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geography
VICTORIAN CURRICULUM

Mark Easton

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Geography skills

Oxford Big Ideas Geography

Oxford Big Ideas Geography is a brand-new series developed and written to meet the requirements of the Victorian Curriculum: Geography across Years 7–10.

Key features

Each chapter of *Oxford Big Ideas Geography* is structured around key inquiry questions from the Victorian Curriculum. Each unit of the text supports teachers and students as they adopt an inquiry-based approach to the key learning areas in geography.

The learning sequence in each chapter is clearly set out under key inquiry questions. Students are encouraged to use their prior knowledge and make predictions at the start of each new topic.

Stunning full-colour photography generates discussion and interest.

Each unit of the Student book combines a range of engaging source materials – such as photographs, videos, data tables, graphs and illustrations – with supporting questions and activities.

Check your learning activities accompany every unit, allowing students to consolidate and extend their understanding. These are graded according to Bloom's Taxonomy – catering for a range of abilities and learning styles.

Source materials – such as photographs, technical illustrations, infographics, cartoons and graphs – simplify difficult concepts and engage reluctant learners.

Complete coverage of all geographical concepts and skills is provided in 'The geography toolkit'. This can be used as an introductory unit of work or a stand-alone reference throughout the year.

Geographical concepts and skills are clearly outlined in a stand-alone reference section called 'The geography toolkit'. All of these concepts and skills are also integrated throughout the text so students can see them at work in context.

Rich task activities encourage students to apply the knowledge and skills they have learned in each chapter to a new and interesting case study, event or issue.

Extend your understanding activities challenge students to conduct further research, or complete group work, to deepen their understanding of an issue or skill being investigated.

Skill drill activities guide and support students step by step as they learn and apply key skills.

Digital support

obook assess

Student **obook assess** provides a fully interactive electronic version of the print Student book in an easy-to-read format. A host of additional resources for students – such as videos, worksheets, interactives objects, online quizzes and multimedia links – are linked to each unit in the book making them easier to access than ever before.

obook assess is compatible with laptops, iPads, tablets and IWBs, and access to content is provided online and offline.

TEACHER obook assess

Teacher support is offered in digital format via **Teacher obook assess.** Teacher notes, answers, tests, additional worksheets, lesson ideas, planning tips and assessment advice are provided for every unit. **Teacher obook assess** allows teachers to manage their classes by assigning work, tracking progress and planning assessment.
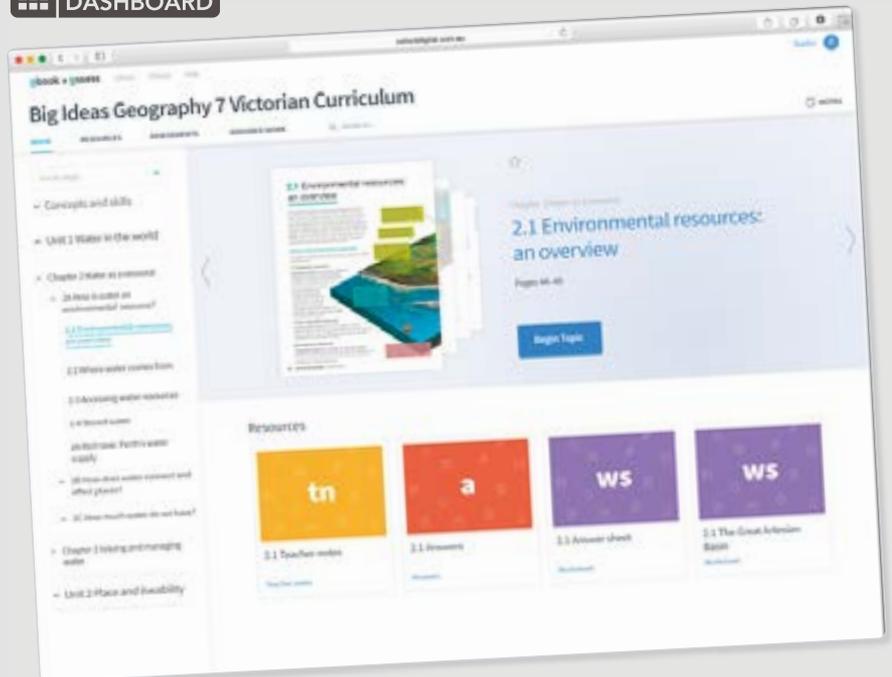
Flevoland, the Netherlands
Located in north-western Europe, the Netherlands has 450
kilometres of coastline along the North Sea. It is one of the most
densely populated places on Earth and is also very prone to flooding.
This makes coastal change and management very important. Dykes,
dams and floodgates are used to control the constant risk of flooding
from storm surges, and wind power from turbines that line the coast
are used as a source of renewable energy.

geography

Concepts and skills

Unit 1 Environmental change and management

Unit 2 Geographies of human wellbeing

The geography toolkit

Geography is the study of the places that make up the world around us. Geographers are interested in how human activities and natural processes change the Earth's places, as well as the links between these places. More than ever before, geographers help other people understand how change affects people and places and how this change can be managed.

Geographers have a sense of wonder and curiosity about the world and this leads them to ask questions about what they see and experience.

Geographers use a range of key concepts and skills to answer such questions. Each of these concepts and skills is a tool that you can use to better understand your world. As you master each of these concepts and skills you will gradually fill your toolkit with a range of useful geographical tools. These will help you better understand this amazing planet.

1A
What are the geographical concepts?

1B
What are the geographical skills?

chapter **1**

Source 1 Mount Kilimanjaro, Africa's highest peak

1C
What is fieldwork?

1D
What are the career opportunities for geographers?

1.1 Geographical concepts

Geographers use seven key concepts to help investigate and understand the world. These concepts provide a framework to thinking geographically and will help guide you through every geographical inquiry. At times you will use several of these concepts at once, while at other times you may focus on just one. The seven key concepts in geography are:

- **place**
- **sustainability**
- **space**
- **scale**
- **environment**
- **change**.
- **interconnection**

Place

A place is a part of the Earth's surface that is identified and given meaning by people. For example, the Serengeti – which is a vast ecosystem in Africa – is a place. It is famous for its enormous plains filled with a range of wildlife. Places aren't defined by size, however. They can be very large, like a whole continent, or small, like a corner of a library. Your home and school are important places for you, because they are places where you live and spend a lot of time.

Places can be natural (that is, shaped by the environment and largely unchanged by humans), or built (that is, constructed by humans). Each place is unique, with its own set of characteristics.

The life of every person and animal on Earth is influenced by place. Places determine our relationships with one another. Our closest relationships are likely to be with people in places that are physically near. The environmental and social qualities of a place all influence the way we live. Climate, landscapes, types of plants and resources, transport networks, entertainment venues and workplaces all have a major impact on our daily lives.

Geographers use the concept of place when they investigate what a place is like, and when they look for explanations for what they see. For example, a geographer visiting Namche Bazaar near Mount Everest (see Source 1) would be interested in the forces that have shaped these mountains.

They would look for clues and begin to ask questions, much like a detective. Why are the sides of the mountains so steep? Why are the highest mountain peaks in a line? Why are there stripes in the mountain peaks? By seeking answers to these
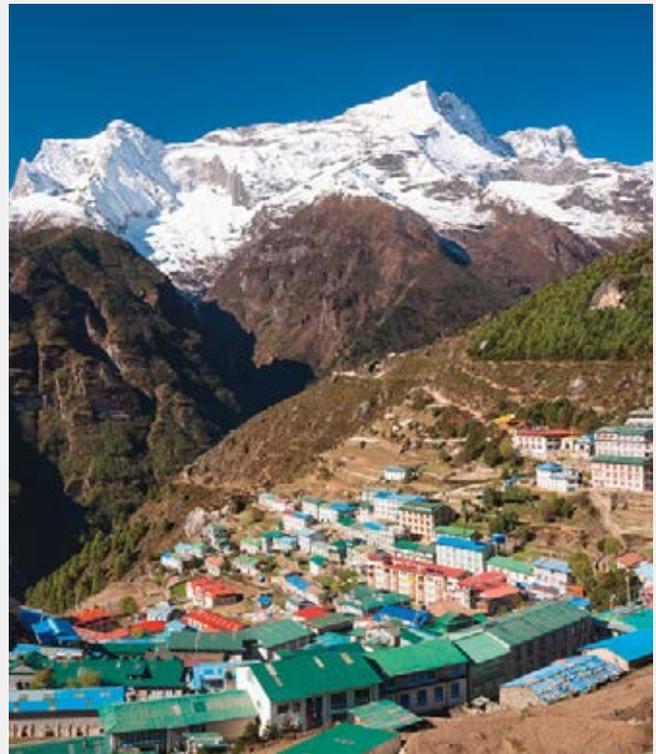
Source 1   The town of Namche Bazaar lies at the base of Mount Everest.

questions the geographer is aiming to explain, not just describe, a place.

Geographers use the concept of place when conducting any geographical inquiry. For example, a geographer visiting Namche Bazaar would use the concept of place to help understand why people choose to live in this challenging environment and how they overcome these challenges. They would also investigate the ways people have altered this environment, and assess the environmental and social impacts of these changes.

Space

To most people, space means the empty universe, but to a geographer it has a different meaning. Geographers use the key concept of space when investigating the way that things are arranged on the Earth's surface. They also investigate the ways people use and change the spaces in which they live.

Geographers look for patterns in the way features and structures are arranged, and the concept of space helps them to do this. It has three main elements:

- location – where things are located on the Earth's surface
- organisation – how and why things are arranged and managed on the Earth's surface by people
- spatial distribution – the shapes and patterns in which things are arranged on the Earth's surface.

At first, you may find you confuse the concepts of place and space, as people often use the words interchangeably. To a geographer, however, the concepts of place and space are quite separate. It may help you to remember that places can be divided and organised into spaces. Spaces also are assigned with different purposes.

For example, a place like your school is organised into different spaces, each with its own purpose. There are spaces for learning, spaces for sports and spaces to eat. Larger places, such as your suburb, town or city, are also organised into different spaces. There are spaces for housing, spaces for businesses, and spaces for sports and entertainment – all with their own function.

Understanding of the location, patterns and planning of spaces helps geographers to make sense of our world. Geographers would look at a photograph like this one of New York City (see Source 2) and might examine it by using the key concept of space in the following terms:

- location – they would observe that Manhattan Island is located in the mouth of the Hudson River and that land is limited. Clearly, there is an open space in the centre of the city. Geographers might identify that it has been designated as a space for recreation and enjoying nature. They may ask questions like, How big is the park? When was it established?
- organisation – they would conclude that there are many tall buildings in a confined area. Were the buildings constructed around a set perimeter, after the park was established? Are the buildings mainly used for business or housing purposes?
- spatial distribution – geographers may investigate how many buildings there are per square kilometre, how sparsely or densely they are situated from each other, and how sparsely or densely they are populated.

Further investigation would reveal that there is a complex network of bridges, ferries, subways and walkways that link the island to surrounding areas. In fact, Manhattan Island in New York is one of the most densely populated places on Earth, with more than 26 000 people living in every square kilometre! New Yorkers would perceive and use the space around them in quite a different way from someone living on a huge block in an outer suburban area.

Geographers also investigate the ways that people use and change the space in which they live. They recognise that different groups of people use space in different ways and that this changes over time. By examining, researching and describing how spaces are used, geographers can further our understanding of the world and help manage it into the future.

Source 2   Manhattan Island in New York is one of the most densely populated places on Earth.

Environment

You will have heard people talk about 'the environment' and probably studied aspects of the environment before. In geographical terms, the key concept of environment means the living and non-living components and elements that make up an area, and the ways they are organised into a system.

Geographers are interested in investigating and describing the relationships between people and the environment. In particular they examine:

- the ways in which different groups of people perceive and use the natural environment and why these perceptions differ
- the ways in which people change the environment and how these changes can be managed
- the impact of environmental hazards on people and how the impacts of these hazards can be reduced.

The world in which we live is made up of many different environments. Some environments are natural (or physical) such as deserts, **grasslands**, mountains, coral reefs, forests, oceans and ice caps. The natural environment provides us with basic resources for living such as food, water and clean air. Natural processes such as tectonic plate movement, **erosion** and weathering have formed these environments over millions of years. In order for an environment to be considered natural its soils, rocks, climate, plants and animals must remain largely untouched by humans. Today there are very few natural environments left on Earth. The Australian World Heritage-listed Heard Island and McDonald Islands are outstanding examples of pristine natural environments with no introduced animals or plant species, and no human impact.

Other environments have been so changed by humans – largely for settlement and economic activity – that very few natural features remain. These are known as built (or human) environments and include large cities, towns, suburbs and areas of farmland. For example, mountainous land in the Philippines has been transformed into terraced pond fields for rice farming by skilfully following the natural contours of the land.

Researching an environment also allows geographers to evaluate how people can best interconnect with that environment, and identify potential risks for people interacting with that environment. For example, examining the landscape and height, as well as the ascent routes of Mount Kilimanjaro (see Source 3) in Tanzania allows prospective travellers to know that, unlike with Mount Everest, they don't need to bring additional oxygen for their climb, but they do need to follow one of six official routes.

The study of different environments helps geographers to better understand and appreciate natural processes, such as how weather works, how mountains are formed and how rainforests and coral reefs grow. The concept helps geographers to analyse the changes humans make to natural environments and better appreciate their impact so that they can be managed more wisely.

Source 3
Mt Kilimanjaro in Africa is a popular place for climbers to interact with the natural environment.

Interconnection

Nothing on Earth exists in isolation. All environments and every living and non-living thing are connected. Geographers use this concept of interconnection to better understand the links between places and people, and how these interconnections affect the environment and the way we live. These connections can be on a local level or a global level.

Natural processes link places and people. For example, the water cycle links the water in the oceans with the land. When it brings rain to inland areas, water flows across the land and into rivers and streams. Farmers rely on this natural link to provide the water they need to grow food.

Links between places and people can affect the way people live. In turn, the way people live can affect places. A relatively small change in one area can have a great impact on another it is connected with. The melting of ice from a glacier at the top of a mountain, for example, will affect the land at the bottom of the mountain. The extra water could potentially damage crops that are being grown there, or the changed conditions may benefit farmers.

Human activities such as the movement of people, the production and trade of goods, and the flow of money within and between different countries also link places and people. Interconnection through electronic means such as mobile phone and Internet is now a part of everyday life for many of us.

Being consumers in a global marketplace also means we are connected to many places via international trade. More than 3000 ships carrying 2 million containers pass through the Port of Melbourne (see Source 4) each year. These ships and the goods they carry link dozens of countries around the world.

Source 4   A container ship prepares to berth at Port Melbourne.

Sustainability

The concept of sustainability relates to the ongoing capacity of the Earth to maintain all life. This means developing ways to ensure the Earth's resources be used and managed responsibly so they can be maintained for future generations.

Sustainable patterns of living meet the needs of the current generations without compromising the ability of future generations to meet their own needs. Many of the world's resources (such as oil, coal and natural gas) are non-renewable. This means that if we continue to use them they will one day run out. Other resources (such as wind, forests, solar and water) are renewable. This means that they replace themselves naturally, or can be replaced to meet the needs of society. Sustainability encourages us to think more carefully about these different types of resources – the ways in which they are formed and the speed at which they are being used. It also encourages us to look more closely at renewable options and take greater care of the Earth. Actions to improve sustainability can operate at a number of levels:

- local – recycling of paper by individuals, schools and households reduces the number of trees that need to be cut down

- national – in Australia, the government has begun to encourage sustainable use of energy by offering incentives to promote the use of solar panels

- international – organisations such as the Marine Stewardship Council (MSC) are working with fisheries and retailers to promote responsible and environmentally viable fishing practices around the world.

There can be debate surrounding the sustainability of an environment, as people or organisations with different interests may put forward different points of view. A tree-logging company may protest that their practices are sustainable because they re-plant as much as they cut down. On the other hand, a conservation group may be equally convinced that a forest cannot be sustained when its trees are cut down. New trees may take decades to grow, in which time the ecosystem will have been altered. Many underdeveloped countries, such as Myanmar (Burma) (see Source 5), face enormous challenges controlling and monitoring forest clearance.

Sustainability is an important concept for geographers. They use it to investigate how natural and human systems work, and understand how resources can be managed in such a way that they will be sustained into the future.

Source 5 Logging in Myanmar (Burma) gives local communities a source of income but leaves hillsides bare and easily eroded by heavy rain.

Scale

The concept of scale is used to guide geographical inquiries. Geographers study things that take place on many different spatial levels – meaning from small areas (such as a local park) to very large areas (such as the use of oil and gas all over the world). They use the concept of scale to look for explanations and outcomes at different levels. For example, a geographic inquiry on climate change may be carried out at a range of scales (from smallest to largest) (see Source 6):

- local – such as an inquiry into increased electricity use (for air conditioning) in your neighbourhood due to higher than average temperatures. Increased energy consumption may result in power outages.
- regional – such as inquiry into coral bleaching on the Great Barrier Reef (see Source 7). Warming ocean temperatures can trigger coral bleaching often resulting in coral death.
- national – such as an inquiry into changing weather patterns and increased frequency of extreme weather events in Australia. This affects government allocation of resources across many sectors (water security, agriculture, emergency services, coastal communities and infrastructure).
- international – such as inquiry into drought in Africa. Rains have become less reliable in many places as the climate has changed and many African nations have been hit by a series of devastating droughts that have brought widespread hunger and starvation.
- global – such as an inquiry into the reduction in Arctic sea ice due to global warming. This reduction in white ice means that less of the Sun's energy is reflected back into space and more is absorbed into the earth and sea, resulting in further increases in temperatures globally.

Some geographic studies investigate a large area. For example, something that affects a whole country, such as a severe drought, would involve a study at the national scale. If an event or phenomenon affects the whole world, such as climate change and rising sea levels, it would be examined at the global scale.

It may be necessary to use different scales when studying the same thing. For example, as mentioned above, climate change is occurring globally and should be examined at the global scale. However, it can be examined at other scales too.

Source 6 Geographical inquiries can be carried out on a number of different scale levels.

Scale	Example of climate change inquiry
Local scale	Electricity consumption in your neighbourhood (increased use of air conditioning)
Regional scale	Coral bleaching on the Great Barrier Reef
National scale	Frequency of extreme weather events across Australia
Global scale	Reduction in Arctic sea ice; rising temperatures throughout the world

Source 7
The Great Barrier Reef off the coast of Queensland is the world's largest coral reef system. A geographical inquiry of the reef could be undertaken at a range of scales.

Change

The Earth is constantly changing. Some changes occur very rapidly and are easy to observe, while others take place over millions of years and are almost undetectable to us.

The concept of change is important in geography because it helps us to understand what is happening around us and to see the world as a dynamic place. Change in both time and space allows geographers to examine how environments develop, transform or disappear.

Change can be the result of natural forces. For example, the Earth has been shaped and changed by climate, earthquakes, volcanoes and running water over millions of years. It can also be the result of human activity, such as the building of a new bridge or clearing of forest for farmland.

Changes also take place on many levels, from local through to global. Local changes that happen quickly, such as storm damage in your street, are easy to observe and explain. Regional or national changes resulting from a bushfire or an earthquake can also happen quickly and their effects can be widespread, with devastating impacts on places and people.

Changes that take place on a global scale can take much longer. Global warming, for example, is a long-term change that happens slowly. Global warming has widespread and long-term effects that are not easily explained.

Observing and understanding changes that are natural and have occurred over time or changes that have been made by humans over time, is an important part of any geographical inquiry. Geographers need to look at different types of changes, why they have occurred, over what time period they have occurred and what further changes may take place as a result.

Sometimes changes can be positive, such as the regeneration of vegetation, while other changes can have negative consequences, such as the pollution of waterways from industry. Geographers play an important role in ensuring that change is managed in a sustainable way.
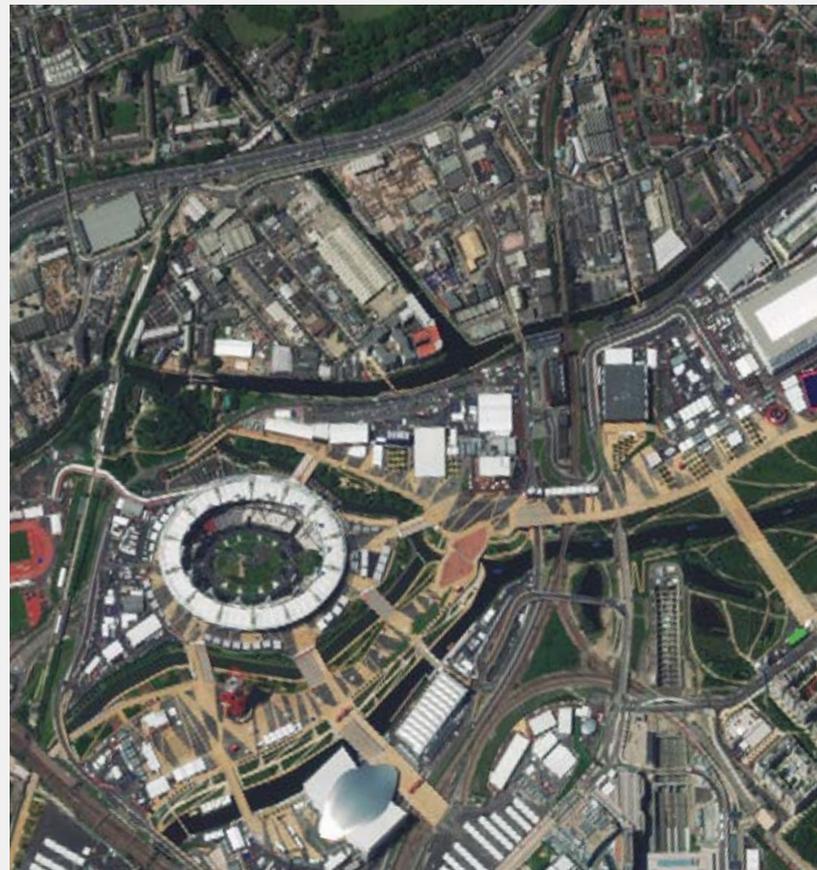
Source 8 In preparation for the 2012 Summer Olympic Games, Newham, in East London, was transformed from a suburb of derelict buildings and polluted rivers into a vast sporting complex.

Source 9 The resources and buildings for the London 2012 Olympic Games were planned with sustainability as a primary concern, adopting a Zero Waste Games Vision. The Velodrome in this photo was built using 100% sustainably sourced timber.

Check your learning 1.1

Remember and understand

1 Is Namche Bazaar an example of the natural, or built environment?

2 List three natural environments and three built environments. Your answers can be drawn from the photographs in this section, or you can use your own observations.

3 At what scale would a study of Mount Kilimanjaro's glaciers take place?

Apply and analyse

4 Examine Source 5.
  a What evidence of change can you identify in this picture?
  b How might this change impact on the natural environment in this place?
  c How might it impact on the people in the nearby village?

5 Examine Sources 8 and 9.
  a Describe the arrangement of the sporting facilities. Using the key concept of sustainability, what factors do you think would need to be considered when planning the development of this area?
  b What examples of interconnection can you identify in these satellite images?

6 Examine Source 2. With a partner, construct four questions you could ask to investigate why so many people live in such a small space. Share your questions with your classmates.

7 Examine Source 4. Use three geographic concepts to describe the Port of Melbourne. Jot down a couple of points for each concept.

8 The geographic concepts are closely linked to each other. For example, a geographer examining the changes at Newham in preparation for the 2012 Olympic Games would be interested in assessing the impacts and sustainability of these changes at the local scale. Describe some possible links between:
  a environment and sustainability
  b space and interconnection
  c place and space
  d scale and environment.

Evaluate and create

9 Research the host city for the next summer or winter Olympics. What changes are being made to natural and human environments in preparation for these games?

10 Choose one of the key geographical concepts outlined in this section. Find a photograph in a magazine or on the Internet that illustrates this concept. Explain your choice of photograph and how you think it describes the concept for you.

1.2 Geographical skills

Geographers are investigators. They explore the world around them by asking questions about what they see. These questions begin an investigation that requires them to collect and analyse information and to communicate what they have discovered. To complete an investigation they need a set of skills such as drawing **maps** and cross-sections, surveying, sketching and presenting information. Five sets of skills are used to complete a full geographical inquiry. These are listed in Source 1.

To become a better geographer you should try to learn new skills as you continue to practice, use and develop the skills you have already learned. It might help you to think of each of these skills as individual tools in your toolkit. For some geographical inquiries, you may only need to use one tool; for others, you may need to use many. As you develop each new skill you will have gained another important tool in explaining the natural processes and human activities that shape our amazing planet.

Source 1   The five categories of skills used in a geographical inquiry

Observing, questioning and planning	• Develop geographically significant questions and plan an inquiry that identifies and applies appropriate geographical methodologies and concepts
Collecting, recording, evaluating and representing	• Collect, select, record and organise relevant geographical data and information, using ethical protocols, from a range of appropriate primary and secondary sources • Evaluate sources for their reliability, bias and usefulness, and represent multi-variable data in a range of appropriate forms, for example, scatter plots, tables, field sketches and annotated diagrams, with and without the use of digital and spatial technologies • Represent the spatial distribution of geographical phenomena by constructing special purpose maps that conform to cartographic conventions, using spatial technologies as appropriate
Interpreting, analysing and concluding	• Evaluate multi-variable data and other geographical information using qualitative and quantitative methods, and digital and spatial technologies as appropriate, to make generalisations and inferences, propose explanations for patterns, trends, relationships and anomalies, and predict outcomes • Apply geographical concepts to synthesise information from various sources and draw conclusions based on the analysis of data and information, taking into account alternative points of view • Identify how **geographic information systems (GIS)** might be used to analyse geographical data and make predictions
Communicating	• Present findings, arguments and explanations in a range of appropriate communication forms, selected for their effectiveness and to suit audience and purpose; using relevant geographical terminology, and digital technologies as appropriate
Reflecting and responding	• Reflect on and evaluate the findings of the inquiry to propose individual and collective action in response to a contemporary geographical challenge, taking account of environmental, economic and social considerations; and explain the predicted outcomes and consequences of their proposal

1.3 Observing, questioning and planning

Observe the world and its geographical characteristics

Understanding our world begins by observing the processes that are taking place all around us. Geographers look at people, land, air, water, plants and animals and the connections between them to understand what is happening. They also seek to investigate where, why and how natural, managed and constructed environments are formed and changed. These observations often include identifying any problems or issues that need to be investigated and resolved.

Developing geographical questions

One of your greatest assets as a geographer is curiosity. Geographers look at the world around them and ask questions about what they see, experience or have thought about. You may, for example, see a news item about a volcanic eruption or hear a report about the world's most liveable cities. Or you may visit the centre of a large city on a field trip or a national park on holiday. As you begin to think like a geographer you will begin to ask questions about these events and places and these questions may be the starting point for a geographical inquiry.

Is this a volcano?

Could it erupt?

Are there other mountains like this nearby?

Why is it so hot down here but there is snow up there?

Is there more snow or less snow than in the past?

Why are there clouds near the top?

How does this mountain affect the climate?

How do people use this mountain?
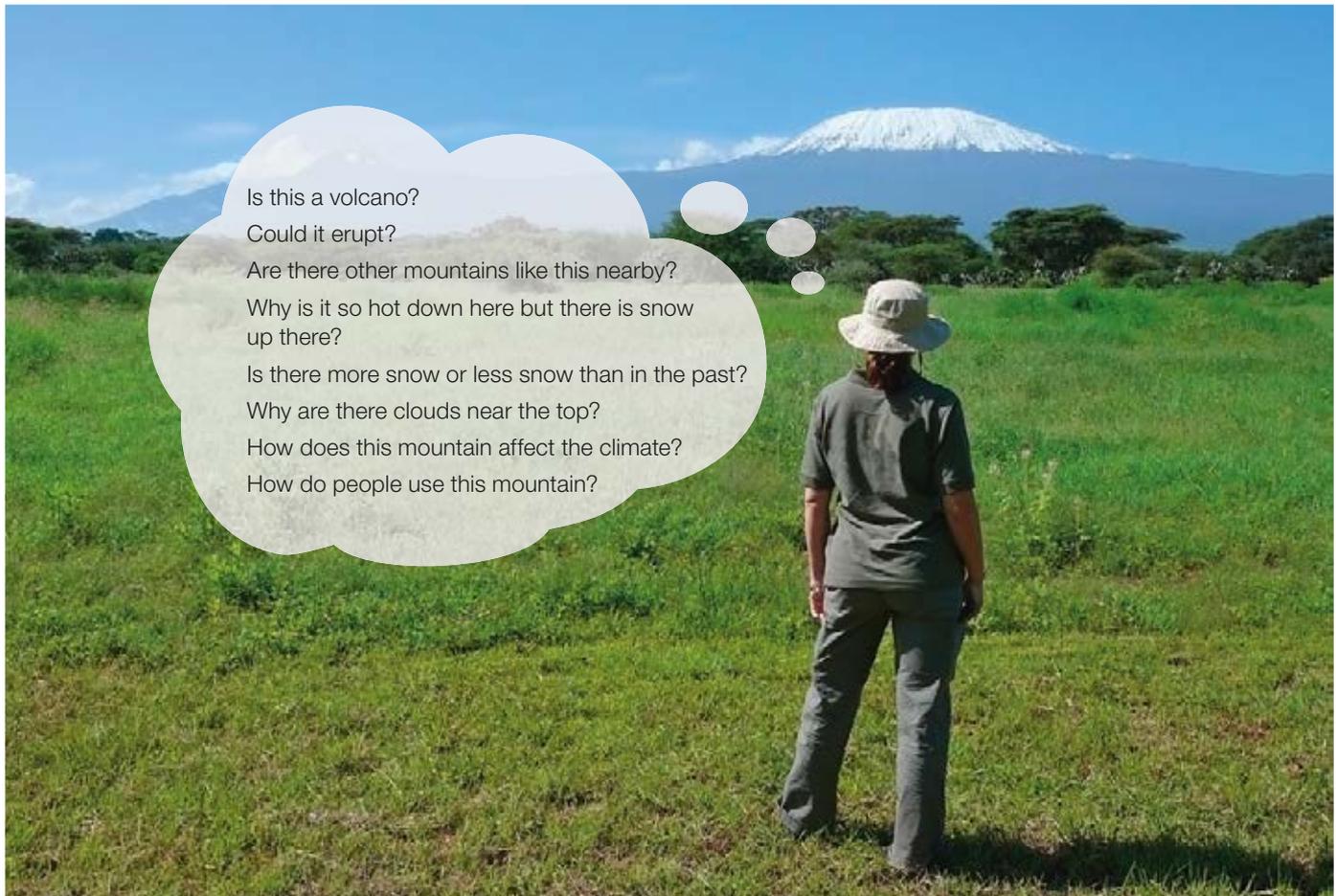
Source 1 Asking questions is an important part of a geographical inquiry. This woman is examining Mount Kilimanjaro, off in the distance.

Plan a geographical inquiry

Asking geographical questions is a good way to develop a range of possibilities for further research and investigation. It is usually best to narrow your investigation by selecting one of the geographical questions you have written as the basis for your inquiry. You should select a question in which you are interested and that helps you to better understand the environment you are investigating.

Planning an inquiry about Mount Kilimanjaro

Having chosen to investigate the key geographical question 'How does this mountain affect the climate?', it is time to consider what information you need to answer this question and where you are going to locate the information. A good way to do this is to use a planning table like the one below.

Source 2 Planning is a key stage in conducting a geographical inquiry.

Key inquiry question	Information needed	Possible sources of this information
How does this mountain affect the climate?	Climate data, particularly temperature and rainfall for places at various distances from Kilimanjaro including the summit	Atlas map to locate towns and cities at various distances from Kilimanjaro
		Encyclopaedia entry for the climates of Kenya and Tanzania
		Online search for climate data for selected towns and cities
	Observation of photographs and satellite images of the region	Photographs and satellite images of Kilimanjaro from throughout this chapter
		Google Earth, including historic imagery
	An understanding of the impact of landforms on temperature and rainfall	Printed resources such as geography textbooks, encyclopaedias and Bureau of Meteorology (BOM) books and leaflets
		BOM website

skill**drill:** Place, space and interconnection

Developing geographical questions

You can learn to develop geographical questions that will help you begin an inquiry about a particular topic or place. Start your questions with the words 'what', 'where', 'how', 'why', 'what impact' or 'what should' when thinking about your topic.

Your questions should examine ideas such as:

- Where is it?
- How big is it?
- What pattern or shape is it?
- Why is it like this? Is it like this because something else is at this location?
- How does it interact with other things in this place?
- How is it changing?
- How should people best manage this change?

The very best questions open up an exciting area for you to explore. Examine Source 1. A visitor to this place might ask a simple question, such as 'How much snow is there on the mountain?'. This is a question with a relatively straightforward answer.

A better geographical question would be to ask 'Does the amount of snow on the mountain change over time?'. This question opens up a whole new area to explore, because the answer to that question will lead on to further questions and greater depth of understanding. Some other example questions are:

- Is this a volcano?
- Why is it green on the ground but there is snow on the mountain?
- Are the animals all eating the same things?
- Is there more or less snow than in the past?
- How do people use the mountain?

Apply the skill

1 Why is 'Does the amount of snow on the mountain change over time?' a better geographical question than 'How much snow is there on the mountain?'

2 Examine Source 5 on page 10, which shows forest clearing in Myanmar. Work with a partner to develop a set of geographical questions about this place.

3 Where could you begin to find the answers to your questions?

Source 3 Mt Kilimanjaro in Africa

Check your learning 1.3

Remember and understand

1 What are the five sets of skills in a full geographical inquiry?

2 Imagine that while watching the news on television this evening you see an item about a large earthquake in China.
   a How could this news item be the beginning of a geographical inquiry?
   b Write a series of geographical questions about this earthquake.

Apply and analyse

3 For the geographical questions that you have written, develop a planning table similar to the one shown here for Mount Kilimanjaro (see Source 2).

Evaluate and create

4 Bring a copy of your local newspaper to class. Search through the newspaper, or think about your local area, and identify examples of stories or issues that could be investigated as part of a geographical inquiry.
   Examples may include a shopping centre extension, or a proposal for a new set of traffic lights or a pedestrian crossing. Choose one local issue and work with a partner to develop a series of geographical questions about it. Then, complete a planning table for one of your questions.

1.4 Collecting, recording, evaluating and representing

Collect, record and evaluate primary and secondary data

Good planning and preparation will ensure that your geographical inquiry will run smoothly, be relevant and give you the answers you are looking for. Once you have identified the issue, formulate your key inquiry question. You can conduct a sound, useful inquiry by following these steps:

- collect and record the information you think you will need to answer your key inquiry question
- evaluate this information and data to determine that it is accurate and relevant
- represent your findings in an interesting and appropriate way (such as tables, graphs, maps and sketches).

Geographers find answers to their questions in many places. They may collect information themselves by interviewing people, taking photographs, making sketches out in the field or conducting surveys and questionnaires. This kind of information will generally only be relevant to a particular inquiry and is called **primary data**.

Often a geographer collects information that supports his or her inquiry but has not been specifically collected or designed by the geographer for the inquiry. This type of information is called **secondary data**. Secondary data sources include maps, graphs, statistics, and websites that someone else has developed. One of the best secondary sources of information may be photographs from newspapers and magazines, and satellite images from Google Earth. It is important to always evaluate any secondary sources for reliability, relevance and bias. This is particularly true for information obtained through the Internet. Unlike a printed source such as a book or atlas it can be very difficult to establish who has written and published information online.

Reliability

When undertaking an inquiry, geographers need to evaluate the sources they use for reliability and potential bias, as well as usefulness. In the case of collecting data from primary sources, such as interviewing subjects directly on a topic, the information gathered will be reliable because it is gathered first-hand. It is therefore important for the geographer to keep in mind any potential bias that may be influencing an interview subject's response. An interview that a geographer is conducting on the potential effects of turning local parkland into an industrial park, for instance, would have very different responses from a representative of the industrial developer than from a member of a local wildlife conservation group. It is important for a geographer to evaluate this kind of bias, and remember to ask questions about the motivation behind it.

When selecting secondary sources, such as maps, graphs, photographs or other data, the geographer also needs to ensure the data is reliable and unbiased. This includes evaluating the creator of the data – is the data from a recognised source like a government body, such as the Bureau of Meteorology or a research agency like the CSIRO? Is the data provided without bias? Or is it presented on a website for a company that might have a vested interest in influencing public opinion?

Ethics in geography

When conducting research and obtaining data for an inquiry, it is important for a geographer to be mindful of issues that are likely to raise ethical concerns. This may include being aware of privacy concerns, ensuring anonymity if required, and obtaining informed consent from research participants. Geographers may also need to outline where and how the information obtained will be used or published, and special attention may need to be given for relational data where geographical references or co-ordinates might disclose a participant's location or identity.

If geographers undertake an inquiry that involves consulting with Aboriginal and Torres Strait Islander communities, they should be aware that there are guidelines and protocols that should be followed. While these are not necessarily rules, it is important to know that Aboriginal and Torres Strait Islander people have distinctive regional and cultural identities that require respectful consideration for meaningful consultation.

This may involve preferred terminology, cues for cultural communication, and other means for making consultation harmonious and productive. If conducting such an inquiry, it is advisable to do further reading, such as of the *Aboriginal and Torres Strait Islander Peoples Engagement Toolkit*, which can be found online.

skill**drill:** Data and information

Evaluating the reliability of websites

There is an enormous amount of material available online, but it is important to keep in mind that not all websites provide reliable information. You must be careful not to naively accept that all information published online is from a reliable source. Websites should be critically evaluated for reliability by following these steps:

Step 1 Find out how old the information is. When was it first published? This will help you decide whether it is useful for your inquiry or not.

Step 2 Find out who published the information. Is it possible they have a bias? You can often find out more about the organisation publishing information by going to their 'home' page or 'about us' page.

Step 3 Look at the extension at the end of the website address, as this gives you an important clue about the origin of the information. For example .com is used by commercial organisations such as online stores, .org is used by non-commercial organisations such as NGOs and welfare groups, .gov by government departments, .edu refers to schools and universities, .biz by businesses and .mil by military groups.

Step 4 If you cannot find out when the information was published or who published it, it is probably too unreliable to use in a geographical inquiry. Look for a more reliable source of information.

Apply the skill

1 Common websites used for reference information include the CIA World Factbook, the Australian Bureau of Statistics, National Geographic and the United Nations Development Programme. Using the steps listed above, assess the reliability of the data found on these websites.

Source 1 This web page offers data about Tanzania. How can you determine if it contains reliable information?

Evaluating and representing geographical data visually

Geographers present the information they gather during their inquiries in a number of different ways. They make maps, create graphs and tables or even draw diagrams to help them look for patterns in the data they have gathered. These tools help geographers analyse and interpret the information they have gathered, and also present the information to other people (the general public, the government, the media) and help them understand the geographer's findings.

Maps

One of the most useful tools that geographers use to process information is a map. A map is a simplified plan of an area. Maps are drawn in the plan view (directly from above) because this ensures the scale will be the same across the entire area. If maps were drawn from an angle, some parts of the mapped area would look distorted and so it would not be an accurate representation of the area. When properly used, maps can reveal a great deal about our planet and the ways in which we use it.

Topographic maps

A piece of paper only shows two dimensions: width and length. The Earth's surface, however, has a third dimension: height. Cartographers (map makers) use a variety of methods to show this third dimension.

Topographic maps are one of a geographer's most useful tools. Because most topographic maps are drawn of a small region they can show that region in great detail, right down to individual buildings and rocks. They also show the height of the land above sea level through the use of **contour lines**, which join together all places of an equal height. By learning to interpret the contour patterns made by these lines you can work out the shape and height of the land that has been mapped (see Source 2).

ROUND HILL OR VOLCANO
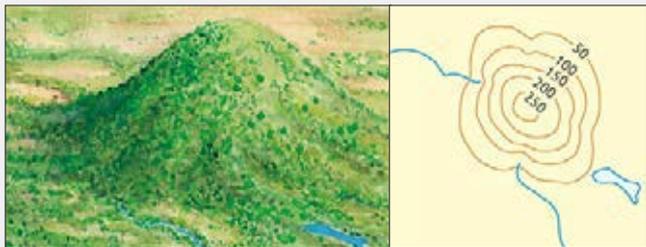
VALLEY

RIDGE
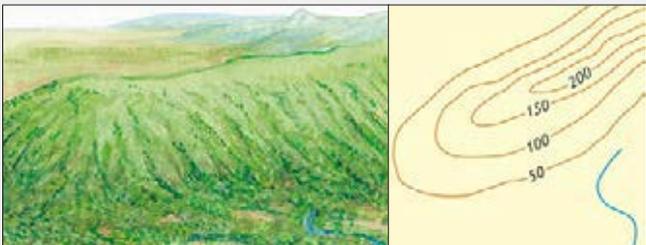
SPUR

CLIFF
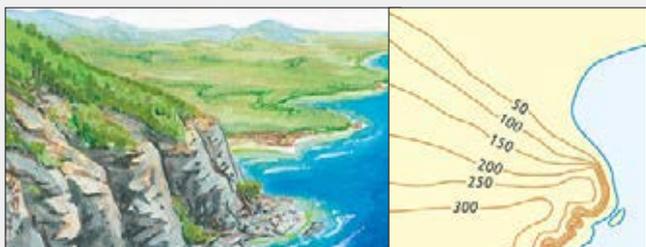
PLATEAU
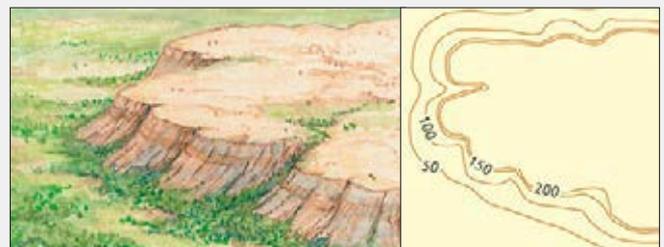
Source 2   Common contour patterns

Digital maps and terrain models

There are about 6000 man-made satellites orbiting the Earth. Many of these collect digital data about the shape and height of the land and transmit it back to computers on the ground. This data is then interpreted and can be used to draw maps. Cartographers can use computer programs to add colours to these digital maps to highlight certain aspects of the environment. In Source 3, for example, the land has been shaded according to its height. The data can also be manipulated in other ways. In Source 4 it has been used to create a side view of the landform being mapped. This type of illustration is known as a digital terrain model.
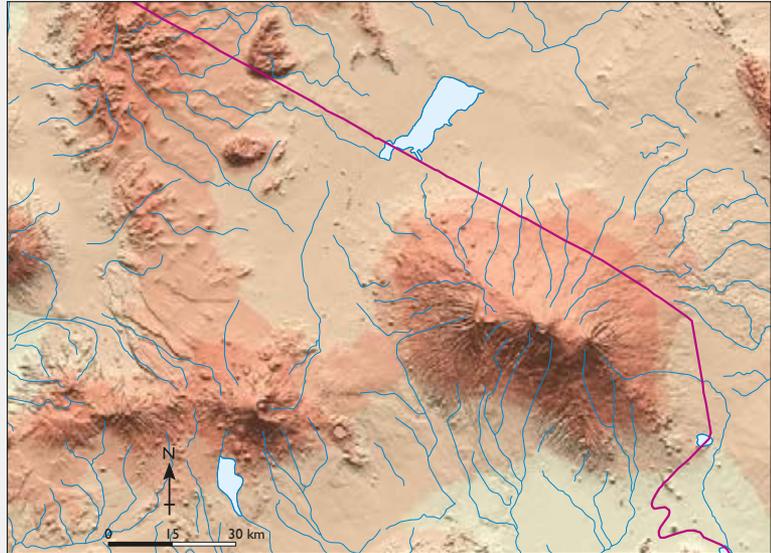
Source 3 In this digital map of the Mount Kilimanjaro region land has been shaded according to its height above sea level. Shadows have also been added to help map users understand the shape and height of the land.

Source 4 This is a digital terrain model of Mount Kilimanjaro and the surrounding area. The data was collected by a NASA space shuttle and an orbiting satellite. Cartographers have exaggerated the height of the landform so that it appears twice as high as it actually is.

Cartograms

You will have already seen **cartograms** in the course of your geography studies. These are the maps that look distorted and have areas that appear thinner or more enlarged than they would normally be, depending on what they are showing. Cartograms are sometimes called 'value by area' maps, which means the spaces on the maps are distorted to show a representation of a value rather than land area.

For example, while Vietnam is a relatively small country in terms of land area, it is the fifth largest rice growing country, so it would be exaggerated to a much greater relative size. The United States of America, which actually has a much larger land mass than Vietnam, is the 10th largest rice producer, so would appear much smaller than actual size on a cartogram.

There are various software programs available that can generate cartograms.
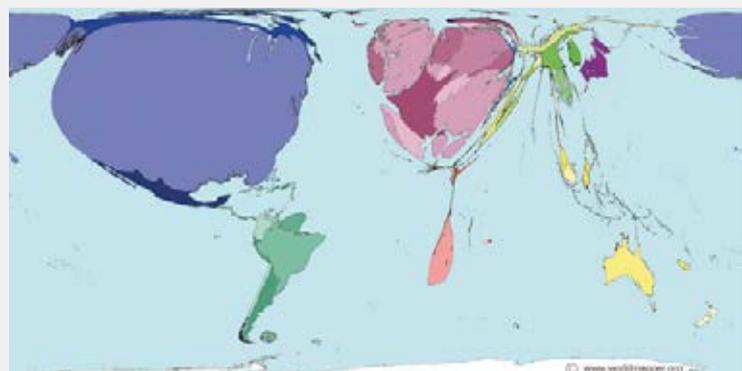
Source 5 This cartogram shows the percentage of the population living on more than US$200 a day. The distortion shows that the United States has many more people living on this amount than Asia does.

Graphs

In Years 7 and 8 you will have learned how to create and interpret simple graphs, such as **bar graphs**, column graphs and pie charts. In Years 9 and 10 you will be working with more complex graphs. You won't necessarily be creating these kinds of graphs yourself, but you will be learning how to interpret them and make sense of the information they provide. Some of these styles of complex graphs are described below.

Climate graphs

Climate graphs show the general climate of a place – what the weather is like overall in a certain location, graphing the average monthly temperature and rainfall over the course of a year (or other set period of time) (see Source 6). Climate graphs combine line and column graphs. Temperature is recorded as a **line graph** and rainfall is recorded as a bar graph.
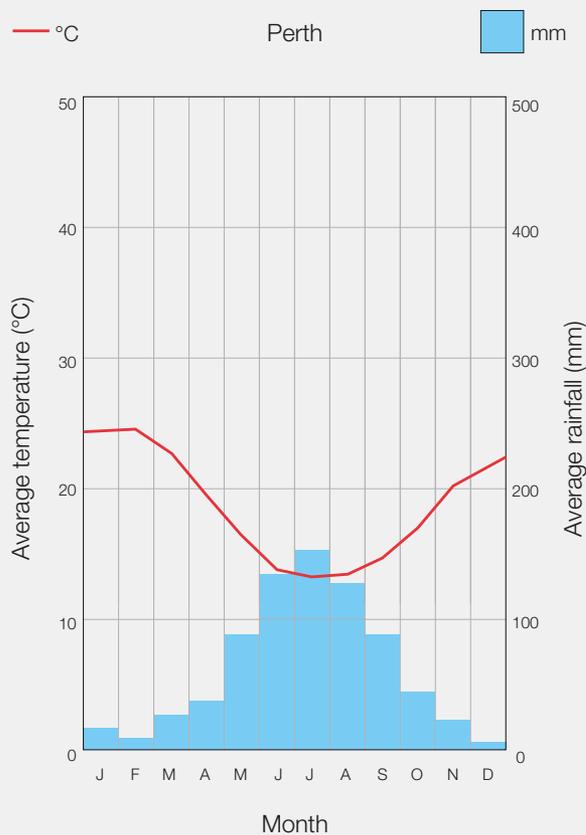
Source 6 A climate graph showing the average monthly temperature and rainfall in Perth

Compound column graphs

A **compound column graph**, sometimes called a stacked column graph or stacked bar graph, is used by geographers to compare the parts of something to the whole. They are a more complex type of column graph in which each column is split into sections. The results are then stacked on top of each other, in different colours or different shades of a colour, so that results can be easily compared (see Source 7).

Each column in a compound column graph represents a total, and each different coloured segment represents a part that makes up that total. The graph in Source 7, for example, shows the total increase in world population, from 1950 projected up to 2050. Of the total increase in population, it is immediately clear that Asia, coloured light purple, has experienced and will continue to experience the greatest growth. It is also immediately clear that Oceania, coloured red, has experienced very small population growth in comparison. Presenting the information in this way means we can quickly see and compare a number of figures that contribute to a total.
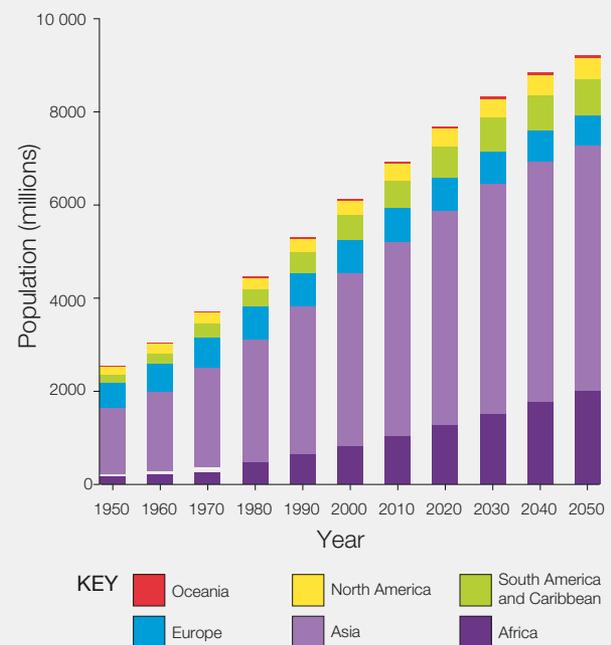
Source 7 A compound column graph showing the increase in world population by region, 1950–2050 (columns on the right provide projections)

Population pyramids

Population pyramids are horizontal bar graphs that show the proportion of males and females in different age groups in a population. They can be used in a number of ways. Most commonly, they are used to compare the population structures and growth rates of different countries. A triangular-shaped graph shows a population with a high birth rate – that is, the population in that country is growing – while a graph that tapers in (is narrower) at the younger ages indicates a population that is contracting or declining (see Source 8).

Population pyramids can also help geographers to identify the ways in which the population in a single country is changing over time. In these population pyramids of Australia's population, for example, it is clear that the percentage of Australia's population over the age of 65 increased between 1960 (see Source 9) and 2009 (see Source 10). Geographers describe this change as the ageing of the population.
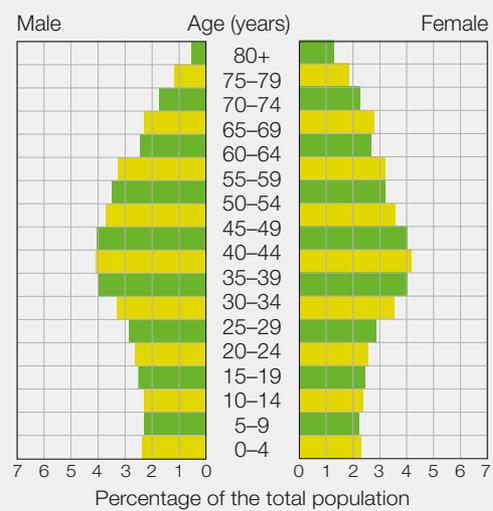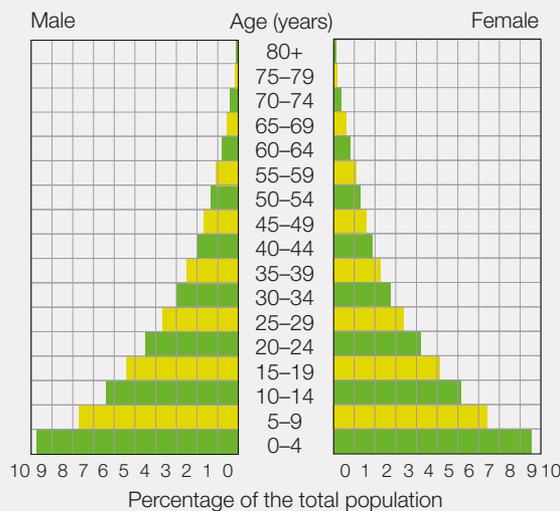
Source 8   Population pyramids showing growing (left) and contracting (right) populations
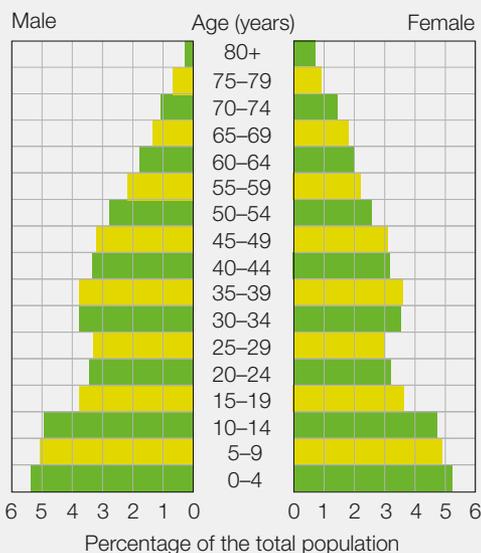
Source 9   Population pyramid for Australia, 1960
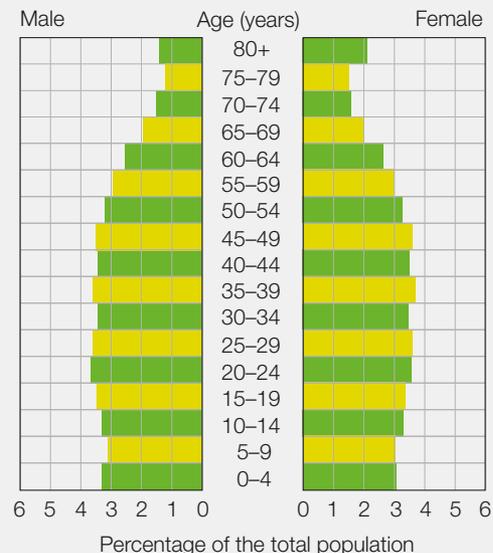
Source 10   Population pyramid for Australia, 2009

Scatter plots

Maps can be useful for showing a pattern but they don't really explain that pattern. A special type of graph, called a **scatter plot**, (or scatter graph) is a better way of doing this. A scatter plot compares two sets of data in a visual way so that connections between them can be easily seen. Scatter plots are also called scattergrams. The following scatter plot compares the amount of original forest cover remaining in selected Asian countries with their population growth rates. It is essentially testing the theory that forests are more endangered in countries where the population is growing rapidly.

