich countries of the world; most rich countries are industrialised and incomes are high. After fulfilling their everyday needs of water, food and shelter, most people have money left over for buying consumer goods and luxury items
<b>developing country</b>	poor or middle-income country. In many of these countries, most people depend on subsistence farming. For all but the few people who are very rich, life is a constant struggle to satisfy the basic needs
<b>development</b>	a process of change that results in an improvement in the quality of life of a community. It usually involves reducing poverty
<b>economic growth</b>	the growth in the productive capacity of the economy (and national income)
<b>fertility rate</b>	the average number of children born to a woman
<b>formal economy</b>	that part of an economy subject to government regulation and taxation. It is included in gross national product, unlike the informal economy
<b>fuelwood</b>	any wood collected and used as fuel
<b>Industrial Revolution</b>	a period of major industrialisation that took place in Britain and the rest of Europe during the late 1700s and early 1800s
<b>infant mortality rate</b>	the number of infants per 1000 live births who die between birth and their first birthday
<b>life expectancy</b>	the average period that a person may expect to live
<b>middle class</b>	the social group positioned between the upper and working classes. It includes professional and business people and their families
<b>pardah</b>	the practice of concealing the female body from the eyes of males
<b>replacement level</b>	the number of children each woman needs to have to maintain current population levels (zero population growth)
<b>sati</b>	the practice of burning a widow alive on her husband's funeral pyre
<b>social infrastructure</b>	the basic facilities necessary for human development; includes health (hospitals), education (schools) and housing
<b>subsistence production</b>	production at a level sufficient for a person's own use or consumption, without any surplus for trade

**7.0** An Indian girl searches through garbage for scrap at a landfill site in New Delhi, India.

# 7.1

## Development and human wellbeing

The term 'human wellbeing' refers to people's quality of life. It takes into account the extent to which an individual, family, or larger social grouping (for example a community or even a whole country) can be characterised as being healthy, happy and prosperous. There are significant variations in the level of wellbeing experienced by people between and within countries.

### Development

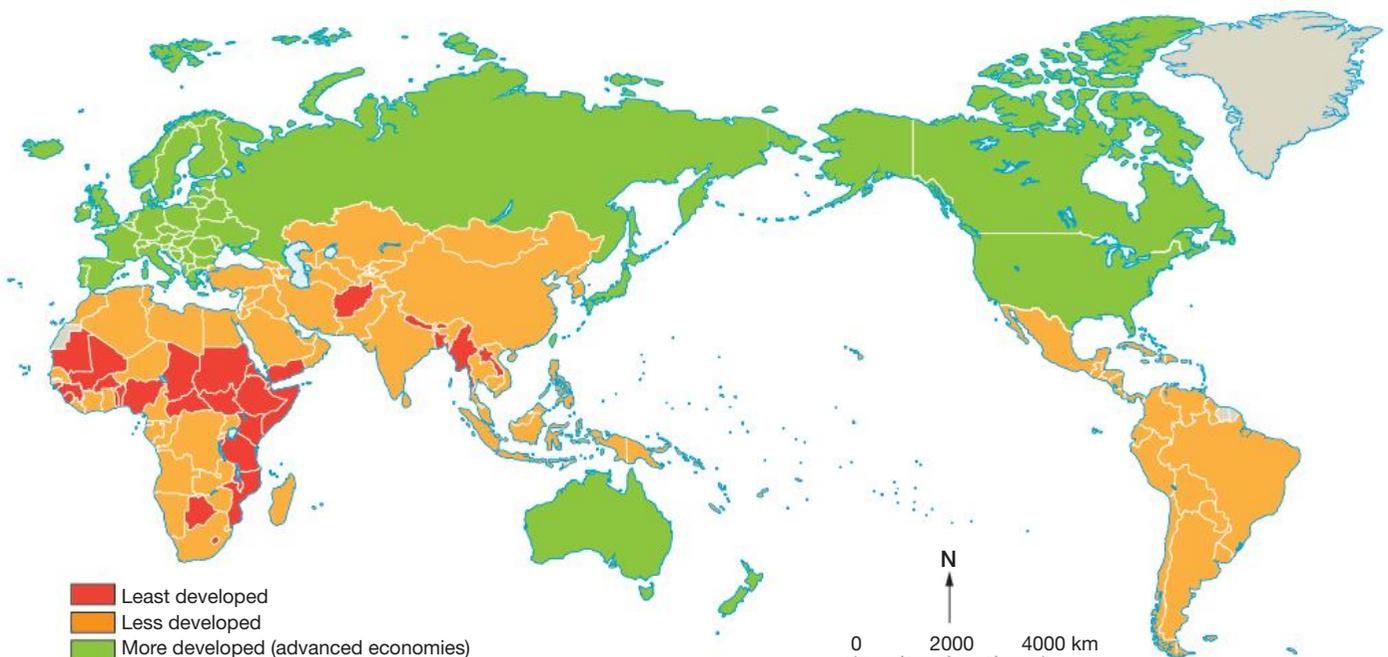
'Development' is a contested term. How it is defined depends on the beliefs people hold, their perspective or view of the world. It can be defined as simply the outcome of **economic growth**, or it can be understood in terms of a dynamic, socio-economic process, the aim of which is a sustained improvement in people's quality of life (or wellbeing) as perceived by those affected by change.

Human wellbeing is often measured by the rate of economic growth. Such growth is driven by the consumption of goods and services. Development policies are often based on the belief that higher growth rates and greater affluence increase people's quality of life. If the gross domestic product (GDP) is rising, we should all be better off, but experience, in both developed and developing countries, shows that even when people have more money and material possessions, they do not necessarily become happier or more satisfied with their lives. Other, non-economic, factors also play a role.

### Developed and developing worlds

Countries have traditionally been considered to be **developed** or **developing**. This division is becoming increasingly problematic, as some countries once described as 'developing' have emerged as major economic powers and their people enjoy a high level of wellbeing. A more commonly used division now is that of 'more developed' countries, 'less developed' and 'least developed'. The distribution of these three divisions is shown in Figure 7.1. The more developed world accounts for 1.24 billion people; the less developed, 5.8 billion; and the least developed, 876 million.

7.1 The more developed, less developed and least developed regions and countries





7.2 Too many of the world's people still have an unacceptable standard of living.

## SPOTLIGHT

### Global inequalities

In early 2014, Oxfam, the international non-government aid agency, reported that the world's 85 richest people controlled wealth of \$1.7 trillion, an amount equal to that held by the world's poorest 3.5 billion people. In other words, a small group of people, just enough to fill a double-decker bus, had accumulated as much wealth as that shared by half the world's people. This staggering figure highlights the inequalities evident in the world today. The wealth of the richest 1 per cent of the world's population was about \$110 trillion, 65 times the total wealth of the bottom 50 per cent of the world's population.

Although poverty has been reduced, inequality has not. In the 20 years between 1990 and 2010, the number of very poor fell by half (as a percentage of the total population) in developing countries, from 43 per cent to 21 per cent—a reduction of almost 1 billion people. Despite such gains, 1.1 billion of the world's 7 billion people still live below the internationally accepted extreme-poverty line of just \$1.25 a day.

## Poverty

Poverty is the state of human beings who are poor; that is, they have little or no material means of surviving—little or no food, shelter, clothes, healthcare, education and other physical means of living and improving their lives. Some definitions of poverty are relative, rather than absolute. The term 'poverty reduction' applies to measures that lift people out of poverty.

## ACTIVITIES



### Knowledge and understanding

- 1 Explain what is meant by the term 'human wellbeing'.
- 2 Define 'development'.
- 3 Distinguish between developed and developing countries. Explain why this distinction is becoming difficult to sustain. What alternative terminology is used to overcome this problem?

### Applying and analysing

- 4 Construct an annotated mind map to illustrate the characteristics of developing countries.

### Geographical skills

- 5 Study Figure 7.1. Describe the distribution of the world's least developed countries.

# 7.2

## Measuring and mapping human wellbeing

Differences in human wellbeing between and within countries can be measured using a range of qualitative and quantitative indicators. When this data is mapped, spatial patterns emerge. These patterns, the reasons for them and the ways in which they change over time are of interest to geographers.

### Assessing human wellbeing

Human wellbeing can be measured using qualitative (subjective) measures of how people perceive the quality of the life they experience, or quantitative (objective) measures, for example **life expectancy**, education levels and income.

### Qualitative indicators

The qualitative or subjective indicators of human wellbeing are those aspects of our standard of living that are difficult to measure, such as political freedoms, social opportunities and guarantees of personal security. They include human rights, the nature of governing institutions, the quality of the environment, the level of social participation and access to leisure. These aspects are about the capacity of the individual to exercise their rights, especially economic, cultural and social rights. They involve the elimination of poverty, inequities, suffering and injustice.

### Quantitative indicators

There is a range of objective (measurable) indicators used to assess human wellbeing.

### Gross national product per capita

When many people think about human wellbeing, they often focus on economic growth. It is not surprising, therefore, that gross national product (GNP) per capita is one of the most commonly used measures of human wellbeing. GNP per capita is the total value of goods and services produced within a country in a particular year, together with income received from other countries (for example interest and dividends), less similar payments made to other countries, divided by the country's population.

The use of GNP has been criticised for failing to accurately measure economic activity, especially in developing countries, where much of the activity takes place outside the **formal economy** or where data collection processes

are often under-resourced. Other indicators used to measure economic growth are energy consumption per capita and employment. Such production-based indicators can be used to rank countries on the basis of their relative economic development. However, they tell us very little about the spatial and social inequalities in the distribution of benefits derived from economic growth, and they tell us nothing about the qualitative dimension of human wellbeing.

### Composite quantitative measures

Several new indices have been introduced over the years to provide a more accurate insight into human wellbeing. These include a range of multiple component (or composite) measures such as the Human Development Index (HDI), the Inequality-adjusted Human Development Index (IHDI), the Multidimensional Poverty Index (MPI) and the Gender-related Development Index (GDI).

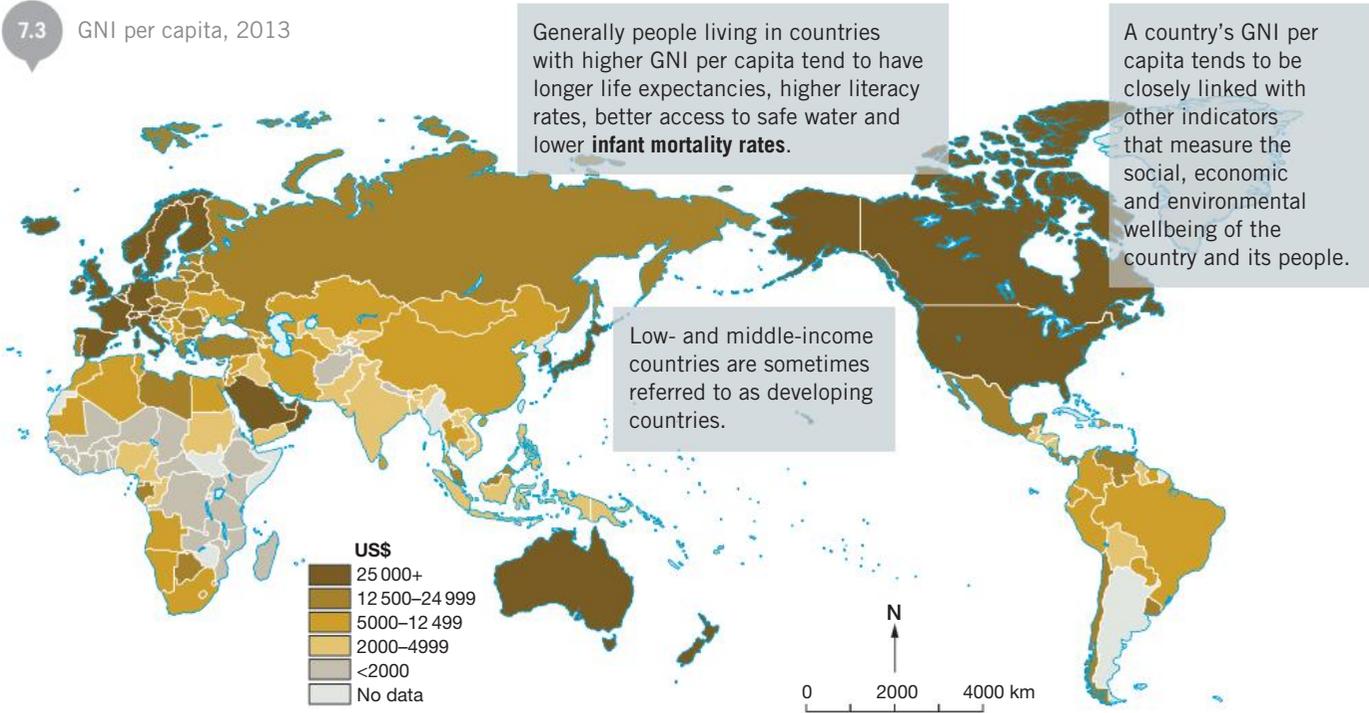
### Human Development Index

The HDI allows for a range of developmental factors to be taken into account when measuring human wellbeing or progress. These factors are income, life expectancy and education. The index is not without its limitations. While it allows for easy comparisons between countries on an aggregate of the indicators, it does not provide an indication of the relative performance of each of the components. It also tells us little about inequalities in wellbeing within countries.

### Inequality-adjusted Human Development Index

The IHDI seeks to measure the level of human wellbeing and the level of inequality. Under conditions of perfect equality, the IHDI is equal to the HDI, but falls below the HDI if inequality rises. IHDI is a measure of the actual level of human development (taking into account inequality), while the HDI can be viewed as an index of the potential human development that could be achieved if there is no inequality.

7.3 GNI per capita, 2013

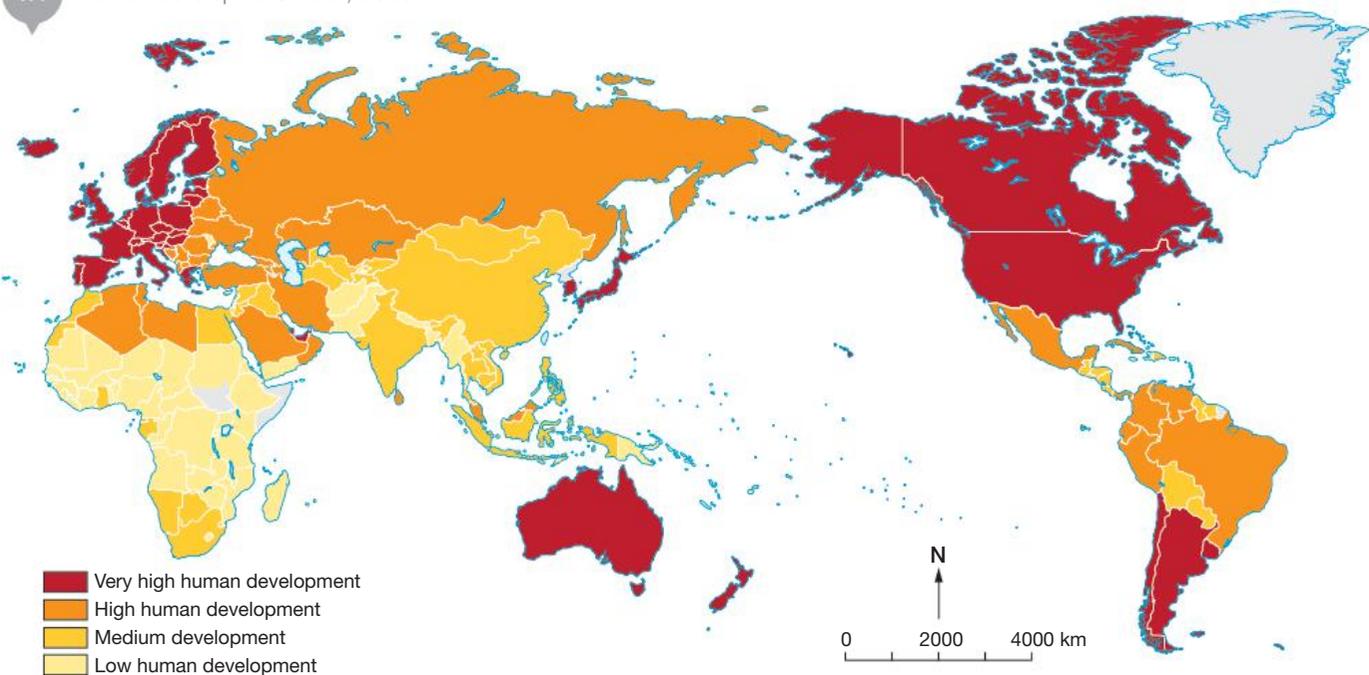


World's 10 richest countries as measured by GNI per capita, 2013		
Rank	Country	GNI per capita (US\$)
1	Norway	98 860
2	Switzerland	82 730
3	Luxembourg	76 960
4	Denmark	59 770
5	Australia	59 570
6	Sweden	56 210
7	Canada	50 970
8	USA	50 120
9	Netherlands	48 250
10	Austria	48 160

World's 10 poorest countries as measured by GNI per capita, 2013		
Rank	Country	GNI per capita (US\$)
10	Eritrea	450
9	Uganda	440
8	Madagascar	430
7	Ethiopia	410
6	Liberia	370
5	Niger	370
4	Malawi	320
3	Burundi	240
2	Democratic Republic of the Congo	220
1	Somalia	128

Source: World Bank

7.4 Human Development Index, 2013



Source: Human Development Report, 2013

HDI Rank 2012	Country	Inequality-adjusted HDI rank 2012	Country
1	Norway	1	Norway
2	Australia	2	Australia
3	USA	3	Sweden
4	Netherlands	4	Netherlands
5	Germany	5	Germany
6	Sweden	6	Ireland
6	Ireland	7	Switzerland
8	Switzerland	8	Iceland
9	Canada	9	Denmark
10	South Korea	10	Slovenia
11	Iceland	11	Finland
12	Denmark	12	Austria
13	Israel	13	Canada
14	Belgium	14	Czech Republic
15	Austria	15	Belgium
16	France	16	USA
17	Slovenia	17	Luxembourg
18	Finland	18	France
19	Spain	19	UK
20	Italy	20	Spain
21	Luxembourg	21	Israel
22	UK	22	Slovakia

Source: United Nations Development Programme

Table 7.5 shows the HDI ranking for the top twenty-two rated countries compared to their inequality-adjusted ranking. While the United States of America has the third-highest HDI, its ranking dropped to 16 when it was adjusted for income, health and educational inequality.

## SPOTLIGHT

### Millennium Development Goals

The Millennium Development Goals (MDGs) are a set of targets established by the United Nations following the Millennium Summit in 2000. The member nations of the UN, together with a large number of international organisations, committed to achieve the goals by 2015. The goals were to:

- eradicate poverty and hunger
- achieve universal primary education

- promote gender equality and empower women
- reduce child mortality
- improve maternal health
- combat HIV/AIDS, malaria and other diseases
- ensure environmental sustainability
- develop global partnerships for development.

Each goal was accompanied by a specific set of targets.

## Multidimensional Poverty Index

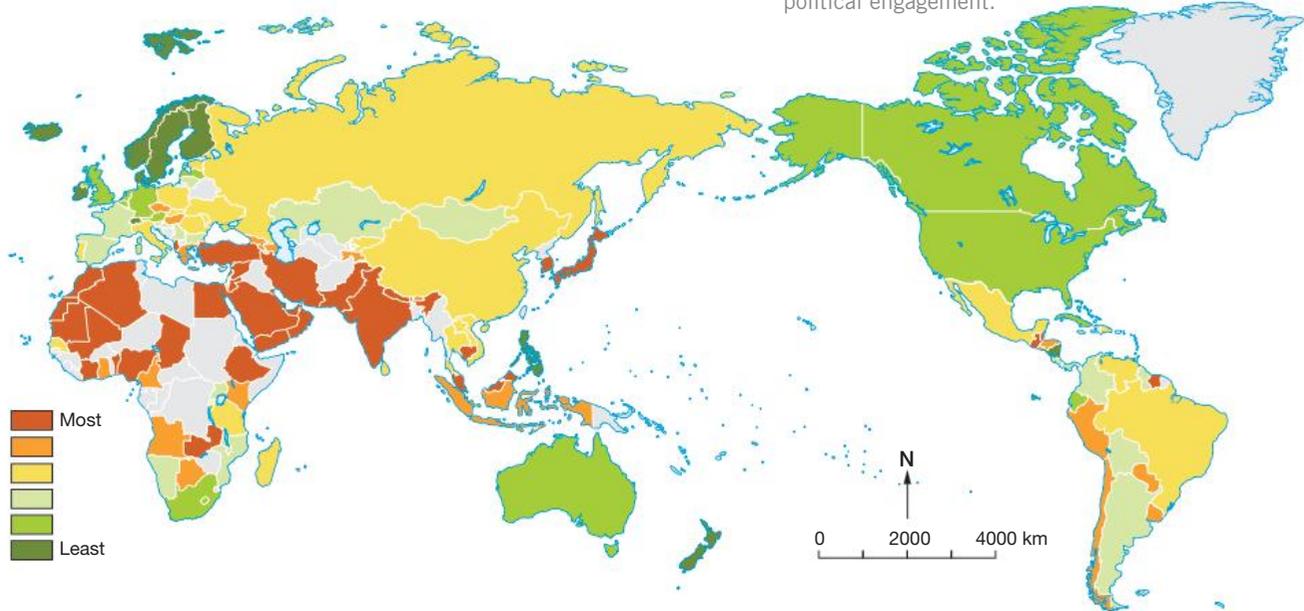
The MPI was developed in 2010 by the United Nations Development Programme and the Oxford Poverty and Human Development Initiative. It uses a range of factors, beyond just income-based criteria, including nutrition and child mortality; years at school and percentage of children completing five years at school; percentage of households with electricity, proper sanitation, access to safe drinking water; and factors such as the type of household flooring and the type of cooking fuel used.

## Gender-related Development Index

The GDI 'discounts' the HDI for gender inequalities in its component indicators and the Gender Empowerment Measure (GEM), which measures gender inequality in terms of political and economic participation by women, for example the number of female politicians and participation in the labour force and types of work.

7.6

The Gender-related Development Index measures the gap between the sexes in four key areas—health (life expectancy, etc.), access to education, economic participation (salaries, job type and seniority) and political engagement.



Source: World Economic Forum, 2013

## ACTIVITIES

### Knowledge and understanding

- 1 Distinguish between quantitative and qualitative data.
- 2 Explain why geographers are interested in mapping such data.
- 3 List the various quantitative measures of human wellbeing. Explain what each seeks to measure.
- 4 Explain what is meant by the term 'composite measure'.
- 5 Outline the disadvantages of relying on a narrow measure such as GNP per capita.
- 6 Explain what the IHDI seeks to measure.
- 7 Outline the qualitative measure typically used to measure human wellbeing.

### Geographical skills

- 8 Study Figure 7.3. With the aid of an atlas, describe the distribution of countries classified as:
  - a 'high income'
  - b 'low income'.

- 9 Study Figures 7.3 and 7.4. Write a sentence or two outlining any significant differences in the pattern of human wellbeing illustrated by GNI per capita and the HDI.
- 10 Study Figure 7.5. Identify those countries whose:
  - a IHDI is considerably below its 2012 HDI rank
  - b IHDI is considerably above its 2012 HDI rank.

### Investigating

- 11 Undertake research to complete the following table.

Country	GNI per capita	Life expectancy	HDI	IHDI	MPI
Australia					
Mexico					
Turkey					
Uganda					
Niger					

# 7.3

## Changes in spatial wellbeing

For ten of the past twenty centuries, India was the world's 'wealthiest' country. In eight of the past twenty centuries it was the second-wealthiest country—China was the richest. So before the Industrial Revolution, levels of human wellbeing in India and China were generally higher than in Europe. This demonstrates that relative levels of human wellbeing change over both time and place.

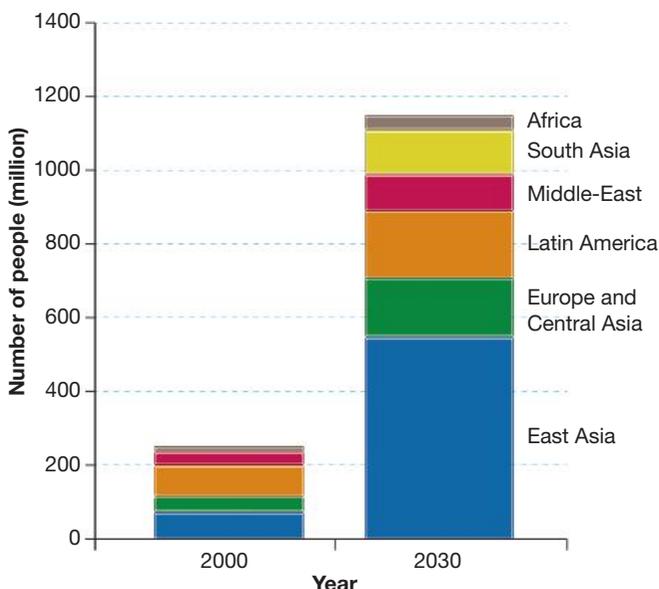
### Progress in human wellbeing

In 2013, the United Nations (UN) reported that poverty reduction in the developing world was exceeding all expectations. It concluded that there was a 'global rebalancing' taking place, with higher growth in at least forty poor countries, helping to lift hundreds of millions of people out of poverty and into a new global **middle class** (see Figure 7.7). It also concluded that the wellbeing and prospects of so many people had never changed so dramatically in such a short period of time. Showing the way are nations such as Rwanda, Nepal and Bangladesh, where extreme (or absolute) poverty could disappear in the lifetime of present generations. Close behind are Ghana, Tanzania, Cambodia and Bolivia.

This improved global picture is the result of international aid and development projects investing in schools (see Figure 7.8), health clinics, housing, infrastructure and improved access to water. The UN noted that trade is a key factor in improving conditions in countries such as Afghanistan, Ethiopia, Rwanda and Sierra Leone. These improvements were observed in the past, when poverty was measured strictly in income terms, without taking into account factors such as health, education and living standards.

This improvement can, at least in part, be attributed to the success of the UN's Millennium Development Goals.

**7.7** Growth of the developing world's middle class, 2000–30. The developing world's middle class is expected to expand to more than 1150 billion people by 2030.



Source: World Bank

**7.8** Education programs in Nepal are improving the wellbeing of people.



## India's and China's changing fortunes

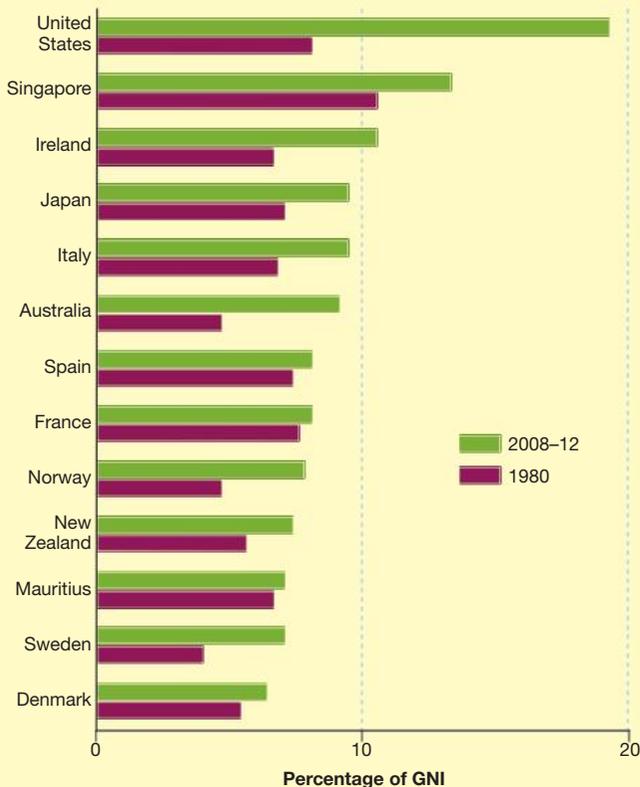
Experts conclude that at the dawn of the **Industrial Revolution** (about 1750), India's per capita income was some 10 per cent above that of England. They also argue that India's and China's technological sophistication once exceeded Europe's. For example, when Marco Polo visited China in the 1290s, he found that the Chinese were far ahead of the Europeans—he brought back to Europe porcelain, paper, paper currency and the compass. By 1800, levels of human wellbeing in China, India and Japan were lower than those in Europe. The balance had changed. The people of Europe (and North America) were then to enjoy generally higher levels of human wellbeing for the next two and a half centuries.

### SPOTLIGHT

#### The rich getting richer

Despite reductions in poverty levels worldwide, inequalities within countries continue to grow. The share of national income of the richest 1 per cent has grown significantly since 1980.

7.9 Share of national income going to the richest 1 per cent of the population, selected countries, 1980 to 2008–12



## Looking to the future

By 2020, there will be a major shift in the global balance of economic power compared with today. Emerging economies will grow in importance and China will overtake the United States of America in terms of GDP. Consumer markets in emerging economies will present great opportunities, but their rapid growth will pose a challenge to the global environment. Translating this economic success into improvements in human wellbeing will be a major challenge. China has had great success in alleviating poverty, but qualitative indicators of human wellbeing, such as human rights and the state of the environment, lag well behind those in most developed countries.

## Australian wellbeing

Levels of human wellbeing have been high in Australian for much of its post-1788 history, and are now among the highest levels of human wellbeing in the world. Australia's Aboriginal and Torres Strait Islander people, however, experience levels of wellbeing well below those of non-Indigenous Australians.

## ACTIVITIES

7.2

### Knowledge and understanding

- 1 Outline the key pieces of information relating to changes in the spatial wellbeing over time highlighted in this unit.
- 2 List some key technologies Marco Polo brought to Europe from China.
- 3 Explain how the spatial pattern of wellbeing is likely to change in the future.

### Applying and analysing

- 4 What implications will the shift in the global balance of power have for human wellbeing?

### Geographical skills

- 5 Study Figure 7.7. Estimate the growth in the developing world middle class between 2000 and 2030. Which region of the developing world is expected to show the greatest proportional increase in the size of its middle class between 2000 and 2030?
- 6 Study Figures 7.9. Estimate the difference in percentage between 1980 and 2008–12 for each country. Rearrange the graph from the greatest to the least difference. Describe any changes between Figure 7.9 and the new list. Can you account for these differences?

# 7.4

## Causes of spatial inequality: External factors

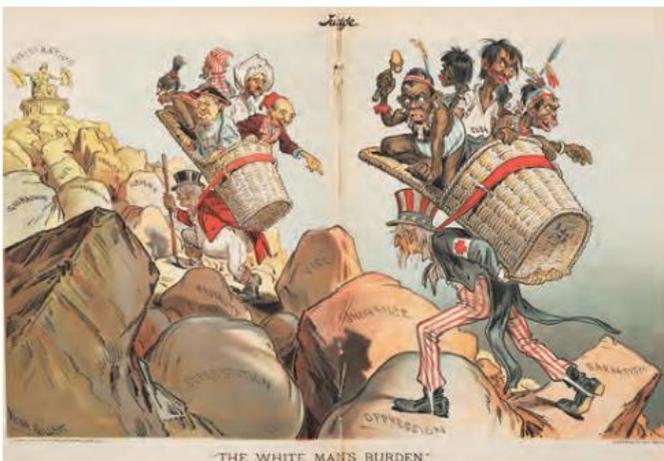
It is important to explore further some of the factors that have contributed to the creation of more developed, less developed and least developed patterns of development. Factors originating within countries or regions are not the only causes of poverty. Some of the commonly recognised external causes are historical.

### Legacy of history

Many of the world's poorest countries were once colonies, part of vast European empires. In the years immediately after World War II, most colonial powers gave up, or were forced to give up, their colonial territories. The legacy of **colonialism** remained and it influenced the development paths of many of the former colonies.

Many of the colonies were used as markets for finished products and other surpluses produced in the industrialised countries. At the same time, the colonies supplied raw materials and foodstuffs needed by the colonial power. Restrictions were often placed on colonies so that they could not produce goods that were already produced by the colonial power, or trade freely with countries other than the colonial power. Such arrangements were obviously designed to benefit the colonial power rather than the colony (see Figure 7.10), and placed severe limits on the colony's economic

7.10 'The White Man's Burden (Apologies to Kipling)', *Judge Magazine*, 1899. The 'White Man's Burden' was originally a poem by Rudyard Kipling. It offered a critique of European imperialism and the notion that Western domination was for the benefit of the developing world.



activities. Many of these established trade relationships have continued with the wealthy countries, long after the demise of colonialism, continuing to dominate international trading relationships. The uneven distribution of wealth between countries is thus shaped by relationships established in the colonial era. Many of the former colonies still suffer from continued economic dependence on the more developed regions of the world.

### Trade imbalances

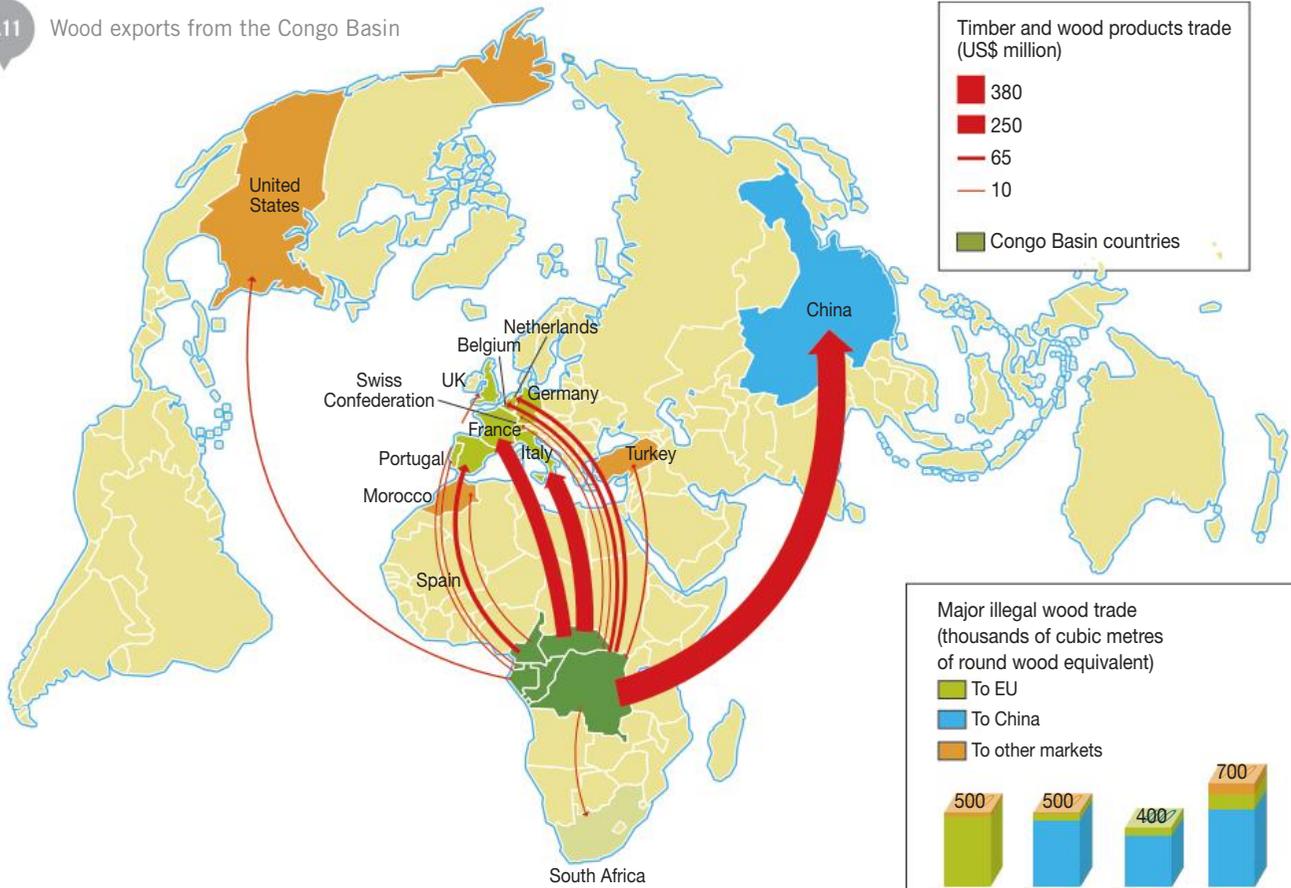
Most developing countries are still net importers of manufactured goods. Manufactured goods are generally more costly than the raw material exports that most developing countries are able to sell. Many poor countries are still dependent on the industrialised, wealthy countries for numerous high-cost imported goods. Meanwhile, these poor countries rely heavily on the exploitation of their natural resources (see Figure 7.11) and the production of agricultural products for their export earnings.

Developing countries have increased their share of global output, but they are usually at a disadvantage in world trade: the value of their imports often exceeds the income earned from their exports. As a result, they are likely to incur a debt rather than earn surplus income through trade.

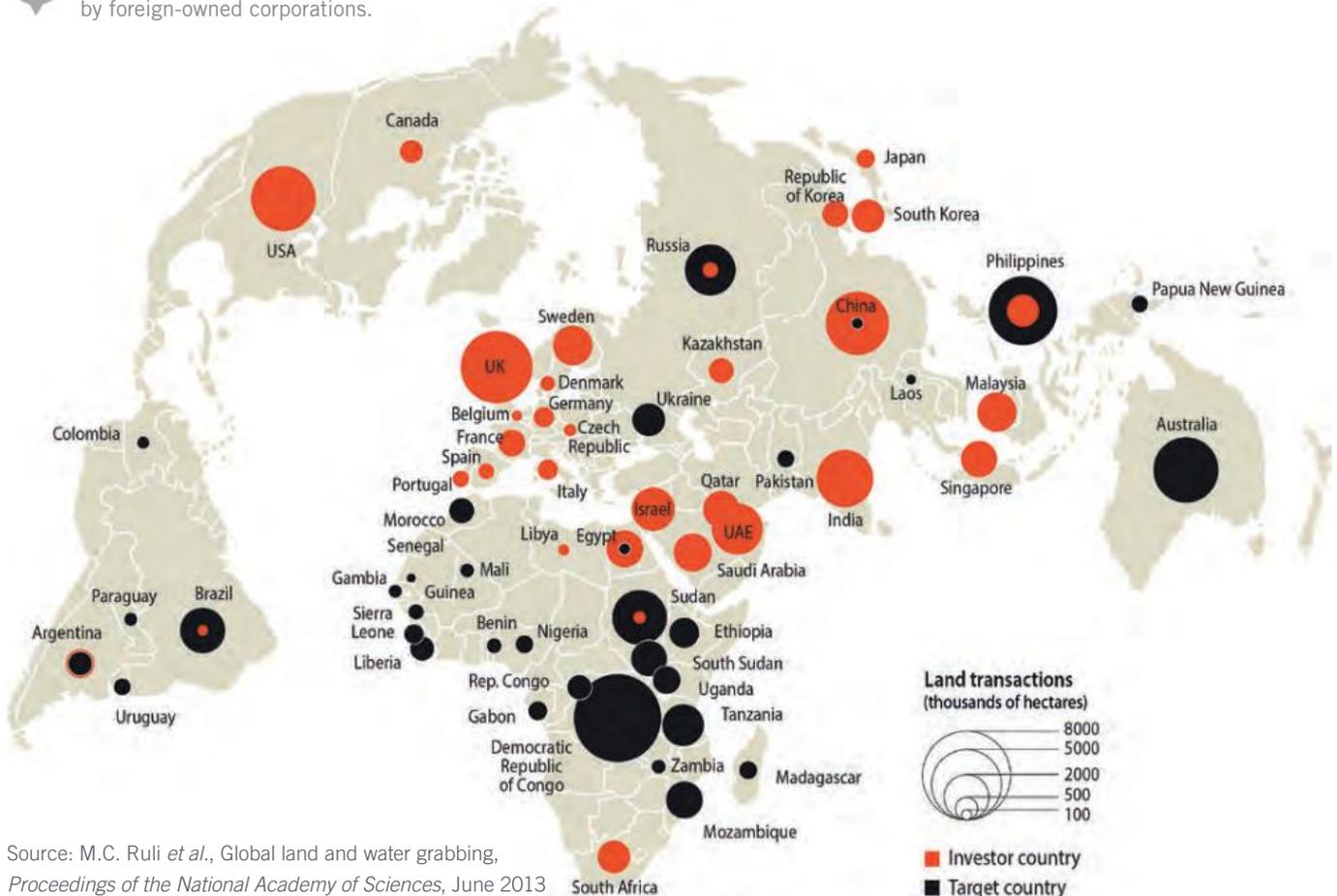
In many poor countries, people have been encouraged to convert farmland from **subsistence production** to production of **cash crops** (such as tea, coffee and flowers), in order to earn export income. This can have devastating effects on poor local farmers, who forego more dependable subsistence farming systems in favour of cash cropping. In doing so, they become dependent on export income, which in turn depends on continued and consistent demand for cash crops. Their country also becomes highly dependent on unreliable sources of export earnings.

The large-scale acquisition of land throughout the developing world by developed nations, shown in Figure 7.12, threatens traditional forms of agriculture in places such as Africa.

7.11 Wood exports from the Congo Basin



7.12 Africa is a target for large-scale land acquisitions by foreign-owned corporations.



Source: M.C. Ruli *et al.*, Global land and water grabbing, *Proceedings of the National Academy of Sciences*, June 2013



7.13

Child workers on a cocoa farm, Sinikosso, Cote D'Ivoire

## Transnational corporations

Transnational corporations (TNCs) are large organisations that have operations in several countries. The parent company is usually based in a developed country. TNCs frequently operate subsidiary companies in developing countries. Developing countries are attractive to TNCs because of their abundant supply of cheap labour, often accompanied by less stringent industrial relations laws regarding wages, hours of employment and working conditions. They also appeal because of the lower cost of inputs (such as land and services) and the availability of cheap raw materials.

Figure 7.13 shows a child worker on a cocoa farm. There have been widespread reports of child slavery in the least developed countries that rely on exports.

The goods manufactured cheaply in poor countries are sold to consumers in wealthy countries (or the rich elite in poor countries). These items are frequently beyond the financial reach of those employed to manufacture them.

## Dependency on development assistance

Many poor countries are heavily dependent on development assistance (or overseas aid) supplied by wealthy countries.

There are three major types of aid.

- **Bilateral aid:** This is development assistance provided by governments of wealthy countries to governments of developing countries.
- **Multilateral aid:** Multilateral aid is given by international institutions, such as the World Bank, the International Monetary Fund (IMF) and the Asian Development Bank. This aid is frequently provided in the form of loans.
- **Non-governmental aid:** This is distributed by non-governmental, non-profit organisations (NGOs), which receive most of their income from donations by the general public.

There is considerable debate about how aid should be distributed. Some donors are concerned about corruption. Others fear that aid is being diverted to projects that do little, if anything, to enhance human wellbeing. There is, however, a shift towards poverty-focused projects that directly involve poor people in the design of projects intended to assist them to improve their own lives.

## ACTIVITIES

### Knowledge and understanding

- 1 Describe the nature of the relationship between the colonial power and the colony prior to independence.
- 2 Outline the nature of the relationship after independence.
- 3 Outline how developing countries are often disadvantaged through their engagement in world trade. What impacts can the imbalance in trade have on developing countries?
- 4 Explain why developing countries offer an attractive base for TNC activities.
- 5 Outline the effects of the burden of debt on developing countries.
- 6 Distinguish between bilateral, multilateral and non-governmental aid.

### Applying and analysing

- 7 Construct a mind map to illustrate the external factors that have an impact on human wellbeing in a developing country.

- 8 Study Figure 7.10 then do the following tasks.
  - a Identify the characters shown carrying the peoples of the colonies in baskets. Who do they represent?
  - b Identify the goal being pursued and name the barriers encountered.
  - c Identify the perspective from which the cartoon is drawn.
  - d Would it be appropriate to draw such a cartoon today? If not, why not?

### Geographical skills

- 9 Study Figure 7.11. Identify the main markets for timber and wood products harvested from the tropical forests of the Congo Basin. Why has this fragile and ecologically significant natural resource been exploited?
- 10 Study Figure 7.12 then do the following tasks.
  - a Identify the five largest investor countries.
  - b Identify the regions of the world targeted by those seeking to acquire land.
  - c Describe the overall pattern that emerges.



# Case study: India's colonial legacy

The British ruled the Indian subcontinent from 1858 to 1947. The area over which control was exercised extended over much of present-day India, Pakistan and Bangladesh. The British monarch bore the title of Empress or Emperor of India. British control of India had both positive and negative long-term consequences for the subcontinent.