The percentage of original rainforest and population growth rate for selected Asia–Pacific countries

Source 11   Scatter graph showing remaining forest and the population growth rate.

Because most of the countries lie close to the trend line in this graph it is possible to say that there is a relationship between the amount of forest in a country and the rate at which its population is growing. Countries with the fastest growing populations have the most rainforest remaining. Those countries that lie apart from the general trend such as Bangladesh are called outliers. A geographer studying this graph might use it as the beginning of a geographical inquiry into deforestation in Bangladesh.

Other graphic representations

In addition to maps and graphs, geographers use a range of other visual representations to communicate information they have collected. These include geographic diagrams, sketches, tables, geographic photographs and geographic information systems (GIS). These ways of presenting information allow geographers to communicate their findings in the most clear and appropriate manner.

Geographical diagrams

Geographical diagrams are simplified drawings of the real world. They allow geographers to show the features or characteristics of places or things much more directly than describing them in words. Certain interesting or complex processes can also be easily explained and demonstrated in a diagram, and communicated quickly and effectively by simple visual representation (see Source 12).
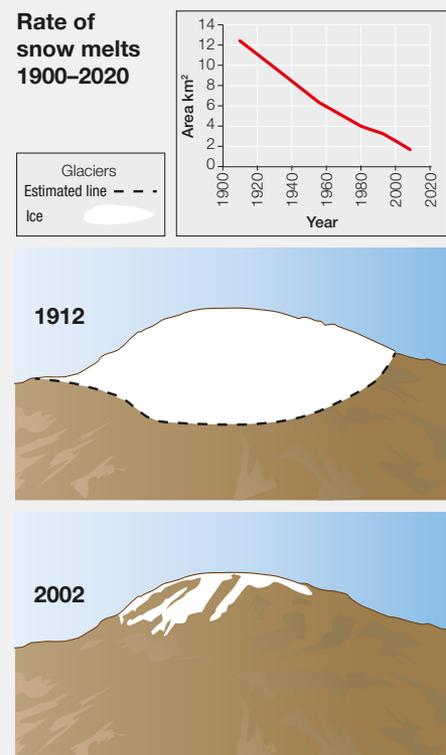
Source 12   This diagram shows the dramatic rate at which snows have melted on Mt Kilimanjaro.

Tables

Tables allow geographers to present and compare data by organising it under different headings. Tables can be useful for presenting information over a range of time periods or locations.

Source 13   This table, based on data gathered by geographers in 2006, shows the change in area of seven glaciers (A–G) on Mount Kilimanjaro, 1912–2003.

Areas (10³ m²)	Glacier Area A	Glacier Area B	Glacier Area C	Glacier Area D	Glacier Area E	Glacier Area F	Glacier Area G	Total
1912	5676	3	27	5011	811	372	158	12058
1953	3829	0	16	2156	493	181	0	6675
1976	2440	0	0	1409	209	113	0	4171
1989	1900	0	0	1168	147	90	0	3305
2003	1304	0	0	1025	132	49	0	2510

Geographical sketches

A **geographical sketch** can be an extremely useful way of collecting information and presenting it in a straightforward and immediate way. They are often completed in the field (and are known as field sketches) or are sketched from photographs. The aim of a geographical sketch is to focus on those parts of the environment that are relevant to the current geographical inquiry. For example, a geographer studying the role of waves in the erosion of a coastline would sketch the rocks and landforms of a beach while another geographer studying tourism at the coast would sketch the buildings and roads at the same beach. Sketches allow the geographer to simplify information to make it easier to understand.
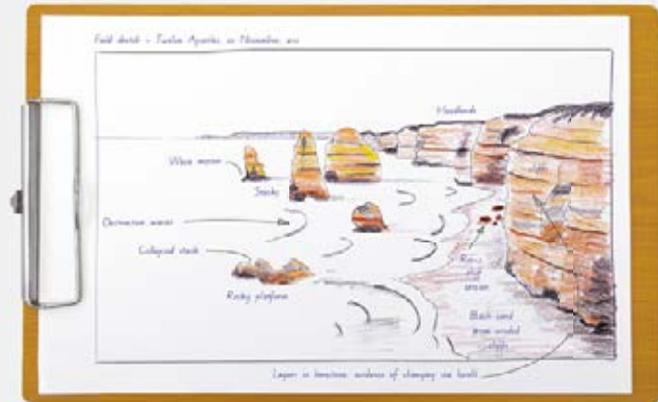
Source 14   Field sketches are useful for capturing information quickly and directly.

Geographic information systems (GIS)

A geographic information system (GIS) is a way of collecting, storing, presenting and using geographical data. GIS encompasses collecting geospatial data – real-world distance between landmarks, water depth, height and width of buildings, layout of streets and suburbs – and presenting it through digital means. Smartphone apps like Google Maps and Google Earth use GIS data to allow you to navigate through the real world, using data that has been gathered using computer technology. GIS has many different applications and is used for planning, telecommunications, transport and logistics, to name just a few.

Source 15   Geographic Information Systems (GIS) gather present real-world geographical data using computer technology. Today, GIS can be found on almost every smartphone in the form of apps like Google Maps and Google Earth.

Geographic photographs

Geographic photographs differ from other types of photographs in that they are taken to depict and present a place or particular feature of the landscape for the purpose of demonstrating an aspect that you are studying. This is quite different from taking photos of you and your friends for fun, or even from taking an attractive picture of a landscape. Geographic photographs are used as a source of data.

Source 16   A geographic photograph demonstrates a particular aspect of a place or environment, like this one of the Mt Kilimanjaro glacier area.

skill**drill:** Data and information

Collecting and evaluating geographic photographs

Geographers take photographs with the purpose of capturing a specific visual reference. This skill in geography is learning to capture a scene on camera that shows exactly what you want it to. You will not necessarily be taking the prettiest picture – you will be taking the picture that is relevant to your inquiry. Then, you can show the key features by adding notes or labels to your photograph. This is known as annotating the photograph. Annotating your photograph will help with your evaluation of the subject, too.

Step 1   Prepare for your session. Read the manual for your camera and get to know what your camera is capable of doing. Learn about exposure and how to frame your subject – there are plenty of tips online to help you with this. It is important to hold your camera steady, or you can practice using a tripod. This is especially useful when collecting photographs of the same place over a period of time.

Step 2   Decide on your subject and ensure you are photographing the relevant parts you want to feature. Select the features of the landscape that show important aspects of your geographical inquiry. Remember your key inquiry question. It could be something like, 'How does tourism affect this environment?' If so, ensure you include evidence of any impact, like rubbish left along a shoreline. In the case of the photo shown here, the key inquiry question was, 'Are the glaciers becoming smaller because of natural or human factors?'

Step 3   Evaluate photo drafts as you go. Remember that your photograph is part of your geography **fieldwork** or study, and ensure that your photographs include the aspects you want to show. You might need to try photographing your subject from different angles, or from above or below it to capture what you are after.

Step 4   **Annotate** your photographs, remembering to focus on the topic of the inquiry. Write short labels that include the key features of the landscape. Keep your labels neat, relatively short and relevant to your inquiry. Note any observations you have and possible causes for changes or damage you note in the environment.

Step 5   Place your labels, taking care not to obscure important parts of the photograph. Space the labels around the photograph without making them too cluttered. Avoid having the lines from the labels crossing each other. If you think you have too many labels, go over them again and delete any you think aren't really relevant to your inquiry question.

Apply the skill

1 Prepare for a geographic photo session. Decide on a subject and head out to a natural environment such as a forest, stream or coastline with your camera. Evaluate your photographs as you go to ensure you are collecting the information you are seeking.

2 Annotate your photographs following the steps listed on the previous page. Choose your best three photos and set up a digital display on the school computer network or print them out and set up a wall in your classroom as a photo gallery.

Small glaciers on Kibo Peak

Kibo Peak, Mount Kilimanjaro

Treeless plain near the summit, perhaps due to cold temperatures and low rainfall

Evidence of human impact: hiker's track leading to summit
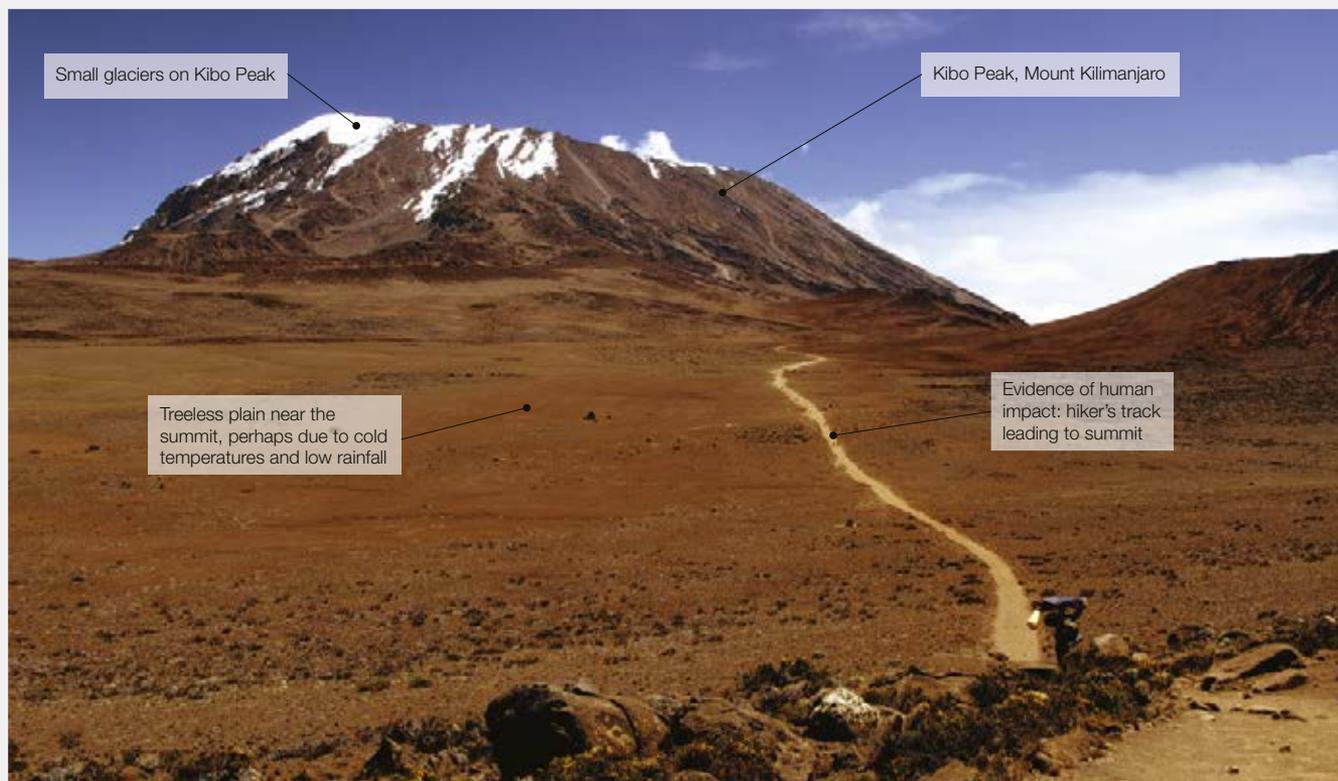
Source 17 An annotated image of Mt Kilimanjaro

Check your learning 1.4

Remember and understand

1 Why is a website that ends with .edu more reliable than one that ends with .com?

2 What advantages do scatter plots have over maps?

3 What do population pyramids show? Why are they a useful tool for geographers?

4 Examine Source 11. In which of these countries is the population increasing most rapidly? How much original forest cover remains in this country?

Apply and analyse

5 What is the difference between primary sources and secondary sources of information? Is the CIA Factbook (see Source 1) an example of a primary or secondary source?

6 Using Source 3, describe the terrain of the region surrounding Mount Kilimanjaro. Do you think Source 3 is more useful for this task than Source 4? Why?

7 Describe the differences between the population pyramids in Sources 9 and 10. What do these differences reveal about the populations at these points in time?

Evaluate and create

8 Examine Source 4. Sketch the probable contour pattern of the landscape shown. Use Source 2 as a guide to common contour patterns.

9 Research the size of the population of a country other than Australia over a 10-year period. Create a graph or graphs to present your findings.

1.5 Interpreting, analysing and concluding

Once you have collected, recorded, evaluated and represented your information, it is time to make sense of it all so that you can reach some conclusions about the geographical questions that began your inquiry. Geographers look for order, diversity, trends, patterns, anomalies and relationships in their information. It can often help to classify information by sorting it into groups.

Using models to identify trends, patterns and relationships in geographical data

There are a number of methods and models that geographers use to help them during this stage of their inquiries. These include the:

- PQE method
- SHEEPT method.

Using the PQE method

PQE is a tool used by geographers to describe the data they have gathered (particularly on maps) and to look for patterns in this data. The letters PQE stand for pattern, quantify and exceptions.

P – Pattern

In this step, you need to give a general overview of any patterns you may identify.

When looking at any form of data, look for things that stand out or form patterns. A pattern may be a group of similar features on a diagram, a concentration of a particular colour or feature on a map, or a particular shape that is created by data on a column graph. For example, when looking at a map of Africa (see Source 1) you might say, 'the forests seem to be located mainly in Central Africa and Southern Africa'.

Q – Quantify

In this step, you need to add specific and accurate information to define and explain the patterns.

Quantifying involves using statistics, amounts, sizes and locations to give specific details. For example, rather than just saying, 'The most forest is located in the centre of the continent', you would need to quantify this statement. You might say instead, '240.3 million hectares of forest has been recorded in Central Africa, compared to 35.4 million hectares in East Africa'.

E – Exceptions

In this step, you need to identify everything that does not fit your patterns.

Often, you may find that there are things in your data that do not fit into a pattern you have identified. These are called exceptions. They also need to be identified and quantified. For example, you might say 'There are also forest regions located in North Africa and West Africa'.

Using the SHEEPT method

SHEEPT is a tool used by geographers to help them consider the many factors that may contribute to the patterns identified in their data. When you are examining issues related to your inquiry, it is useful to think about them in terms of these six factors and rank them in order of importance. This will help you reach your conclusions. The letters SHEEPT stand for:

S social (S) – factors relating to culture and people

H historical (H) – factors relating to past events

E environmental (E) – factors relating to the natural environment (including climate, landforms and vegetation)

E **economic** (E) – factors relating to the earning or spending of money (including income earned from industry and tourism and the cost of building a dam or highway)

P political (P) – factors relating to governments (including laws, regulations and policies)

T technological (T) – factors relating to the availability and use of different types of technology (including the development of greener technologies, alternative energy sources and GIS).
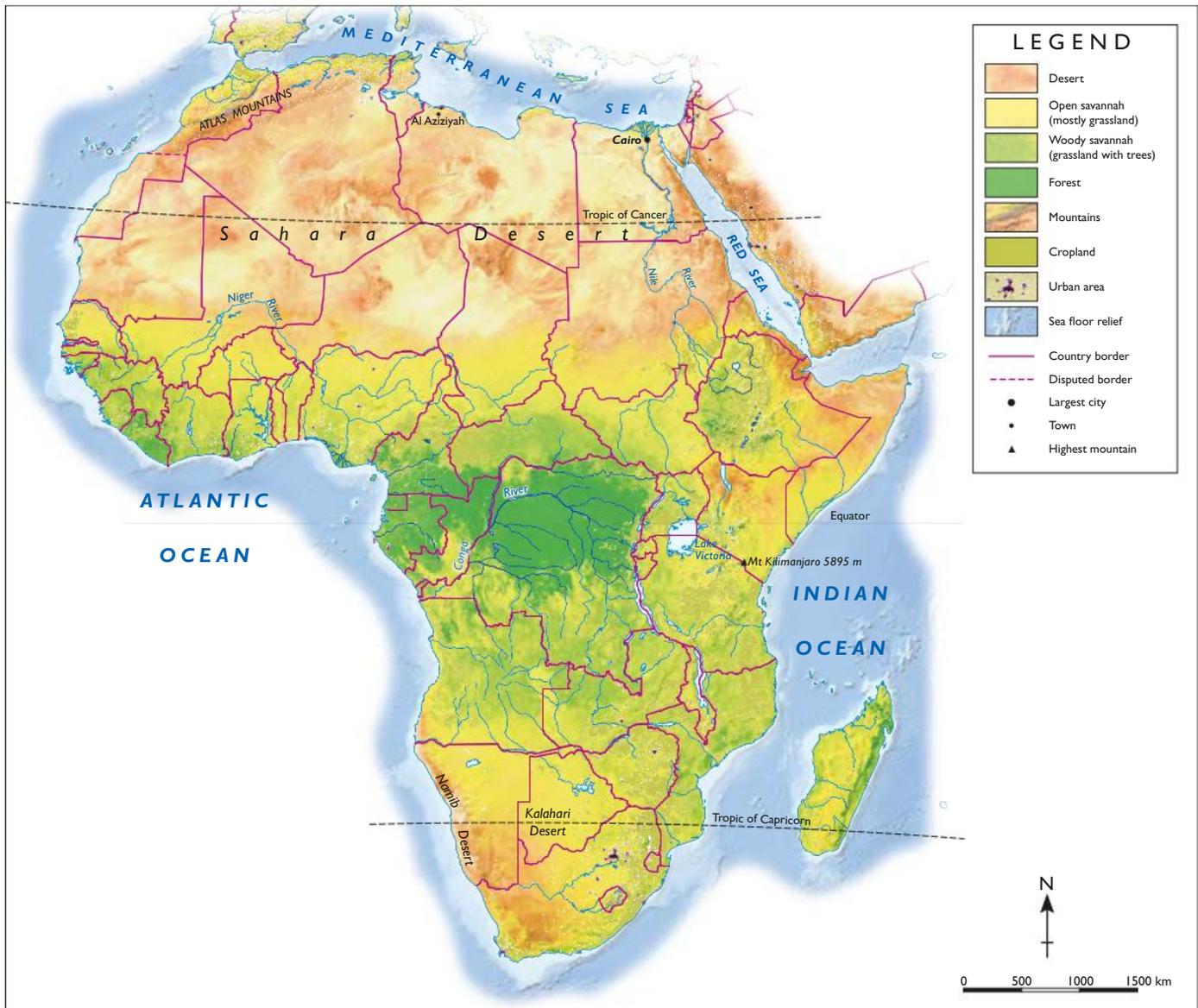
Source 1

Distinguishing between quantitative and qualitative data

Primary and secondary data provide either **quantitative data** or **qualitative data**. Quantitative data includes anything that can be recorded as numbers (for example, Uluru is 3.6 kilometres long and 1.9 kilometres wide and has a circumference of 9.4 kilometres). Qualitative data, on the other hand, includes anything that can be recorded in words (for example, Uluru, one of Australia's best-known natural landmarks, is very large).

The PQE method uses mainly quantitative data.

Examples of quantitative data include:

- climate and temperature statistics
- tourist numbers
- population figures (including birth and death rates)
- types and amounts of food grown
- plant and animal species and wildlife in certain areas
- forest clearance rates
- numbers of people killed in natural disasters
- numbers of volcanic eruptions and earthquakes.

The SHEEPT method uses mainly qualitative data.

Examples of qualitative data include:

- opinions
- points of view
- personal stories
- likes and dislikes
- feelings.

Good geographical inquiries will always be based on a combination of primary and secondary data that is both quantitative and qualitative. Even though qualitative data is an important part of any geographical inquiry, quantitative data is considered to be more valuable because it is less open to personal interpretations and can be more accurately represented in graphs and charts.

Before you move to the next stage of your inquiry, it is important to check that you have recorded all your data without errors and that it is balanced and fair. Your data should not reflect your personal opinions, emotions or attitudes; instead it should present the facts in a clear and concise way.

Using other methods to interpret geographical data

Analysing geographic photographs

Landscapes can be photographed from several different angles depending on the position of the camera at the time the photograph was taken. Each angle makes some features of the landscape easier to see and interpret than other features, and so you need to carefully consider at which angle the photograph has been taken.

Analysing satellite images

A satellite image is taken from space. It allows us to see large areas of the Earth's surface. These images are often used to investigate patterns such as the streams and rivers that radiate from Mount Kilimanjaro. It is difficult, however, to see smaller features of the environment.

Analysing false colour images

You may have heard the terms '**false colour image**' or 'false colour map' before. The term 'false colour' does not mean the colours used in an image are incorrect, it just means different colours have been used to make the image or map easier to interpret. The cartographer or person working on the image has chosen colours that make some aspects easier to see or understand than a normal 'natural' photograph or map would be.

The colours used in a false colour image can be quite exaggerated and unnatural-looking. This is because the colours of the natural features are too similar to demonstrate a particular point or aspect. If someone is trying to show where a muddy brown river meets a brown-coloured riverbank where there are brown rocks and some brownish shrubs, they might decide to use false colour to clearly show where the different elements are. In that case, they may decide to make the shrub areas bright green, the river neon yellow and the rocks bright red, leaving just the river bank brown.

You should examine the accompanying legend to interpret the colours used in a false colour map.

Source 2 In this **ground level photograph** of Mount Kilimanjaro, the camera is being held by someone at the same level as the landscape being photographed. This angle allows you to clearly see the height of any object and the detail in vertical surfaces. However, objects such as the mountain and the tent hide the landscape behind them.

Source 3 In this **oblique aerial photograph** the camera is positioned above the landscape, but is angled towards the scene being photographed (oblique means 'at an angle'). This allows you to see both the foreground and the background of the scene. You can also see both the height of an object and its width or area. Objects in the background, however, seem much smaller than those in the foreground.

Source 4 In this **vertical aerial photograph**, the camera is positioned directly above the landscape. This vertical (or plan) view allows you to see the extent of any feature such as Kilimanjaro's crater. It is very difficult, however, to judge the steepness of the mountainside or the depth of the crater. Plan views are used for making maps, as the scale is the same over the area shown and similar objects look the same size.

Source 5 This image of Mount Kilimanjaro was taken by a satellite orbiting at 830 km above the Earth's surface.

Check your learning 1.5

Remember and understand

1 What do the letters PQE stand for?

2 What do the letters in SHEEPT stand for?

3 What is an oblique aerial photograph?

4 What are some of the advantages and disadvantages of using a vertical aerial photograph?

Apply and analyse

5 Look at Source 1. Use the PQE method to think about Africa's deserts.

   a Can you identify a pattern?

   b Can you quantify this pattern?

   c Are there any exceptions in this pattern?

6 Which type of photograph would you take on a field trip?

7 Some geographers are very interested in the amount of snow and ice on Mount Kilimanjaro, as it has been gradually declining for several decades. Which type of photograph do you think would be most useful to show the decline of the total area of the mountain's snow and ice?

Evaluate and create

8 Conduct your own Internet research on the way in which Mount Kilimanjaro is managed and use the SHEEPT method to think more closely about the factors that impact on it.

   a List at least one point for each of the SHEEPT factors.

   b What conclusion(s) can you make about the way in which Mount Kilimanjaro is managed?

9 The oblique aerial photograph (Source 3) was taken in 1991 and the ground level photograph (Source 2) was taken in 2009.

   a How has the mountain top changed in this time?

   b With a partner, discuss some geographical questions you could ask to investigate why the mountain has changed in this time. Don't worry about the answers; just concentrate on writing some good questions.

   c Share your questions with the class. List three questions from the class discussion that you think could be the beginning of a geographical inquiry.

   d Where could you find information to help you investigate these questions?

1.6 Communicating

During a geographical inquiry you may discover something new that other people should know about. It is important that you be able to communicate your findings clearly and effectively. There are several ways of doing this and you should select the method that best suits your audience and purpose:

- oral methods, such as reports, discussions and debates
- audio methods, such as radio reports
- graphical methods, such as graphs, annotated photographs, sketches and satellite images
- written methods, such as essays or other text-based presentations.

skill**drill:** Data and information

Planning, creating and delivering a PowerPoint presentation

Geographers often present their findings to an audience in order to share the results of an inquiry and help others understand how this impacts on their world. Using PowerPoint is a good way of organising and presenting your findings.

You may have found doing oral presentations a little daunting in the past, but following these steps will prepare you to give a PowerPoint presentation with confidence. PowerPoint allows you to embed images and provides a structure for outlining your key points in a clear and concise way. You can then talk through your presentation using the slides to both prompt and support you – using visual aids captures your audience's attention and makes your presentation a lot more informative, too.

Follow these simple steps and tips when planning, creating and delivering the findings of a geographical inquiry:

Plan your presentation

Step 1 Gather the findings of the research you have carried out as part of your geographical inquiry. This should include any written research materials you have collected, the sources you have used, the results of any surveys or interviews, and a range of relevant images, graphs, maps or photographs.

Step 2 Plan your presentation carefully so it has a clear beginning, middle and end. It's likely that you will have a lot of information, so it's important that you present only the most relevant parts and that these are structured logically for the audience.

Step 3 Know the requirements of your presentation. Your teacher will tell you how long your presentation

Source 1 A PowerPoint presentation can be a very effective way of presenting the findings of your geographical inquiry.

is expected to be and what key points need to be covered. It is important that you plan you presentation in line with these requirements. For example, if you are required to talk for 10 minutes, you might like to present around 10 PowerPoint slides and talk to each one for around a minute. Before you start creating your PowerPoint presentation, it is really useful to sketch out a rough plan of what you want to cover on each slide. Have a practice on your own following your plan. Time how long it takes you to cover the information you plan to fit on one slide. Plan the rest of your presentation using this as a guide.

Create your presentation

Step 4 Once you have worked out the length of your presentation and the content you need to cover, it is time to create your slides. If you are not familiar with PowerPoint, there are plenty of online guides to assist you. Here are some tips to help you create a clear and visually engaging PowerPoint presentation:

- Be sure you present the content in clear, concise dot-point form, not huge slabs of information in paragraph form. You do not need to put all your findings up on the screen.

- Do not fill up your slides with a lot of random pictures that only loosely relate to the content. Include visuals that relate to the content on that particular slide.

- A common mistake is to have objects and text moving on the screen in a way that just distracts the audience. Use graphics, sound, video, animations and transitions only if they add value to the point being made.

- Use a design that ensures your audience can clearly see and read the slides. You need enough contrast between the text colour and the background colour on the slide, and make sure your font size is large enough.

Step 5 Prepare a set of cue cards. When delivering an audiovisual presentation to an audience do not just stand up and read out the text on each slide. Rather, you should be talking in a way that develops and expands the points on each slide. Carefully plan in advance what you are going to talk about during each slide. Record this plan on cue cards, and refer to these cue cards during your speech to remind you of what to say. Cue cards are also a great support to have if you are prone to nerves!

Step 6 Practise your presentation. You can do this on your own, or in front of a friend or family member. You might feel a bit silly at first, but practising will help you perfect your timing and get you used to talking through the key points of your presentation using your cue cards and slides to support you.

Deliver your presentation

Step 7 Before delivering your presentation, be sure that you're confident that the technology you're using is in good working order. Prior to class, check that everything is working as it should and that the screen you are projecting onto is ready and clearly visible to the audience. If your PowerPoint presentation contains any audio or video footage, check that your speakers are working and audible to the audience.

Step 8 Deliver your presentation by working through the slides in the same way you practised. Here are some tips to help you deliver the best PowerPoint you can:

- Speak clearly – not too fast, not too slow. Vary your tone and pitch to make your presentation more interesting.

- One thing at a time – what is on the screen should be the thing you are talking about. Your audience will quickly read every slide as soon as it is displayed. If there are four points on the slide, they will have read all four points while you are still talking about the first point. Plan your presentation so just one new point is displayed at any given moment. Click to go to the next point only when you are ready to talk about that next point.

- Make eye contact with different members of your audience. Do not just look down at your cue cards!

Step 9 Invite the audience to ask questions and do your best to answer them correctly. If you do not know the answer, or are unsure, don't just make something up on the spot. You are better off being honest and offering to answer any questions at a later stage once you've researched the answer.

Apply the skill

1 Prepare and deliver a PowerPoint presentation on an issue of geography that you find interesting. It could be the local issue that you researched in the previous section, or something you have noticed in the news. Ensure you include some interesting visual elements, such as photographs or graphs, as well as your key points.

Check your learning 1.6

Remember and understand

1 Why is communicating an important part of a geographical inquiry?
2 List three ways you could communicate the findings of your geographical inquiry.

Apply and analyse

3 What do you most enjoy about other students' oral presentations? What do you least enjoy?

Evaluate and create

4 Imagine that you are preparing a PowerPoint presentation for your class on the decline of the glaciers on Mount Kilimanjaro. What are some of the main points you would raise in your presentation? What images from this toolkit would you use to illustrate these points?

1.7 Reflecting and responding

Reflecting

The final steps in completing a geographical inquiry are to reflect on the results of your inquiry and the methods that you used. This is an essential step as it allows you to learn important lessons from any mistakes that you have made and apply these lessons in your next geographical inquiry. There are several ways to reflect on your geographical inquiry. Reflecting involves looking at what you have learned, thinking about how it was learned, and asking critical questions about the way your geographical inquiry was conducted. One of the best methods to help you reflect is to complete a self-evaluation checklist (see Source 1).

Responding

As well as reflecting on the ways in which you conducted your inquiry, you also need to respond to what you found out. You may even decide that you need to recommend some action based what you found.

Geographers often use the information gathered and analysed in their inquiry for a specific purpose. This could be to report on an issue and educate people, to raise awareness of a potential problem, or to lobby local, state or federal government about a particular concern. This can be done via various means, from presenting official reports or studies, to using social media and starting an online petition. The work you do as a geographer can contribute to your environment, and responding and acting is an important part of this work.

The title of my geographical inquiry is:

My geographical inquiry set out to investigate:

GENERAL POINTS	My rating					Comments
	1	2	3	4	5	
I was able to complete all stages of my geographical inquiry.						
I was able to answer all my key inquiry questions.						
I was able to plan my inquiry effectively.						
My maps, graphs, tables and diagrams were clear and accurate.						
I was able to analyse my data and reach a conclusion.						
I was able to communicate my findings in an interesting and appropriate way.						

AREAS OF STRENGTH	Comments
My areas of strength are:	
I'm getting much better at:	

AREAS NEEDING IMPROVEMENT	Comments
The part I found most difficult was:	
I need the most help with:	

IMPORTANT ISSUES HIGHLIGHTED BY MY INQUIRY	Comments
The most important thing I learnt from my inquiry was:	
This issue is important to me because:	
This issue is important to my community /country/world because:	

Source 1 A self-evaluation checklist is a very useful way of reflecting on the findings of your geographical inquiry.

Source 2 Children at school near Mount Kilimanjaro using newly installed taps to wash their hands before preparing food

If the results of your geographical inquiry lead you to recommend a plan of action, there are some important things to consider.

- Is it environmentally sustainable? Does the plan impact in a negative way on the natural environment and natural processes?
- Does it bring more economic benefits than it costs? Is it affordable in both the short term and the long term?
- Does everyone affected by this plan of action benefit from its outcomes or just a few people?

Case study

A geographical inquiry conducted on the lower slopes of Mount Kilimanjaro found that many schools lacked a reliable supply of clean water for sanitation. Based on this inquiry, the members of several non-government organisations along with the local villagers laid hundreds of metres of new pipes and installed tanks and taps so that children at the schools could wash their hands before preparing food (see Source 2).

Check your learning 1.7

Remember and understand

1 A self-evaluation checklist is one way to reflect on a geographical inquiry. What are two other ways?

2 Why are the findings of a geographical inquiry often useful to the community?

Apply and analyse

3 What geographical questions do you think began the inquiry that resulted in the new taps in the Tanzanian school shown in Source 2?

4 Why is it important that an action plan for change consider the issue of sustainability?

Evaluate and create

5 Create a checklist to assess your map-drawing skills.

1.8 Fieldwork in geography

Why is fieldwork important?

A historian studying a period in the past will try to find primary sources of information such as letters or diaries to better understand that period. For geographers, the field is an essential primary source of data. Books, websites and maps can give you some information about a particular place but they are usually secondary sources of information. To really understand a landscape or issue you need to go and see it for yourself.

A field trip can be a fun and exciting experience as you spend time with your classmates in an interesting place. As well as being fun, field trips are an essential part of your geography course. This is because fieldwork:

- helps you to better understand how the world 'works' as it builds a bridge between what you learn in a classroom and the world outside that classroom.
- teaches you new skills, particularly in collecting information. Many of these skills, such as surveying and digital mapping, are in demand in the workplace.
- allows you to learn about the world in a new and different way. Not everyone learns well by reading books or answering questions in the classroom. Many students learn more by completing practical, hands-on activities such as fieldwork.
- gives you the opportunity to discover how other people feel about their environment and to compare this to your own values and ideas about your world.
- requires you to be organised and to work cooperatively with other people.

The skills associated with fieldwork

The aim of all fieldwork is to enable you to develop the skills of observation, information gathering, analysis and interpretation of different forms of data and communication of your results. The types of fieldwork you conduct will differ according to your chosen topic and the fieldwork site. All fieldwork is activity-based and inquiry-based. You will be:

- identifying different types of environments and the features within them
- describing what you see around you in geographic terms
- recording data from different sources
- sampling things like water quality and wind speed

- investigating why things are where they are
- comparing different features to see if there is a pattern
- calculating amounts such as water flow, number of different species of plants and animals, visitor numbers
- analysing different forms of data
- forming a more complete picture of the area you are studying
- communicating your findings.

All these activities are aimed at developing and improving your geographic skills and understanding.

Fieldwork locations and inquiry questions

Fieldwork can take place in many locations and for a wide variety of purposes. The best locations tend to be where change is happening before your eyes. Rivers and coasts are popular fieldwork locations because the constant movement of water in these places changes the natural environment, often resulting in a response from people. Shopping centres, parks and city streets are also popular because the constant movement of people creates patterns, flows and changes.

Source 1 You never know where fieldwork will take you! These geographers are using a drill to examine the age of the glaciers on Mount Kilimanjaro.

Source 2 Examples of fieldwork locations and inquiry questions for a range of topics

Unit	Fieldwork locations	Inquiry questions
Biomes and food security	Local farm	What crops or animals are grown on this farm? What makes this place suitable for this type of farming? How has the farmer changed the natural environment? What new technologies is the farmer using? How does this impact on the farm's productivity?
	Rural urban fringe	Is the city growing in this region? What are the main drivers of this growth? How has this impacted on food and fibre production in the past? What evidence is there for changing land use patterns?
Geographies of interconnections	Local business	How is this business connected to people in other places? How have new communication and information technologies changed this business? What is the size and shape of the region served by this business?
	Major shopping centre	How many businesses in this centre are foreign owned? Where are the goods offered in the shops in this centre manufactured? Where do the customers who use this centre come from? How is this shopping centre connected to people in other places?
Environmental change and management	River or stream	What natural processes are shaping this riverine or coastal environment? How do these natural processes impact on human activities? What human activities have changed the natural processes and environment in this place? How have these environmental changes been managed? How effective has this management been? What further management strategies could be used to better manage change in this place?
	Coast	
Geographies of human wellbeing	Two contrasting suburbs	What are living conditions like in these two suburbs? What are the similarities and differences? How can these differences be mapped? Why do these differences occur? How can wellbeing be improved in these places?
	Program to improve wellbeing	What are the aims of this program? Why does this program exist? How successful is the program in reducing inequalities in wellbeing? How could it become more successful? Could this program be applied in other regions and places?

Source 2 provides examples of fieldwork locations and inquiry questions that can be the beginning of an investigation at some of these locations.

Conducting successful fieldwork

Fieldwork is a type of geographical inquiry, so whenever you take part in fieldwork you will need to follow the stages that are outlined in this toolkit, namely:

Stage 1 Observe, ask questions and plan

Begin by looking at an issue or location and compile a set of related inquiry questions that you would like to answer. There are some suggestions in the previous table to get you started. Plan what information you will need to answer your key questions, how you will collect it and what equipment and skills you will need.

Stage 2 Collect, record, evaluate and represent data

Plan your fieldwork so that you can collect the evidence and data that you will need. There is a range of geographic skills that are well suited to field work. These include taking photos, drawing field sketches, conducting surveys and collecting data such as stream and pedestrian flows. You need to consider ethical

principles such as people's right to confidentiality and the right to refuse to take part in a survey. If your class is planning a field trip to a natural environment such as a forest or beach, you will need to ensure you do not damage the environment by trampling on plants or animals, or by dropping litter.

Stage 3 Analyse data and draw conclusions

Analyse the evidence you have collected and look for patterns or clues that will help you to answer your inquiry questions. This is usually done in the classroom where you can more easily draw maps and graphs to interpret your information and reach some conclusions.

Stage 4 Communicate your findings

Communicate what you have found to an audience in the form of a written report, an oral presentation or an annotated visual display (AVD).

Stage 5 Reflect and take action

Think about your fieldwork findings and reflect on ways to improve your investigation process. Finally, decide on a course of action, if this is appropriate. This should take into account environmental, economic and social factors.
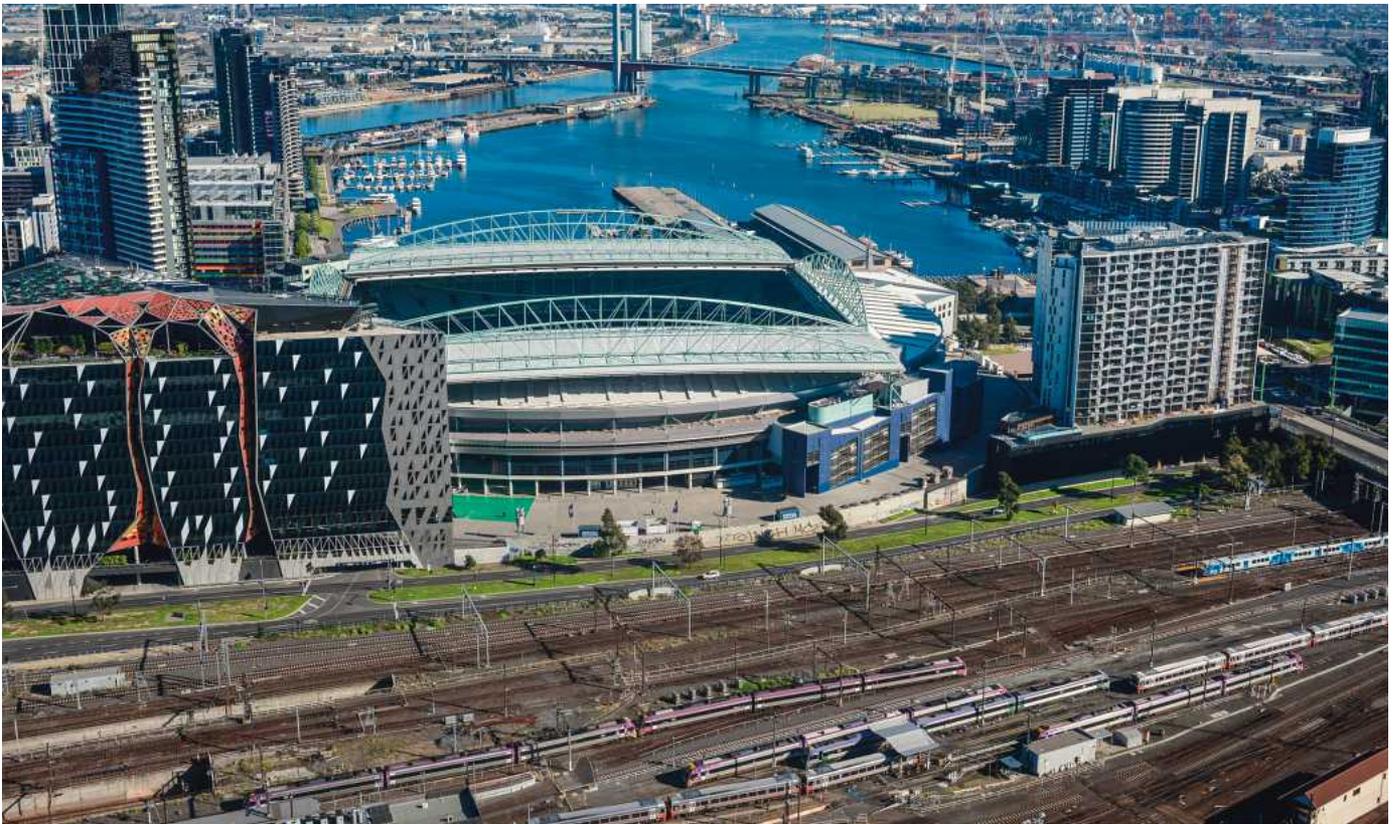
Source 3 An inner city urban renewal projecct

A fieldwork example: Inner city renewal

In the following example, the Year 10 geography class at Gumtree College are investigating an urban renewal project near the central business district (CBD) in their capital city. Fifteen years ago the area was a vast neglected industrial site of old docks, cranes, sheds and railway lines. It has now been transformed into a residential and commercial hub with apartment blocks, office buildings, parks, shops, theatres, television studios and a major sporting arena. The Gumtree College students are investigating this area as part of their studies of environmental change and management of an urban environment.

Stage 1 Observe, ask questions and plan

Prior to their field trip, the students used the Internet and a promotional DVD to learn more about the area. Based on these observations they brainstormed a series of geographical questions that could form the basis of their inquiry. These included:

• How has this region changed over time?

• What are the causes of change in this region?

• What are the consequences of change on the built environment and on the natural environment?

• How are environmental changes in this region managed at present?

• How can environmental changes in this region be better managed in the future?

After some discussion, the students decided on the third question, but decided to modify it slightly to make it easier to study and measure. Their inquiry question

Source 4 Students completing a field sketch of an inner city renewal project

became 'What are the consequences of change in this region on the built environment?'

It was decided that the class would spend one full day in the region after travelling into the inner city by train. Following the field trip they would then spend time in class preparing a field report.

The students spent some time before the field trip planning what information they could collect and observe for their inquiry. They decided that they could investigate previous land uses in the area by accessing old photographs and maps. Then, while on the field trip, they would look for examples of changing land uses. This could include old buildings being demolished, or the appearance of new buildings, roads, bridges or other structures that were not in the old photographs and maps.

Stage 2 Collect, record, evaluate and represent data

The students researched the region and collected a series of photographs that showed the ways in which the region was used in the past and how these uses have changed over time. They found the National Library of Australia website (http://trove.nla.gov.au/) particularly useful. They printed some of these photographs and took them to the area when they visited on their field trip. Activities they completed on the field trip included:

- completing a field sketch of new housing developments in a part of the area (see Source 4).
- taking geographic photographs and comparing these to old photographs (see Source 5). The photographs they took included images of a new train station, new sports stadium, new roads and new apartment buildings. Some students also photographed an old goods shed and old wharf facilities.
- mapping examples of land use changes on an outline map of the region. Included on the map were examples of buildings that have retained their original use, old buildings that have changed use, new buildings and areas cleared for new buildings.
- selecting examples of change as case studies. Some groups of students chose a new train station that had replaced an old one, some chose a new sports stadium that had been built on an area previously used for rail yards, and another group selected a goods shed that had been converted into restaurants. At each site students listed the changes they observed and the impacts of these changes on surrounding areas. They also discussed the possible reasons for these changes. Some completed a field sketch of their case study.

Source 5 Students using old photographs of the region to observe change over time

Stage 3 Analyse data and draw conclusions

After completing their fieldwork, students returned to the classroom to make sense of the information they had collected and recorded. They used this information to make a series of conclusions about changes to the built environments that have occurred over time. In order to do this, they:

- constructed an overlay map to compare an old map of the region with the map they drew while on the field trip. They discovered that the shape of the river banks had changed little and that previous land reclamation areas had remained the same over the last 50 years. The rail yards had been moved to make way for the new sports stadium and the footprint of the new train station was slightly larger than the previous station. Many goods-handling areas and buildings from the previous industrial land use had been replaced with new apartment buildings and a large park. Roads from the CBD had been extended into the new precinct and new tram lines had been added.
- annotated their photographs of their case study sites to show how these sites had changed over time and the impacts of these changes on other areas (see Source 6). Students concluded that change had been uneven, with some areas changing little, while others had undergone large-scale and dramatic changes. They also concluded that one of the driving forces for these changes has been the growth of the population of the city, increasing the demand for inner-city housing.

These buildings are mainly residential providing homes for thousands of people.

New building foundations show that construction is taking place in this area.

important transport link between western suburbs and the CBD

The Goods shed on Central Pier has been changed into restaurants and offices.

street art 'Cow in a tree'

recreation area

The bottom floors are usually shops and bars showing that this is also a commercial area.

Harbour Esplanade: previously an area used for railway lines

Source 6 An annotated geographic photograph completed as part of a geographical inquiry by students at Gumtree College

- concluded that the changes in this area have been largely positive as the area had become an unattractive wasteland prior to the urban renewal project. Some students felt that the area could be improved to make it more attractive for people to live there. They suggested that a school would be an asset in the area, as would more open spaces and recreation facilities like a water park or skate park.

Stage 4 Communicate your findings

Students completed field reports based on their geographical inquiry. Each student was required to complete a sketch book that included a range of visual and written material. Examples of visual material included an overlay map to show change over time and a range of annotated photographs. Written material included reports on the ways in which the area has changed over time and a description of the ways in which it is expected to change over the next 20 years.

Groups of students delivered presentations on their selected case studies. Most used ICT programs such as PowerPoint and Prezi to present photographs of their site. These were posted on the school website and

discussion forum, and several parents from the school community added their own memories about the region as it was in the past. The class discussed the differences and similarities between each of the case studies.

Stage 5 Reflect and take action

Following the submission of their field reports students reflected on their findings and the methods they used to reach their conclusions. They decided that the key inquiry question they had chosen was a good one although several students commented that it was difficult to work out why change had occurred in this place over time. They completed a self-evaluation checklist to reflect on the findings of their fieldwork (see Source 1 on page 34) and the ways in which they could improve.

Many students felt that the overlay map was a very good way to demonstrate how an area has changed over time and suggested that this technique could also be used on old photographs. The fieldwork was used as the basis for a class discussion about the positive and negative impacts of the observed changes on the natural environment.

Check your learning 1.8

Remember and understand

1 Why is it important to plan ahead for fieldwork?

2 What are some of the key advantages of fieldwork for geography students?

Apply and analyse

3 Name a place you are familiar with that could be investigated using some of the techniques used by the Gumtree College students. Work with a partner to decide on a variety of inquiry questions that could be used to guide a field trip to this location.

4 Gumtree College students worked in groups to study individual sites. What are some of the advantages of working in this way rather than as a whole class?

5 Examine Source 6. How might this annotated photograph help the students to answer their inquiry question?

6 What other information could the students have collected on their field trip to help them answer their inquiry question?

Evaluate and create

7 Year 10 students at another school studied change in rivers as part of a geographical inquiry into environmental change and management. They planned a field trip to a local river (see Source 7).

a .What inquiry questions could they generate to guide their inquiry at this site?

b Work in a small group to describe the steps you would undertake to explore one of these questions using fieldwork.

Source 7   This site is the planned location for a fieldwork trip to investigate environmental change and management of a river.

1.9 Careers in geography

In recent years there has been a marked increase in the number and range of jobs and careers that are linked to geography. This is likely to continue well into the future, due to a growing awareness of how important it is to understand our fragile environment. Many employers are also becoming more aware of the many skills that geographers have and the usefulness of these skills in a wide range of careers.

Many geographers find that their skills and expertise are in such demand that they can easily find employment all around the world. There are many jobs and careers that are linked to your study of geography at school. Some of these are listed in Source 1.

Source 1 Studying geography can lead to many interesting and exciting careers.

Working indoors	Sharing knowledge	Related opportunities
Urban planner	Cartographer: both printed and digital maps	Studying hazards and disasters
Meteorologist and climatologist	Teacher	Studying climate change
GIS specialist	Environmental educator	Archaeologist
Transport planner	Map editor and librarian	Agricultural scientist
Working with statistics such as census data	Tour guide	Researcher
Geomatic / geospatial engineer	Writer/editor	Medical geographer/ health services planner
Regional planner	Journalist	Social data analyst
Geography analyst/ strategy consultant	Travel consultant	Developing new GIS applications

Working indoors

Not all geography jobs involve working outside. New information and communication technologies (ICT) have increased the number and range of geography careers that are completed indoors. Many of these are involved with planning future strategies and changes to the built environment. Planners are concerned about the ways in which different parts of a suburb or city fit together and the links between them. Like many geographers, planners increasingly use GIS systems and other ICT applications. A relatively new geography career is using geomatic engineering. This uses GPS, GIS, 3-D computer images, surveying, satellite images and photos in the field of engineering. It is one of Australia's fastest growing ICT fields.

Career profile: Lucy Johnson – Urban planner

Lucy Johnson uses her geographic skills to help create and manage liveable spaces in a city council planning department. Residents and developers who wish to change the ways in which their properties are used must apply to Lucy and her fellow planners for permission. She assesses every proposal carefully to ensure that it does not adversely affect the natural environment or other local residents. 'Some proposals are met with great opposition from residents, who are extremely passionate about preserving their streetscapes and the character of their neighbourhood,' says Lucy. It is part of her job to find a balance between development and the protection of the character of the neighbourhood.

Lucy believes that, '…town planning is crucial, not just in creating physical environments, but in sustainably changing the way in which we use land and accommodate population growth. Our resources are finite and we must ensure that future generations can live and prosper just as we do.' She also believes career opportunities in her chosen field are vast, varied and increasingly more important.
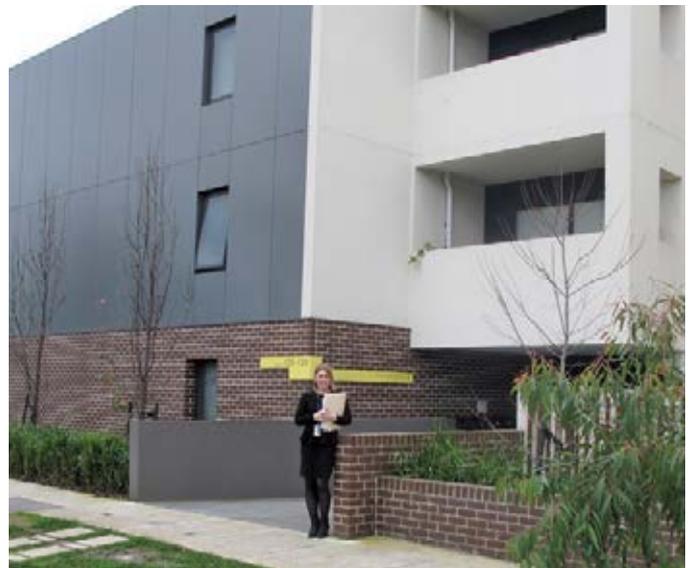
Source 2 Lucy Johnson is an urban planner who helps to create liveable spaces in Melbourne.

Sharing knowledge

Geographers are good communicators who are used to working in teams to solve problems and propose solutions. Many geographers have used these and other skills to share their knowledge with the community. There are many career opportunities in education, including teaching in schools and universities – even overseas. Other geographers work in publishing, as writers, journalists, editors or cartographers.

Source 3 This Australian geography teacher is educating Fijian kindergarten children about the importance of better nutrition and increased physical activity.