## British control of India

Britain's interest in India can be traced to the activities of the East India Company during the first half of the eighteenth century. Initially, the company established a trading presence along the subcontinent's coast. This presence expanded in the latter half of the century, when the British waged a war against regional rulers on land in eastern and south-eastern India. The outcome was Britain's ability to exercise political control over the rich province of Bengal.

By the end of the century, British rule had been consolidated and extended up the Ganges valley to Delhi and over most of the peninsula of southern India. The British had by then established a military superiority that would enable them to extend control over all the remaining Indian states, either by conquering them or by forcing their rulers to become accommodating allies.

During the period of British control, India comprised two types of territory: British India and the native Princely States. The control of the latter was exercised through indigenous Indian rulers by the central government led by a Viceroy—the official appointed to administer India in the name of the British monarch. British India consisted of provinces administered by British-appointed governors, lieutenant governors or chief commissioners.

## Legacy of British rule

British rule had a number of enduring benefits. These include:

- the unification of more than 550 Princely States into a single political entity that would ultimately form the foundation of an independent India, Pakistan and Bangladesh.
- the establishment of parliamentary democracy built on the principles of one-person, one-vote; the rule of law; and an independent judiciary
- a system of public administration—the 1000-strong Indian Civil Service provided the foundations for strong, efficient government after independence

- the establishment of universities and stock exchanges
- education for both males and females
- the building of transport infrastructure, especially ports, dams, irrigation canals, roads and railways, as well as communications technologies such as telephone and telegraph, which later helped India to modernise
- the introduction of the English language, which provided a source of unity for the subcontinent
- the banning of the caste system and attempted abolition of a range of cultural practices, including **sati** (the custom of widow burning) and infanticide (the killing of infants).

The costs of British rule included economic exploitation. Before the British occupied India, the country was one of the richest countries in the world. When the British left in 1947, India was poor and industrially backward. The British had restricted the development of any industry that would compete with those back in England. India's role was to supply the raw materials needed by Britain's factories (for example cotton) and a market for its manufactured products (cloth). Britain extracted large trade surpluses from India, and forced it to export commodities and become a dumping ground for British manufactured goods.

Many people believe that India's bureaucracy—a legacy of British colonialism—has held back the Indian economy for more than four decades through its insistence on time-consuming bureaucratic processes ('red tape'). Bureaucratic processes have also discouraged foreign investment in the country.

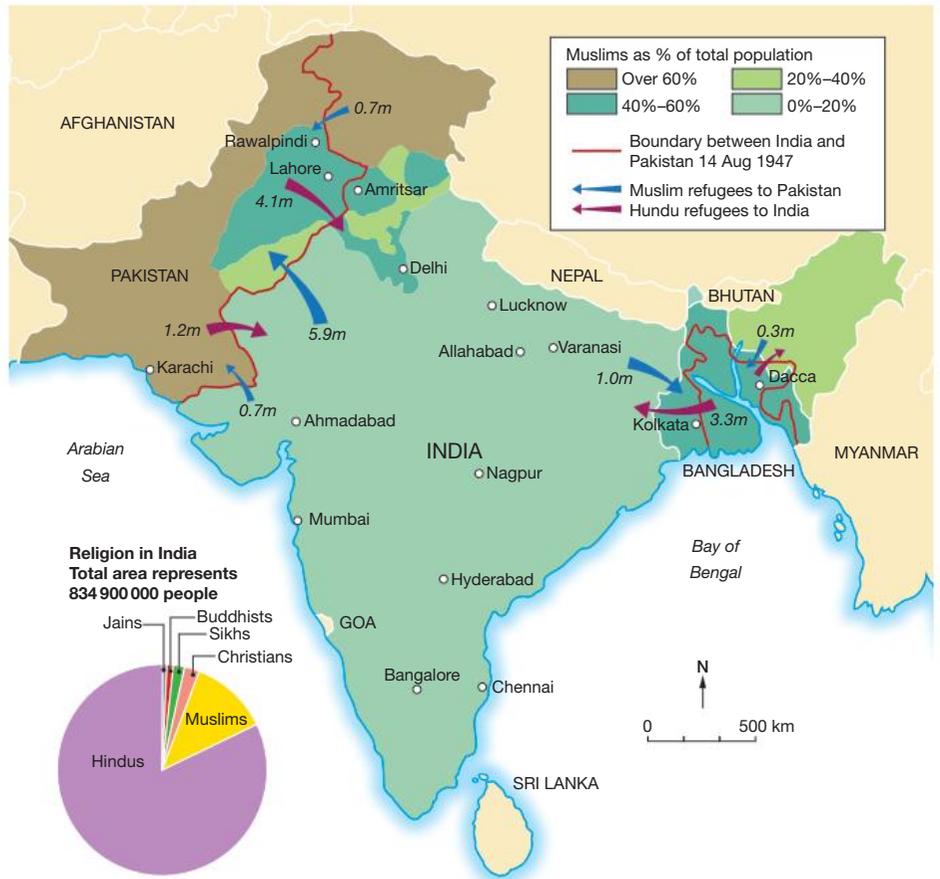
The manner in which the British withdrew from India created political instability and initiated an arms race in the region. This instability detracts from efforts to enhance human wellbeing.

## Partition of British India

In 1947, the British Indian Empire was partitioned (or divided) into two sovereign states—India and Pakistan (which later split into the Islamic Republic of Pakistan and the People’s Republic of Bangladesh), as shown in Figure 7.14. This partition involved more than just the division of territory. It involved the division of the Empire’s assets, including the British Indian Army, the Indian Civil Service and other administrative services, the railways and treasury. The haste with which the partition of India occurred resulted in the mass displacement of people and outbreaks of religious-based violence. As many as 1 million people died. Once the new borders were established, about 14.5 million people crossed into what they hoped was the relative safety of a religious majority—Islam-dominated Pakistan or Hindu-dominated India, as shown in Figure 7.15.

The partition of the British Indian Empire was a highly controversial arrangement, and remains a cause of much tension on the Indian subcontinent today. It has hindered efforts to enhance the human wellbeing of people within the region.

7.14 The partition of India



7.15 Crowded Indian train during the partition of India



## ACTIVITIES

### Knowledge and understanding

- 1 State the duration and extent of British colonial control of India.
- 2 Outline the benefits of British colonial control of India.
- 3 Explain how the British hindered India’s economic development.
- 4 Outline the costs of the partition of India.

### Applying and analysing

- 5 Draw a mind map of the benefits and costs of British colonial rule in India.
- 6 Create a KWL chart on the partition of India and how this has contributed to political instability in the region.

### Geographical skills

- 7 Study Figure 7.14. Using information from the map, write a report outlining the movement of people as a result of the partition of India in 1947. In doing so, explain these movements.

# 7.6

## Causes of spatial inequality: Internal factors

When we study the spatial variation in human wellbeing we are confronted with the question as to why some countries are more developed than others. Why, for example, do Australians have a higher level of wellbeing than people living in Uganda? The obvious response to such a question is that the barriers to development must be lower in Australia than in Uganda.

### Population growth

A country's ability to provide for the needs of its people is affected by the growth rate of its population. If the rate of population growth exceeds the rate of economic growth, for example, the share of the 'economic pie' each person gets becomes smaller. Similarly, a country's ability to provide medical and educational facilities, infrastructure and adequate food supplies is immediately affected by any rise in **fertility rates**.

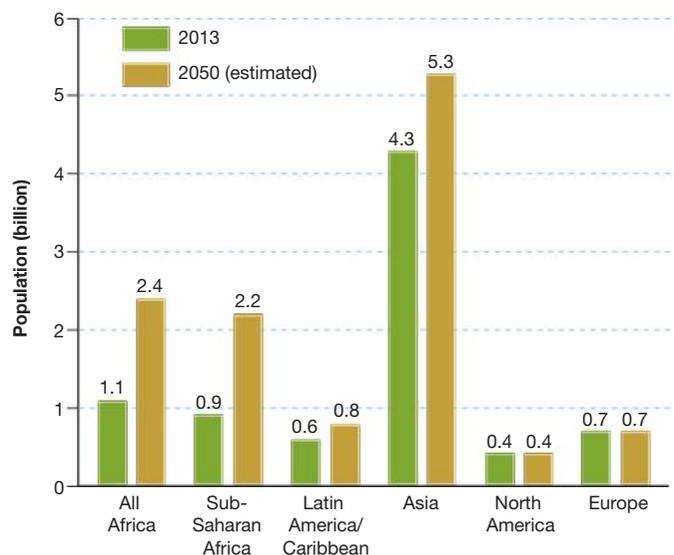
### Predicting population growth

With a projected growth of 1.3 billion between now and 2050, Africa will add more population than any world region. Virtually all of that growth will be in the fifty-one countries of Sub-Saharan Africa, the region's poorest countries. Even this projection assumes that birth rates will decline steadily in all countries of Sub-Saharan Africa because of an increase in the use of family planning. If birth rates do not decline steadily, future projections of population growth will have to be increased.

The world's population is projected to reach 9.6 billion by 2050. Most of this growth will take place in those countries least able to cope. While the total population of developed countries will remain at about 1.3 billion, the population of the world's least developed forty-nine countries is projected to double from about 900 million in 2013 to 1.8 billion by 2050, as is shown in Figure 7.16.

Much of this growth will occur in Africa, which is expected to be home to 2.5 billion people—a quarter of the total world population—by 2050, up from its current population of about 1.1 billion. This growth is a consequence of the high fertility rates in Africa, which at 4.8 children per woman now, is almost twice the global average of 2.5 children per woman. Nigeria, the most populous nation in Africa, is expected to have a population of 444 million by 2050.

7.16 Population growth by region, 2013 and 2050



### Resource base

The differing levels of wellbeing that people experience can be partially attributed to the resource base available to communities or countries. Some countries have been able to generate considerable wealth from the exploitation of natural resources. The United Arab Emirates, for example, has been able to generate vast wealth by exploiting oil reserves. Other countries, however, have only limited opportunities to generate income from the exploitation of natural resources.

When a country's biophysical environment (that is, its climate, soils and landforms) is capable of supporting a range of agricultural activities, the country has the potential to become self-sufficient in food production. Surpluses can be traded internationally to generate capital for investment in other areas. If the environment is incapable of supporting large-scale food production, a country may be forced to rely on costly imports to meet the needs of its people.

A lack of natural resources need not be an impediment to the enhancement of human wellbeing. Japan, for example, has few natural resources but has been able to achieve a high level of wellbeing by importing raw materials and exporting manufactured goods.

## Political instability

Attempts to alleviate poverty and improve human wellbeing can be hampered by political instability, which can cause war and civil unrest, weak political institutions and corruption. Instead of funds being devoted to development-related activities and projects, or the enhancement of **social infrastructure**, which may improve levels of human wellbeing, they are often diverted to finance the activities of the military and police forces. Conflict can result in damaged infrastructure, destruction of crops, displacement of people and disruption of the economy.

While much of the present-day political instability in Africa is internal, its origins often lie in the artificial national boundaries. These are a product of European colonial expansion, which divided Africa into colonies without taking local interests into consideration.

7.17

Africa's debt burden limits the prospects of advancing human wellbeing.

## Debt burdens

Under pressure to meet debt accumulated in the early post-colonial era, many developing countries sought to increase export earnings by allowing the exploitation of natural resources such as native forests and mineral deposits. For the same reason, they encouraged the production of cash crops for sale to the consumers in developed countries. Many poor countries struggle to cope with the burden of debt repayments (see Figure 7.17).

The debt burden of developed countries has been at the centre of a campaign by a range of NGOs. The global Make Poverty History campaign, for example, has campaigned for global debt relief.

## Militarisation

Once colonies achieved independence, they were faced with concerns about their security. These concerns were reinforced by ruling elites, who often saw a strong military as a means of protecting their position of privilege. Expenditure on armaments contributed to the newly autonomous country's debt burden and used resources that could have been devoted to meeting the basic needs of its people.





Women returning home with fuelwood, Burkina Faso, Africa. A reliance on fuelwood in areas with rapidly growing populations contributes to desertification.

## Environmental degradation

Environmental degradation in developing countries is both a symptom of poverty and a contributor to ongoing disadvantage. At the local level, people are often engaged in practices that can cause environmental degradation. This is frequently the result of the struggle for survival. Population growth and increased use of land for commercial agriculture can force the expansion of subsistence agricultural activities into more marginal areas. This results in land being cleared for agricultural purposes or to access timber for **fuelwood** (See Figure 7.18). Furthermore, the overuse of the land results in the loss of soil fertility. At the national level, the need to repay foreign debt means that governments have encouraged the extension of cash cropping, mining and forestry, frequently at the expense of the environment.

In some areas, such as the Sahel region of Africa, overuse of land and destruction of ground cover have led to rapid desertification. Because the boundaries of the desert are gradually being extended, arable land is subject to increasing pressure through overuse. Subsistence farmers simply do not have the resources to reverse these processes or to be able to reduce their use of the land. Thus, the land is further degraded and becomes less fertile, and the

poor become still poorer. Today there is growing concern about the impacts of climate change on the world's most vulnerable people.

## Compounding issues

There are a number of issues that compound the difficulties faced by developing countries.

- Low levels of human wellbeing hinder development. It can be argued, for example, that poor health can reduce the productivity of people. Similarly, low levels of national income mean that some governments do not have the capacity to invest in healthcare services and education facilities.
- The priorities of governments may affect human wellbeing within countries. For example, one government may choose to spend the limited available capital on meeting the basic needs of the poor majority. Another government may direct it towards priorities such as the protection of the interests of wealthy elites or military expenditure.
- The persistence of rigid social systems and cultural traditions can hinder improvements in wellbeing for some social groups or communities.

## ACTIVITIES

### Knowledge and understanding

- 1 Explain the relationship between population growth rates and the prospects for increasing levels of human wellbeing.
- 2 Account for the expected growth in Africa's population in the period to 2050.
- 3 Explain the link between a country's resource base and levels of human wellbeing. Are there any exceptions?
- 4 State how political instability affects efforts to enhance human wellbeing.
- 5 Explain how environmental degradation is both a symptom of poverty and a contributor to ongoing disadvantage.
- 6 State the cause of desertification in the Sahel region of Sub-Saharan Africa.

### Applying and analysing

- 7 Study Figure 7.17. Explain the point the cartoonist is making.

### Geographical skills

- 8 Study Figure 7.18 then do the following tasks.
  - a Calculate the percentage increase in the projected population of Africa, Sub-Saharan Africa and Asia. Which region will show the greatest rate of increase?
  - b Compare the rate of increase in Sub-Saharan Africa with 'All Africa'.
  - c Which regions will have no net increase in population between 2013 and 2050?

### Investigating

- 9 Investigate the use of fuelwood in developing countries. Include in your report the following information:
  - a what the fuel is used for
  - b how collection results in land degradation
  - c alternatives to fuelwood.

## Case study: India's booming population

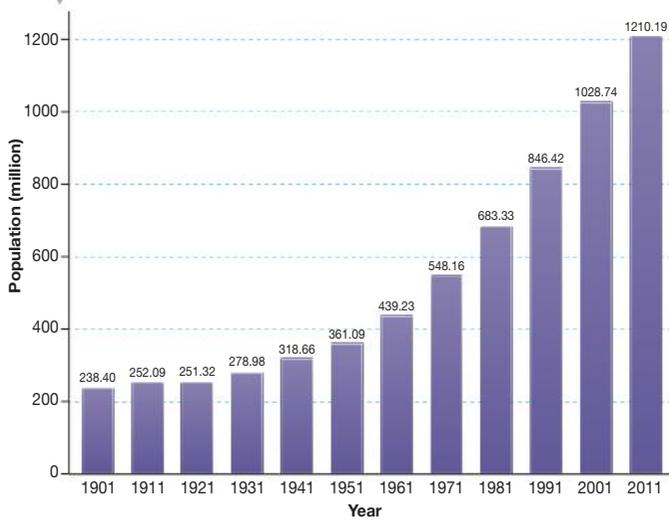
In 2013, India's population reached 1.28 billion people. Despite falling fertility rates, India's population is projected to overtake China's. Thirty-one per cent of India's population is under 15 years of age, and more than 50 per cent is under 25 years. Future population growth is unavoidable, given the size of the under-15 age group, as this group will shortly enter the child-rearing stage.

### India's population growth

Figure 7.19 shows the decade-by-decade increase in India's population since 1901. Despite the increase, the fertility rate has decreased, as is shown in Figure 7.20. The decline in fertility has been attributed to increased female education participation rates, urbanisation and rising standards of living.

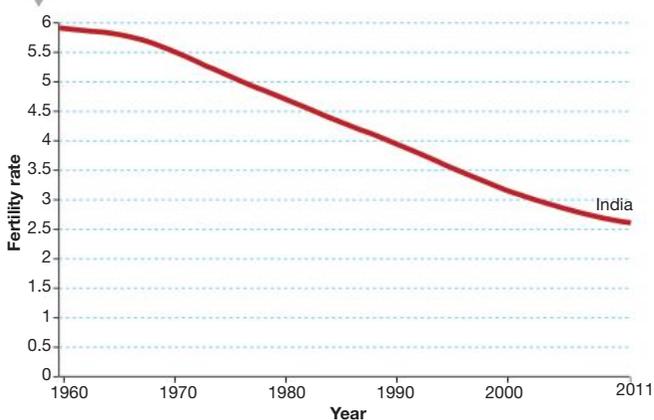
India's population growth is not uniform throughout the country. Figure 7.21 shows that the rate of fertility differs throughout the country; consequently, population growth also varies throughout the country. Population growth rates are still relatively high in India's Hindi-speaking heartland, but below **replacement level** in the south.

7.19 Decadal growth in India's population, 1901–2001



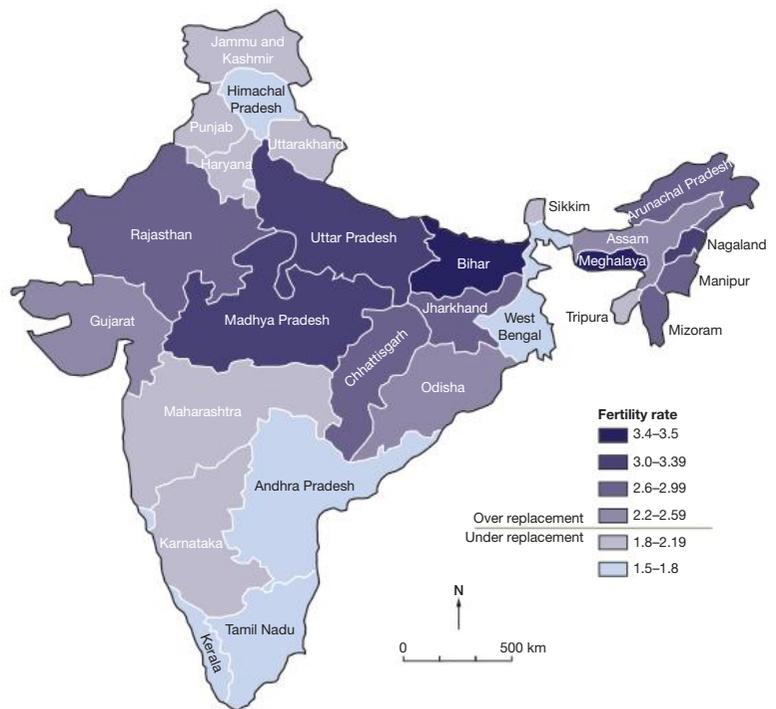
Source: India Population Commission

7.20 India's fertility rate, 1960–2011



Source: Google Public Data

7.21 Fertility rates in India, by state and territory, 2012

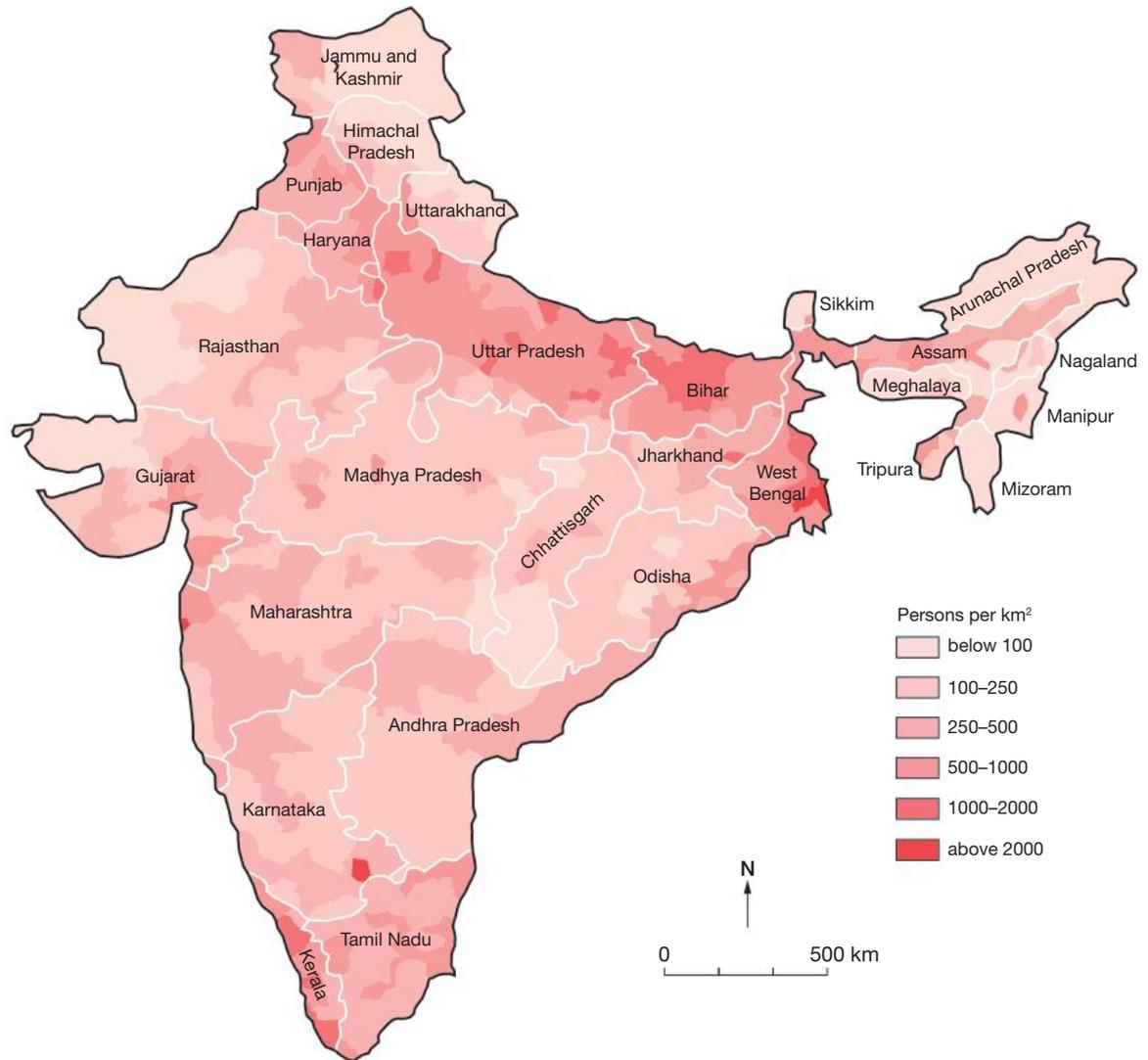


## Population distribution and density

While India occupies just 2.4 per cent of the earth's surface, 17.5 per cent of the world's population lives there. The most densely settled parts of the country are the Ganges River valley and the eastern and western coastal margins of the Deccan Plateau, as shown in Figure 7.22.

A string of northern states, which lie just to the south of the Himalaya mountain range, are dominated by cold, arid deserts and fertile valleys. The physical limitations of the region limit population density.

7.22 Population density in India



## ACTIVITIES

### Knowledge and understanding

- 1 List the reasons given for the decline in fertility rates.
- 2 Explain why the proportion of the population under the age of 15 years is important in terms of future population growth.

### Geographical skills

- 3 Study Figure 7.19. Using data from the graph, describe the trends in India's decadal population growth.
- 4 Study Figure 7.20. Using data from the graph, describe the trend in fertility since 1960. What factors explain this trend?
- 5 Study Figure 7.21. Identify the states with the highest and lowest fertility rates. Outline the overall spatial pattern of fertility.
- 6 Study Figure 7.22. Which areas have the highest population density? Which have the lowest?

# 7.8

## Geoskills: Population pyramids

A population pyramid is a graphical representation of a population's age and sex structure. Geographers study such graphs to determine the age distribution of a population. They also tell us about the potential for future population growth. India and Australia have quite different-shaped population pyramids. Being able to read these pyramids tells us a lot about the demographic characteristics of the two countries.

### Interpreting population pyramids

A population pyramid is a special type of bar graph. The vertical axis of the graph shows the various age groups of the population, while the horizontal axis shows either the actual number or the proportion of the population for both males and females. Because each population pyramid represents 100 per cent of a particular population group, comparisons can be made with the population pyramids of other populations and of the same population over time.

The shape of a population pyramid is also important because it tells us a lot about the particular population. For example:

- if the base of the pyramid is wide, then the population is said to be 'young'
- if the upper part is relatively wide, then the population is said to be 'old' or 'ageing'
- fewer people than expected in a particular age group might indicate events such as war, famine, disease or large-scale emigration
- more people than expected in a particular age group might indicate the impact of a baby boom and/or immigration.

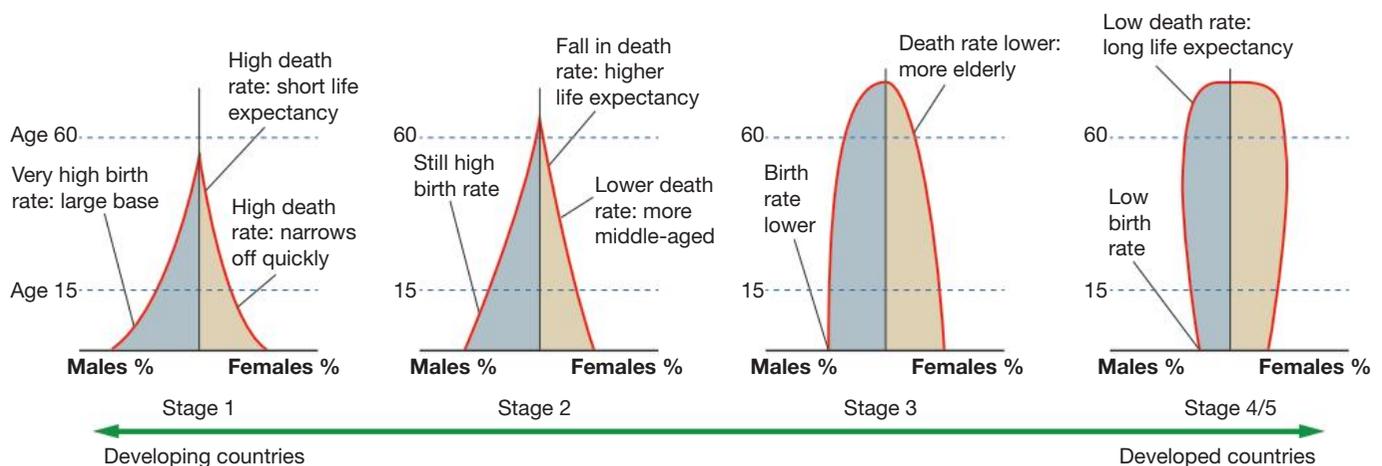
Figure 7.23 shows a series of pyramid shapes, with an explanation of conditions under which such population structures develop.

Populations are often divided into broad age groups based on their level of independence. The dependent parts of the population are usually defined as the '14 years and under' age group and the '65 years and over' age group. The changing proportion of the population in each age group provides us with valuable information about future population trends. If the proportion of the population aged 65 years and over is growing, the population is said to be ageing. If the proportion of the population aged 14 years and under is decreasing, the birth rate is declining, as is the rate of population increase.

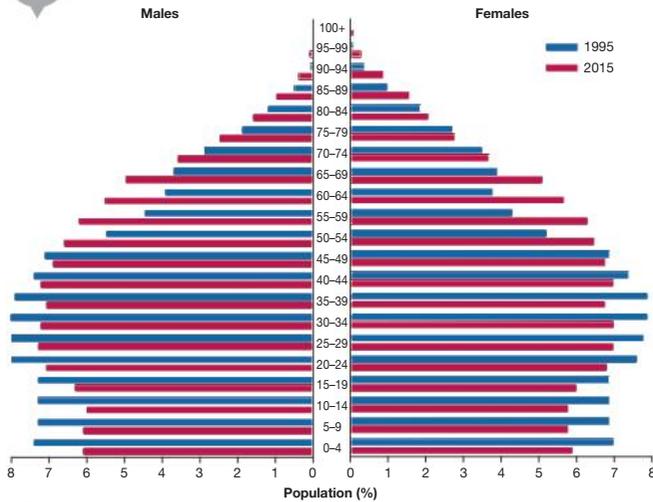
### Population pyramids: Australia and India

The populations of India and Australia are different; the population structures are also different, as is illustrated in Figures 7.24 and 7.25.

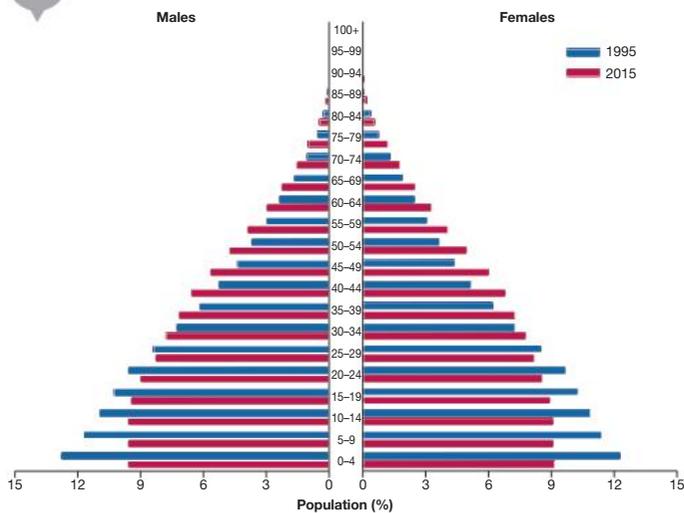
7.23 Common population pyramid shapes and the conditions under which they develop



7.24 Population pyramid of Australia, 1995 and 2015 (%)



7.25 Population pyramid of India, 1995 and 2015 (%)



7.26 Projected age–sex data for Australian and India, 2050 (%)

	Australia		India	
	Males	Females	Males	Females
0–4	5.3	5.1	6.6	6.5
5–9	5.4	5.1	6.6	6.6
10–14	5.5	5.2	6.7	6.6
15–19	5.7	5.3	6.8	6.7
20–24	6.1	5.8	6.9	6.7
25–29	6.5	6.2	7.0	6.7
30–34	6.6	6.3	7.0	6.6
35–39	6.7	6.3	7.0	6.6
40–44	6.6	6.2	7.0	6.6
45–49	6.5	6.1	6.9	6.5
50–54	6.4	6.1	6.7	6.4
55–59	6.4	6.1	6.1	5.9
60–64	5.9	5.8	5.3	5.4
65–69	5.4	5.4	4.5	4.9
70–74	4.6	4.8	3.6	4.1
75–79	4.0	4.5	2.6	3.3
80–84	3.0	3.8	1.5	2.1
85–89	2.0	2.9	0.7	1.1
90–94	1.0	1.9	0.2	0.5
95–99	0.4	0.9	0.0	0.1
100+	0.1	0.4	0.0	0.0
Population	29012740		1656553632	

Source: US Census Bureau

## ACTIVITIES

### Knowledge and understanding

- 1 State what population pyramids show.

### Geographical skills

- 2 Study Figures 7.24 and 7.25 then complete the following tasks.
  - a Estimate the proportion of the population under the age of 15 in Australia in 1995 and 2015.
  - b Estimate the proportion of the population under the age of 15 in India in 1995 and 2015.
  - c Estimate the number of Australians under the age of 15 in 2015.
  - d Estimate the number of Indians under the age of 15 in 2015.
  - e Estimate the proportion of the Australian population over the age of 64 in 2015.
  - f Estimate the proportion of the Indian population over the age of 64 in 2015.

- g Using data from the graphs, contrast the population structure of Australia and India in 2015.

- h Using Figure 7.23, classify the structure of the Australian and Indian populations in 1995 according to stage of the demographic transition.

- 3 Study Table 7.26. Construct the population pyramids of Australia and India using the 2050 population projections. Compare the under 15 years of age and over 64 years of age populations with the structure of the two countries' populations in 2015.

### Investigating

- 4 Using the US Census Bureau's international population database, generate a population pyramid for a selected developing country in Africa (1995, 2015 and 2050). Compare your selected population pyramid with those of Australia and India.

# 7.9

## Case study: India's caste system

India is a culturally diverse nation and is also an emerging economic powerhouse. India still struggles to address the great disparities in human wellbeing in the country. As in all societies, cultural factors can either enhance or obstruct efforts to improve people's quality of life.

### India's diverse culture

India is a place where several cultures interact. The most significant of these are the Aryan, in the north, and the Dravidian people in the south. Add to this India's religious diversity. The country is the birthplace of Hinduism, Buddhism, Jainism and Sikhism. Today, Hinduism and Buddhism are the world's third- and fourth-largest religions respectively, with a combined number of followers of approximately 2 billion.

### India's caste system

India's caste system is a form of social stratification. Traditionally, it divided Indian communities into thousands of hereditary groups called Jati. Each Jati was identified with a traditional job function or tribe. The Jati featured four broad caste groupings with hundreds of sub-castes. The main groups were:

- Brahmin: priests, scholars and teachers
- Kshatriyas: warriors, administrators and law enforcers
- Vaishyas: farmers, cattle raisers and traders
- Shudras: service providers and servants
- Panchama: outcasts or untouchables, known as Dalits.

### India's untouchables

The Dalits (or untouchables) were the lowest social status group in the Hindu caste system and were actually born below the caste system. The untouchables were assigned, by birth, to spiritually contaminating work that nobody else wanted to do. They lived on the fringes of Indian society and were associated with occupations regarded as ritually impure, such as leather tanning, butchering, and removal of rubbish, animal carcasses and waste. Dalits worked as manual labourers cleaning streets, latrines and sewers. According to Hindu beliefs, such jobs corrupted the workers' souls, making them unfit to mingle with other kinds of people.

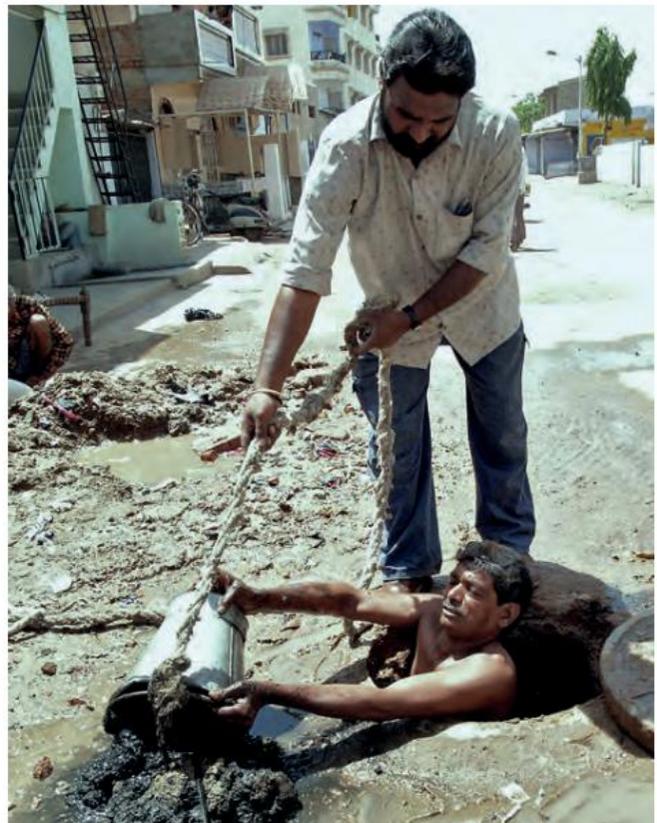
Humans were born untouchable as a form of punishment for their conduct in a former life. People born into the untouchable caste, could not ascend to a higher

caste within their lifetime. They had to marry fellow untouchables, and could not eat in the same room or drink from the same well as a caste member.

In the Hindu religion (with its belief in reincarnation), untouchables who followed the restrictions outlined above were rewarded with a promotion to a caste in their next life.

Discrimination against lower castes is illegal under Article 15 of India's constitution. Despite affirmative action laws for lower castes that have been introduced by government, there is still discrimination and violence against people of lower castes.

7.27 Dalit workers cleaning a blocked sewer





7.28 Women from different organisations demanding safety for women on International Women's Day in Lucknow, India, 2013

## Role and status of women

While Indian women have held high office, including that of president and prime minister, women continue to face atrocities such as rape, acid throwing, dowry killings and forced prostitution. Traditions such as sati are now illegal, although some instances of the practice are still found in remote parts of the country. **Purdah** is still practised by Indian women in some communities, and child marriage remains prevalent, despite it being illegal under Indian law.

Women are less likely to participate in education and, in most Indian families, women do not hold any property in their own names and do not receive any inheritance. Due to weak law enforcement, women continue to have little access to land and property. In fact, some laws continue to discriminate against women in regard to land and property rights.

Activists in India argue that the way in which women are treated will not improve unless the way boys are brought up changes. It is said that young men grow up as 'little princes'. They are often allowed to misbehave with impunity, told that everything they do is wonderful, and taught that women exist only to serve them and gratify their needs. Such attitudes cannot help but promote a distorted view of women and their role in society.

## India's political culture

India is a federation of states with a parliamentary system of government based on the Westminster system inherited from the British. It is also the world's largest democracy. The notion of 'majority rule' is tempered only by the legally prescribed protections enjoyed by minority groups.

For most of the time since independence, India's government has been led by the Indian National Congress (INC), the party of Mahatma Gandhi. In the pre-independence era, the party was at the forefront of the struggle for independence. Today, the party is considered to be to the centre-left in Indian politics. India's other major political party is the right-wing Hindu nationalist Bharatiya Janata Party (BJP). The BJP won the 2014 Indian election.

Initially, INC economic policy focused on the promotion of public sector enterprises. In recent times, however, the INC has embraced more economic liberal policies that recognise the importance of free markets. They have favoured economic liberalism while claiming to care for the wellbeing of those in the weaker sectors of the economy. The BJP, on the other hand, promotes the privatisation of infrastructure and services, and the roll-back of labour and environmental protections. The party also favours Indian heritage and culture over all things Western.

The culture of corruption is widespread and extends from the top to the bottom of Indian society. It is said that government ministers cream off tens of millions of dollars and claim to be affronted when their corrupt activities are exposed. A bribe of 100 rupees allows a person to escape a traffic fine and the poor must pay baksheesh (a gratuity, tip, or bribe) in order to be issued a ration card by an official.

## India's merging middle class

As a result of the economic growth experienced over the past two decades, India has a rapidly growing urban middle class. Today, it numbers about 300 million people. The vast mass of India's rural population, however, remains impoverished and the people's lives continue to be influenced by the ancient Hindu caste system.

Vikram's experience (see the article below) is typical of those fleeing to India's cities in search of a better life for their families. It does, however, highlight the immense challenges India faces in increasing the level of wellbeing of its people.

While discrimination on the basis of caste is now illegal and various measures have been introduced to empower disadvantaged groups and give them easier access to opportunities such as education and work, some 30 per cent of India's population still lives below the poverty line. For these people, the benefits of economic progress have spread more slowly than promised, too many social ills remain unaddressed, and governance failures and inefficiencies persist.

# INDIA: A NATION AT THE CROSSROADS

*Ben Doherty is the South Asia correspondent for Fairfax Media. In an article written for Fairfax, publishers of the Sydney Morning Herald and The Age newspapers, Ben tells of his encounter with the Vikram family.*

About the same time as I came to Delhi, a family moved in around the corner.

A couple of hundred metres from my neat, whitewashed house in a middle-class south Delhi neighbourhood, a Rajasthani family took up residence on the side of the road.

Their new home was a blue tarpaulin tied to the fence outside a 12th-century Mughal tomb, between a stinking rubbish dump where the rag pickers and the drunks spend their days and a busy road. A narrow strip of dirt, 3 metres at its widest, between the fence, the rotting garbage, and the road, was their existence.

They came in winter, as I did. It was cold in Delhi that year. Whenever I passed, the family—how many members there were was hard to tell—seemed pressed together under as many blankets as they could gather. It rained.

But gradually the weather warmed, and the family took confidence that a couple of weeks without eviction had become a month. Their home became more substantial.

They built a wooden house, with some scavenged tin for a roof, held down with rocks. The hessian sack at the entrance was replaced by a wooden door, with hinges they forged themselves in a pit fire at the front door.

The family, I learnt, consisted of two brothers, their wives and children.

Soon they built a second wooden hut, leaning off the first, then illegally

rigged electricity from a nearby wire to bring power. They got a small TV from somewhere and set it up in a corner, and charpoys (stretchers) for beds. Lately, they've been wrestling with a discarded old washing machine with a broken lid, trying to get it to work.

Their shelter has become a home.

The head of the family, the older brother Vikram, is a gruff, taciturn fellow. Heavy shouldered and bearded, his face, when at rest, seems set in a scowl.

He's not been the easiest man to get to know. But gradually, with my regular passage on foot past his front door, a nod of recognition has become a 'namaste' and, now, the occasional conversation.

We sit, perhaps once a week when I'm in town, over chai and puri, bought from a food cart down the road.

He barely eats himself. He spends our conversation tearing up the warm, fried bread with his fingers and feeding it to whichever of the children is wandering by at the time...

... He and his brother Mani are from Rajasthan. There are 18 people in their combined families: wives, children, mothers and in-laws. They are from a nomadic tribe known as the Gadia Lohars, the literal translation of which is 'blacksmiths on the wheel'. And so it is with them. Like their father and his father before, Vikram and Mani are smiths, spending their days over fire pits outside their front doors, banging at the red-hot metal, forging picks and hammers and skewers for tandoori ovens. Stacked by their homes is their stock, from which they make a modest industry selling to passers-by, tradesmen and local homeowners.

Their family has come to Delhi to seek a better life. Gradually, over three years, they've found it. From their Spartan first shelter, their homes have become liveable, and even, Vikram insists, comfortable. The house has no plumbing or toilet, but their lives are better here than they've been before.



7.29 A better life: Vikram working outside his family's home

Vikram has four children, all of whom attend school, in between helping with work.

The youngest carries around her books and pencil case. She has a white-and-green uniform, which her mother rips from her back every afternoon to start furiously washing for the next day.

'All of my kids are in school. I want to see at least one of them, any

one of them, become something,' Vikram says.

The family tries to make each day a little better than the last. There is something new to save up for, an improvement to the house, shoes or a book for a child, a new tool to make work easier, or more profitable.

Source: Ben Doherty, *Sydney Morning Herald*, 1 February 2014

## ACTIVITIES

### Knowledge and understanding

- 1 Describe the extent of India's cultural diversity.
- 2 Describe India's caste system and explain how it can hinder efforts to improve people's quality of life.
- 3 Outline the status of Indian women in Indian society. How might it be improved?
- 4 Describe the main policy positions of India's two major political parties.
- 5 Outline the economic divisions in India.
- 6 **a** Who are the Dalits and what status do they hold in Indian society?  
**b** What occupations have they traditionally performed?  
**c** What social limits were imposed in the Dalit people?

### Applying and analysing

- 7 As a class, debate the following topic: 'The caste system was a form of social control'.
- 8 Study the newspaper extract 'Ben Doherty's Indian experience' then, as a class, discuss the following questions.
  - a** In what ways is the experience of Vikram and his family typical of people throughout the developing world?
  - b** In what ways does the experience of Vikram reflect India's ingrained cultural traditions?
  - c** In what ways has the wellbeing of Vikram and his family improved?
  - d** How would you cope living in such conditions?

# Case study: Water conflict in South Asia

Since the partition of India in 1947, the exploitation of the water resources of the Ganges, Brahmaputra and Meghna river catchments and the Indus River catchment has been the source of ongoing conflict between India and Bangladesh and, in the case of the Indus, India and Pakistan. The situation is complicated by the highly seasonal rainfall, rapidly increasing population densities and climate change.

## Ganges–Brahmaputra–Meghna river system

The Ganges–Brahmaputra–Meghna (GBM) river system is one of the world's largest (see Figure 7.30). The Ganges and the Brahmaputra originate in the Himalaya Mountains. They are joined by the Meghna, then drain through Bangladesh to the ocean. In the process, the rivers have built up the Bengal Delta, the largest and most populated delta on earth.

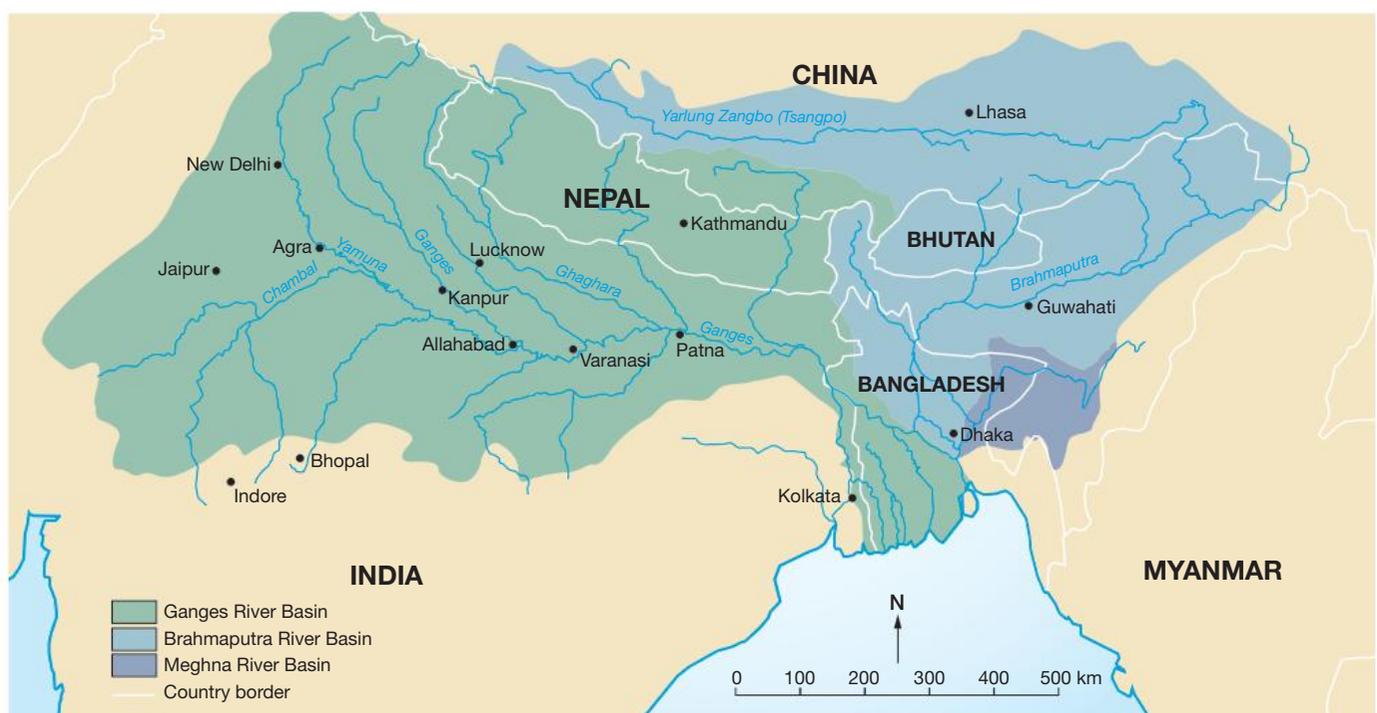
The Ganges River catchment extends from its headwaters in the Himalaya Mountains of south-western Nepal to the Bay of Bengal coast in Bangladesh. After descending from the Himalaya, the river meanders across the northern plains of India, from Uttar Pradesh to West Bengal.

7.30 Being a major transboundary river, the Ganges is at the centre of the regional political and diplomatic processes of the Indian subcontinent.

## Tensions in the GBM catchment

The Ganges is central to the spiritual wellbeing of millions of people. It is also of critical importance to the economy and environment of the eastern part of the Indian subcontinent.

Economic priorities such as food grain production and maintenance of the navigability of the rivers to the Port of Kolkata led to the construction of a barrage at Farakka, close to India's border with Bangladesh in 1975. For people downstream in Bangladesh, fresh water availability depends on the amount of water diverted upstream by India. As a result of water diversions, Bangladesh has experienced a 50 per cent decline in flow during the dry season. Such a dramatic decline has caused a series of problems, including a drop in agricultural and fish production, saltwater intrusion and ecological imbalance in estuarine areas, and reduced navigability.



In 1996, a 30-year treaty was signed by India and Bangladesh. The treaty specifies dry season water flows that are generally adequate except for times of extreme drought, during which Bangladesh suffers. Nevertheless, while the barrage has spurred economic growth in the Indian state of West Bengal, downstream users of the Ganges in Bangladesh are suffering from water shortages that are predicted to worsen.

## Indus River

The Indus River basin, shown in Figure 7.31, has a total area of 1.12 million square kilometres distributed between Pakistan (47 per cent), India (39 per cent), China (8 per cent) and Afghanistan (6 per cent). The Indus River basin starts high in the Himalaya Mountains and flows south through Pakistan out into the Arabian Sea. In Pakistan, the Indus River basin covers about 65 per cent of the country, comprising the provinces of Punjab and Khyber Pakhtunkhwa, and most of the territory of Sindh province and the eastern part of Balochistan. The drainage area lying in India covers approximately 14 per cent of the total area of the country. An estimated 300 million people live in the Indus River basin.

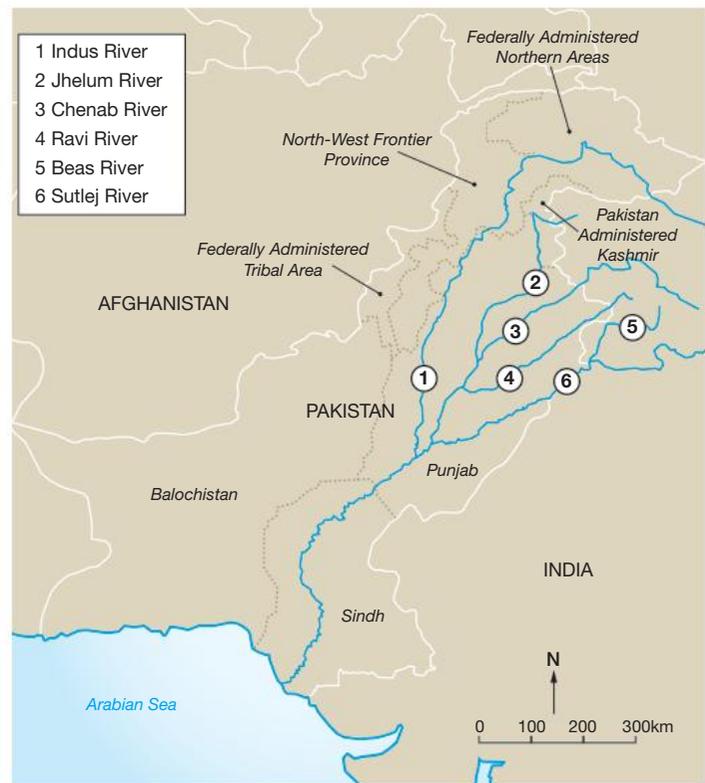
## India–Pakistan water conflicts

Conflict of the use of the waters of the Indus River has been a source of tension between India and Pakistan since independence in 1947. In 1960, the World Bank brokered a water-sharing agreement between the two countries. Under the agreement, India was granted exclusive rights to the waters of the eastern rivers (the Sutlej, Beas and Ravi) and their tributaries before the point at which the rivers entered Pakistan. Pakistan was granted the rights over the waters of the western rivers (the Indus, Jhelum and Chenab) and their tributaries. Pakistan's share of the total Indus system was over 80 per cent. India secured less than 20 per cent.

The most recent source of conflict has been India's proposal to build the Kishanganga hydroelectric dam on the Neelum River. Pakistan is concerned that the project will have an adverse impact on the flow of the river, which is a tributary of the Jhelum River. Pakistan is constructing the Neelum–Jhelum hydropower plant downstream of the Kishanganga site on the Jhelum.

In late 2013, the International Court of Arbitration issued a ruling granting approval for the dam under strict conditions that partially addressed Pakistan's concerns about the provision of an environmental flow.

7.31 Indus river system



## ACTIVITIES

### Knowledge and understanding

- 1 Identify the main political issue that complicates water management in the rivers of the Indian subcontinent.
- 2 Outline the source of tensions in the GBM catchment and how they are being addressed.
- 3 Identify the source of water resource conflict between India and Pakistan. How was this conflict resolved?

### Applying and analysing

- 4 Prepare a KWL chart about either the Ganges River system or the Indus River system.

### Investigating

- 5 Investigate the spiritual importance of the Ganges River to the people of India and Bangladesh. Present your findings as a written report.
- 6 Investigate a recent water-related conflict on the Indian subcontinent. Present your findings as an oral report supported by a multimedia presentation. Your report needs to include the following information: a map of the region, an overview of the issue and solutions to the problems, and your proposed solutions.

7.4

CHAPTER

# 8

# ISSUES IN HUMAN WELLBEING



**I**n 2015, the world's population reached 7.3 billion. This figure is so big it is difficult for us to comprehend it. Another way of looking at the population, and its defining characteristics, is to think of the world as a village of 100 people. If this were the case, it would look something like this:

- 61 would be Asians, 14 would be Africans, 11 would be Europeans and 14 would be from the Americas
- 26 would be below the age of 15 years, and 8 would be over the age of 65
- 20 people would control 80 per cent of the village's resources
- 80 people would live on less than US\$80.00 per day and of these, 50 would live on less than US\$2.50 a day.
- 15 people would be undernourished, 1 would be dying of starvation and 21 would be overweight
- 23 would not have shelter to protect them from the wind or rain, 40 would lack access to sanitation, and 13 would not have clean water to drink
- 20 would consume 45 per cent of all the energy used
- 83 would be able to read and write, 17 would not
- 7 would have a college degree
- 22 would own, or have access to, a computer
- 9 would own a car and 75 would have a mobile phone.

In this chapter we investigate the range of challenges facing the countries of the developing world, with a focus on access to clean water, sanitation and shelter, and child exploitation.

## KEY IDEAS

- To describe the level of human wellbeing people living in developing countries experience and how this has changed in recent decades
- To understand the main challenges facing developing countries
- To investigate how the challenges in developing countries are being addressed and to what effect

## GLOSSARY

<b>child labour</b>	the employment of children in an industry or business, especially when illegal and exploitative
<b>debt bondage</b>	an arrangement whereby a person is forced to pay off a loan with direct labour in place of currency, over an agreed or indeterminate period of time
<b>improved sanitation facility</b>	a sanitation system that ensures human excreta does not come into contact with humans
<b>indentured servitude</b>	a labour system whereby a person is bound to work for another for a specified period of time
<b>maternal mortality</b>	the death of a woman while pregnant or in the days after giving birth or having a pregnancy terminated
<b>sanitation</b>	the infrastructure related to the collection and disposal of human waste
<b>slum</b>	a rundown established neighbourhood in which most people live in poverty
<b>squatter settlement</b>	an informal, often illegal, settlement, built by poor people from material scavenged from the streets
<b>urban decay</b>	the process whereby a part of a city falls into a state of disrepair

# 8.1

## Human wellbeing: The issues

There is great diversity between and within all countries. A variety of challenges more commonly confront developing countries than developed countries. These challenges have an impact on people's wellbeing and act as a barrier to development.

### Barriers to improving human wellbeing

#### Poverty

Extreme poverty is most common in areas where poor health and lack of education deprive people of productive employment; environmental resources have been depleted or spoiled; and corruption, conflict and poor governance result in the waste of public resources.

Worldwide, 1.2 billion people live in extreme poverty, despite the proportion of people living on less than US\$1.25 a day falling from 47 per cent in 1990 to 22 per cent in 2010. This means that about 700 million fewer people lived in conditions of extreme poverty in 2010 than in 1990. In China, extreme poverty dropped from 60 per cent in 1990 to 16 per cent in 2005 and 12 per cent in 2010. Sub-Saharan Africa and southern Asia account for about 40 per cent of the world's population living in extreme poverty.

#### Low per capita income

In general, developing countries tend to have low levels of per capita income compared to wealthier countries. By the end of the first decade of the twenty-first century, the richest 20 per cent of the population had three-quarters of the world's income, while the poorest 40 per cent between them consumed only 5 per cent of the world's income. The very poorest 20 per cent of the global population had only 1.5 per cent of the world's income.

#### Lack of adequate shelter

Approximately 33 per cent of the urban population in the developing world, or about 863 million people, lived in **slums** in 2012. The proportion of the urban population living in slums was highest in Sub-Saharan Africa (61.7 per cent) followed by South Asia (35 per cent). While these percentages are declining, absolute numbers are not, due primarily to the fast pace of urbanisation.

#### Lack of access to clean water and sanitation

Some 768 million people still rely on water from unsafe sources. Eighty-three per cent of these people (636 million) live in rural areas. Of those who have access to a source of safe drinking water, 38 per cent do not enjoy the convenience and associated health and economic benefits of piped drinking water at home. Instead, they spend considerable time and energy queuing up at public water points and carrying heavy loads of water over long distances.

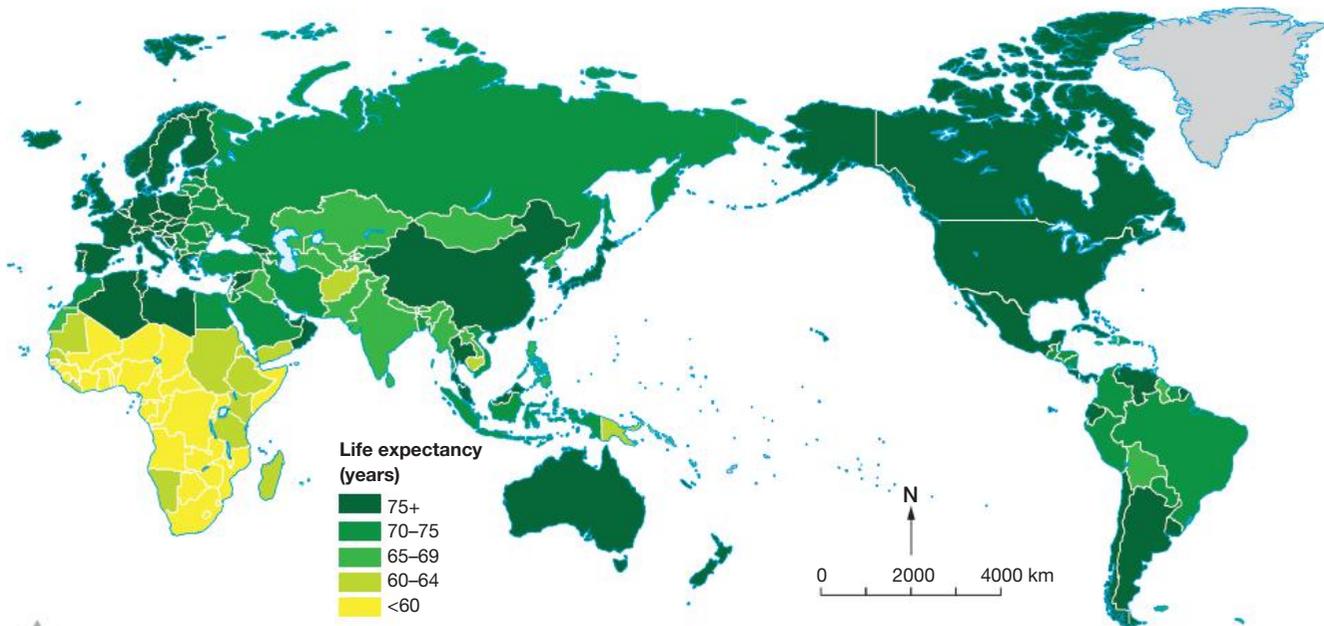
The United Nations estimates that 2.5 billion people do not use an **improved sanitation facility**. In Sub-Saharan Africa, 44 per cent of the population uses either shared or unimproved facilities, while in southern Asia, the proportion of the population using shared or unimproved facilities has declined to 18 per cent, but open defecation remains the highest of any region (39 per cent). Between 1990 and 2011, 1.9 billion people gained access to a flush toilet or other improved sanitation facility.

#### Low life expectancy

Diseases originating from contaminated water supplies, inadequate **sanitation**, poor nutrition, inadequate or inappropriate health care and poor hygiene disproportionately affect the poor. Many diseases deepen poverty and make living conditions worse.

Many diseases in poor countries are preventable and treatable. Poverty often prevents people from accessing these treatments and medications. Gastroenteritis, which can readily be treated, results in about 1.8 million child deaths annually. A greater proportion of women and infants in less developed countries are likely to become very ill or die as a result of lack of medical care at childbirth.

The average life expectancy in the least developed countries was only 59 years in 2012, compared with 78 years in the more developed countries. Figure 8.1 illustrates the differences in life expectancy for people in wealthy and poor countries.



8.1 Life expectancy, 2013

Source: Population Reference Bureau



8.2 Pneumonia, diarrhoea, malaria, measles, HIV/AIDS and malnutrition are the primary killers of children in developing countries. Many of these diseases are preventable through inoculations.

## Dietary deficiencies

Dietary deficiencies result from inadequate food intake. The amount of food available may be inadequate or it may be of poor quality. In 2014, 25 per cent of the world's population was classified as undernourished. Most undernourished people lived in developing countries. Women and children are the most vulnerable. India alone has 65 million undernourished children. Worldwide, 495 million women and children under 5 years of age are undernourished—150 million, or one in four in Africa; 315 million, or one in seven in Asia; and 30 million, or one in eleven in Latin America and the Caribbean.

## Low access to health services

The availability of health services is generally low in developing countries. In Africa, countries such as Niger, Malawi and Tanzania have just two physicians per 100 000 people, while Uganda and Angola have eight. In Australia, there are 374 physicians for every 100 000 people, while the equivalent measure in Belgium is 449 for every 100 000 people.

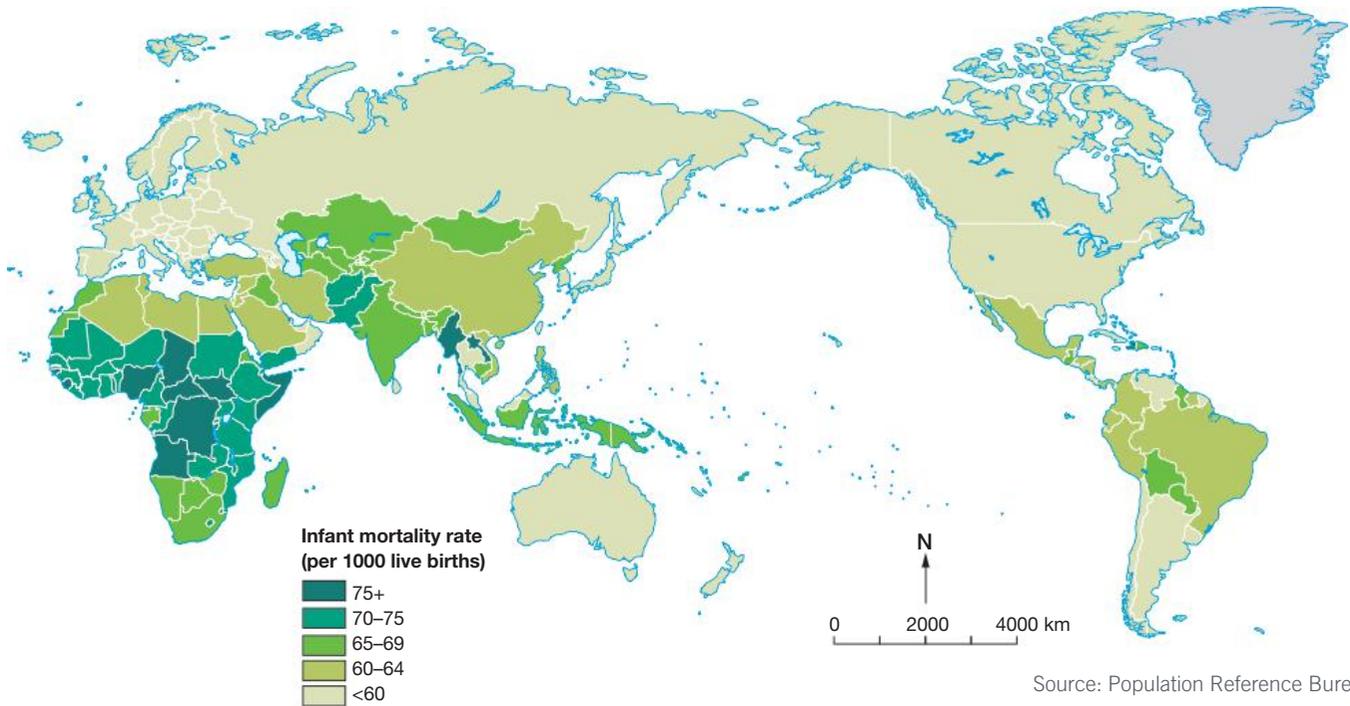
## High maternal mortality rates

**Maternal mortality** is defined as the death of a woman while pregnant or in the days after giving birth or having a pregnancy terminated. High rates of maternal mortality occur in the same countries that have high rates of infant mortality. This reflects a lack of access to skilled medical care during childbirth and poor nutrition. Over 90 per cent of maternal deaths occur in developing countries.

Significantly, however, the global maternal mortality ratio has declined by 47 per cent over the last two decades, from 400 maternal deaths per 100 000 live births to 210 between 1990 and 2010. All regions have made progress, with the highest reductions in eastern Asia (69 per cent), northern Africa (66 per cent) and southern Asia (64 per cent).

## High infant mortality rates

In the less developed countries, infant mortality rates were 45 per 1000 live births in 2012, and 72 per 1000 in the least developed countries. This compares with just five deaths per 1000 in the more developed countries. The under-5 mortality rate is particularly high in some of the poorest countries—more than 120 per 1000 live births in some countries. In Afghanistan, the rate was 129 per 1000 live births. Australia's rate was just 3.9.



Source: Population Reference Bureau

### Relatively high levels of illiteracy

The adult literacy rate is generally 99 per cent in developed countries, compared with 76 per cent in developing countries. In the least developed countries, the adult literacy rate is just 54 per cent. India's literacy rate was 73 per cent in 2013.

Worldwide, 57 million children were not attending school in 2013. Thirty million of these were in Sub-Saharan Africa. While progress has been made in the number of children receiving a primary education, the rate of improvement is slowing. Between 2000 and 2011, the number of children not attending school declined by almost half, from 102 million to 57 million, but between 2008 and 2011, the number of children of primary school age not attending school fell by only 3 million.

Children and adolescents from the poorest households are at least three times more likely to be not attending school than those from the richest households. Girls are more likely to be not attending school than boys in both primary and lower secondary age groups, even girls living in the richest households.

### High rates of population growth

Worldwide, annual population growth is 2.5 per cent; in developed countries it is 1.5 per cent, in developing countries it is 2.6 per cent, and in the least developed countries it is 4.4 per cent. Growing populations in the world's poorer countries place added strain on already limited national resources. This creates additional demand for employment, schooling, infrastructure, health and other services.

8.3 Infant mortality, 2013

### Child exploitation

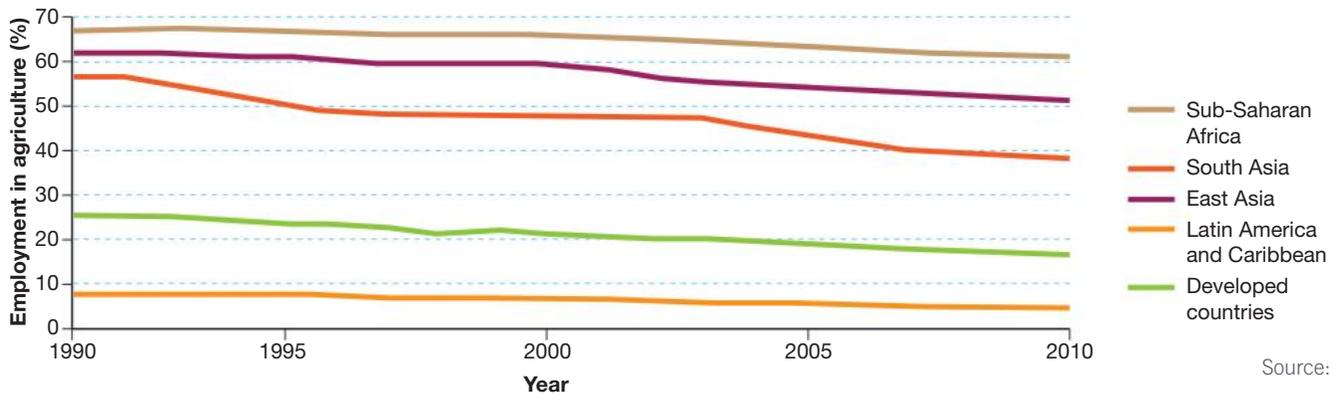
Hundreds of millions of children are exploited. Much of this occurs in developing countries. The worst types of exploitation are **child labour** and trafficking, child marriage and sexual exploitation.

### Indebtedness

Developing countries tend to be heavily indebted. Initiatives to 'forgive' debt since the early 1990s have reduced the debt burden of many countries. Despite this, on average, the total debt service burden of developing countries still represents 13 per cent of total exports of goods and services. The external debt of many developing countries drains public budgets, using the resources needed to support essential service provision and improve levels of human wellbeing. For debt reduction initiatives to be effective, the money saved needs to be used to boost social programs and reduce poverty.

### Emphasis on primary production

Worldwide, one-third of the global workforce is engaged in agriculture, often subsistence production. Although the process of urbanisation has been accelerating in developing countries, the greater percentage of their labour force is still engaged in agricultural activities, as is outlined in Figure 8.4. The percentage of the population engaged in agriculture was less than 2 per cent in the United States of America in 2010. About 60 per cent of all child labourers—129 million girls and boys—work in agriculture. More than two-thirds of them are unpaid family members.



## Rural-urban inequality

There continues to be a significant gap between the wellbeing of those living in rural areas compared with people living in urban centres. In 2011, only 53 per cent of births in rural areas were attended by skilled health personnel compared with 84 per cent in urban areas. Eighty-three per cent of people without access to a source of improved drinking water live in villages.

## Low levels of technology

In developing countries there are comparatively low levels of technology and science-based applications in agriculture and industry. Labour-intensive methods of production still dominate in both agriculture and industry in the world's poorest countries.

## Low levels of energy consumption

Low national incomes are often reflected in low levels of public infrastructure provision. In 2012, 1.3 billion of the world's people were living without electricity. Most of these people (493 million) lived in South Asia, followed by Africa (587 million) and East Asia (182 million).

8.4

Employment in agriculture is falling worldwide, but the sector still accounts for more than half of total employment in Sub-Saharan Africa and South Asia.

In Afghanistan, for example, only 30 per cent of the population has access to electricity. Worldwide, 80.5 per cent of people have access to electricity. In developing countries, the figure is 74.7 per cent. In the USA, consumption of electricity was 87 217 kilowatt-hours of electricity per person in 2012 compared with India's 6280 kilowatt-hours. The worldwide average was 21 283 kilowatt-hours of electricity per person.

## Lack of commitment to environmental sustainability

The growth in global carbon dioxide emissions is accelerating; emissions are now more than 46 per cent higher than they were in 1990. Forests continue to be lost at an alarming rate. Overexploitation of marine fish stocks is resulting in diminished yields. Birds, mammals and other species are heading for extinction at an ever faster rate, with declines in both populations and distribution.

# ACTIVITIES

### Knowledge and understanding

- 1 Outline the extent of extreme poverty in the world.
- 2 State the extent to which access to water and sanitation impacts negatively on human wellbeing.
- 3 How many people are estimated to be involved in primary production around the world.

### Applying and analysing

- 4 Outline the extent to which hunger and diet deficiencies exist in the world today. What are the consequences of poor nutrition?
- 5 Outline the relationship between the provision of electricity infrastructure and electricity consumption per capita. What other factors may influence energy consumption?

- 6 Construct an annotated mind map to illustrate the characteristics of developing countries.
- 7 Draw up a list of improvements that have taken place in human wellbeing since 1990.

### Geographical skills

- 8 Study Figures 8.1 and 8.3.
  - a Describe the distribution of:
    - i the lowest and highest life expectancy rates
    - ii the lowest and highest infant mortality rates.
  - b Is there a link between the two maps? Explain.
- 9 Study Figure 8.4. Using data from the graph, describe the trends in agricultural employment.

8.1

# 8.2

## NGOs: Making a difference

Over the last 20 to 30 years there has been a growing awareness that the challenges facing the developing world require more than just the interventions of governments. Individuals, working individually or collectively, can make a real difference. Non-governmental organisations now play an important role in improving people's human wellbeing by engaging with communities.

### Non-governmental organisations

A non-governmental organisation (NGO) is any non-profit, voluntary citizens' group organised on a local, national or international scale. It is typically task-oriented and driven by people with a common interest. NGOs perform a variety of service and humanitarian functions. These include bringing citizens' concerns to governments, advocating and monitoring policies and encouraging political participation through provision of information. Some NGOs are organised to deal with specific issues, while others promote a range of causes. They provide analysis and expertise, serve as early warning mechanisms, and help monitor and implement international agreements. People join NGOs because they believe they can achieve more by working with others to influence the decision-making processes of governments and large corporations.

### NGOs and development assistance

NGOs are active in addressing a range of challenges facing developing countries, such as:

- water and sanitation: Lifewater International, WaterAid, Safe Water Network, Water for People and Wash, Charity: Water
- healthcare: Médecins Sans Frontières (see Figure 8.5), CARE International and the Red Cross
- worker exploitation: Global Exchange, Clean Clothes Campaign and Rugmark
- wellbeing of children: Save the Children, Smith Family
- human rights: Amnesty International and Human Rights Watch
- development (range of issues): Oxfam, World Vision.

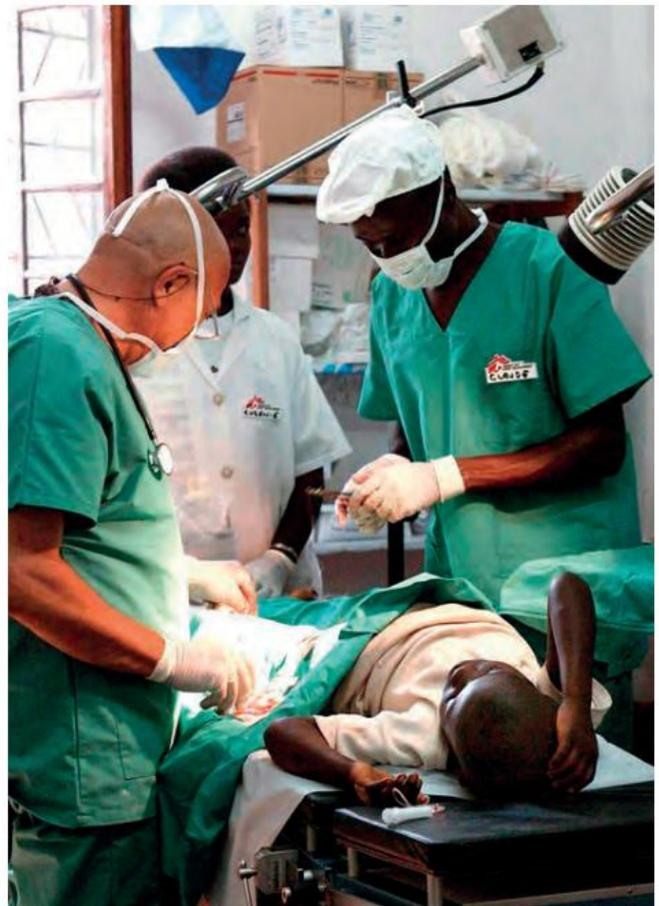
### NGOs in the field

Many NGOs are able to reach the most marginalised and vulnerable people in developing countries. They are able to work in areas that are difficult to access because of armed conflict or civil unrest because they do not take

sides between warring factions. Many also have expertise in working in emergency situations where fast and flexible responses are essential. NGOs focused on development-related projects are also skilled in empowering local communities. Their initiatives are likely to have long-term benefits only when recipients of the assistance are involved in the planning, design, construction, operation and maintenance of projects. This creates a sense of ownership and responsibility for a project. NGOs are also skilled in getting the most out of even small investments of capital.

8.5

Médecins Sans Frontières volunteer medical personnel provide emergency assistance in a field hospital.



## SPOTLIGHT

### Amnesty International

Amnesty International is an independent NGO with over 3 million supporters in more than 150 countries and territories. The vision of Amnesty International is to enhance human wellbeing through the creation of a world in which every person enjoys all the human rights enshrined in the Universal Declaration of Human Rights and other international human rights instruments. One way in which this NGO works to achieve its mission is to act on behalf of some of the most vulnerable members of society.

Amnesty International plays a very specific role in the international protection of human rights by focusing its activities on prisoners.

- It works to secure the release of prisoners of conscience. These are people detained for their beliefs, colour, gender, ethnic origin, language or religion, who have not used or encouraged violence.
- It works for the fair and prompt trials of all political prisoners. It also works on behalf of people who have been detained without charge or trial.
- It opposes the death penalty, torture and other cruel, inhumane or degrading treatment or punishment.

Amnesty International seeks to raise public awareness about human rights abuses (see Figure 8.6) and mobilise public opinion by having its supporters participate in letter-writing campaigns. Written appeals calling for the release of specific prisoners of conscience are sent to government leaders accused of suppressing prisoners' human rights.

Amnesty International protests are examples of active citizenship. This involves people taking seriously their responsibilities as citizens and becoming active participants in the political process.



8.6 Amnesty International protest in London, 2007, against inhumane treatment of prisoners at the US military prison at Guantanamo Bay, Cuba

## ACTIVITIES



### Knowledge and understanding

- 1 Explain what an NGO is. Why has the number of these organisations grown in recent years?
- 2 Outline the ways in which NGOs achieve their aims in the field.
- 3 Explain what Amnesty International is. What are the aims of this organisation?
- 4 Describe how Amnesty International acts to protect people's human rights.

### Applying and analysing

- 5 As a class, discuss the ways in which NGOs act to increase public awareness of particular issues and influence decision makers.

- 6 Conduct a class brainstorm on the following question: 'Why would I want to join an NGO?'
- 7 Design a sticker that highlights the issues addressed in this unit. Use design or desktop publishing software for a professional finish.

### Investigating

- 8 Select one of the NGOs listed in this unit. Access the NGO's website. Prepare a short oral report outlining the origins of the organisation, its mission and the main issues it deals with.

# 8.3

## Access to water

One of the targets of the Millennium Development Goals was to halve the percentage of people without sustainable access to safe drinking water and basic sanitation between 1990 and 2015. Although this target was met in 2010, nearly 800 million people still rely on unimproved water sources (surface water from lakes, rivers, dams, or unprotected dug wells or springs) for their drinking, cooking and personal hygiene.

### Improved sources of water

Access to an 'improved water source' refers to the availability of a clean, safe and reliable source of drinking water. Improved drinking water sources include piped water on premises (a piped household water connection located inside the user's dwelling, plot or yard) and other improved drinking water sources (public taps or standpipes, tube wells or boreholes, protected dug wells, protected springs and rainwater collection). Worldwide, nearly 800 million people still depend on unimproved drinking water sources.

#### DID YOU KNOW?

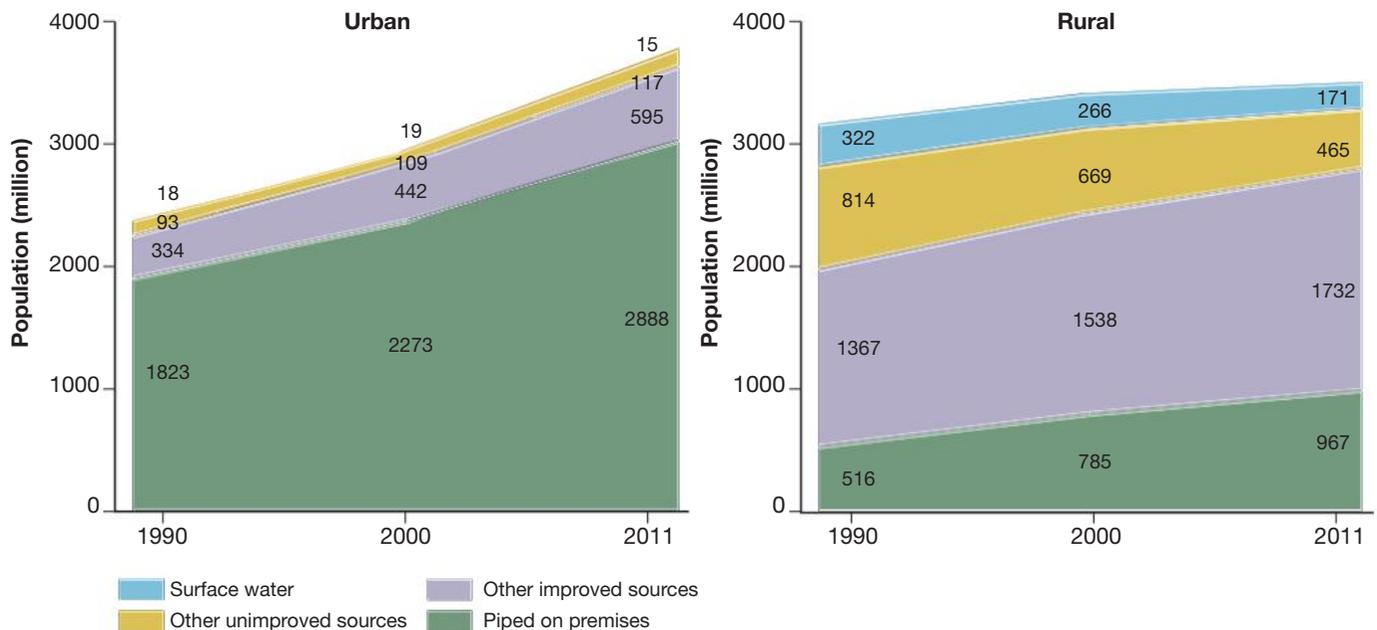
Currently, more than two-thirds of the population in Africa must leave their home to fetch water for drinking and domestic use.

### Access

The proportion of the world's population with access to improved drinking water sources increased from 76 per cent to 89 per cent globally between 1990 and 2011. While the proportion of the population with access to water is above 90 per cent in Latin America and the Caribbean, northern Africa and large parts of Asia, it is only 63 per cent in Sub-Saharan Africa. There are also big gaps between urban and rural water access. While an estimated 96 per cent of the world's urban population had access to an improved water supply source, only 81 per cent of rural dwellers did. Figure 8.7 shows the variation in access between urban and rural areas.

8.7

Population with access to drinking water, urban and rural areas, 1990, 2000 and 2011 (million)



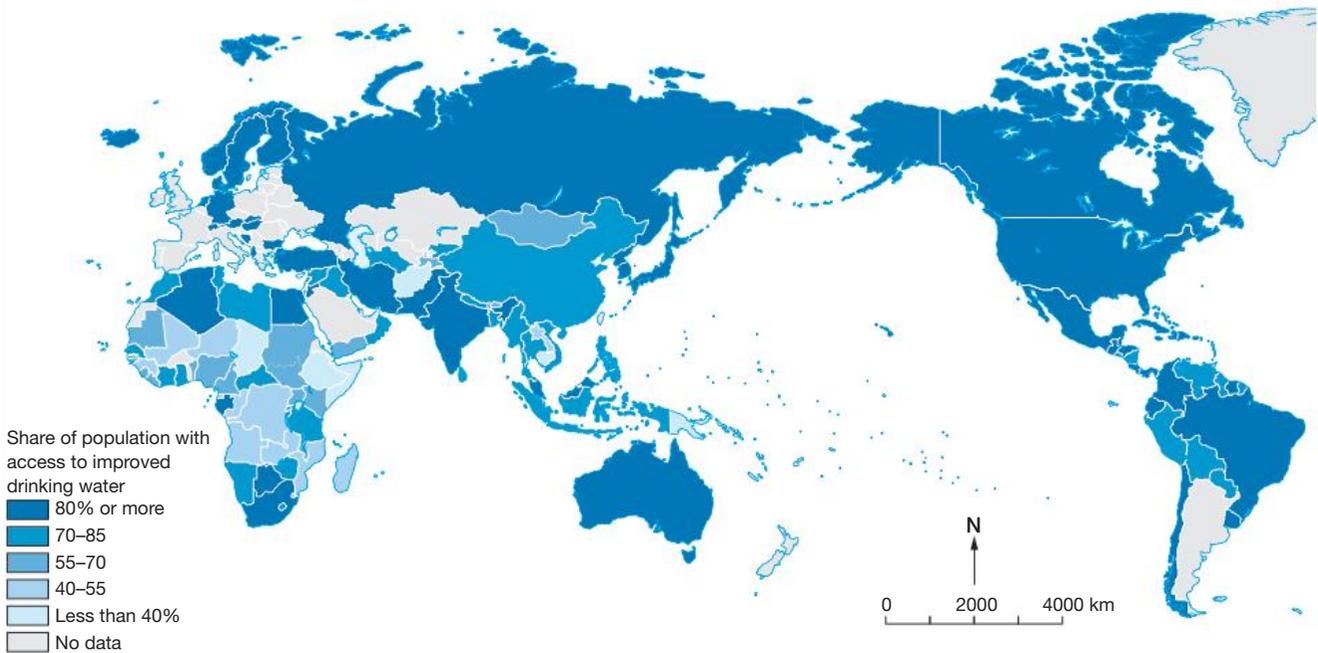
Source: MDG Report, 2013

## Choropleth maps

Choropleth maps are a special type of thematic map. Areas on the map are shaded in proportion to the measurement of the data being displayed. A system of colour progression is used to depict the data. This typically takes the form of different shades of the one colour, with the darker shade showing the distribution of the highest data category.

Figure 8.8 is an example of a choropleth map. The areas coloured the deepest shade of blue are those with the highest percentage of the population who have access to an improved water source.

8.8 Access to an improved water source



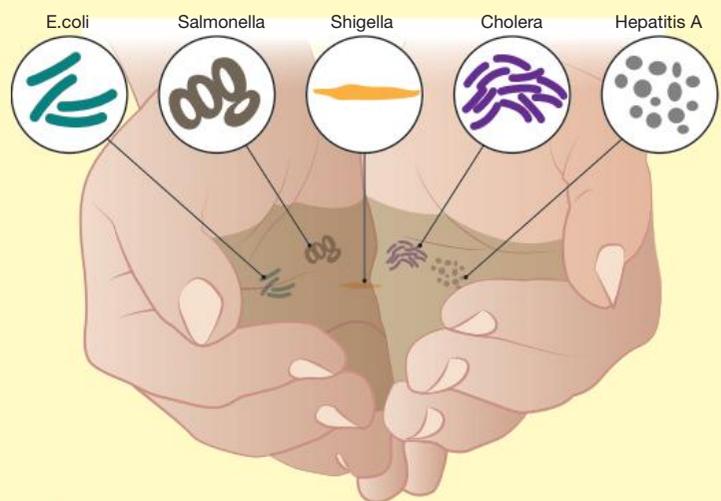
Source: World Health Organization, 2012

## SPOTLIGHT

### Waterborne disease

Waterborne diseases occur when people drink contaminated drinking water. When the same contaminated water is used in the preparation of food, people can contract a range of food-borne diseases. Examples of diseases transmitted through contaminated water are diarrhoea, cholera, dysentery, typhoid and hepatitis A.

Diarrhoea is responsible for the deaths of 1.8 million people every year, most of whom are children living in developing countries. The main source of this disease is water contaminated by untreated human waste. Lack of proper sanitation is a serious health risk. It affects billions of people around the world, especially the poor and disadvantaged.