Exploring new ideas

The inquiry and research skills that are part of your geography course (including observing, questioning, interpreting, analysing and communicating) are in great demand in many industries. Many geographers are also researchers who explore new ideas and propose new ways of thinking about the world in which we live. These geographers are making new and exciting discoveries in areas such as climate change, reducing the impacts of disasters, the spread of diseases and food security. They are also in demand with mining and oil companies around the world (see Source 4).

Source 4 These geographers are using a 3-D visualisation and GIS to predict the most productive locations for oil drilling.

Check your learning 1.9

Remember and understand

1 Why is the number of careers in geography likely to increase in the future?

2 List three jobs you could do as a geographer if you wanted a job where you could explore new ideas.

Apply and analyse

3 What geography careers in Source 1 are connected to the concept of sustainability?

4 What skills do geographers have that make them useful in helping communities recover from natural disasters?

5 Why do you think a background in geography would be useful for an archaeologist?

Evaluate and create

6 Select one of the careers from Source 1 that interests you. Research this career and prepare a one-page fact sheet that includes at least one picture. Include answers to the following questions in your career fact sheet.

   a What qualifications are needed in this career?

   b How does someone working this career use geographic skills and concepts?

   c What aspect of this career do you think is most attractive?

Changing and managing the environment

Biosphere 2 is one of the world's largest scientific experiments. It is located in the Arizona desert. It is a miniature replica of the world's **biomes** and was built to explore the possibility of sustaining human life on other planets. Eight people were sealed inside for two years with the aim of surviving without outside help. Despite a cost of US$200 million, Biosphere 2 could not generate enough breathable air, drinkable water or food for the eight people inside. After 18 months, oxygen had to be pumped in from outside.

The Earth supports 7 billion people every day, supplying us with the water, air and food we need to survive. Today, many human activities are threatening the planet's ability to support life. As a result, it is vitally important that we take care to manage the environment.

2A
What is environmental change?

1   One of the biggest problems faced by the inhabitants of Biosphere 2 was a build-up of carbon dioxide and falling oxygen levels. How are these levels maintained on Earth?

2   How do you think the inhabitants dealt with their waste?

2B
What factors influence environmental change?

1   Biosphere 2, built north of the expanding city of Tucson, came under threat in 2007 when the land on which it sits was going to be used for a new housing estate. Apart from housing, what are some other ways in which people change the land?

2   How would the building of Biosphere 2 have changed the surrounding land?

Source 1 Biosphere 2 was built in 1987 with the aim of creating an artificial environment on Earth that could sustain human life and be transferred to other planets.

2C

How are we responding to environmental changes?

1 How do the Earth's systems provide us with a supply of fresh water?

2 Brainstorm some of the ways in which the supply of fresh water on Earth is threatened.

2.1 Understanding environmental change

We live in a changed world. Today, less than a quarter of the planet's land surface can still be considered to be wild. The rest of the Earth's surface has been transformed in a variety of ways by human activities. These activities include:

- removing natural tree cover to use the land for farming and cities
- damming and diverting rivers to produce electricity and more reliable sources of water
- digging for valuable minerals and energy sources beneath the surface
- polluting the land, air and water with waste materials.

These changes have had dire consequences for many ecosystems and species of plants and animals that we share the planet with. Tens of thousands of species are becoming extinct each year, largely as a result of the loss of natural habitat, but also due to pollution and the changes brought about by climate change. There are three main categories of environmental change: changes to the land, changes to the atmosphere and changes to water.

Changes to the land

As the human population has increased over the last two centuries, cities, towns and farms have spread rapidly across the Earth's surface. This process has greatly altered the soils and plants of the land. Perhaps the greatest changes have been to the world's forests. Vast areas have been cleared to make way for farms and cities and the forests' resources (such as wood from trees) have been used for energy and building materials. Less than one-quarter of the world's original forest cover remains intact today and the small amount that remains is under increasing pressure from expanding populations in Africa, Asia and South America. Fertile soil, too, is a declining resource as overuse has led to a loss of fertility, soil erosion (see Source 1) and increased salt in many regions.

Changes to the atmosphere

The Earth is surrounded by a combination of different gases known as the **atmosphere**. These gases provide many of the requirements for life on Earth as we

Source 1 A gigantic dust storm approaches the capital city of Sudan, Khartoum. Dust storms such as these are becoming more frequent. They are the result of changes made to the land such as over farming and the removal of natural land cover (like trees and other vegetation).

know it, including oxygen and fresh water. The atmosphere also protects the Earth (and everything on it) from the freezing cold conditions and dangerous ultraviolet rays of space. Despite the importance of the atmosphere to sustaining life on Earth, it has been used as a dumping ground for many gases and chemicals produced by human activities. The burning of fossil fuels such as coal for transport, electricity generation and industry has changed the natural levels of certain gases in the atmosphere. In addition to this, many airborne chemicals have been released through the production of goods and services we use every day, such as steel and oil (see Source 2). In some cases, the chemicals released into the atmosphere have brought about a partial breakdown in the layer of gases (known as the ozone layer) that shields us from ultraviolet light. In addition to this, they are responsible for an increase in the acidity of rain, and a warming of the atmosphere leading to global changes in our climate.

Changes to water

Fresh water is vital to the survival of all life on Earth. Water is used by humans in countless ways. We use it for drinking, washing, transport, fire-fighting, producing electricity, mining, fishing and recreation, as well as a host of other things. Above all, however, we rely on fresh water for producing the food we eat. About 70% of the total water taken from rivers, streams and underground water sources is used to irrigate crops and provide water for farm animals.

The diversion and damming of rivers to provide a reliable supply of water for farmers and for city dwellers is causing water shortages in other places around the world.

Human changes to the natural water supply are also having serious impacts on the natural environment. Some fresh water supplies are now becoming so polluted that they are undrinkable, leading to further problems for the animals, birds, fish and plants who also rely on the water to survive.

Source 2 These trees in Wales have been killed by a combination of acid rain and other pollution. Over the last 30 years, emissions from nearby steel manufacturing plants and oil refineries have brought about increased levels of acid rain resulting in this environmental change.

Source 3 The Glen Canyon Dam in the Arizona Desert, USA provides water and electricity to the nearby town of Page. Around the world, human changes to water supplies are having serious impacts on the natural environment.

Check your learning 2.1

Remember and understand

1 How have human activities impacted the land?

2 Why have human changes to the environment increased over the last 200 years?

Apply and analyse

3 Examine the image of Glen Canyon Dam. List all of the human impacts on this environment that you can see.

4 Sources 1 and 3 show the effects of environmental changes in desert areas. What factors do you think make these areas particularly vulnerable to the effects of human activities?

Evaluate and create

5 Make a list of all of the environmental changes mentioned on these pages.
   a Rank them from the one you know the most about to the one you know the least about.
   b For the three at the bottom of your list, write one question you would like answered before you have finished this unit.
   c Share your three questions with your classmates.

2.2 Degrading the land

The loss of productivity and decline in fertility of land-based environments as a result of human activities is referred to as land degradation. Land degradation currently affects about one-quarter of the world's total land area and about 38 per cent of the world's farmed areas. About 1.5 billion people, including many Australians, are directly affected by land degradation. It is also contributing to climate change, as cleared, degraded land stores much less carbon than natural land cover such as rainforest. The three main types of land degradation are soil degradation, soil erosion and ecosystem decline.

Soil degradation

Soil degradation refers to the loss of fertility of the soil, often due to a chemical change. Soil can degrade by becoming compacted by large machinery and hard-hooved animals such as cattle and sheep, or becoming acidic due to a build-up of fertiliser or a loss of soil nutrients caused by farming the land too intensively. One of the greatest problems for Australia is the build-up of salt in the topsoil (called **salinity**).

Soil erosion

Soil **erosion** is when soil is gradually worn away by natural phenomena such as rivers, rain, waves, glaciers and the wind. Human activities, particularly clearing trees for farming, accelerate erosion in many places. Cleared land is more vulnerable to wind erosion, gully erosion (water scouring away the land) and sheet erosion (the loss of topsoil over a large area). Much of Australia is at risk from one or more of these types of erosion (see Source 3).

Ecosystem decline

As well as soils, the natural **ecosystems** of an area, such as forests and streams, can become degraded. This may be through a loss of vegetation, the invasion of alien plant and animal pests or a decline in the quality of streams and rivers. When coupled with a decline in soil quality, a degradation of ecosystems can lead to **desertification**, particularly in areas close to existing deserts.

Source 1 Soil can be carried on the wind for thousands of kilometres. This dust storm which blanketed Sydney, Canberra and Brisbane in 2009 originated near Kati Thanda (Lake Eyre) in South Australia. Dust was carried as far as northern New Zealand.

Source 2 In some arid and semi-arid areas of Australia, cattle grazing has led to a breakdown in soil structure and the loss of plants. This can lead to areas such as this becoming desertified.

AUSTRALIA: DISTRIBUTION OF LAND DEGRADATION
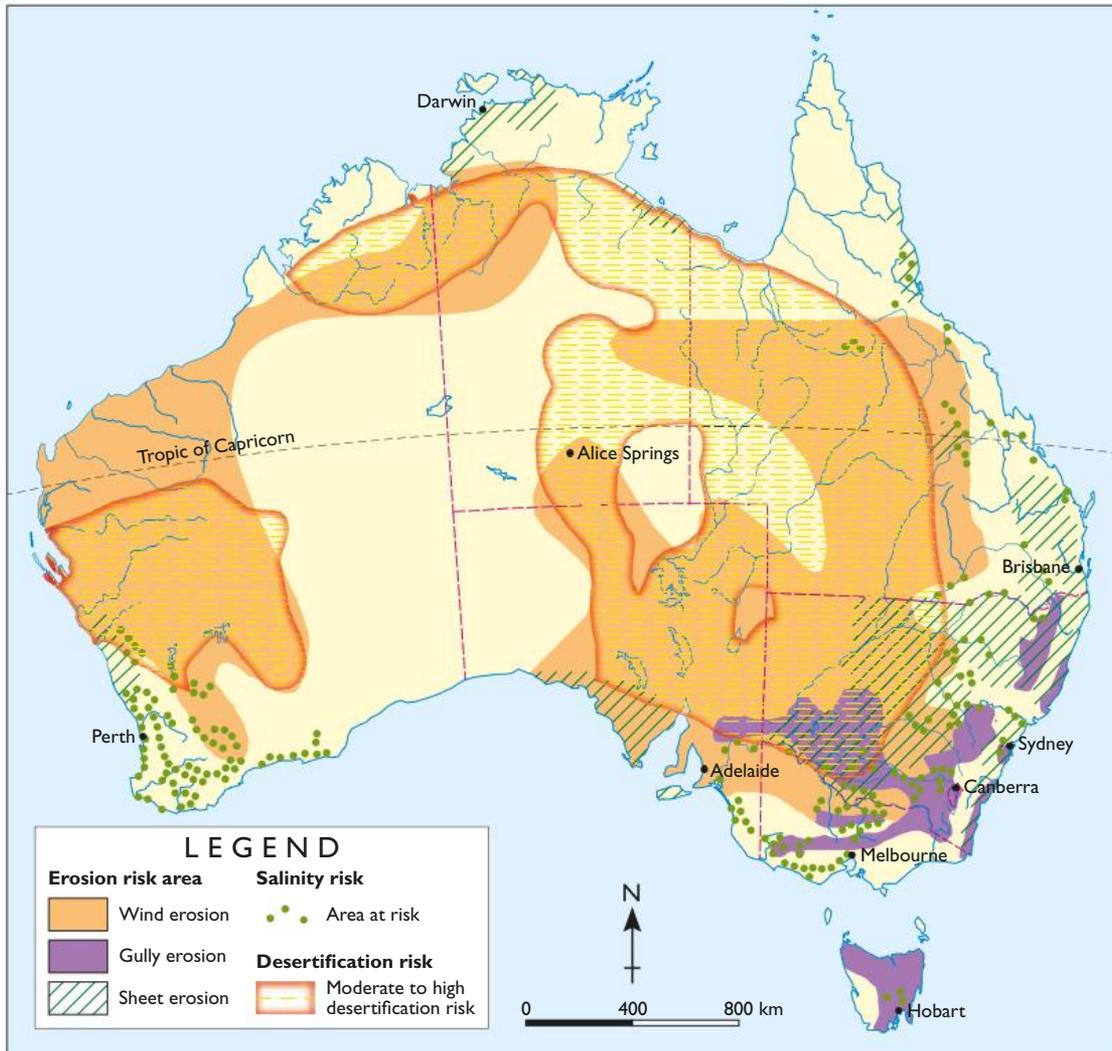
Source 3

Check your learning 2.2

Remember and understand

1 What is land degradation?

2 Why is land degradation a concern for many people in Australia and around the world?

Apply and analyse

3 Conduct research to compare the footprint of a cow with that of a kangaroo. What does this tell you about the relative impacts of introduced and native species on Australia's soils?

4 Use an atlas to estimate the distance covered by the 2009 dust storm shown in Source 1.

5 Examine Source 3.

    a Describe the areas of Australia at risk from gully erosion. Use the names of states and specific places in your description. You may need to refer to a more detailed map of Australia to assist you.

    b Which areas are most at risk from salinity?

    c List those areas that are at risk from erosion, salinity and desertification.

    d Use the SHEEPT method to list the reasons why some places are more at risk of land degradation than others. For more information on the SHEEPT method, refer to page 28 of 'The geography toolkit'.

Evaluate and create

6 Examine Source 2, showing a degraded environment in Australia. Discuss in a small group some steps that could be taken to restore this land. Use these steps to develop and present an action plan. This should include an annotated copy or field sketch of Source 2.

2.3 Degrading the atmosphere

The layer of gases that surrounds the Earth – known as the atmosphere – is being degraded in many ways. Pollutants such as carbon, nitrogen and sulphur released into the atmosphere from factories and transport are disturbing the natural balance of gases that form the atmosphere. This change in the composition of the atmosphere, together with a reduction in forest cover, is responsible for an increase in global temperatures and changes in our climate. We will examine the effects of climate change later in this chapter, but to begin we will examine some of the health impacts that increases in air pollution are having on the planet and how these are affected by changes in the **ozone layer**, a region of the atmosphere that protects the Earth from the Sun's ultraviolet radiation.

WORLD: ANNUAL DEATHS CAUSED BY OUTDOOR AIR POLLUTION

Source 1

Source: Oxford University Press

Air pollution

Air pollution is considered to be the world's worst environmental health risk today. Air pollution leads to increased rates of asthma, lung and heart disease. It is estimated that more than 3.5 million people around the world die each year from outdoor air pollution (see Source 1). This is largely the result of breathing air with high concentrations of fine particles from traffic exhaust, factory and power plant emissions, and fires. Another 4.3 million deaths each year are the result of indoor air pollution. These are largely due to fuels such as coal and dried animal waste that are burned indoors for heating and cooking (mainly in developing countries).

As tougher laws and restrictions governing emissions from factories and vehicles are introduced in countries across the developed world, outdoor air quality is slowly improving. However, in many countries across the developing world, air quality is actually getting worse. This is particularly true of countries in Asia and Africa. In these countries, the number of deaths each year from air pollution is increasing. This is due mainly to the rapid growth and expansion of cities. As these cities grow, the demand for cheap energy increases. Currently, the cheapest and most reliable source of energy in these countries comes from burning fossil fuels such as coal and oil. Measurements of air quality show that 98 per cent of cities in the developing world have rates of air pollution that exceed safe guidelines.

India – an air pollution hotspot

India has some of the highest levels of air pollution on the planet. In a recent report published by the World Health Organization (WHO) half of the world's 40 most polluted cities were in India. The list includes the vast cities of Delhi, Jaipur and Lucknow (see Source 2). It is estimated that more than half a million Indians die prematurely from the effects of air pollution each year. Much of this pollution comes from a rapid increase in the number of vehicles clogging India's congested roads. In addition to this, there has been a rapid growth in industry across India. More and more, these factories demand cheap energy and much of this energy comes from coal-fired power plants.

Source 2 Commuters on the streets of India's capital, Delhi, face serious air pollution from vehicle exhaust and emissions from coal-fired power plants. More than half a million Indians die prematurely from the effects of air pollution each year.

In fact, around 70 per cent of India's electricity is generated from burning coal, much of which is imported from overseas. Australia exports about 47 million tonnes of coal to India each year, a figure that is expected to grow in the future as the population grows and demand increases.

A good news story – the recovering ozone layer

Around 10 kilometres above the surface of the Earth sits a concentration of ozone – molecules that contain three atoms of oxygen. This region of the atmosphere is known as the ozone layer. The ozone layer shields the Earth and its inhabitants from much of the Sun's ultraviolet radiation. Exposure to this radiation is linked to increased rates of cancer, especially skin cancer, as well as lower productivity of plants.

The number of ozone molecules in the ozone layer is constantly changing, but in the 1970s scientists recorded a steady decline of ozone (particularly in an area above Antarctica). Known as the ozone hole, this reduction of molecules was linked to the release of chemicals into the atmosphere from aerosol cans and refrigerators. In 1987, an international agreement banned the use of these chemicals in an attempt to stop the ozone hole from increasing in size. In recent years, there are signs that the ozone layer is beginning to recover. It is now expected that it will return to 1980 levels by 2070. The Secretary-General of the United Nations referred to this agreement as 'perhaps the single most successful international agreement to date'.

Check your learning 2.3

Remember and understand

1 What is the ozone layer?

2 Why is the air quality so poor in India?

Apply and analyse

3 Use the geographic concept of interconnection to describe Australia's role in air pollution in India.

4 Air pollution has been described as a 'transnational' problem, meaning that it crosses international borders. Explain why this makes it a difficult problem to solve.

5 Examine Source 1.
   a Which regions have the highest death rates due to air pollution?
   b In which regions do you predict the rates to grow? Give some reasons for your answer.

Evaluate and create

6 Access the real time air quality map at http://aqicn.org/map/ This shows the current pollutant levels for hundreds of cities around the world.
   a Scroll down for the legend. Describe the distribution of the cities that have levels currently greater than 150 AQI (air quality index).
   b What precautions are suggested for people who live in these cities?
   c Describe the AQI in Australian cities.
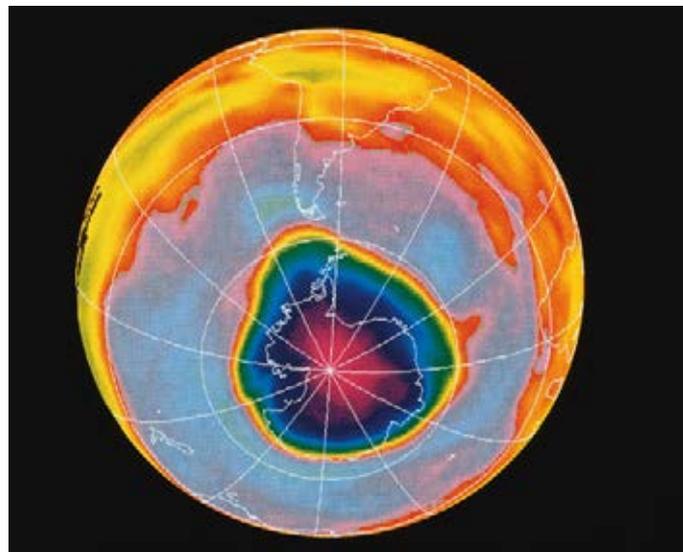
Source 3 A satellite map showing a severe depletion or 'hole' in the ozone layer over Antarctica on 3 October 1990. The hole appears here as the violet and pink areas covering Antarctica (outlined in white) and beyond.

2.4 Degrading water

Inland waters such as rivers, lakes and wetlands are some of the world's most degraded environments. Human activities have reduced the quality and quantity of clean fresh water in many of these places. Extracting water from rivers to use in homes, factories and farms, and damming rivers for water supply, flood control and hydroelectricity have all affected the health of these inland waters. Pollution from farms and industry sources entering these waters has also caused damage.

People extract large amounts of fresh water from various natural sources. The highest demand for fresh water is for irrigating farms to grow food. In Australia, for example, 70 per cent of the water extracted from rivers and **aquifers** is used in farming. As the world's population and its demand for food and water grows, many of the world's water resources are becoming degraded by having too much water extracted. This has led to shrinking lakes in some regions and increased salinity in the water in others.

Damming the rivers

Of the world's 292 large river systems, two-thirds have been changed by dams and reservoirs. Dams disrupt the flow of water, flooding some areas and stopping water reaching other areas. Damming also disrupts ecosystem services such as the provision of fresh water, fertile soil and food production. The natural interaction between rivers and coastal ecosystems is degraded as fewer nutrients and less water and sediment reach the river mouth and sea.

Pollutants in our water

Water pollution is the contamination of our rivers, lakes, wetlands, estuaries, seas and oceans. This pollution can be the result of human activities near the water such as shipping, fishing and oil drilling, or from activities conducted on land, a long way

Source 1   An irrigation dam near Mahabaleshwar in western India

Source 2   A toxic bloom of blue-green algae caused by excess nutrients from farm fertilisers has built up in a dam in northern California.

from the waterways. Land activities such as the use of fertilisers and pesticides in farming, littering, clearing land, creating tips and landfill, processing sewage and industrial activities can all cause pollution of the waterways.

The results of water pollution are devastating. People lose access to safe, clean, drinking water. Fish and other animals in the water are killed or slowly decline in health and population numbers and an important food source is lost. In extreme cases, water pollution can contribute to widespread food shortages and famine.

keyconcept: Sustainability

Africa's disappearing lake

Lake Chad was once one of Africa's largest and most important freshwater lakes. It provided water to millions of people across four countries and supported a great diversity of wildlife. In 1963, it was the world's sixth largest lake with a total surface area of 23 000 square kilometres. By 2001, this had declined by almost 75 per cent to a paltry 300 square kilometres. This decline is due to a combination of factors including:

- increasing population in the region (e.g. the population of all four affected countries is expected to double by 2050 adding another 300 million people to the region.)
- increasing demand for water to irrigate crops
- drying of the climate due to a decrease in the number of large rainfall events such as monsoonal storms
- extremely high rates of evaporation due to the climate and the shallowness of the lake
- increasing desertification in the Lake Chad catchment area.

For more information on the key concept of sustainability, refer to page 10 of 'The geography toolkit'.
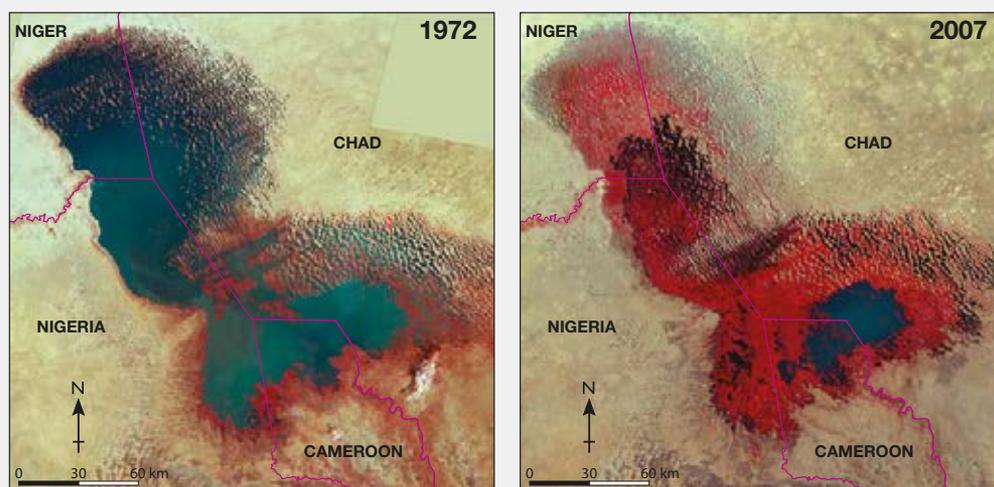
Source 3
Satellite images of Lake Chad in 1972 and 2007

Check your learning 2.4

Remember and understand

1 In what ways can building a dam contribute to water degradation downstream?

2 Which human activities contribute to water degradation?

Apply and analyse

3 How do you feel about the scene in Source 2? What has caused water degradation in this river?

4 Use the SHEEPT method to classify the factors responsible for the degradation of fresh water resources around the world. (For more information on the SHEEPT method refer to page 28 of 'The geography toolkit'.)

5 Examine Source 3.
   a Describe the changes in Lake Chad evident in these two satellite images.
   b Do you think that Lake Chad will disappear completely? Give some reasons for your answer.

6 Examine Source 1.
   a Why do you think this dam might have been constructed? Give evidence from the photograph for your answer.
   b How has this dam changed the natural environment?

Evaluate and create

7 Construct a flow diagram to explore the links between the factors responsible for the decline of Lake Chad.

8 What are some of the issues affecting the health of fresh water resources in your region?

2.5 Damming the rivers

There are many human activities that bring environmental change to streams and rivers but perhaps the most dramatic of these is building a dam across a river. One of the main reasons dams are built is to allow a reservoir of water to build up behind the dam which can then be used for the irrigation of farms, a reliable water supply for towns and cities, flood control and for recreation. The energy of the moving water can also be captured behind the dam, and when released through pipes and turbines inside the dam can be used to generate electricity.

This type of electricity (hydroelectricity) provides a cleaner alternative to other methods of power generation such as coal and oil burning.

As international pressure mounts to reduce carbon emissions, more and more dams are being built across fast-flowing rivers all over the world. Generally speaking, the bigger the dam, the greater the amount of electricity it can generate. Big dams (over 15 metres high) are now considered the most efficient. There are more than 50 000 big dams in the world, half of which are in China, who has 1600 more under construction. China is by far the world's leading hydroelectricity generator and is home to the Three Gorges Dam, the largest dam in the world.

While big dams bring many benefits, they can also create problems for the environment. Source 1 shows some of the human and environmental impacts of damming a fast-flowing river.

People are displaced and must relocate. This can bring cultural change.

Rotting vegetation releases greenhouse gases such as methane

Lake increases incidences of water-borne diseases, particularly in warmer climates.

Ecosystems of plants and animals are flooded.

Dam blocks natural migration paths for fish such as eels and salmon.

Water released from the top of the lake is warmer, raising downstream temperatures.

decrease in downstream soil fertility leading to fewer fish

Sediment builds up in the reservoir. This traps nutrients and makes the dam less efficient.

danger of catastrophic flood due to dam collapse

River banks can erode more quickly if water is released from the dam.

Natural river cycles of high and low flow are disrupted causing environmental changes downstream.

Source 1   Some of the human and environmental impacts of damming rivers

keyconcept: Sustainability

The world's largest river restoration project

While much of the world seems engaged in a dam-building frenzy, in the north-western United States two large dams are being torn down piece by piece. For nearly 100 years there have been hydroelectricity dams on the Elwha River in Washington State, but in 2011 excavators mounted on barges began dismantling them.

Most of the Elwha River runs through the Olympic National Park. Studies on the impact of the dams found that natural ecosystems had significantly declined in quality and capacity as a result of the dams. The greatest impact was on the Chinook salmon, whose migration to spawning rivers had been blocked. This resulted in a 70 per cent decrease in spawning sites (where salmon reproduce). This then impacted on river fertility and reduced the amount of food available to wildlife in the national park such as bears. By removing the dams, it is hoped that the natural ecosystems will be restored.

For more information on the key concept of sustainability, refer to page 10 of 'The geography toolkit'.

ELWHA RIVER: FORMER LOCATIONS OF THE ELWHA RIVER DAM AND THE GLINES CANYON DAM
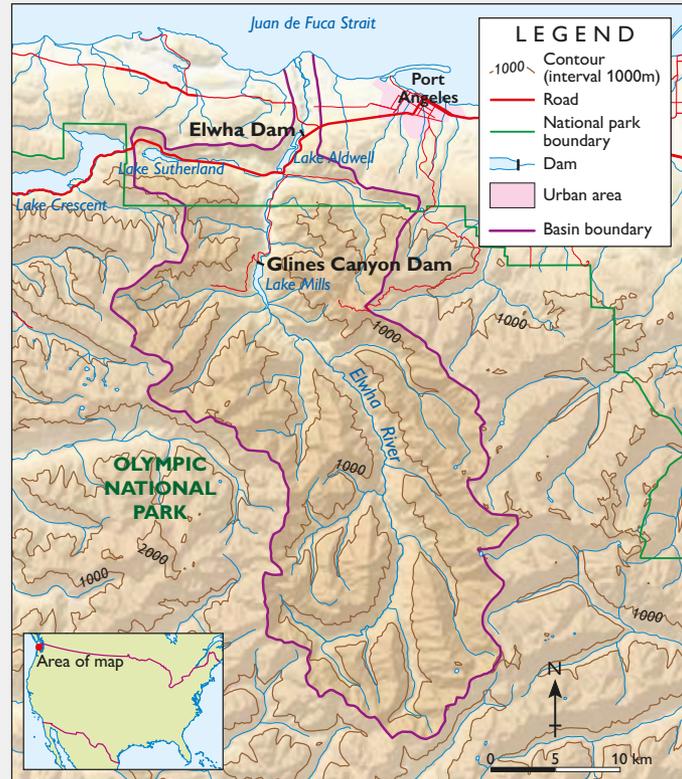
Source 2   Source: Oxford University Press

Source 3   The 64-metre-high Glines Canyon dam partially removed in March, 2012.

Check your learning 2.5

Remember and understand

1   Why are many fast-flowing rivers dammed?

2   Why has the Glines Canyon dam been removed?

Apply and analyse

3   Most of the world's big dams are in China. Brainstorm the factors that may be responsible for this. Classify them using the SHEEPT method. (For more information on the SHEEPT method, refer to page 28 of 'The geography toolkit'.)

4   Examine Source 2.

   a   Describe the location of the dams on the Elwha River.

   b   Estimate the length of this river and the area of its catchment.

   c   Why is it important to consider the whole catchment rather than just the river when analysing the impact of a dam?

Evaluate and create

5   Source 1 shows some of the negative impacts of dams. Create a similar diagram with a dam's potential positive impacts on people and the environment.

6   Debate this topic: 'Despite their negative impacts, dams are beneficial to people and the environment.'

2.6 Pollutants in our water

More than one billion people around the world today lack access to safe drinking water. This is due to many factors, one of which is the contamination of freshwater sources such as rivers, streams and groundwater with harmful substances. As well as making water unsafe to drink, pollutants reduce the ability of the environment to provide other ecosystem services such as food supply, pest control and recreation.

Pollutants that enter our waters can be classified as either physical, chemical or biological.

Physical pollutants

Physical pollutants include particles of soil eroded from the landscape and washed into the waterways and any litter such as plastic bags, cigarette butts, shopping trolleys and tyres. It is estimated, for example, that more than 7 billion cigarette butts are littered in

Australia each year. Many of these end up washed into drains and carried to streams and coasts where they release chemicals and present a danger to marine life and seabirds.

Soil washing into the waterways is a major source of pollution. These particles of soil can make water cloudy and prevent sunlight entering the water, affecting the plants and animals. When the sediment settles, it can smother small animals and plants living in the water. These sediment particles may also have other substances bound to them such as chemicals and bacteria that can cause pollution.

Chemical pollutants

Chemical pollutants include heavy metals, oils, pesticides, industrial chemicals and salt. When the concentration of chemicals in waterways reaches
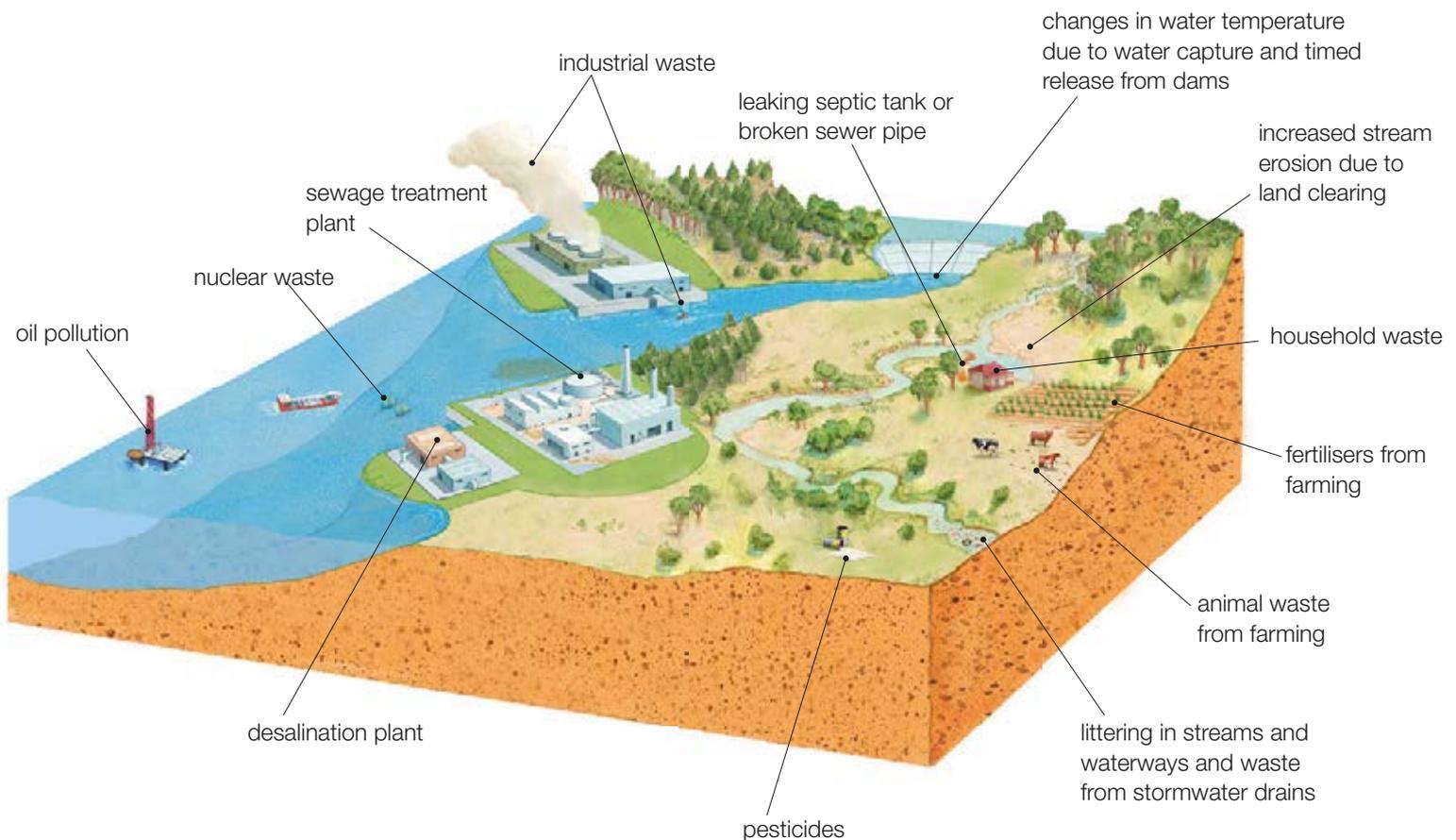
Source 1 Major sources of water pollution

levels that are above natural levels it causes pollution. For example, too much of a naturally occurring plant nutrient changes the chemical balance of water causing excessive plant and algae growth.

Biological pollutants

Biological pollutants include bacteria, parasites and invasive plants and animals. Biological pollutants come from a range of sources including sewage treatment plants, farms, factories and storm water. They can cause harm to other plants and animals in the water, or cause harm to people who drink the water. Bacterial and parasitical pollution such as giardia in the water is usually spread by human and animal waste entering waterways, causing illness.

Source 3 An estimated 100 million tonnes of mining waste was discharged into the Queen River in Tasmania between 1893 and 1995, giving it the reputation as Australia's most polluted river.

keyconcept: Place

The Ganges River

One of the world's most polluted rivers is the Ganges River of India. An estimated 2900 million litres of sewage is emptied into the river every day, creating a toxic river. In addition, the river is used to dispose of medical waste, dead bodies and waste from tanneries (where leather is made from animal skins) and other factories. A count of harmful bacteria in the river found levels 100 times higher than those considered safe for human use. Millions of people rely on the water of the Ganges for drinking, bathing and cleaning, as well as for its **spiritual** significance.

For more information on the key concept of place, refer to page 6 of 'The geography toolkit'.

Source 2 Around 2 million people a day bathe in the Ganges River, one of the world's most polluted rivers.

Check your learning 2.6

Remember and understand

1 What are the three main types of water pollution?
2 Which of these is the main source of pollutants in the Ganges River?

Apply and analyse

3 Examine Source 1, showing some of main sources of water pollution. Classify each of these as physical, chemical or biological.
4 As well as water pollution, what other environmental impacts of mining can you identify in Source 3, showing the Queen River valley? How might these also contribute to water pollution?
5 There have been several government attempts to reduce pollution in the Ganges River but these have been largely ineffective. Discuss some possible reasons for this with a partner and then with your class.

Evaluate and create

6 The United Nations considers these 10 rivers to be the most 'at risk': Salween-Nu, Danube, La Plata, Rio Grande, Ganges, Indus, Nile, Murray–Darling, Mekong and Yangtze.
   a Locate each of these rivers on a world map and describe their distribution.
   b Select one of these rivers and research the problems it faces.
   c Present your findings to the class.

2A rich task

Return to Eden

The region at the **confluence** of the Tigris and Euphrates Rivers in Iraq once supported one of the world's great wetlands – the area where farming was first developed as well as the location of the world's first towns. For this reason, many thought of the area as the Garden of Eden. The wetlands once covered 20 000 square kilometres and supported complex communities of plants, animals, birds and people.

Between the 1970s and 2002, however, the area of the marshes shrunk by more than 90 per cent and the only major marsh that survived was the Al Hawizeh Marshes sitting on the Iraq and Iran borders. This was a result of new irrigation dams that drew water from the rivers upstream to support further agriculture. Much of the marshland became dry and the ecosystems collapsed. The numbers of migratory birds declined dramatically and the local people were forced to move to the cities.

Since 2003 many of the drainage structures have been dismantled and the marshes allowed to reflood. By the end of 2006, more than half of the region had been reflooded and much of the original vegetation had recovered. Farmers are also returning to the area.

skill**drill:** Data and information

Constructing overlay maps from satellite images

One way to show how a place has changed over time is to construct an overlay map of the area. **Overlay maps** allow geographers to show a place at two different times so that they can instantly see any changes that have taken place. To construct an overlay map from two satellite images, follow these steps:

Step 1 Construct a base map of the region using the earlier satellite image. This should be traced rather than drawn freehand to make it as accurate as possible. Draw a rectangle the same size and shape as the satellite image. Add key natural and human features: rivers, canals, towns, and lakes.

Step 2 Add labels to rivers and towns. Add a north arrow, legend and title. Include the date of the image, scale and source.

Step 3 On a plastic sheet or piece of tracing paper construct a map of the same region from a later satellite image. Ensure that the two satellite images you use show the same region at the same scale. This map will sit on top of your base map so line up features such as rivers that have stayed the same.

Step 4 Place the overlay map on top of the base map and use a piece of tape like a hinge along the top to stick them together.

Step 5 Add a title to the overlay map that does not cover the one on the base map. A north arrow, legend, scale and source should not be needed as these are the same as for the base map.

Apply the skill

1 Construct an overlay map of the marshes using the 2000 and 2010 satellite images in Source 1.

2 Describe the changes to the rivers and marshes of this region from 2000 to 2010 as shown in your overlay map.

3 Describe the scale of this series of environmental changes. Is this change at the local, regional, national, international or global scale? Give some reasons for your answer.

Extend your understanding

1 The decline and rebirth of the Mesopotamian Marshes is an example of the pressure faced by many of the world's freshwater resources but it is also a beacon of hope as it shows that areas can be restored. Select one of these other examples of water resources under pressure: Aral Sea, tributaries of the Dead Sea, Kara-Bogaz-Gol lagoon, Everglades wetlands, Lake Chad, Lake Balkash, Lake Chapala, Lake Nakuru or the Coorong.
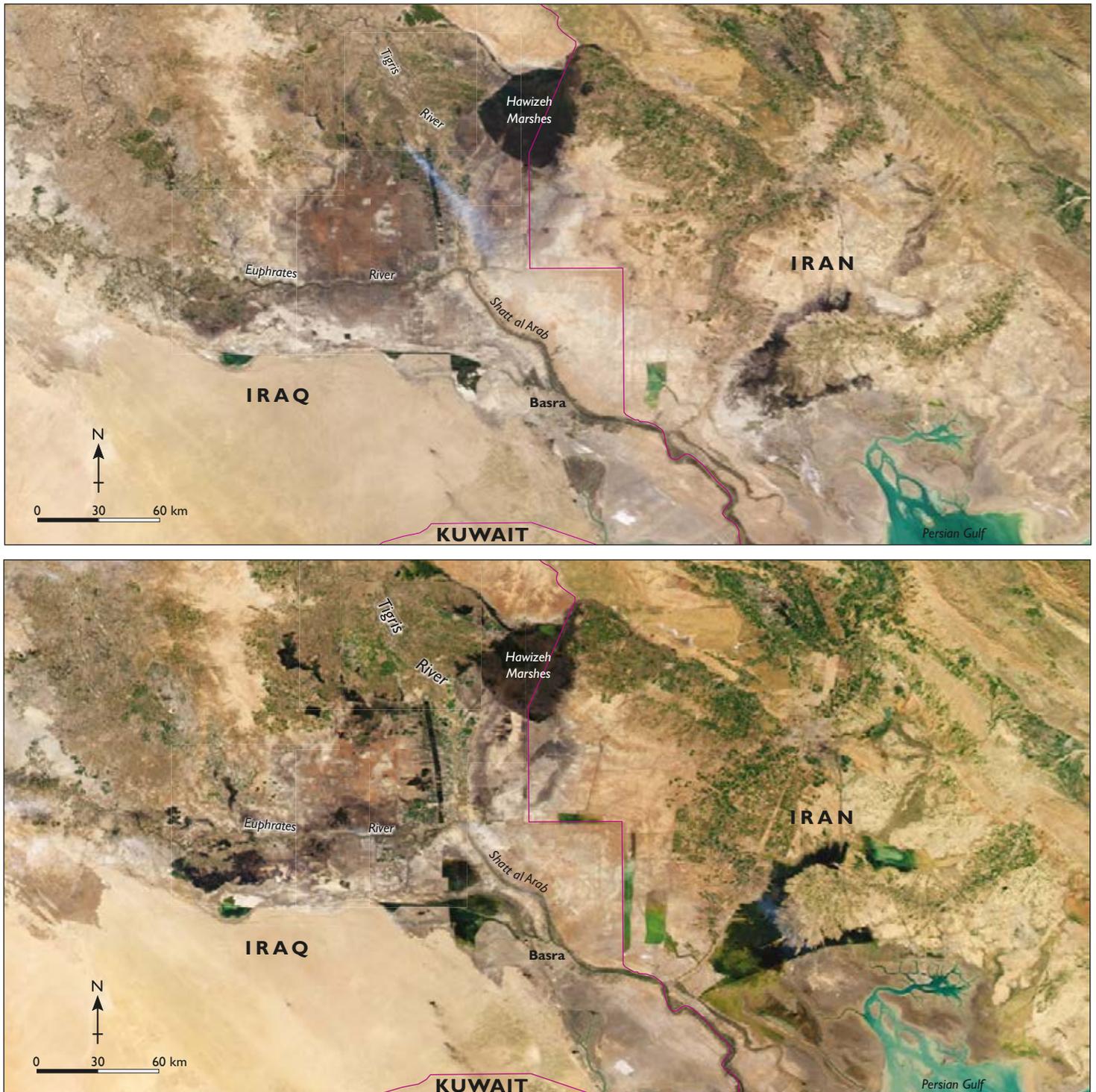
Source 1 Satellite images of the Mesopotamian Marshes from 2000 and 2010 (the green areas show the extent of the marshes)

Work in groups to:

a Research the changes that have occurred over time.

b Describe the causes of these changes.

c Describe any attempts that have been made to restore the natural environment and comment on their effectiveness.

d Present your findings as an Annotated Visual Display (AVD). Use images such as satellite images, maps and aerial photographs in your display.

e Compare your example to those researched by other groups in your class. What are the similarities between them? What is unique about the one you researched?

2.7 Our environment: the key to sustaining life

As far as we know, planet Earth is the only place in the universe capable of supporting human life. This is because the environment here provides organisms such as plants and animals with everything they need to survive: food, light, water and air. Humans, of course, are one of these organisms, and our survival on Earth is largely due to the services provided by the natural environment around us (see Source 1).

Unlike most other organisms, however, humans have the ability to degrade the environment to such an extent that the **ecosystem services** on which we rely become threatened. This is now happening around the world in many different places and in many different ways.

A working environment

The way in which we think about our environment has changed dramatically over the last few decades. Once seen as a bottomless pit of resources providing everything we need, it is now viewed as a fragile system threatened by human actions. The ecosystem services it provides (like clean air, plant pollination and fertile soil) have long been ignored or taken for granted.

This is partly because, unlike products we can touch such as food, water and timber, humans have been unable to put a monetary value on these ecosystem services. However, as the environment becomes degraded, the true value of these services is beginning to be recognised.

The four S's of ecosystem services

Ecosystem services can be classified according to the products they provide and the functions they perform. There are four main classifications: **sources**, **sinks**, **services** and **spirituality**.

Sources

Sources (also called provisioning services) are those natural products that can be used or converted by humans for our use. For example, mineral deposits such as coal which we turn into fuel, iron ore which we use in manufacturing, timber from natural forests, and food sources – from plant crops to deep sea fish.

moderating weather extremes

purifying the air, providing oxygen

protection from UV rays

building and maintaining soil fertility

controlling farming pests

places for recreation and reflection

providing shade

decomposing and dispersing waste

providing food and fibre

protection from river and coast erosion

plant pollination

dispersing seeds

cycling and moving nutrients

filtering water

Source 1 Some of the ecosystem services provided by the environment

Sinks

Sinks (also called regulating services) are those processes in the natural environment that absorb our waste. For example, micro-organisms in oceans break down oil spills. In a similar way, bacteria in the soil breaks down human waste.

Services

Services (also called supporting services) are things that are done for us by the natural environment that don't produce consumable resources. For example, wetlands filter water and slow floodwaters. Forests absorb carbon dioxide and produce oxygen.

Spirituality

Spirituality (also called cultural services) refers to the personal relationships that human beings have with the environment. For some, this is a deep connection to the land formed over many generations (such as the connection that Indigenous Australians have with their ancestral lands). For others, it is the experience of spending time in the natural environment and the sense of wellbeing that this brings. For example, people taking part in activities such as surfing and bushwalking often feel a deep connection with the environment.

Check your learning 2.7

Remember and understand

1 What are ecosystem services?
2 Why do we often take them for granted?

Apply and analyse

3 Classify each of the ecosystem services shown in Source 1 as source, sink, service or spirituality.
4 Can you think of one more example of each?
5 Examine the image of the Australian Alps (Source 2) and give an example of a source, sink, service and spirituality function of this environment.

Evaluate and create

6 Which of the ecosystem services shown in Source 1 do you consider to be the most valuable to humans? Justify your choice.
7 Which ecosystem service do you think is most threatened by human activities? What would change if this service could no longer be provided by the environment?
8 The designers of Biosphere 2 attempted to provide all of the ecosystem services shown in Source 1. Conduct some research to find out which services they were able to provide easily and which were the most difficult to provide.

Source 2 This rock formation is known as The Cathedral. It is located in Mt Buffalo National Park in Victoria. Mt Buffalo is part of a mountainous region of south-east Australia known as the Australian Alps. The traditional owners of these parts of Australia – such as the Walgal and Ngarigo people – have a deep spiritual connection to the land.

2.8 Challenges to sustainability

Virtually all human activities impact on the natural environment in some way, but humans can reduce these impacts by using the Earth's resources sustainably. The concept of **sustainability** relates to the ongoing capacity of the environment to support the lives of all living things into the future. The sustainable use of resources such as **fossil fuels**, forests and oceans is about carefully managing these resources so that they meet the needs of today without compromising the ability of future generations to do the same – put simply, it is about using the Earth's resources at levels that allow the planet to replace or replenish them naturally. This is a particularly important concept when we consider our use of natural resources that supply us with food and water, such as forests, rivers, the oceans and farmland. If resources are used sustainably, the quality of the environment is maintained and the resources will continue to provide for future generations.

Case study: the fishing industry and world fish production

Fish are a vital food resource, providing over 15 per cent of the animal protein eaten each day by three billion people. Currently, about 540 million people are employed in the fishing (fish catching) or aquaculture (fish farming) industries.

Many of the world's fish species, however, have been fished beyond sustainable levels and their numbers are now in serious decline (see Source 1). More than half of the species investigated by the United Nations are described as being 'fully exploited' and have no

Source 2   These Bluefin tuna are caught in the Mediterranean Sea then fattened in cages before being shot, frozen and shipped to Japan to become sushi. Remaining stocks of wild tuna are listed as endangered species but little is being done to protect them.
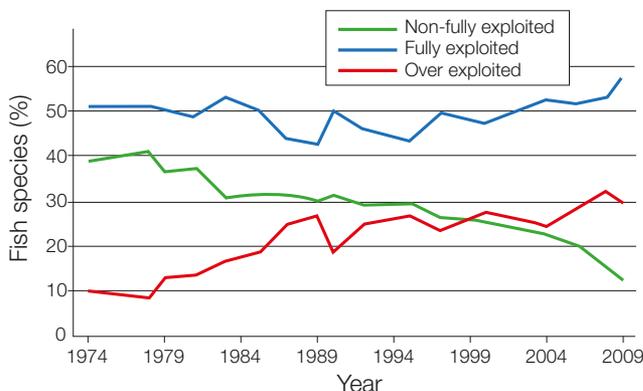
Source 1   Global trends in world marine fish species supplies since 1974   Source: FAO

potential for increased production in the future. Another third of fish species are described as being 'over exploited'. This means that they are currently being fished at an unsustainable level. However, if effective management plans are put in place now to reduce the numbers taken from the sea, these species may recover.

Unsustainable levels of fishing are being driven by the food demands of an increasing world population and by modern fishing techniques. These techniques include using spotter planes and GPS to locate large schools of fish, fishing in deeper waters and dragging huge nets along the ocean floor. Fewer and fewer fish are now surviving to adulthood, because they are being caught and eaten as juveniles, before they have had a chance to breed and produce more fish. This means that the fish being caught are not being replaced.
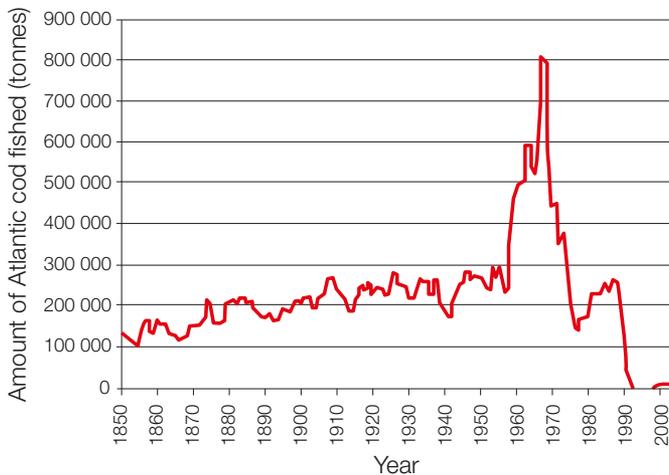
Source 3 Amount of Atlantic cod fished off the East Coast of Newfoundland, 1850–2000

Source 4 Large-scale fishing practices implemented from the 1960s onwards devastated the population of Atlantic cod in the United States and Canada.

A warning from the past: the disappearing Atlantic cod

The people of the north-western United States and Canada have fished the coastal waters of the Atlantic Ocean for hundreds of years. The most prized fish of their catch is the Atlantic cod which once existed in vast numbers. Up until the mid-1950s, around 300 000 tonnes of Atlantic cod were caught each year in the region's waters. By the middle of the 1960s, large-scale fishing trawlers, using vast nets and mechanical winches, were catching 100 tonnes of Atlantic cod an hour. By 1968, the amount caught peaked at more than 800 000 tonnes before the Atlantic cod population collapsed. Despite attempts to protect the remaining cod in the last few decades, the population has never recovered (see Source 3).

Making fishing sustainable

In more recent times, countries such as Australia, New Zealand and the USA have put in place fisheries management plans to make their fishing industries sustainable and to ensure good numbers of fish stock in the ocean in the future. These plans monitor fish populations and place quotas on the fishing industry, limiting the numbers of fish that can be caught. These management plans have proven very effective at increasing and maintaining fish numbers.

Consumers can also play a part in ensuring the sustainability of fish supplies by choosing to only eat fish that have been farmed or caught in sustainable ways. Organisations such as the Australian Marine Conservation Society provide lists of fish that are safe to eat and fish that you should avoid because they are endangered.

Check your learning 2.8

Remember and understand

1 In your own words, define sustainability.
2 Explain why the history of Atlantic cod fishing is an example of unsustainable resource use.

Apply and analyse

3 Copy and annotate Source 3 to describe the important trends and changes in the numbers of Atlantic cod caught off the coast of Newfoundland, 1850–2000.