8.9 Contaminants found in water that cause waterborne diseases



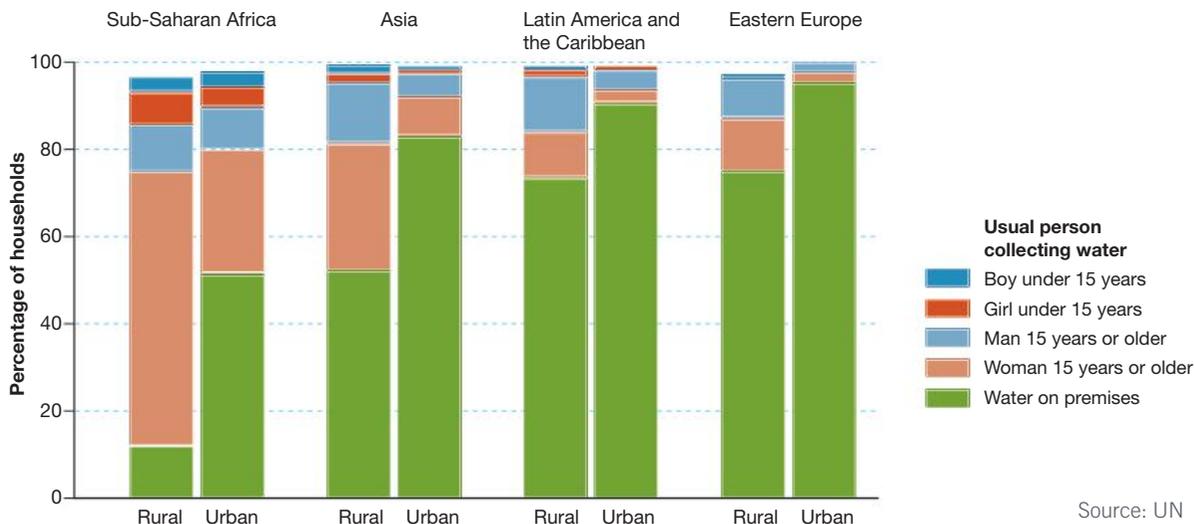
8.10 Indian women living in the state of Telangana, 200 kilometres from Hyderabad, carrying water to their village

## Water: a woman's burden

In many countries, women are responsible for fetching the water for their family, as shown in Figures 8.10 and 8.11. Water is required for drinking, cooking, washing clothes and personal hygiene. Women often walk many kilometres, carry heavy burdens, wait for hours and have to pay exorbitant prices. Often the water is contaminated, even deadly. In these instances, they face a terrible choice—certain death without water or possible death from waterborne disease. It has been estimated that women in developing countries spend a combined 200 million hours a day collecting water.

Once they are old enough, young girls join the effort. They too spend countless hours fetching this basic necessity of life. The work they do is often dangerous. The sides of a well can collapse, burying the women and girls. There is also the physical burden of the loads carried. Water-filled containers are often carried on the head. This creates physical demands on the body, especially the spine and neck.

8.11 Distribution of household by person responsible for water collection, by region and urban/rural areas, 2005–07



Source: UN

The impacts, however, go beyond physical injury. The dual aspects of the water crisis—lack of water and of sanitation—lock women in a cycle of poverty. They cannot attend school; they cannot earn an income.

Many NGOs focus their efforts on providing a convenient, safe source of water for communities throughout the developing world. The benefits of installing a simple pump are many, but include:

- increased school attendance, level of education and literacy rates, as girls no longer need to miss school to secure water for their families
- improved health for women and girls
- reduced child and maternal mortality as a result of access to safe water and improved hygiene during childbirth
- reduced physical injury from lifting and carrying heavy loads of water
- reduced risk of rape and sexual assault, and increased safety as women and girls do not have to walk long distances to fetch water
- new opportunities for women's employment as well as greater autonomy and independence.

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the extent to which access to improved water sources has increased since 1990.
- 2 Explain what constitutes an 'improved water source'.
- 3 Explain what a choropleth map is and state the technique that is used to show variations in data categories.
- 4 Outline the health implications of carrying large amounts of water over long distances.
- 5 Describe the benefits of providing villages with safe, convenient sources of clean water.

### Geographical skills

- 6 Study Figure 8.7. Using data from the graph, write a series of paragraphs outlining the variations in access to drinking water experienced by those living in rural and urban areas.
- 7 Study Figure 8.8. With the aid of an atlas, describe the spatial distribution of countries in which less than 40 per cent of the population has access to an improved source of water.

8.3

# 8.4

## Case study: Access to water in India

The demand for water in India's is growing rapidly, driven by population growth and rising standards of living, at least for some. This demand, combined with the pollution of surface water, has resulted in increased groundwater extraction. As a result, water tables are dropping quickly and the situation is not sustainable. The link between water and food security and health in India means that urgent solutions are required.

### Access to an improved water source

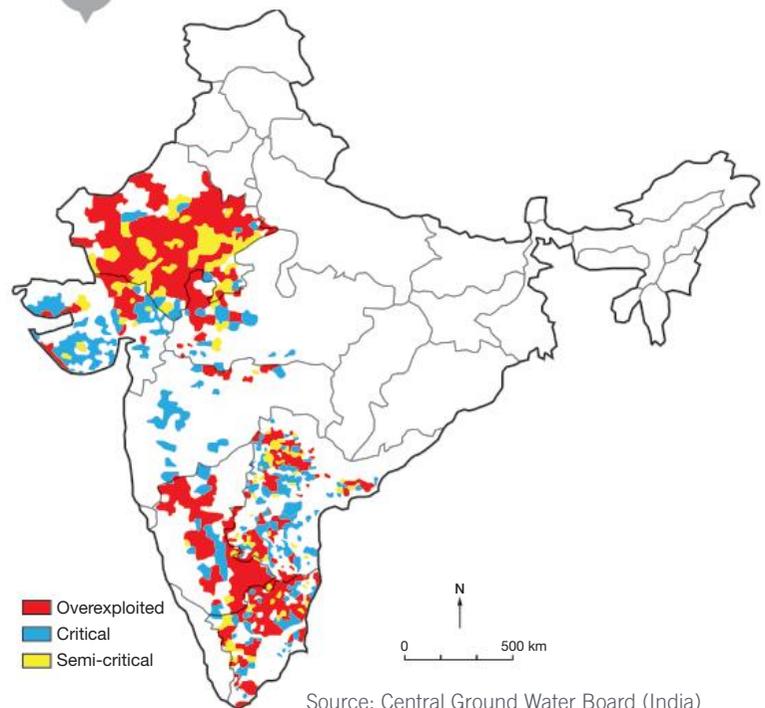
While 92 per cent per cent of Indians have access to an improved water source, only 25 per cent have it piped to their homes—the remainder obtain it from communal sources. These figures compare favourably with the figures on access to sanitation—only 35 per cent of Indians have access to sanitation. The difference in access to improved water sources and sanitation reflects the priority given to the construction of water-related infrastructure in the past. This is a significant improvement since 1990, when only 72 per cent had access to an improved source, and only 18 per cent had access to sanitation. In rural areas, where most Indians continue to live, 84 per cent have access to an improved water source, while only 21 per cent have access to sanitation.

### Groundwater

Groundwater is a critical resource in India, accounting for over 65 per cent of irrigation water and 85 per cent of drinking water supplies. While the nation's average annual rainfall is high by world standards, much of it (up to 80 per cent) falls during the summer monsoon (that is, from early June to September) and is highly variable. The combination of these climatic conditions and a range of human-related pressures has driven India's households, farmers and industry to depend increasingly on groundwater rather than surface water.

Much of India's surface water supplies are unsafe for drinking or farming—more than 70 per cent of India's surface water resources are polluted by human waste or toxic chemicals. Groundwater is widely seen as a safe alternative. This dependence on groundwater is leading to a rapid deterioration in the nation's groundwater resources, as is shown in Figure 8.12. It is estimated that 60 per cent of the country's groundwater stores will be in a critical state of degradation within 20 years. Wells are having to be dug deeper and deeper as the watertable is dropping by up to 33 centimetres a year in some places.

8.12 Groundwater supplies under threat in India



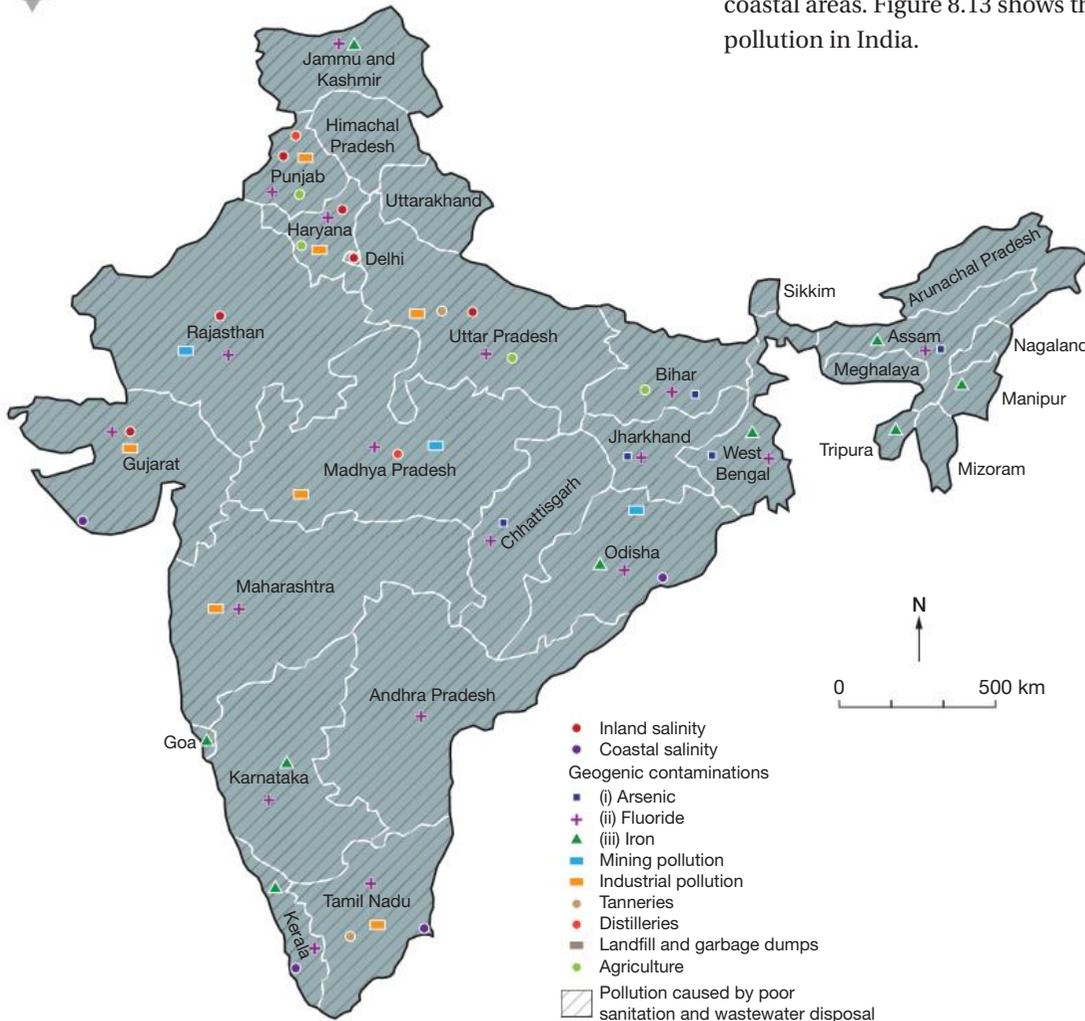
The decline in India's groundwater resources is due a number of factors. Groundwater enables irrigated agriculture in areas located far from rivers. In urban areas, the water supply infrastructure is often poor and unreliable. As a result, well drilling is typically regarded as the most cost-effective way of obtaining household water. In Delhi, an estimated 40 per cent of the water transported through the mains system is lost through leakage. For many residents, the only alternative to bores is expensive supplies purchased from water trucks.

In rural areas, subsidised electricity makes it cheap for farmers to pump groundwater from wells. The low cost of the water encourages excessive water withdrawal and inefficient irrigation practices. In order to feed a growing and more affluent population, it is anticipated that agricultural water demand will double between 2014 and 2030.

## Water contamination

As wells are drilled ever deeper, the water that is extracted often contains elevated levels of arsenic, fluoride and other harmful chemicals. Arsenic poisoning is now widespread in the lower Ganges River Valley. The health impacts include headaches, confusion, severe diarrhoea and drowsiness. As the poisoning develops, convulsions occur.

8.13 Groundwater pollution



When the poisoning becomes acute, diarrhoea, vomiting, blood in the urine, cramping muscles, hair loss and stomach pain may occur. Arsenic poisoning can ultimately result in a victim lapsing into a coma and dying.

Falling water tables can also result in contaminants entering the water table from external sources such as surface water polluted by sewage, agricultural fertilisers and industrial waste. Saltwater penetration is a problem in coastal areas. Figure 8.13 shows the extent of groundwater pollution in India.

## ACTIVITIES

### Knowledge and understanding

- 1 State why it is important that the issue of India's dwindling groundwater supplies is addressed.
- 2 Outline the level of access to improved water sources in India. How does this compare with access to sanitation? Why is there a difference?
- 3 Explain why India's groundwater stores are declining.
- 4 State why groundwater can be used as a substitute for surface water.
- 5 List the groundwater contaminants and outline the health impacts of arsenic poisoning.

### Applying and analysing

- 6 Discuss the challenge of providing access to improved sources of water for India's urban population. Is the provision of communal sources of water acceptable? Explain your answer.

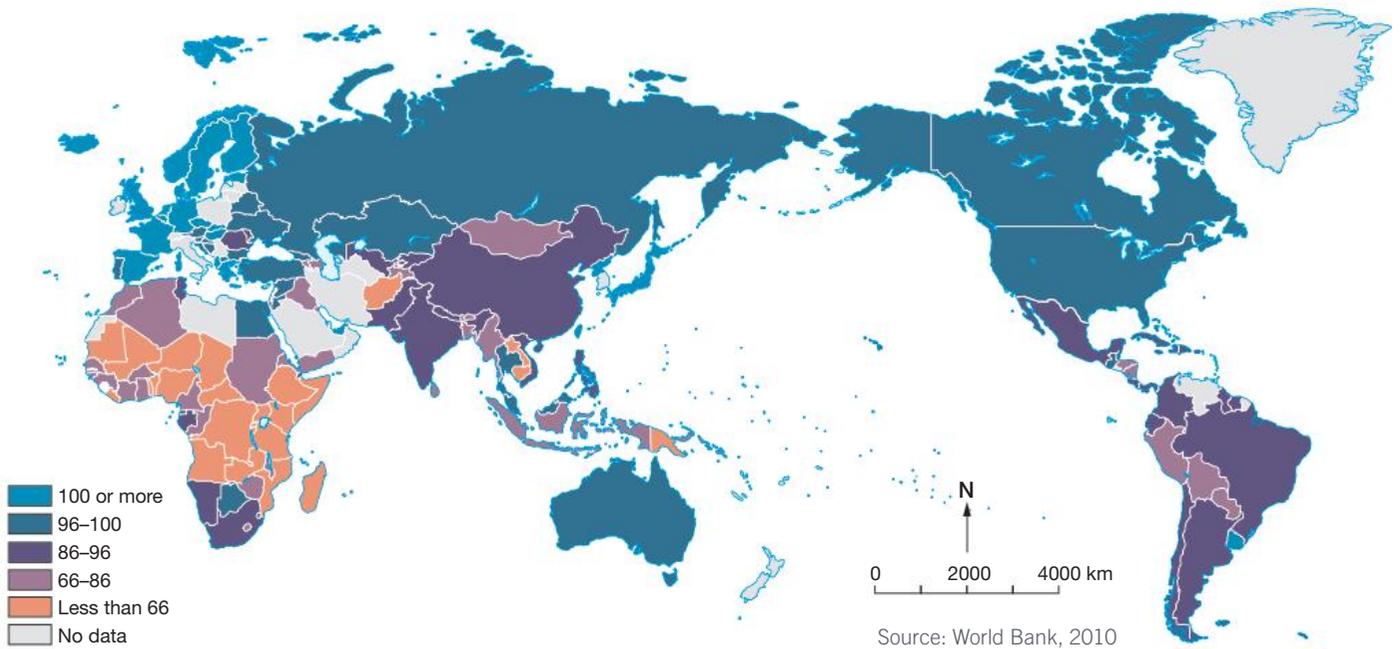
### Geographical skills

- 7 Study Figure 8.12. Describe the spatial distribution of groundwater supplies under threat.
- 8 Study Figure 8.13. Describe the spatial distribution of groundwater pollution.

# 8.5

## Access to sanitation

Sanitation is a basic need and provides a means of safeguarding people's physical wellbeing. The provision of adequate sanitation in communities prevents the spread of disease. Currently, around 1 billion of the world's population lack access to adequate sanitation.



8.14 Percentage of population with access to adequate sanitation facilities

### Access to improved sanitation

Figure 8.14 illustrates worldwide access to adequate sanitation facilities. In 1990, just under half (49 per cent) of the global population had access to improved sanitation. By 2013, this had increased to 64 per cent. The MDG target for 2015 is 75 per cent. From 1990 to 2011, 1.9 billion people gained access to a latrine, flush toilet or other improved sanitation facility (see Figure 8.15).

### Sanitation infrastructure

Lack of sanitation infrastructure forces people to defecate in the open, in rivers or near areas where children play or food is prepared. This increases the risk of disease transmission. The Ganges River in India has 1.1 million litres of raw sewage dumped into it every minute. This is frightening when you consider that just one gram of faeces in untreated water may contain 10 million viruses, one million bacteria, 1000 parasite cysts and 100 worm eggs.

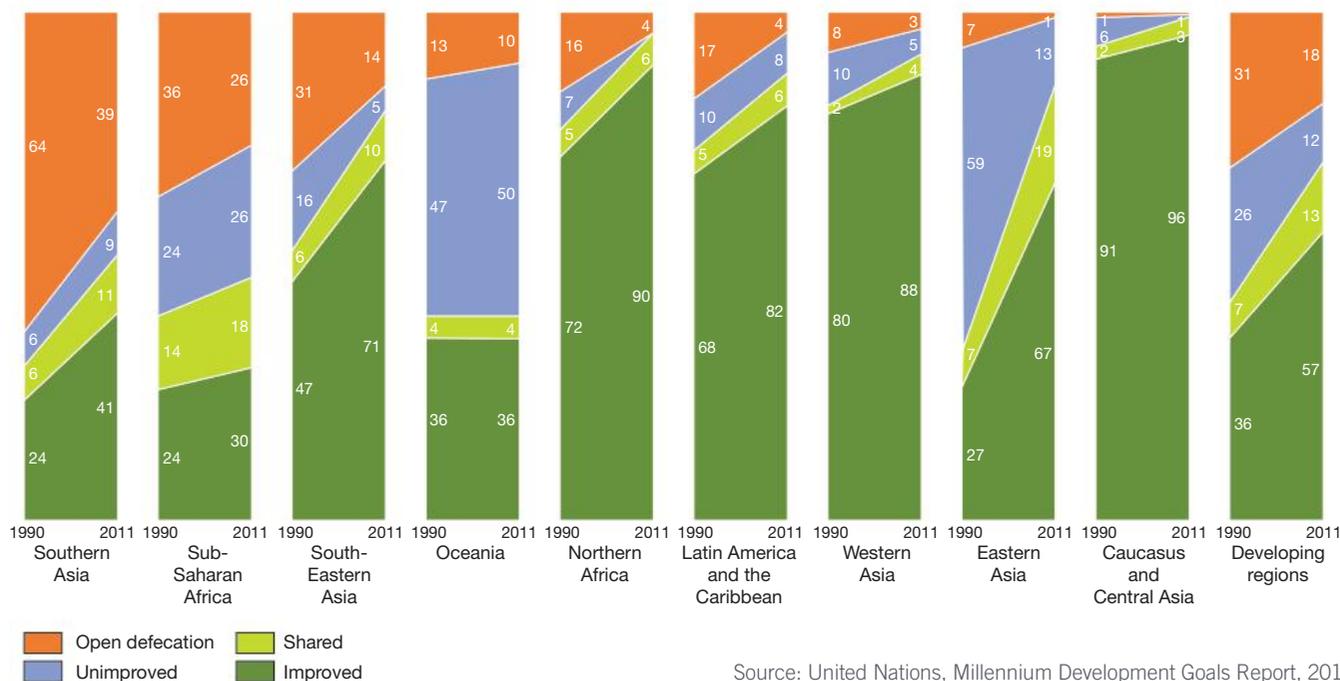
Improving sanitation infrastructure can have an immediate impact on public health. It can, for example, reduce diarrhoea death rates by up to a third. In Africa, 115 people die every hour from diseases linked to poor sanitation, poor hygiene and contaminated water.

In addition to improvements to people's health, the provision of sanitation has a number of important social benefits. The provision of sanitation in schools, for instance, encourages children to attend school, particularly girls. The liveability of neighbourhoods improves as the incidence of open defecation declines.

### Addressing the issue

While the proportion of the global population that resort to open defecation declined from 24 per cent in 1990 to 15 per cent in 2011, it remains a problem. In response, authorities now focus on stopping the practice of open defecation through community-level action and influencing social norms to the point where open defecation is no longer considered acceptable. In almost 100 countries around the

8.15 Proportion of population by sanitation practices, 1990 and 2011 (per cent)



Source: United Nations, Millennium Development Goals Report, 2013

world, new approaches to sanitation have taken root and the number of declared ‘open-defecation-free villages’ is rising.

This is only part of the challenge. Providing the necessary infrastructure (toilets, storage facilities, pumping stations, sewerage and water pipelines and treatment works) is a major undertaking. It is expensive and, with rapid rates of urbanisation, it is often difficult for many urban authorities to keep pace with population growth. However, not all solutions need be expensive or high-tech. The construction of communal toilet facilities is a low-cost response to the lack of sewerage infrastructure.

### The pour-flush toilet

The pour-flush toilet has a water seal that avoids the problems associated with odour and insects. Excreta deposited in the latrine is flushed by pouring 2–3 litres of water into the pan. The mixture is directed into a pit, where the biodegradation of organic wastes occurs. The water used in the flushing process percolates through the soil surrounding the pit. The potential for groundwater pollution is, therefore, very high. Pour-flush toilets are not a suitable solution to the sanitation needs of the urban poor when the groundwater table is close to the surface.

Sludge has to be regularly emptied from the pit. The use of two adjoining pits alternately enables the sludge in a full pit to undergo further decomposition while the other pit is being used. It also facilitates the manual emptying of sludge after further decomposition.

As with pit latrines and composting toilets, grey water (waste water from the kitchen, laundry and bathroom but not the toilet) has to be treated separately. This is often done by the construction of a seepage pit or trench.

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the consequences of people not having access to adequate sanitation facilities.
- 2 Describe the impacts of untreated sewage on waterways such as the Ganges River.
- 3 Explain why the provision of sanitation is considered to be so important to people’s wellbeing.
- 4 Outline the strategies being used to meet the sanitation needs of people. What are the benefits of these strategies?

### Geographical skills

- 5 Study Figure 8.14. With the aid of an atlas, identify the regions of the world that experience the lowest levels of access to sanitation.
- 6 Study Figure 8.15. Using data from the graph, write a paragraph outlining the advances made in the provision of sanitation between 1990 and 2011.

# 8.6

## Case study: Access to sanitation, Mumbai, India

A project funded by the World Bank, the Mumbai Municipality Slum Sanitation Program, is bringing an improved quality of life to people living in slums of Mumbai. The city is home to 6.9 million slum-dwellers, who live in approximately 2000 slum areas spread throughout the metropolitan area. Fifty-four per cent of the city's population lives in such conditions.

### Lack of sanitation infrastructure

During the development of Mumbai, the construction of sewerage infrastructure was given a lower priority than solid waste disposal, stormwater drainage and water supply. As a result, only a small area of the city has a sewerage collection and treatment system. Most of the city's slums are not serviced by sewer lines. In these areas, waste water drains into septic tanks.

Mumbai's slums are, as a consequence, inadequately serviced by public or communal toilets. These facilities, constructed by Maharashtra Housing and Area Development Authority or the city's water supply and sewerage department typically did not have water or electricity connections, and are now mostly in poor condition due to the lack of maintenance.

As a result of their poor condition (see Figure 8.16), together with long queues, especially in the morning, many slum-dwellers defecate in the open. Women often prefer to defecate in the open instead of using the dirty toilets. Furthermore, men and women's toilets are often not separated. This reduces the sense of privacy and can lead to the harassment of women.

The 'pay and go' toilets provided by the city in places such as railway stations and bus stops are difficult for the poor to access because of the fee charged for their use (typically 2 rupees per person). The unsatisfactory processes involved in the collection and treatment of sewage within the slums results in the spread of disease and the degradation of the natural environment.

8.16 A men's public toilet in a slum in Mumbai, India



## Mumbai Municipality Slum Sanitation Program

The aim of the Mumbai Municipality Slum Sanitation Program (MMSSP) is to improve the inadequate sanitary conditions in Mumbai's slum areas through the provision of communal toilet blocks.

The success of the initiative is based on community engagement. The participatory approach was a condition of the World Bank funding. The community has been involved in the planning, design, construction, operation and maintenance of the toilet blocks. Giving the slum-dwellers a sense of ownership and responsibility for the facilities is expected to improve the operation and maintenance of the toilet blocks.

The first phase of the project (completed in December 2005) involved the construction of 328 toilet blocks with more than 5100 separate compartments. These toilets were planned to serve the needs of 250 000 people, or 50 people per toilet cubicle. The second phase of the project aimed to add an additional 35 000 toilets. The community blocks are for the benefit of a specific community, not for public use.

Ninety per cent of the World Bank funding was directed towards the improvement of the centralised sewerage system (for example with additional treatment plants and extended sewer lines), while 10 per cent of the funding was used to build the communal toilet blocks, which averaged US\$1400 per block.

### Communal toilets

Each block consists of a two-level structure built of reinforced concrete. It houses an average of ten to twenty pour-flush toilets that require half a bucket of water for flushing (see Figure 8.17). Most of the waste is directed to septic tanks when it is not possible to connect with a sewer line. Each has an overhead water tank and electricity.

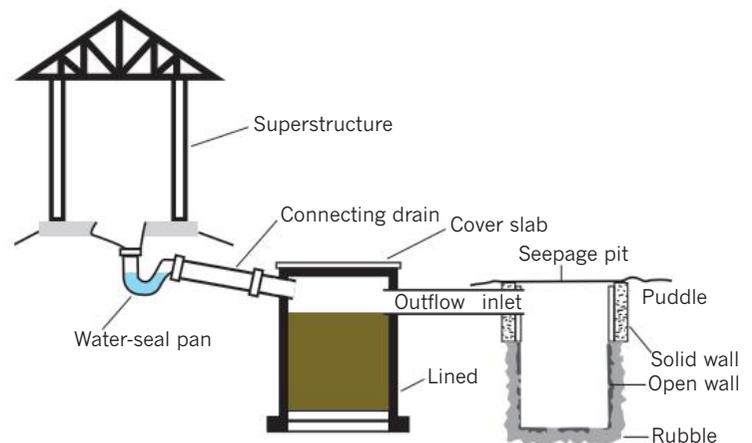
The blocks are open 24 hours a day. The sludge that is produced in the septic tanks is removed and carted away to dumping grounds by tankers. The liquids are taken out and disposed of into stormwater drains. Many of the blocks are not accessible by tankers due to the density of building and lack of open space for constructing access roads. In these areas, people have to take out the sludge manually.

To use the facilities, residents must either pay a monthly fee for a family pass or pay on a per-use basis. The money collected pays for cleaning and maintenance.

### Project outcomes

The outcomes of the program include improved public health as a result of the improved sanitation facilities and the empowerment of slum-dwellers, who have been given a voice in the decision-making process. There is also an increased awareness of the importance of sanitation and personal hygiene. The human wellbeing of the city's slum-dwellers has been enhanced.

8.17 Pour-flush toilets are a relatively cheap response to the needs of people in unplanned urban settlements.



## ACTIVITIES

### Knowledge and understanding

- 1 Outline the nature of the sanitation issue in Mumbai.
- 2 Explain why Mumbai lacks the required infrastructure.
- 3 State the consequence of slum-dwellers not having access to communal toilets or being unable to afford to use 'pay-as-you-go' facilities.
- 4 Outline the approach to sanitation provision adopted by the MMSSP and funded by the World Bank.
- 5 Identify the social and environmental impacts associated with the MMSSP.

### Applying and analysing

- 6 As a class, discuss the social and environmental advantages and disadvantages of communal toilet facilities such as those built under the MMSSP. Use this information to construct a mind map.
- 7 As a class, brainstorm why the construction of sewerage infrastructure, like that found in Australian cities, would be an impractical response to the sanitation needs of people living in Mumbai's slums.

# 8.7

## Child exploitation

Millions of children worldwide are victims of abuse. In developing countries, abuses related to poverty are widespread. The worst types of abuse are child labour and trafficking, child marriage and sexual exploitation. Children whose human rights are violated have an increased risk of death, poor physical and mental health, homelessness and HIV/AIDS. They are unlikely to receive an education. This locks them into a vicious cycle of poverty.



### Child labour

UNICEF estimates that 150 million children aged 5–14 years are engaged in child labour; that is, one in six children in the world. Many are working in hazardous situations or conditions (see Figure 8.18). Some children work in deep underground mines, while others work in factories, handling toxic chemicals and pesticides or using dangerous machinery. They also work as domestic servants and plantation labour. Some are forced into child prostitution.

The problem is worst in Sub-Saharan Africa, where it is estimated that about one in three (or 70 million) children is engaged in child labour. In South Asia, another 44 million children are working. India has the highest number of child workers of any single country—an estimated 29 million children between the ages of 5 and 14.

8.18 Children at work in a charcoal factory in the Philippines

Those living in the poorest households and in rural areas are most likely to be engaged as child labourers. Those burdened with household chores are overwhelmingly girls. Millions of girls who work as domestic servants are especially vulnerable to exploitation and abuse. Labour often interferes with children's education.

### Child trafficking

The trafficking of children—often by illegal means—involves the recruitment, abduction, transportation or receipt of children for the purpose of exploitation. Exploitation includes forcing children into prostitution, forced labour and begging, and using them for the harvesting of internal organs. It may also include illegal international adoption,

trafficking for early marriage and the recruitment of child soldiers. Child trafficking is a crime under international law and under the national legislation of many countries.

## Child marriage

Despite many countries restricting marriage to those above a minimum age of 16 to 18, traditional (underage) marriages are still widespread. Poverty, tradition and conflict make child marriage relatively common in Sub-Saharan Africa, South Asia and the Middle East. In many tribal systems, a man must pay the girl's family in order to marry her. In many parts of Africa, this payment, which is made in cash, cattle, or other valuables, is less for older girls. Even before puberty it is common for a married girl to leave her parents to be with her husband.

Many early marriages are linked to poverty, as the girl's parents often need the money raised to feed, clothe, educate and provide shelter for the rest of the family. In parts of Ethiopia and Nigeria, over 50 per cent of girls are married before the age of 15 and some are married as young as the age of 7. In parts of Mali, 39 per cent of girls are married before the age of 15. In Niger, over 70 per cent of girls are married before the age of 18 (see Table 8.19).

## Sexual exploitation

Prostitution of children under the age of 18 years, child pornography and the (often related) sale and trafficking of children are widely seen as crimes of violence against children. They are a form of economic exploitation, just like forced labour or slavery. The children exploited in this way often suffer damage to their physical and mental health. They are especially vulnerable to sexually transmitted diseases, including HIV/AIDS. Under Australian law, any Australian found guilty of involvement in child sex tourism faces up to 17 years in jail.

## Child soldiers

Thousands of children serve as soldiers in armed conflicts around the world. Boys and girls, some as young as 8 years old, serve in government forces and armed opposition groups. They carry out a variety of roles. They may fight on the front lines, participate in suicide missions, and act as spies, messengers or lookouts. Once recruited, children undergo varying degrees of indoctrination. Often this process is very brutal. Girls may be forced into sexual slavery. Many are abducted or recruited by force, while others join out of desperation, believing that armed groups offer their best chance for survival.

Children are still involved in armed conflict in a number of countries. These include the Central African Republic, the Democratic Republic of the Congo, Mali, Pakistan, Somalia, Sudan, Syria and Yemen among others (see Figure 8.20).

8.19 Child marriage (under 18 years): 20 highest-prevalence countries in the world (percentage of all marriages)

Country	Percentage of all marriages
Niger	75
Central African Republic	68
Chad	68
Bangladesh	65
Guinea	63
Mali	55
South Sudan	52
Burkina Faso	52
Malawi	50
Madagascar	48
Mozambique	48
India	47
Eritrea	47
Somalia	45
Sierra Leone	44
Zambia	42
Nepal	41
Dominican Republic	41
Ethiopia	41
Nicaragua	41

Source: Girls not Brides, 2013

8.20 A child soldier at the Cambodian refugee camp of Nong Samet on the Thai–Cambodian border



# Slavery

Worldwide, nearly 30 million people, many of them children, are enslaved. They are trafficked to work in the sex industry or as forced labour, and they are sometimes victims of **debt bondage** or even born into servitude. There is still evidence of hereditary slavery, particularly in parts of West Africa and South Asia. According to the Global Slavery Survey of 2013, slavery still exists in 162 countries and almost 21 million people are victims of forced labour (see Figure 8.22).

**Slavery** is the possession or control of people to deny freedom and exploit them for profit or sex, usually through violence, coercion or deception. The definition includes **indentured servitude**, forced marriage and the abduction of children to serve in wars (child soldiers).

## SPOTLIGHT

### Ending child marriage

Every year it is estimated that 14 million girls are married before they turn 18. Globally, about 400 million women aged between the ages of 20 and 49 were married before the age of 18.

UNICEF and NGOs such as Girls Not Brides are working together to eliminate child marriage, by:

- providing information, skills and support networks for married girls or girls at-risk for early marriage
- educating parents, religious/traditional leaders and community members
- improving the accessibility and quality of schooling for girls.
- providing economic support and incentives for girls and their families
- fostering and enabling legal and policy frameworks.

Ban Ki-Moon, Secretary General of the United Nations, said that 'education for girls is one of the best strategies for protecting girls against child marriage'. Expanding access to primary and secondary education can delay, and even prevent, early marriage. According to a study conducted by the International Center for Research on Women, girls with 0–3 years of education were six times more likely to marry before adulthood than girls who had received a secondary education. Many child brides are forced to leave school early.

In Addis Adaba, Ethiopia, it is estimated that three-quarters of streetwalkers are escapees from the countryside, fleeing early marriage. One local NGO, Godanaw Rehabilitation Integrated Project, is providing skills training and healthcare to thousands of female streetwalkers. At AGOHELMA, one of the oldest orphanages in Ethiopia, one of their main aims is to educate women and enhance their economic power.

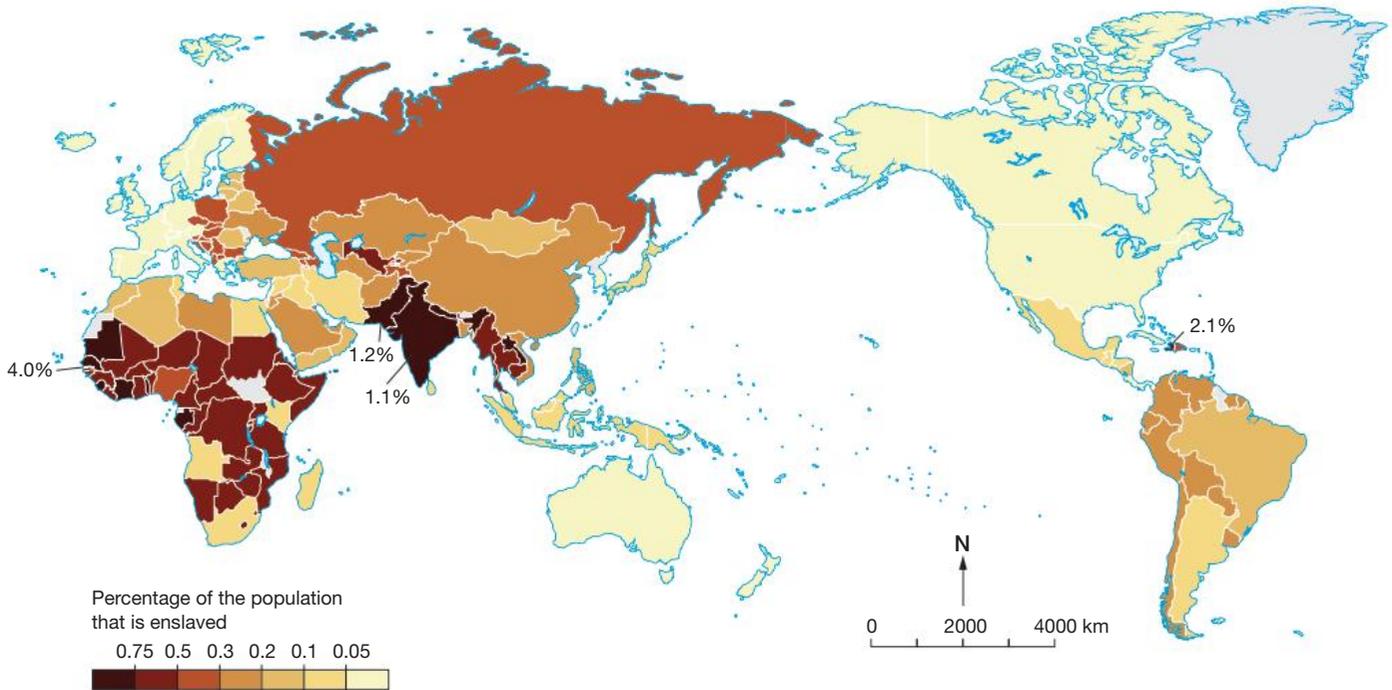


8.21 Female secondary school students sit under a poster showing the periodic table of the elements in the courtyard at an AGO school (founded by Abebech Gobena in 2013) in Addis Ababa, Ethiopia.

Ten countries account for three-quarters of the world's slaves. In India, where slavery ranges from bonded labour in quarries and kilns to commercial sex exploitation, 13.9 million people are enslaved. After India is China, with 2.9 million, followed by Pakistan (2.1 million), Nigeria (701 000), Ethiopia (651 000), Russia (516 000), Thailand (473 000), Democratic Republic of Congo (462 000), Myanmar (384 000) and Bangladesh (343 000).

Often the victims of enforced labour are captured or kidnapped before being sold or kept for exploitation, whether through 'marriage', as unpaid labour on fishing boats, or as domestic workers. Others are tricked and lured into situations they cannot escape, with false promises of a good job or an education.

8.22 Percentage of the world's population that is enslaved



Source: Global Slavery Index, 2013

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the consequences of child exploitation in developing countries.
- 2 State how extensive child labour is in developing countries. Where is it most commonly practised?
- 3 Explain what child trafficking is. List the reasons why children are traded.
- 4 Explain the link between poverty and child marriage.
- 5 Define 'slavery'.

### Applying and analysing

- 6 As a class, discuss the issue of child exploitation. Summarise the key points raised in the discussion in the form of a mind map.
- 7 Debate the following topic: 'For many people living in developing countries, putting their children to work is a necessity and should not be viewed as exploitation'.

### Geographical skills

- 8 Study Figure 8.22. With the aid of an atlas, identify the parts of the world with the highest percentage of the population enslaved.

### Investigating

- 9 Use the internet to investigate the issue of child labour or child trafficking. Develop a short multimedia presentation to educate the public about the extent of the problem. Give at least one example of child labour and the steps that non-governmental organisations such as UNICEF are taking to address the problem.

# 8.8

## Case study: Child exploitation in India

India's challenges are many, but the exploitation of children is one of the more serious. All forms of modern slavery and exploitation are found in India, from severe forms of inter-generational bonded labour to the worst types of child labour, commercial sexual exploitation and forced marriage. Millions of Indian citizens are engaged in forced labour as a result of debt bondage, and people trafficking is widespread.

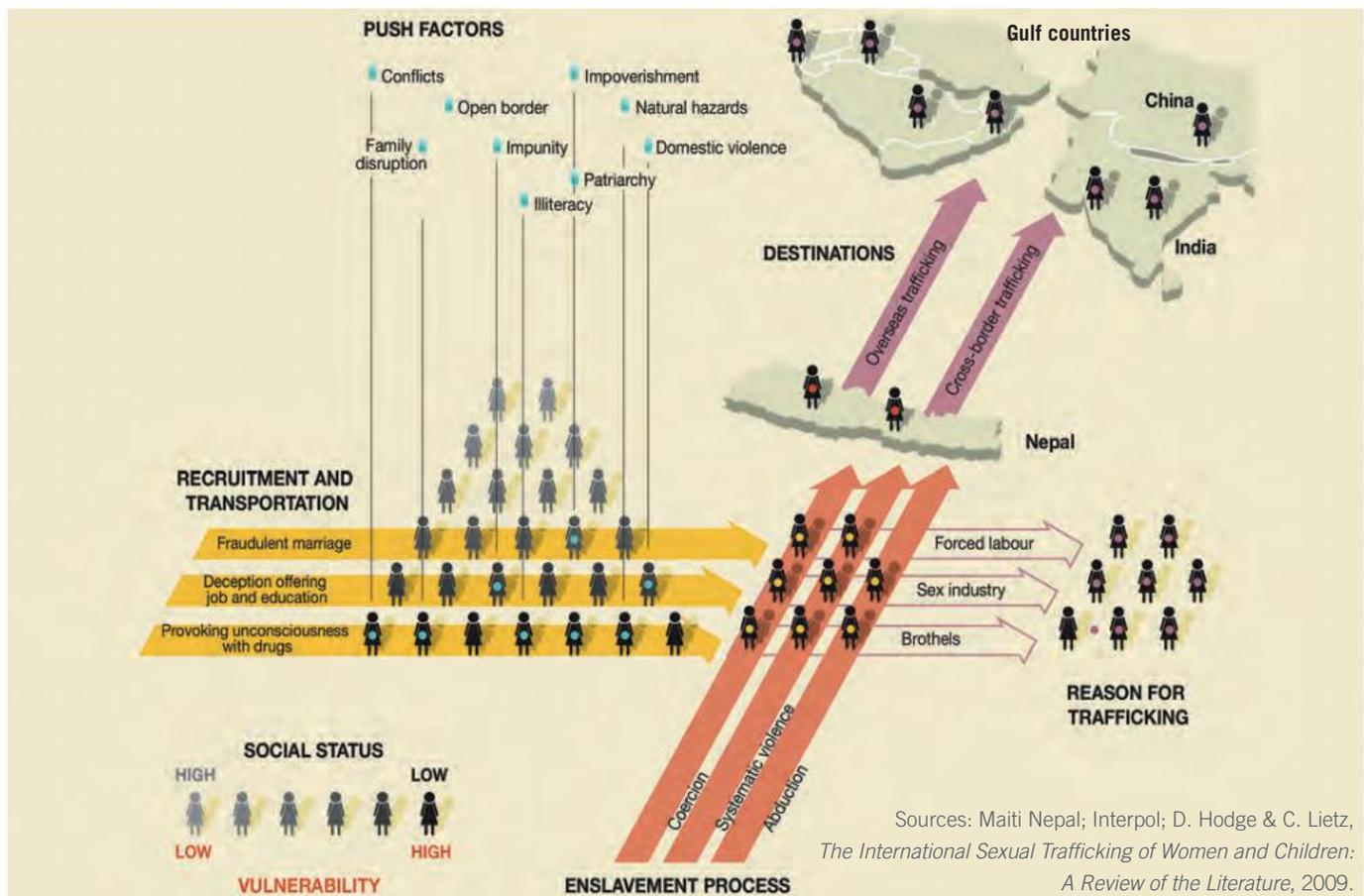
### Cross-border migration

Cross-border migration occurs on massive scale. Low-skilled migrant workers, many of them children, are at particular risk of exploitation. Large numbers of Nepali and Bhutanese migrants, who are exempt from Indian migration visa regulations, fall victim to recruiters and exploiters who take advantage of their vulnerability. Figure 8.23 outlines the human trafficking patterns between Nepal, India and other countries, and the push factors involved.

### People trafficking

Ninety per cent of trafficking in India is internal, rather than international. Some internal migrants are lured from poor rural communities to relatively wealthy cities by brokers on the false promise of employment. Trafficked men, women and children make up significant shares of the workforce in industries such as construction, textiles, brick making, mines, fish and prawn processing and hospitality. However, many of India's enslaved people have not moved from one place to another—they are enslaved in their own villages. Many are trapped in debt bondage to a local landowner or born into slavery because of caste, customary, social and hereditary obligations.

8.23 Patterns of human trafficking in Nepal



For people enslaved in their own area, corruption, land grabs and asset domination by high-caste groups leave them without protection. Government benefits such as the National Employment Guarantee, food rations, primary health care and pensions simply cannot be accessed because of the lack of effective public administration. Some enslaved people do not officially exist—they have no birth registration or identification documents—which makes it difficult for them to access entitlements.