Evaluate and create

4 Aquaculture is seen by many as the best way of providing fish for human consumption in the future. Research this booming industry. Do you see this as a sustainable alternative to traditional fishing?

Construct your own line graph to explore global trends in fish supplies into the future.

a Draw up a set of axes: the vertical axis (*y*-axis) should show the percentage of fish species from 0 to 100 per cent. The horizontal axis (*x*-axis) should show the year from 1974 to 2050.

b Copy the line showing fish species that are 'over exploited' from Source 1 onto your graph.

c Based on the trend from 1974–2009, continue this line in a different colour to show the likely trend until 2050.

d Describe the trend shown on your completed graph. If your prediction turns out to be true, what will this mean for the fishing industry and consumers around the world?

2.9 Loss of biodiversity

Biodiversity refers to the variety of living organisms on the planet. Biodiversity is measured by the number of species present in a particular ecosystem or region. The Earth's biodiversity is currently under threat, decreasing at a rate that rivals the mass **extinction** of the dinosaurs. It is difficult to give an exact figure on the number of species reaching extinction each year but it has been estimated at between 17 000 and 100 000 species annually. The world's most famous fossil hunter, Dr Richard Leakey, believes that this represents 'a rate comparable with the impact of a giant asteroid slamming into the planet'.

This loss of biodiversity not only impacts the natural environment but also has serious consequences for all human beings on Earth. Ecosystem services such as food, fibre and fresh water supplies, crop pollination by insects and birds, and protection against natural disasters are in decline.

Source 1   Much of the world's land surface is no longer in its natural state. Farmland and cities have replaced areas once covered by forests and grasslands. Farming, as with this beef cattle farm in Brazil, tends to replace hundreds of species with just one. This greatly reduces biodiversity.

What's causing the loss of biodiversity?

This loss of biodiversity is due almost entirely to the impact of just one species – humans. Our use of the Earth's resources and the changes this use brings to the natural environment are pushing many species to extinction. The five main causes of this are:

- habitat change such as deforestation
- over exploitation of resources such as fresh water
- pollution of land, water and air
- the spread of **invasive species**
- **climate change** brought about by human activity.

Species facing extinction

The International Union for the Conservation of Nature (IUCN) is an organisation that assesses the likelihood that species will become extinct. Of the almost 50 000 species they have studied, 36 per cent can be considered threatened with extinction. Birds and amphibians (such as frogs) are particularly under threat (see Source 3).

A world without frogs?

The number of frog species in the world is in dramatic decline and many researchers are linking this to climate change. The skin of frogs is particularly thin and permeable, meaning that moisture is able to pass through it easily. With the drier, warmer climate, many frogs are losing more water through their skin than they are taking in.

They are also losing their breeding grounds, as small ponds and water collected in the hollows of trees are drying up and disappearing.

Source 2   The last golden toad was seen in 1989, and like 33 other amphibian species since then, it is now considered extinct.
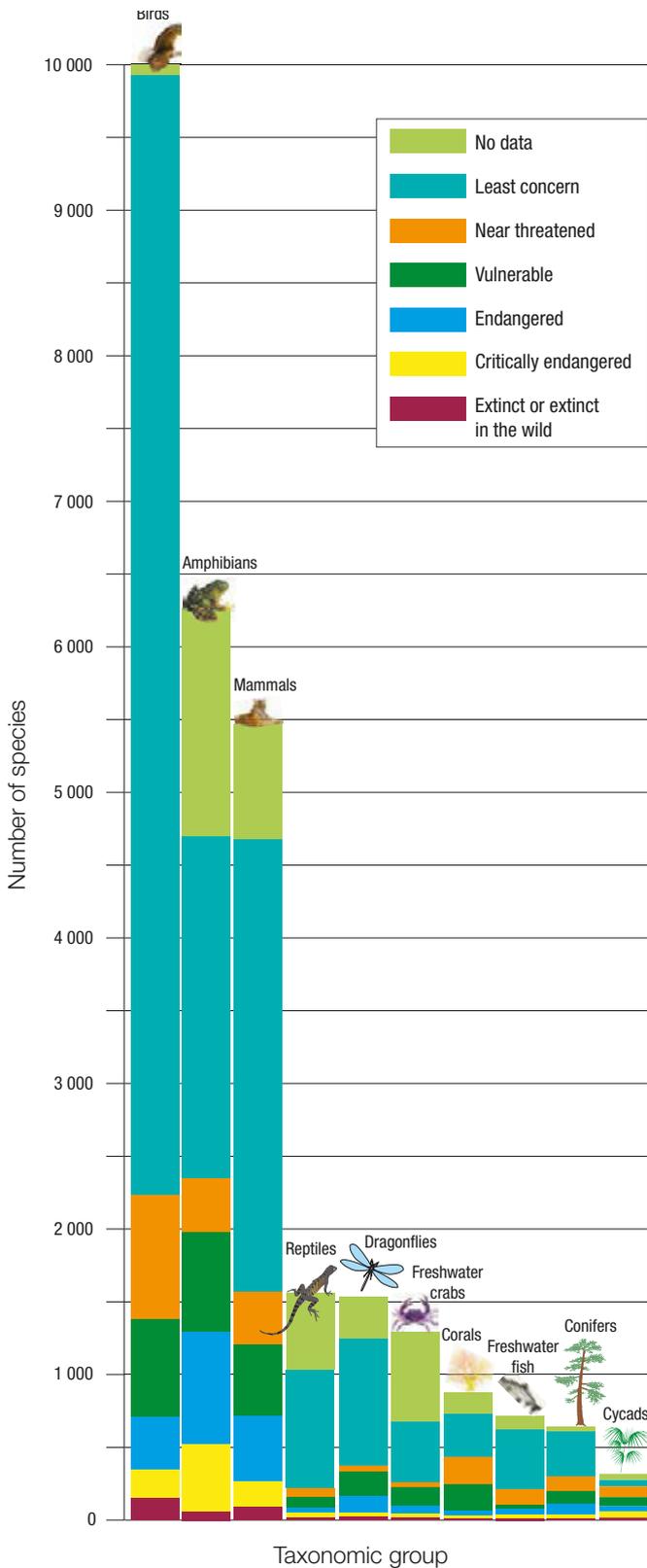
Source 3 IUCN data on the levels of threat faced by the major life groups (known as taxonomic groups)

The greatest threat, however, is from disease. A parasitic fungus from Africa, known as amphibian chytrid, has spread across the planet in the last few decades. Warmer temperatures associated with climate change have created favourable conditions for the spread of this parasite which was previously held back by cooler night-time temperatures.

After studying the spread of this disease in Central America, a leading researcher in this field stated that 'disease is the bullet killing frogs, but climate change is pulling the trigger.' He found that two-thirds of all of the region's species of harlequin frogs were already extinct from this combination of factors. He and other scientists believe that frogs may be the planet's early warning system on climate change.

Check your learning 2.9

Remember and understand

1 What is biodiversity?

2 Why is biodiversity important?

Apply and analyse

3 How would a person with a human-centred world view (see Source 2 on page 76) feel about the environmental change shown in Source 1?

4 Examine Source 3.

  a Which taxonomic group has suffered the most extinctions? Which of the five main causes of biodiversity loss do you think is most responsible for this?

  b Use the graph to describe the levels of threat faced by amphibians.

  c What is the level of threat facing the world's corals? Find out what ecosystem services would be threatened by a loss of coral species.

Evaluate and create

5 Describe the change in biodiversity shown in Source 1. Which of the five main causes of the loss of biodiversity does this illustrate?

6 Find an image which illustrates another of the causes and give it a suitable title and caption.

  Search for the IUCN red list on the Internet. Use this list to investigate Australia's Southern Corroboree Frog. How many of these frogs remain in the wild and what dangers do they face?

2.10 Climate change

Although the world's climate has been changing for millions of years, in more recent times there has been an increase in the concentration of certain gases in the atmosphere. Many of these gases – known as **greenhouse gases** – are found naturally in the environment, but human activities have increased the levels of these gases to a point where they are influencing the global climate. The four main greenhouse gases include:

- carbon dioxide from burning fossil fuels such as coal
- methane from the large-scale farming of livestock
- nitrous oxide from the use of fertilisers
- fluorinated gases from refrigerators and solvents.

Greenhouse gases trap some of the Sun's energy within the atmosphere causing temperatures to rise. This is known as **global warming**.

When temperatures rise, other changes take place in the world's ecosystems. Rainfall patterns change, as some places become drier and others become wetter. Ice melts and less snow falls in both the polar regions. Sea levels rise and droughts, floods, cyclones and bushfires become more severe and more frequent. These, and other changes associated with increased greenhouse gases, are changing the world's ecosystems and the services they provide.

Environmental responses to climate change

Ecosystems develop and flourish under specific environmental conditions. As climate change alters these conditions, the plants and animals within the ecosystems respond in one of four ways:

- They change their basic biology – certain animals may reproduce less often or lay smaller eggs.
- They change the timing of certain events such as flowering – certain plants may flower earlier or later depending on the conditions. This can impact on birds that rely on these plants for food.
- They die out – when a species dies out it can have serious impacts on the entire ecosystem.
- They move – in general, many plants and animals are moving towards the poles and into higher altitudes (Source 2), as temperatures in these places are similar to those in their previous habitats. This affects plants and animals already living in these places.

Source 1   Some of the causes of human-induced climate change

solar radiation

blanket layer of greenhouse gases traps solar radiation, warming the planet

carbon monoxide from motor vehicles

carbon dioxide from aeroplane travel

carbon dioxide from burning fossil fuels

carbon dioxide from forest clearing and burning

fluorinated gases from propellants and coolants

methane from animals and nitrous oxide from fertilisers

Case study: Climate change and the Saami

One of the largest Indigenous groups in the Arctic region is the Saami people of northern Scandinavia. Numbering around 70000 people and living in one of the world's harshest environments, many Saami groups rely on traditional reindeer herding for their livelihood. They migrate north in spring and summer and south in winter to find sufficient food, such as grass and small shrubs, for their herds. A typical herd is made up of several thousand reindeer. Typically, Saami herders will travel hundreds of kilometres a year with their herds.

While it would seem that warmer temperatures would bring better grazing conditions to the frozen Saami lands, the reverse is actually true. Warmer winter temperatures melt the snow, turning it to water. It then refreezes as a layer of ice which the reindeer cannot penetrate to reach the lichen below. This ice is known as *cuokke* to the Saami people and can result in their herds starving to death. The Saami respond by keeping their herds in pens and feeding them hay and straw but this food is expensive and difficult to find. These changing conditions may bring an end to the Saami's nomadic way of life which has existed for thousands of years.
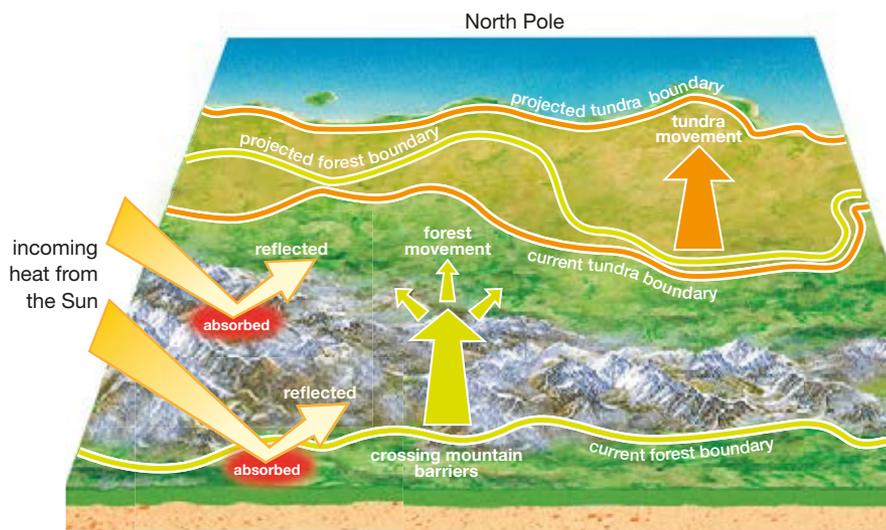
Source 2 The movement of tundra (frozen, treeless land) and forests towards the North Pole in the Arctic. As mountain slopes become forested they absorb more heat from the Sun rather than reflecting it, further increasing temperatures.

Check your learning 2.10

Remember and understand

1 What are some of the main causes of climate change?

2 How might climate change bring an end to the traditional Saami way of life?

Apply and analyse

3 Discuss with a partner how climate change affects ecosystem services (see Source 1 on page 60). Brainstorm these ideas as a class.

4 Describe the impact of climate change on plants and animals in the Arctic region.

5 Why is more solar radiation absorbed as forests move northwards?

Evaluate and create

6 Construct a flow diagram that shows how plants and animals respond to environmental changes. Add examples of these responses to your diagram.

7 The Saami people are not the only Indigenous people whose way of life is threatened by climate change. Research the impact of climate change on Indigenous people in the Pacific Islands and compare their situation to the Saami.

Source 3 A Saami man moves his reindeer herd north in spring.

2.11 Pollution

Pollution is any substance released into the environment that has harmful or poisonous effects. Polluting substances reduce the ability of the natural environment to provide ecosystem services. Pollution is often a side-effect of a process intended to benefit human beings. Pesticides, for example, are designed to kill harmful insects that damage crops but they can also pollute our water and kill beneficial organisms such as bees. The loss of bees then reduces the amount of pollination that occurs, setting off a chain of negative effects in the environment. Here we look at some common forms of air, water and land pollution.

Air pollution

Air pollution is the contamination of the atmosphere through the release of harmful gases and small particles. Air pollution can happen on a variety of scales. Sometimes it is local (for example, a factory releases smoke and gases through a smokestack affecting the surrounding area). In urban environments such as Santiago, however, factories, vehicles, houses and other sources of pollution combine to produce large-scale pollution which affects the air quality right across the city (see Source 1). When this large-scale pollution causes changes to the atmosphere, for example pollutants such as carbon dioxide and methane trapping the Sun's heat in the atmosphere and causing global warming, we have pollution on a global scale.

Source 1 Air pollution in Santiago, Chile, is trapped by the Andes Mountains and can remain over the city for days, even weeks.

Source 2 When an offshore oil platform exploded in the Gulf of Mexico in 2010, it caused one of the largest oil spills in history.

Water pollution

Water pollution is the contamination of rivers, lakes, wetlands, estuaries, seas and oceans through the release of harmful substances. Water pollution can be caused by human activities on or near the water such as shipping and deep-sea oil drilling. Ships, for example, release waste water and oil into the sea causing pollution. Land activities, sometimes a long way from water, can also lead to pollution entering our waterways. These land activities include farming (especially when using fertilisers and pesticides), littering, land clearing, creating tips and **landfill**, processing sewage and industrial activities. Industrial or farming waste released into a river can travel the length of that river and enter waterways, causing water pollution over a widespread area. Likewise, litter washed down stormwater drains during a storm can end up polluting the ocean.

Land pollution

Land pollution is the contamination of areas of land through the release of harmful substances. Soil contamination is often localised, such as at the sites of old petrol stations, mines, sewage treatment facilities or landfill. Soil contamination can also occur on a much larger scale, such as increasing **salinity** (salt levels) in the soil resulting from rising water tables in Australia's Murray–Darling Basin. Land pollution can cause the contamination of groundwater, which is often an important source of drinking water.

WORLD: GLOBAL DISTRIBUTION OF POLLUTION
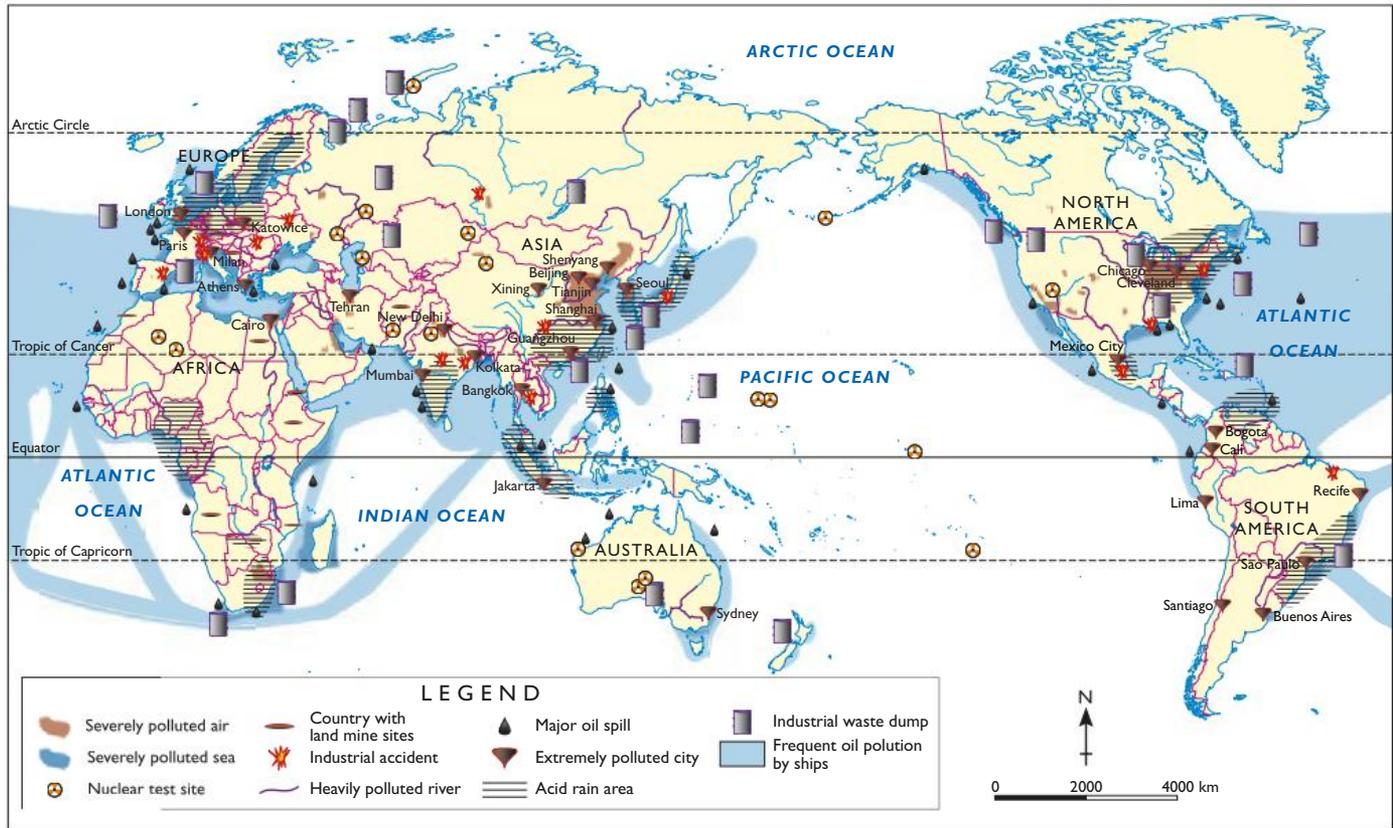
Source 3

Source: Oxford University Press

Source 4 Landfill can cause soil contamination.

Check your learning 2.11

Remember and understand

1 Define and give examples of the main forms of pollution.

Apply and analyse

2 Examine Source 3.

    a Describe the distribution of severe air pollution.

    b Use an atlas to list those countries with landmine sites. Are landmines an example of pollution? Why/why not?

    c Which countries experience three or more types of pollution? What may be the underlying causes of pollution there?

3 In what ways would the explosion of an offshore oil platform (see Source 2) pollute the environment?

Evaluate and create

4 Source 3 shows acid rain as a form of pollution. Research acid rain and report on its causes, distribution and effects on ecosystem services.

5 Which type of pollution do you consider has the greatest impact on ecosystem services?

2.12 The real cost of your mobile phone

When exploring the ways in which the environment is changing, it is important to look not only at the effects of these changes but also their causes. For example, when investigating declines in fish populations, geographers look for causes such as increases in world population, pollution levels and changing consumption patterns. Similarly, when looking at the environmental changes brought about by industry and mining around the world, geographers need to explore a range of possible causes. One of the main factors driving the growth in mining and production is increased demand for electronic consumer goods such as mobile phones. Current estimates put the number of mobile phone subscribers around the world at about 6 billion. This number has increased significantly over the past decade (see Source 5). The **raw materials** used in the production of mobile phones come from different locations around the world. Dramatic increases in demand for these materials has created serious environmental problems in a number of locations.

polymer plastics 29%
silicon plastics 10%
epoxy 9%
organic polymer plastics 2%
other plastics 8%
PLASTICS
flame retardants 1%
OTHER
METALS
copper 15%
iron 3%
nickel 1%
zinc 1%
coltan 1%
other 4%
ceramics 16%

Source 1 The raw components of a mobile phone

Plastics

Plastics are a by-product of refining oil. Oil is usually found in the Earth's crust and is accessed by drilling into the crust, either on land or on the seabed. There are significant environmental risks associated with mining and using oil. These range from the potential for oil spills at the mine site to the greenhouse gases produced when oil is used for fuel. Many plastics are hard to dispose of and take thousands of years to break down. Since the 1950s, more than a billion tonnes of plastic has been discarded around the world.

Metals

Copper

Because copper conducts electrical signals, it is used a great deal in electronic devices. Copper is mined in many places around the world. Chile's Escondida copper mine is the world's largest. The mine is essentially two giant pits dug into the desert floor. Waste rock is left in piles called tailings and copper is transported in pipes 180 kilometres to the coast. Like many large mines,

Source 2 This bird has died from eating plastic which it mistook for brightly coloured fish. Thousands of sea birds and other marine animals die each year in this way.

Escondida is located in the desert. This creates problems for the mining operators who need water for their mining operation and their workers. A desalination plant is being built on the coast to provide this water. The water will be piped to the mine.

Source 3 The Escondida copper mine in the Chilean desert

Source 4 A coltan mine in the Democratic Republic of the Congo. As well as causing environmental change there is also evidence that profits from coltan mining are being used by armies in the region to fund long-running and bloody conflicts.

Coltan

Coltan is a mineral ore, high in iron, that is used in mobile phones as well as video-game players and some computers. Australia is the world's largest supplier of coltan. The Democratic Republic of the Congo (DRC) in Africa is another large supplier. To reach the coltan in the DRC, miners have stripped away rainforest, including the rainforest in national parks. The roads they cut through the rainforest to reach the mines are then used by local people hunting wild animals for food. One of the animals hunted by locals for meat in the rainforest is the gorilla. The western lowland gorilla is now a critically endangered animal and has all but vanished from the rainforests of the DRC.
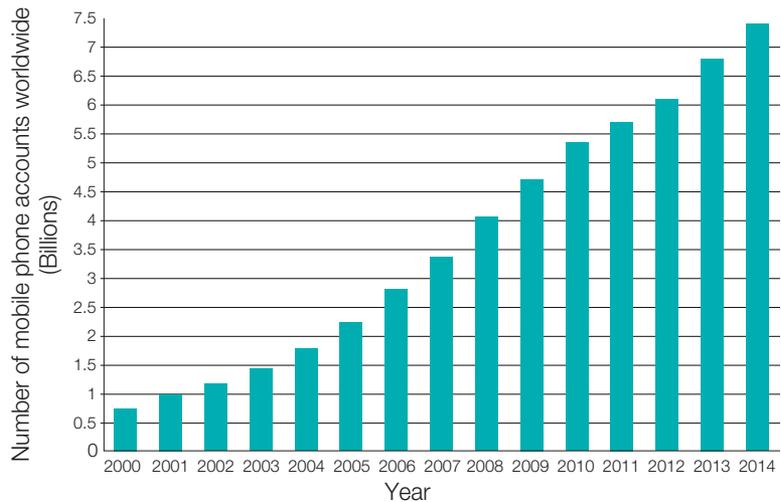
Source 5 Growth in the number of mobile phones worldwide

Check your learning 2.12

Remember and understand

1 How does the production and use of plastic change the environment?

2 What is coltan? How has the mining of coltan changed the environment in the Democratic Republic of the Congo?

Apply and analyse

3 Examine Source 5 carefully.
   a Describe the global trend in mobile phone use over the period.
   b Conduct research to determine the five countries around the world that have experienced the largest growth over this period. Why might this be the case?

4 The bird in Source 2 was found on the Midway Islands. Use an atlas to locate these islands and explain where you think the plastic that caused the death of this and many other birds originated.

Evaluate and create

5 Select another popular consumer item of your choice and research the environmental changes brought about by its production and use.

2.13 Ecosystem decline: invasive species

Invasive species is a term used by geographers and scientists to describe groups of organisms (e.g. plants, animals, bacteria or fungi) found in an area they are not native to. In many cases, invasive species upset the biological diversity of areas they spread to and can have other negative effects. Many ecosystems around the world are threatened by invasive species of plants, animals and insects. Sometimes, invasive species are brought to a new place deliberately. For example, goats and rabbits were brought to Australia on the First Fleet to provide a source of food for the new settlers. Other species may be brought to a new place accidentally. For example, rats often hide aboard ships going to new places. Other marine pests were brought to Australian seas unintentionally in ballast water carried on container ships.

However they move from one place to another, invasive species have the potential to degrade the land and disrupt the natural balance of the ecosystem. They often compete with native species for food, land or water, leading to a loss of biodiversity. Australia has 362 invasive species, the second highest number in the world (see Source 1). Some of the world's most successful invasive organisms include the castor oil plant, Chytrid frog fungus, domestic cat, black rat, American mink and the water hyacinth.

Source 1

❷ Chytrid frog fungus (*Batrachochytrium dendrobatidis*)

Native to: Africa

Invaded: All six continents. The fungus has infected 93 frog species, more than half of which are Australian.

Method of invasion: Frogs carrying the fungus introduced as a food source and for scientific purposes.

Preferred biomes: Rainforests, freshwater sources

Impacts: About one-third of all amphibian species have the fungus, causing a decline of frog species worldwide.
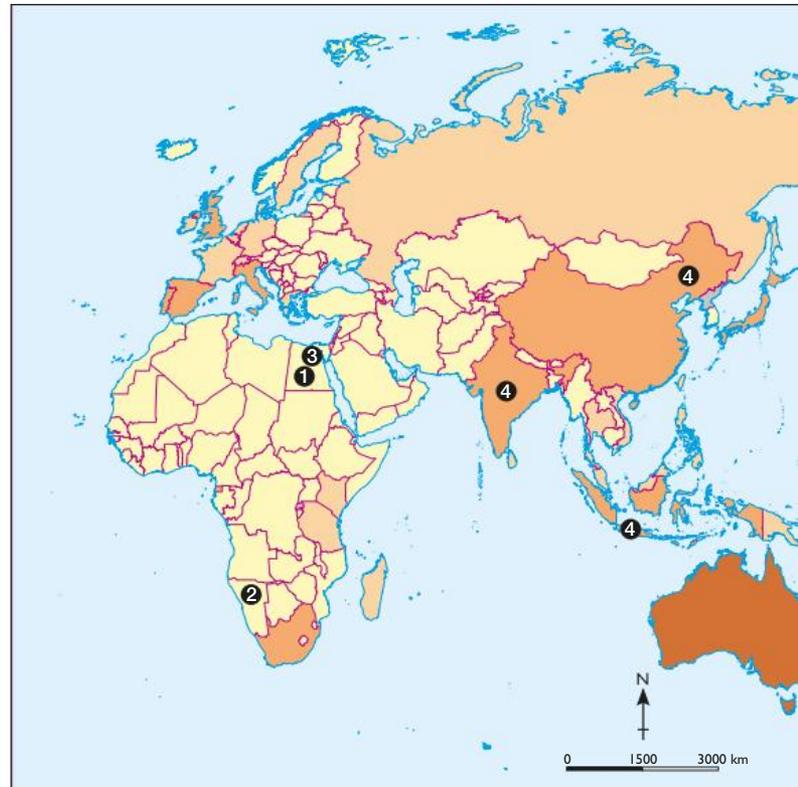
❶ Castor oil plant (*Ricinus communis*)

Native to: North-east Africa and the Middle East

Invaded: Common on every continent except Antarctica

Method of invasion: Carried as an ornamental plant and cash crop in the production of castor oil. Seeds dispersed by rodents and birds

Preferred biomes: Grassland, temperate forest

Impacts: Displaces native plant species, poisonous to many animal species including humans

❸ Domestic cat (*Felis catus*)

Native to: Unknown (first domesticated in ancient Egypt)

Invaded: Virtually every country, listed as a harmful species in more than 60

Method of invasion: Carried as pets or to restrict rat numbers and then released or escaped into the wild

Preferred biomes: Grasslands, forests and tundra close to water

Impacts: Caused or contributed to the extinction of birds and small mammals around the world, particularly on islands

6 Water hyacinth
(Eichhornia crassipes)

Native to: South America

Invaded: Widespread in streams and rivers around the world particularly in North America and Europe

Method of invasion: Carried as an ornamental plant

Preferred biomes: Freshwater sources including rivers, lakes and streams

Impacts: Grows as a thick mat clogging rivers and streams, inhibiting plants and some fish species and providing a habitat for other pests including malarial mosquitoes

Check your learning 2.13

Remember and understand

1 How do invasive species move between countries?

2 How can an animal that is not a pest in one country become a major pest when introduced to a new country?

3 How do rats cause land degradation?

Apply and analyse

4 Compare the six examples of invasive organisms shown. What are some of the similarities? How is each unique? Which do you consider has had the greatest impact?

5 Examine Source 1.

   a Which countries have the highest numbers of invasive species?

   b Why do you think these countries have so many invasive species? What features do they share that might help to explain the high numbers?

   c Why do you think that Africa and the Middle East have such low numbers of invasive species?

Evaluate and create

6 Some researchers consider humans to be an invasive species. Complete a file card for the human species describing their method of invasion, preferred biomes and impacts.

7 Australia is one of the most invaded countries but is also the origin of many plants and animals that are considered invasive species in other countries. These include the golden wattle, Queensland fruit fly, Australian magpie, spotted jellyfish and brushtail possum. Research one of these invading Australians. Describe how and where it has spread and its impact on native plants and animals.

LEGEND

Number of invasive species

- Over 400
- 300 to 399
- 200 to 299
- 100 to 199
- 50 to 99
- Under 50
- No data
- **①** Country of origin of species

Source: Oxford University Press

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④ Black rat
(Rattus rattus)

Native to: South-East Asia, north-east China and India

Invaded: Widespread around the world

Method of invasion: Deliberately introduced as a food source or accidently introduced as a stowaway on ships

Preferred biomes: Grassland, temperate forest, tropical forest

Impacts: Preys on native birds (especially flightless species and the eggs of seabirds), reptiles and insects, eats native plants and seeds, major agricultural pest. They have caused or contributed to the extinction of birds, mammals, reptiles and plants.

⑤ American mink
(Neovison vison)

Native to: North America

Invaded: Widespread throughout Europe

Method of invasion: Bred in mink farms for their fur, they escape or are released by animal activists

Preferred biomes: Forests near wetlands and rivers

Impacts: Kills large numbers of native species such as voles and salmon, can drive native mink from their habitats

Invasion of the cane toad

Native to Central and South America, cane toads were released in northern Queensland cane fields in 1935 to help control cane beetles which were eating and destroying the sugarcane plants. The cane toads were of little benefit to the farmers but as they spread beyond the cane fields, southwards into New South Wales and westwards towards Western Australia, they soon became pests themselves. Like many introduced species, cane toads have no natural predators in Australia, so there was little to stop their spread.

Animals such as snakes, goannas, freshwater crocodiles and quolls have eaten frogs for millions of years. They see cane toads as a new food source. However, the poisonous skin of the cane toad kills its attacker within minutes. This is devastating the local populations of these native animals.

Source 2 The cane toad has become a serious pest in Queensland and the Northern Territory.

skill**drill:** Data and information

Using a topographic map to explore environmental change

Because topographic maps show the shape of the land in great detail, they are one of the most useful tools used by geographers. By adding extra information, topographic maps can be used to show changes over time and the reasons for these changes. Source 3 has been drawn to show the expansion of the cane toad's territory every year from 2006 to 2012. The **contour lines** on the topographic map show the shape of the land over which the cane toads are spreading (including the heights of valleys, hills and ridges). Geographers use this information to measure and predict the rate and direction of the cane toad's spread. Follow these steps:

Step 1 Look closely at the lines and dates showing cane toad expansion to estimate in which direction the spread is moving.

Step 2 Are the lines becoming closer together or further apart from one year to the next? This will tell you if the rate of spread is increasing or decreasing.

Step 3 Select an area between two lines that shows a typical rate of spread. Use the line scale to estimate the distance between the lines in this place. This will give you a rate in kilometres per year. Divide this by 52 to give you a rate per week. This could also be expressed as metres per week.

AUSTRALIA: DISTRIBUTION OF CANE TOADS, 2012

Area of topographic map

Broome

Carnarvon

LEGEND
Cane toad distribution
1935
1950
Current
Predicted 2030
Suitable habitat

N

0   500   1000 km
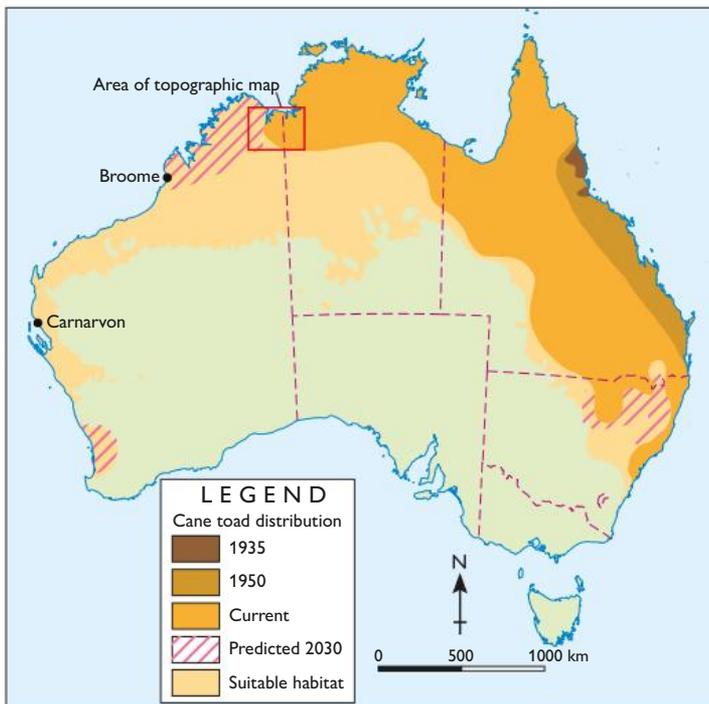
Source 1   Source: Oxford University Press

NORTH-EAST WESTERN AUSTRALIA AND NORTH-WEST NORTHERN TERRITORY: ADVANCE OF THE CANE TOAD 2006–2012
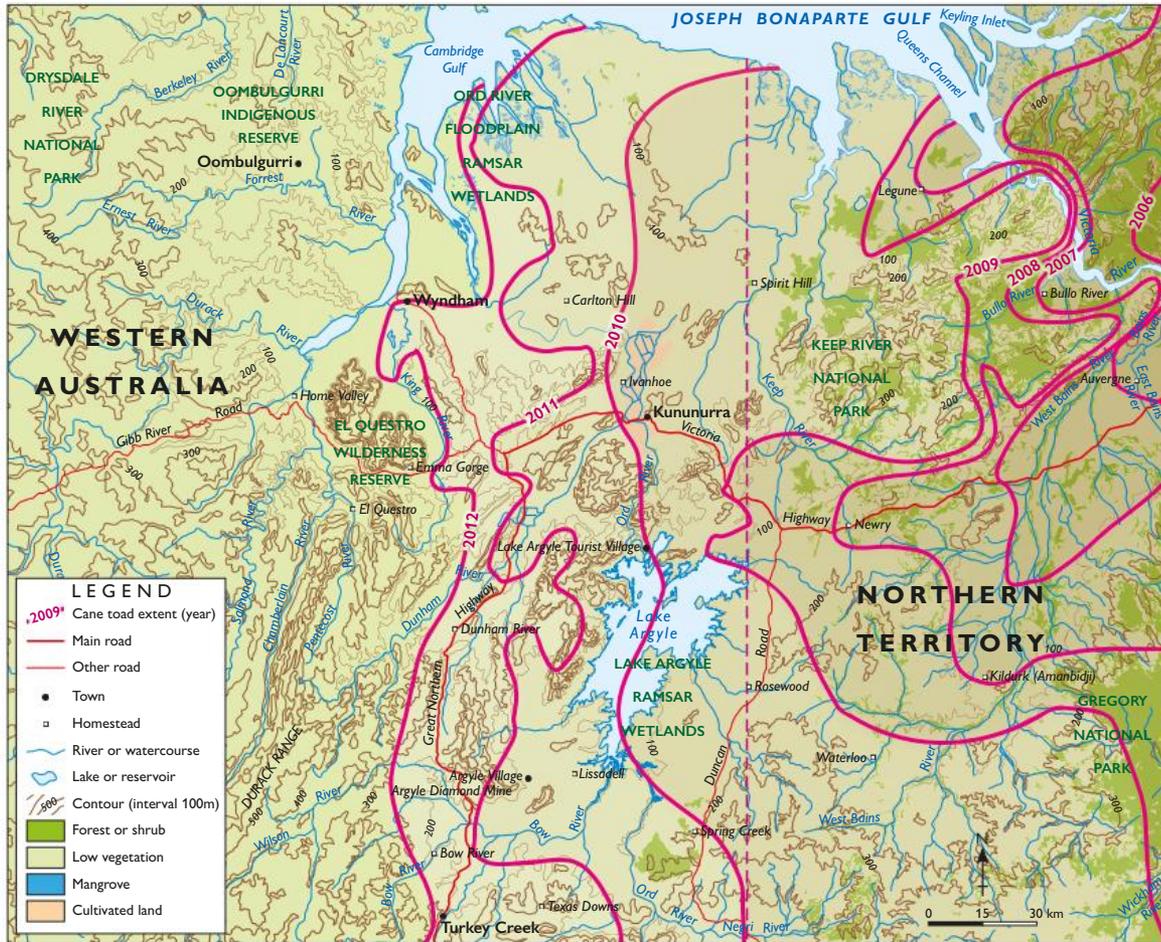
Source 3

Source: Oxford University Press

Step 4 Look at the contour lines and other features shown in the legend to identify any natural or built features that are affecting the pattern and rate of spread being shown on the map.

Apply the skill

Examine Source 3 carefully and complete the following tasks.

1 Using the steps provided, estimate the direction in which cane toads are spreading across northern Australia.

2 Calculate the rate of spread for the cane toad between 2011 and 2012.

3 Use the rate of spread you calculated, together with the line scales provided in Sources 1 and 3, to estimate the amount of time it will take cane toads to spread to the Western Australian towns of Broome and Carnarvon.

What natural features appear to be affecting the rate of spread of the cane toad?

Extend your understanding

Examine Source 1.

1 Estimate, in square kilometres, the size of the region currently inhabited by cane toads.

2 Estimate the size of the region cane toads are predicted to inhabit under current climate conditions.

3 How do you think climate change will affect the distribution of cane toads? Why do you think this is the case?

4 Kakadu National Park in the Northern Territory contains vast areas of protected wetlands and large numbers of unique plants and animals. Cane toads were first detected in the park in 2001 and since then have had a range of devastating impacts on this unique environment. Research these impacts and the efforts taken by park authorities to minimise them. Discuss the effectiveness of these methods with your classmates.

2.14 One world, many views

In December 2011, Miranda Gibson, a 30-year-old school teacher, built a platform in a tree 60 metres above the forest floor in Tasmania's Styx Valley. She then set up home on the platform and vowed not to leave it until the tree and the surrounding forest had been granted protection from logging companies. Armed with a laptop and wireless Internet connection, she wrote a daily blog which was viewed by tens of thousands of supporters. She also made the news around the world. Despite freezing cold, snow and rain, she remained up the tree for 449 days, an Australian record, and was forced down only when a nearby bushfire threatened her safety. While she had many supporters around the world, she also had many critics. At one stage, a pro-logging group camped at the base of the tree to protest against Gibson's protest.

Why is it that some people become so passionate about preserving the natural environment while others do not? For example, one person can look at a rainforest and see the beauty of nature, whereas the person standing beside them can only see the money to be made by turning the tree into timber. We can see these differences all over the world, wherever the natural environment is changing.

Studies show that different people view the environment in different ways because of the fundamental beliefs they hold about human beings and our place in the natural world. The reasons for holding these beliefs are very complex, but it appears that where we live, our standard of living, our education and our religion all play important roles. Although each person's view of the world is unique, researchers have managed to classify them into four major groups (see Source 2). It is important to understand that one view is not necessarily 'better' or 'worse' than another, it is simply different.

Source 1 Miranda Gibson made her home high in the branches of this tree for 449 days.

World views

Human-centred

Egocentric
I am the most important creature on Earth. Everything and everyone else is important to the extent that they support me and my lifestyle.

Anthropocentric
Humans are the most important species. We are in charge of the Earth and the natural world. We can use nature to support us and our lifestyle.

Earth-centred

Ecocentric
We should do whatever we can to minimise our impact and preserve the Earth's biodiversity. We are no more important than any other organism.

Biocentric
We have a responsibility to use the Earth's resources in a sustainable way. Other species may be useful to us but they also have as much right to exist as we do.

Source 2 World views about the environment

What is your world view?

In order to evaluate the different ways in which people view the world, US environmental social researchers have developed a set of 15 statements called the New Ecological Paradigm (NEP) scale. People are asked to read each of the statements and decide whether they agree or disagree with them on a scale from 1 to 5, where 1 is 'strongly disagree' and 5 is 'strongly agree'. This allows researchers to compare the world views of different groups of people within and between countries.

Source 3 The New Ecological Paradigm (NEP) scale

1 We are approaching the limit of the number of people the Earth can support.

2 Humans have the right to modify the natural environment to suit their needs.

3 When humans interfere with nature it often produces disastrous consequences.

4 Human ingenuity will ensure that we do not make the Earth unliveable.

5 Humans are seriously abusing the environment.

6 The Earth has plenty of natural resources if we just learn how to develop them.

7 Plants and animals have as much right as humans to exist.

8 The balance of nature is strong enough to cope with the impacts of modern industrial nations.

9 Despite our special abilities, humans are still subject to the laws of nature.

10 The so-called 'ecological crisis' facing humankind has been greatly exaggerated.

11 The Earth is like a spaceship with very limited room and resources.

12 Humans were meant to rule over the rest of nature.

13 The balance of nature is very delicate and easily upset.

14 Humans will eventually learn enough about how nature works to be able to control it.

15 If things continue on their present course, we will soon experience a major ecological catastrophe.

Source: Dunlap, Riley E.; et al. (2000). Measuring endorsement of the new ecological paradigm: A revised NEP scale. *Journal of Social Issues, 56* (3), 425–442

Check your learning 2.14

Remember and understand

1 What is the main difference between human-centred and Earth-centred world views?

2 Use Source 2 to classify Miranda Gibson's world view.

Apply and analyse

3 Read the 15 statements in Source 3. In a table, record the numbers of the statements you agree with in one column and the numbers of the statements you disagree with in another. (If you agreed with all or most of the seven even-numbered statements, researchers would classify you as having a human-centred world view. If you agreed with all or most of the odd-numbered statements, they would classify you as having an Earth-centred world view.)

   a Describe your world view based on your responses to this test. Did you find your results surprising?

   b Find a classmate with a similar world view to you and discuss with them their views of Miranda Gibson's anti-logging protest.

   c Find a classmate with a very different world view to yours and find out what they think about the anti-logging protest.

   d Ask an older person such as one of your parents to respond to the 15 statements and compare their responses to yours.

Evaluate and create

4 Do you think the NEP scale is an accurate way to evaluate people's world views? Can you suggest any ways in which this method could be improved?

5 Using the Internet, do some further research on the issue of logging in Tasmania's Styx Valley. Identify the individuals and groups who believe the area should be logged and the individuals and groups who believe the area should be protected from logging.

   a For each of the individuals or groups, summarise their point of view in regard to logging in the Styx Valley.

   b Give some possible reasons why these different points of view exist in relation to this issue.

2.15 Living water

Indigenous Australians have been part of the Australian landscape for more than 40 000 years. Over that time they have developed relationships with the land and the water that have helped them to survive and thrive in some of the harshest environments on Earth. As non-Indigenous Australians struggle with issues such as **water scarcity** and degradation, some are learning that the principles followed by Aboriginal and Torres Strait Islander peoples provide a model that can help them to view and use water more sustainably.

While Indigenous views and values vary from place to place and are both diverse and complex, it is possible to see some common principles with regards to their relationship with water. For example, many Aboriginal peoples refer to permanent sources of water as 'living water'. This describes the importance of water as not only a life-giving force but also of having a life of its own. Indigenous people do not see water as a mere commodity or resource but as a sacred source of life.

> Water is the life for us all. It's the main part. If we are gonna lose that I don't know where we gonna stand. If that water go away, everything will die. That's the power of water.
>
> John 'Dudu' Nangkiriyn

Holistic views of the natural world

Indigenous Australians believe that all features of a landscape (land, water, animals, plants and people) are inextricably linked together to form one interconnected whole. Change in one part of the landscape will bring change to the others. This fundamental belief is a key component of Aboriginal views of creation as well as the management of land and water. This traditional view, dating back tens of thousands of years, is now accepted as scientific fact by many researchers and scientists who refer to it as interconnection.

This holistic view of landscapes links Indigenous people with the natural world. Indigenous people believe that they have custodial responsibility for the land and water in the country in which they live and that this responsibility is passed to them by their ancestors and from them to their descendants. Water resources such as rivers, lakes, billabongs and groundwater are protected by a complex series of laws, customs and beliefs. The Nyungar people of south-western Western Australia, for example, throw a handful of sand into streams and lakes as they approach, in order to warn the spirit of the water of their approach.

For more information on the key concept of interconnection, refer to page 9 of 'The geography toolkit'.

Source 1   According to the traditional beliefs of the Gagudju people of Kakadu, a creator-being, known as Almudj, created the waterholes of the region. Almudj brings the wet season every year, may appear as a rainbow, can punish people by drowning them and lives in a pool beneath a waterfall.

Case study: the Police Lagoons

The views of Indigenous Australians with regard to the management of water can, at times, conflict with the views of non-Indigenous Australians, many of whom believe that water is a commodity that can be bought, sold and traded. There are, however, many examples of communities who have been able to take into account both sets of views when developing water management strategies.

One of these is the town of Dirranbandi and the nearby Police Lagoons, a series of wetlands beside the Balonne River in southern Queensland. The Police Lagoons are ephemeral wetlands which means they only fill with water during the rainy season. Before European settlement, the lagoons filled with water once a year and provided an important habitat for plants and animals. The lagoons were also an important meeting place for ceremonies, including burials, for the Kamilaroi and Kooma Indigenous peoples, as well as a source of food. With the development of large-scale farming in the region, including the establishment of Cubbie Station, the largest cotton farm in Australia, the Balonne River floods less often and the lagoons are without water for longer periods of time.

Following consultation with local Indigenous people, a new management plan for the lagoons will be developed that will take into account the cultural needs of the Indigenous population and emphasise sustainability. Information and knowledge will also be shared between the Indigenous community and government geographers. This will lead to a healthier wetland and see more frequent flooding of the lagoons.

Source 2 Satellite image of the Balonne River floodplain in southern Queensland

Check your learning 2.15

Remember and understand

1 Why do the views of Indigenous and non-Indigenous Australians sometimes conflict?
2 Why do you think that Indigenous views are often ignored when decisions about water use are made?

Apply and analyse

3 How might the Indigenous concept of interconnection help non-Indigenous Australians to better manage scarce water resources in arid regions of Australia?
4 What are your beliefs about the natural environment? Where do these beliefs come from?
5 Examine Source 2.
   a Describe the location of the Police Lagoons.
   b This is an ephemeral wetland. Explain how an ephemeral wetland operates.
   c Why are these wetlands significant to local Aboriginal peoples?
   d What land uses can you identify in the satellite image?
   e How do these land uses put pressure on the water resources in this region?

Evaluate and create

6 Discuss a set of guidelines or rules that could be introduced to help water users and managers use the expertise and knowledge of Indigenous peoples in making decisions about water use in Australia.
7 Research the interconnection between water resources in your local area and Indigenous Australians. How have these interconnections changed over time?

2.16 Responding to salinity

Salt is a natural part of the Australian environment. Deposited by salt-laden winds from the sea and from the weathering of rocks, it is a component of most soils. It has been estimated, for example, that in parts of Western Australia the soil typically contains between 170 and 950 tonnes of salt per 10 000 square metres. Because this salt has accumulated slowly over millions of years, Australia's native vegetation has adapted to the salty soils. The native deep-rooted trees and shrubs soak up much of the rainwater entering the soil. This keeps the **water table** low in the ground and means the salt stays deep in the soil and away from plant roots.

However, changes in the Australian landscape since the arrival of Europeans have significantly altered this system. Large areas of native vegetation have been cleared and replaced by shallow-rooted crops and grasses (Sources 1 and 2). This means that much more water is held in the soil and so the water table rises, bringing with it the salt

that has accumulated over millions of years. It collects in low-lying areas, killing the introduced plants. As the water evaporates, salt is left at or near the surface, creating large salt pans where nothing can grow (see Source 4). The salt also moves across the landscape turning freshwater streams into salty drains.

In some places, **irrigation** also increases the amount of water in the soil. This has the effect of raising the water table and bringing salt to the surface. Studies estimate that salinity currently affects 19 500 Australian farms and 20 000 square kilometres of agricultural land, much of it in Western Australia's wheat belt. At present, it has the potential to affect 46 000 square kilometres of agricultural land. This is expected to increase to 136 000 square kilometres within 50 years. This makes salinity Australia's most serious and widespread land degradation issue.

deep roots
groundwater low
groundwater
rock
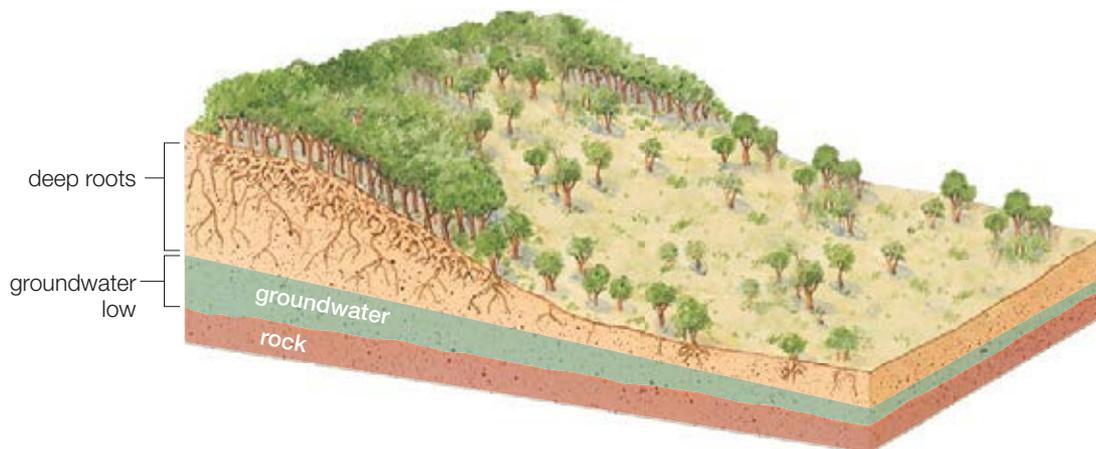
Source 1   Salt in the Australian landscape before land clearing

high level of salt in water
shallow roots
groundwater high
groundwater
rock
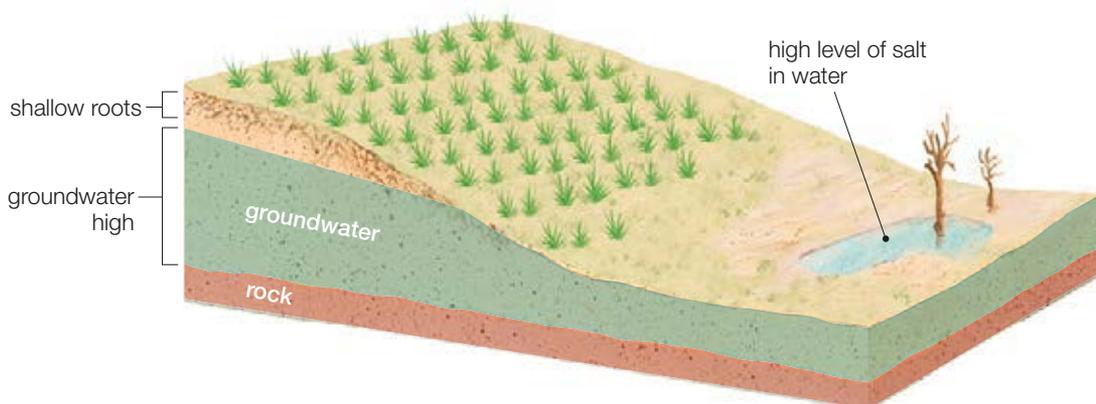
Source 2   Salt in the Australian landscape after land clearing

keyconcept: Change

Salinity in the Western Australian wheat belt

The largest area of salty soils in Australia is in the south-west corner of Western Australia, a region known as the wheat belt. This is a vast area of 19.3 million hectares, 16 per cent of which is at risk of salinity due to rising water tables. Most of this is agricultural land and would result in lost profits for farmers of at least $80 million a year. Source 3 shows the areas of the wheat belt with rising water tables in 2000 and the predicted salinity-affected areas in 2050.