## Forced labour

Forced labour takes place in factories and on farms. It is especially common in brick making, leather tanneries, mining and quarrying, the textiles and garments industries, domestic work and forced begging. Bonded labour, whether through debt or other forms of ‘bondage’ of workers, is widespread in quarrying, brick making, construction and mining.

## Sexual exploitation

The sexual exploitation of Indian children is widespread. Commercial sexual exploitation has traditionally taken place in specific areas, but is now more widely dispersed and is increasingly found in rural areas and at transport hubs, roadside restaurants and houses in suburban areas. Commercial sexual exploitation is increasingly arranged through the use of mobile phones, making it harder for authorities to locate and tackle.

## Other forms of exploitation

Non-labour-based forms of modern slavery, such as forced marriage, illegal adoptions and organ trafficking, all occur in India. Forced marriage is partly a result of the gender imbalance in some parts of the country. Marriage brokers in states with the greatest shortage of women import young girls from poorer states. The girls are forced into marriages arranged by the broker in return for a fee. The low status of women and the widespread occurrence of domestic violence in Indian society put victims at risk of modern slavery. Commercial surrogacy, while legal in India, is a practice open to potential exploitation.

## Causes of exploitation

### Poverty and caste system

Poverty and India’s caste system are the main causes of child exploitation in India. The World Bank estimates that almost 30 per cent of Indians live below the international poverty line of less than US\$1.25 per day. Indians most likely to be forced into slavery are those from the ‘lower’ castes (Dalits), and the indigenous communities (Adivasis), especially women and children.

## SPOTLIGHT

### Debt bondage (or bonded labour)

Debt bondage is a person’s pledge of their labour or services (or that of their children) as repayment for a loan or other debt. The labour or service required to repay the debt may not be specified, and the duration of the bond may be undefined. Debt bondage can be passed on from generation to generation. Debt bondage was legally abolished in India in 1976, but remains widespread in practice.

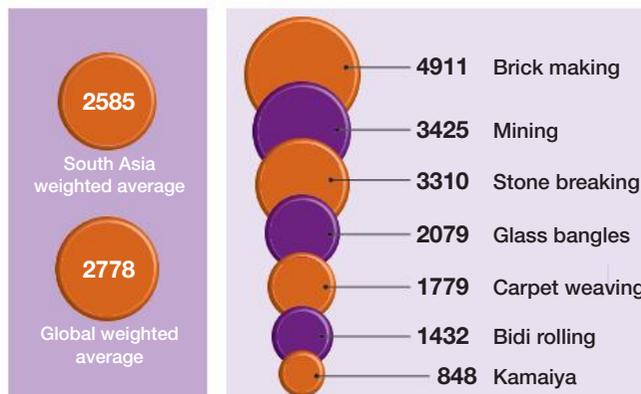
It is estimated that there are 18 to 20.5 million bonded labourers in the world. The majority live in four countries: Bangladesh, Nepal, Pakistan and India. Proposals to abolish bonded labour include:

- enforcing existing anti-forced-labour laws
- raising minimum wages
- enacting reforms that enable low-caste peasants to own land
- expanding financial credit to the poor
- opening new markets to labourers
- mounting public awareness campaigns.

## Labour laws

It is difficult to collect data about the informal economy in India. Figure 8.24 outlines the estimated value of worker exploitation in South Asia, mainly India.

8.24 Estimated value of exploitation by industry in South Asia, 2011, US\$



India has rigid labour laws and numerous regulations that prevent the growth of an organised sector in which work protections would be easier to monitor, and work more productive and higher paying. The unintended effect of Indian complex labour laws has been the growth of the informal sector. After the agricultural sector, which employs 60 per cent of child labour, the informal manufacturing and retail sectors are the largest employers of child labour. The dominance of family-operated enterprises in the informal sector also encourages the exploitation of child labour.



8.25 Children who were rescued from working as bonded labour stage a protest against slavery in New Delhi, India.

## Addressing exploitation

While India has ratified a number of key international conventions relevant to child exploitation, enforcement has been inconsistent. Bonded labour has been criminalised in India, under the Bonded Labour System (Abolition) Act since 1976, but enforcement has been weak. Amendments to the Penal Code in April 2013 criminalised all forms of human trafficking in accordance with the definition in the UN Trafficking Protocol. The amended Penal Code is broad enough to include most forms of forced labour, bonded labour and forced marriage. It remains to be seen whether the Penal Code will be used in this way.

Other recent actions give some hope that exploitation can be addressed. In October 2012, the Supreme Court issued a judgment requiring all states to carry out surveys to identify and release those in bonded labour. Other important Supreme Court interventions include mandating rural and urban local bodies to report cases of bonded labour to the District Magistrates, who are able to implement laws

protecting the rights of the exploited. The enactment of the Protection of Children from Sexual Offences Act in 2012 and the recent increase in activity of the National Commission for the Protection of Children's Rights are important measures that demonstrate the government's renewed commitment to fight the exploitation of children. There has also been a focus on brothel raids and the rescue of victims.

NGOs have also been active in supporting the exploited, and have campaigned for more effective government intervention (see Figure 8.25). Unfortunately, there have been reports of human rights defenders being targeted for their anti-slavery work. Attacks on activists, as well as victims, commonly occur when workers are assisted to leave the workplace at which they have been enslaved. NGOs also complain about the complicity or interference of government officials keen to avoid upsetting powerful slaveholders and traffickers. Some accept bribes to turn a blind eye to exploitation. The justice system is very slow generally, so victims have no confidence in its capacity to deliver a result. Penalties are small, especially compared with the profits being made.

## SPOTLIGHT

### Bonded child labourers, India

Ferozabad is the centre of the glass industry in India. Estimates of the number of children working in glass factories range from 8000 to 50000—exact numbers are difficult to obtain. Anti-Slavery International estimates that 70 to 80 per cent of the children working in glass factories are bonded by debt incurred by their parents, usually on advances of loans. Most of the children belong to the landless agricultural sector, and are expected to continue working until their parents' loans are paid off. The children, some as young as 8 years old, have to live at the factories and look after themselves.

Conditions in the factories are horrendous and workers do not wear protective work gear—no gloves, shoes or eyewear. The heat from the furnace can reach temperatures of 1400 to 1600 degrees Celsius and there is little ventilation. Injuries are commonplace, with cuts from broken glass and burns from the furnaces and molten glass. Long-term health is also affected; soot and dust cause respiratory diseases such as asthma and bronchitis, and eye problems.

8.26 Children working in a glass factory



## ACTIVITIES

### Knowledge and understanding

- 1 List the types of child exploitation found in India.
- 2 Identify the areas of employment in which illegally trafficked people are found working.
- 3 Outline the difficulties that internally trafficked and locally enslaved people experience.
- 4 Explain the term 'debt bondage'.
- 5 Outline the recent developments in the distribution of sexual exploitation.
- 6 Explain why forced marriage is a major problem.
- 7 Outline the causes of exploitation. Why is the growth of the informal sector especially significant?
- 8 Outline the actions being taken to address the exploitation. What impediments are there?

### Applying and analysing

- 9 Discuss the following statement: 'For many people living in developing countries putting their children to work is a necessity and should not be viewed as exploitation'.
- 10 Develop a poster campaign highlighting the evils of child exploitation.

### Investigating

- 11 Investigate one NGO working to end child exploitation in India. Present your findings as an illustrated report.

# 8.9

## Access to shelter

Shelter is one of humanity's most basic needs, but due to poverty many people are forced to live in unacceptable conditions. The problem is worst in the world's developing countries where large cities, often referred to as megacities, are growing at a rapid rate, largely as a result of urbanisation.

### Urbanisation

For the millions of poor in developing countries, the move to urban areas has always been seen as a means of improving their standard of living; that is, getting better jobs and earning higher incomes. This motivation, when combined with their experience of deteriorating conditions in rural areas, has generated a flow of migrants to cities, particularly in the last three decades.

### Big shift

Throughout the developing world, the numbers of people moving from rural areas into large cities have overwhelmed authorities. They have found it impossible to meet the demand for housing and even the most basic urban infrastructure, such as water and power supplies, sanitation and public transport, not to mention medical services and schools. Many people moving to these urban areas are poor and unable to find accommodation. They are forced to find shelter in **squatter settlements** or slums. Squatter settlements are informal, often illegal, settlements, built by poor people using material scavenged from the streets. A slum is a rundown established neighbourhood in which most people live in a state of poverty.

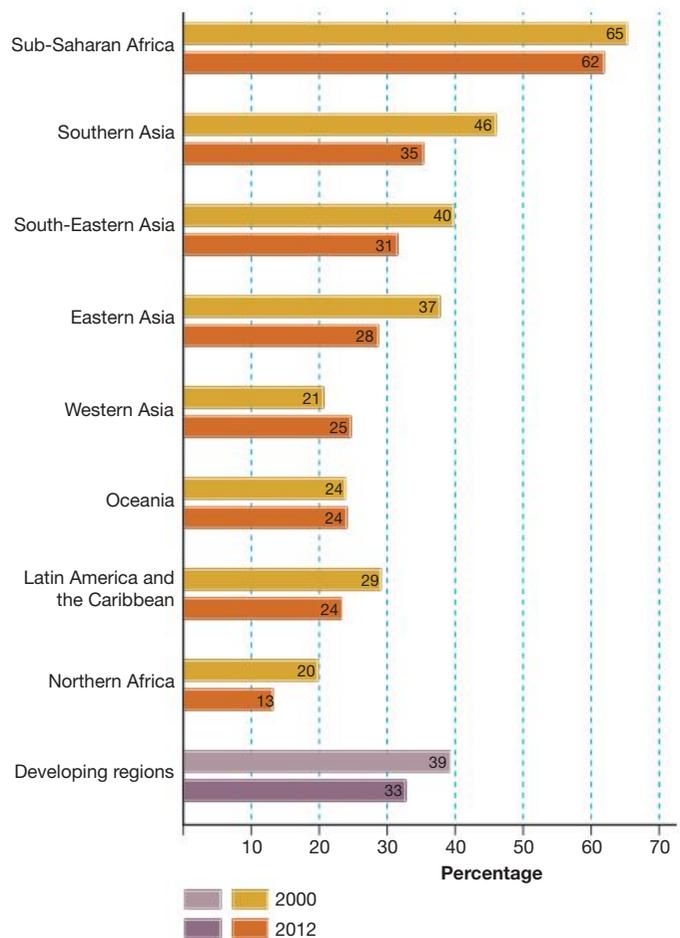
Worldwide, approximately one-third of the developing world's urban population, or about 940 million people, live in squatter settlements and slums. As is shown in Figure 8.27, the proportion of the urban population living in slums is greatest in Sub-Saharan Africa. Western Asia is the only region in which the proportion of the population living in slums has increased since 2000.

### Squatter settlements

With few resources or skills, many of the new arrivals are unable to find space in the slums of the megacities. Their only option is to build their own simple housing on vacant land, using materials scavenged from the streets. Because of their 'non-legal' status, squatter settlements have few services and little infrastructure.

The plight of these people is often ignored by government agencies, many of which view the 'invasion' of urban areas by 'the masses' and the development of squatter settlements as a social evil to be eliminated. Bulldozing of these settlements is common.

8.27 Proportion of urban population living in slums, 2000 and 2012



Source: United Nations, Millennium Development Goals, 2012

## Slums

Slums are areas of congested, substandard housing characterised by poverty, squalor, and urban and social decay. They differ from squatter settlements only in terms of land tenure. Typically, slum owners have title to the land on which the slums are located.

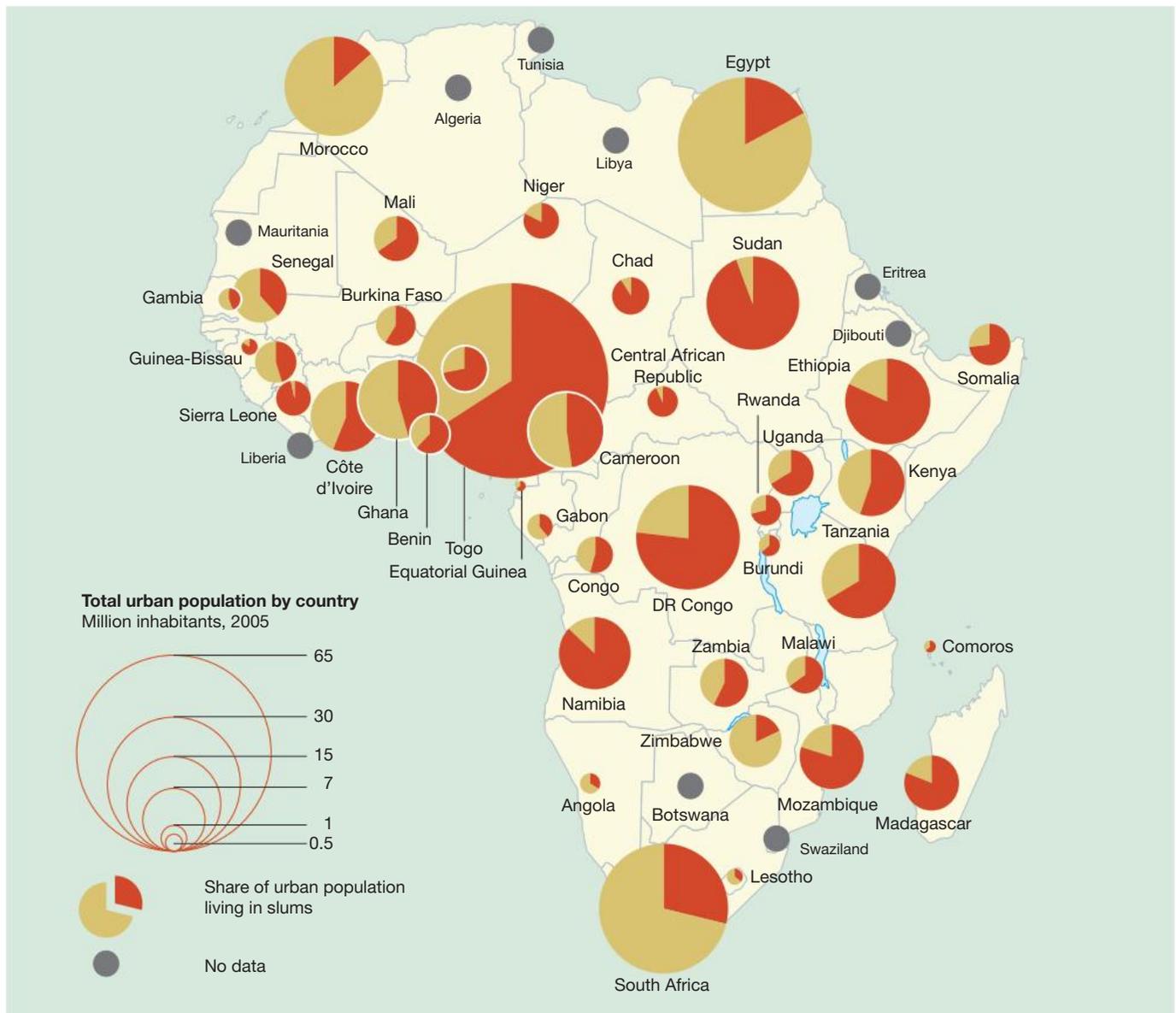
Slums develop for a variety of reasons. These include rapid rural-to-urban migration, economic stagnation and depression, high unemployment, poverty, poor planning, politics, natural disasters and social conflict. Generally, however, the poor concentrate in those areas of the city where rents are lowest, resulting in spatial concentrations of the poor and marginalised.

**8.28** Africa's slum populations. Note that this map does not include separate data for Sudan and South Sudan, as the data was generated before partition.

## Africa's rapidly growing cities

Africa has joined India and China as the third region of the world to reach a population of 1 billion people—a number that is expected to double by 2050. By then, there will be three times as many people living in Africa's cities. The continent that had fewer than 500 000 urban dwellers in 1950 may have 1.3 billion, or 60 per cent of its population, one hundred years later.

Cairo is now Africa's largest urban area, with 11 million people, but by 2015 it will have been overtaken by Lagos, with around 12.4 million inhabitants. By 2020, Kinshasa is expected to be the continent's second-largest city. Many of the new dwellers will crowd into slums. Others will simply build their own rough shelters on any unoccupied land (see Figure 8.28).



Source: UNDESA, *The World Urbanisation Prospects, The 2009 Revision*, 2010.

## SPOTLIGHT

8.29 Kibera slums

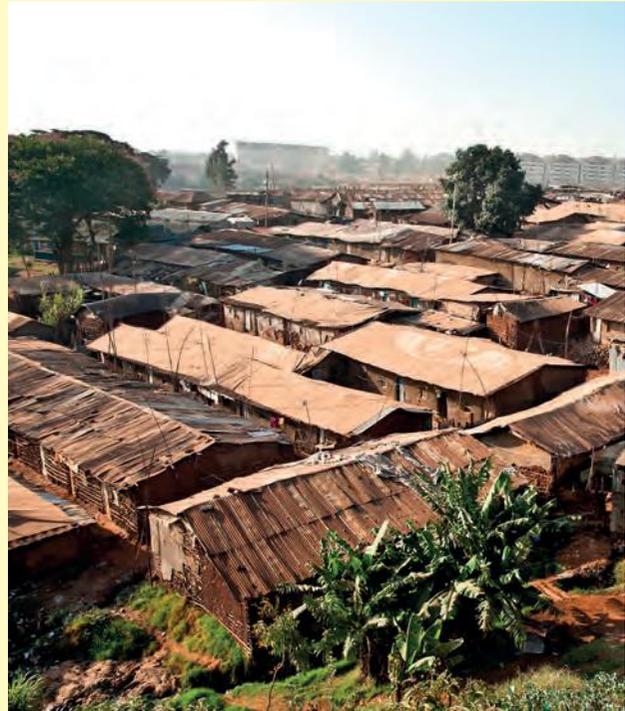
### Mapping slums

Kibera and Mathare are the oldest and largest slums in Nairobi, Kenya. They comprise thirteen villages and are home to nearly 200 000 people. In 2012, a group of activist cartographers and local community members got together to map the area, using handheld Global Positioning System (GPS) devices. The slum has no addresses or street names, no open or communal spaces, and the sewers are open. The group mapped the location of buildings and narrow lanes, but they also mapped informal schools, storefront churches, daycare centres, dark corners with no streetlights, illegal dumping grounds and broken manholes. With the aid of the map, the community was able to lobby local authorities to install street lights in the more dangerous areas.

The slum mapping movement began in India and has spread around the world. Maps enable slum communities to:

- bring the most urgent problems to the attention of the authorities
- be presented as evidence when dealing with authorities
- record their habitation of an area
- show that a slum is not an empty space and is inhabited.

NGOs can also use the maps to raise awareness of the needs of communities.



8.30 The Mathare Valley, shown here in an aerial map. Residents are using handheld GPS devices to map the area.



## Addressing the problem

A range of strategies is used to address the issue of squatter settlements and the development of slums. These include a combination of slum removal, slum improvement initiatives, urban infrastructure upgrades and public housing construction.

In the case of squatter settlements, the most effective approaches involve giving people legal title to the land on which they have built their simple shelters. With the security this provides, people are more willing to invest whatever money they might have in improving their housing. Authorities can also improve the health and wellbeing of the squatters by providing basic infrastructure: clean water, communal sanitation facilities, electricity, schools and health clinics. NGOs play an important role in addressing the needs of these communities.

## Homelessness

Homelessness, which exists in more, less and least developed countries, is an example of the inequalities in human wellbeing that exist within and between

countries. Without access to shelter, the homeless are forced to 'sleep rough' on pavements, in parks and under bridges and freeway overpasses. There are many causes of homelessness. Some of the most common are poverty, lack of affordable housing, mental illness, substance abuse, domestic violence, natural disasters, evictions and foreclosures. Worldwide, there are an estimated 100 million homeless people.

In Australia, one in every 200 people is homeless; that is, without safe, secure or affordable housing. In 2008, 105 000 Australians experienced homelessness. Fifty-six per cent were males, 44 per cent females. Twenty-five per cent were Aboriginal and Torres Strait Islander people. Twenty-three per cent of Australian's homeless were children and one in four people was under 18 years of age. Fourteen per cent were over the age of 55 years.

Of those who are homeless, 44 per cent are staying temporarily with relatives and friends, 20 per cent are living in boarding houses, 18 per cent are sleeping rough on the streets and 18 per cent are staying in accommodation provided by the homeless support system.

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the impacts of lack of shelter on the wellbeing of people.
- 2 Explain the process of urbanisation. Why does it lead to the growth of slum and squatter settlements?
- 3 Explain the difference between a slum and a squatter settlement.
- 4 Outline the response of authorities to the growth of squatter settlements.

### Applying and analysing

- 5 Study Figure 8.29. As a class, brainstorm the conditions and problems facing people living in such conditions.
- 6 As a class, discuss why giving people legal title to the land on which they have built their homes often results in the improvement of their quality of life.
- 7 Drawing on your discussion in Activity 6, write an account of what it would be like to spend a week in a squatter settlement.

### Geographical skills

- 8 Study Figure 8.27. Identify the region that experienced the greatest reduction in the proportion of its urban population living in slums between 2000 and 2012. In which region did the proportion of the population living in slums increase?

- 9 Study Figure 8.28. Which country has the largest urban population? Which country has the highest proportion of its urban population living in slums? Estimate the size of South Africa's urban population.

### Investigating

- 10 Access the Habitat for Humanity website. Outline the role of the NGO and give at least one example of how it seeks to improve the conditions in which people are forced to live in developing countries.
- 11 Use the internet to investigate the issue of access to shelter in a megacity. Present your findings to the class in a multimedia presentation. Include in your presentation the following:
  - map of the slum area
  - population statistics: past, current and future of the city and slum
  - information about where slum-dwellers come from
  - reasons for people's move to the city and identify the reason as a SHEEP (social, historical, economic, environmental or political) factor
  - discussion of the major issues in the slum.Select one of the major issues facing the slum-dwellers and investigate efforts to improve this issue.

## Case study: India's squatter settlements and slums

In Kolkata, over a small open fire on a noisy traffic island, a woman cooks the evening meal for her family. They are surrounded by piles of uncollected garbage and fumes from the constant traffic. Like other homeless people in the city, the family survives on the chicken skins discarded by a butcher and vegetables dropped from carts at a nearby market.



### India's urban poor

Despite the economic gains and poverty reduction achieved in recent years, India still has 260 million people living below the poverty line. This makes the country home to 22 per cent of the world's poor. While most of these people live in rural areas, increasing numbers are to be found in the country's large cities. About one in six of India's city dwellers are homeless, or crowd into the city's squatter settlements, or live in urban slums.

India's low-income urban housing settlements fall into two categories: officially recognised settlements located within the city, called *bastis*; and unrecognised settlements located in marginal land (squatter settlements). The *bastis* are spread throughout the city, often occupying valuable

8.31 The squalid living conditions of an Indian squatter settlement

land. People who are too poor to rent or buy homes in the *bastis* usually find shelter in the squatter settlements. These typically occupy vacant private land or unused public spaces—land adjacent to railway lines, canals and highways, and under bridges.

### Living conditions

The living conditions in India's slums and squatter settlements are, by Western standards, often squalid (see Figure 8.31). In squatter settlements, the constant fear of demolition discourages people from upgrading their simple dwellings. Squatter settlements are overcrowded and lack basic utilities, such as water, electricity and sanitation.

## Indian census

In 2011, Indian authorities completed the first census of India's vast slum population. A slum was defined as a residential area in which the dwellings were unfit for human habitation by reasons of dilapidation, overcrowding and lack of ventilation, light or sanitation.

The census revealed that 13.8 million households or about 64 million people lived in urban slums and squatter settlements nationwide—that is 17.4 per cent of all urban households. More than one-third of slum homes surveyed had no indoor toilets and 64 per cent were not connected to a sewerage system. About half of the households lived in only one room or shared with another family.

Despite this hardship, 70 per cent had televisions and 64 per cent had mobile phones. Most overcame the lack of government infrastructure by rigging up elaborate, mostly illegal, connections to the electricity grid.

## Indian urbanisation

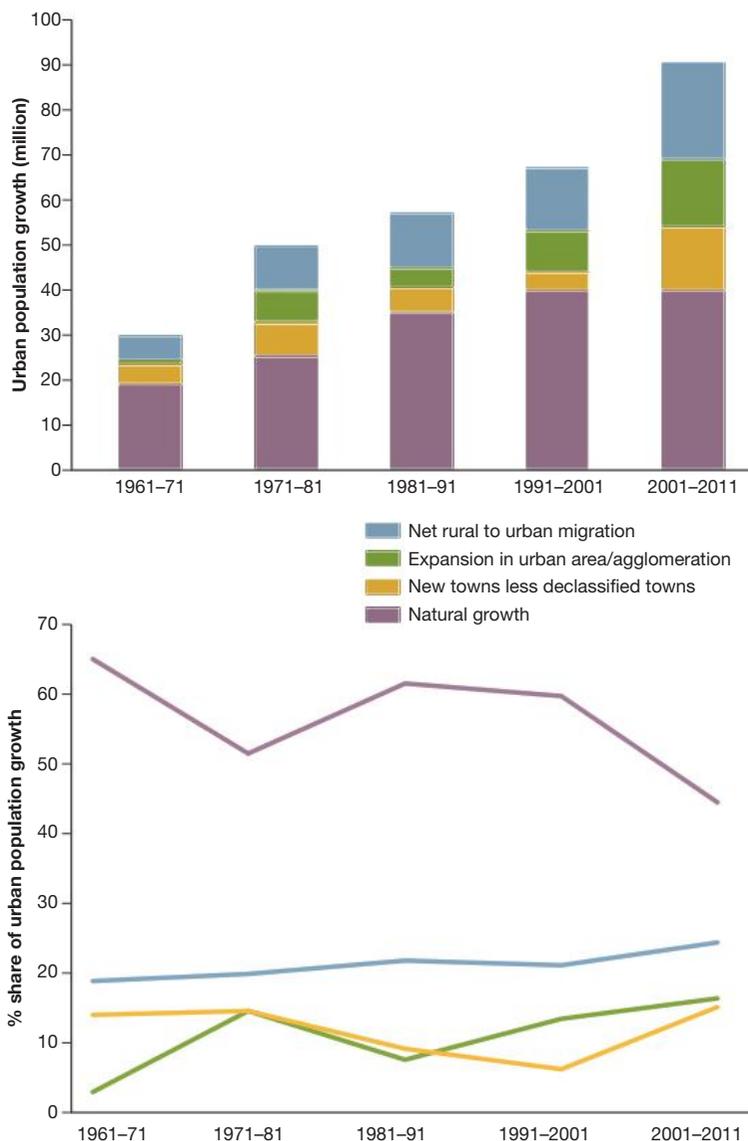
India's urbanisation levels are relatively low by developing world standards (see Figure 8.32). The bulk of urban migration is projected to take place over the next 20 to 25 years, resulting in an additional 300 million urban dwellers. Many of these new arrivals will crowd into the large urban slum districts and squatter settlements.

While only about a quarter of India's population is urban, this fraction represents 309 million people. At least twenty-three Indian cities have more than a million residents. The largest of these is Mumbai (12.4 million) followed by Delhi (11 million), Bangalore (8.4 million) and Hyderabad (6.8 million).

## Kolkata

The city of Kolkata (Calcutta) has a population of over 4 million people. Adding the population of the metropolitan area takes the total to over 14 million people. About 4 million people live in Kolkata's slums, and another 1 million live in illegal squatter settlements. Just 20 000 units are added to the city's housing stock each year, a number well short of the 50 000 units needed.

Most of Kolkata's *bastis* have fallen into a state of **urban decay** since the 1980s, principally because municipal governments lack the funds needed to maintain basic services. *Bastis* frequently have inadequate access to water, sanitation, sewerage, drainage and waste disposal. They are also overcrowded and crime is a growing problem. While the *bastis* offer legally recognised tenure, which provides stability to residents, tenure also increases the price of housing. This excludes many of the urban poor.



Source: IIHS analysis, based on Census of India, 2011

8.32 Components of urban population, 1961–2011

Those too poor to live in the *bastis* find shelter in the squatter settlements that occupy vacant public and private land outside the city centre. Occupants of such settlements are denied land tenure rights and receive no services. The threat of eviction is ever present.

The Indian Government has initiated several programs to improve housing conditions for the poor. The most significant of these—the Jawaharlal Nehru National Urban Renewal Mission—aims to improve basic services and secure tenure in poor urban neighbourhoods. Another initiative—the National Slum Development Program—uses a combination of physical infrastructure and social services to upgrade slums, provide clean water, upgrade drainage and sewers and construct community bathrooms and shared toilets.

Other initiatives include simplifying legal processes, conferring land title or tenure status on squatters, and increasing access to housing finance for low-income people.



8.33 Oblique aerial photograph of Dharavi. The density of housing is clearly evident in this image.

## Dharavi

Dharavi, in Mumbai, is one of the world's largest slums (see Figure 8.33). It was established in the 1880s, during the British colonial era, to house the rural poor migrating to the city and the workers of polluting factories relocated from the peninsula on which Mumbai (then called Bombay) was located.

Today, Dharavi is a multi-religious, multi-ethnic district with over 1 million people packed into just 217 hectares. About 60 per cent of the population is mainly Hindu, while 30 per cent is Muslim. The rest are mainly Christian or Buddhist. Among the Hindus, about 20 per cent are Dalits—members of the lowest caste—who work in animal skin production, tanneries and leather goods factories.

Over the years, the slum-dwellers of the district have suffered from numerous epidemics, including typhoid, cholera, leprosy and polio, and other disasters. Often the spread of these diseases is linked to poor sanitation. Authorities estimate that there is just one toilet for every 1440 residents. As a result, residents use local waterways as toilets. This leads to the spread of contagious diseases.

Like many other slum districts and squatter settlements, Dharavi has an active informal economy in which numerous household-based enterprises employ many of the slum residents. The annual turnover of business is estimated to be more than US\$650 million a year. Industries include leather tanning, textile production and pottery.

Few of those living in Dharavi own the land on which they live. Seventy per cent belongs to the government, which is unwilling to give the slum-dwellers the land free. Instead, they are treated as squatters.



8.34 Artist's impression of a redeveloped Dharavi

## SPOTLIGHT

### Slumdog Millionaire

The 2008 British film *Slumdog Millionaire* won eight Oscars, including Best Picture and Best Director, at the 2009 Academy Awards.

In the film, a Mumbai teenager, who grew up in the city's slums, becomes a contestant on the Indian version of 'Who Wants To Be A Millionaire?' He is arrested on suspicion of cheating, and while he is being interrogated, scenes from his life in the slums of Mumbai are played, to explain why he knows the answers to the questions asked.

Despite the film's success, there was controversy over the way it portrayed Indians. Some people argued that the film promoted Western stereotypes about poverty in India. Others alleged that the slum-dwellers were depicted in ways that violated their human rights. Social activists in Mumbai protested that the film exploited the poor for the purposes of profit, and that its title was offensive and demeaning, and insulted their dignity.

The child actors featured in the film continue to live in makeshift shacks in the slums of Bandra, a suburb of Mumbai.



8.35 *Slumdog Millionaire* movie poster

## Redevelopment

The Maharashtra state government has plans to redevelop Dharavi and transform it into a modern township, complete with proper housing and shopping complexes, hospitals and schools (see Figure 8.34). It is estimated that the project will cost US\$2.1 billion. There has been significant local opposition to the plans, largely because existing residents are due to receive only a small allocation of land (about 25 square metres each). Also, only those who lived in the area before the year 2000 are to be resettled.

The city of Mumbai has embarked on an ambitious program to house the city's poor. With the financial support of the World Bank, authorities have built 60 000 low-cost housing units for slum-dwellers. They have also invested US\$8 billion in the construction of new roads and a metro rail system. The task, however, is enormous. The city needs to build 1 000 000 new housing units if it is to adequately house the city's poorest residents.

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the scale of the housing crisis in India.
- 2 Differentiate between *bastis* and 'squatter settlements'.
- 3 Describe the living conditions of the slums and squatter settlements.
- 4 Define the term 'slum' in your own words.
- 5 Outline the nature and extent of the shelter crisis in Kolkata. What has been the government's response?
- 6 Outline the role that Dharavi plays in the economic life of Mumbai.

### Applying and analysing

- 7 View selected scenes from the film *Slumdog Millionaire*. Write a paragraph or two expressing your reaction to the living conditions in Mumbai's slums. Share your reaction with others in the class.

- 8 Study Figures 8.33 to 8.34. Describe the nature of the community depicted and what it might be like after the area is redeveloped. Do you think that those currently living in Dharavi will benefit from such a proposal?

### Geographical skills

- 9 Study Figure 8.32 then answer the following questions.
  - a What was the largest contributor to urban growth in the period 1961–71?
  - b What contribution did net rural to urban migration make to urban population growth in 2001–11?

### Investigating

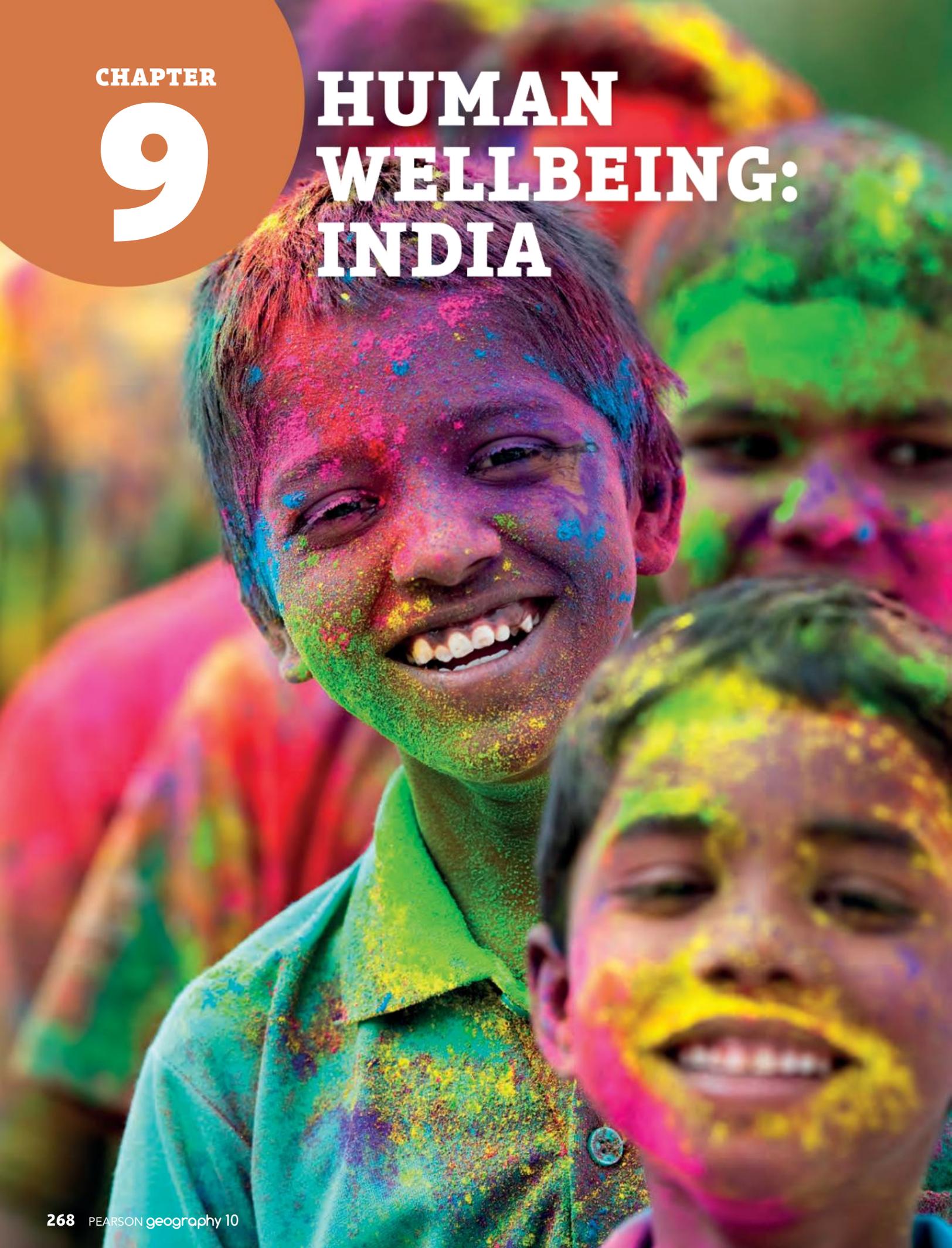
- 10 Using the internet, locate descriptions of the lived experience of people who live in India's *bastis* or squatter settlements. Share your stories with others in your class. What do these depictions have in common?

8.4

CHAPTER

# 9

# HUMAN WELLBEING: INDIA



**I**ndia is a land of great contrasts. Spread across its 3.3 million square kilometres is a range of biophysical environments. These include deserts (in the west), high mountain ranges (to the north), golden beaches (in the south) and dense rainforests (in the north-east).

The country is also culturally diverse. In the north, people are predominantly fair-skinned Indo-Aryan. In the south and along the east coast, the population is mainly Dravidian, who are people of darker complexion. There are twenty-two constitutionally recognised languages in two major linguistic families: the Indo-Aryan languages in the north and the Dravidian languages in the south. When local dialects are taken into account, the number of languages exceeds 1600.

The most striking aspect of this diversity is the socio-economic variations that occur across the country. While India is an emerging economic and political power with an expanding middle class, it remains burdened by high levels of poverty. India's economic growth and development tend to be skewed towards the southern, western and north-western states, while the north-central, central and eastern states have experienced deteriorating levels of human wellbeing. The reasons for these spatial variations are complex. They are deeply rooted in the country's past and affected by complex social, political and economic factors.

In this chapter we focus on the spatial patterns of human wellbeing in India, the factors contributing to these patterns and the strategies being pursued to reduce the variations in the quality of life experienced by people.

## KEY IDEAS

- To understand the pattern of human wellbeing in India
- To recognise the main challenges facing India and the factors that contribute to these challenges
- To investigate how NGOs, transnational bodies and governments seek to enhance the wellbeing of India's poor

9.0

Boys painted up to celebrate Holi festival, an ancient Hindu religious festival also known as the festival of colours or the festival of love, India, 2010

## GLOSSARY

<b>capitalism</b>	an economic system in which the means of production, distribution and exchange are controlled largely by private individuals or corporations rather than the state
<b>communal violence</b>	violence as a result of tensions between different ethnic groups
<b>feudalism</b>	a social/political system under which an elite owns land while peasants farm it, often in exchange for protection and a share of the crops and/or livestock produced
<b>free market</b>	an economic system in which prices are determined by unrestricted competition between privately owned businesses
<b>import substitution</b>	an economic policy that involves replacing foreign imports with domestic production
<b>intergovernmental body</b>	an organisation whose members represent sovereign states (member states) or intergovernmental organisations
<b>mixed economy</b>	an economic system in which both the private sector and the state play a role in the economy, reflecting characteristics of both market-based economies (capitalism) and planned economies
<b>monsoon</b>	a seasonal wind in the South and South-East Asia region, which blows from the south-west between May and September, bringing rain (the wet monsoon), and from the north-east between October and April (the dry monsoon)
<b>misogyny</b>	hatred or dislike of women
<b>patriarchal attitude</b>	the belief that society and government should be controlled by men
<b>protectionism</b>	a policy that shields a country's domestic-based industries from foreign competition by taxing imports
<b>purchasing power parity (PPP)</b>	a technique used to determine the relative values of different currencies
<b>real GDP</b>	the value of economic output adjusted for price changes such as inflation (increases in prices) or deflation (decrease in prices)
<b>socialism</b>	the political and economic theory of social organisation that holds that the means of production, distribution and exchange should be owned or regulated by the community as a whole
<b>socio-economic</b>	relating to or concerned with the interaction of social and economic factors

# 9.1

## India: An emerging economic giant

India is an emerging economic giant with a rapidly growing middle class. By some estimates, India's GDP will grow from US\$8.17 trillion in 2013 to be the world's third-largest in 2030, with a GDP close to US\$6.1 trillion. Only the economies of China and the United States of America will be larger. Extending the benefits of this economic growth to India's poor is the key to raising the human wellbeing in the country.

### Changing approaches to economic development

In the period from independence (1947) to 1991, India embraced a **mixed economy** model of economic development that combined features of both **capitalism** and **socialism**. State-owned enterprises, **protectionism** and **import substitution** were features of the country's development policy and practice. In 1991, India embraced a more liberal, **free-market** model of economic development, with the government investing heavily in the infrastructure needed to promote economic growth. Economic growth rates increased, as did per capita income.

### Economic growth rates

India's annual GDP growth rate peaked in 2010 at 10.5 per cent before declining sharply to 6.3 per cent in 2011, 3.2 per cent in 2012 and 4.4 in 2013, as shown in Figure 9.1.

9.1 Growth in India's GDP rate, annual percentage change, 1980–2013

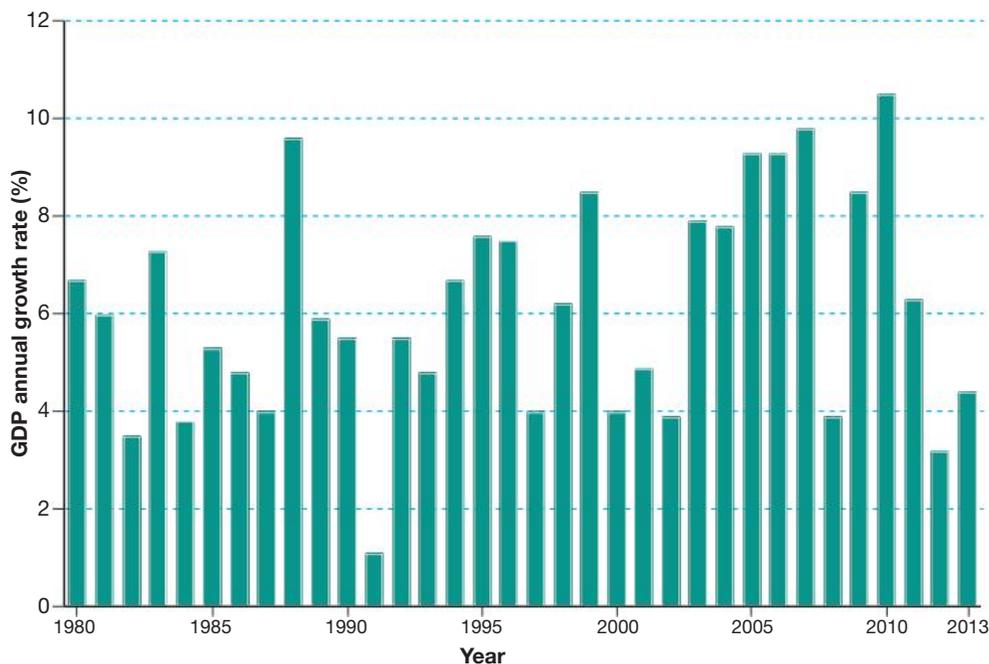
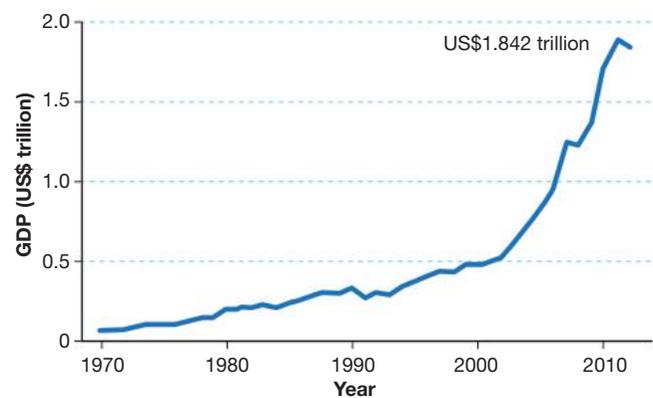
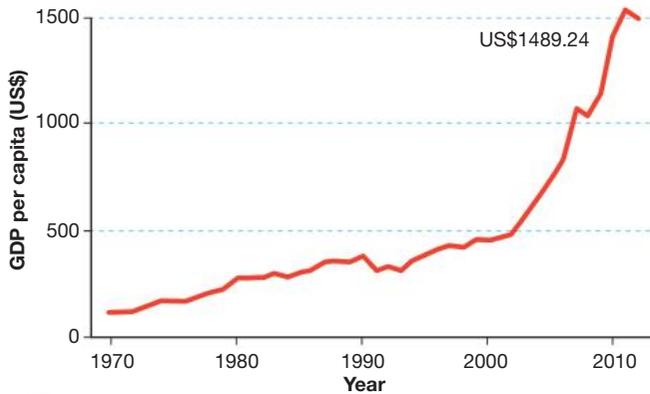


Figure 9.2 outlines India's GDP annual growth in US dollars since 1970. GDP per capita grew from US\$114.40 in 1970 to US\$455.44 in 2000 and US\$1489.24 in 2012, as shown in Figure 9.3. India's engagement in international trade has also increased. In 2011–12, foreign trade grew by 30.6 per cent.