Salinity in the wheat belt also poses a threat to biodiversity as plants and animals lose their habitats. As salt accumulates in the low-lying regions in the landscape such as freshwater lakes, plants and animals that live in these regions are at the greatest risk. At least 1500 plant species in Western Australia suffer from salinity with 450 possibly becoming extinct. Animal species are likely to decline by one-third if salinity continues to spread. For more information on the key concept of change, refer to pages 12–13 of 'The geography toolkit'.

WESTERN AUSTRALIA: DRYLAND SALINITY RISK IN THE SOUTH-WEST IN 2000 AND 2050

LEGEND
- High risk of salinity
- Public land
- Border of wheat belt
- Major road
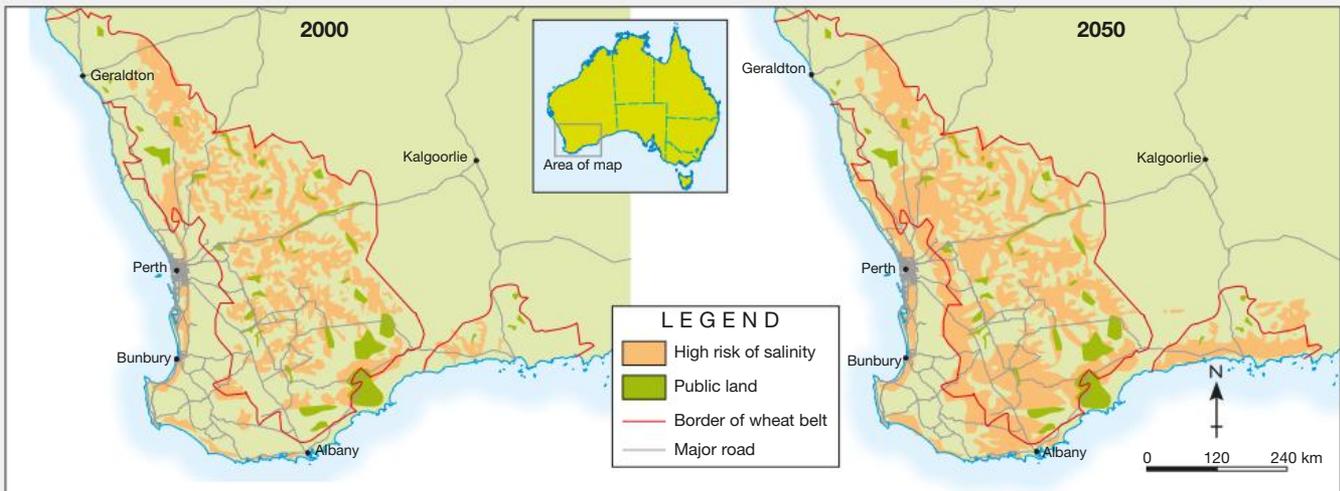
Source 3

Source: Oxford University Press

Source 4   Salt rising to the surface in the Western Australian wheat belt

Case study: fighting salinity at Toolibin Lake

In many local areas, attempts are being made to repair the damage of the past. These attempts tend to be small in scale, as repairing degraded land is expensive and difficult to achieve over a large area. For the repairs to be effective and not cause further damage, it is important for those undertaking the work to have a detailed understanding of the complex ecology of the site.

Toolibin Lake, in the Western Australian wheat belt, is a small ephemeral wetland (meaning it only fills with water occasionally, depending on rainfall).

As one of the last remaining freshwater wetlands in the region, it contains important habitats for a number of plant and animal species, many of which are endangered. In the 1970s, the lake bed began to show signs of increasing salinity and many trees died. Source 5 shows the distribution of salinity in the area. A geographic investigation found that this was due to the flow of salty water into the lake from surrounding farmland together with a rising water table. In the

TOOLIBIN LAKE: AREAS OF SALINITY
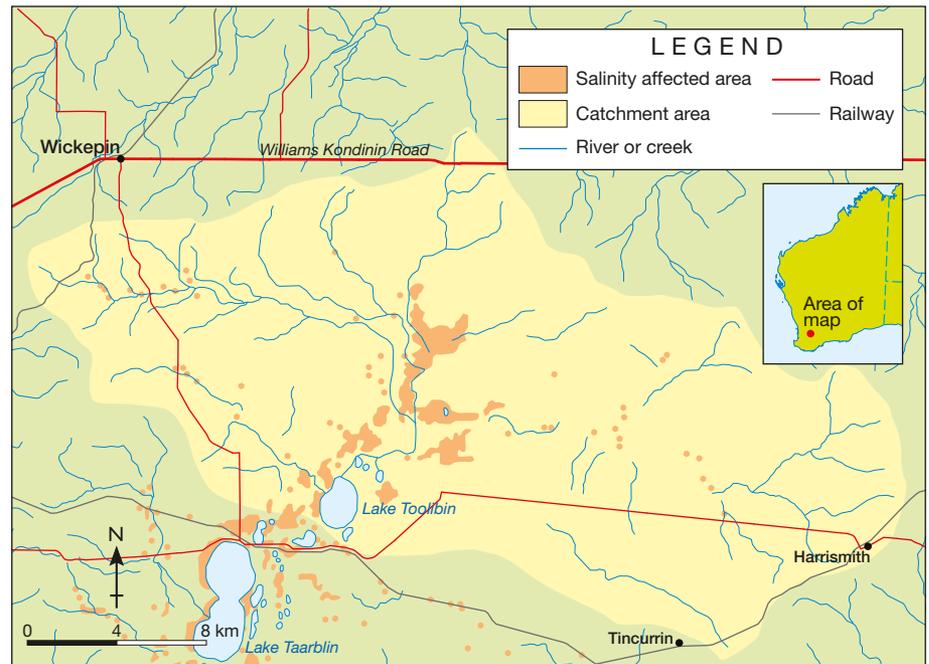
Source 5

Source: Oxford University Press

1990s, a number of measures were put in place to lower the water table and reduce the salinity (Source 6).

These measures included measuring the salt levels in the stream that flows into the lake and diverting excessively salty water to a nearby lake. Pumps on the lake bed were installed to lower the water table and

Diversion gates measure the salinity of water flowing into the lake. Salty water is diverted, fresh water flows into the lake.

A buffer zone of vegetation is protected and replanted around the lake shore.

A channel carries salty water to nearby Taarblin Lake.

Toolibin Lake

Taarblin Lake

11 large pumps on the lake bed pump salty water from the ground to lower the water table.
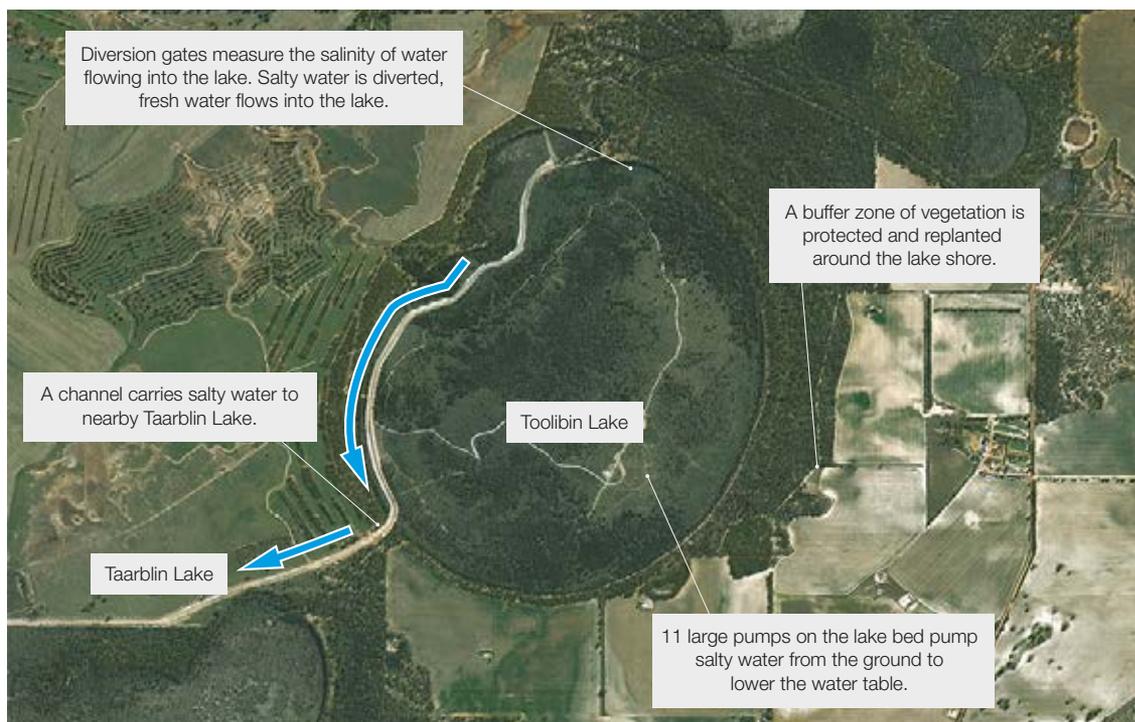
Source 6
An aerial photograph of Toolibin Lake showing the measures used to lower the water table and reduce salinity

to remove salty water from the soil. Around the lake, belts of trees were planted to intercept water as it flowed towards the lake and also to help in lowering the water table.

A review of these measures in 2010 showed that the water table had been held below the target of 1.5 metres across most of the lake. However, an analysis of satellite imagery from 1990 to 2009 showed that in some areas of the lake, trees had flourished, but in others, they had continued to decline.

Researchers then examined the ways in which the two dominant tree species, sheoak and paperbark, had responded to changing water and salt levels. They found that the trees had responded in very different ways. New sheoak seedlings were found on the floor of the lake but the paperbark trees had continued to decline in health and numbers. This information could then be used to develop new management plans for the lake. Much of this is now centred on working with the local Landcare group. Landcare is a national network of thousands of locally-based community groups who care for the natural resources of Australia. In the Toolibin Lake much of this work has focussed on increasing the number of trees planted on surrounding farms. The farms in the area tend to grow cereal crops such as wheat. Getting the farmers to put trees on their farms will further reduce salinity across the region.

Building an eco-bridge

Additional measures are being introduced to help endangered animals in the region such as the red-tailed phascogale, which is a small marsupial. Farmers and other land managers are being encouraged to plant trees in corridors between existing stands of native trees, fence off remaining vegetation and creeks and to control feral pests such as cats and foxes. It is hoped that these activities will provide a large, linked safe area, known as an eco-bridge, for native species to thrive.

Source 7   The red-tailed phascogale, a small marsupial, is one of 32 rare or endangered animal species in the wheat belt.

Check your learning 2.16

Remember and understand

1   Where does salt in the soil come from naturally?
2   How did the arrival of European settlers in Australia affect soil salinity?
3   Why is the water in Toolibin Lake becoming salty?

Apply and analyse

4   Classify the causes of salinity at Toolibin Lake using the SHEEPT method. For more information on SHEEPT, refer to page 28 of 'The geography toolkit'.
5   Examine Source 3.
    a   Describe the predicted change in salinity in the wheat belt between 2000 and 2050 in terms of both area and distribution.
    b   How do you think this change will impact on the natural environment of the region?
6   What is an eco-bridge? Explain how the measures put in place to protect endangered species could also help to reduce salinity.

Evaluate and create

7   Research ways in which farmers throughout the wheat belt may be able to lower the water table and reduce salinity.
8   In small groups, discuss why repairing land degradation in the Toolibin Lake area has been so difficult. What do you think this means for repairing the damage of a much larger area such as the entire Western Australian wheat belt?

2.17 Responding to deforestation

One of the leading causes of land degradation on a global scale is **deforestation**. Forests have been cleared by humans for thousands of years. Traditionally, forests have been cleared for farming, to clear the way for human settlements and to provide building materials. Today, two key economic realities continue to drive deforestation:

1　Trees grow slowly and other crops such as soya beans grow quickly. As populations continue to grow and expand, and people tend to their current needs rather than the needs of future generations, forests continue to be cleared and replaced by farms to provide people with income and food.

2　Many ecosystem services provided by forests, such as absorbing and storing carbon and filtering water, do not have a monetary value and cannot be bought and sold. Produce from farms and timber from forests are easily bought and sold so are seen as more valuable to local populations than intact forests.

Source 1　A section of Amazon rainforest in Brazil that has been cleared for cattle ranching

Case study: the Amazon rainforest

The Amazon, the world's largest tropical **rainforest**, provides an example of the changes that are sweeping across many forest biomes today. Well known as a biodiversity hot spot due to its large numbers of plant and animal species, the Amazon is now considered to be an environmental hotspot too. The Amazon covers an area roughly the size of Australia, but since the 1970s, an area the size of New South Wales has been cleared for other uses. In recent years, rainforest clearing has slowed but still continues. Source 2 shows deforestation levels since 1990. Some climate scientists believe that unless the remaining rainforest is protected, a combination of climate change, droughts, fires and deforestation will gradually turn the rainforest into **savanna** and **grasslands**.
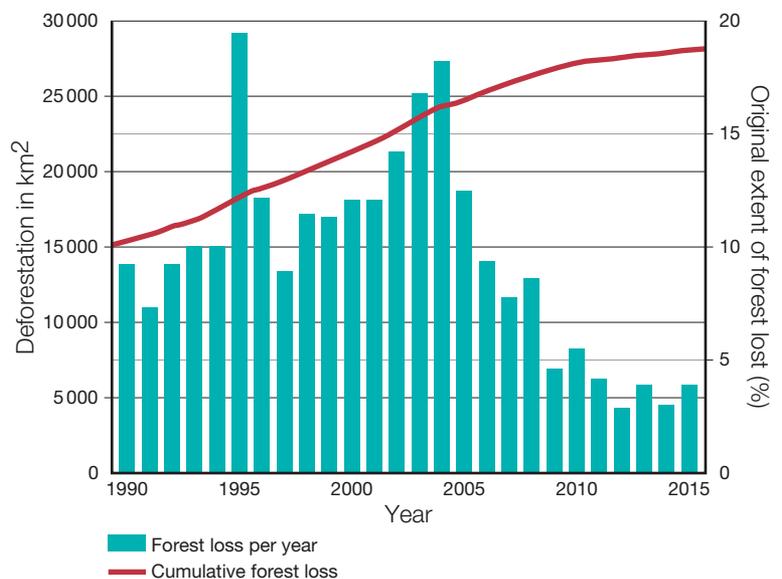
Source 2　Annual and cumulative deforestation of the Amazon rainforest in Brazil

skill**drill:** Place, space and interconnection

Using satellite images to analyse environmental change

Satellite images are a useful tool for observing change over a large region of the Earth's surface. By examining them closely, you can describe changes that have occurred over time and suggest explanations for these changes.

Step 1 Examine two satellite images taken at the same location at different points in time.

Step 2 Locate the area on the Earth's surface using an atlas.

Step 3 Look closely at the first image. Describe the natural and human features that you can see.

Step 4 Describe the differences between the first image and the second one.

Step 5 Try to quantify the changes. For example, if there has been desertification, calculate the area of desert shown in each of the images. The difference will give you the area that has changed over time.

Step 6 Suggest an explanation for these changes based on your observations.

Apply the skill

1 The two satellite images in Source 3 show a section of the Amazon rainforest in the state of Rondúnia, western Brazil, in 1975 and 2012.
Follow the steps above to describe the satellite images shown and explain the changes that have taken place in this section of the rainforest over the 37-year period.

Source 3 Two satellite images of a section of the Amazon rainforest in the state of Rondúnia, western Brazil. The top image was taken in 1975 and the image on the bottom was taken in 2012. Urban areas are represented by pink shading; light green shading represents farmland and dark green shading shows the rainforest areas.
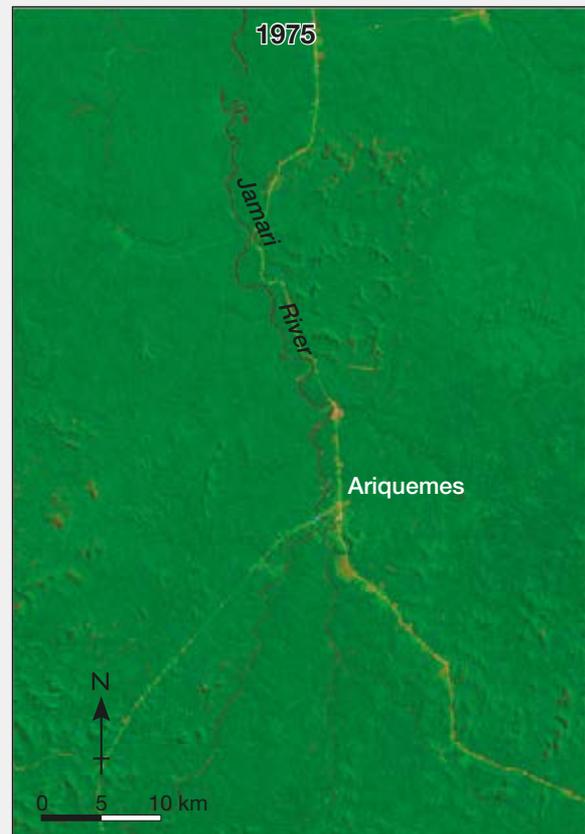
Managing change in the Amazon rainforest

Many of the world's forested areas have been altered by human activities. It has been estimated that of the 60 million square kilometres of forest that once covered the Earth, only about two-thirds still remains. Each year the world loses about 50 000 square kilometres of forest, most of it converted to farmland to grow food to support growing populations. For reference, the entire state of Tasmania is around 70 000 square kilometres. While deforestation may seem to be an unstoppable process, there are encouraging signs of change in some regions of the world, including the Amazon rainforest.

The Amazon rainforest is a vast biome, covering an area of more than five million square kilometres. While most of the Amazon lies in Brazil, it also stretches into seven neighbouring countries including Suriname. By studying satellite images (such as those shown in Source 3), scientists have been able to estimate that 15 per cent of the forest has been lost since 1970. The vast size of the forest, and the types of changes that are taking place there, make it a very difficult environment in which to manage change. There are signs, however, that international cooperation and modern spatial technologies may be helping to slow the rate of deforestation in the Amazon.

Amazon Region Protected Areas (ARPA)

The Amazon Region Protected Areas (ARPA) program is the largest tropical forest conservation effort in the world. Led by the Brazilian Ministry for the Environment and funded by a number of organisations such as the World Bank, the German government and the World Wildlife Fund, it aims to protect 150 million acres (600 000km²) of rainforest.

Areas suitable for conservation are identified in the forest and then protected from deforestation by Brazilian law. Some of the identified areas have been partially deforested in the past and are now managed by local communities in order to rehabilitate them. This allows the forest to recover.

By 2012, 128 million acres (518 000km²) of the Amazon were protected by law. This figure meant that the Brazilian government was on target to achieve its goal of tripling the area of the rainforest under protection compared to levels in 2000.

Source 4   Tumucumaque Mountains National Park is the world's largest tropical forest national park. It is now part of the ARPA program and is protected by law from deforestation.

Source 5 A Trio tribesman in Suriname using a GPS device to help map his forest home.

Modern spatial technologies

The Amazon rainforest is home to hundreds of indigenous tribes who have been greatly affected by deforestation. Because no official records are kept, it can be difficult for indigenous tribes to prove ownership of the land on which they have lived for thousands of years. This situation can make them, and their tribal lands, vulnerable to the influences of outsiders who have an established record of moving in and claiming the land and clearing it for use as farms, mines and dams.

Modern spatial technologies such as global positioning systems (GPS) and Google Earth are beginning to change this situation. Some tribes, such as the Trio people of Suriname, have been provided with handheld GPS devices and training that allows them to map the area of the forest in which they live. The Suriname government has begun to recognise these digital maps as official documents which can provide the tribespeople with proof of ownership of the forest.

In Brazil, some tribes are investigating possible threats to their homeland by using the satellite and aerial images on Google Earth. By looking closely at the images they can see changes over time, investigate these and pass on information to government officials. These changes may include expanding soya bean farms or runoff from a mine changing water quality in streams and rivers.

Check your learning 2.17

Remember and understand

1 Why are forests cleared?
2 What do many climate scientists believe may happen to the Amazon rainforest in the future?
3 What is the ARPA program? What are the aims of this program?
4 How have modern spatial technologies helped to protect forest areas in the Amazon rainforest?

Apply and analyse

5 Look closely at Source 2.
 a Describe the trend in Amazon forest loss since 1990.
 b Roughly calculate the average amount of rainforest lost each year.
6 The image in Source 5 was taken near the village of Kwamalasamutu in Suriname. Use Google Earth to locate this village and then zoom out to investigate changes such as deforestation nearby.

Evaluate and create

7 Imagine that the Brazilian government decided to ban forest clearing and instead encouraged people to replant the forest.
 a How would this decision affect ecosystem services and the Brazilian economy?
 b Is this likely to happen? Give some reasons for your answer.

Deforestation on Easter Island

Easter Island is one of the world's most remote places. It lies in the Pacific Ocean, over 2000 kilometres from the nearest inhabited country. When European explorers first visited the island in the 16th century, they found the local people living in primitive conditions and engaged in almost continual warfare. Most baffling of all were the more than 600 stone statues weighing hundreds of tonnes that dotted the island.

The statues were built by the ancient Polynesians who lived on the island, probably as a tribute to tribal chiefs. To move them from the quarry to prominent sites, islanders used the trunks of large trees to create tracks and rollers. Over time, the population of the island reached about 7000 and there was increased pressure on timber resources for statue transport as well as for housing, boats, fuel and agriculture. The trees, however, were not being replaced by new growth, because rats brought by the original Polynesian sailors as a food source ate all the seeds.

The destruction of the island's trees and shrubs led to a decline in living conditions for the people. Statue building ceased, the population declined, soils became less fertile and more easily eroded, water quality declined and, as competition for scarce resources increased, tribal warfare broke out.

In many ways, the history of Easter Island serves as a warning to the rest of the world about the dangers of extreme environmental change.

skill**drill:** Data and information

Interpreting topographic maps

Topographic maps show a small region of the Earth's surface in great detail. This includes the height and shape of the land (known as the topography) which is shown through the use of contour lines or relief shading. By examining topographic maps, geographers can better understand the natural environment and the ways in which human activities bring about environmental change. Follow these steps when interpreting a topographic map:

Step 1 Read the title of the map so that you know what the map is showing. You may like to find it in an atlas so that you understand its location relative to other places.

Step 2 Look closely at the legend and find an example of each feature shown in the legend on the map. Take note of those features which often appear together and those that occupy large areas on the map.

Step 3 Use the line scale to roughly estimate the overall size of features on the map. For example, the length of an island or the distance between two cities.

Step 4 Look closely at the legend showing the colours used to represent the height of the land. Look at the patterns of these colours on the map and try to picture the landforms that are shown. Remember that the closer together these colours appear the steeper the land.

Source 1 A selection of stone moai statues on Easter Island

EASTER ISLAND: TOPOGRAPHIC MAP

Source 2

Source: Oxford University Press

Apply the skill

1 How did statue building contribute to deforestation on Easter Island?

2 Examine Source 2.

  a Use the legend to describe the relief (shape of the land) of Easter Island. In your description use the names of specific places such as mountains.

  b How has the relief affected the distribution of roads and populated places?

3 Examine the distribution of the moai in Source 2.

  a Use the line scale to estimate the distance from the quarry site at Puna Pau to the Vai Mata ahu (stone platform).

  b Describe the distribution of the statues on the island.

  c How does the relief affect this distribution?

Extend your understanding

1 How did statue building contribute to environmental change on Easter Island?

2 The reasons for the decline of the Easter Islanders are still widely debated. Use the Internet to find out about two or more conflicting theories. Why is there often disagreement about historical events?

3 Did the Easter Islanders use their resources sustainably? Give three reasons for your answer.

4 What lessons are there from Easter Island for the ways in which we use ecosystem services today?

Unit 1 Environmental change and management

Coastal change and management

Coasts are areas where the land meets the sea. Home to more than one billion people around the world, coastal areas are some of the most visited and heavily populated areas on the planet. Human activities in coastal areas have affected many of the natural environmental processes there. This has led to a wide range of issues including a loss of biodiversity, high levels of pollution, erosion, and rising sea levels due to climate change. In fact, coasts are one of the Earth's most threatened environments.

Coasts are critically important – not only to the people who live along them, but also to the health of the planet. Around the world, geographers are playing a vital role in developing strategies to manage these problems and protect coasts for future generations.

3A

How is the coastal environment changing?

1 As a class, discuss the ways in which human activities have impacted on the coastal landscape shown in Source 1.

2 How would a 2-metre rise in sea level affect this coast?

3B

How can coastal changes be managed?

1 In Source 1, what evidence can you see of management strategies to control or limit human activities that may have a negative impact on the natural environment?

2 Brainstorm further strategies that could be put in place to protect this coast. Why do you think these have not been used in this environment?

Source 1 Welcome to Hong Kong, China – one of the most densely populated coastal cities on Earth. Changes brought about by human activities in coastal areas like Hong Kong need to be carefully managed in order to protect the environment for future generations.

chapter 3

3C
How can geographers help to manage coastal changes?

1 While the impacts of human activities are obvious on this coastline, their root causes are less obvious. What might some of these fundamental causes be?

2 Why do changes at coastal environments differ from place to place?

3.1 Change in coastal environments

Coasts are very dynamic places – they are constantly changing. Crashing waves, strong currents, tidal waters and hazards (such as storms and tsunamis) all transform coastal environments. People, too, bring about many changes to these environments. From simple activities, such as walking across a sand dune, to complex study activities, such as the construction of shipping ports and sea walls, humans have serious effects on coastal areas. In many cases, these activities are responsible for **coastal degradation**.

Increasing populations, particularly in coastal areas, bring widespread and significant change to the coastal environment. Examples include building marinas, harbours, ports and breakwaters.

Flat, fertile land near the coast is often intensively farmed.

Declining fresh water flows in rivers due to water extraction for farming and urban users impacts on coastal lagoons and estuaries.

Sea levels are rising as a result of climate change. This increases coastal erosion particularly during storms and reduces habitat for coastal plants and animals.

Coastal visitors may impact on the coast, with activities such as snorkelling and scuba diving.

Source 1   Some common examples of coastal degradation

Coastal degradation can be observed on many scales. It may be local, like when litter is dropped on a popular holiday beach, or regional, like when an oil spill washes ashore along hundreds of kilometres of coastline. The effects of coastal degradation are varied, and can include the loss of plant and animal species, or the arrival of an invasive species that permanently affects biodiversity in the area. Examples of coastal degradation can include sand dunes being washed into the sea, changing the coastline, or blooms of toxic algae damaging the marine environment. Source 1 provides an overview of some common forms of coastal degradation.

Over the course of this chapter we will be exploring some of the changes that are having the greatest impact on coastal environments. These include climate change, population growth in coastal areas, the loss of coastal biodiversity and marine pollution.

Pollution from inland sources such as farms, cities and industries is carried to coastal estuaries and river mouths by rivers.

Land is often reclaimed from the sea in areas where flat land is in short supply.

Desalination plants change the salinity of water in the local area.

Overfishing of certain species by commercial trawlers destroys natural ecosystems.

Invasive species from both the land and the sea impact on coastal ecosystems. Ballast water carried in ships can transport invasive species around the world.

Harbours are dredged to allow larger ships to reach ports.

Warmer waters means that fish that thrive in cooler waters move away from their usual habitats. This can cause the starvation of other animals and birds and the death of coral.

Check your learning 3.1

Remember and understand

1 What are some of the changes currently impacting coastal environments?

2 Are coastal environments close to cities more at risk from degradation than those in remote areas? Give some reasons for your answer.

Apply and analyse

3 The three main drivers of environmental degradation are climate change, population growth and economic growth. Examine Source 1.
   a Classify each of the causes of coastal degradation shown according to one of these three drivers.
   b Are there any changes that could not be classified in this way?
   c Which of the three drivers appears to be responsible for most of the changes shown?
   d Classify each of the changes shown according to whether they are taking place on the local, regional, national, international or global scale.

4 Use the geographical concept of interconnection to describe the links between changes on the land and changes at the coast.

Evaluate and create

5 Select one of the causes of coastal degradation shown in Source 1. Suggest a solution for the problems this creates.

3.2 A dynamic balance

While this chapter focuses primarily on the ways in which human activities bring about changes to coastal environments, it is also important to remember that natural processes are constantly shaping and changing the coast too. Rocks are eroded and material such as sand is transported by the energy of waves, tides and currents, creating a landscape that is constantly evolving. All this change means that coasts are very complex environments to study and understand.

Understanding natural processes in coastal environments

Geographers often use models – such as the systems model – to understand environments, study the relationships between environments, and learn more about the intricate forces that cause changes.

To apply a systems model to a coastline, each individual **landform** is considered to be a separate compartment. Energy such as wind and waves, and matter such as water and sand are studied as they arrive at and leave each compartment. Arriving energy and matter are referred to as inputs and leaving energy and matter are outputs.

Source 2 A range of coastal landforms are evident at Cape Byron, the easternmost point on the Australian mainland.

If the inputs are greater than the outputs, then the coastline and its landforms such as dunes and **spits** increase in size and the coast grows outwards. If the outputs are greater than the inputs, then landforms decrease in size and the coast retreats (see Source 1).

wind erodes sand from dune forming blow-outs

rivers bring silt, mud and sand, especially during floods

management bodies replenish the beach

mining removes sand from the beach

waves erode dunes during storms

sand

cliff erosion

longshore drift transports sand away from the beach

loose rock

constructive waves

destructive waves

rip current

longshore drift current

longshore drift transports sand onto beach from another part of the coast

sand is deposited into bays and estuaries

sand is lost through rips, especially during storms

Source 1 How natural processes change coastal environments. Green arrows represent inputs while red arrows represent outputs.

keyconcept: Change

Dynamic equilibrium

Energy inputs on the coast – the waves and wind – often erode and transport matter, particularly sand. When matter is transported, the shape of the beach changes. When coastal landforms are in balance with energy inputs this is known as dynamic equilibrium. In this state, energy inputs are absorbed with no movement of matter, and the shapes of the landforms remain unchanged.

When dynamic equilibrium does not exist, inputs and outputs do not remain in balance, and the landscape changes.

In the case of a storm, energy inputs will not be constant, so erosion and deposits will not be in balance. Matter is eroded and transported offshore and the shape of the beach changes. Once the storm ends and the energy inputs return to 'normal' again, dynamic equilibrium returns and the beach will remain unchanged for as long as the energy inputs remain constant.

For more information on the key concept of change, refer to pages 12–13 of 'The geography toolkit'.

Source 3 In June 2016, a massive storm hit the east coast of Australia, claiming up to 15 metres of the coastline in some places. The owner of this property in the Sydney suburb of Collaroy returned to his home to find his backyard and in-ground swimming pool claimed by the waves. This storm is an example of how the dynamic equilibrium in this environment was disrupted.

Check your learning 3.2

Remember and understand

1 What are the main energy and matter inputs in coastal environments?

Apply and analyse

2 Use the systems model to describe the changes that are taking place in Source 2.
3 Examine Source 3.
   a What evidence is there for the movement of sand?
   b How has this movement changed the shape and location of the coastline?
   c Explain whether this is an example of dynamic equilibrium.
4 Select a coast that you know well (or one that you have visited on a field trip). Describe the energy and matter inputs and outputs in this environment and explain how these have shaped the coastline. For example, a series of sand dunes may have been formed by low energy waves bringing sand from a river mouth.

Evaluate and create

5 While many coastlines were heavily eroded by a 2012 storm on the north-east coast of the United States, others hardly changed.
   a Brainstorm some reasons why variations exist in the way coasts are changed.
   b Rank your reasons from the one most likely to explain these variations to the one least likely. Justify your rankings.
6 Complete a field sketch of Source 2. On your sketch, label the individual compartments that geographers would study.

3.3 Climate change and coasts

The world's climate is changing. Human activities such as land clearing and fossil fuel burning have led to increased amounts of carbon dioxide in the atmosphere. This is leading to **global warming**. As a result, the Earth's natural ecosystems are changing or adapting to the higher temperatures. Plants and animals that are unable to adapt to the warmer conditions are either moving towards the poles, where conditions are cooler, or facing extinction.

Global warming is also affecting coasts. In fact, coastal systems are undergoing greater change than virtually any other environment. As the interface between the land and the sea, coastal systems face pressures from changes in both of these places. Source 1 summarises the effects of climate change on coastal areas. One of the greatest concerns for Australian coastal areas is the rising of sea levels.
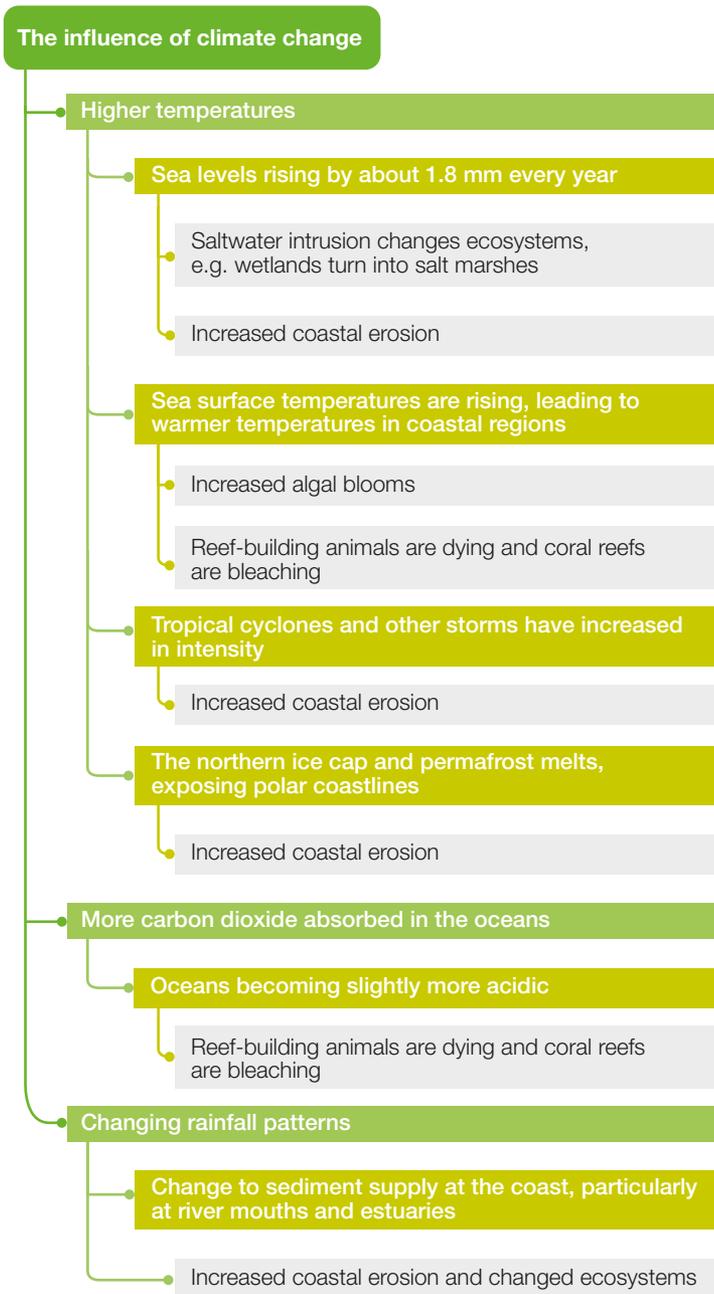
Australia's rising seas

It can be difficult to convince people that sea levels are rising. This is because ocean and coastal waters are constantly changing as waves, tides and currents keep them in movement. Also, sea levels are rising very slowly. This doesn't mean that they are not rising, however. In fact, sea levels have been rising for at least a century. Scientists use a combination of tide gauges and new technologies such as satellite altimeters (instruments used to measure altitude) to monitor and measure sea-level changes. These measures show that sea levels have risen by about 1.8 millimetres per year over the last century and by about 3 millimetres per year since the mid 1990s.

The physical impact of rising seas

An Australian government report in 2011 stated that, 'Sea levels are rising around Australia. A sea-level rise of a metre or more during this century is plausible. It could be less or much more. Between 16 000 and 250 000 individual homes are potentially at risk of inundation from a 1.1 metre rise in sea level.'

As well as the risk to homes situated on the coastline, rising sea levels are expected to cause:

- an increase in the erosion of beaches, with some beaches expected to disappear completely
- an increase in the incidence of flooding in low-lying coastal areas
- saltwater to enter coastal aquifers, destroying freshwater sources
- an increase in the severity of extreme weather events such as cyclones, bringing with them increased incidences of serious storm damage.

The influence of climate change

Higher temperatures

Sea levels rising by about 1.8 mm every year

Saltwater intrusion changes ecosystems, e.g. wetlands turn into salt marshes

Increased coastal erosion

Sea surface temperatures are rising, leading to warmer temperatures in coastal regions

Increased algal blooms

Reef-building animals are dying and coral reefs are bleaching

Tropical cyclones and other storms have increased in intensity

Increased coastal erosion

The northern ice cap and permafrost melts, exposing polar coastlines

Increased coastal erosion

More carbon dioxide absorbed in the oceans

Oceans becoming slightly more acidic

Reef-building animals are dying and coral reefs are bleaching

Changing rainfall patterns

Change to sediment supply at the coast, particularly at river mouths and estuaries

Increased coastal erosion and changed ecosystems

Source 1 The influence of climate change on the coast

AUSTRALIA: TREND IN SEA SURFACE TEMPERATURES AND SEA LEVEL RISE

LEGEND

Trend in sea surface temperatures (°C/10 yrs) 1970 to 2012

- 0.20 to 0.24
- 0.16 to 0.20
- 0.12 to 0.16
- 0.08 to 0.12
- 0.04 to 0.08
- 0.0 to 0.04

Sea level rise (mm per year) early 1990s to 2010

- 8mm
- 4mm
- 0mm
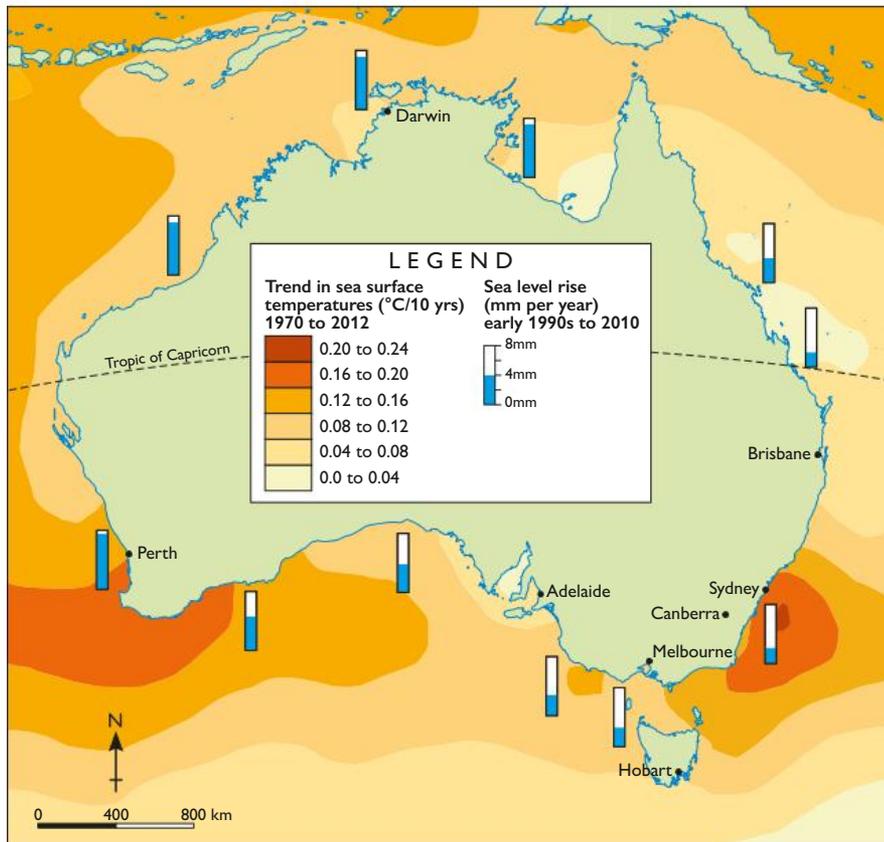
Source 2   Source: Oxford University Press

Coastal squeeze

As sea levels rise, important coastal ecosystems such as mangroves and salt marshes respond by retreating inland. However, in many places, sea walls and other coastal structures mean they cannot move and are therefore trapped in a narrowing strip of land (see Source 3). This process is known as coastal squeeze. This has led to healthy salt marshes and mangrove forests that are highly effective natural barriers to erosion being killed off by built structures that, in many cases, are much less effective at controlling erosion.

Source 3   This sea wall in Manche, France, is squeezing the salt marsh (centre) into a narrower strip as sea levels rise.

Check your learning 3.3

Remember and understand

1   What is coastal squeeze? What causes this problem?

2   Why is coastal erosion expected to increase as sea levels continue to rise?

Apply and analyse

3   Examine Source 2.
   a   Describe the general pattern in sea surface temperature rises around Australia over the period 1970–2012.
   b   Which regions of Australia experienced the greatest rises in sea levels from the early 1990s to 2010?
   c   Based on the data provided, are you able to identify any links between sea surface temperature rise and rises in sea level around Australia? Why or why not?

4   Add four boxes to Source 1 to provide additional examples of the impacts that rising sea levels and sea surface temperatures will have on natural and human environments.

5   Visit the OzCoasts website (www.ozcoasts.gov.au) and locate the sea level rise maps section. Use these maps to examine the predicted sea level rise in a capital city or region of your choice. Describe the impacts that a 110-centimetre sea level rise would have.

3.4 The impact of climate change on the Great Barrier Reef

Queensland's Great Barrier Reef is not only one of the world's most beautiful natural treasures; it is also one of its most important. Extending over 2300 kilometres and 14 degrees of latitude, the reef contains over 2900 separate coral reefs and some of the world's most extensive mangrove and seagrass ecosystems. But the combined effects of a changing climate – rising sea temperatures, rising sea levels, **ocean acidification**, and extreme weather events – are causing problems for this remarkable natural environment.

Rising sea temperatures

Studies show that the current temperatures of the Coral Sea are warmer now than at any time over the last 300 years. On average, temperatures are 0.4° Celsius warmer than they were in the late 1800s. As average temperatures rise, warm weather events heat the sea surface to a temperature that coral polyps (the tiny organisms that construct the coral reef) cannot tolerate. The coral polyps feed on algae, but the warmer water temperature causes a build-up of poisons in the algae. In order to survive, the polyps expel the algae on which they feed, as well as some of their own tissue.

This process turns the coral white and is known as coral bleaching. Over the short term, bleaching does not kill the coral polyps. However, if sea temperatures remain high over an extended period, the coral polyps eventually starve and the reef will die out.

Rising sea levels

As the climate warms, land ice is melting. For example, the Greenland ice sheet, which covers 80 per cent of Greenland, is melting an average of 195 cubic kilometres per year. The water from this melting ice ends up in our oceans. Rising sea temperatures are also causing the ocean to expand as a result of the warmer water.

In the Coral Sea, sea levels are rising by about 3 millimetres per year. This is expected to have little impact on the coral reefs as they can grow upwards by about 6 millimetres per year. Surrounding ecosystems, however, are likely to be severely affected. As saltwater intrudes further inland, environments such as mangroves and freshwater lakes are expected to change significantly. Low-lying islands are also expected to disappear beneath the rising seas, changing the distribution of nesting birds and turtles.

Source 1   An example of mass coral bleaching on the Great Barrier Reef

Source 2   The Great Barrier Reef islands such as Heron Island are important nesting sites for the endangered loggerhead turtle.

Ocean acidification

Ocean acidification is a term used to describe the change in water chemistry caused when the carbon dioxide we pump into the atmosphere is absorbed into the ocean. The extra carbon dioxide in the water makes it more acidic. Ocean acidification can have dire consequences for a coral reef.

As carbon dioxide is absorbed into the ocean, it reduces the amount of carbonate (a kind of salt) in the water. Marine animals need this carbonate to make their shells and skeletons. Reef-building animals such as coral polyps then use these shells and skeletons to create a reef. With fewer shells and skeletons available, construction of the reef is seriously limited. Over the long term, ocean acidification is expected to be the greatest challenge facing the Great Barrier Reef.

Extreme weather events

Increases in the severity and frequency of flooding and tropical cyclones also pose serious threats to the reef. Flooding brings increased sediment to the reef and this sediment smothers plants. Pesticides and other chemicals are also carried by floodwaters, adding to the levels of pollution in the water around the reef.

Cyclones generate large and powerful waves which damage corals and the reef structure. One of the worst cyclones to hit the reef in recent times was Cyclone Yasi in 2011 (see Source 3). Reefs are able to recover from these natural events but need time to do so. As extreme weather events become more frequent, reefs have less recovery time.

GREAT BARRIER REEF: DAMAGE FROM CYCLONE YASI, FEBRUARY 2011
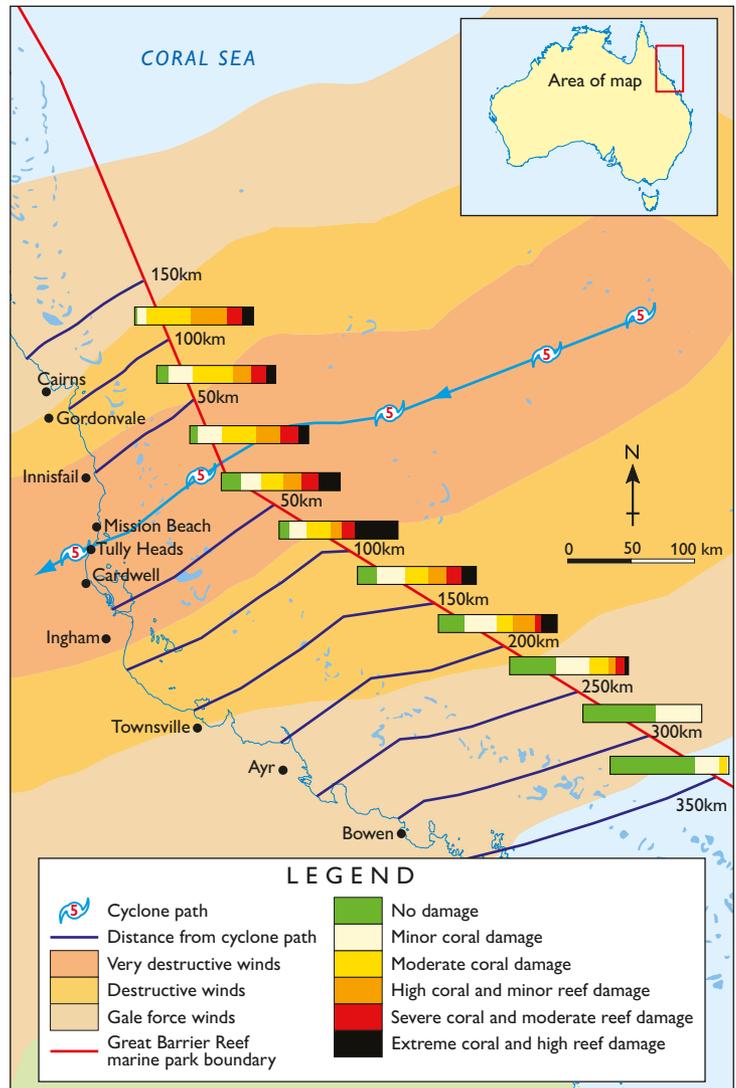
Source 3 Source: Oxford University Press

Check your learning 3.4

Remember and understand

1 Why are sea levels around the world rising?

2 How do rising sea levels impact on nesting birds and turtles?

Apply and analyse

3 Examine Source 3.

 a Describe the track of Cyclone Yasi and the areas in which the winds were most destructive.

 b In which areas was reef damage the greatest? Which areas suffered the least damage?

 c Describe the relationship between wind speed and reef damage.

Evaluate and create

4 Construct a flow chart or mind map showing the impact of ocean acidification on coral reefs.

5 Rank the four impacts of climate change described here from the one likely to have the greatest impact on the reef to the one likely to have the least impact. Write a paragraph justifying your ranking.

6 Imagine that the Great Barrier Reef disappeared due to the combined effects of climate change. How would this affect the Queensland coast and the Queensland economy?

3.5 The impact of population growth on coasts

About one-quarter of the world's population live within 100 kilometres of the coast. Most of the world's megacities in both the developed and developing world are located on the coast and many of them are growing rapidly. In China, for example, 1000 people a day move to coastal cities from the country's interior. The impact of billions of people in millions of coastal cities, towns, villages and farms has caused one United Nations expert to state that 'humankind is in the process of annihilating coastal and ocean ecosystems.'

The impact of human settlements on coastal areas

The coast has always been an attractive place for human settlement. Coastal regions provide access to food and water, and people have long used boats and ships for transportation. But the growing number of people along the coast, together with increasing levels of trade and movement between settlements have had many detrimental effects on coastal ecosystems:

- Engineering structures such as sea walls, **groynes**, breakwaters, training walls and marinas have hardened the coast and changed natural cycles of **erosion** and **deposition**.
- Changing the natural flow of water by dredging channels, diverting rivers and building dams has altered the amount of fresh water and sediment arriving at the coast, impacting on natural ecosystems and landforms.
- Discharging sewage into the ocean, the run-off of fertilisers from farms and other contaminants entering coastal waters have caused pollution in the oceans.
- Increased numbers of people in coastal areas has led to overfishing of the fish and shellfish. In some places coastal fish stocks have fallen by 90 per cent in the last 30 years.
- Ports are often an entry point for invasive species that bring dramatic changes to coastal ecosystems.
- The presence of large numbers of people on beaches have an impact: people leave litter on beaches, they walk over native plants and impose walkways, they can destroy breeding areas of sea birds and bring predators such as dogs into the environment.

Source 1   The contrast between the natural and built-up environments of Tokyo Bay, Japan. A beach in Tokyo Bay (left), and reclaimed land near the CBD (right).

Continued growth and competition for land

Many coasts have been converted from natural ecosystems to human landscapes. Cities need space to grow and harbours for trade and transport. Mangroves, marshes and **estuaries** have been drained and filled in, sand dunes flattened and built over and communities of coastal plants cleared. In some places, land for expansion has been so scarce that new land has been built in bays and estuaries from rocks, rubbish and silt from the sea bed (known as **land reclamation**).

Case study: Tokyo Bay

The largest example of reclaimed land is Japan's Tokyo Bay. Twenty per cent of the bay has been filled in to create 250 square kilometres of new land. This new land was created around the edge of the bay using urban waste and silt from the bottom of Tokyo Bay. The reclaimed land is now home to some of the world's most expensive real estate including an international airport and Tokyo Disneyland.

In September 2013, Tokyo was selected as the host city for the 2020 Summer Olympic Games. Many of the sporting venues will be built on reclaimed land and this is expected to further increase the property values in the areas surrounding Tokyo Bay.

TOKYO BAY: EXTENT OF RECLAIMED LAND
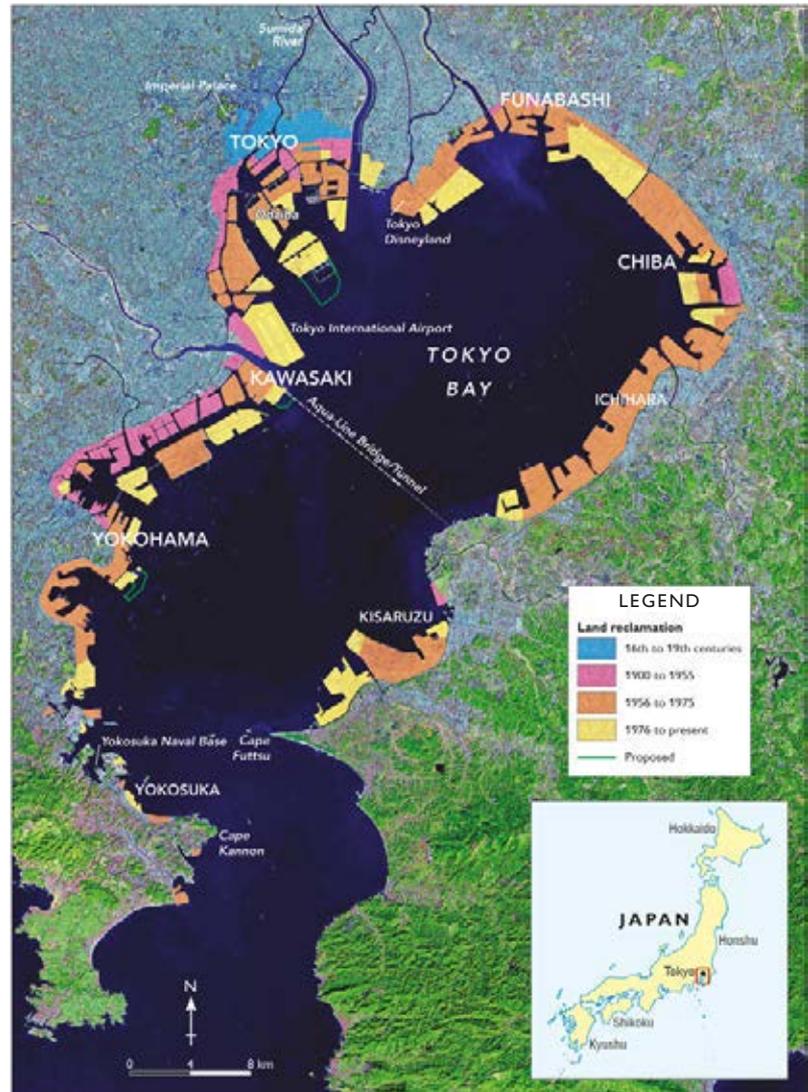
Source 2 Source: National Geographic

Check your learning 3.5

Remember and understand

1 What is land reclamation and why is it used?

2 Describe the changes to coastal ecosystems as a result of coastal city growth.

Apply and analyse

3 Use an atlas to research the location of the world's megacities (cities with over 10 million people). How many megacities are coastal? How many of these coastal megacities are on river mouths or estuaries?

4 Why would the impacts described on these pages be particularly serious for small island communities?

5 Would the population impact on coasts be greatest in developing or developed countries? Discuss this with a partner and then with the class.

Evaluate and create

6 Construct an overlay map of Tokyo Bay using Source 2. On the base map show the natural outline of the bay. On the overlay show the total area of reclaimed land. Describe the spatial change over time shown on your map.

7 Use Google Earth to explore the coastline of Tokyo Bay. Estimate the percentage of the coastline that is:

a heavily modified (for example, reclaimed land)

b lightly modified (for example, sea walls or groynes constructed)

c not modified.

3.6 Loss of coastal biodiversity

The number of plant and animal species on a global scale is in decline. The drivers of this wave of extinction are all caused by human activities such as the destruction of habitats, overexploitation of ecosystem services, pollution, climate change and the introduction of invasive species. Recent studies of the four key coastal ecosystems – mangroves, seagrass beds, salt marshes and coral reefs – reveal that all are declining in size and biodiversity.

Mangroves

Mangroves provide a wide range of crucial ecosystem services in many tropical areas, including providing wood, protecting communities from the effects of offshore storms and as a breeding ground for fish and crustaceans. Despite their importance, about one-fifth of the world's mangroves have been lost since 1980, an estimated area of 36 000 square kilometres (see Source 1). Countries such as Kenya, Liberia and Puerto Rico have already lost over 70 per cent of their mangrove forests. Currently, the United Nations estimates that mangrove forests are being cleared at four times the rate of land forests. Mangroves have been cleared to make way for agricultural land, harbours, housing and fish farms.

Source 1   Many mangrove forests, such as here in Malaysia, have been cleared to make way for shrimp farms.

Source 3   The amazing leafy seadragon, threatened by a loss of seagrass near Australia's southern cities.

Seagrass beds

Seagrass beds are an important ecosystem for dugongs and manatees (both large sea mammals) and the leafy seadragon (see Source 3), as well as providing food for hundreds of other species. Seagrass beds are also important for stabilising sediments in the water, absorbing carbon dioxide and protecting against erosion. Over the last 200 years, about 30 per cent of the world's seagrass beds have disappeared, many of them within the last few decades. The main threats to seagrass beds and the biodiversity they support are the dredging of the sea bed, the development of tourist marinas and water pollution from rivers and streams.

Salt marshes

Salt marshes are intertidal habitats, meaning they are above water at low tide and under water at high tide. Salt marshes are essential for healthy fisheries and coasts. They provide food, refuge and a habitat for the offspring of more than 75 per cent of marine species, including shrimp, crab and many fish. Birds also feed on the marshes. Salt marshes protect shorelines from erosion and reduce flooding by slowing and absorbing rainwater (see Source 2). They also help to maintain water quality by filtering runoff and absorbing excess nutrients. Twenty-five per cent of the world's salt marshes have already been lost; many turned into agricultural land for farming.

Source 2   Salt marshes protect shorelines from erosion and reduce flooding.

Coral reefs

Coral reefs are home to one-quarter of the world's fish species. The richest area of coral is the western Pacific Ocean. In the 1980s, 66 per cent of the region's reefs were covered in living coral, but by 2004 this had declined to just 4 per cent. In the Caribbean Sea, the amount of living coral fell by one-quarter in a single year.

Up to a billion people rely on the ecosystem services provided by coral reefs, including food, protection from waves and storms and income from reef-based tourism. Despite their importance, the coral reefs are under threat.

As well as the threats from warmer sea temperatures causing coral bleaching, coral reefs are also in danger from human activities such as land-based industries increasing the levels of sediment and pesticides in the ocean, and from invasive species such as the crown-of-thorns starfish.

WORLD: CORAL REEFS AT RISK IN 2013 AND PROJECTED TO BE AT RISK IN 2050
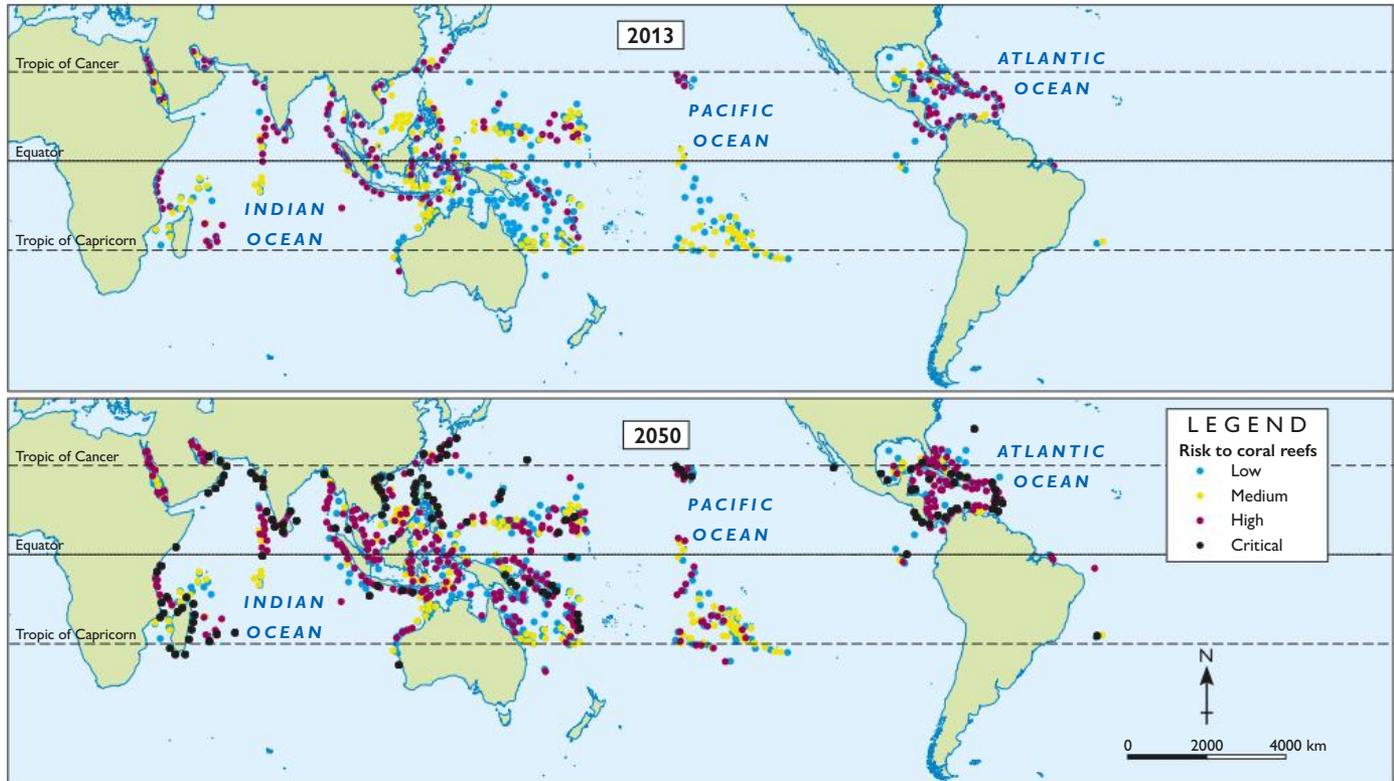
Source 4

Source: Oxford University Press

Check your learning 3.6

Remember and understand

1   What ecosystem services are provided by the four coastal habitats discussed? Classify these as sinks, sources, services or spiritual functions.

Apply and analyse

2   What are the five drivers of biodiversity loss in coastal habitats? Give an example of each of these.

3   Examine Source 4.

   a   Describe the distribution of the world's coral reefs using the PQE method. For more information on the PQE method refer to page 28 of 'The geography toolkit'.

   b   Which reefs were most at risk in 2013?

   c   Which reefs are projected to be at risk by 2050?

Evaluate and create

4   Sketch Source 1 and shade intact mangroves and disturbed mangroves using two different colours. Label features of the natural and human environments.

5   Research the threats faced by one coastal species in Australia such as the dugong, orange bellied parrot, coastal emu, grey nurse shark, marine turtles or sea snake, and present your findings to the class.

3.7 Coastal and marine pollution
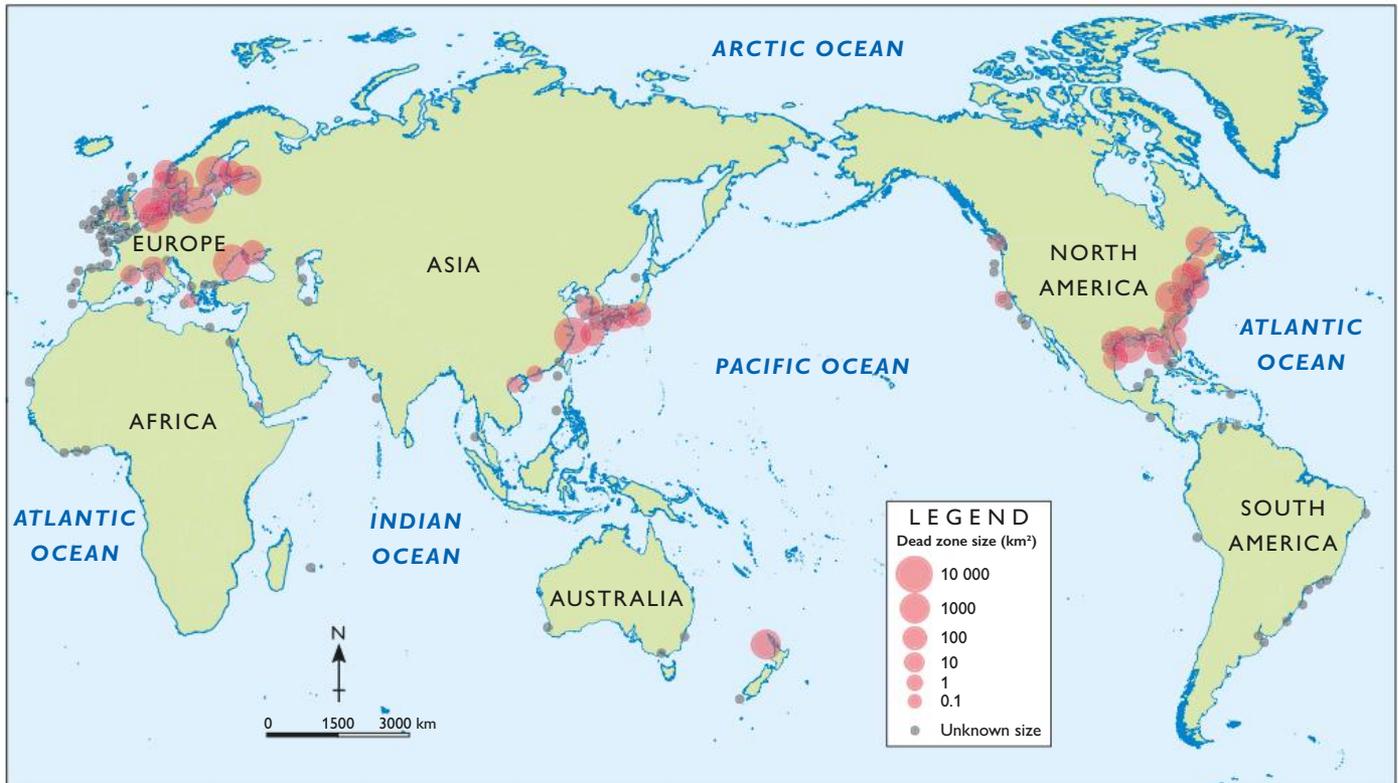
Source 1

Source: Oxford University Press

A pollutant is any substance released into the environment that has a harmful or negative effect on the natural environment. Coasts are particularly vulnerable to the damaging effects of **pollution** as pollutants released on land and in the sea usually find their way to the coast, carried by rivers, tides, waves and ocean currents.

Sources of coastal pollution

While it might be tempting to think that most coastal pollution comes from people using the coast such as beach-goers and people fishing, this is generally not the case. Rivers carry urban pollutants such as sewage, industrial waste, chemicals and water washed from streets and yards as stormwater to the coast. Rivers also bring pollutants from rural areas such as animal manure, pesticides and fertilisers washed from the land in heavy rain. Deforestation in river catchments also increases the amount of sediment and fresh water carried to the coast. One of the most serious consequences of coastal and marine pollution is the formation of dead zones in the ocean (see Source 1).

Source 2   This bloom of algae, triggered by fertilisers washed from farms, covered beaches in southern China in 2011.

keyconcept: Environment

Marine dead zones

Marine dead zones are areas of fresh water or salt water where oxygen concentration has become too low to support life. Some rivers carry a cocktail of pollutants, all of which arrive at the coast. Waves, tides and currents then carry these pollutants along the coast and out to sea where they can cause great environmental damage. Arguably the most serious damage is the creation of marine dead zones in the ocean, devoid of oxygen and marine life. Dead zones form in summer with the warmer weather conditions encouraging algae blooms which then go on to deplete oxygen levels in deeper seas (see Source 3).

Although the number and size of marine dead zones fluctuate, they are on the increase. In the 1960s, only 39 dead zones were identified, compared with 405 in 2000. Some dead zones are only a few square kilometres in size and last only a few months. The largest dead zones, however, are massive. Dead zones in the Baltic Sea and Gulf of Mexico can be more than 18 000 square kilometres in size.

For more information on the key concept of environment, refer to page 8 of 'The geography toolkit'.

1 Fresh water containing nitrogen and phosphorus from fields and streets washes into the ocean.

2 The nitrogen and phosphorus causes algae and phytoplankton blooms to form on the surface of the ocean.

3 As the blooms die, they drop to the sea floor and decompose, using up oxygen in the deep water.

4 In summer, as sea temperatures rise, the sea water forms into two layers. Oxygen levels in the deeper layer fall below the level needed to support marine life, and everything dies.

lighter, fresher, warmer surface water

heavier, saltier, cooler, deeper water

Source 3 How a marine dead zone forms

Check your learning 3.7

Remember and understand

1 What is meant by the term 'marine dead zone'?

2 What are the causes of marine dead zones and what are the effects of these zones?

Apply and analyse

3 Examine Source 1.
   a Describe the distribution of the world's largest marine dead zones using the PQE method. For more information on the PQE method refer to page 28 of 'The geography toolkit'.
   b Describe and account for the relationship between marine dead zones and areas of high population density.

4 Why do dead zones grow and decline throughout the year?

Evaluate and create

5 Marine dead zones can be explored through the geographical concept of environment, but they could also be used as an example of the geographical concept of interconnection. Describe how dead zones relate to interconnection.

6 In small groups, discuss possible solutions to the problem of marine dead zones and present your ideas to the class. You may wish to research the ways in which communities and nations have responded to a large dead zone in the Black Sea as a starting point.

Dunwich's disappearing churches

Dunwich is a small coastal village located in south-eastern England. Its current population is only 100 people, but in the 13th century Dunwich was one of the largest ports in eastern England. With a population of around 3000 people, it was one of England's 10 largest towns. Merchants traded wool, grain, fish, wine and furs across the North Sea to Iceland, the Netherlands and France. Dunwich had eight churches, three chapels and two hospitals.

Storms, tides and longshore drift have all combined to make Dunwich a very different place today. The coastline at Dunwich has receded, on average, 1 metre per year and is now 2 kilometres west of its position in Roman times in the 4th century CE. Buildings that sit on the present-day cliffs were once 2 kilometres inland.

Large storms in 1286 and 1328 swept large areas of the town into the sea. Because there was so much material deposited in the sea, the harbour was blocked by the growth of a large spit. Trade and fishing were ruined and the population declined. By 1347, a quarter of the city had been lost, and the remainder of Dunwich disappeared into the sea over the next few hundred years. Most of the original buildings have disappeared, including all eight churches. The last one disappeared early in the 20th century (see Source 1).
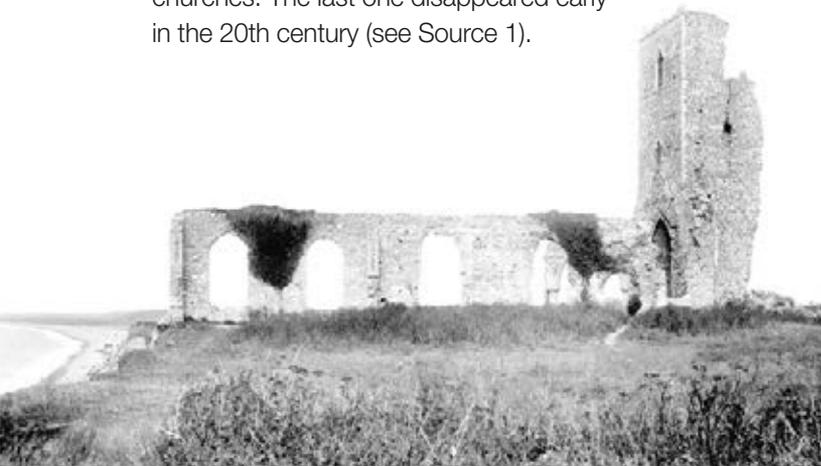
Mapping environmental change using multiple overlays

Creating **overlay maps** is a useful technique for showing and measuring environmental change. To complete a multiple overlay map follow these steps.

Step 1 Construct a base map of the region using the current topographic map. This should be traced rather than drawn freehand to make it as accurate as possible. Include key natural and human features such as the coastline, towns, roads and the extent of the marshes.

Step 2 Add labels such as rivers and town names. Add a north arrow, legend, title, scale and source.

Step 3 On a plastic sheet or piece of tracing paper, construct a map of the same region from the earliest map you have at the same scale. Remember that this map will sit on top of your base map, so features such as rivers that have remained the same should line up.

Step 4 Place the overlay map carefully on top of the base map and use a piece of tape like a hinge along one side to anchor the overlay in place.

Step 5 Add a title to the overlay map that does not cover the one on the base map. A north arrow, legend, scale and source should not be needed as these are the same as for the base map.

Step 6 Repeat steps 3–5 to complete an overlay from another map of the same region from another time. Hinge this at the opposite side of the base map with a piece of sticky tape.

Apply the skill

1 Complete a multiple overlay map using the topographic map in Source 3 as the base map, the 200 map as the first overlay and 1587 as the second overlay (both Source 2).

2 Describe the changes that occurred to this coastline between 200 CE and 1587. Was the dominant process during this time erosion or deposition?

3 What other features on the 200 map might help to explain the dominant process that occurred between 200 and 1587?

4 What effects did these changes have on human activities?

Source 1   The last of Dunwich's old churches photographed in 1908 shortly before it collapsed into the sea.

DUNWICH: CHANGING COASTLINE
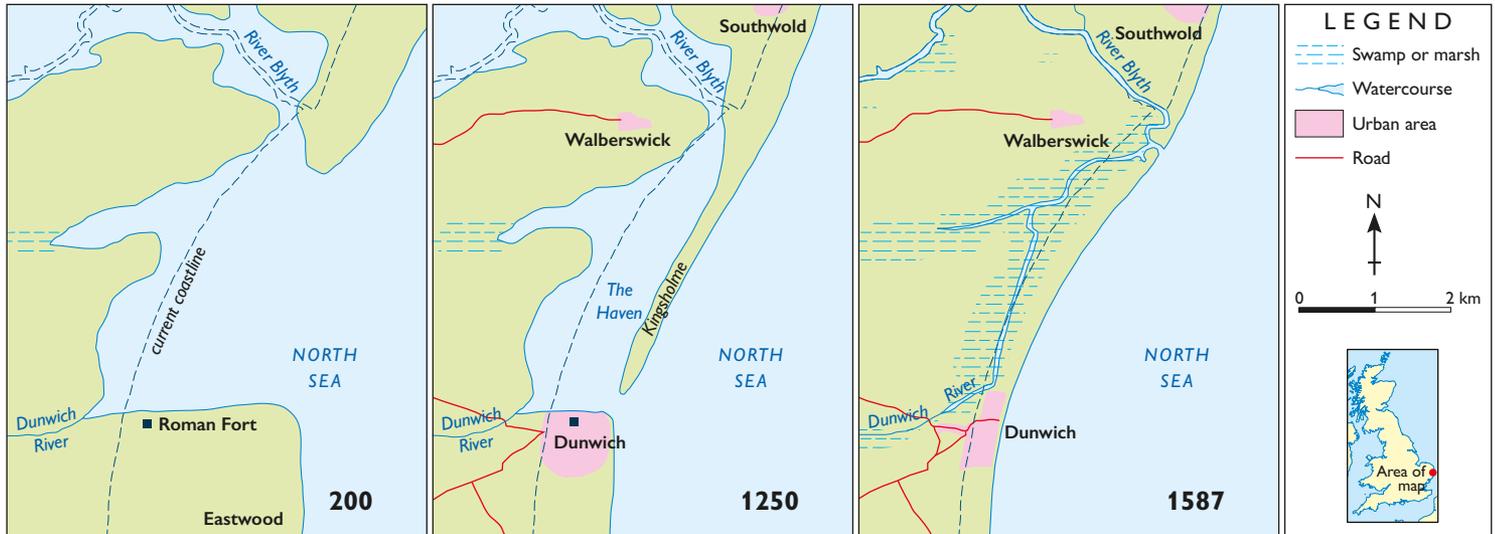
Source 2

5 Describe the changes that have occurred to this coastline since 1587. Is the dominant process erosion or deposition?

6 Estimate the area of lost land since 1587. Do this by multiplying the length of this strip of land by its average width.

DUNWICH: TOPOGRAPHIC MAP

Source 3   Source: Oxford University Press

Extend your understanding

Conduct some extra research on the Internet and complete the following tasks.

1 In an effort to stop further erosion of this coastline the local authorities have commissioned a study into possible protection measures. The study reports that there are three main options available to the local community: sea walls, groynes and breakwaters. Which of these measures would you recommend the local authorities adopt to manage erosion on this coastline? Give at least three reasons for your answer.

2 Some members of the local community have campaigned against the hard engineering techniques suggested in the study. They argue that a managed retreat system is the only sustainable option. Conduct research on this approach and decide if you agree with them. Give some reasons to support your decision.

Source 4
The steep face of dunes at Dunwich are the result of continued erosion.

3.8 New ways of managing coasts

Many attempts have been made by people in the past to try to control the natural coastal processes of erosion, transportation and deposition. Unfortunately, due to a poor understanding of these natural processes, attempts have often made problems worse or simply moved them to another part of the coast. In addition, issues have tended to be managed on a local scale without regard for the broader environments that influence the coast such as river catchments and marine ecosystems.

More recently, a greater understanding of natural processes as well as a recognition of the widespread impacts of coastal management has led to new approaches. These include soft engineering (using natural processes), integrated coastal zone management (ICZM), and the protection of coastal ecosystems with special marine reserves.

Managing natural processes: hard vs soft engineering techniques

One of the key principles underpinning effective coastal management is to work with natural processes. In the past, coastal management has tended to use 'hard' engineering. Hard engineering refers to the building of structures such as sea walls, groynes, artificial reefs, rock armour and **breakwaters** to protect coastlines from the erosive effects of waves or to trap sand. The main hard engineering techniques are shown in Source 1.

Many people in coastal areas like these hard options as the results are obvious and immediate. These structures tend to be expensive, however, and to have a high impact on natural environments. In many cases, they also create other problems or simply move the problem further along the coast.

By comparison, soft engineering coastal management techniques use the natural processes of the coast. They are often less expensive than hard
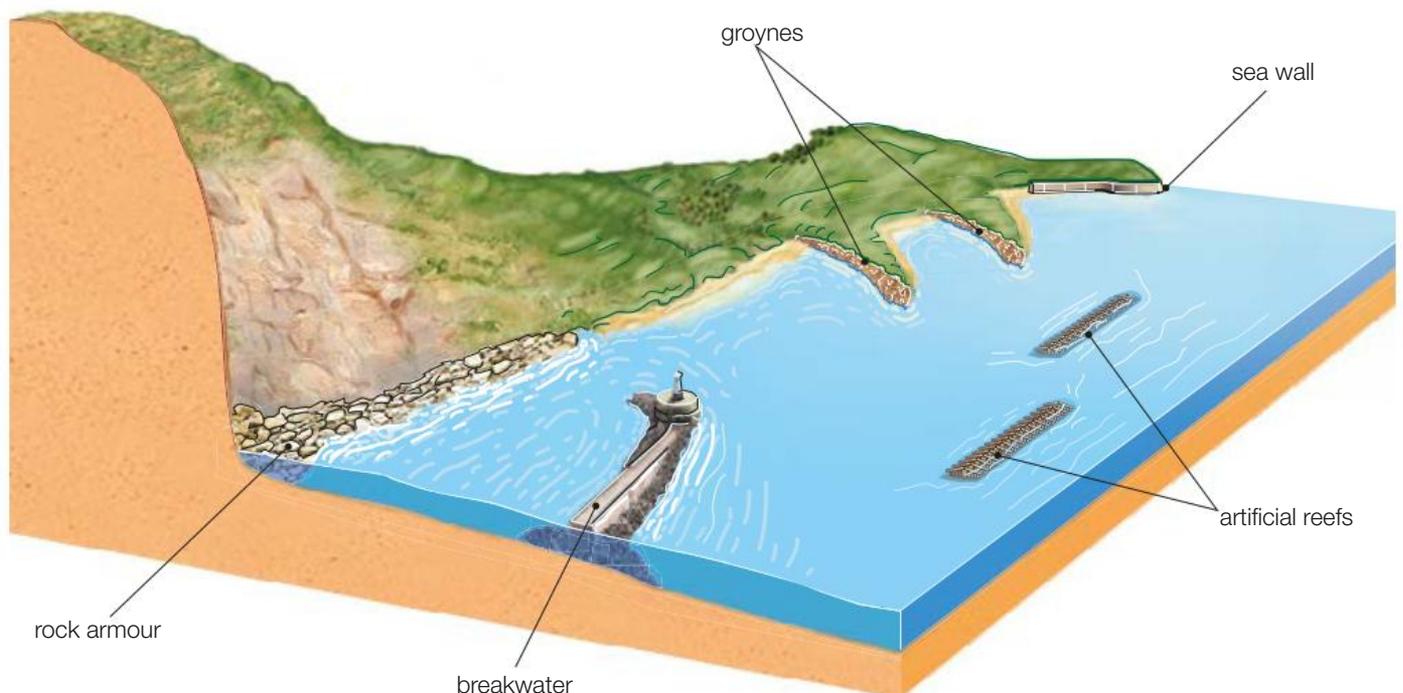
Source 1 A stretch of coastline showing a number of hard engineering techniques commonly used around the world today

engineering options, and are considered to be more sustainable as they have less impact on the natural environment. There are two main types of soft engineering – beach nourishment and managed retreat.

- Beach nourishment replaces beach material such as sand that has been removed by erosion or longshore drift (see Source 2). Beaches are a natural defence against erosion and coastal flooding and are a desirable feature of the landscape for residents and tourists alike. The natural process that eroded the beach in the first place will continue, however, so the beach needs to be nourished again and again.

- Managed retreat involves the relocation of human settlements and hard engineering defences such as sea walls and groynes so that the natural processes of erosion and deposition can take place. In many cases, low-lying areas flood allowing salt marshes, wetlands and mudflats to re-establish themselves in these areas (see Source 3). Over time, these habitats provide a natural defence against further erosion. Unlike many hard engineering techniques, managed retreat can be relatively inexpensive. However, people living in these regions can be unwilling to relocate and need to be compensated for the loss of their properties.

Source 2 In the Netherlands a vast sand peninsula 2 kilometres long and 1 kilometre wide has been constructed. Dubbed the 'sand engine', waves and currents are redistributing the peninsula along the shore where it is expected to nourish the beaches and form sand dunes.

Source 3 Managed retreat at Abbotts Hall Farm in Essex, England, has allowed salt marshes to be re-established.

Check your learning 3.8

Remember and understand

1 What are the main differences between hard and soft engineering techniques?

2 Describe the process that is occurring at Abbotts Hall Farm (see Source 3).

Apply and analyse

3 What is beach nourishment? Outline some of the possible positive and negative environmental impacts of this soft engineering technique.

Evaluate and create

4 Match the hard engineering technique with its function and possible disadvantage.

Technique	Function	Possible disadvantage
Sea wall	Absorbs the energy of waves and allows the build-up of sand to form a beach	Can be difficult and expensive to find and place suitable rocks to form the wall
Groyne	Protects cliffs, land and buildings from erosion and can also lessen the risk of coastal flooding from storm surges	May weaken longshore drift and allow sand to build up – sometimes creating a tombolo
Rock armour	Absorbs the energy of waves and provides a safe harbour for boats	Can ruin the appearance of the beach and be costly to maintain
Breakwater	Traps material carried by longshore drift and allows a beach to be built up	Can be very expensive to build and maintain. The breakwater reflects rather than absorbs wave energy so waves may continue to cause erosion elsewhere.

3.9 Change at Rainbow Beach

Rainbow Beach is a small community located on a massive dune system that runs along the Queensland coast near the southern tip of Fraser Island. Formed over two million years, the dunes are part of one of the world's greatest sand dune complexes that includes Fraser Island – the world's largest sand island. In places, the dune system is 200-metres high and is held in place by large areas of scrub, forest and grasses.

While Aboriginal occupation of the region dates back 5500 years, European settlement began with a sand-mining operation north of the town in the mid 1960s. A road built to reach the sand mine was soon used by tourists to access Fraser Island and the new town of Rainbow Beach (see Source 1). The sand-mining operation finished in 1976 but the population of the small town continued to grow slowly. Now home to about 1000 full-time residents, visitor numbers swell in summer holiday periods as people arrive to use the camping ground as well as several motels and resorts.

The key management issue faced by the region is the erosion of the sand dunes, particularly during storms. This is an example of a potential conflict between natural processes and human activities. Sand dunes naturally change in response to long-term and short-term changes in wind patterns, sand supply and sea levels. The erosion of the foredune at Rainbow Beach (a dune ridge running parallel to the ocean) is a natural event. However, as the erosion is now putting buildings at risk and making the beach unsuitable for recreation activities, some local residents and the Gympie Regional Council are proposing to try to control the erosion.

A study of the region found that the risk of severe dune erosion at Rainbow Beach is very low but some people are still concerned that during a severe storm important buildings could be lost. The council plans to install large sandbags at the base of the dunes in front of the Surf Life Saving tower, along 260 metres, to slow erosion and protect a new amenity block that has been built on top of the dunes.

Source 2   A 2009 storm severely eroded the Rainbow Beach foredune, placing the Surf Life Saving tower in danger of collapse.

Source 1   An oblique aerial photograph of Rainbow Beach, looking south. The foredune and two blowout dunes (known locally as the Carlo Sand Blow and the Little Sand Blow) can be seen to the south of the town.

keyconcept: Place

Coastcare at Rainbow Beach

There are 2000 Coastcare groups in Australia. Each group is made up of volunteers who work with local governments to identify problems and then work together to solve them. At Rainbow Beach, the local group has identified the loss of native vegetation, the trampling of dune vegetation by visitors accessing the beach, sand skiing on the sand blows, coastal erosion, environmental weeds, beach parking and rising sea levels due to climate change as the key issues in the area.

Some of the projects the Coastcare group at Rainbow Beach have undertaken include restoring native plants and removing weeds, protecting the dunes, monitoring bird populations and improving wetland areas.

For more information on the key concept of place, refer to page 6 of 'The geography toolkit'.

Source 3 Rainbow Beach has a very active Coastcare group.

Source 4 A range of management strategies are in place at the main beach in Rainbow Beach. The fencing and walkway direct people to enter the beach on this path, protecting surrounding dunes.

Check your learning 3.9

Remember and understand

1 Describe the natural environment of Rainbow Beach.
2 Describe the human activities bringing about change to this place.
3 What is Coastcare?

Apply and analyse

4 Is the plan to place sandbags at the base of the dunes an example of hard or soft engineering? Give some reasons for your answer.
5 What management strategies can you identify in Sources 3 and 4? What is each strategy designed to achieve and how effective do you think each will be in achieving its aims?

6 What are the similarities and differences between changes at Rainbow Beach and changes at Abbotts Hall Farm in Essex (see Source 3 on page 109)?

Evaluate and create

7 The Little Sand Blow is increasing in size as it moves westward. Construct a flow diagram or field sketch that shows the:
   • natural processes responsible for this movement
   • human activities that may be contributing to the movement
   • impacts of this movement on the environment
   • possible responses by the local government and Coastcare group.

3.10 Integrated Coastal Zone Management (ICZM)

In response to the serious issues facing coastal and marine ecosystems, a major United Nations conference held in 1992, called the Earth Summit, proposed a new system for managing coastal environments. Known as Integrated Coastal Zone Management (ICZM) it is now a widespread practice in many coastal nations, such as New Zealand, India, Canada, Bangladesh and the Netherlands.

The United Nations recognises that one of the common issues associated with coastal management is that government departments and interest groups often propose very different solutions to issues depending on their own needs and interests. In most cases, these solutions ignore the needs of other coastal users. The many coastal interest groups include residents, the tourism industry, fisheries, farmers, forestry, manufacturing, mining, waste disposal, marine transportation and real estate developers.

The key to ICZM is that it seeks to pull together the many groups and individuals with an interest in the coast in an integrated way when devising a management plan. The key principles of ICZM are outlined in Source 2. The success of ICZM is then dependent on funding, consistent government priorities and the expertise available to organise and manage large projects.

Eight principles of Integrated Coastal Zone Management

- Involve all relevant governments
- Take a long-term view
- Use a holistic approach
- Consider local conditions
- Work with natural processes
- Get people involved
- Use a range of approaches
- Be prepared to change strategy

Source 2 The eight key principles of Integrated Coastal Zone Management

Source 1 The challenges facing many coastal environments require an integrated approach.

Case study: ICZM in Bangladesh

Each ICZM plan is designed to best address the issues of the country it has been developed for. In Bangladesh, for example, the key issues are rising sea levels that bring saltwater floods to low-lying communities and the impacts of cyclones and storm surges. It is estimated that a one-metre rise in sea level would leave 17 000 square kilometres of land in Bangladesh submerged and 15 million people without a home (see Source 4). It will affect 1 million hectares of farmland and threaten the fresh water supplies of three major cities.

In response to these threats the Bangladeshi government, with the assistance of the World Bank and expertise from the Netherlands, has developed an ICZM strategy that focuses on disaster mitigation. To date 150 000 hectares of mangroves have been replanted and more than 2500 cyclone shelters constructed.

BANGLADESH: PREDICTED IMPACT OF 1-METRE SEA-LEVEL RISE

LEGEND
Heavily populated areas
Land submerged after 1-metre rise in sea level

Source 4   Source: Oxford University Press

Source 3   A nursery for mangrove trees. These will be used to replace some mangrove areas lost to farming and forestry and help to reduce flooding.

Check your learning 3.10

Remember and understand

1 What is ICZM?

2 How and why has ICZM been implemented in Bangladesh?

Apply and analyse

3 Source 3 on page 105 illustrates a significant problem in many coastal areas – marine dead zones. Work with a partner to use the eight key principles of ICZM to suggest how people could manage this issue. For example, using a holistic approach might mean getting farmers to be more careful in their use of fertilisers. Perhaps nutrient levels in streams could be monitored so that farmers could better manage their application of fertiliser, particularly in times of heavy rainfall.

Evaluate and create

4 What do you see as some of the barriers to ICZM principles being adopted in Bangladesh?

5 What do you see as some of the advantages in managing coastal changes using this approach?

3.11 ICZM in the Netherlands

The province of Zeeland in the Netherlands is a large agricultural area that is home to more than 380 000 people (Source 3). Much of the region lies below sea level. The land has been drained and reclaimed, creating new islands that are linked by bridges and tunnels. The area has an intricate series of levees (known as dykes) and dams that hold back the waters of the North Sea and regulate the flow of the rivers to the sea. The province also supports a large fishing industry and is home to the largest national park in the Netherlands.

In Zeeland, ICZM is used to reduce flooding from storm surges. The largest of the flood protection dams, the 9-kilometre-long Oosterscheldekering, links two of the largest islands in Zeeland. The 62 steel doors that make up the barrier can be lowered or raised in response to tides, storms and other sea level changes (see Source 1). For most of the year, seawater can flow freely beneath the dam so that marine ecosystems in the bays and estuaries of the delta can be maintained.

The dam, which was opened in 1986, has been declared one of the Seven Wonders of the Modern World and bears a plaque with the words, 'Here the tide is ruled by the wind, the moon and us (the Dutch).' Any long-term changes in sea level due to climate change will place greater pressure on this region and on these amazing engineering works.

The series of dams, storm surge barriers and bridges have provided many benefits for the people of the Zeeland region. As well as protecting them from storm surges and flooding, large areas of former saltwater estuaries have been converted into freshwater lakes creating a reliable supply of water. The dams and bridges also link together island communities that had been isolated for hundreds of years and the calmer waters of the river mouths and estuaries are safe for shipping and recreational boating.

Source 1   The Oosterscheldekering storm surge barrier in Zeeland

North Sea

Zeeland

Oosterscheldekering

Source 2   An aerial photograph of Zeeland showing a number of dams and storm surge barriers (including Oosterscheldekering)

ZEELAND: TOPOGRAPHIC MAP

LEGEND

— Principal road	▪ Glass house cultivation		▪ Park or recreation area
— Secondary road	Contour with value (interval 5 metres)		Open area
— Minor road	Built-up area		Lake/dam
× Wind turbine	Cultivated land		Watercourse
▪ Building/s	Forest		

Source 3

Source: Oxford University Press

Check your learning 3.11

Remember and understand

1 Why was the Oosterscheldekering constructed?

2 Locate the province of Zeeland in an atlas and describe its location.

Apply and analyse

3 Use the eight key principles of ICZM (see Source 2 on page 112) to comment on the flood protection provided by Oosterscheldekering. For example, how does this barrier take local conditions into account?

4 Examine Sources 2 and 3.

   a What factors do you think may be responsible for the large sandbanks forming in the Oosterschelde?

b Identify the different land uses on the island of Schouwen-Duiveland.

c Describe the relief of the island using the contour lines on the map.

d Describe the southern shore of the island.

Evaluate and create

5 Draw a sketch map of the vertical aerial photograph in Source 2. On your map label the key natural and human features of the landscape.

6 The Oosterscheldekering is only one part of a much larger flood protection scheme. Use Google Earth to examine the region and find other examples of flood protection.

3.12 Protecting the coast

An effective way to manage and protect natural environments such as coasts is to give them legal protection. This helps ensure that harmful activities are banned or limited. In Australia, this is achieved mainly through a system of national parks (on land) and marine reserves (in the surrounding seas and oceans).

National parks

Each state and territory of Australia has a large number of special places, both coastal and inland, that the government has decided to protect. These might be as small as a single historic house or beach, or as large as a wilderness or **national park**. Despite the name, virtually all of Australia's more than 550 national parks are the responsibility of the individual state and territory governments.

Although management strategies differ between states, the common ideals are that the land, plants and animals within the parks have protection from activities that threaten their existence and that people should be able to visit these special places. This can lead to problems, as visitors who come to see these areas in their natural beauty may threaten the very environment they are visiting. The managers of the national parks have the task of controlling what visitors do in each park by limiting or restricting certain activities in sensitive areas.

Marine reserves

While national parks protect special places on land, Australia's diverse marine environments also need to be protected. In 2012, the Australian government announced the creation of one of the world's largest marine reserve networks. Around 3.1 million square kilometres of our oceans are now managed mainly for the purposes of biodiversity conservation. This is an area roughly equivalent to the land area of Queensland and the Northern Territory combined.

Managing a marine reserve is particularly challenging because, unlike national parks on land, fences and signs aren't easily erected to limit access to particularly sensitive areas. Instead, marine reserves are divided into zones, and certain activities are allowed, banned or limited in each zone. It is the responsibility of anyone who enters a marine reserve to be aware of the activities permitted within each zone.

Every marine reserve in Australia, except for the Great Barrier Reef which is recognised as a special case, has been assigned a particular management category (see Source 2). These are the same as those adopted in other countries and have been developed by the International Union for the Conservation of Nature (IUCN).

Source 1 Royal National Park is Australia's oldest. Established in 1879, it protects large areas of coastal rainforest and ancient sand dunes.

Source 2 The IUCN management categories for the conservation of marine reserves

IUCN number	Name of reserve type	Purpose of the reserve
Ia	Strict nature reserve	Managed primarily for scientific research or environmental monitoring
II	National park	Protected and managed to preserve its natural condition
IV	Habitat/species management area	Managed primarily to ensure the maintenance of habitats or to meet the requirements of specific species
VI	Managed resource protected area	Managed to ensure long-term protection and maintenance of biological diversity with a sustainable flow of natural products and services to meet community needs

Source 3 Freycinet Marine Reserve on Tasmania's east coast includes large areas designated as strict nature reserves due to the biodiversity of the coast's offshore seamounts (undersea mountains) and bird populations.

AUSTRALIA: NATIONAL PARKS AND MARINE RESERVES, 2012

LEGEND

- Santuary and marine national park zone (IUCN Ia and II)
- Recreational use zone (IUCN II and IV)
- Habitat protection and conservation park zone (IUCN IV)
- Habitat protection zone (Coral Sea IUCN IV)
- Special purpose zone (IUCN VI)
- Special purpose zone (oil and gas exclusion) (IUCN VI)
- Multiple use zone (IUCN VI)
- General use zone (IUCN VI)
- Marine park
- National park
- - - Australian Exclusive Economic Zone (EEZ)
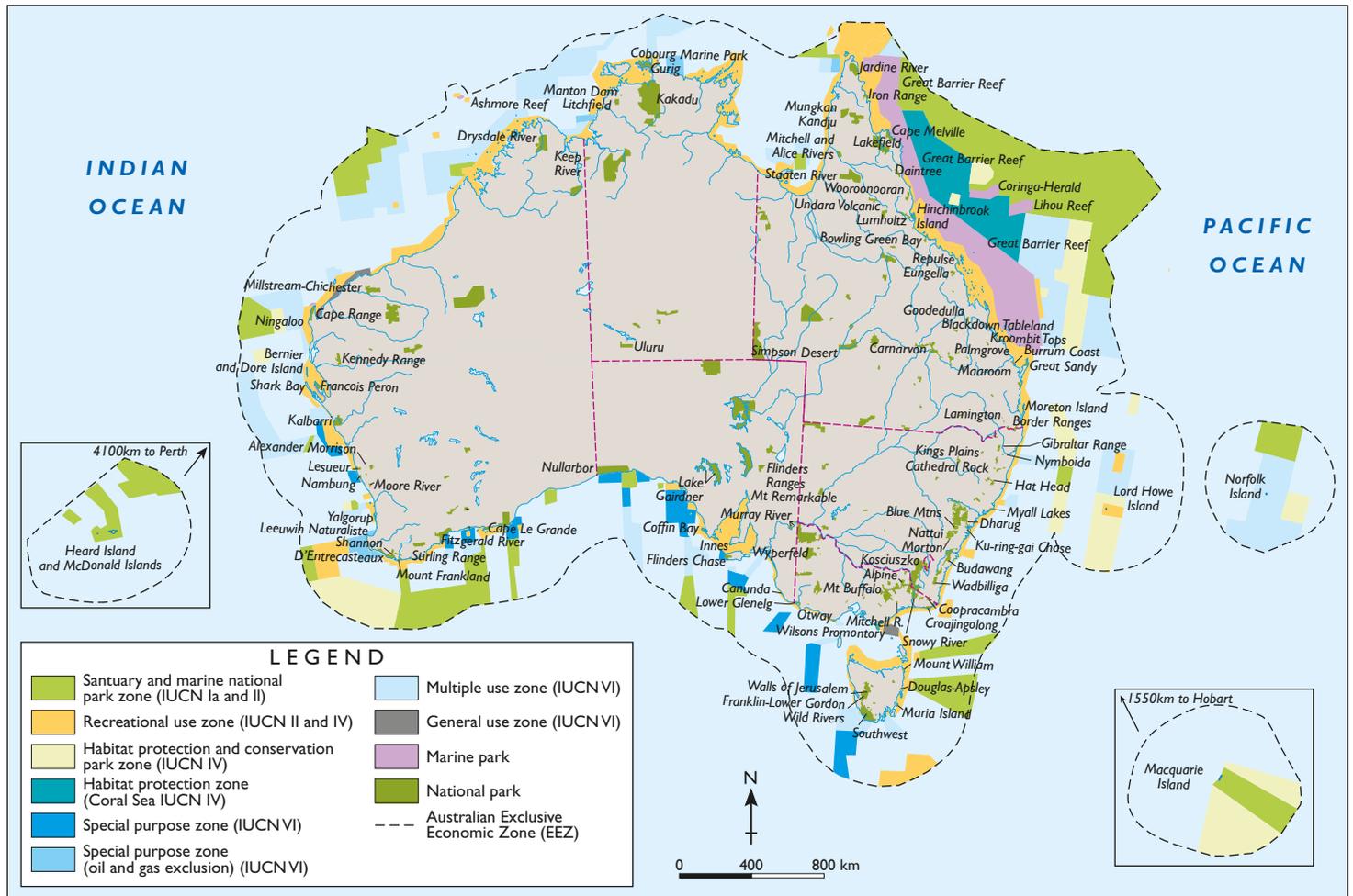
Source 4

Source: Oxford University Press

Check your learning 3.12

Remember and understand

1 In what ways are natural environments protected in Australia?

2 What are the ideals behind the management strategies implemented in national parks?

Apply and analyse

3 Examine Source 4.
   a Where are Australia's largest marine reserves located?
   b Describe the location of marine reserves in the state in which you live.

4 Examine Source 1, showing a person in a protected coastal area. Describe what they are doing and how this may impact on the natural environment. How could park managers in this area limit these impacts?

Evaluate and create

5 There were many objections to the Australian government announcement in 2012 that millions of square kilometres of ocean were to become marine reserves. In small groups consider which Australian groups would be likely to support this announcement and who would be likely to oppose it. Brainstorm the arguments that each of these groups would use to support their points of view.

6 Source 4 shows the extent of Australia's Exclusive Economic Zone (EEZ). Research this area and find out the benefits for Australia in having such a large EEZ. You may also like to find out about the Timor Gap and how this was created.

3.13 Reducing the impacts of coastal tourism

Tourism is the world's largest industry. It generates more than $US8 trillion a year in income and employs about 220 million people worldwide. Tourism in coastal areas has experienced a surge in recent years, and for many coastal communities it has become the largest contributor to their economy. While tourism has the potential to alleviate poverty and bring better infrastructure such as new roads and public services, it also has the potential to bring about major environmental degradation.

Tourism not only attracts visitors to coastal areas but also locals, who move to the coast for work, providing the goods and services tourists require. Tourism also brings developments such as hotels, jetties, roads, airports and shopping strips, often with minimal or hurried planning. The result is that many coastal tourism hubs are under significant environmental pressure.

The potential negative environmental impacts of tourism are many. Greater numbers of people bring increased pollution and landfill (see Source 1). As ecosystems such as mangroves, wetlands and reefs are removed to make way for hotel developments, there is a subsequent decline in biodiversity and an increased risk of beach loss from erosion and natural disasters.

In addition, an increased demand for fresh water, food (especially seafood), energy and sanitation make tourism a huge consumer of natural resources.

Ecotourism: a way forward?

Ecotourism is one option that coastal tourism operators are using to make their industry more sustainable. It is also a strong marketing tool, appealing to tourists who want more environmentally friendly travel. The International Ecotourism Society (TIES) defines ecotourism as 'responsible travel to natural areas that conserves the environment and improves the wellbeing of local people'. TIES believes that those who implement and participate in ecotourism activities should:

- minimise environmental impacts
- build environmental and cultural awareness and respect
- provide positive experiences for both visitors and hosts
- provide direct financial support for conservation
- provide financial benefits and empowerment for local people
- ensure sensitivity to the host country's political, environmental and social climate.

Source 1 Cruise ships that carry up to 4000 passengers each contribute to the 70 000 tonnes of waste generated annually from tourism in the Caribbean region.

keyconcept: Sustainability

The Penguin Parade

One of Victoria's most popular tourist attractions is the nightly arrival of hundreds of Little Penguins at Summerlands Beach on Phillip Island. This natural event attracts around 1 million visitors per year, more than half of whom are from overseas. As well as a tourist attraction, the Penguin Parade is also an example of minimal impact ecotourism and conservation.

As a non-profit organisation, the Phillip Island Nature Park uses the income generated from the parade to protect, conserve and restore the natural environment of the region. The organisation has become a world expert on the Little Penguins as well as carrying out vital research on seals and seabirds. In order to protect the penguins, rangers undertake large- and small-scale revegetation and habitat restoration programs. As a result, the penguin population climbed from 19 000 in the 1980s to 32 000 in 2013.

Much of the restoration and revegetation work is on the site of a former housing estate located adjacent to the Penguin Parade. Between 1985 and 2010, the Victorian government purchased and removed hundreds of holiday homes, as well as the roads, gardens, power cables and septic tanks that made up the Summerlands Estate. The area is now prime habitat for the penguins. Future plans include moving the visitor centre and car parks so that the land on which they now sit can also be restored to natural habitat.

For more information on the key concept of sustainability, refer to page 10 of 'The geography toolkit'.

Source 2 Raised boardwalks and viewing platforms minimise the environmental impact of visitors to the Penguin Parade and allow penguins to move freely from the ocean to their burrows every evening.

Check your learning 3.13

Remember and understand

1 What is ecotourism?
2 In what ways can the Penguin Parade on Phillip Island be considered to be an example of ecotourism?

Apply and analyse

3 Source 1 shows a cruise ship docking at a Caribbean port. Describe the changes that have been made to the coast as a result of tourism that can be seen in this photo.
4 Compare these changes to those that have occurred at the Penguin Parade.

Evaluate and create

5 Imagine that an international tourism operator has proposed to build a port for cruise ships at Rainbow Beach (see Source 1 on page 110) and that that you have been appointed the company's environmental consultant. Brainstorm the impacts of this development on the natural environment. Use the ecotourism principles provided to make recommendations that minimise these impacts. Prepare a report for the tourism operator with your recommendations. You may like to include a map and sketches in your report.

3.14 Indigenous management of the coast

Prior to European colonisation in 1788, the coastal areas of Australia supported large numbers of Aboriginal and Torres Strait Islander peoples. The coasts provided a reliable source of food both from the sea and the surrounding land.

Today, nearly half of all Indigenous Australians live near the coast. Many maintain a close association with the coast through cultural and historic connections, through continued use of coastal resources and by law. In the Northern Territory, for example, Aboriginal communities own and manage approximately 85 per cent of the coastal land.

Coastal places with special significance to Indigenous Australians are under the same environmental threats as other coastal places: from population and economic growth, land use changes, climate change and the arrival of invasive species. Indigenous communities are now working with government to restore lands that are important to them. This joint approach means that factors of Indigenous heritage are taken into account when decisions are made about the use and restoration of degraded areas.