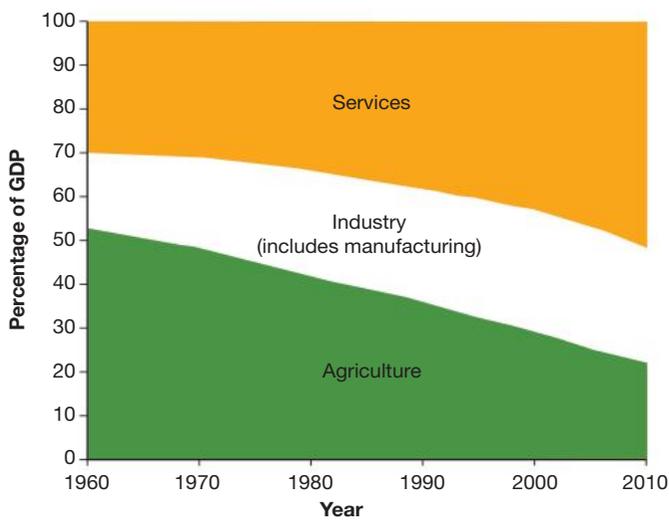
9.2 India's growth in GDP in US dollars, 1970–2012



9.3 India's growth in GDP per capita, 1970–2012



9.4 Sectoral composition of GDP in India, 1960–2010



Today, India's economy is the world's tenth-largest. Ranked on a GDP per capita basis, however, it is 141st. With a population growth rate of 1.58 per cent (well above the global rate of 1.14 per cent), improving GDP per capita is a significant challenge. Unemployment is relatively high at 9.8 per cent (2010–11), and India's central government debt stands at 48.4 per cent of GDP, which is the highest among emerging economies such as China, Brazil and Russia.

## Changing composition of economic activity

Figure 9.4 outlines the major structural changes in the Indian economy, especially in terms of the contribution made by the different sectors of economic activity to the country's GDP. Agriculture has declined as a share of economic activity, while industry and services have grown. The greatest growth has been in the provision of services, which now account for 50 per cent of all economic activity.

There have also been changes in the types of economic activity undertaken in India. Figure 9.5 shows a traditional craft-based manufacturing industry.

9.5 Traditional, craft-based manufacturing at a Stanford Cricket Industries factory in Meerut, Uttar Pradesh



## SPOTLIGHT

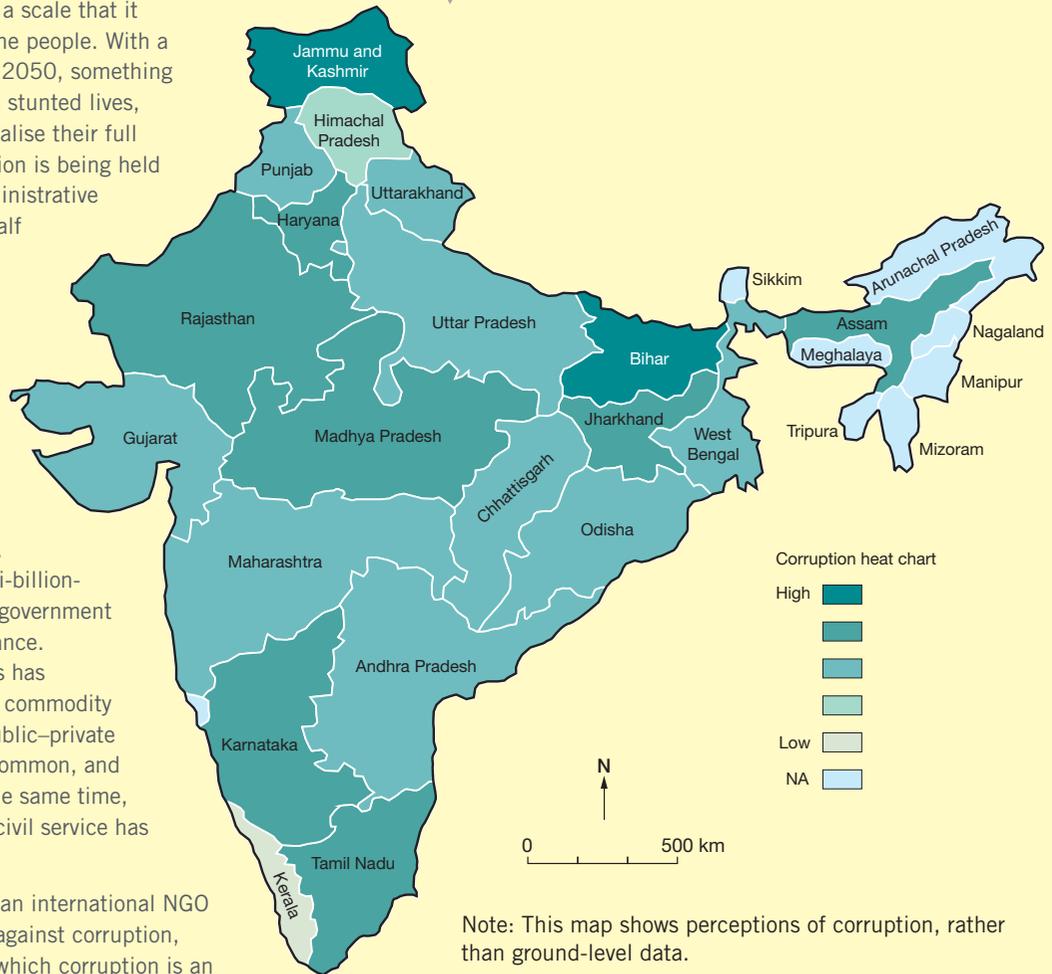
### Corruption undermines Indian progress

Corruption in the soon-to-be world's most populous country is so ingrained and on such a scale that it threatens the wellbeing of the people. With a population of 1.7 billion by 2050, something like a billion people will live stunted lives, denied the opportunity to realise their full potential, because their nation is being held back by corruption and administrative incompetence. More than half of all Indians (54 per cent) admitted to paying a bribe to an official in 2013, a higher proportion than in Nigeria (44 per cent) or Indonesia (36 per cent).

India's entry into the global economy has created unprecedented opportunities for dishonesty. Property has become a multi-billion-dollar business overseen by government officials who are paid a pittance. The value of mining licences has increased rapidly along with commodity prices. Privatisations and public-private partnerships have become common, and prone to manipulation. At the same time, the effectiveness of India's civil service has declined sharply.

Transparency International, an international NGO involved in the global fight against corruption, ranks India as a country in which corruption is an issue. India and Australia are compared in Table 9.6. Figure 9.7 shows the spatial pattern of perceptions of corruption in India.

9.7 India: Spatial pattern of corruption



Note: This map shows perceptions of corruption, rather than ground-level data.

Source: Transparency International

9.6 Corruption in India and Australia, selected measures

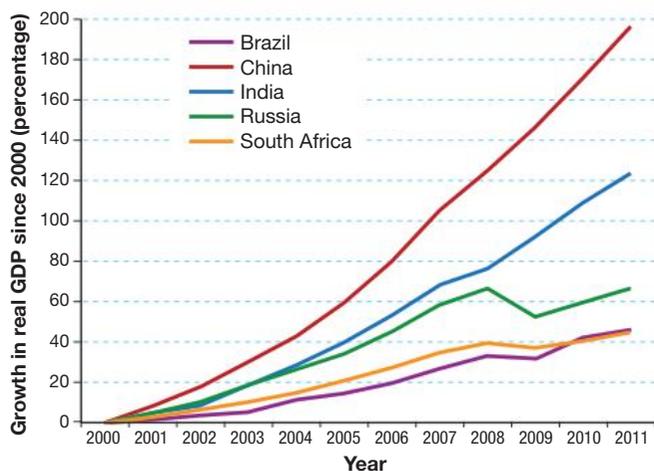
Measurement	Explanation	India	Australia
Corruption perceptions index	Ranks countries/territories based on how corrupt a country's public sector is perceived to be. Ranks range from 1 (very clean) to 177 (highly corrupt).	94	9
Bribe payers index	Ranks 28 of the world's wealthiest and most economically influential countries according to the likelihood of their firms to bribe abroad. Ranks range from 1 (very clean) to 28.	19	8
Control of corruption	Control of corruption reflects perceptions of the extent to which public power is exercised for private gain. Point estimates range from about -2.5 to 2.5. Higher values correspond to better governance outcomes.	-0.516	2.061

Source: Transparency International

## International comparisons

As shown in Figure 9.8, India's economy (as measured by **real GDP**) has been expanding at a faster rate than other emerging economies since the early 2000s, with the exception of China.

9.8 Growth in India's real GDP compared with that of China, Brazil, Russia and South Africa, 2000–11



Source: UN

## Qualitative indicators

Qualitative indicators reveal India's development challenge.

- Life expectancy is 65.8 years.
- Mean years of schooling is 4.4 years.
- Gender Inequality Index score is 0.61.
- Human Development Index (HDI) ranking is 136 (score 0.554).
- Inequality-adjusted Human Development Index (IHDI) value is 0.393.

The extent to which the IHDI falls below the HDI is an indicator of the inequality still evident in Indian society. Other indicators also highlight the challenge India faces. For example, a 2011 survey conducted by India's Central Pollution Control Board showed that just 160 out of nearly 8000 towns had sewerage systems and sewage treatment plants. Over 600 million Indians lack even primitive toilet facilities.

## Persistent inequalities

While some progress has been made in reducing poverty in India, significant inequalities still exist.

- According to the World Bank, India's poverty rate declined from 37.2 per cent of the population in 2005 to 29.8 per cent in 2010.
- If the percentage of the population living on US\$1.25 a day (**purchasing power parity—PPP**) is used as a poverty line, the decline has been from 41.6 to 32.7 per cent.

- If the percentage of the population living on US\$5.00 per day (PPP) is used, the reduction in poverty is a marginal decline from 97.3 per cent in 2005 to 96.3 per cent in 2010.
- In absolute terms, 394 million Indians lived in poverty in 2010, down from 469.3 million in 2005.
- The richest 20 per cent of Indians account for 52.81 per cent of income, while the poorest 20 per cent make do with just 8.54 per cent.
- In rural India, about 34 per cent of people live on less than US\$1.25 a day, down from 44 per cent in 2005.
- In urban India, 29 per cent of the population lived on less than US\$1.25 in 2010, down from 36 per cent in 2005, according to the World Bank.
- On a state-by-state basis, GDP per capita ranges from 192 652 rupees in the state of Goa and 175 812 in Delhi to just 24 681 in Bihar.

## ACTIVITIES

9.1

### Knowledge and understanding

- 1 Outline the changes in the approach to economic development in India post-independence.
- 2 Outline the evidence that India has a relatively high level of inequality.
- 3 Outline the extent of corruption in India and describe the impacts of corruption.

### Geographical skills

- 4 Study Figure 9.1. In which year did the annual rate of GDP peak? Describe the trend since 2005.
- 5 Study Figure 9.2. Using data from the graph, describe the trends apparent in India's GDP since 1980.
- 6 Study Figure 9.3. Estimate India's per capita GDP in 1980, 1990, 2000 and 2010. Describe the changes that took place in the rate of growth over this 30-year period.
- 7 Study Figure 9.4. Using data from the graph, describe the changes in the relative contribution of each sector of economic activity to India's GDP in the period 1960–2010.
- 8 Study Figure 9.8. Compare India's GDP growth with that of other emerging economies.
- 9 Study Figure 9.7. Identify the states in which corruption is a major issue.

### Investigating

- 10 Using the internet, find the most recent Indian GDP and GDP per capita data available. Update Figures 9.1, 9.2 and 9.3. Investigate the reasons for the trends identified.

# 9.2

## India: Patterns of human wellbeing

There are great variations in the wellbeing experienced by people across India. These differences have both spatial and social dimensions. In other words, how Indians live depends, to a large extent, on where they live and their social circumstances.

### Spatial variations in human wellbeing

Economic growth and development has been most rapid in India's southern, western and north-western states, while the north-central, central and eastern states have experienced deteriorating **socio-economic** standards. This economic and social difference is a legacy of India's socio-economic, political and cultural complexity.

### Historical influences

Historically, some states were more prosperous than others, resulting in variations in socio-economic development across the various regions of India. The south and the west of India have traditionally been much more affluent than the north and the east. Also, the various invasions experienced by the north (including those of the Greeks and Mongols) held back the developmental prospects of the region for centuries. The north was also the part of the country that suffered the most exploitative aspects of British colonialism, a legacy that continues to be reflected in the regional socio-economic polarisation: the south and western regions achieve advances in human wellbeing, while the north and east struggle to deliver improvements in people's quality of life. The south largely escaped the disruptive impacts of invasion and colonialism, and has less poverty.

### Economic policy after 1991

The economic and development policies pursued by the Indian Government after 1991 have tended to reinforce existing patterns of spatial inequality. This is because the economic growth, which resulted from the policy change, has been focused in particular regions. While western states such as Maharashtra and Gujarat, and southern states such as Andhra Pradesh and Kerala, are making progress in reducing poverty and raising living standards, India's northern states, especially Uttar Pradesh, and eastern states, including Bihar and Odisha (formally Orissa), are among the country's poorest states.

Andhra Pradesh is an example of a state that has benefited from the shift in economic policy. It is one India's most developed states, with a booming information technology industry based in its capital city, Hyderabad. There has also been an effort to develop the state's rural areas. As a result, it has been able to lower its poverty rate to 9 per cent, well below the India-wide average of 22 per cent. By way of contrast, in Odisha, a state in which corruption is widespread, the poverty rate is 33 per cent. This can, at least in part, be explained by the entrenched culture of **feudalism** found in rural areas.

While India has experienced relatively high rates of economic growth over the past decade or so, many minorities (and regions) appear to have been marginalised by the policies.

### Social patterns in human wellbeing

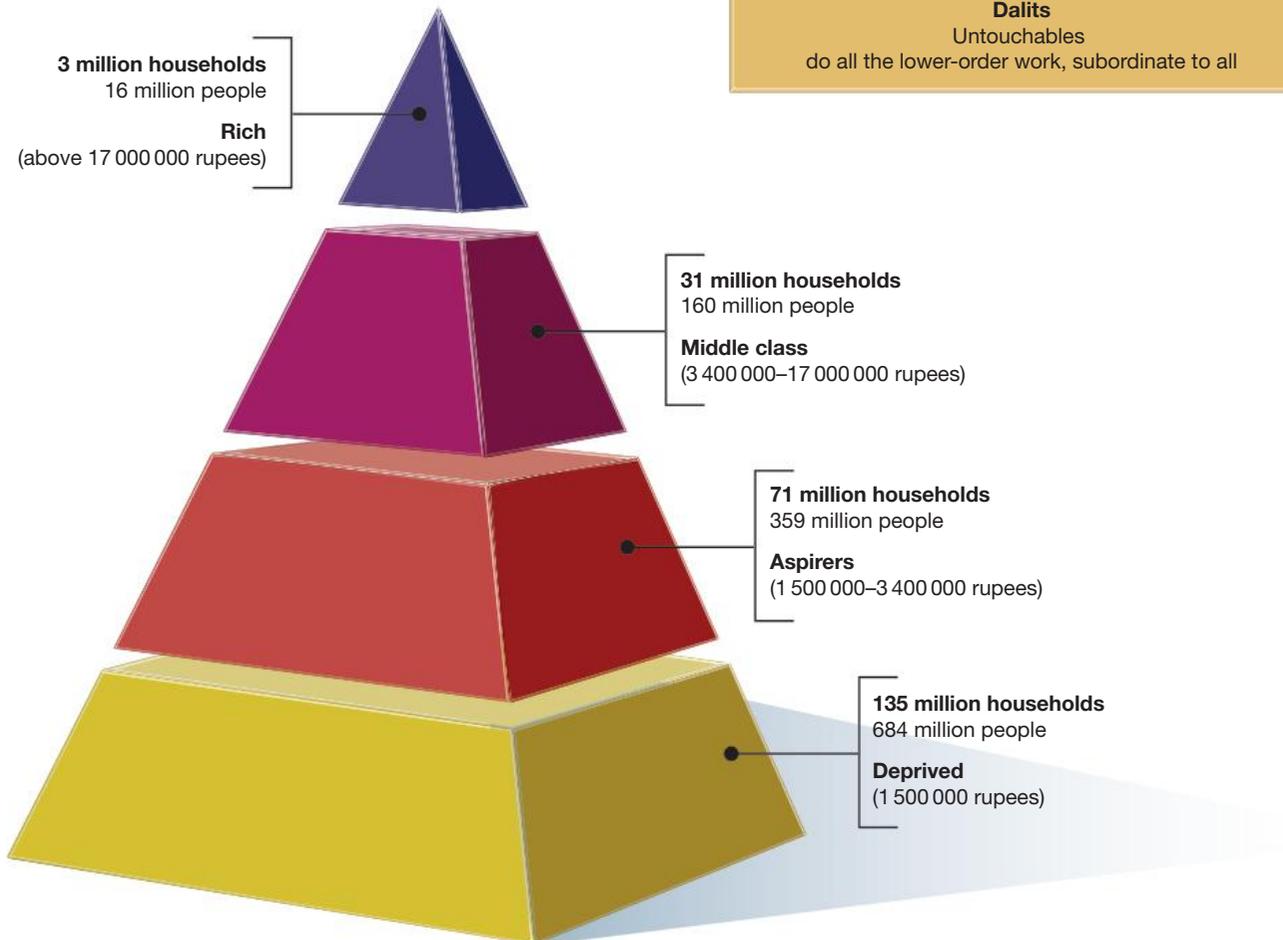
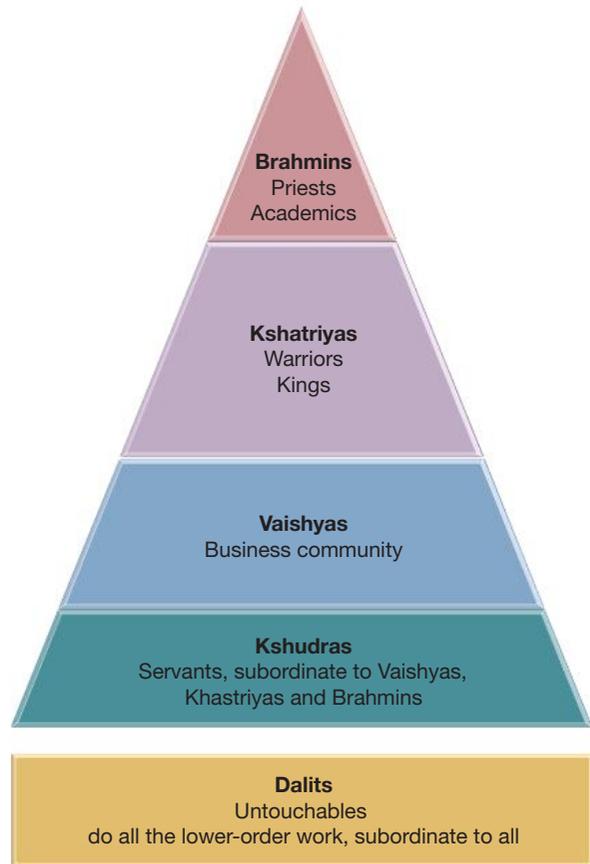
Since 1991, India has focused on the promotion of corporate services such as telephony and ICT rather than on developing the country's manufacturing base. As a result, large segments of the Indian population have been excluded from the development process. In opening its markets to global competition, India's small-scale self-employed population (a large percentage of which are Muslims) has been especially disadvantaged. As a result, one-third of the 200 million Muslims living in India continue to live below the poverty line. More generally, the top 5 per cent of Indian households own 38 per cent of total assets, while the bottom 60 per cent own just 13 per cent (see Figure 9.9).

India's caste system still casts a shadow over the lives of many Indians, especially those of the Dalit caste (the untouchables). Dalits are at the bottom of the Hindu caste system (see Figure 9.10). Despite laws to protect them, they still face widespread discrimination in India. While India's constitution bans the practice of untouchability—

members of India's higher castes will not touch anything that has come in physical contact with the Dalits, the lowest caste—the practice is still widespread. Examples of discrimination include the local barber refusing to cut the hair of a Dalit man, a group of children being forced to eat lunch separately from their classmates, and a women who is required to walk for hours to fetch water because she is not allowed to use the public tap in her village. Very few people manage to break out of the cycle of poverty and caste that they are born into. Untouchability helps to lock Dalits, who traditionally do the dirtiest manual jobs, in their occupations.

Caste still shapes the way the India is run. The Indian Government and bureaucracy are dominated by the upper castes and the caste system helps to explain why 15 per cent of the population is kept on the very margins of society by the circumstances of their birth.

9.10 Indian caste system

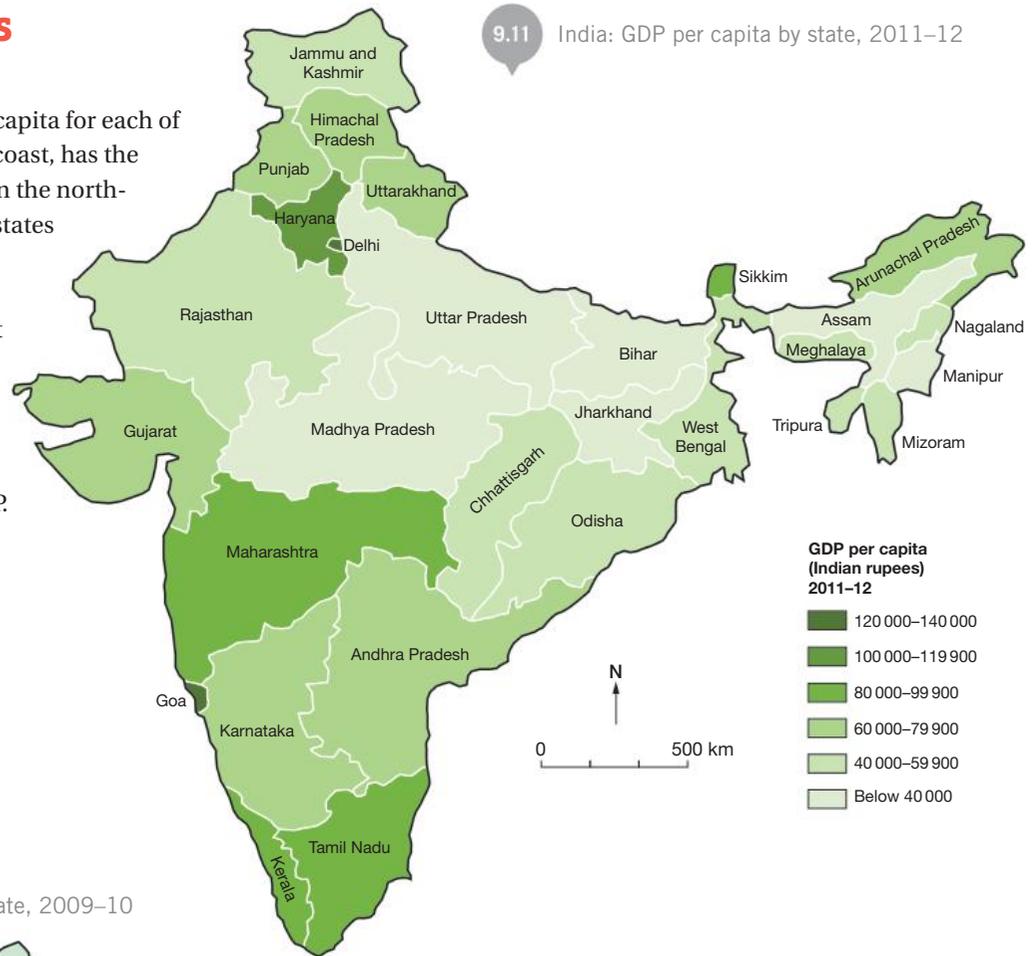


9.9 Household income pyramid, 2012

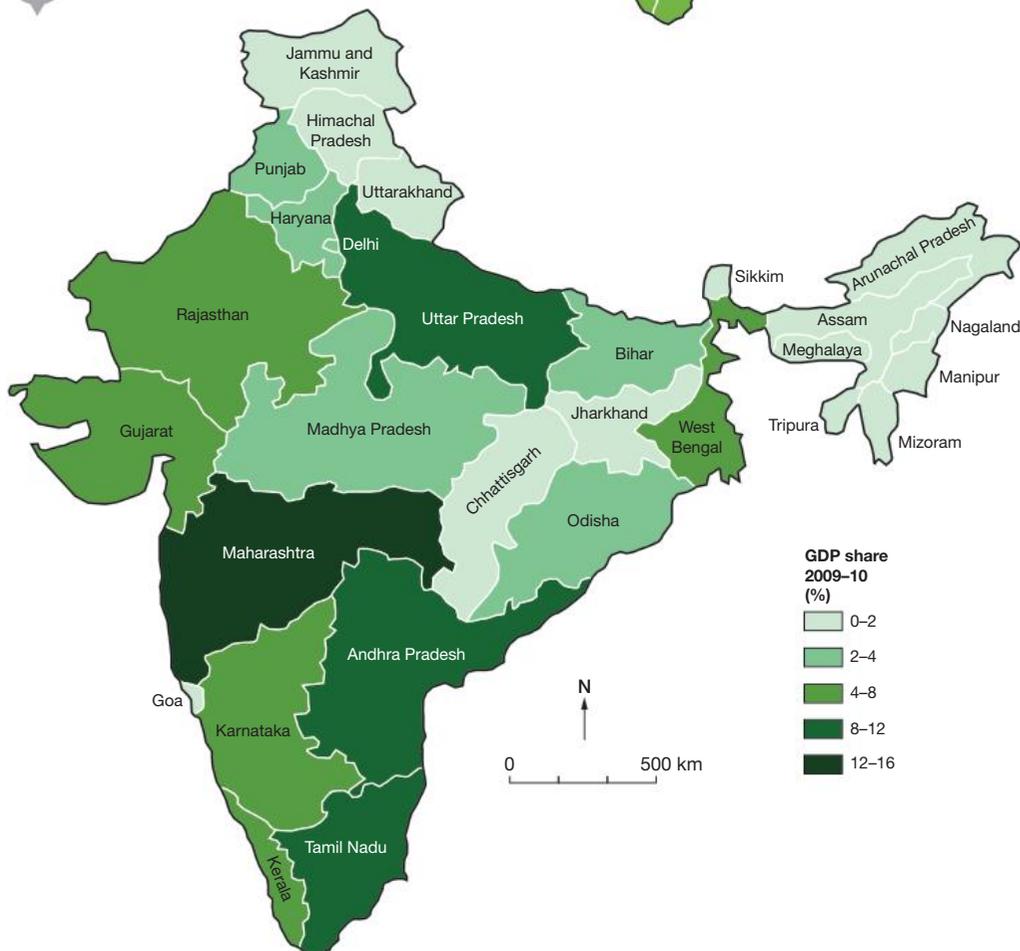
## Spatial patterns

### GDP

Figure 9.11 shows the GDP per capita for each of India's states. Goa, on the west coast, has the highest GDP per capita. Bihar, in the north-east, has the lowest. Generally, states in the north and north-east are the most disadvantaged on this measure. Figure 9.12 shows that states such as Maharashtra, Uttar Pradesh, Andhra Pradesh and Tamil Nadu dominate India's economy in terms of their share of total GDP.



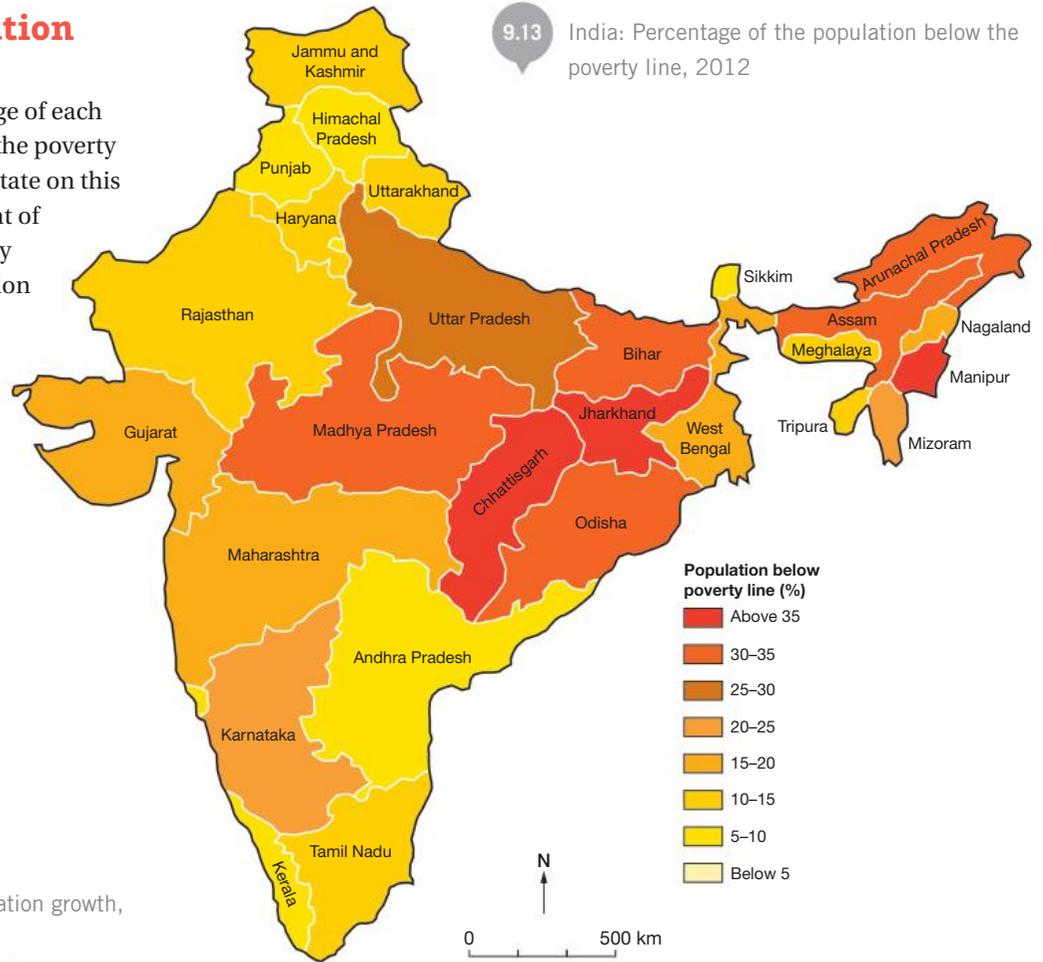
9.12 Share of India's GDP by state, 2009–10



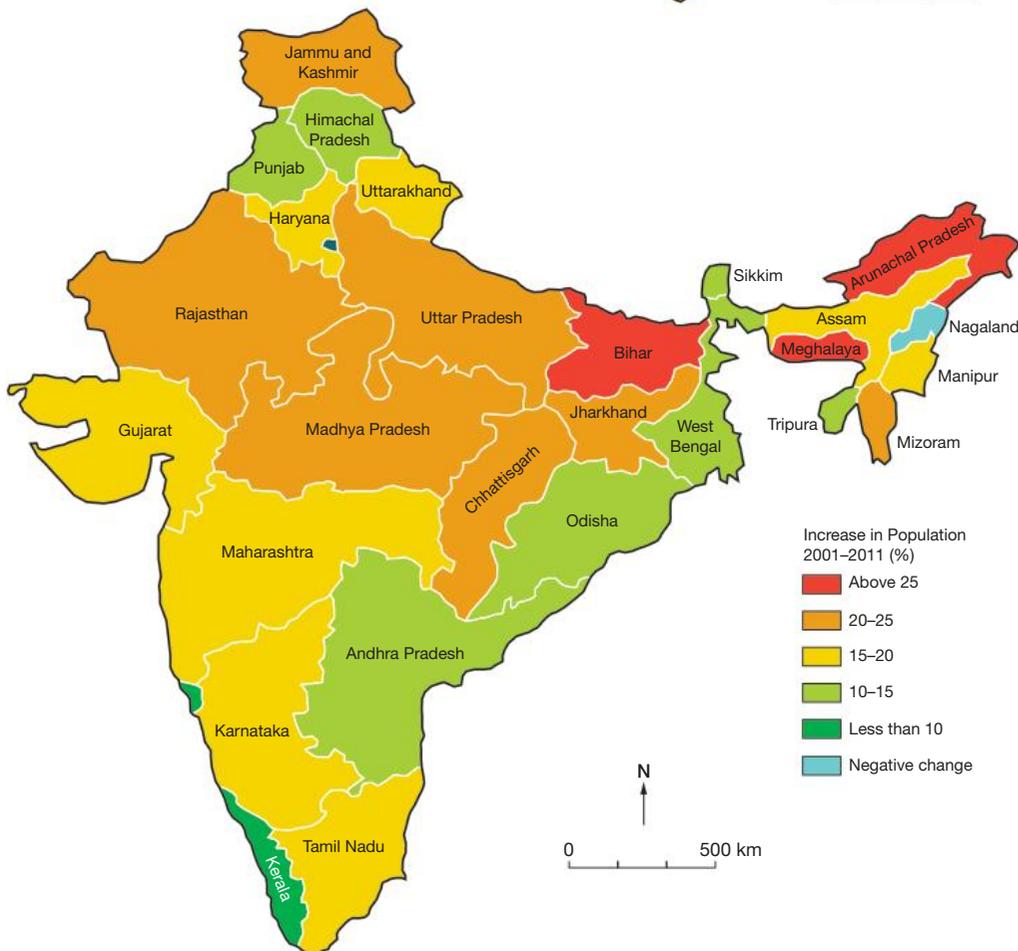
## Poverty and population increase

Figure 9.13 shows the percentage of each state's population living below the poverty line. Chhattisgarh is the worst state on this measure, with nearly 40 per cent of its population below the poverty line. Figure 9.14 shows population increase by state.

9.13 India: Percentage of the population below the poverty line, 2012



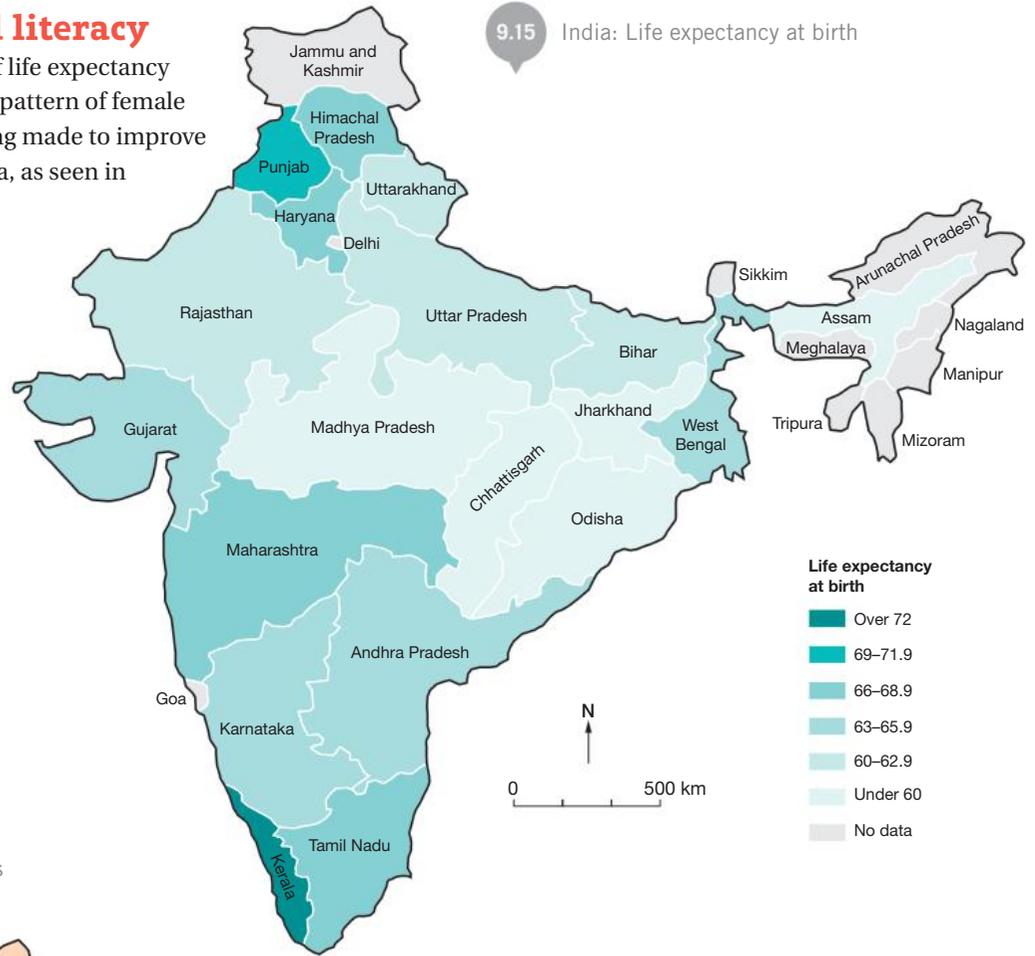
9.14 Spatial variations in population growth, 2001-11



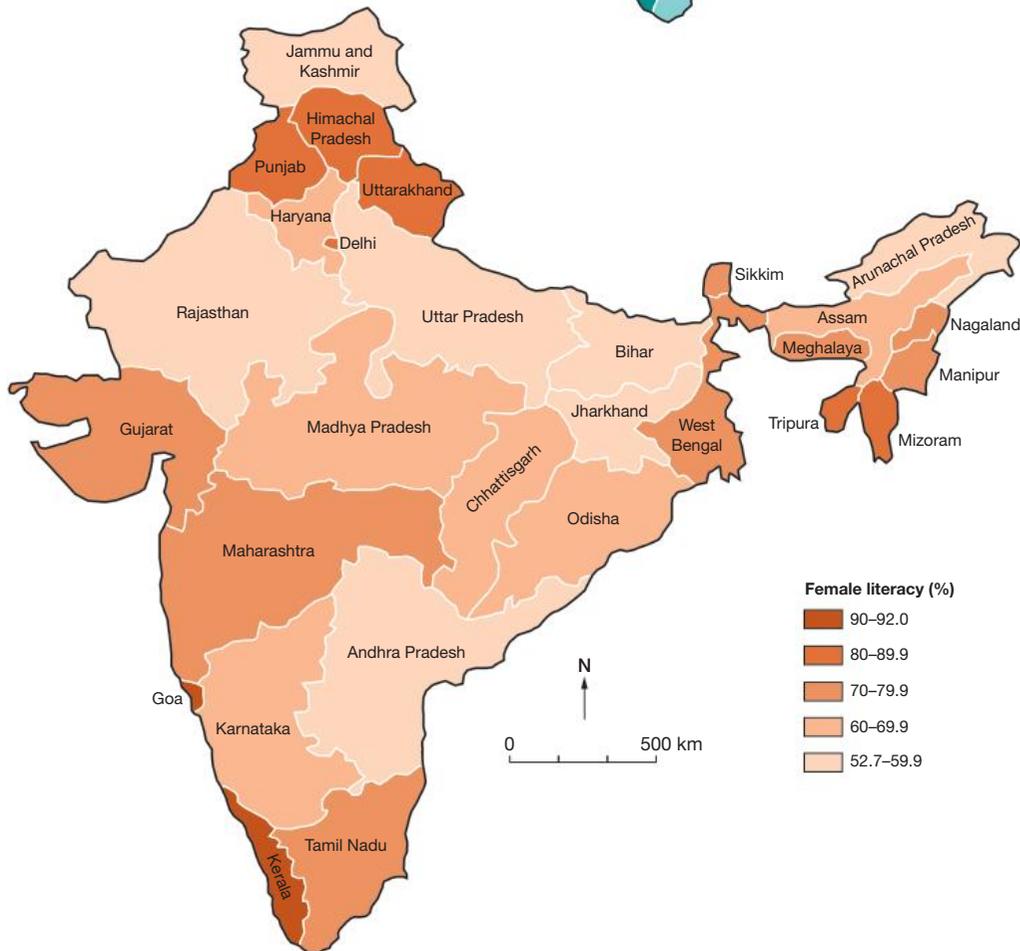
## Life expectancy and literacy

Figure 9.15 shows the pattern of life expectancy in India. Figure 9.16 reveals the pattern of female literacy in India. Efforts are being made to improve female literacy throughout India, as seen in Figure 9.17.

9.15 India: Life expectancy at birth



9.16 India: Female literacy rates





9.17 Students in a government-run school in a slum area on the outskirts of Jammu

## ACTIVITIES



### Knowledge and understanding

- 1 Describe the general spatial pattern of economic growth and development in India.
- 2 Identify the historical influences on the pattern of wellbeing in India.
- 3 Outline the consequences of the economic and development policies pursued by the Indian Government after 1991.
- 4 State the impact of India's approach to economic development on the small-scale, self-employed population.
- 5 Outline how the caste system continues to cast a shadow over the lives of many Indians.

### Geographical skills

- 6 Study Figure 9.9. Using the data shown in the income pyramid, describe the distribution of household income in India.
- 7 Study Figure 9.11.
  - a Identify the Indian states with GDP per capita of 60 000 rupees and above.
  - b Describe the distribution of these states.
- 8 Study Figure 9.12.
  - a Identify the Indian states that each account for more than 8 per cent of India's GDP.
  - b Which state has the greatest share?
- 9 Study Figure 9.13.
  - a Identify the states with more than 20 per cent of their population below the poverty line.
  - b To what extent does the pattern reflect the spatial pattern shown in Figure 9.12?
- 10 Study Figure 9.14.
  - a Identify the regions of India that show the greatest rates of population increase in the decade 2001–11.
  - b Which regions experience the lowest rates?
- 11 Study Figure 9.15.
  - a Describe the general pattern of life expectancy.
  - b To what extent does the pattern of life expectancy reflect the spatial pattern shown in Figure 9.13?
- 12 Study Figure 9.16.
  - a Name the states in which female literacy rates are the lowest.
  - b How do these compare with the pattern of disadvantage shown in Figure 9.13?
  - c Explain the relationship between the two indicators of human wellbeing.

# 9.3

## India: Contrasts in human wellbeing

There are very significant spatial variations in the level of human wellbeing experienced by people in India. Some states have been better positioned to enhance the standard of living of their people than others. In this unit, we compare the wellbeing of people in Bihar and Odisha with that experienced by people living in Maharashtra and Andhra Pradesh. We also examine some of the barriers to development.

### Barriers to development

There is a range of barriers to the development of India's states. Some of the most significant of these are climate-related natural hazards, terrorism, corruption, communal unrest and the status of women.

### Climate-related natural hazards

Natural disasters in India, many of them climate-related, hamper efforts to combat poverty and enhance human wellbeing. Droughts, flash floods, cyclones and landslides brought on by torrential rains pose the greatest threat.

9.18 India's monsoons often bring widespread and destructive flooding.

Flooding is the most common natural disaster in India (see Figure 9.18). The heavy south-west monsoonal rains cause the Brahmaputra and other rivers to overflow their banks, flooding surrounding areas. The floods can kill thousands and displace millions. The **monsoon** rains, especially when excessive or early, may ruin crops.

Most of India receives a high level of rainfall. As a result, almost all of India is flood-prone, and flash floods and torrential rains have become increasingly common in central India in recent decades, coinciding with the rising temperatures linked to global warming.



India's geographical position also means that it is affected by tropical cyclones. These disrupt the lives of millions of Indians living in coastal areas. Tropical cyclones are particularly common in the northern reaches of the Indian Ocean in and around the Bay of Bengal. Cyclones bring heavy rains, storm surges and winds, which often isolate affected areas. In the North Indian Ocean Basin, the cyclone season runs from April to December, with peak activity between May and November.

## Terrorism

Development is hindered in places affected by internal and external social and political instability. From time to time, tensions arise with both China and Pakistan. India is also facing a growing number of home-grown threats, which are potentially more serious than cross-border disputes.

Terrorism in India can be categorised as either external or internal. External terrorism emerges from neighbouring countries; internal terrorism emanates from religious or **communal violence** and political and/or economic factions.

Since the partition of India and Pakistan in 1947, there has been conflict over the state of Kashmir. Kashmir, a predominantly Islamic state, is part of India, where the majority of people are Hindus. Extremist terrorist groups, especially the Kashmiri separatist forces operating from bases in Pakistan, have often targeted Mumbai. For example, in 2008 Mumbai was attacked and 164 people were killed over a period of four days at twelve locations.

The cost of maintaining the security force need to safeguard against such attacks is a major drain on Indian finances and diverts resources from development-based initiatives.

## Corruption

Corruption involves a lack of integrity or honesty, and usually takes the form of bribery. Corruption, like terrorism, eats away the country from the inside. Corruption has been deeply entrenched in India's bureaucratic and political system for decades. Some politicians and bureaucrats have amassed a great deal of private wealth, much of it 'black money', which has been deposited, untaxed, in overseas accounts. This form of corruption results in a significant loss of revenue. Estimates put the loss of taxable income at US\$420 billion over the past decade. Levels of corruption vary across India.

## Communal unrest

Tensions can arise between India's cultural and ethnic groups. Hundreds of people are killed each year in religious-based violence between Muslims and Hindus. Figure 9.19 shows police arresting rioters in Hyderabad during communal violence between Hindu and Muslim mobs.

9.19 Riot police arrest, Hyderabad



## Status of women

Indira Gandhi became India's first female prime minister in 1966, and today a number of women hold high office in politics and business. Many sport and business leaders are women, and a generation of newly empowered young women is going out to work in large numbers. However, many women in India still face prejudice, violence and neglect. India has a gender-based imbalance in the population due to female foetuses being aborted and baby girls killed after birth. It is estimated that about 12 per cent of women disappear at birth, 25 per cent die in childhood, 18 per cent die during the reproductive years, and 45 per cent die at older ages.

Deeply entrenched **patriarchal attitudes** and widespread **misogyny** in many parts of the country need to be addressed to raise the status of women.

## Human wellbeing in India's states

### Odisha

Odisha (formerly Orissa) is located on India's east coast on the Bay of Bengal. While some economic progress is evident, the state remains one of the country's poorest.

Nearly a third of the state's population lives below the poverty line and the infant and maternal mortality rates are some of the highest in the country. Forty per cent of all children under 3 years of age are underweight. Orissa also has India's second-highest proportion of scheduled caste and tribal people. Tribal communities constitute almost half of the state's poor. The literacy rate in these communities is one of the lowest in the country.



Agriculture and agriculture-related industries are Odisha's main form of economic activity and employ about 76 per cent of the total working population. Raising the living standards of those in rural areas is a major challenge.

The state's developing industries are largely based on its mineral reserves. Odisha accounts for a fifth of India's coal, a quarter of its iron ore and a third of its bauxite. Also important is the development of the information technology sector. Strategies to promote industrialisation include the upgrading of transport infrastructure: road networks, an international airport at Bhubaneswar, major ports and rail network connecting the state to the rest of India.

Floods and cyclones are the main obstacles to Odisha's development, as many of the most populated areas are situated near the Bay of Bengal.

## Bihar

Bihar is located in north-eastern India. It is one of the country's poorest states, lagging behind others in terms of social and economic development. Corruption is widespread and presents a major hurdle for improvements in human wellbeing. Rapid population growth also makes it difficult to raise living standards. Bihar, with a population

of 103 million people, is India's third-most populous state after Uttar Pradesh and Maharashtra. In the decade to 2011, the state experienced a 25 per cent growth in its population, which is among the highest in India; and with a fertility rate of 3.7, it is only going to increase further. Nearly 90 per cent of the population lives in the rural areas.

There are substantial variations in development across the state, with north Bihar lagging behind due to low agricultural productivity, poor irrigation facilities and high vulnerability to floods.

About a third of Bihar's population lives below the poverty line, which is much higher than the national average of 22 per cent. However, if factors beyond income are considered (for example in the Multidimensional Poverty Index, which takes health, education and living standards into account), about 79.3 per cent of the state's population lives below the poverty line. Poverty in Bihar results from low per capita landholding, a very small industrial base and limited opportunities in the service sector. Poor infrastructure and resourcing of social, health and education sectors compound the problems. Due to limited opportunities in the state, there is large-scale seasonal migration of farm workers to other parts of the country.

Bihar's performance on other human development indicators, such as health, education and sanitation, is also below the national average. For example, Bihar has the country's lowest literacy rates at 63.82 per cent. Adult illiteracy affects skill attainment and income potential. The percentage of underweight children is 55.9 per cent. Tube wells are the most important source of drinking water in the state, with nearly 91 per cent of the population dependent on them.

Terrorism is a major issue in Bihar. Various insurgency groups frequently attack local police and politicians. Poor governance and the law and order system in the state have helped increase the disruption caused by such groups. Bihar has witnessed many massacres by these groups.

## Maharashtra

Maharashtra is India's wealthiest state and its second-most populous after Uttar Pradesh. Maharashtra accounts for 18 per cent of the country's industrial output and 13.4 per cent of its GDP. The state's GDP per capita is more than 83 400 rupees per person per year, more than three times that of Bihar and 40 per cent greater than the all-India average. Only 17 per cent of its people live below the poverty line, compared with the all-India figure of 22 per cent. Mumbai, the state's capital, is India's largest city and its financial capital. The city houses the headquarters of India's major corporate and financial institutions.

Most of the state's industrial enterprises are clustered around Mumbai. The main industries are chemicals, processed foods, refined petroleum, machinery and equipment, textiles, basic metals, pharmaceuticals and motor vehicles. The service sector also makes an important and expanding contribution to the state's economy. About two-thirds of the population is rural and lives in villages. Fifty-five per cent of the population is dependent on agriculture for their income.

The government of Maharashtra actively seeks industrial investments from domestic as well as foreign institutions. It has invested heavily in the infrastructure required to support economic growth.

Maharashtra, or more specifically Mumbai, is one of India's major cultural centres. Mumbai is the largest film production centre in India (often referred to as Bollywood), and one of the largest in the world.

## Andhra Pradesh

Andhra Pradesh is India's fifth-most populous state and one of its wealthiest. Agriculture is the backbone of Andhra Pradesh's economy. The state is known as India's 'rice bowl' and it is also the leading producer of cash crops such as tobacco, groundnut, chillies, turmeric, oilseeds, cotton, sugar and jute.

While Andhra Pradesh's is one of the country's most industrialised states, manufacturing accounts for a small percentage of the state's income. Industries such as shipbuilding, aeronautics and the manufacture of electrical equipment, machine tools and drugs have clustered around Hyderabad and Vishakhapatnam.

The service sector of the state accounts for 43 per cent of the state's GDP and employs 20 per cent of the workforce. In recent years, Hyderabad has emerged as a major information technology centre. The city is now home to 1300 information technology firms, including Microsoft, Google, IBM, Yahoo, Dell and Facebook.

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the climate-related hazards that affect development in India.
- 2 Describe the nature of terrorism in India and outline its impacts.
- 3 Explain how corruption detracts from the development potential of Indian states.
- 4 State how violence in India affects the country.
- 5 Explain how the status of Indian women hinders development.

### Applying and analysing

- 6 a List the barriers to development identified in this unit and rank the barriers from the most to the least impact. Justify your ranking.  
b Would you add any more barriers to the list? Explain.

### Investigating

- 7 Select two Indian states, one relatively wealthy and the other poor. Investigate the developmental indicators for the selected states and the factors either promoting or hindering development and efforts to promote human wellbeing. Present your findings as a multimedia presentation.
- 8 Undertake research in order to complete the following table of development indicators.

	Odisha	Bihar	Selected poor state	Maharashtra	Andhra Pradesh	Selected relatively wealthy state
GDP per capita						
HDI Index						
Inequality-adjusted HDI						
Fertility rate						
Life expectancy						
Child mortality rate						
Literacy rate						

# India: Enhancing human wellbeing

Indian governments and their agencies, intergovernmental bodies such as the World Bank and United Nations, and NGOs all play a role in promoting human wellbeing in India. The development-related initiatives they promote operate on a variety of scales. They include government-based policies to promote development, strategies targeting groups experiencing social and economic disadvantage.

## Government-based initiatives

Governments set the policy framework that governs the ways economies operate and develop. The policies can either promote or hinder development. In recent decades, India's government has:

- created a large, well-educated workforce able to meet the needs of corporations investing in India (for example, the call-centre industry depends on speakers of English and has also proved especially valuable in the area of research and development)
- maintained relatively low wages that attract foreign and local investment into an economy that is now less centrally controlled and directed
- exploited a wealth of industrial and agricultural resources, which can provide raw materials for industries
- invested in transport infrastructure, including road, rail, ports and airports
- promoted a growing middle class, with disposable income to purchase locally made goods and services, such as computers and motor vehicles.

The Indian Government has also put in place an ambitious Five-Year Plan (2012–17), India's twelfth such plan. The plan includes expensive infrastructure projects in water supply, energy expansion, manufacturing development, and transportation; rebuilt irrigation systems; new factories; new power plants; larger coal mines; modernisation of a substandard electricity grid; expansion of the national rail transport network, and more urban subways. The goals of the plan are to:

- keep annual economic growth above 7 per cent
- add tens of millions more citizens to the ranks of the middle class
- achieve these objectives in a way that significantly reduces the pressure that India's growth is putting on its water, land, air and mineral resources.

While human wellbeing has been enhanced by such policies and plans, not all people have experienced the benefits of economic growth.

## Bringing electricity to India's rural poor

In 2012, India produced nearly 930 billion kilowatt-hours of electricity, 65 per cent of which came from coal. However, almost 200 billion kilowatt-hours of power were lost due to the country's old and inefficient electricity grid. In other words, one-fifth of the electricity produced never reached the customer. Not only was the electricity wasted, so too were the billions of cubic metres of water, and hundreds of millions of tonnes of carbon were needlessly emitted. While this energy is wasted, four hundred million Indians, or one-third of the population, still live without electricity, according to the Indian Government.

Rather than going to the expense of constructing expensive Western-style electricity production and distribution infrastructure, small, locally based energy projects are seen by many as the most effective response. India's latest Five-Year Plan promotes the idea of a decentralised power grid. This involves connecting homes, village by village, to local solar-powered installations (see Figure 9.21). Progress has, however, been slow. In 2012–13, 754 megawatts of solar-powered electricity were installed, compared with 1699 megawatts of wind energy generation and 60 000 megawatts of energy fuelled by coal and natural gas.

## Transnational institutions aiding development

The World Bank and the United Nations Development Programme (UNDP) are two transnational institutions that work with people at all levels of society to drive and sustain the kind of development that enhances people's wellbeing. In 2014, the UNDP had forty-five projects across India, the main purposes of which were environment and sustainable development (38 per cent of funding), democratic governance (28 per cent) and poverty reduction (34 per cent). The World Bank currently funds seventy-eight development-related projects worth US\$23.6 billion.



9.21 Solar power can make a big difference to people's quality of life.

## World Bank

### Water and sanitation projects

In early 2014, the World Bank entered into a US\$500 million agreement to improve rural water supply and sanitation services in four of India's poorest states—Assam, Bihar, Jharkhand and Uttar Pradesh. Support for the initiative dates from 1991. Since that time, the bank has contributed more than US\$1.4 billion, benefiting 24 million rural households in more than 15 000 villages. Such initiatives meet a real need. Only a third of India's households have access to tap water and domestic toilets.

### Other projects

Other projects focus on the development of transport infrastructure, for example, Mumbai's massive rail and road infrastructure development and state highway projects in Gujarat and Rajasthan. The bank also invests in education, with a US\$500 million project to increase access to good-quality secondary education. Watershed initiatives, coastal disaster risk management, AIDS control initiatives and low-income housing initiatives are also among the projects funded by the World Bank.

## International NGOs

Given the immensity of the challenges faced by India, it is not surprising that the world's best known NGOs can be found operating throughout the country.

CARE International focuses on the most marginalised people through its large-scale projects in education, health and HIV/AIDS and emergency response. In particular, CARE focuses on empowering women and girls to improve their situations and to be leaders in the communities. CARE works with the poorest of the poor in more than 100 districts, in a total of eleven states across India.

Among the many initiatives of the Save the Children organisation is a network of 150 *balwadis* in northern Mumbai. These provide pre-primary education for children between the ages of 3 and 5 years, which help builds a strong foundation for the formal years of schooling. The children who attend the *balwadis* typically come from the slum communities. They have very limited access to clean water and sanitation facilities. Most of these children are first-generation learners from families on very low incomes.

## Indian-based NGOs

India has thousands of NGOs, ranging from those that work right across India to those that work at local levels. For the most part, these bodies are effective in reaching the most marginalised and vulnerable people in Indian society. Programs include working with other organisations to build canals (see Figure 9.22). The Bharatiya Agro Industries Foundation (BAIF) is one such NGO. Founded in 1967, the foundation seeks to promote sustainable living in rural India.

### Enhancing the wellbeing of Khondla's farmers

While Indian authorities are slow to recognise it, enhancing human wellbeing begins in villages such as Khondla, in the state of Chhattisgarh. In the village, some 336 kilometres to the north of Raipur, the state's capital, the BAIF is working with rice farmers to design and develop a low-cost irrigation and water conservation project. The Indian-based NGO's environmental objective is to recharge the area's groundwater reservoirs, which local farmers say have been declining in recent years. The project includes all the village's farmlands and all 300 farm families.

The NGO's social objective is to raise people's standard of living. In this regard, the success of the initiative is being measured in terms of larger harvests and increased crop yields. Small dams, channels and gravity are used to capture the rainfall that pours off the surrounding ridge and distribute it to the village's rice paddies (see Figure 9.23). Farm incomes have grown as output and yields have increased.

The initiative highlights one of the key development issues in India—the struggle between local projects that are seen to make a difference to the lives of people living in the country's 600 000 villages, such as Khondla, and the very costly and complex industrial modernisation promoted by the national government.

The total cost of the BAIF project is just US\$160 000. It is an environmentally safe and relatively low-cost way of addressing the challenges of food production and water security.

9.22 Canal project funded by the World Bank





9.23 Increased rice production has helped raise the standard of living for the people of Khondla, Chhattisgarh.

## ACTIVITIES



### Knowledge and understanding

- 1 Outline the government-based initiatives designed to promote development.
- 2 State the objectives of the Indian Government's ambitious Five-Year Plan (2012–17).

### Applying and analysing

- 3 Copy and complete the following table, assessing each NGO program on how it will benefit in the following areas.

### Investigating

- 4 Using the internet, investigate the range of development-related initiatives funded by the World Bank in India. Select one of these to investigate in detail. Prepare a short written report, outlining the nature of the initiative and its impact on people's wellbeing.

Criteria	World Bank: Bringing electricity	Indian-based NGOs: Khondia's farmers	International NGOs: Water and sanitation
Environmental			
Economic			
Social			

# Case study: World Vision—making a difference

World Vision is one of the many international NGOs working to improve the opportunities of India's poor. It is the organisation's belief that effective development empowers poor and marginalised communities to change their circumstances, and to sustain and build upon that change.

## World Vision's developmental focus

From its establishment in 1947, World Vision has been focused on giving people, especially children, opportunities to improve their lives. In the 1970s, World Vision's programs broadened from enhancing the wellbeing of individual children to community development. Since the 1980s, the 'welfare' approach has gradually changed to a more collaborative relationship with poor, marginalised people and communities, enabling them improve their lives and take control of their futures.

9.24 World Vision's approach to development

## Area Development Programs

World Vision's Area Development Programs (ADPs) help communities to achieve basic standards of physical, intellectual, socio-economic and moral wellbeing. World Vision's community workers facilitate this by living in the communities, learning about people's problems and helping them find their own solutions. Rather than treat the effects of poverty, ADPs help communities to find ways to confront the root causes of poverty and help people improve their livelihoods. World Vision's partnerships with communities, as well as local governments, other NGOs, corporations and citizens around the country make this possible. Each World Vision ADP touches the lives of 20 000 to 1 000 000 Indians. There are 162 ADPs spread over twenty-five states, working in over 5000 communities.

Water and sanitation	Health	Food and environment	Education	Economic development	Disaster risk management
By improving access to clean water and sanitation and hygiene education, waterborne illnesses decrease and health improves. Children have more time for school and women have more time for work and family care because they no longer have to walk long distances to collect water.	By focusing on prevention strategies and access to health and nutrition services for mothers, infants and children, World Vision helps to ensure their survival and protect them from disease and ill-health. Healthy children learn more effectively at school and are best placed to reach their full potential.	When communities have secure, stable access to nutritious food and can sustainably manage their environment, children have the food they need to live active, health lives. When farmers can produce enough food for household needs they can sell surplus produce to cover education and healthcare costs.	By increasing children's access to quality education, starting with pre-school, children gain the knowledge and skills they need to lead healthy and productive lives, earn an income in adulthood, and contribute to the future wellbeing of their families and communities.	By supporting communities to develop small businesses, improve farming methods and form cooperatives and savings and loans groups, parents are more able to provide for their children's needs, and children grow up better nourished and educated.	By equipping communities to reduce environmental hazards and better prepare for natural disasters, lives and livelihoods can be protected against events such as droughts, floods and cyclones, and resilience can be built up. World Vision also support them with an emergency response when disasters hit.



9.25 Ruby draws safe drinking water from a water pump installed by World Vision in 2011. Families now do not have to walk long distances to obtain water and the community enjoys better health outcomes. The community contributes to the repair and ongoing maintenance of the well in a sustainable way.

9.26 Many schools in rural areas and urban slums do not have supplies of clean drinking water. Many children fall ill because they drink unsafe water from the taps. In Ravi Nagar Nagpur, 1200 children at Drona Public School now benefit from access to safe, clean drinking water with the installation of the Reverse Osmosis water filtration system. This system is highly effective in filtering even the smallest impurities. The rest of the community also uses the water.



9.27

**a** Sakuntola, 28, cleans fish from a pond stocked and maintained by a women's self-help group. World Vision provided seed money for the fishpond and training for the women's group, which also does weaving, sells firewood and operates a group rice paddy field.



**b** In Assam, the women in the self-help group meet twice a month. Facilitated by World Vision, the women have learnt to work together and invest in other businesses that raise money for their families. They also provide loans to one another and have raised goats and sold them to buy more profitable piglets. Oranges and papayas are bought wholesale and sold for a profit. They now stock a profitable fishpond and share income from weaving sales.



9.28

**a** World Vision has developed classes for children with special needs who are otherwise stigmatised and miss out on education.

**b** Badal, on the far right, is intellectually impaired and has difficulty with speech and some movements. Before joining the class, Badal was withdrawn but now speaks more and is growing in confidence and a sense of belonging. The classes include basic reading, drawing, music and life skills.





**9.29** a and b A group of 12–17-year-old girls in the slums of Delhi meets to support one another, and learn about ways to address gender discrimination in their community. The group has provided a forum for the girls to share their struggles, and empowered them to follow their dreams and not be limited by stereotypes. The group also seeks to inform and educate other members of the community about the rights of girls in their community.



## ACTIVITIES

### Knowledge and understanding

- 1 Outline how the focus of World Vision's aid program changed over time.
- 2 State the objectives of World Vision's Area Development Programs. How are these objectives pursued?
- 3 Outline the extent of World Vision's work in India.
- 4 Give examples of how the wellbeing of women is being addressed.
- 5 Identify the ways in which access to education is being addressed.

### Applying and analysing

- 6 Study Table 9.24. Write a series of paragraphs outlining World Vision's approach to community-based development and the areas of need in which it works.

### Investigating

- 8 Access the World Vision website. Investigate a specific Indian-based aid initiative. Develop an illustrated oral report to communicate your findings.



# 9.6

## Geoskills: Exploring India using maps

In this unit, you will use an atlas map to explore India. India is large and vast with many different regions. The ethnic make-up of the people is diverse, but there are two major groups: the Aryan, in the north, and the Dravidian, in the south. Hindu and English are used officially, but more than 1600 languages and dialects are spoken, and the constitution recognises twenty-two regional languages.

### Discovering India

#### Location

India is located in a part of Asia sometimes called the subcontinent or South Asia (see Figure 9.27).

#### Facts

- Highest point: Mt Kanchenjunga (8598 m asl)
- Longest river: Brahmaputra River (2900 km<sup>2</sup>)
- Size: 3 287 263 km<sup>2</sup>
- Land: India occupies just 2.4 per cent of the total surface of the earth yet contains about 6 per cent of the world's known wildlife.

#### Biomes of India

The country has ten bio-geographic zones.

- Trans-Himalaya: This is very cold and arid. The only vegetation is sparse alpine plants.
- Himalaya. The flora vary according to altitude and climatic conditions, from tropical rainforests to dense sub-tropical and alpine forests.
- Desert. Vegetation consists of tropical thorn forests, tropical dry deciduous forests and sandy deserts.
- Semi-arid. Vegetation consists of tropical thorn forests, tropical dry deciduous forests and sandy plains.
- Western Ghats. This zone covers only 5 per cent of India's land surface but is home to over 4000 plant species found in the zones diverse forests.
- Deccan Peninsula. This large area of raised land covers about 43 per cent of India's total land surface. This region is fertile and large parts are covered by tropical forests.
- Gangetic plains. The soil in this region is fertile from river deposits. Much of the land is agricultural.
- Coast. The natural vegetation consists of mangroves.
- North-east. Vegetation is mainly evergreen and semi-evergreen rainforests and grasslands.
- Islands. This zone comprises islands with mainly tropical evergreen forests.

### ACTIVITIES

#### Knowledge and understanding

Study Figure 9.30 then do the following tasks.

- 1 Identify the countries that border India to the north.
- 2 Name the prominent landform feature that dominates India's northern border.
- 3 Name the bay into which the Ganges and Brahmaputra rivers flow.
- 4 Name the sea to the west of India.
- 5 Name the rivers flowing through the following cities:
  - a Allahabad (25°27'N, 81°50'E)
  - b Vijayawada (16°34'N, 80°40'E)
  - c Jabalpur (23°10'N, 79°59'E)
- 6 State the general direction in which the Ganges River flows.
- 7 Identify the cities located at the following latitudes and longitudes:
  - a 26°53'N, 75°50'E
  - b 25°37'N, 85°12'E
  - c 26°50'N, 80°54'E
  - d 27°09'N, 78°00'E
- 8 State the latitude and longitude of the following cities:
  - a Mumbai
  - b New Delhi
  - c Kolkata
  - d Bangalore
  - e Hyderabad
- 9 Calculate the straight-line distance between:
  - a Mumbai and Kolkata
  - b New Delhi and Bangalore
  - c Kolkata and Mumbai
- 10 State the direction of:
  - a Kolkata from Mumbai
  - b Bangalore from Kolkata
  - c New Delhi from Kolkata

Source: *Wildlife Protected Area Network in India: A Review*, Wildlife Institute of India, 2000



CHAPTER

# 10

# HUMAN WELLBEING: AUSTRALIA



**A**ustralians enjoy one of the highest levels of human wellbeing in the world. As a nation they also enjoy one of the highest life expectancies of any country, although this is not true for Aboriginal and Torres Strait Islander people. Indigenous Australians can expect to live 10 to 17 years less than other Australians. Babies born to Indigenous mothers die at more than twice the rate of other Australian babies, and Aboriginal and Torres Strait Islander people experience higher rates of preventable illness such as heart disease, kidney disease and diabetes. The mortality rates for Indigenous Australians are on a par with the rates in some of the world's poorest nations. The origins of this disadvantage lie in the dispossession of their traditional lands, their marginalisation in Australian society and, in some instances, overt racism.

Addressing this disadvantage is a national priority, but progress has been slow. Experience has shown that the most effective interventions are those that include local Indigenous communities in decision-making processes. Non-governmental organisations play an important role in the delivery of assistance, and activists within Indigenous communities have shown leadership by initiating a range of self-help initiatives.

In this chapter we focus on the experience of Aboriginal and Torres Strait Islander people as an example of spatial differences in wellbeing within a country, and evaluate the differences from a range of perspectives. We also explore initiatives designed to reduce the gap between Indigenous and non-Indigenous Australians.

## KEY IDEAS

- To understand the extent to which the wellbeing of Indigenous Australians varies from that enjoyed by non-Indigenous Australians
- To investigate to what extent Indigenous disadvantage varies spatially
- To describe how Indigenous disadvantage is measured
- To investigate how Indigenous disadvantage is being addressed by governments, NGOs and self-help initiatives

## GLOSSARY

<b>Country</b>	the land to which an Indigenous Australian belongs and their place of Dreaming
<b>dispossession</b>	the act of taking away or forcing people from their land, economic base, way of life and culture
<b>non-governmental organisations (NGOs)</b>	non-profit, often volunteer-based, groups of people seeking to achieve a collective goal locally, nationally or internationally
<b>self-help initiative</b>	a project to assist people to improve their situation or their community without assistance from others
<b>socio-economic status</b>	level of economic and social wellbeing based on factors such as employment, income, education and social position relative to those of others
<b><i>terra nullius</i></b>	(Latin) a territory belonging to no one, or a territory over which no one claims ownership; the concept has been used to justify the invasion and colonisation of Australia

# 10.1

## Spatial patterns of advantage and disadvantage

Indigenous Australians experience disproportionate levels of disadvantage that seriously affect their wellbeing. Life is toughest for those living outside metropolitan areas, especially in remote areas.

### Socio-economic status

A widely accepted indicator of disadvantage is a person's **socio-economic status**. It takes into account factors such as educational attainment, occupation, income and housing. The Australian Bureau of Statistics (ABS) defines relative socio-economic advantage and disadvantage in terms of people's access to material and social resources, and their ability to participate in society.

In every part of Australia, Indigenous Australians are worse off, and do not enjoy the same level of wellbeing, as most other Australians. They consistently experience disproportionately higher levels of social disadvantage.

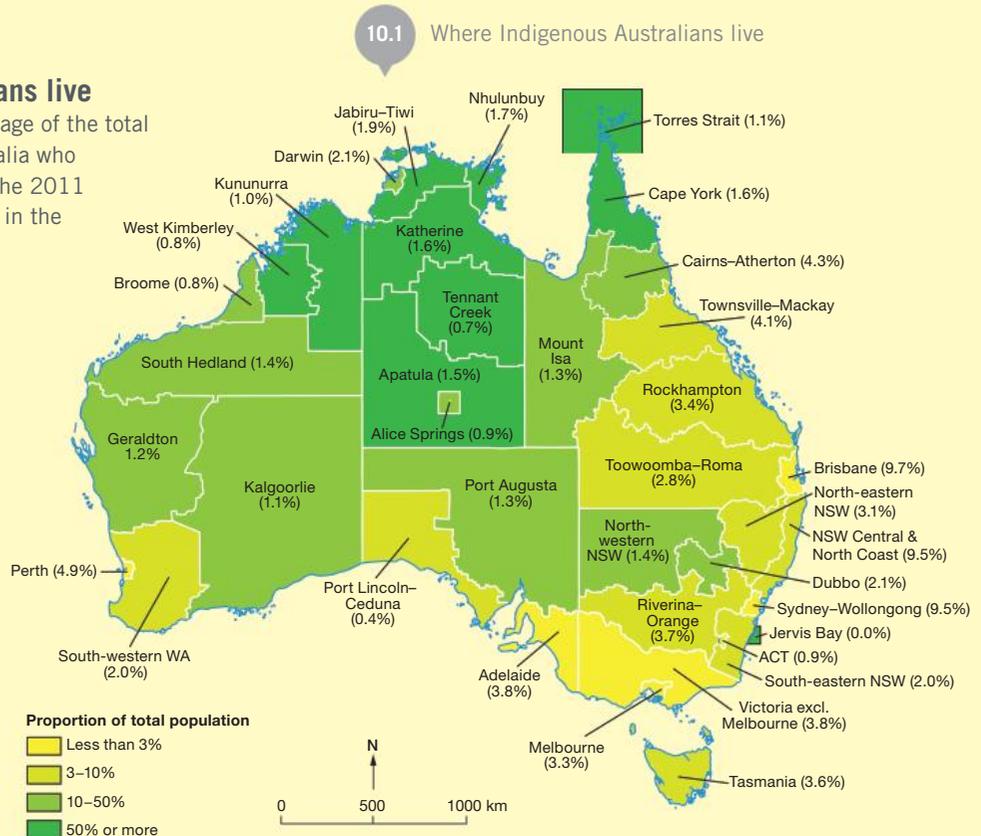
### Housing

Indigenous Australians are more likely to live in areas where their friends and neighbours are relatively disadvantaged. More than a third of Indigenous Australians (36.6 per cent) live among the most disadvantaged 10 per cent of the Australian population and only 1.7 per cent live among the most advantaged top 10 per cent.

### SPOTLIGHT

#### Where Indigenous Australians live

Figure 10.1 illustrates the percentage of the total population in regions across Australia who identified as being Indigenous in the 2011 Census. The percentage is highest in the relatively remote regions of north, central and western Australia. Yet the regions with the greatest absolute numbers of Indigenous Australians are in the south and east of the country—Brisbane, the central and northern coasts of New South Wales, and the Sydney–Wollongong region all have an Indigenous population of 60 000 or more. The most remote regions have populations of about 10 000 or less.



## Variations in the spatial patterns of disadvantage

The Australian Bureau of Statistics uses a variety of economic and social information about people and households within an area to create the Index of Relative Socio-economic Advantage and Disadvantage (IRSAD). The ABS measures education levels, occupation and types of jobs, home ownership and size, car ownership, internet connection and the health and disability within an area.

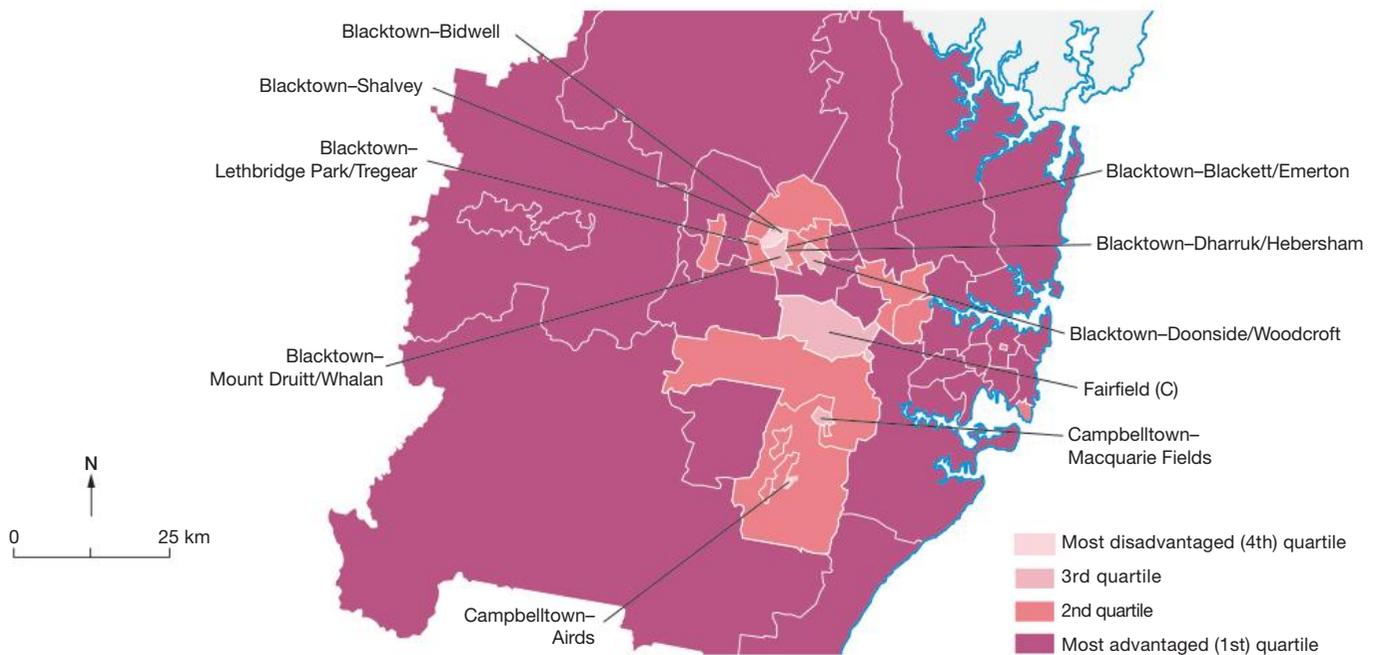
- A low score indicates greater disadvantage and a lack of advantage. For example, there are many households with low incomes, or many people in unskilled occupations, and few households with high incomes, or few people in skilled occupations.
- A high score indicates a relative lack of disadvantage and greater advantage. For example, there are many households with high incomes, or many people in skilled occupations, and few households with low incomes, or few people in unskilled occupations.

## Spatial patterns in Sydney

While the advantage and disadvantage differences between Indigenous and non-Indigenous populations are greatest in remote areas, even in remote areas some communities fare better than others. There are also wide variations in both regional and urban communities.

The Sydney metropolitan area has the greatest diversity in the socio-economic status of Indigenous Australians. In 2011, according to the IRSAD, six of the seven most advantaged Indigenous areas in Australia were found in Sydney. The smallest disadvantage gap between the two populations was in Sydney's lower north. Yet ten areas that were found to be especially disadvantaged were also in Sydney (see Figure 10.2).

10.2 Patterns of Indigenous advantage and disadvantage in Sydney



## ACTIVITIES

### Knowledge and understanding

- 1 Identify those parts of Australia that have the highest percentage of Indigenous Australians and those that have the greatest numbers.
- 2 Describe the ABS definition of socio-economic status.
- 3 Outline the measures used to determine socio-economic status.
- 4 Describe how advantage and disadvantage are measured.

### Geographical skills

- 5 Study Figure 10.1 then answer the following questions.
  - a In which state/territory do Indigenous Australians make up the largest percentage of the population?
  - b In which state/territory do Indigenous Australians make up the smallest percentage of the population?
  - c What percentage of Australia's Indigenous population is found in New South Wales?
  - d What percentage of Australia's Indigenous population is found in the Northern Territory?



# 10.2

## Origins of disadvantage

Despite having lived sustainably in Australia for up to 60 000 years, Aboriginal and Torres Strait Islander people were quickly plunged into turmoil with the arrival of Europeans in 1788. Many of the issues that trouble Indigenous Australians and disadvantage them today can be traced back what has happened in the past and the attitudes of non-Indigenous people at the time.

### Dispossession

Aboriginal and Torres Strait Islander people believed in respect and responsibility for **Country**, their ancestors and each other. They believed in the collective responsibility for land. They did not see it as a privately owned commodity to be bought and sold.

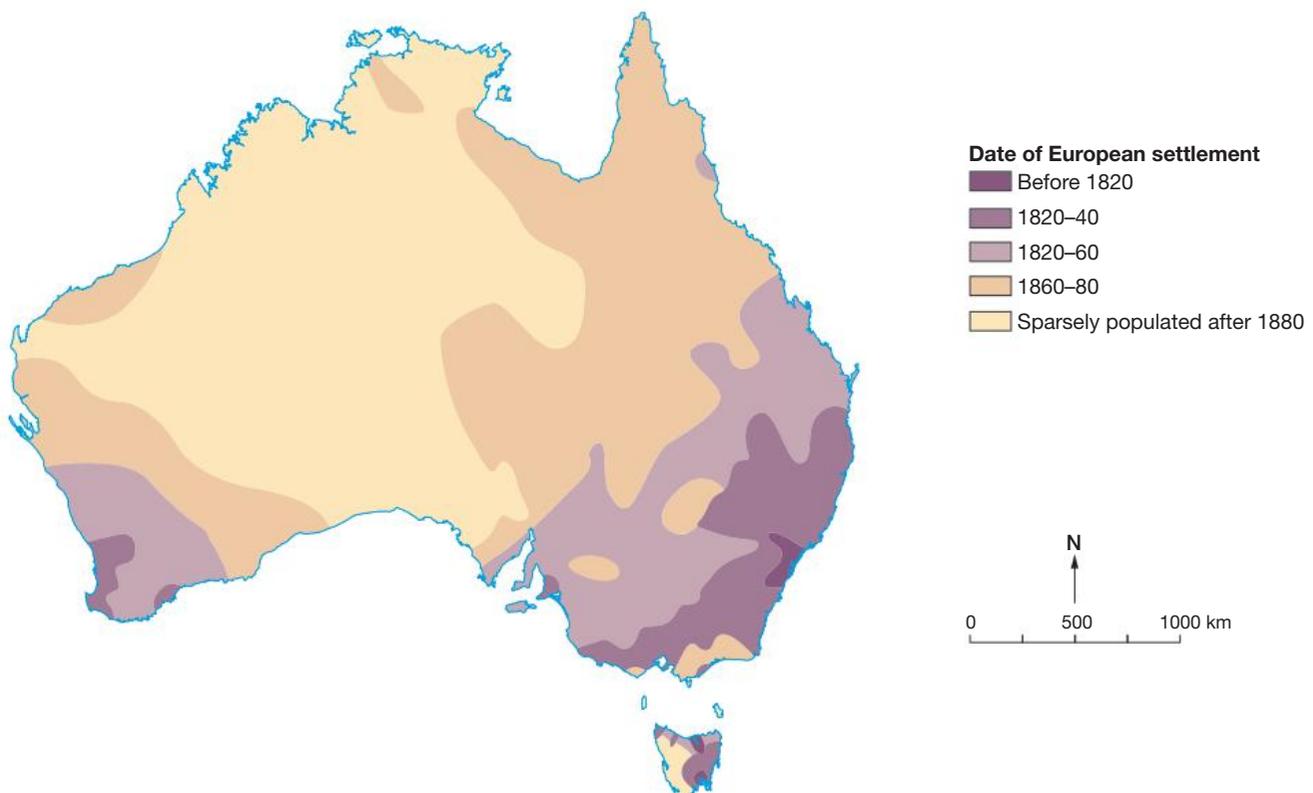
### The colonial mindset

When the British arrived, they laid claim to the country, applying the notion of *terra nullius*—a land belonging to no one. They justified this position by arguing that there were no permanent structures to indicate ownership. Thus, the occupancy rights of the original inhabitants were ignored and, from an Aboriginal perspective, the invasion of their lands by Europeans began.

### Missions and reserves

The colonial frontier spread out from the British colony in New South Wales across the continent during the nineteenth century (see Figure 10.3). There were inevitable conflicts as Aboriginal people resisted having their food and water supplies taken away from them. They were excluded from their traditional lands. Some were offered refuge on mission settlements, but they were expected to adopt European ways (see Figure 10.4). The government also established reserves where they could protect and control Aboriginal communities, but the conditions were often very poor. Many drifted to the edges of towns, and lived in the worst of circumstances.

10.3 Settlement of Australia





10.4

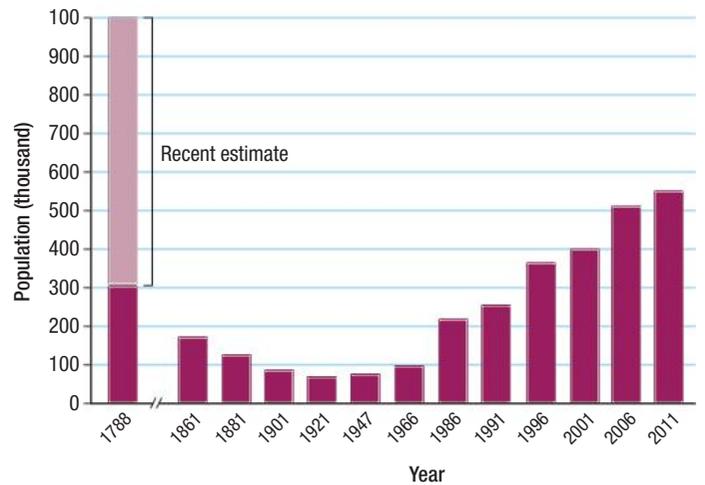
An Aboriginal community outside the church of a mission at Lake Tyers in Victoria's Gippsland region in 1910

Indigenous Australians were severely affected by the spread of European settlement. They had no immunity to introduced diseases such as influenza, tuberculosis and smallpox. Disease swept through communities even before they came in direct contact with any settlers. The Indigenous population dipped below 100 000 in the first half of the twentieth century, as shown in Figure 10.5.

## Consequences of dispossession

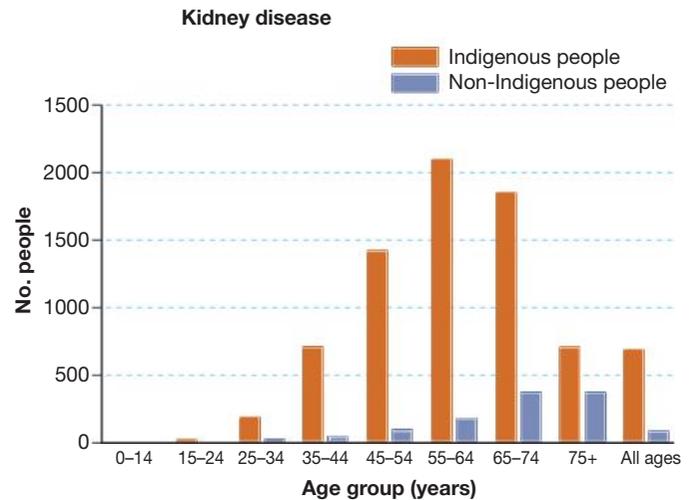
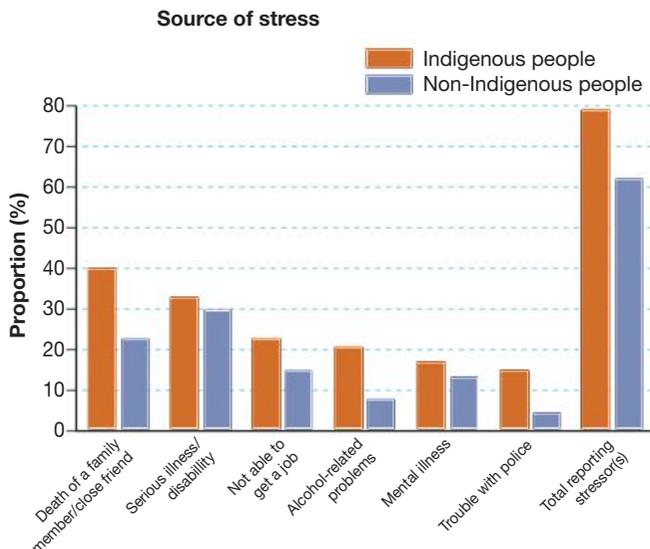
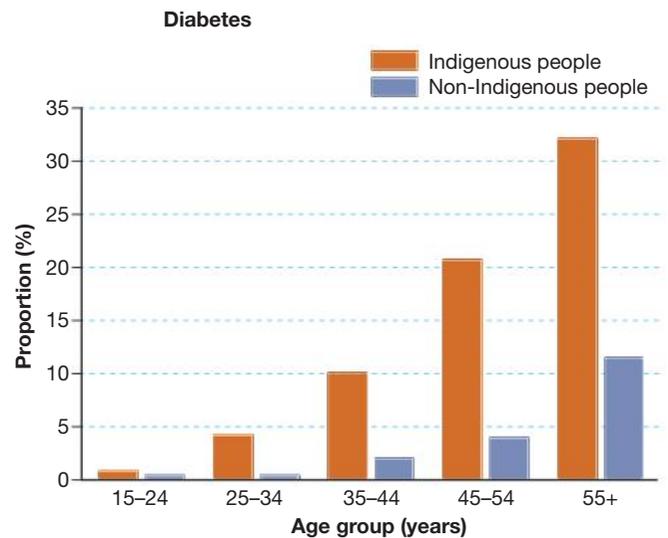
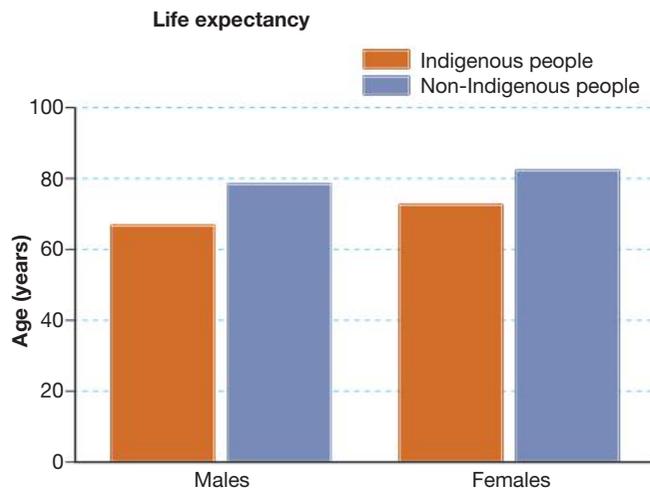
The forced relocation of Indigenous Australians from their traditional lands to missions and settlements had a dramatic impact on their health and wellbeing. The social consequences of **dispossession** and marginalisation compounded the problems. They could no longer support themselves as they had done successfully for tens of thousands of years. This resulted in a dependence on government welfare payments. They were pushed into remote areas, far removed from many of the services most Australians take for granted.