Case study: Indigenous management of the Coorong

> The land and waters is a living body. We the Ngarrindjeri people are a part of its existence. The land and waters must be healthy for the Ngarrindjeri people to be healthy. We are hurting for our Country. The Land is dying, the River is dying, the Kurangk (Coorong) is dying and the Murray Mouth is closing. What does the future hold for us?
>
> Tom Trevorrow, Ngarrindjeri Elder,
> Camp Coorong, 2002

The region known as the Coorong, where the Murray River reaches the sea, covers an area of 14 000 square kilometres. The Coorong was recognised as a Wetland of International Importance and as a breeding ground for many bird and fish species by the Ramsar Convention on Wetlands in 1985. Due to a combination of factors, including water extraction in the Murray–Darling Basin, drought and barrages (dams) built across the Murray
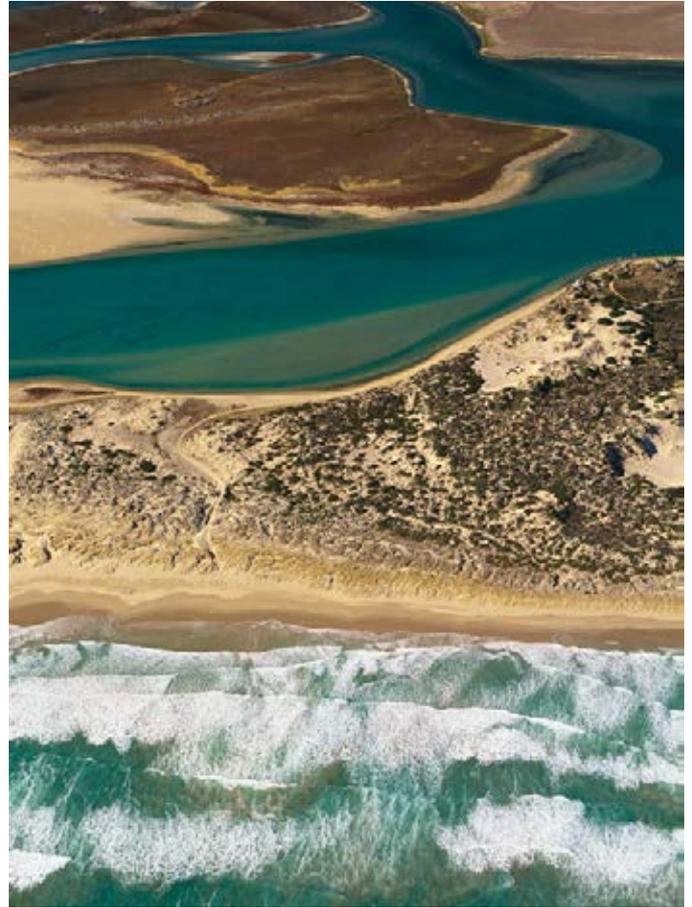
Source 1 An oblique aerial photograph of the Coorong, Lower Lakes (including Lake Alexandrina and Lake Albert) and Murray Mouth region of South Australia

to hold back sea water, the region has become severely degraded. In particular, the waters of the Coorong Lagoon and lakes have become saltier than the sea, wetlands have dried out and acidic soils have become exposed. Another cause of this degradation has been the building of dams that collect water during wet seasons and then release this water during dry seasons. This has disrupted the natural cycle of the Murray River of floods and droughts and had a dramatic effect on the natural ecosystems of the river, particularly at its mouth. In some years, so little water flows through the mouth that it closes, cutting off the lakes of the region from the sea.

The traditional owners of the region, the Ngarrindjeri people, maintain a strong connection with the lands and water of the Coorong. They believe that the health of their nation is closely linked to the environmental health of the region, and that a

freshwater flow that allows plants and animals to thrive must be maintained.

The Ngarrindjeri community through the Ngarrindjeri Regional Authority (NRA) has formed a close relationship with the South Australian Department of Environment, Water and Natural Resources (DEWNR) to deal with short-term crises in the region and to plan for a sustainable future. This has resulted in the adoption of a long-term plan which aims to secure a future for the region as a 'healthy, productive and resilient wetland system that maintains its international importance.' The plan includes a number of specific goals:

• to protect and restore natural habitats
• to restore viable populations of native bird, fish and other animal species. Restoring the natural flow of fresh water to the Coorong and Lower Lakes are seen as a key component of this goal.
• to improve water quality and increase flows through the wetlands. It is proposed, for example, that very salty water be pumped out of the lagoon to the sea.
• to recognise the Ngarrindjeri community's association with the area.

Large areas of dunes, wetlands and farmland have already been replanted using native plant species as the first step in this plan to restore the Coorong area.

Source 3   South Australian Environment Minister Paul Caica and NRA chairman Tom Trevorrow meet at the Coorong in 2012 to sign a new management agreement for the region.

Check your learning 3.14

Remember and understand

1 Why did many Aboriginal and Torres Strait Islander peoples live near the coast in the past?

2 Why are the Ngarrindjeri people particularly concerned about the health of the Coorong ecosystems?

Apply and analyse

3 Use Source 1 to describe the natural environment of the Coorong and Lower Lakes. Include the water and land features that you can identify.

4 Examine Source 2.
   a Describe and account for the location of Indigenous lands.
   b Describe the locations of the barrages. Why have the barrages been built in these places? How would they change the natural environment of Lake Alexandrina and the Coorong?

Evaluate and create

5 Use the eight key Integrated Coastal Zone Management principles shown in Source 2 on page 112 to devise a strategy to improve the health of the Coorong ecosystem.

6 Research which other wetlands in Australia are listed in the Ramsar Convention.

COORONG: INDIGENOUS LANDS AND NATIONAL PARKS

Source 2

Source: Oxford University Press

Ningaloo Coast

On the north-west tip of Western Australia is one of the world's most spectacular coastal environments. Long white beaches run along the shore, and visitors can swim out from the beach to Australia's longest fringing reef (a reef that lies extremely close to shore). The region has about 300 000 visitors a year, many of them arriving between April and July for a chance to snorkel with whale sharks. The region is also home to dugongs and visited by humpback whales and greenback turtles.

Much of the region is under some form of legal protection as part of the Ningaloo Marine Reserve and Cape Range National Park. It is also Australia's newest World Heritage site, having been added to the World Heritage List in 2011.

Though a remote and relatively pristine area, the Ningaloo Coast faces a number of potential environmental threats. These include:

• oil and gas exploration off the coast
• damage to coral reefs from boat owners anchoring in the fragile reef areas
• illegal fishing
• plastic bags killing turtles and whales by intestinal blockage
• damage to vegetation from off-road driving
• waste disposal and pollution
• increasing level of water consumption
• potential for bushfires
• invasive species (foxes, goats, cats) destroying or attacking native plants and animals.

Other potential issues in the area include a RAAF bombing range south of Cape Range National Park, which may threaten important limestone caves and sinkholes, and livestock from local farms that could damage vegetation if they are not appropriately managed. In addition, the development of oil and gas reserves in offshore basins and shelves could present a future threat to the coast and reef.
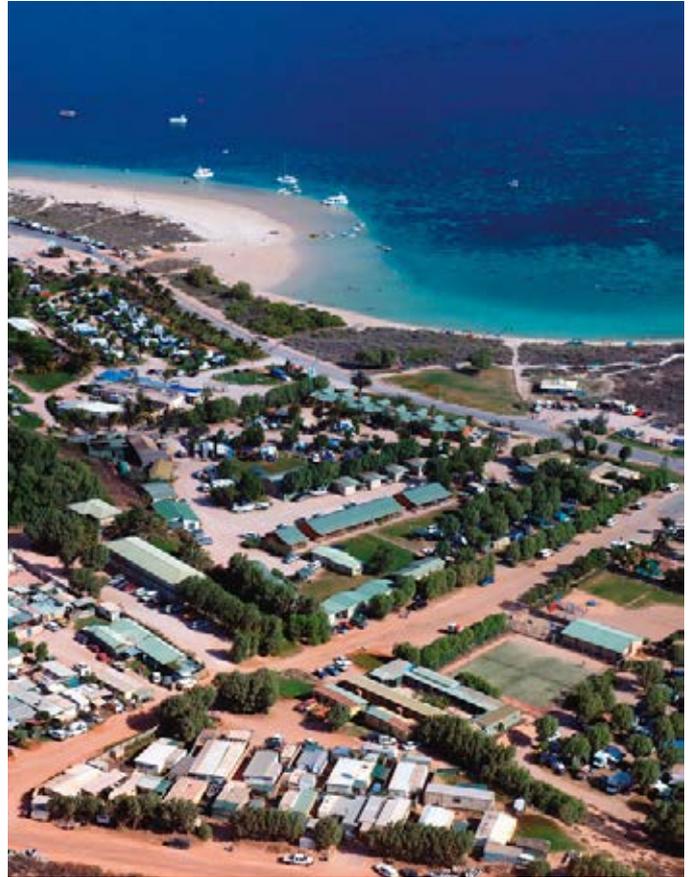
Source 1 The small town of Coral Bay is used as a launching point for whale watching and fishing boats.

skill**drill:** Data and information

Analysing complex maps

Complex maps contain more than one set of information. Geographers use complex maps to analyse different features, reveal patterns and explain links between features in a given area. You can analyse a complex map by following these steps.

Step 1 Look carefully at the map and read its title to make sure you understand what is being shown.

Step 2 Examine the map's legend. Complex maps can have more than one part to a legend, and these parts will be represented on the map in different ways. For example, in Source 2 areas of colour are used to show the location of recreational use zones and state marine reserves. Different symbols are also used, to show roads and coastal water boundaries.

Step 3 Train your eyes to look for one set of information at a time. For example, look at solid blocks of colour on the map and work out what they tell you.

Step 4 Move to a different set of information by selecting another symbol or block of colour from the legend. Examine the map to identify this symbol or area of colour.

Step 5 Look for concentrations of the same symbol in areas to see if patterns exist.

Step 6 Note any patterns you can find on the map between different features and locations.

Step 7 Describe the degree to which patterns are connected.

Step 8 Try to suggest reasons for the connection between the two patterns.

Apply the skill

Look at the map of Ningaloo Marine Reserve (Source 2).

1 Find the symbol for multiple use marine zones in the legend then locate these areas on the map. Describe the concentration of these areas.

2 What relationship is there between the multiple use marine zones and the location of recreational use areas?

3 Describe the location of the Ningaloo World Heritage area.

Extend your understanding

Do some further reading on the Internet to complete the following tasks.

1 Research Ningaloo's World Heritage listing.
  a What does World Heritage mean?
  b Why are sites placed on this list?
  c Why was the Ningaloo Coast added to the list?

2 In the early 2000s, a large resort and marina called Coral Coast Resort was planned for the coastal area to the north of Coral Bay known as Maud's Landing. Find out about these plans and why the resort was not built.

NINGALOO: MARINE RESERVE AREAS

LEGEND

- Cape Range National Park
- State marine reserve
- Recreational use marine zone (IUCN II)
- Multiple use marine zone (IUCN VI)
- Defence Reserve
- Coral reef
- Urban area
- World Heritage area boundary
- Coastal waters boundary
- Main road
- Minor road
- 4WD track
- Camping area
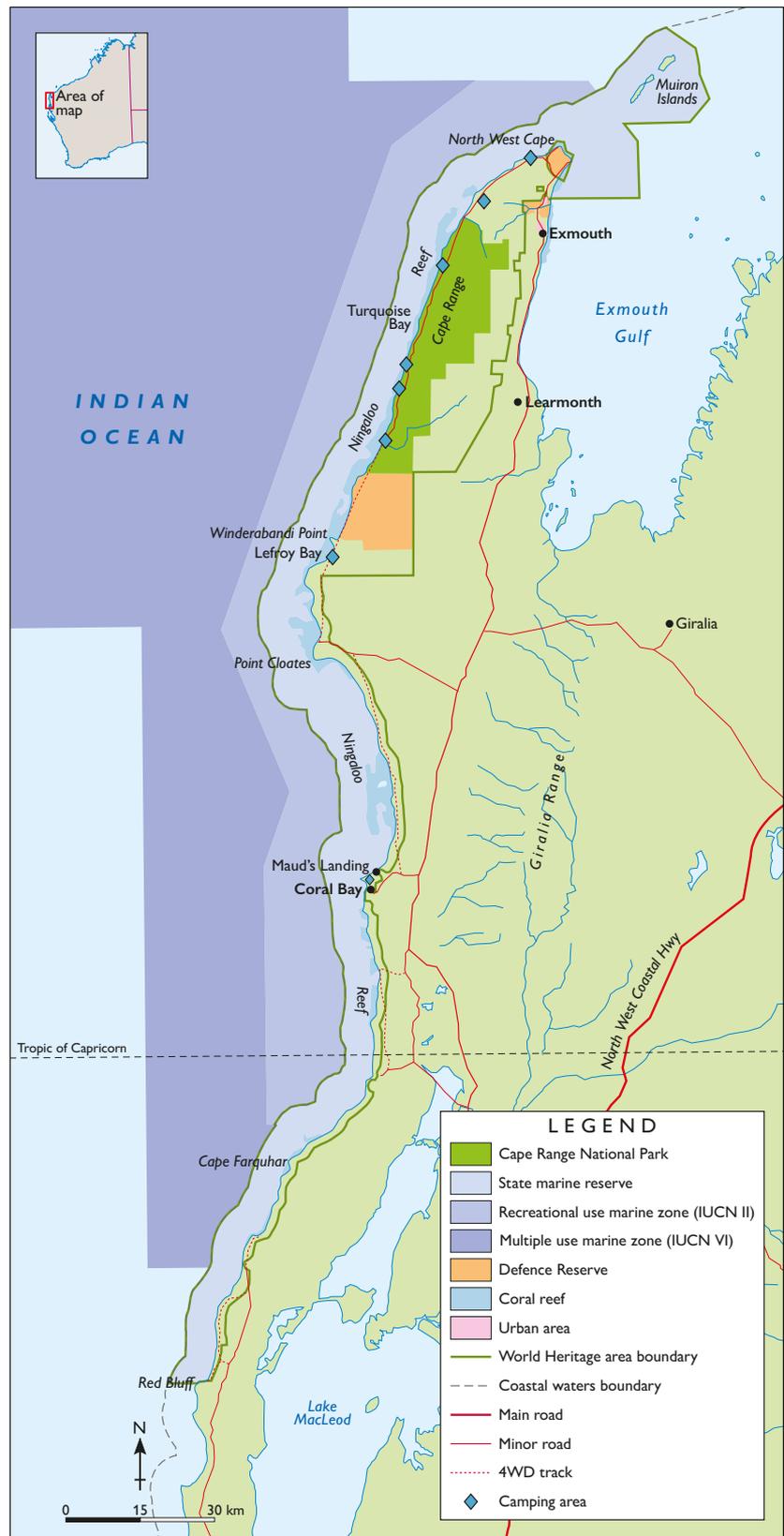
Source 2   Source: Oxford University Press

3.15 The role of geographers in managing environmental change

Geographers have an important role to play in the management of environmental change. Because geographers draw on knowledge and skills from the natural sciences (such as geology, biology, chemistry and physics), the social sciences (such as psychology, history and economics) and humanities (such as philosophy) they are uniquely placed to see the 'whole picture' when examining environmental change. Geographers can, for example, consider the reasons why people act in a certain way and consider the impacts of these actions on the environment. They can also help to explain why people respond to change in different ways and, most importantly, recommend a course of action that is beneficial to both the natural environment and people.

Fieldwork case study

When examining environmental change such as coastal erosion, geographers often begin by developing a set of geographical questions. The geographer then sets out to answer these questions using a range of geographic tools. One of the most useful tools is fieldwork – visiting the environment being studied and observing it firsthand.

When exploring changes at the coast, geographers use a range of specific techniques. These include constructing cross-sections of dunes, cliffs and other landforms, photographing evidence of change and measuring **longshore drift**. By visiting the same site at regular intervals (for example, once a year) geographers can also observe changes that have occurred between their visits. It may be important to visit the site at different times of the year to observe seasonal changes such as the effects of storm waves during winter or the impacts of holiday-

makers during summer. The following case study is an example of the sort of environmental issues that might be explored by a geographer completing fieldwork.

Case study: coastal issues at Old Bar, New South Wales

The small coastal town of Old Bar, located on the mid-north coast of New South Wales, faces a range of environmental changes. The town is located on a dune system within a river delta and is home to around 4000 permanent residents. It also has a large number of visitors, particularly during holiday times. The dunes are eroding rapidly at a rate of up to 1 metre per year and this is threatening homes and infrastructure. Studies have found that the dunes in this area have experienced periods of erosion in the past but that rising sea levels are making the current situation more severe.

Local residents are worried that trail-bike riders on the dunes are causing more damage and that the old site of a sand-mining business, which operated

Source 1   An oblique aerial photograph of Old Bar showing the location of a proposed real estate development

back in the 1980s, is an erosion hot spot. Some are also concerned that a proposed 10-hectare housing estate south of the town will further damage the dunes. Many residents believe that building two artificial reefs at the cost of $10 million would protect the coast from further erosion. However, an expert study recommended that a managed retreat coupled with a sloping sea wall of sand-filled bags and regular beach nourishment was a better option.

Photographs from fieldwork at Old Bar

Source 3   Dune erosion has destroyed some homes and is threatening others.

Source 2   In some places the beach is composed of pebbles as well as sand.

Source 4   Evidence of erosion includes a large Norfolk pine tree which has fallen onto the beach.

Check your learning 3.15

Remember and understand

1   Why is fieldwork an essential tool for geographers?
2   Why are geographers uniquely placed to help describe and manage environmental change?

Apply and analyse

3   Look carefully at the photographs on these pages. Create a series of geographical questions that could be used as the basis of a field trip to Old Bar. You may like to begin your questions with the words 'what', 'where', 'how', 'why', 'what impact' and 'what should'. Share your questions with a partner and then with the class.

4   Why would many residents prefer artificial reefs to be constructed rather than implementing the soft engineering approach of managed retreat?
5   What would be the advantages and disadvantages of sea walls and beach nourishment at Old Bar?

Evaluate and create

6   Read page 37 of 'The geography toolkit' and use the tips on conducting successful fieldwork to design your own fieldwork investigation of Old Bar. Outline the five stages of your inquiry, making sure that you investigate:
   a   the causes of coastal erosion
   b   the effects of coastal erosion
   c   the responses to coastal erosion.

3.16 Using spatial technologies

Geographers use a range of tools to describe and predict environmental change. These tools may be as simple as direct observation or involve measuring and recording the changing width of a beach with a tape measure. Increasingly, however, digital tools are being used to measure change and to help manage dynamic environments such as coasts, forests and farms (see Source 1). These tools rely on the collection of data from sources such as the **global positioning system (GPS)**, aerial photographs, ships and tide meters. The data collected is then analysed by computer programs and made available for use by **geographic information systems (GIS)** and **digital terrain modelling (DTM)** as well as other applications.

Global positioning system (GPS) satellites provide location information anywhere on Earth.

Airborne laser scanners produce a digital image of the land while in flight.

Ground-based GPS reference stations measure satellite signals.

research vessel

Side scan sonars create images of the sea floor.

Echosounders measure the ground underwater.

sampling

Seismic reflection systems bounce waves off the sea floor, providing information about the surface.

Source 1 Geographers use a range of digital data collection methods.

As more and more coastal communities become concerned about the impacts of rising sea levels due to climate change, there is a greater demand for more advanced methods of monitoring the coastline. This is driving a boom in coastline monitoring through spatial technologies and is making more data and information about coastal changes available to geographers than ever before.

Digital terrain models (DTMs)

A DTM shows the relief (or shape) of the land in three dimensions (see Sources 2 and 3). Much of the data needed to create a DTM is collected from special sensors on satellites. This data is represented as a raster (grid of squares) and manipulated by technicians to form a model of the Earth's surface. These models can help geographers 'see through' features of the environment such as coastal waters and forests to examine the terrain below. They can be used to predict areas at risk from erosion and other hazards, such as coastal flooding. This information can then be used to help manage the environment to limit the effects of these potential hazards and disasters.

Source 2 In this DTM, the height of the land and the depth of the sea are represented by changes in colour.

Source 3 The same data used to create the first DTM has been combined with an aerial photograph to create a more realistic digital representation of the landscape.

keyconcept: Interconnection

Geographic information systems (GIS)

GIS uses digital data to create a series of maps of a particular landscape. Each map focuses on a different aspect of the environment, such as the ocean depth, salinity, roads, settlements and relief. Using a GIS program, the maps are presented as a series of layers which can be switched on and off. This enables geographers to compare different aspects of the environment and look for interconnections between them.

GIS is particularly useful in examining and managing change in coastal environments. It allows geographers to isolate different and competing land uses, to see beyond political and physical boundaries and to measure change over time.

The Netherlands provides a good example of the use of this technology. Every year, the entire 350-kilometre-long Dutch coastline is digitally mapped and measured using methods similar to those shown in Source 1.

The maps and cross-sections produced in this annual survey are compared to the first survey of this kind, undertaken in

1990. Areas of coastal erosion and accretion (growth) are clearly displayed on GIS maps and are used by coastal managers to make changes in coastal defence strategies such as beach nourishment and sea walls.

For more information on the key concept of interconnection, refer to page 9 of 'The geography toolkit'.
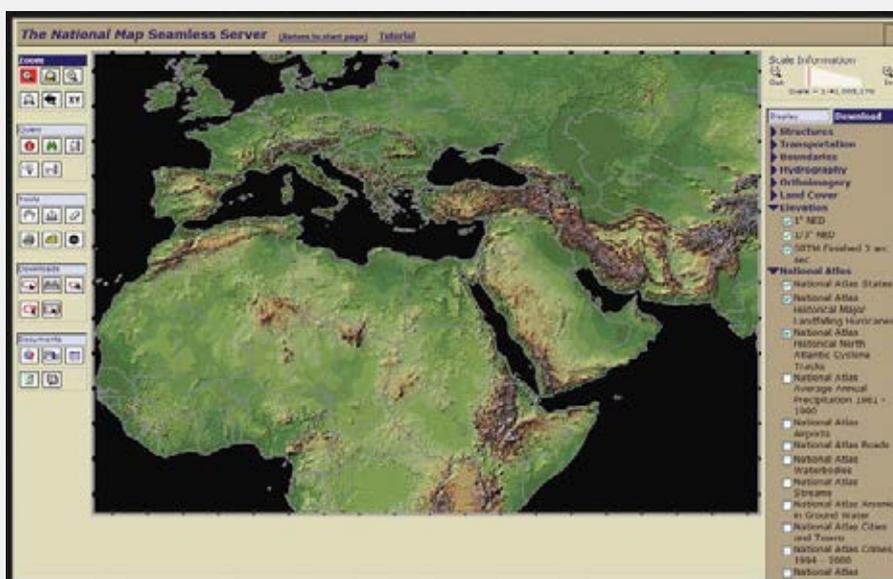
Source 4 A GIS map of North Africa and Europe. A range of GIS tools are shown in the left-hand margin and the map layers are available in the right-hand margin. By manipulating these tools and layers, geographers can create their own maps and examine regions in great detail.

Check your learning 3.16

Remember and understand

1 Why do geographers use digital tools?

2 How is data collected to create GIS and DTMs?

Apply and analyse

3 Examine Sources 2 and 3.
   a What evidence is there that this coastline is under threat of erosion?
   b Which of these DTMs would be most useful to an engineer planning the placement of new groynes? Give some reasons for your answer.
   c Who would find these models useful?

Evaluate and create

4 Examine Source 1 on page 124 showing the proposed real estate development site at Old Bar in New South Wales before completing the following tasks.
   a Imagine that the developer at Old Bar has asked you to suggest a range of digital data collection methods to create a GIS that will assist them with their planning. Describe the most relevant data collection methods to use.
   b Now sketch the map layers that you think the developer would most like to see included in the program.

3.17 Understanding spatial variations

Each place on the Earth's surface is unique. In the same way that no two people are exactly alike, natural environments such as forests, glaciers and coasts all differ. The reasons for these variations may be complex, but recognising them is a critical part of understanding why different places have different problems. Geographers examine these differences (also known as **spatial variations**) and use what they find to propose solutions and responses to environmental change and/or issues. It is important to remember that these solutions and responses need to be site-specific. They may work in one place but not work in another. Some environments are also more resilient to change than others.

The factors that need to be looked at when considering spatial variations in environments can be divided into two groups – natural factors and human factors.

Natural factors

Geographers often use models to help them understand processes that take place in the natural world. One of these models (known as the four spheres model) is particularly useful when investigating the natural factors that influence spatial variations. The four spheres that interact to form unique landscapes include:

1 the **atmosphere** – all of the gases that surround the Earth
2 the **biosphere** – all living things on Earth (i.e. plants, animals, humans and other organisms)
3 the **hydrosphere** – all of the water on Earth (i.e. in solid, liquid and gaseous forms)
4 the **lithosphere** – the outer rocky layer of Earth (i.e. crust).

Source 1 provides an example of how the four spheres model can be used to investigate and describe how natural factors interact to shape coastal environments.

Atmosphere
Biosphere
Hydrosphere
Lithosphere

Wind moves soft material such as sand.

Temperature influences plant and animal growth.

Marine organisms such as coral polyps shape the coast.

Coastal vegetation supports biodiversity, filters sediments and stabilises loose sediments such as sand.

Rivers carry water and sediments to the coast. The volume of the sediment load is determined by factors such as rainfall, the size of the river basin and its rock type.

currents, tides and storms

Waves are responsible for most of the natural shaping of the coast.

the shape of the ocean floor such as the location of the continental shelf or coral reefs

ocean bottom type: hard and rocky or soft, sandy and muddy

Up to 80% of the world's coasts are rocky and steep; the remainder is made up of loose materials such as sand, mud or gravel.

Source 1   An analysis of an Australian coastal environment using the four spheres model

Source 2 The Gold Coast in Queensland is an example of an anthropogenic coast.

Human factors

People have always been drawn to the coast. Coastal environments provide us with many ecosystem services that we need to live and thrive such as food, shelter, transport, recreation and flat land for building. Areas near the mouths of rivers also provide fresh water and fertile soil. Human influence tends to be concentrated in certain places on the coast where these ecosystem services are most available. In these places, the coastlines are now so altered by human activities that some geographers refer to them as anthropogenic coasts (see Source 3), meaning humans have become the dominant force in these environments.

Source 3

Features of an anthropogenic coast
• Coastal protection constructions such as sea walls
• Cleared vegetation
• Dredged shipping channels
• Mining operations including sand mining and oil drilling
• Fishing and aquaculture
• Coastal agriculture
• Forestry
• Shipbuilding and other industries
• Shipping and port facilities
• Dammed rivers for hydroelectric power generation
• Naval and other defence operations
• Tourism and recreation
• Roads
• Draining coastal wetlands and salt marshes
• Land reclamation
• Cities

Check your learning 3.17

Remember and understand

1 Name the four interconnected spheres that make up the Earth.

2 List four ecosystem services that the coast provides us with.

Apply and analyse

3 Would rocky coasts be more resilient to change than sandy coasts? Give some reasons for your answer.

4 Choose a section of coastline you have visited or know well and describe the natural and human processes that have shaped it.

Evaluate and create

5 In the same way that natural factors can be classified, so too can human factors. One method is to classify them as social, historic, environmental, economic, political or technological (making the acronym SHEEPT). Use this method to classify the human factors listed in Source 3. For more information on the SHEEPT method, refer to page 28 of 'The geography toolkit'.

3.18 Assessing environmental change

In Australia, and in many other countries, building projects that are likely to impact on the natural environment must go through a process of environmental assessment. This involves a study of the likely impacts of the proposed project on the environment. The resulting document is called an Environmental Impact Statement (EIS) and is generally prepared by a geographer with specialised training.

When completed, the EIS is submitted to the relevant authority, for example the state planning ministry. The state planning ministry then has the authority to stop the project if they feel it has too much impact on the environment. Alternatively, they may request changes to aspects of the project in order to minimise the environmental impacts.

Case study: the Ichthys Project

The Ichthys Project (named after the classical Greek word for 'fish') is the largest oil and gas mining project to be undertaken in the Northern Territory. It is being built by INPEX, a worldwide gas exploration company, and its partners, with construction in the Timor Sea and Darwin. Natural gas, an extremely valuable energy

ICHTHYS PROJECT: LOCATION OF THE PROPOSED OFFSHORE WELLS, PIPELINE AND ONSHORE PLANT
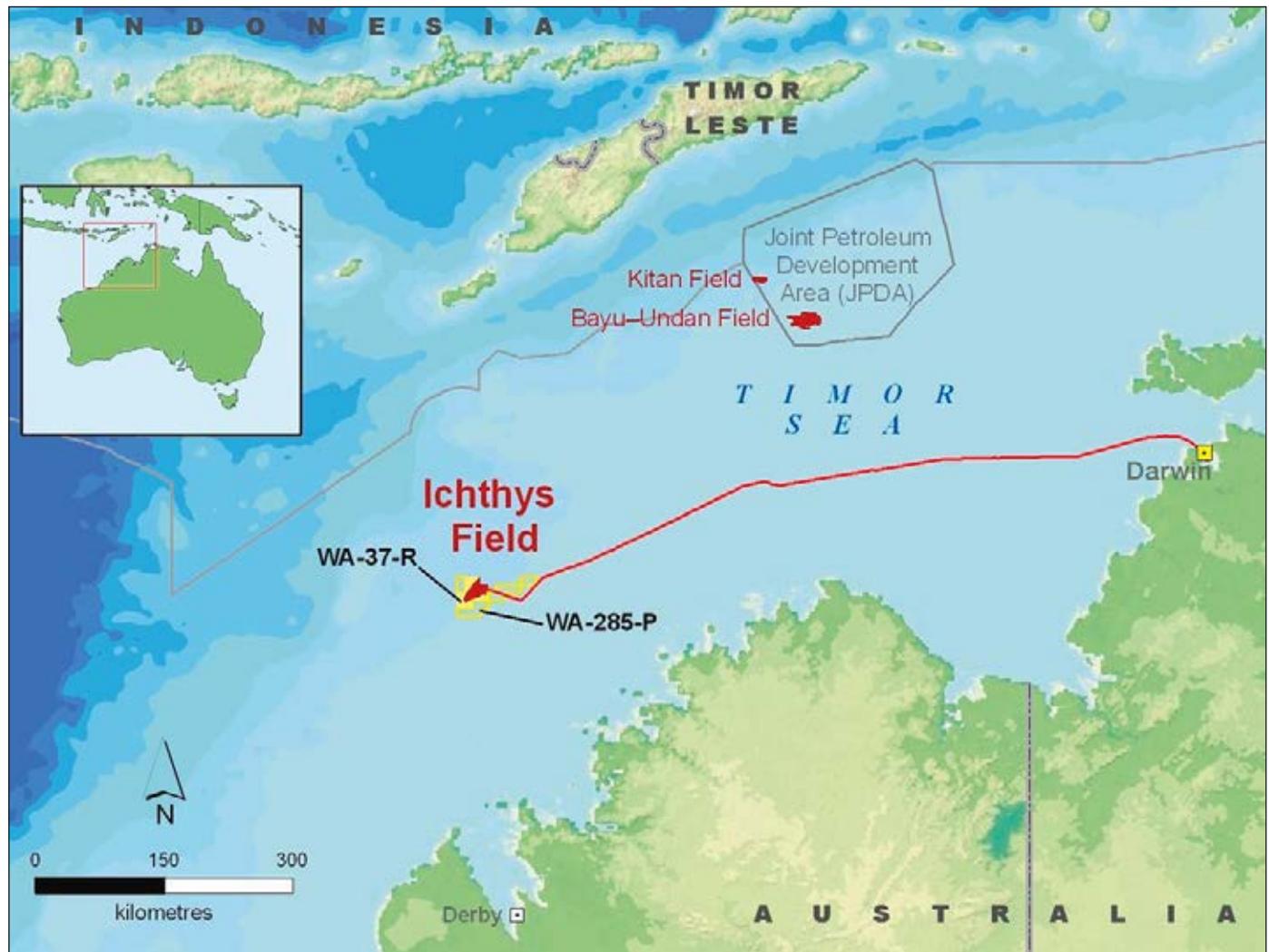
Source 1

Source: AAP

source, will be extracted from beneath the Timor Sea and then transported to Darwin through a pipeline that will be laid on the seabed.

The massive project is set to deliver significant social and economic benefits to Australia, bringing jobs, training, business opportunities, and advancement for the energy industry.

The three stages of the project – the offshore wells, the pipeline and the onshore facilities at Darwin – were all assessed for their environmental impacts before the project was allowed to proceed.

The onshore processing plant is being constructed on Middle Arm Peninsula to the south of Darwin and close to an existing natural gas plant. The following factors were studied as part of the three-year environmental assessment of the project:

- the impact of dredging parts of the harbour and the disposal of the dredged material on corals, sea grass and marine animals such as dolphins, dugongs and turtles. Dredging involves the removal of a large rock shoal by methods such as using explosives (three explosions per day for 57 weeks) or specialised dredges.
- an increase in underwater noise and the impact of this on dolphins which use sound to navigate
- impacts on shore birds and wading birds, particularly from the loss of mudflat habitat and the potential of oil spills
- impacts on fish species including the commercially important barramundi and on crustaceans, especially mud crabs
- the removal of areas of mangrove forest, including plants listed as vulnerable to extinction, and the possible impacts of increased sedimentation on other areas of mangrove
- disposal of waste water, including sewage from the plant and the village built to house up to 3500 construction workers
- air and noise pollution and the effects of these on Darwin residents
- greenhouse gas emissions. The project, when completed, will be the largest emitter of greenhouse gases in the Northern Territory and one of the largest in Australia.

Based on their assessment of the impacts and potential benefits of the project the Northern Territory government allowed it to go ahead, as long as the company made a number of changes to reduce the potential environmental impact and agreed to a range of recommendations. These included:

- monitoring and researching the health of Darwin Harbour for 40 years
- long-term research of coastal dolphins to assist with their conservation
- a $3 million donation to Charles Darwin University to assist in oil and gas research
- an extensive mapping project covering the natural habitats of the Darwin region.

Source 2 A computer-generated image of the completed onshore processing plant near Darwin

Check your learning 3.18

Remember and understand

1 What is an Environmental Impact Statement (EIS) used for?

2 List the potential benefits as well as potential negative impacts of the Ichthys Project.

Apply and analyse

3 Examine Source 1.
   a Estimate the total length of the pipeline.
   b What are some of the potential impacts of the pipeline?

4 Examine Source 2. Describe the changes to the natural environment as shown in this computer-generated image.

5 Why would INPEX agree to the range of recommendations put forward by the Northern Territory government?

Evaluate and create

6 Explain the importance of each of the Northern Territory government's recommendations for the natural environment.

7 Brainstorm with your classmates what cultural, economic and environmental factors a government would need to consider when deciding whether or not to approve a project such as the Ichthys Project.

3.19 Responding to environmental issues

Once an environmental issue has been identified and assessed, it is often necessary to come up with a suitable response. The environmental response must be individually designed for that particular environment. Management responses that are effective in one place may be ineffective or even damaging in other places.

When considering a suitable response to environmental issues, important questions to ask include:

- Does the response deal with the causes of the issue as well as its effects?
- Is the response affordable in both the short and long term?
- Is the response beneficial to all natural environments, or does it just move the problem and perhaps result in greater environmental changes in another place?
- Is the response fair to all of the relevant stakeholders?

Case study: Sierra Leone's disappearing beaches

Sand mining is having a serious environmental impact on the coastal environment in the African nation of Sierra Leone. The capital city, Freetown, is experiencing a population and building boom. The population is growing by about 70000 people per year and there is a growing demand for new housing as well as commercial and industrial buildings. Many of these buildings are made from concrete which requires vast quantities of cheap, good quality sand. Sand-mining operations can involve up to 40 trucks at a time, each with a team of diggers, who shovel sand from a beach. This process is creating changes in both the natural environment, as the sea is able to penetrate further inland, and the human environment. Local residents are being affected as the remaining dunes are eroding rapidly and houses are falling into the sea.

Possible responses

Sierra Leone is trying to build a viable tourism industry to boost the nation's economy but tourist resorts are in danger of losing their beaches. A possible response to

Source 1 Sand mining on Hamilton Beach, Freetown, Sierra Leone

this problem would be to declare sand mining illegal and arrest those who continue to take sand from the beaches. Another possible response would be to import sand from other places.

Some of the factors to consider when planning a response to the issue of sand mining in Sierra Leone are:

- Sierra Leone is one of the world's poorest countries. Many people struggle to earn enough money to provide adequate food, shelter and water for their families. Sand mining provides a source of income for hundreds of men and their families.
- As a developing country, levels of technology in industries such as transport and mining are low.
- Coastal areas are often heavily used for many purposes: fishing, residences, tourism, recreation and a source of building materials.
- As dunes disappear, coastal erosion is accelerating and is now up to 6 metres per year in some places.
- Global climate change is expected to raise sea levels on this coast and to increase the number and severity of storms generating large, destructive waves.
- Sierra Leone's police force has not enforced previous bans on sand mining.
- Corrupt local officials accept payments from the construction companies to continue the sand mining.
- The main sources of sand, Hamilton and Lakka beaches, are located within Freetown's urban sprawl (see Source 2).

skill**drill:** Place, space and interconnection

Evaluating possible responses to environmental issues

Complex environmental issues often require complex responses. Geographers can propose possible responses or assess the environmental, economic and social sustainability of responses proposed by governments. Geographers can evaluate possible responses against a set of criteria. For example, the issue of sand mining in Sierra Leone requires an urgent response. If the situation continues, hundreds of people will lose their homes, the tourist industry will collapse and many people will lose their jobs. The area around Freetown will also lose many ecosystem services such as storm protection.

When evaluating possible responses to environmental issues such as the one in Sierra Leone, follow these steps:

Step 1 Read all of the background information carefully and make sure that you understand it. Conduct some additional research on the issue if anything is unclear.

Step 2 In some cases, you may need to suggest your own responses to environmental issues. In other cases, you will evaluate responses suggested by others. For example, in the case of Sierra Leone:

- Response 1 – Declare sand mining illegal and arrest those who continue to take sand from beaches.
- Response 2 – Import sand from other places.

Step 3 Develop a set of criteria to evaluate each of the suggested responses. These criteria should consider all sides of the issue, for example economic viability, environmental sustainability and social justice.

Step 4 Create a table to evaluate each response against each criterion. You may like to use symbols such as:

√ – criterion met   % – criterion partly met
× – criterion not met   ? – unsure.

Step 5 Use the data in your table to select the best response to the issue. You may need to reconsider particular aspects of the response (and make modifications), or combine aspects of more than one response, to come up with the best solution.

Step 6 Based on your evaluation, present your final recommendation. Include maps and diagrams to help describe the proposal and the intended benefits.

Apply the skill

1 Follow the steps to develop a sustainable response to beach sand mining in Sierra Leone.

Source 2 Hamilton and Lakka beaches shown on the edge of Freetown's urban sprawl

Check your learning 3.19

Remember and understand

1 Why is beach sand mining a problem?
2 Why doesn't the Sierra Leone government just ban beach sand mining?

Apply and analyse

3 List the effects of illegal sand mining and rank them from the most to least significant in terms of the severity of environmental impact.

Evaluate and create

4 Beach sand mining also occurs in other countries including Liberia, Morocco, India, Jamaica and New Zealand. Research beach sand mining in one of these places and make a list of the underlying reasons for the practice.
5 Using Source 3 on page 129, identify the human factors that are shaping the coastline of Sierra Leone. How do these differ from those shaping the coastline at Old Bar (see pp. 124–5)?

Gulf of Mexico oil spill

The Gulf of Mexico lies between the United States, Mexico and Cuba and contains one of the world's busiest oilfields. There are almost 4000 active oil wells in the Gulf along with a further 27 000 abandoned wells.

In April 2010, the Deepwater Horizon, an active oil well operated by British Petroleum (BP), exploded and sank to the sea floor, 1500 metres below the surface. Oil gushed from the well for three months while BP and American authorities tried desperately to plug the hole. The results were catastrophic. An oil slick covering 1500 square kilometres started moving towards the American coastline. Thousands of sea birds, fish, dolphins and turtles were covered in oil and died. Other animals along the shoreline such as crabs and molluscs were also badly affected. Local industries such as fishing and tourism collapsed, and many people lost their livelihoods.

skill**drill:** Data and information

Analysing environmental accidents using complex maps

In the case of an environmental accident, the impacts of the accident usually have multiple causes. Geographers try to go beyond the obvious cause (the oil well blew up) to explore other factors that have influenced the course and extent of the impacts. These are generally a combination of natural processes and human activities. Complex maps contain more than one set of information. Geographers use complex maps to analyse different features, reveal patterns and explain links between features in a given area. You can analyse a complex map by following these steps.

Step 1   Look carefully at the map and read its title to make sure you understand what is being shown.

Step 2   Examine the map's legend. Complex maps can have more than one part to a legend, and these parts will be represented on the map in different ways. For example, in Source 1 natural environments are shown using a range of colours and towns and cities with a range of symbols.

Step 3   Train your eyes to look for one set of information at a time. For example, look at solid blocks of colour on the map and work out what they tell you.

Step 4   Move to a different set of information by selecting another symbol or block of colour from the legend. Examine the map to identify the symbol or areas of colour.

Step 5   Look for concentrations of the same symbol in areas to see if patterns exist.

Step 6   Note any patterns you can find on the map between different features and locations.

Step 7   Describe the degree to which patterns are connected.

Step 8   Try to suggest reasons for the connection between the two patterns.

Apply the skill

1   Using Source 1, analyse the causes and effects of the Gulf of Mexico oil spill. Once you have completed your analysis, fill in the table below as a way of organising your results. An example has been done for you.

Geographic factor	Possible contributing feature	Description of feature
Physical environment	Shape of the coastline	The Gulf of Mexico is an extensive broad bay which opens to the Atlantic Ocean and Caribbean Sea in the east.
	Features of the seabed	
	Location of coastal marshes	
Natural processes	Ocean currents in the Gulf	
Demographics	Distribution of towns and cities	
	Location of oil refineries and oil rigs	

GULF OF MEXICO: EXTENT OF OIL SPILL FROM DEEPWATER HORIZON, 2010

Source 1

Extend your understanding

In addition to complex maps, geographers use information from a range of additional sources to explain how the impacts of the accident progressed and to look at the longer-term impacts on the environment. Research the Gulf of Mexico oil spill on the Internet before answering the following questions.

1   Can you identify any contributing factors to the accident that are not shown on Source 1 (for example

any economic or technological factors). What was their role in the accident? Add these factors to the table provided.

2   Since 2000 more oil wells have been drilled in much deeper water than in the past. Some experts believe that this was an important factor in this disaster. Why do you think wells are now being drilled in much deeper water?

Contributing factors	Possible contributing feature	Description of feature
Economic factors	Level of development of USA	
	Importance of oil in USA economy	
	Tourism and fishing industries	
Technological factors	Operation of oil refineries and oil rigs	
	Technical failure of oil rig	

Source 2   The fire on the Deepwater Horizon oil platform
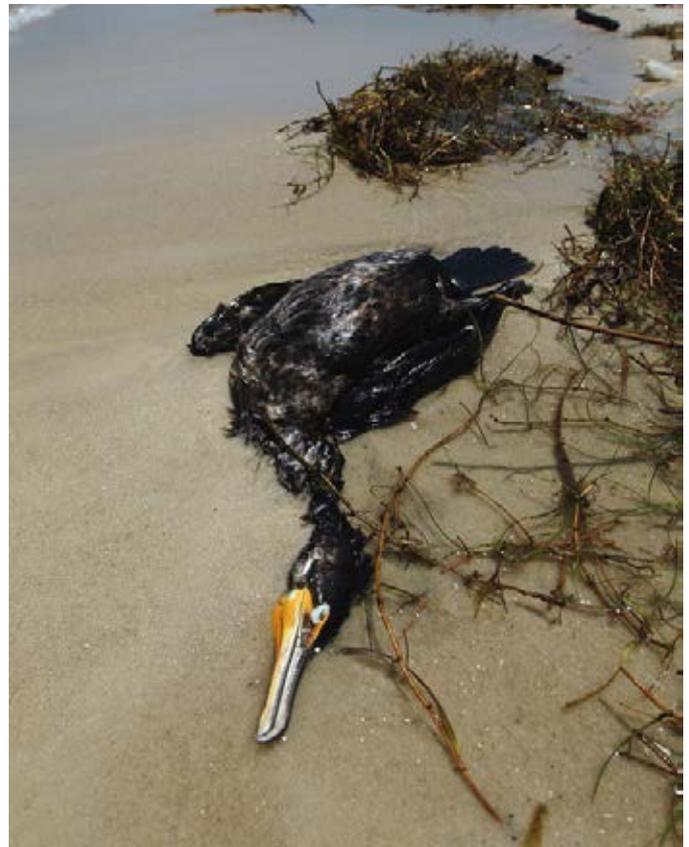
Source 3   Marine animal populations in the Gulf of Mexico were devastated by the oil spill in 2010. In total, around 750 million litres of crude oil was released into the gulf affecting fish, dolphins, whales, sea turtles and birds, as well as molluscs across the sea bed.

3 Sources 4 and 5 show some of the community responses and protests to the Gulf of Mexico oil spill. Shortly after the incident in 2010, civil and criminal charges were brought against BP in the American courts.

Conduct research to answer the following questions:

a What kinds of charges were brought against BP in the aftermath of the Gulf of Mexico oil spill in 2010? Who brought these charges against BP?

b How did BP plead in the case?

c How was the case resolved? How was BP penalised and how much did they have to pay?

d Do you consider this amount to be appropriate? Give reasons for your answer.

Source 4 These signs were erected on the front lawn of a home in Grand Isle, Louisiana, shortly after the Gulf of Mexcio oil spill. Each cross represents something that was affected by the oil spill, including many species of fish and other sea creatures.

Source 5 Activists hold signs during a protest in front of the Hale Boggs Federal Building on the first day of the trial over the Deepwater Horizon oil rig spill on 25 February 2013 in New Orleans, Louisiana.

An unequal world

The city of Sao Paulo in Brazil is home to more than 11 million people. Like many cities around the world today, there are huge differences between the way people in some parts of the city live compared with others. The access they have to food and fresh water, the types of houses in which they live, their levels of education, access to health care and levels of employment vary enormously. Geographers are interested in measuring these variations and exploring the reasons why they exist. Studying the links between all of these factors gives geographers an idea of the level of **wellbeing** in different populations. Wellbeing is an overall measure of the ability of human beings to access the things they need in order to live happy and healthy lives.

In this chapter we will explore some of the reasons why these enormous variations in wellbeing exist in different populations around the world and look at some of the many ways in which geographers measure them.

4A
How does wellbeing vary around the world?

1 Compare the standards of housing that you can see in the Paraisópolis favela with housing standards in the region where you live. What are the similarities and differences?

4B
How does wellbeing vary within countries?

1 What variations in living standards can you identify between those living in the favela and those living in the apartment block?

2 Why do you think these variations exist in such a small area?

Source 1 An apartment building with a pool and tennis court shares a fence with one of Sao Paulo's largest favelas (a shanty town or slum), Paraisópolis (meaning 'Paradise City'), home to about 100 000 people. This scene starkly illustrates the inequalities in wellbeing worldwide.

chapter

4

4.1 Defining wellbeing

Geographers define wellbeing as the ability of people to access the things they need in order to live happy, healthy and contented lives. Whether a person is born in a refugee camp in Tanzania, a megacity in China, a rural town in France or a coastal city in Australia, their basic requirements for life are the same. The primary requirements include fresh water, a secure food supply, shelter, clothing, and safety. Once these primary needs have been met, secondary needs, such as good health, the ability to make a decent living and access to education become important in determining an individual's level of wellbeing.

Source 1 China has one of the world's fastest growing economies. However, as in all countries, wealth is unevenly distributed.

The ability to meet these needs varies a great deal within communities, within countries and between countries. Many people around the world struggle simply to find enough food to eat or enough water to drink every day. Other people lack access to good health care or the ability to send their children to school. These experiences lead to a wide range of variations in human wellbeing. Geographers are interested in describing these variations and exploring possible reasons for them. They are also interested in analysing any strategies introduced to improve wellbeing and offering possible responses to resulting problems.

Three of the most important variables that influence levels of wellbeing around the world today are wealth, health and education.

Wealth

Our access to the basic necessities of life (and other wants we may have) are determined largely by our degree of wealth and our ability to earn a living. Wealth is generated by producing and selling things, earning wages from work, making investments or owning assets. If we have enough wealth, we can use it to access a wide variety of goods and services. If we do not, we may struggle to buy things such as food, medicine and tools that we could use to generate more wealth (see Source 1). There are huge variations in wealth across the globe. It is estimated, for example, that the wealthiest one per cent of adults own 40 per cent of the world's assets and that the three richest people in the world are wealthier than the world's 48 poorest countries combined.

Health

Human health is affected by a wide range of factors. Clean air, clean water and a secure supply of nutritious food are all vital but other factors are also important. These include the ability of a community to treat and control the spread of diseases, provide health care when individuals are sick or injured, care for the vulnerable such as babies and the aged, and provide emergency services in times of crisis. Access to health care is vital during natural disasters such as a drought or man-made disasters such as war, which can limit supply of food and water. People living in war-torn countries often struggle to find the basic requirements needed for a healthy life.

Source 2 People in Singapore enjoy one of the world's best healthcare systems. A baby born in Singapore is 45 times more likely to survive their first year of life than a baby born in Afghanistan.

Source 3 In 2013, about 74 per cent of Indian adults could read and write. This compares with a rate of just 12 per cent in 1947. Despite this dramatic improvement, India is home to the world's largest number of illiterates.

Education

Access to a formal education is viewed by many people as the key to improving wellbeing. Being able to read and write gives people access to a greater number of services and provides a range of options that can lead to better jobs, higher wages and improved standards of living. Education also increases people's self-esteem and allows them to have more control over their future.

In many communities, education is difficult to obtain. In many countries, poverty and conflict are the two major reasons why children do not attend school. Education can be especially difficult for girls to obtain, because in many cultures educating boys is seen as more worthwhile. While parents may work hard to send their sons to school, they prefer to have their daughters helping out at home.

Despite these obstacles, rates of schooling and literacy (the ability to read and write) are increasing around the world. In Sub-Saharan Africa, for example, the enrolment rates of children in primary school rose from 58 per cent in 1999 to 76 per cent in 2010. This means that 43 million more children received a primary education in the region by 2010. In wealthy countries, such as Australia, New Zealand and the United States, education is seen as so valuable that it is made compulsory, free and universal.

Check your learning 4.1

Remember and understand

1   Write your own definition for the term 'human wellbeing'.
2   Why is access to education seen by many as the key to improving wellbeing?

Apply and analyse

3   What are some of the ways in which a person's wellbeing could be measured?
4   Describe the contrasts in wealth shown in Source 1.
5   Why do you think survival rates of babies are so poor in Afghanistan? Make a list of possible reasons. Explain why the survival rates of babies are so much better in Singapore.

Evaluate and create

6   Conduct some research and describe wellbeing in Australia. Use the headings of wealth, health and education to guide your description.
7   Which photograph on these pages best shows what wellbeing means to you? Give some reasons for your answer.

4.2 Different views of wellbeing

The way in which we define wellbeing is dependent on a large number of factors. These include our values, beliefs, history, environment, level of education, language and **culture**. People from different environments and cultures often view wellbeing in vastly different ways. For example, owning your own home might be considered a factor that increases wellbeing, but in many Indigenous Australian communities guardianship of the land is considered more important to wellbeing than individual ownership.

Common indicators of wellbeing

Geographers often rely on a range of **quantitative data** to measure and compare levels of wellbeing around the world. Two of the most common measures used today include **Gross Domestic Product (GDP)** and **literacy rates**. These measures are referred to as universal indicators because, while they are not perfect, the data they provide is easily obtained and allows geographers to make basic international comparisons.

Gross Domestic Product (GDP) provides a measure of the total market value (i.e. the monetary value) of all the goods and services produced in a country in a given year. By dividing the GDP of a country by the total number of people living there, the GDP per capita can be calculated. This gives an approximation of the value of goods and services produced per person in the country each year. This data is then used to assess the average productivity and wealth of individuals.

Another universal indicator used to measure and compare wellbeing around the world is literacy rates. Literacy rates give an indication of the number of people in a population who are able to read and write. Data relating to literacy is often used as a measure of educational results in different countries. In general, low levels of literacy and education can impede the economic development of a country and affect wellbeing.

Although universal indicators like GDP and literacy rates are commonly used by geographers, they do not provide an objective and complete picture of the situation. For example, relying only on GDP to measure wellbeing assumes that feelings of wellbeing in a population are based exclusively on how much money people have. In the same way, using only literacy rates assumes that feelings of wellbeing are linked exclusively to people's level of education. From our own experiences we know that it's just not that simple. These quantitative measures do not take into account the many different attitudes and values of people within a population, nor do they give an indication of how satisfied individuals may feel with their place in society. In order to give a more complete picture, a range of additional data – known as **qualitative data** – needs to be taken into account. Qualitative data about wellbeing is often more difficult and time consuming to collect because it is gathered from surveys and interviews.

Source 1 For Indigenous Australians wellbeing is partly determined by connection to the land.

Over the course of this unit we will be looking more closely at a range of different indicators of wellbeing, including one developed by the United Nations known as the **Human Development Index (HDI)**, which combines a range of different measures into one.

Wellbeing for Indigenous Australians

Many Indigenous Australians have a view of wellbeing based on traditional beliefs of inter-relationships between individuals, their community and the land. Wellbeing is achieved when the relationships between these factors work together in harmony. This is often described as a holistic view of wellbeing. Importantly, ill-health will arise and persist when the harmony of these relationships is disrupted.