10.5 Changes in the Indigenous population



Source: ABS

10.6 Indigenous and non-Indigenous populations on selected health-related matters



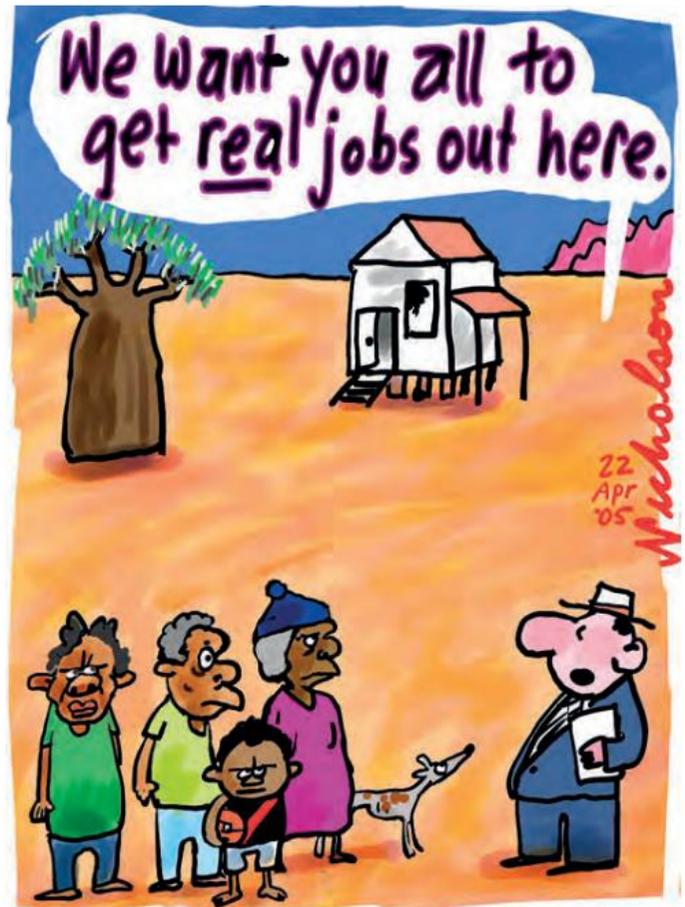
Source: ABS, 2009

Indigenous Australians generally have poor health compared with other Australians. Heart disease is a major cause of premature death, and diseases such as diabetes, liver and kidney disease, and cancers linked to smoking, are more prevalent in Indigenous Australians, as illustrated in Figure 10.6. The health of Indigenous people prior to their contact with Europeans was much better, as they had a more nutritious diet and an active lifestyle.

Discrimination, depression, poverty and idleness feed behaviours that affect quality of life. Drug and alcohol addiction and abuse have become embedded in many Indigenous communities, with serious consequences. Heavy drinking brings on health problems and leads to violence, which often triggers assaults, self-harm, and family breakdowns.

### DID YOU KNOW?

Indigenous people are twice as likely to be smokers than non-Indigenous people. Petrol sniffing has also become common in young males, who risk brain damage and premature death.



10.7 Cartoon by Nicholson, *The Australian*, 2005

## ACTIVITIES

### Knowledge and understanding

- 1 Explain how the British justified their claim on Australia.
- 2 Outline how the Aboriginal way of life was affected by the spread of settlement.
- 3 Describe how Aboriginal health and wellbeing suffered.

### Applying and analysing

- 4 Study Figure 10.7. As a class, discuss the point Nicholson is seeking to make in his cartoon. What is the link between work and social and economic disadvantage?

### Geographical skills

- 5 Study Figure 10.5 then answer the following questions.
  - a What was the estimated percentage change in population from 1788 to 1921?
  - b For how many decades was the population estimated to be below 100 000?



- 6 Study Figure 10.6. Using data from the graphs, write a paragraph comparing Indigenous and non-Indigenous population on the health-related issues illustrated.

### Investigating

- 7 Research the living conditions of Aboriginal and Torres Strait Islander people after they were displaced by European settlement. Prepare an annotated visual display contrasting this existence with their traditional way of life and demonstrate how it affected their health and wellbeing.

## Measuring wellbeing

The difference in the levels of disadvantage between Australia's Indigenous and non-Indigenous populations is widely acknowledged and considered unacceptable. Aboriginal and Torres Strait Islander people are disadvantaged in many ways. Obtaining accurate measurements of such disadvantage is vital if we are to eliminate the gap.

### Measures of wellbeing

#### Life expectancy

The differences are most apparent in the population pyramid in Figure 10.8. The shape for the Indigenous population resembles that of a developing country, with lower life expectancies and a younger population. Over one-third of the population is aged 15 years or less, compared to one-fifth of the non-Indigenous population.

Life expectancy is a broad indicator of a population's long-term health and wellbeing. In 2010–11, the life expectancy for Indigenous males was estimated to be 69.1 years, which is 10.6 years less than for non-Indigenous males. For Indigenous women it was 73.7 years, some 9.7 years below non-Indigenous women. In 2011, fewer than 4 per cent of Indigenous people were 65 years or over, compared to 14 per cent of non-Indigenous people. Figure 10.8 shows that there has been a slight improvement in recent years, but the life expectancy of Indigenous Australians is still unacceptably low compared with that of other Australians.

#### Health

A health survey of Aboriginal and Torres Strait Islander people in 2012–13 revealed that:

- one in six Aboriginal and Torres Strait Islander people had asthma (twice as high in remote areas)
- one in eight reported diseases of the ear and/or hearing problems
- one in eight had heart disease
- they were three times more likely than non-Indigenous Australians to have diabetes.

#### Education

There is a significant number of Indigenous students who are failing basic literacy and numeracy tests, and a large gap is evident between Indigenous and non-Indigenous educational outcomes, particularly at higher

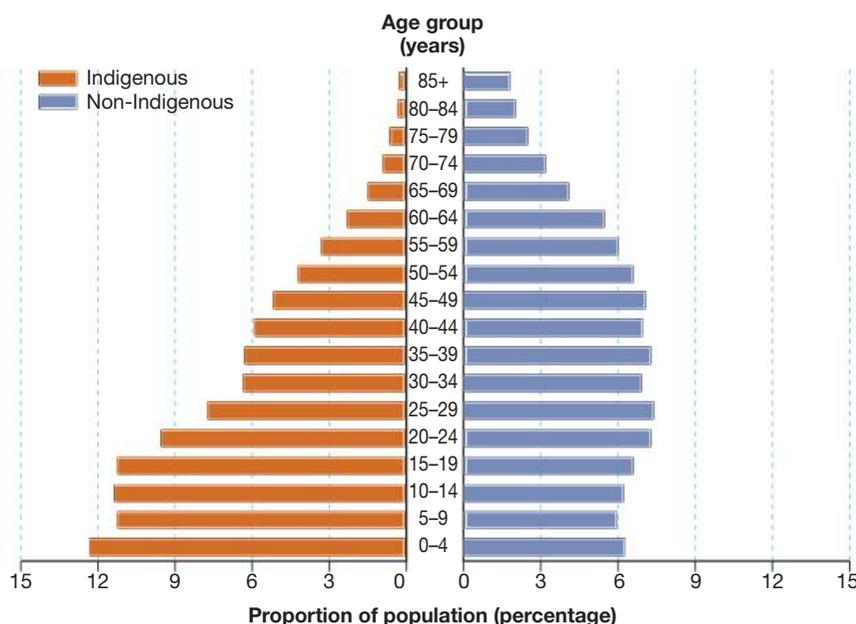
levels of attainment. Gaining an educational qualification provides broader life prospects for young people. In 2011, only 44 per cent of the Aboriginal and Torres Strait Islander population aged 15–64 had attained Year 12 or Certificate Level II or above, nearly 30 per cent less than the non-Indigenous rate of 73 per cent.

### Impact of remoteness

As Figure 10.9 illustrates, disadvantages tend to increase with the degree of remoteness. Indigenous people in all remote and very remote areas are comparatively disadvantaged across each of the measures of education, employment and income. A rate ratio compares the rates of disadvantage in two groups that differ by demographic characteristics or exposure history. In Figure 10.10, the rate for the Indigenous population is divided by the rate for the non-Indigenous population.

10.8

Population pyramid of Indigenous and non-Indigenous populations

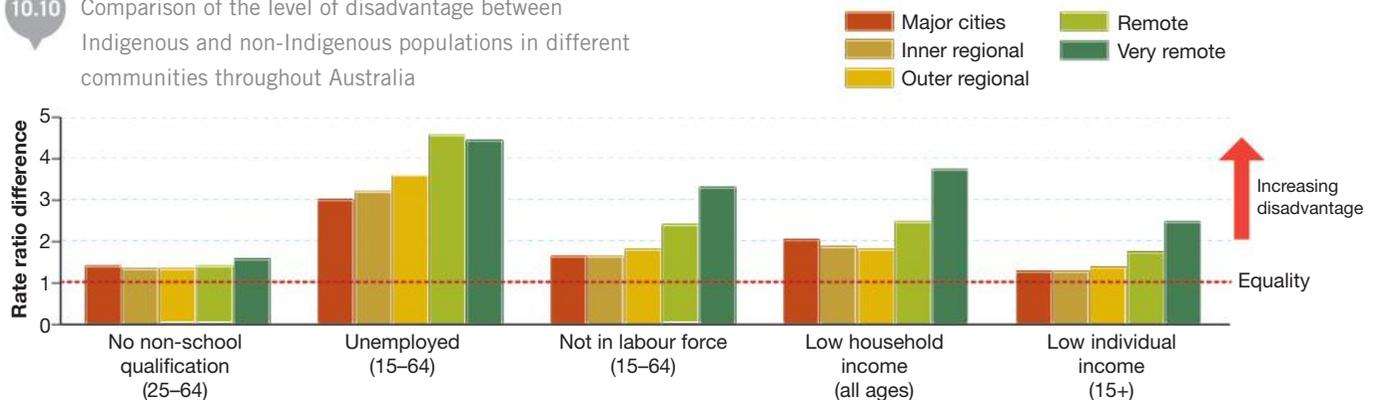


	Aboriginal and Torres Strait Islander (years)	Non-Indigenous (years)	Total	Difference between non-Indigenous and Aboriginal and Torres Strait Islander life expectancy at birth (years) <sup>(a)</sup>
<b>Males</b>				
Major cities and inner regional	68.0	79.9	79.7	11.9
Outer regional, remote and very remote	67.3	78.5	77.4	11.2
<b>Females</b>				
Major cities and inner regional	73.1	83.0	82.8	9.9
Outer regional, remote and very remote	72.3	82.5	81.5	10.2
<b>Difference between males and females</b>				
Major cities and inner regional	-5.1	-3.1	-3.1	--
Outer regional, remote and very remote	-5.0	-3.9	-4.1	--

(a) Differences are based on unrounded estimates  
-- Not applicable

Source ABS, Life tables for Aboriginal and Torres Strait Islander Australians, 2013

Comparison of the level of disadvantage between Indigenous and non-Indigenous populations in different communities throughout Australia



Source ABS, 2006 Census of Population and Housing

## ACTIVITIES

10.3

### Knowledge and understanding

- 1 Why is it important to measure disadvantage?
- 2 Compare the life expectancy of Indigenous and non-Indigenous populations.
- 3 Describe the health of Indigenous Australians.
- 4 Describe the effect of remoteness on the levels of disadvantage experienced by Indigenous Australians.

### Geographical skills

- 5 Study Figure 10.8 then do the following tasks.
  - a Compare the percentages of the Indigenous population in the 0–9 years cohort with the percentage of non-Indigenous Australians.

- b Compare the percentage of the Indigenous population above 65 years with the percentage of non-Indigenous Australians.
- 6 Study Figure 10.10 then answer the following questions.
    - a In what measurement are the Indigenous population most disadvantaged compared with the non-Indigenous population?
    - b In what type of regions do Indigenous Australians experience the most disadvantage?

# Disadvantage in remote communities

The level of disadvantage experienced by Indigenous Australians increases with the degree of geographic remoteness. Overcoming such disadvantage is regarded as a national priority by the Australian Government. The issues are often complex, however, and will require governments to work with Indigenous communities rather than simply impose what outsiders consider to be the most appropriate response.

## Recognising the disadvantage

Isolation compounds the multiple disadvantages suffered by remote communities (see Figure 10.11), already shattered by family dysfunction. The people are often welfare-dependent and there are serious social issues associated with drug and alcohol abuse and gambling.

## Education

Indigenous schools—those with more than 75 per cent Indigenous enrolments—have the highest educational failure rates in Australia. Some 20 000 students are enrolled in such schools, which are located mainly in bush communities on Indigenous land where there is no private-sector economic activity and no real jobs. As a result, the inhabitants are totally dependent on welfare. These schools typically have failure rates of more than 90 per cent. In the few schools where specific programs have been put in place to get students to school, and students make progress from day to day and from week to week, attendance booms.

## Education in remote communities

Improving educational outcomes is the key to overcoming disadvantage. Acquiring literacy and numeracy skills improves employment prospects. Breaking away from welfare dependency and gaining meaningful work transforms lives and flows on to better health and living conditions. This can only be achieved if children are able to attend a school. Some live so far away from existing schools that it would not even be possible to get there in a day. Those living in the remotest areas suffer the greatest disadvantage and ways must be found to address the situation.

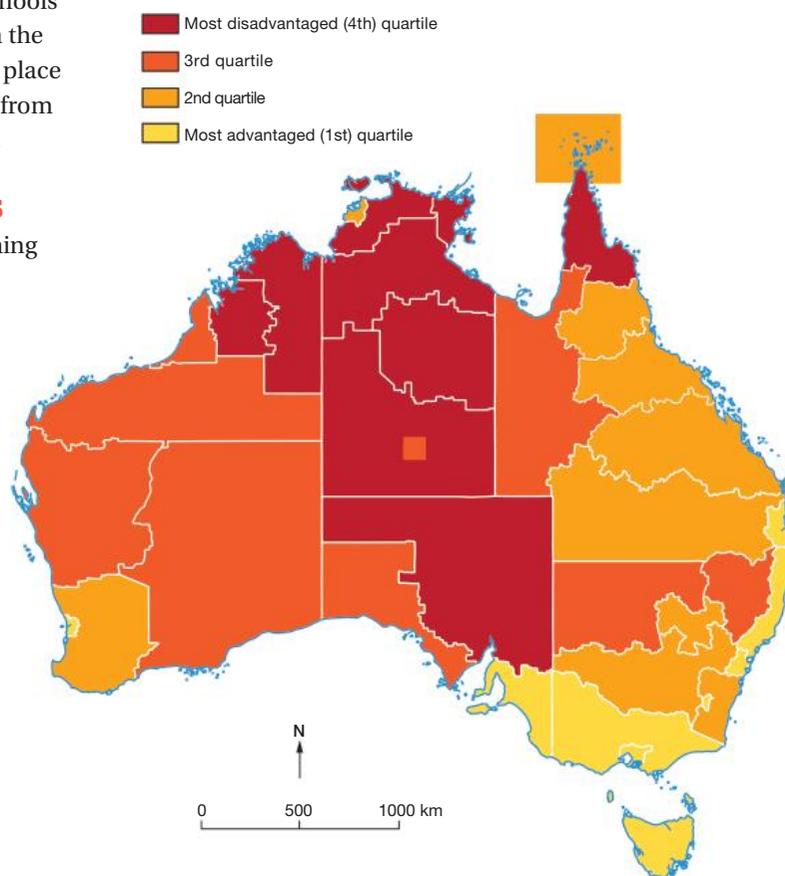
Getting students to attend schools regularly is difficult in communities where parents do not value education. It is of the utmost importance that school attendance is effectively promoted.

The success of a school is closely tied to the quality of the teachers. Good teachers must be provided with incentives such as public housing to remain in remote communities, where they are desperately needed.

## Reconnecting with country

Traditional lands are deeply significant to Indigenous Australians, and those who have lost their connection to it have suffered the most. The barriers that prevent Aboriginal and Torres Strait Islander people from living on their Country according to their culture need be removed.

10.11 Disadvantage/advantage across Australia. The most disadvantaged parts of Australia are in remote areas.



## SPOTLIGHT

### Remote community of Yuendumu

With a population of 800 people, Yuendumu is one of the largest Aboriginal communities in central Australia. As it sits on the edge of the Tanami Desert and is some 300 kilometres north-west of Alice Springs, the community has faced all the problems associated with remoteness. Isolation, idleness and boredom have led to violence and alcohol and substance abuse, especially among young people.

The community faced a crisis in 1993 when half of the teenage population had taken to petrol sniffing and roaming the street in gangs at night. As a response to the crisis, these young people were taken from Yuendumu to

a safe environment at Mount Theo, a remote outstation 160 kilometres away and over 50 kilometres from the closest road, so they could not run away. Here they were looked after by the Warlpiri tribal elders, while their bodies detoxified and recovered from petrol sniffing.

While at Mount Theo, the young people reconnected to their traditional country and its culture with trips to significant sites. There was a mix of recreational and cultural activities, and they were taught how to hunt and track animals, cook traditional food, paint and make their own fires. It was a safe and supportive environment for them to discuss and deal with their problems. The program successfully stopped petrol sniffing in the community.



10.12

Founders of the Mt Theo Program, Johnny Miller OAM and Peggy Brown OAM, who set up the outstation as a place of respite for petrol sniffers in 1993

## ACTIVITIES

### Knowledge and understanding

- 1 Describe the problems faced by remote communities.
- 2 Explain why education is important.
- 3 With reference to the Mt Theo program, assess the importance of connection to Country in overcoming disadvantage.

### Applying and analysing

- 4 Consider the distribution of the Indigenous population throughout Australia. Do you think that efforts to improve the quality of life of Indigenous Australians should be directed to remote areas? Justify your decision.

### Geographical skills

- 5 Study Figure 10.11 then do the following tasks.
  - a List all state and territories from the most advantaged to the most disadvantaged.
  - b What are the most advantaged areas in New South Wales, Queensland and Western Australia? Can you provide reasons for this distribution?

### Investigating

- 6 Research how the young people of Yuendumu are currently being supported. Present your findings in an annotated visual display. Include a location map of Yuendumu.

# Closing the gap

A commitment to 'closing the gap' has been initiated to overcome the disparity in human wellbeing that exists between the Aboriginal and Torres Strait Islander people and non-Indigenous Australians. In 2008, the Council of Australian Governments agreed to a partnership between all levels of government to work with Indigenous Australians on addressing the multiple disadvantages that exist.

## Targets

All governments are committed to six ambitious targets set by the Council of Australian Governments (COAG). These are listed in Figure 10.13. Over time, a strategic framework has been developed to tackle the underlying causes of Indigenous disadvantage in areas such as life expectancy, early childhood, health, education and employment (see Figure 10.14).

10.13 Closing the Gap targets

Closing the Gap targets	
	Close the life expectancy gap within a generation (by 2031)
	Halve the gap in mortality rates for Indigenous children under five within a decade (by 2018)
	Ensure that all Indigenous 4-year-olds in remote communities have access to early childhood education within 5 years (by 2013)
	Halve the gap for Indigenous children in reading, writing and numeracy within a decade (by 2018)
	Halve the gap for Indigenous people aged 20–24 in Year 12 or equivalent attainment rates (by 2020)
	Halve the gap in employment outcomes between Indigenous and non-Indigenous Australians within a decade (by 2018)

Comprehensive strategies and policies will need to be sustained for a long time given the enormity of the challenge.

Each of the targets is measurable and closely monitored to determine if progress is being made. Results are published annually by the Australian Government in the Closing the Gap reports.

## SPOTLIGHT

### Closing the Gap, Prime Minister's Report, 2014

While progress has been made in some areas, the government conceded that that some targets have not been met.

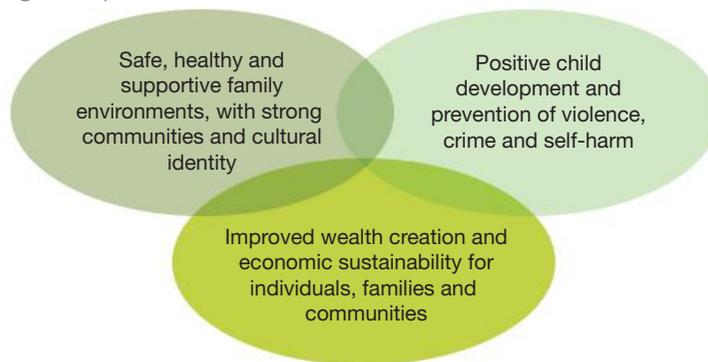
- While there has been a small improvement in Indigenous life expectancy, progress will need to accelerate considerably if the gap is to be closed by 2031.
- The target to halve the gap in child mortality within a decade is on track to be met.
- In 2012, 88 per cent of Indigenous children in remote areas were enrolled in a pre-school program.
- Progress against the target to halve the gap in reading, writing and numeracy within a decade has been disappointing.
- The target to halve the gap for Indigenous people aged 20–24 in Year 12 or equivalent attainment rates by 2020 is on track to be met.
- No progress has been made against the target to halve the employment gap within a decade.

Getting children to school is the Australian Government's number-one priority in Indigenous affairs. Poor attendance means that Indigenous children find it hard to perform at school.

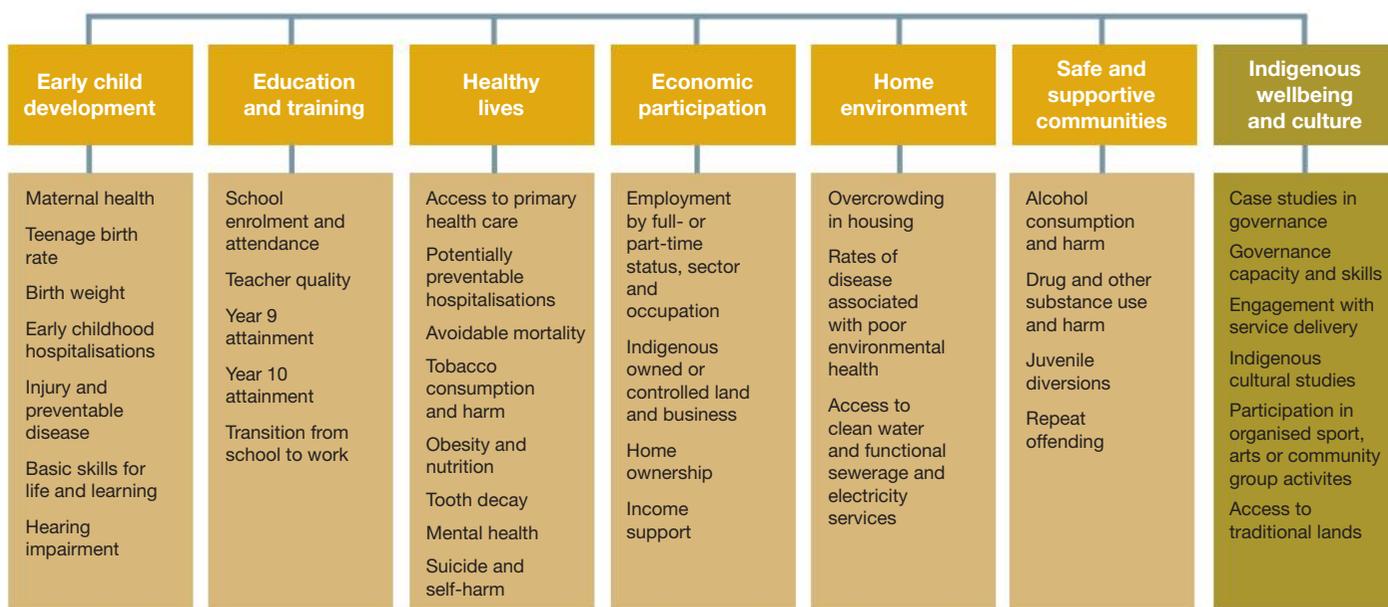
We must break the cycle of non-attendance to ensure that today's children are educated and equipped to become future leaders in their communities.

From Term 1 this year (2014) we introduced a plan to get Indigenous children back to school in 40 remote communities in the Northern Territory, South Australia, New South Wales, Queensland and Western Australia.

Source: Adapted from *Closing the Gap, Prime Minister's Report, 2014*, Australian Government



COAG targets	Headline indicators
Life expectancy	Post-secondary education—participation and attainment
Young child mortality	Disability and chronic disease
Early childhood education	Household and individual income
Reading, writing and numeracy	Substantiated child abuse and neglect
Year 12 attainment	Family and community violence
Employment	Imprisonment and juvenile detention



## ACTIVITIES

### Knowledge and understanding

- 1 Explain why the Closing the Gap program was initiated.
- 2 Summarise the findings of the Closing the Gap Prime Minister's Report 2014.
- 3 Account for the government choosing 'getting children to school' as its number-one priority.

### Applying and analysing

- 4 Refer to Figure 10.14. Select one of the COAG targets and show how some of the strategic areas for action shown would work towards achieving that target.

- 5 Create a symbol to represent the Closing the Gap commitment.

### Investigating

- 6 Research the strategies used by the Australian Government to improve the school attendance of Indigenous students. Present your finding in a newspaper report.

## Self-help initiatives

While national leadership and funding is important, local and regional actions are crucial in addressing the multiple disadvantages faced by Aboriginal and Torres Strait Islander people. Self-help initiatives empower Indigenous people and build upon and reinforce a network of resources and relationships within the local community. The Wik people of Cape York Peninsula are back on their land and forging a new future for their people.

### Indigenous stockmen back in the saddle where the wild cattle roam

When wild cattle mustered off the coastal wetlands of Cape York got top price at the Mareeba sales in September 2012, the Wik people took a step out of the tortured past of welfare dependence towards securing their economic future.

Just weeks before the Federal Court travelled to the missionary town of Aurukun, 650 km northwest of Cairns, to deliver the final determination of the 20-year Wik native title case, the \$1.32-a-kilogram paid for the herd of Brahman and red horn cross marked an equally important milestone for a community besieged by addiction, violence and unemployment.

Frustrated with decades of government programs, offering only menial jobs and little training, four of the Wik clans in 2011 incorporated a company, APN Cape York, that is drawing on traditional and historical knowledge and the latest in cutting-edge innovation to turn a profit and return people to their traditional 'country'.

With the help of contracted cattlemen, young men who were jobless and on 'the grog' before being recruited by APN are resurrecting the legend of the



Indigenous stockman, mustering the progeny of the herd left behind after the 1990s demise of the white-run pastoral company. [See Figure 10.15.]

Stephen Marpoondin told *The Weekend Australian*: 'This is part of our history, this is what our fathers and grandfathers did. There was pride and it hasn't been there for a long time.'

'But now we are back on our land, working, learning, the fellas in town look up at us, they want to get away from the grog and fighting and come work with us.'

The company's head, Canberra Grammar-educated traditional owner

**10.15** With the help of contracted cattlemen, young Aboriginal men are being recruited to muster the wild cattle.

Bruce Martin, said APN arose out of anger about the 2009 imposition of the Bligh Government's Wild Rivers preservation laws throughout Cape York and a growing desire for the community to determine its own destiny.

The son of traditional woman Dorothy Pootchemunka and anthropologist David Martin said APN was driven by

the families living in Aurukun who met monthly to direct its operation. 'The company came out of the families talking about what they wanted for the future and to take control,' he said. 'We want sustainable businesses, ones that employ our people, properly train our young people as stockmen, builders, plumbers.'

Modestly resistant to be labelled a 'leader', Mr Martin said it was also about returning the community 'to country', the expansive plains and wetlands teeming with wildlife, through improvements in infrastructure and the economic need to work the land.

Camps of workers and their families are springing up along the lakes and waterways as the business of mustering and yarding the wild cattle runs from dawn to dusk. Indigenous stockmen work alongside the few non-indigenous contractors, veteran cattlemen who are passing on their expertise. The main camp, where plans are made and orders given, is a cheerful place, with a permanent fire, an endless supply of food and a shared atmosphere that important work is being done.

'What the governments never understood, and where the regional organisations have fallen short, is



that they prescribed to us what they thought needed to be done,' Mr Martin said.

'But to get any plan to work, you need to take ownership and that is what we have done.'

APN is also moving into the construction business and has set up a ranger division, winning competitive tenders for environmental management programs across the 750 000 hectares of 'country' that stretches along the western side of the Cape York Peninsula.

Using traditional burn-off methods, they have reduced the number of late dry-season fires sparked by lightning

**10.16** The young stockmen are back on their land, learning and working and taking pride in what they are doing.

strikes in an abatement program being banked as carbon credits, with the oversight of the CSIRO, to be eventually traded on the market.

The burgeoning success of APN, governed by a board made up of people from the four clans, is more evidence of a seismic shift among the leadership of the 1200 people living in Aurukun to tackle dysfunction and to move from a reliance on 'sit-down money'.

Source: Michael McKenna, *Weekend Australian*, 27 October 2012

## ACTIVITIES

### Knowledge and understanding

- 1 Outline the problems faced by the Wik people in Cape York.
- 2 Describe how they are undertaking to change their lives and why they take such pride in their efforts.
- 3 Explain the impact this initiative has on the community.

### Applying and analysing

- 4 As a class, discuss the following questions:
  - a Why has this initiative been successful where other regional organisations have fallen short?

- b What is meant by the final comment: 'to tackle dysfunction and to move from a reliance on "sit-down money"'?

### Investigating

- 5 Research the history of Indigenous stockmen in Australia and create a collage of photographs.
- 6 Research the Wik native title case. Prepare a summary report on this case and assess how it is significant to the current self-help initiative being undertaken by the Wik people.



# Role of NGOs

While governments have an important leadership role in addressing Indigenous disadvantage, non-governmental organisations are also very active in helping to build better lives for the Aboriginal and Torres Strait Islander people. In many instances, they work closely with people to build on and strengthen the network of relationships and the resources of local communities.

## What NGOs offer

Given all that needs to be done to ensure that the life opportunities of Indigenous Australians are comparable to those of non-Indigenous Australians, non-governmental organisations (NGOs) have a significant role to play. By their very nature, those who work or volunteer in such organisations display a genuine desire to make a difference in the lives of others. The NGOs are able to raise funds from donations or subscriptions, and this money is put to use in supporting initiatives to enhance the wellbeing of Indigenous people.

Global NGOs often become involved in widely publicised issues. The situation of the Aboriginal and Torres Strait Islander people has drawn international attention. Amnesty International has been vocal in campaigning to protect the human rights of Indigenous Australians, especially the maintenance of their connection with their traditional, ancestral lands.

Many Australian NGOs are very committed to working with Indigenous Australians.

## Anglicare NT

Anglicare NT is one of the main providers of government-funded welfare, social justice and community development programs in the Northern Territory. Over eighty-five different programs now run in urban, regional, rural and remote communities, with 300 staff and 250 volunteers working for the organisation.

- **Child and Youth Residential Support Service:** This provides a stabilisation, assessment and transition unit for children and young people aged between 8 and 17 years who cannot immediately be placed with kin or in foster care. They are assisted in reconnecting with family and schooling, and their health problems are attended to.
- **East Arnhem Youth Services:** This is a free and confidential service that provides support, information, referral and practical assistance to young people,

families and communities. It delivers the following programs:

- ReConnect—early intervention youth homelessness program, linking young people, family and community
- Youth Drop In Activity Zone—after school and holiday and activity events
- Your Choice Nhungu Malatjarryunaru—information, education and activities for young people and families, reducing alcohol and drug-related harm.
- **Paperbark project—Bellies, Birth and Bubs:** This program provides pregnancy awareness sessions, runs youth-friendly childbirth education classes, supports remote-based infant/maternal health/midwifery practitioners, hosts community awareness events and provides targeted perinatal support for Indigenous young women from remote communities.

10.17 Paperbark project—Bellies, Births and Bubs: an Anglicare NT program



## The Fred Hollows Foundation

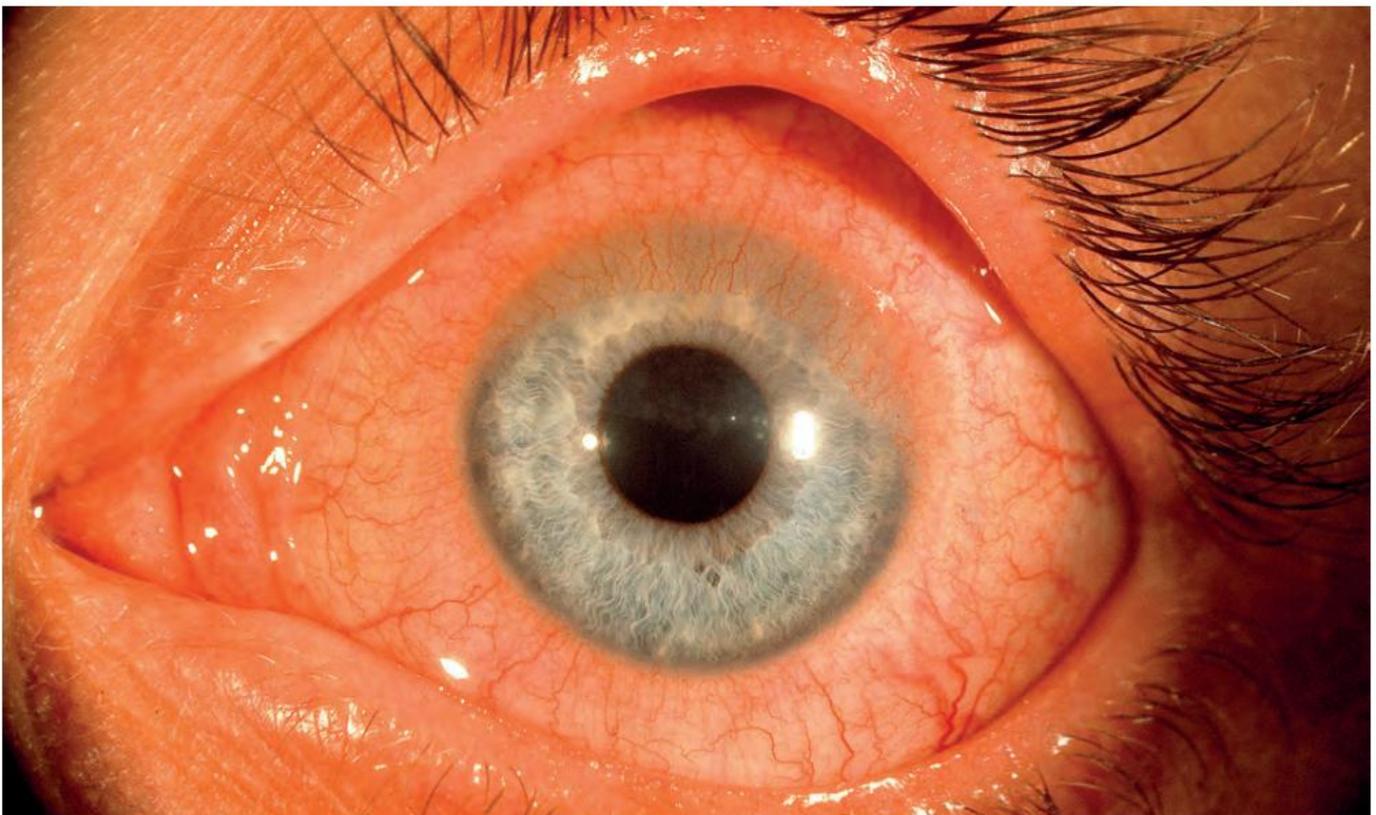
The Fred Hollows Foundation is inspired by the work of the late Professor Fred Hollows (1929–93). When he became aware of the high incidence of eye disease among Aboriginal and Torres Strait Islander children and adults, Professor Hollows organised the provision of medical services to treat people in remote areas. Professor Hollows was disturbed that the preventable disease trachoma was widespread among the Indigenous population, yet not found in the non-Indigenous population.

Fred Hollows inspired many doctors and other health professionals to volunteer their time for his national program, National Trachoma Eye Health Program, to eliminate eye disease in Indigenous Australians. From 1976 to 1978, his teams visited 465 communities and screened 100 000 people, of whom 62 000 were Indigenous Australians.

They found that nearly half Australia's Indigenous population had trachoma, and in some regions in the Northern Territory and Western Australia, the rate was 80 per cent. Approximately 27 000 people were treated for trachoma, more than 1000 operations were performed and more than 7000 pairs of glasses were dispensed.

The Fred Hollows Foundation was established in 1993. It continues to work to achieve Professor Hollows' vision of a world in which no one is needlessly blind, as is shown in Figure 10.18. Since 2013, the foundation has been working with governments to restore the sight of 200 Indigenous people, with programs ranging from the Outback Eye Service targeting thirty Indigenous patients in western New South Wales, to running a Cataract Eye Surgery Week at Bourke Hospital in 2014.

**10.18** A close-up of a person with trachoma, a chronic inflammation of the external lining tissue of the eye and eyelids



## ACTIVITIES

### Knowledge and understanding

- 1 Describe how NGOs are active in addressing Indigenous disadvantage.
- 2 Outline the services provided by Anglicare NT.
- 3 Assess the work of the Fred Hollows Foundation.

### Investigating

- 4 Select an NGO that works with Indigenous people. Research this NGO and create a pamphlet to promote the NGO and encourage people to donate to it.



# Review and reflect **3**

## Activity 1

### Millennium Development Goals

- a** Investigate the United Nation's Millennium Development Goals.
- i** What are the goals for the provision of clean water and sanitation?
  - ii** Is progress being made in meeting these goals?
  - iii** What other issues are being addressed by this initiative?
- Present your findings as a report.

- b** Investigate alternative approaches to the provision of sanitation in cities in developing countries, especially approaches sponsored by NGOs and international bodies such as the World Bank.

Or

Investigate the contribution of non-government organisations to the UN's Millennium Development Goals initiative. Give specific examples of the projects sponsored by NGOs. Evaluate the success of such initiatives.

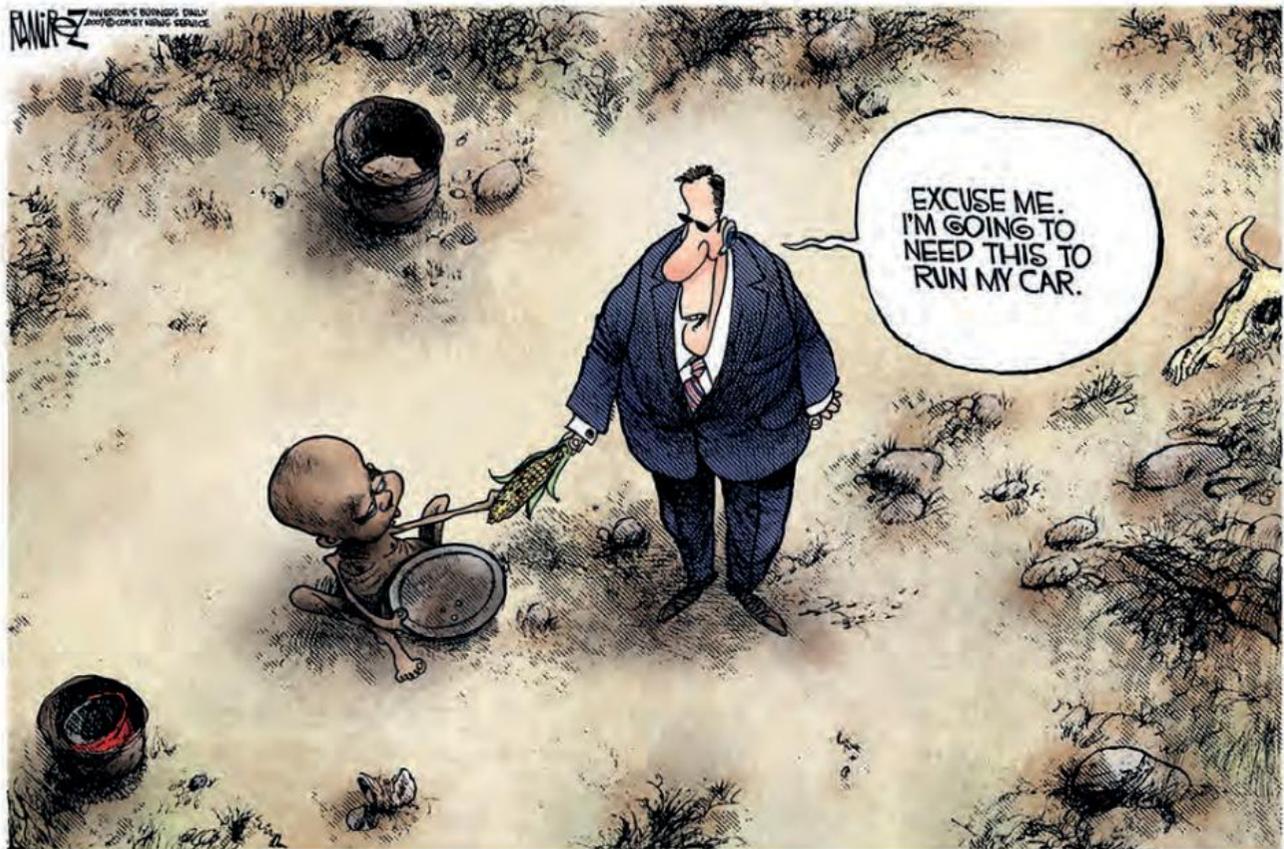
## Activity 2

### Development issues: Cartoon interpretation

Study Figure R&R 3.1. As a class, brainstorm all the development-related issues raised by this cartoon. Make a copy of the cartoon and annotate it, using the points raised in the discussion.

R&R  
3.1

Competition for the use of natural resources



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## Activity 3

### Class debate

Debate the following topic: 'The pursuit of economic growth rather than social justice is the best way to help the poor. The benefits of growth will eventually trickle down'.

R&R  
3.2

Pathways to enhanced human wellbeing



## Activity 4

### Movie study

*Slumdog Millionaire* is the story of an Indian orphan, Jamal, who was born in the slums of Mumbai. He wins 20 million rupees on 'Who Wants to be a Millionaire?', but his success during the program raises questions. How could an uneducated 'slumdog' make it so far on such a challenging game show? Did he cheat? Or is it destiny? The answer is revealed through flashbacks and memories of a painful journey that has led Jamal to the game's 'hot seat'.

View the movie and then, as a class, discuss the following questions:

- What does the movie reveal about the quality of life experienced by Jamal and other Indians?
- What does the movie reveal about Indian society?
- How do criminals take advantage of India's slum-dwelling children?
- Would you have liked to live the life Jamal experienced?

## Activity 5

### Speech interpretation

... It [reconciliation] begins, I think, with the act of recognition. Recognition that it was we who did the dispossessing. We took the traditional lands and smashed the traditional way of life. We brought the diseases. The alcohol. We committed the murders. We took the children from their mothers. We practised discrimination and exclusion.

It was our ignorance and our prejudice. And our failure to imagine these things being done to us. With some noble exceptions, we failed to make the most basic human response and enter into their hearts and minds. We failed to ask—how would I feel if this were done to me?

As a consequence, we failed to see that what we were doing degraded all of us ...

Source: from a speech by Paul Keating, former prime minister of Australia, at Redfern Park in Sydney, 10 December 1992

Study the extract from Paul Keating's famous Redfern address.

- Explain, in your own words, what Keating is saying in the extract.
- Why do you think this speech is considered to be very important for the reconciliation process?
- Why would some people object to a prime minister making such a statement? Do you think the statement is justified? Explain.
- What is meant by the term 'empathy'?

## Activity 6

R&R  
3.3

### Indigenous Australians: Cartoon interpretation

- Study the cartoons shown here. Identify the issues being addressed by the cartoonist and write a brief explanation of each. Working in a group, discuss your interpretations. In your group, reach agreement on the meaning of each cartoon. Share your group's views with the rest of the class.
- Using the cartoons, relevant information in the text and your own knowledge, evaluate the opinion adopted by the cartoonist. Does the cartoonist seem to favour one particular point of view or perspective? If so, how did you determine this? What do you think is the aim of the cartoonist?
- Select one of the cartoons. Write a report outlining the issues it raises.



R&R  
3.4



R&R  
3.5



R&R  
3.6



R&R  
3.7



R&R  
3.8



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