It can therefore be difficult to measure the wellbeing of Indigenous Australians using only the common universal indicators. The Australian Bureau of Statistics has recently attempted to develop a model that takes into account Indigenous values when considering wellbeing levels. As well as using measures of health, literacy and wealth, this new model includes wellbeing measures related to an individual's connection to their community, ancestry, cultural traditions and identity, land and spirituality.

Case study: Bhutan and Gross National Happiness (GNH)

> It's easy to mine the land and fish the seas and get rich. Yet we believe you cannot have a prosperous nation in the long run that does not conserve its natural environment or take care of the wellbeing of its people, which is being borne out by what is happening to the outside world.

Thakur Singh Powdyel, Bhutan's Minister of Education

Since 1971, the tiny Himalayan country of Bhutan has rejected GDP as the way to measure the wellbeing of its people and instead adopted a measure known as Gross National Happiness (GNH).

While this might seem like nothing more than a good idea, in Bhutan it is taken very seriously. A GNH measure is taken every year as the country's government attempts to move its citizens towards a happier state. The four guiding principles of GNH are equitable social development, cultural preservation, conservation of the environment and promotion of good governance.

Source 2 Since 1971, Gross National Happiness has replaced Gross Domestic Product as a measure of wellbeing in Bhutan.

Children are taught these principles at school along with better environmental practices and basic agriculture. At school, bells have been replaced with soothing music and there are daily meditation sessions. In a recent study that measured happiness in 178 countries, the Bhutanese ranked as the eighth happiest people on the planet. Bhutan was the only country in the top 20 with a low GDP.

Check your learning 4.2

Remember and understand

1 What is Gross Domestic Product (GDP) an indicator of? Why is it often used as a measure of wellbeing?

Apply and analyse

2 How do you think Gross National Happiness would be measured?

3 Why do you think other countries have not adopted Bhutan's measure of GNH?

Evaluate and create

4 What are some important aspects of your own wellbeing? In what ways are they similar or different to the Bhutanese view of wellbeing?

4.3 Mapping wellbeing

Geographers often use a range of maps to explore the spatial patterns in wellbeing within and between countries. Maps can be used to show variations in wellbeing around the world using specific indicators, such as the Human Development Index (HDI) or levels of poverty. By using a range of different mapping techniques, geographers can easily identify if countries with a high proportion of people living in poverty are clustered together or spread across the globe. They can then use this information to make comparisons and draw conclusions about the level of wellbeing in these places.

Choropleth maps

Choropleth maps give a quick impression of a spatial pattern by using dark and light shades of the same or similar colours. Darker shades usually show 'the most' and lighter shades show 'the least'. In Source 1, for example, countries are shaded according to their Human Development Index (HDI) rating. This measure, developed by the United Nations, combines several indicators into a single measure. The world's countries are ranked using indicators of health (**life expectancy**), education (literacy) and income (Gross Domestic Product). This ranking is then used to place the world's countries into four categories ranging from very high HDI to low HDI. The United Nations uses the same measure each year in its annual *Human Development Report* so that a country's scores, rankings and categories are regularly updated.

WORLD: HUMAN DEVELOPMENT INDEX RATINGS
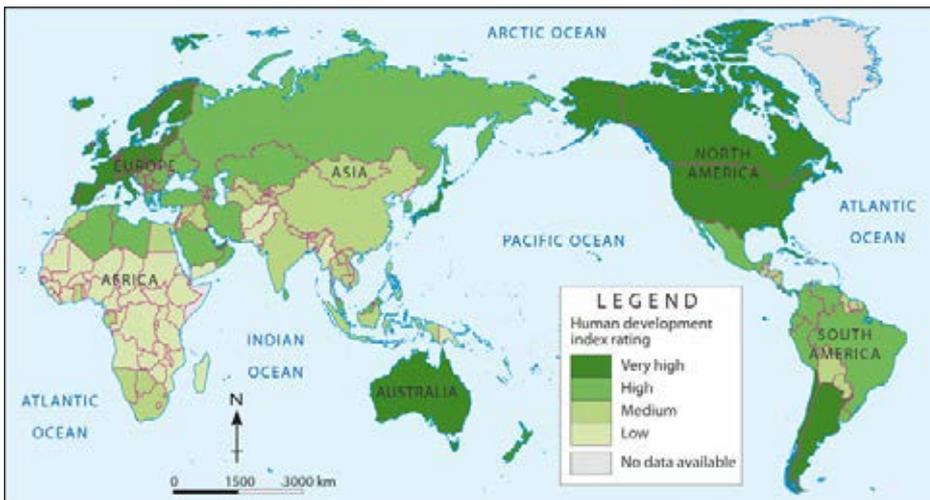
Source 1   Source: Oxford University Press

Cartograms

A **cartogram** is a type of map that displays countries in roughly their correct geographic locations but the size of countries is determined by the variable being mapped. For example, in Source 2, the size of each country is determined by the proportion of the world population that is living in poverty within that country. The larger the country is shown on this map, the greater the number of people living in poverty in that country. The smaller the country is shown on the map, the fewer the number of people living in poverty.

The colours are added to the map to divide the world into geographic regions so that different cartograms can be easily compared.

WORLD: PROPORTION OF POPULATION LIVING IN POVERTY
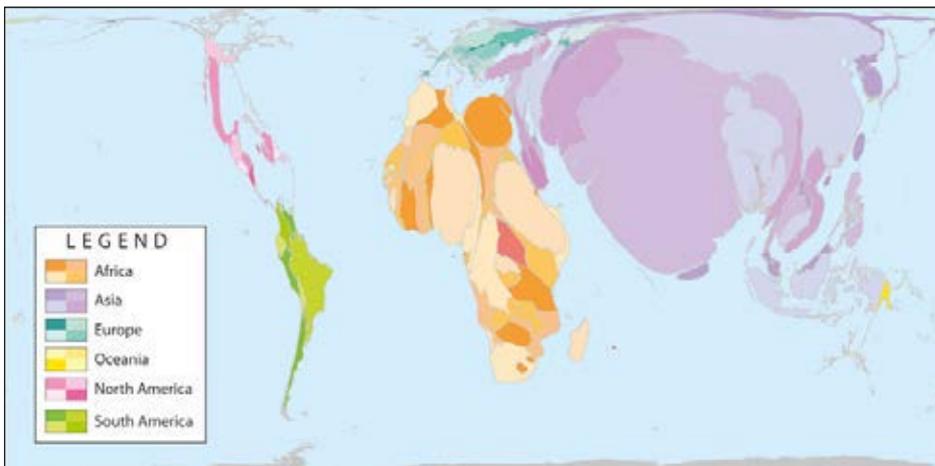
Source 2   Source: Oxford University Press
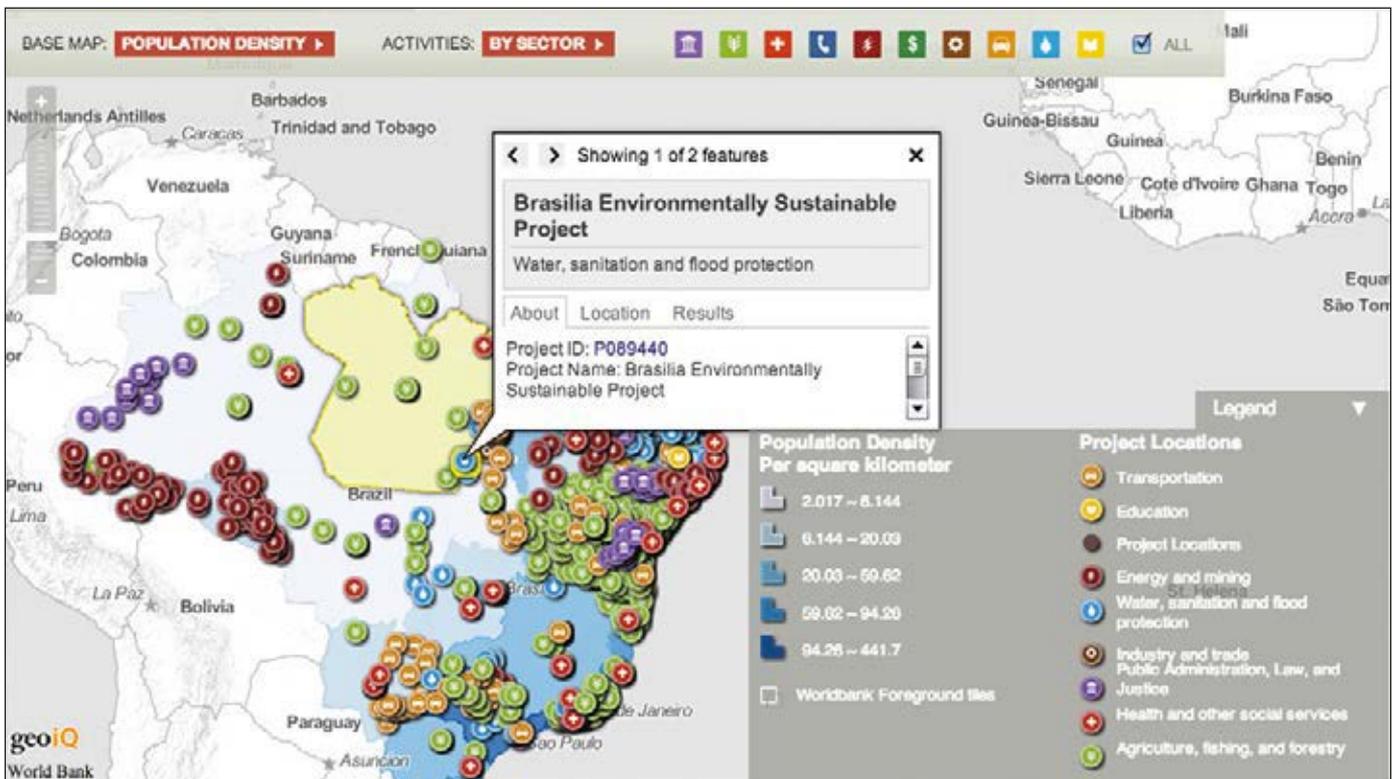
Source 3 Screenshot of a World Bank GIS map showing a range of projects currently being undertaken to improve sustainability and wellbeing in Brazil

GIS maps

Geographic Information System (GIS) maps display data as a series of layers of digital information. Each layer of the map focuses on a different aspect of the environment, such as poverty, population, roads, settlements or land relief. When using a GIS program, geographers can switch layers on and off, allowing them to compare different aspects of the environment and look for interconnections between them. International organisations such as the World Bank are increasingly using GIS technology to map their activities and projects.

Check your learning 4.3

Remember and understand

1 What is the HDI and what is it used for?
2 What is a cartogram?

Apply and analyse

3 Do you think cartograms or choropleth maps are more useful for investigating variations in patterns of wellbeing? Give some reasons for your answer.
4 Describe the patterns of World Bank sponsored projects that you notice in Brazil on the GIS map.

Evaluate and create

5 Use the 'World statistics' section in your obook to complete this task.

a In groups of three, each research a different indicator of wellbeing in South America: GDP, literacy rates or life expectancy.

b With your data, each create a choropleth map for the countries of South America. Use the same colours or shades for all the maps.

c Place the maps on the classroom wall beside each other so that you can easily compare them. What similarities do you notice? What are some of the key differences?

4.4 Exploring links between wellbeing

Aspects of wellbeing such as health, wealth and education are usually closely related. A change in one aspect of a person's wellbeing usually affects other aspects of their wellbeing. For example, children who attend school tend to have better health than those who do not. Links such as these can be seen at the national scale as well as at the local scale. One of the most useful tools when exploring these links is a special type of graph known as a **scatter plot**.

Scatter plots

Scatter plots are similar to line graphs in that they are used to display data plotted against two variables. Scatter plots are used by geographers to show the degree to which one of the variables shown on the graph is related to the other. This relationship is known as the **correlation**. Commonly, scatter graphs show data for a number of countries, each of which is represented by a dot on the graph. When the dots come close to forming a straight line, they are closely related and therefore are said to have a high correlation. When the dots do not come close to forming a straight line, they are not closely related and

Source 2 This scatter plot taken from the Gapminder website is exploring the correlation between life expectancy and fertility rates (children per woman) worldwide.

therefore are said to have a low correlation (see Source 1). When the trend is increasing, the correlation is positive. When the trend is decreasing, the correlation is negative. A trend line is often added to a scatter plot to demonstrate the strength of the relationship between the two variables.

Source 1 shows a selection of the most common trends that can be represented on a scatter plot. With the introduction of digital graphing tools it has been possible to add more data to make scatter plots even more useful. Three variables can now be graphed to create a three-dimensional scatter plot. By animating graphs it is also possible to show changes in variables and their correlation over time. In Source 2 the size of each dot is determined by the size of the population of the country. The graph is able to show life expectancy in each country as well as **fertility rates**.
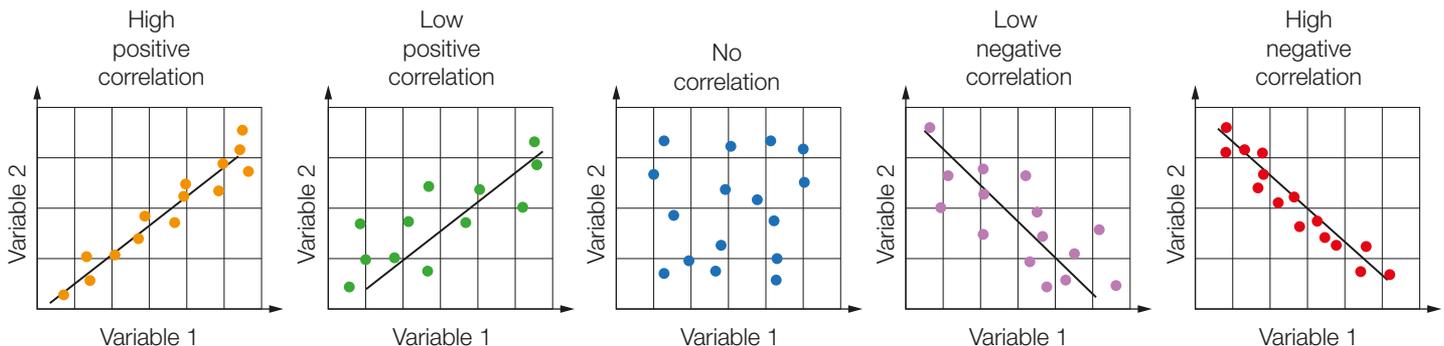
Source 1   Simple scatter plots showing different types of correlation

skill**drill:** Data and information

Constructing scatter plots using Microsoft Excel

You can use a computer program such as Microsoft Excel to construct a scatter plot and show the correlation between two variables. Note: These instructions may vary a little depending on the version of the program you are using.

Step 1 Enter the data into an Excel spreadsheet. The first indicator goes into column A and the second into column B. The data for each country must go into a separate box, known as a cell, on the spreadsheet.

Step 2 Highlight all of the cells containing data.

Step 3 Using the menu at the top of the spreadsheet select insert→scatter→the first scatter plot. This will convert your data into a scatter plot.

Step 4 The vertical axis usually defaults to begin at zero but the correlation is often easier to see if it begins slightly less than the lowest value being graphed. Look at your graph and decide what you would like as the lowest value on the vertical axis. Use layout→axes→primary vertical axis→more primary vertical axis options→change minimum auto to minimum fixed and enter the value you have decided on. Close the menu.

Step 5 Right click on one of the dots on the graph and select add trendline→linear.

Step 6 Use the chart tools menu 'layout' to turn off the gridlines and the legend. Add a title and label the axes.

Apply the skill

1 Use the 'World statistics' section in your obook to find the life expectancy and GDP rates for all the countries of Oceania. With this data construct a scatter plot exploring the links between life expectancy and GDP per person for the countries of Oceania.

Source 3 A scatter plot showing the correlation between life expectancy and GDP per person for South America countries

Check your learning 4.4

Remember and understand

1 What is the purpose of scatter plots?

2 What does the word 'correlation' mean?

Apply and analyse

3 Describe the relationship between life expectancy and children per woman as shown in Source 2. Describe what this means in your own words.

4 Describe the relationship between life expectancy and GDP per person as shown in Source 3. Why do you think this correlation exists?

a Scatter plots often contain one or two countries that do not conform to the general pattern and sit apart from most other countries on the graph. These are called outliers. How many outliers can you identify in Source 2?

b Why do you think these countries do not conform to the general pattern?

Evaluate and create

5 Visit the Gapminder website (www.gapminder.org) and download Gapminder World. Click the play button to see how countries have changed over time. Explore the graphs on this website by selecting different indicators for each axis and watching the ways in which their correlation changes.

4.5 Contrasts in wealth

By any measure, the world's wealth is unevenly distributed (see Source 2). The richest one per cent of the world's population has approximately the same amount of income as the poorest 56 per cent of the world's population (3.5 billion people). All 10 of the world's poorest countries are in Africa.

Measuring wealth: Gross Domestic Product (GDP)

A country's Gross Domestic Product (GDP) is one way to measure wealth. This is done by calculating the size of its economy by adding the total value of all goods and services produced during a year. To make meaningful comparisons between countries, the total GDP is divided by the size of the population to produce a measure known as GDP per capita. Source 1 shows the GDP of countries worldwide, together with a listing of the world's 10 richest countries and the world's 10 poorest countries.

In 2012, the GDP per capita of Qatar, the world's richest country, was $103 900 and the GDP per capita of the Democratic Republic of the Congo, the world's poorest country, was $272. Australia's GDP was $42 000. (All these figures are given in US dollars.)

	World population	World income (%)
Richest 20%		81.2
Second 20%		9.4
Third 20%		5.6
Fourth 20%		2.4
Poorest 20%		1.4

People living on less than $1.25 a day (22%)

People living on less than $2 a day (40%)
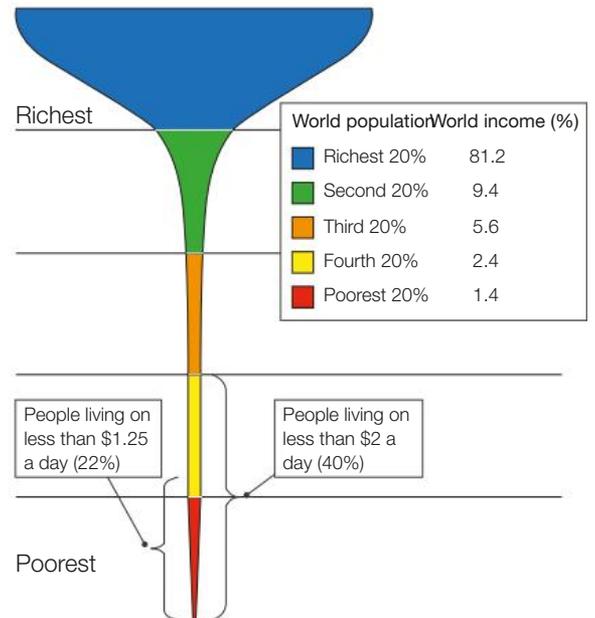
Source 2 A graph of the world's wealth distribution, 2011, known as the 'champagne glass distribution' because of its shape

WORLD: GROSS DOMESTIC PRODUCT SHOWING RICHEST AND POOREST

LEGEND
Gross Domestic Product per capita (US$)
- Over 25 000
- 10 000 to 25 000
- 5000 to 10 000
- 2000 to 5000
- 1000 to 2000
- Under 1000
- No data available
- Qatar Richest countries
- Niger Poorest countries
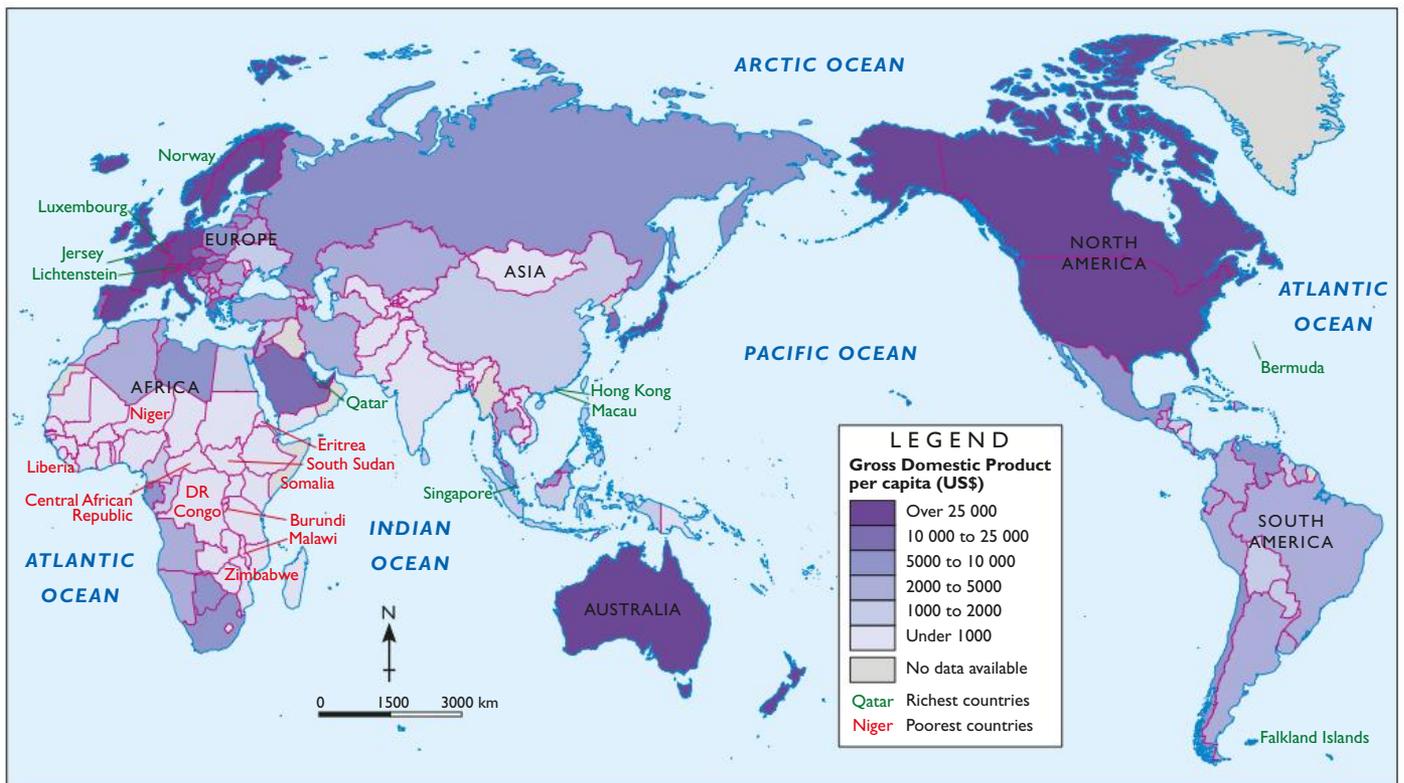
Source 1

Source: Oxford University Press

Source 3
Indian and Nepalese window-washers abseil down a skyscraper in Doha, the capital city of Qatar.

Case study: levels of wealth in Qatar

As mentioned, the residents of Qatar are, on average, the wealthiest people on Earth. Its two million people earn an average of US$103 900 each year (compared with the global average of US$12 500). Qatar is a tiny country (slightly smaller than the Sydney metropolitan area) with vast reserves of oil and gas. The wealth generated from developing and exporting these resources has been used to increase the state of wellbeing for many Qatari residents. The country boasts one of the world's best healthcare systems, while water, gas, electricity and even food are partially paid for by the state. The employment opportunities in Qatar attract many migrants from other Middle Eastern countries as well as from South and South-East Asia, particularly India, Nepal and the Philippines. More than half of the population is made up of foreign workers (the highest migration rate in the world).

Check your learning 4.5

Remember and understand

1 Where are the world's ten poorest countries?
2 Examine Source 3. Why do you think these men have travelled from Nepal to Doha to do this work?

Apply and analyse

3 When GDP per capita is calculated, small countries with a low population are often at an advantage over countries with large populations. Explain why this is the case.
4 Examine Source 1. In a carefully worded paragraph, describe the global distribution of wealth using the PQE method. For more information on the PQE method, refer to page 28 of 'The geography toolkit'. Refer to specific regions and countries in your description.

5 Describe the pattern of wealth distribution as shown in Source 1.

Evaluate and create

6 Conduct some extra research on the Internet to complete the following task.
   a Brainstorm the factors that might help to explain why global wealth is so unevenly distributed. Why are people in some countries such as Qatar, the USA and Australia wealthy while people in other places are not?
   b Try to think of as many reasons as you can and then classify them into groups of factors. Decide on headings for these groups.

4.6 Living in poverty

In 2000, the United Nations set several wellbeing targets that they aimed to meet by 2015. These targets became known as the Millennium Development Goals. The first of these was to eradicate extreme hunger and poverty by halving the proportion of people living on less than US$1.25 a day (known as the 'poverty line'). The 'poverty line' is the estimated minimum income needed per day in a particular country to secure the necessities of life. The target was met five years early, due largely to the economic development of countries with large populations such as Brazil, China and India. This meant that a lot fewer people were living in extreme poverty than in the past. This, of course, is great news but this improvement in wellbeing was not felt in all of the world's countries.

In the countries of Africa that lie south of the Sahara Desert (a region known as Sub-Saharan Africa), almost half of the population lives on less than US$1.25 a day. While this proportion has decreased over the last few decades, it still leaves 420 million people living in absolute poverty. Almost 60 million of these live in the Democratic Republic of the Congo (DRC), the world's poorest country.

Case study: wellbeing in the Democratic Republic of the Congo

Source 1 Gold mining in the DRC is hard, back-breaking work with little hope of personal gain. For many people in rural areas, however, it provides one of the only opportunities for on-going work. Up to 150 000 mines dot the landscape in the Ituri district of the Orientale province. Gold is seen by many as a road to wealth and worth fighting for. This has resulted in armed conflict in the Ituri district. It is also taking workers away from farming, leaving the country without enough food to feed its people.

Source 2 The capital of the DRC is Kinshasa. Kinshasa's population is expected to top 10 million within the next year or so when the city will become the world's newest megacity. Migrants from rural areas and a high birth rate have swelled the number of people in the city. Many of the city's residents live in slums such as this one in the city's east.
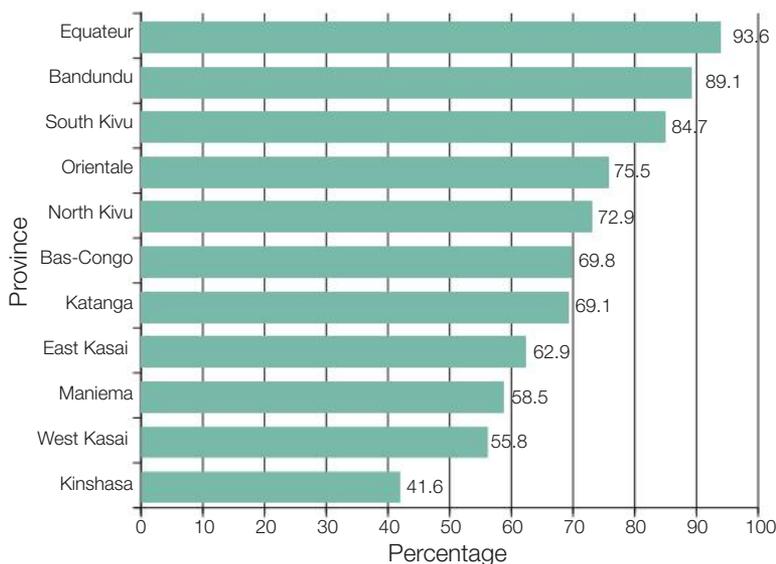
Source 3 The percentage of the population of the Democratic Republic of the Congo living in poverty, by province, 2005.

Province	Percentage
Equateur	93.6
Bandundu	89.1
South Kivu	84.7
Orientale	75.5
North Kivu	72.9
Bas-Congo	69.8
Katanga	69.1
East Kasai	62.9
Maniema	58.5
West Kasai	55.8
Kinshasa	41.6

DEMOCRATIC REPUBLIC OF THE CONGO

LEGEND

Forest	
Woody savannah	
Open savannah	
Ongoing conflict or civil war	

○	Coal	★	Lead
■	Coltan	▲	Manganese
★	Copper	★	Oil
▲	Diamonds	★	Tin
●	Gold	⬡	Uranium

Towns with more than 250 000 people

7 000 000

1 000 000
500 000
250 000

Kinshasa

○**Kamina** 100 000 to 250 000 people
○Kipushi 50 000 to 100 000 people
○Kaniama 20 000 to 50 000 people

—— Country border
- - - Province border

0   150   300 km

Source 4

Source: Oxford University Press

Check your learning 4.6

Remember and understand

1 What is meant by the term 'poverty line'?

2 What are the Millennium Development Goals?

Apply and analyse

3 Use Sources 3 and 4 to examine and describe the relationships in the DRC between:

a conflict and poverty

b mineral deposits and poverty

c city living and poverty.

4 Access the indicators of wealth for Qatar and the DRC in the 'World statistics' section in your obook. Use these to write five statements comparing the wealth of the people living in these countries.

Evaluate and create

5 Trace an outline map of the DRC including the province borders. Use the data in Source 4 to construct a choropleth map of poverty in each province.

6 Describe the pattern of poverty within the DRC using the PQE method. Use the names of specific places in your description.

4.7 Contrasts in health

In some countries, people struggle to obtain the most basic health care services and doctors work in hospitals that are old and poorly equipped. In other countries, hospitals have state-of-the-art facilities and access to the newest treatments and drugs. While it is easy to see how unevenly distributed health services are worldwide, the level of health and its contribution to the wellbeing of a community or country is a complex concept. There are many other variables that can affect the health of people, including diet and other lifestyle factors.

For these reasons, geographers rely on indicators of health such as life expectancy and the infant mortality rates to measure and compare the health of individuals within countries. Other indicators such as the number of doctors per 1000 people and access to reliable water can also be used to examine the reasons why health differs between countries.

Thirst and hunger

The greatest threat to good health in the world today is hunger. The simplest way to improve the health of people around the world is to provide them all with enough clean water to drink and enough food to eat. One in eight people worldwide are undernourished, making them more susceptible to disease, less productive in their work and more likely to die young. Hunger is often the result of a range of factors including conflict, natural disaster, poverty and environmental degradation.

Dirty water causes health problems as well, including diarrhoea, and carries diseases such as cholera and typhoid. Around 780 million people around the world do not have access to clean water, and 345 million of these live in Africa. The importance of clean water cannot be under-estimated. More than 3.4 million people die each year from diseases caused by dirty water or a lack of sanitation, including thousands of children every day.

Life expectancy

Life expectancy is the average number of years that a person can expect to live. For people in developing

WORLD: HUNGER LEVELS 2012
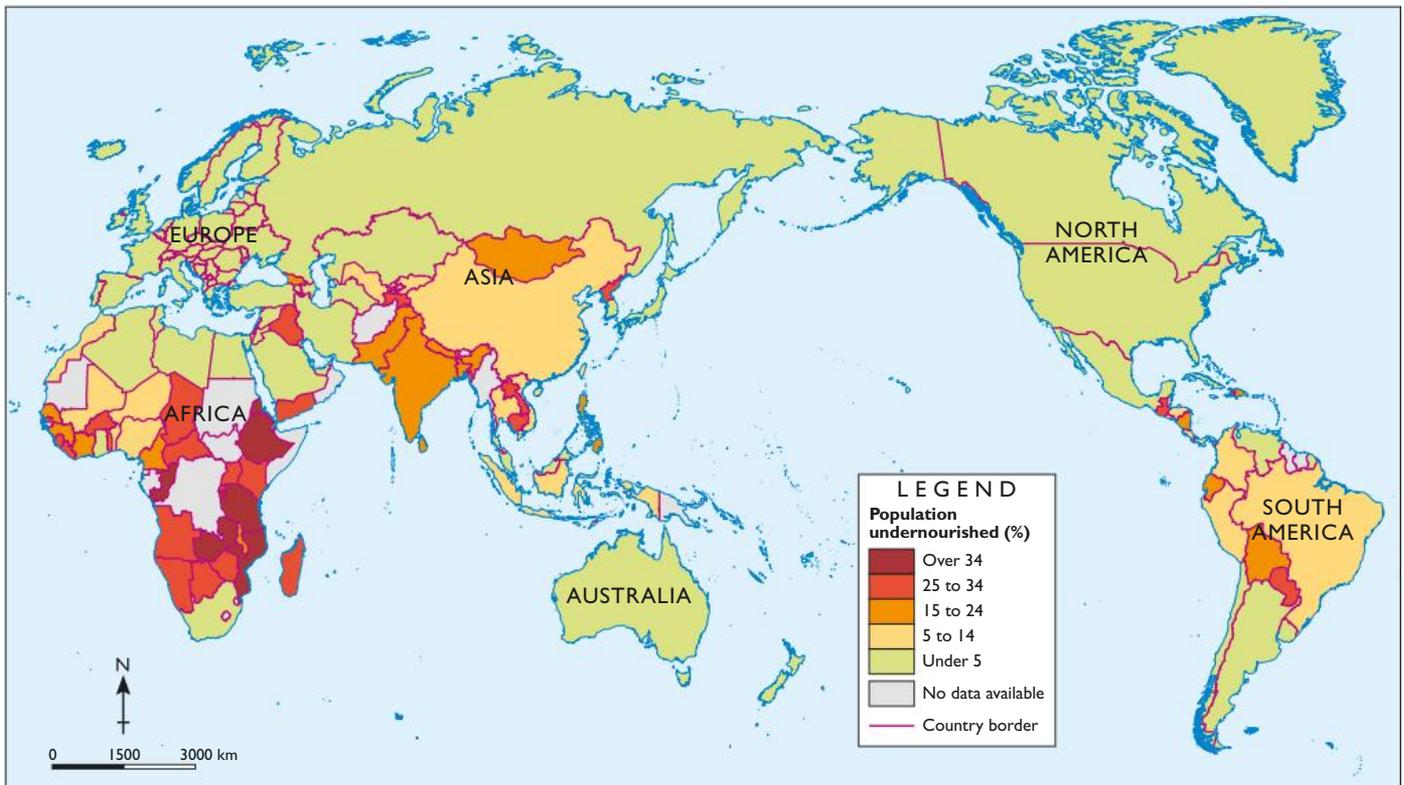
Source 1

countries, life expectancy is generally shorter than for people in developed countries. A child born in Sub-Saharan Africa in 2013, for example, can expect to live for 55 years, while a child born on the same day in the USA can expect to live for 79 years – 24 years longer. The lower life expectancy in Sub-Saharan Africa is due to a wide range of factors including the presence of diseases such as malaria and HIV AIDS, poor water and **food security** and poor access to health care. Source 3 clearly shows the relationship between the wealth of a country and the life expectancy of its citizens.

Infant mortality

In the same way that life expectancy varies greatly between the developing and the developed world, **infant mortality** rates (the proportion of children who die in their first year) are also strikingly different (see Source 3). A child born today in Sub-Saharan Africa is 12 times more likely to die in their first year of life than a child born in the USA.

Studies of infant mortality in developing countries have discovered some specific factors that put children at higher levels of risk. Children and their mothers are much more vulnerable in rural areas than in cities. Women in cities tend to give birth in hospitals and health clinics, while women in rural areas often give birth at home without a nurse or doctor present. Children born to educated mothers, even those with only a primary school level of education, also have a higher survival rate. In some regions survival rates can be up to three times greater than for children of uneducated mothers.

Number of deaths in children under 5 years (per 1000 children) — **Life expectancy at birth (years)**

Source 3 The links between a country's wealth, child deaths and life expectancy

Source 2 Mali, a country in West Africa, has one of the highest infant mortality rates in the world. Vaccinations against disease and more clinics for mothers and children are seen as crucial steps in lowering this rate.

Check your learning 4.7

Remember and understand

1 In your own words, explain the links between poverty and indicators of health like life expectancy and infant mortality.

2 What are some of the effects of hunger?

Apply and analyse

3 Examine Source 1.
   a In which regions of the world are more than 95 per cent of the population well nourished?
   b In which regions of the world are more than 25 per cent undernourished?
   c Compare this map with other world maps in this chapter. What links can you find between hunger and other factors such as Gross Domestic Product (Source 1 on page 148) and literacy rates?

4 Using the 'World statistics' section in your obook, compare the life expectancies of people born in two different regions of the world – one developed and one developing. Compare average life expectancy in these regions with infant mortality. What pattern do you notice when comparing these two figures?

Evaluate and create

5 Use information from your own research on the Internet to complete the following task.
   a One of the Millennium Development Goals is to reduce the infant mortality rate by two-thirds between 1990 and 2015. By 2010, it had fallen by one-third. Research how this was achieved and suggest changes that could be made to reach the goal by 2015.

4.8 The Sub-Saharan HIV epidemic

One of the most serious health challenges facing individuals and communities in developing countries is the spread of the Human Immunodeficiency Virus (HIV) which can lead to Acquired Immunodeficiency Syndrome (AIDS). HIV is a virus that attacks the body's immune system and makes people highly susceptible to infections. As the body is unable to fight these infections, common illnesses become life-threatening. About 34 million people are living with HIV worldwide. Sixty-nine per cent of these people are in Sub-Saharan Africa where almost one in 20 adults has the virus (see Source 2).

HIV is a contagious disease spread through contact with blood, most commonly through poor health practices such as sharing intravenous needles and having unprotected sex. Tragically, unborn children can contract the virus from their mothers and newborns can contract it through breastfeeding. Over 300000 children per year become infected with HIV from their mothers. Treating pregnant women who are HIV positive with suitable medicines is seen as the frontline in the battle to reduce and eventually eliminate HIV.

The impacts of HIV/AIDS

The spread of HIV among populations in Africa is having devastating impacts on communities. These include:

- impacts on population – the loss of life among age groups that would usually be at their most productive; lower life expectancy across the population as a whole; and the slowing of population growth.
- impacts on families and households – the loss of income and cost of caring for infected family members has increased poverty levels; families face discrimination and social stigma; loss of parents has left increasing numbers of orphans and single-parent families or resulted in an increased burden on extended family.
- impacts on food security – the loss of workers on farms has affected productivity leading to reduced farm output and subsequent food shortages.

Source 1　Mourning her eighth child to die from HIV-related illnesses, an 80-year-old Uganda woman is left to care for her surviving three grandchildren.

AFRICA: ADULTS LIVING WITH HIV

LEGEND

Percentage of adults aged 15–49 living with HIV

- Over 20
- 10 to 20
- 5 to 10
- 2 to 5
- Under 2
- No data available

1.2m Number of people with HIV in countries with more than 1 million infected
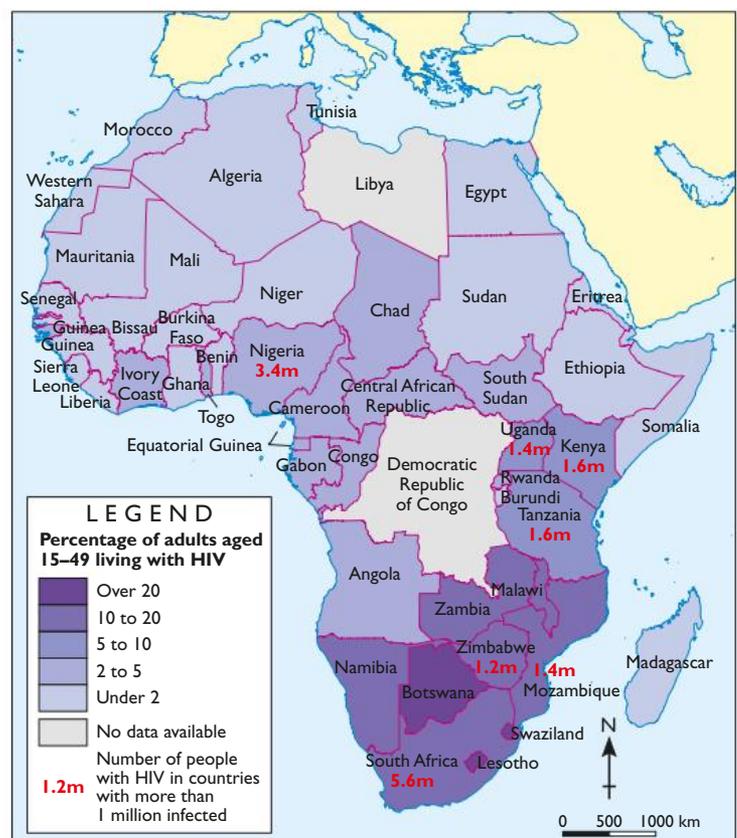
Source 2

- impacts on health care – greater demands placed on healthcare systems, with increased strains on doctors, nurses, hospitals and pharmacies often in areas already under stress; the death of healthcare workers; funds needed to treat other diseases are being diverted to treat HIV patients.
- impacts on education – the death of teachers; fall in attendance by children caring for ill parents or replacing them in the workforce; loss of income makes it harder to pay school fees.
- impacts on the economy – the strain on the national economy from increased health costs and a fall in GDP increases income inequalities and poverty; loss of 'human capital' such as skilled and educated young people.

HIV health programs

The United Nations has embarked on an ambitious program to reduce and even eliminate HIV/AIDS. The program is called 'Getting to Zero' and lists as its main targets zero new HIV infections, zero discrimination against those with the virus and zero AIDS-related deaths. There are a large number of projects that have proven effective in reducing HIV, in particular the use of new drugs (known as antiretroviral therapy) for those with the infection. For those without the infection, education programs aimed at preventing future infections have been very effective.

In recent years, the number of people who have been newly infected with the virus has fallen. In Sub-Saharan Africa, for example, new infections fell from a peak of 2.4 million in 2001 to 1.8 million in 2011. Along with this decline has come a fall in the number of people dying from HIV-related illnesses. This is largely due to the greater availability of medicines for low- and middle-income households, particularly in developing countries (see Source 3). Studies show that successful treatment of the virus is often followed by improved economic conditions in these countries.
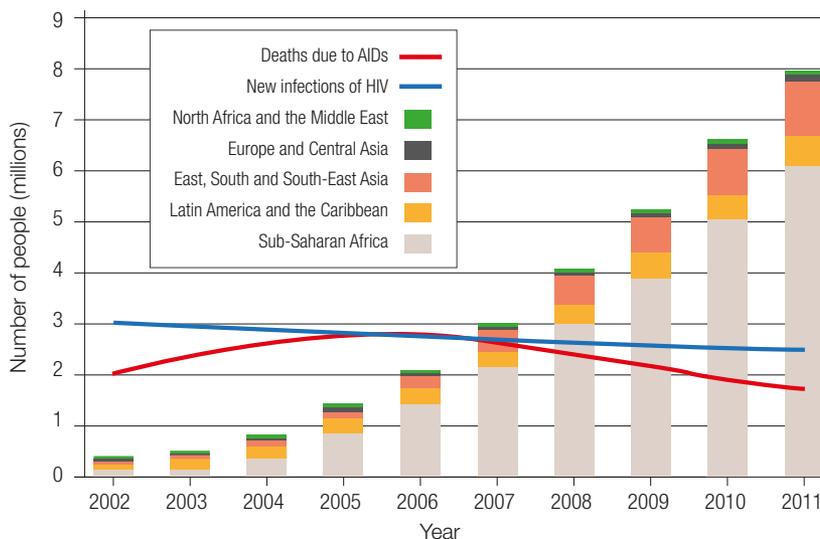
Source 3 Number of people receiving HIV therapy in low- and middle-wealth regions of the world, 2002–2011

Check your learning 4.8

Remember and understand

1 What is HIV?

2 Examine Source 1. Describe what has happened to her family. What do you think she is feeling? How do you feel about her situation?

Apply and analyse

3 Examine Source 3.
  a Describe the general trend in the treatment of HIV on a global scale.
  b In which regions of the world has the number of people receiving treatment grown most quickly?
  c What do you see as some of the barriers to infected people receiving treatment? How could these barriers be overcome?
  d Describe and account for the trend in AIDS deaths in these regions since 2002.

4 Examine Source 2.
  a Which country in Africa has the greatest percentage of adults living with HIV?
  b Which country has the greatest number of people living with HIV?
  c Describe the general pattern of infection as shown on the map.

Evaluate and create

5 Classify the effects of HIV into impacts on individuals, impacts on communities and impacts on nations.

6 Select an African country with high rates of HIV infection as shown in Source 2.
  a Refer to the 'World statistics' section in your obook for more information on this country. Use this data to describe other indicators of wellbeing there.
  b Use your research skills to investigate the health situation in this country. In your research, focus on rates of HIV infection and find out if they are increasing or decreasing.

4.9 Contrasts in education

Education provides much more than the opportunity to read, write and count. It is seen by many international aid agencies and experts in the field as the key to helping people, communities and nations lift themselves out of poverty. Education provides individuals with opportunities to become more engaged with society, to have a range of skills and tools to better care for themselves and their children, to participate in the workforce and improve their country's economy, to live healthier lives, to combat poverty and to reduce inequalities in wellbeing.

Literacy rates

Literacy rates measure the percentage of adults who can read and write and are often used as an indicator of education levels within countries. Literacy rates can be difficult to calculate, however, as many countries do not keep accurate data. It is also important to be aware of potential variations in literacy within countries. In many countries, for example, people in rural areas have lower literacy levels than city dwellers. In other countries, girls are not given the same educational opportunities as boys.

Source 1 Between 1999 and 2010, the percentage of Sub-Saharan African children attending school rose from 58 per cent to 76 per cent. Despite this remarkable improvement, 33 million children receive no schooling.

WORLD: LITERACY RATES

LEGEND

Literacy rate (percentage of population)

- Over 95.0
- 85.0 to 95.0
- 75.0 to 84.9
- 60.0 to 74.9
- 40.0 to 59.9
- Under 40.0
- No data available
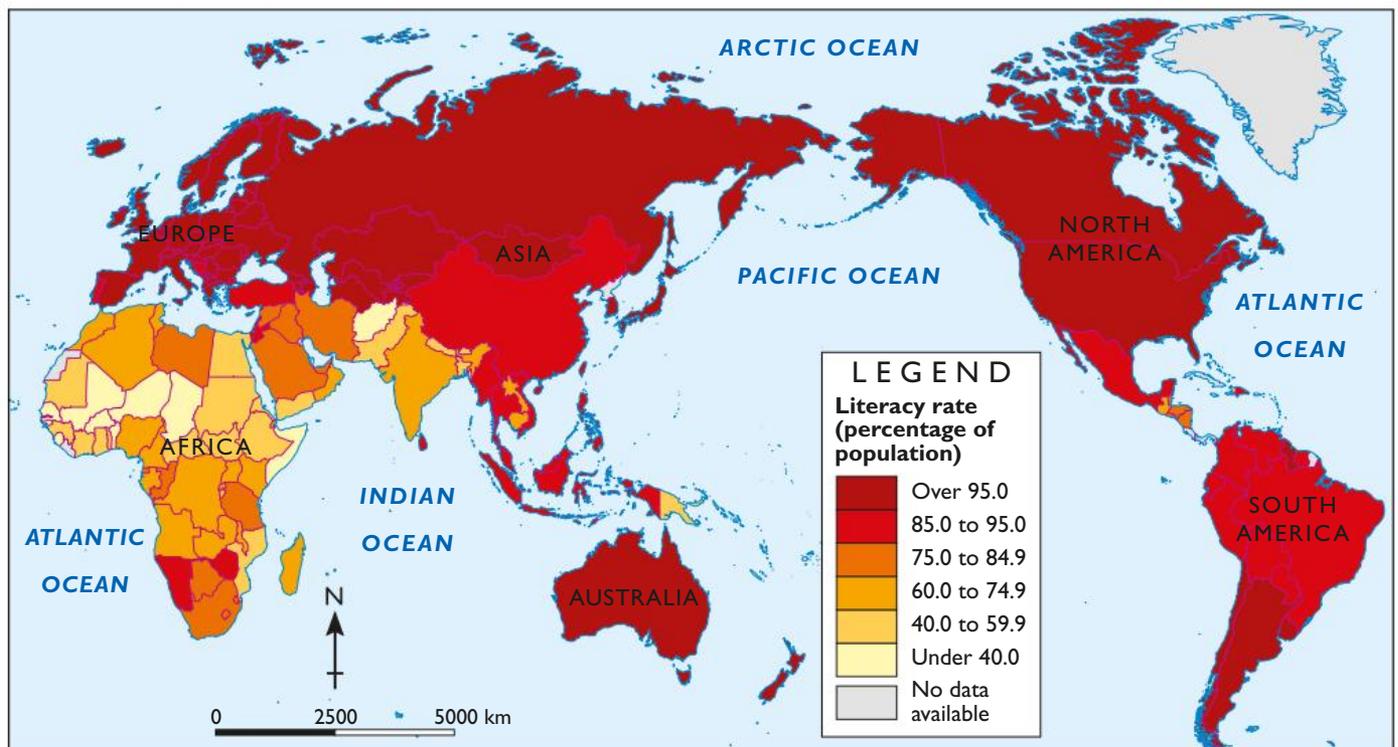
Source 2

Source: Oxford University Press
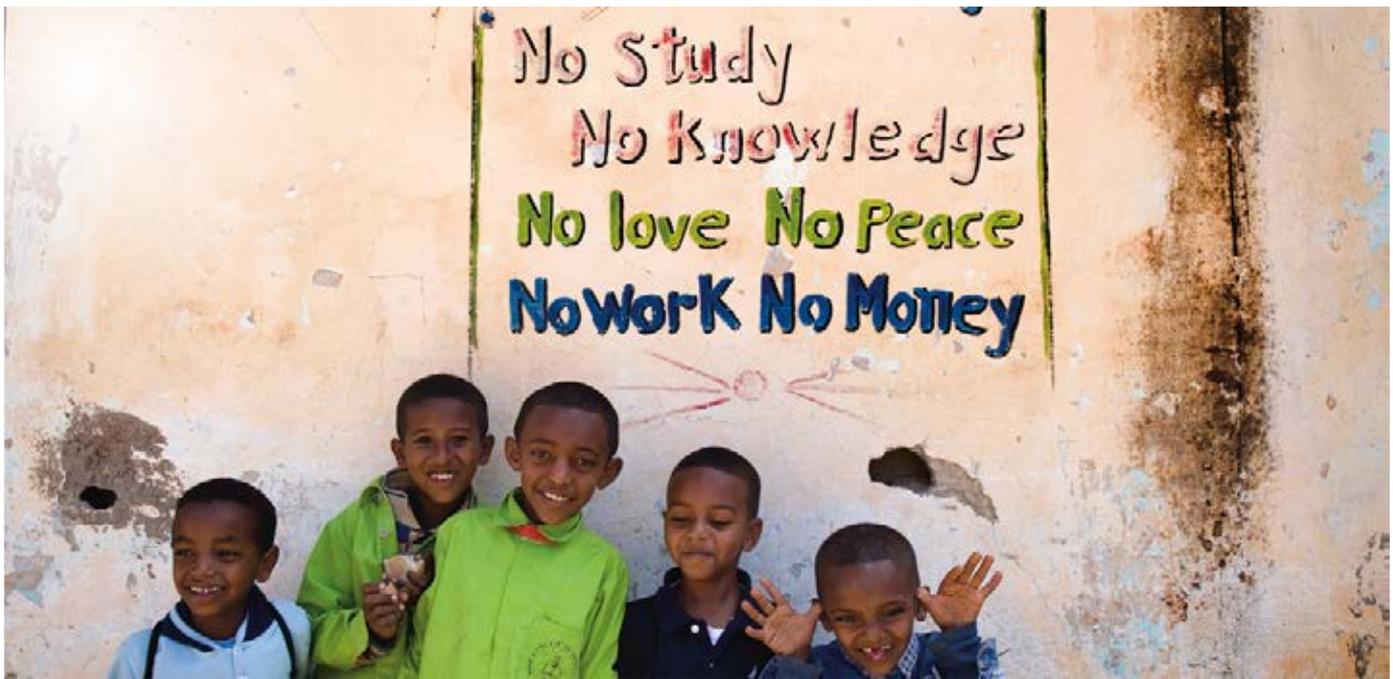
Source 3 Eritrea has one of the world's lowest primary school enrolment rates. This is due to a number of factors, including school fees, poor infrastructure and the role of many children as workers on subsistence farms.

Barriers to successful education

Access to education varies widely across the globe. In developed countries such as Australia, Britain, Germany and France, about 99 per cent of all school-aged children are enrolled in schools. In developing countries such as Mali, Ethiopia and Niger, it is only 90 per cent. While the enrolment rate has improved markedly over the last two decades, a 90 per cent participation rate means that 61 million children of primary school age are not receiving an education. More than half of these children are in Sub-Saharan Africa. A further one-fifth are in South Asia.

There are many factors that determine whether or not a child will attend school. These include:

- system barriers – such as a lack of trained teachers, classrooms and educational materials including books
- attendance barriers – such as school fees, distance to school, poor transport networks and the concern of many parents about the safety of their children. Many children also work to help support their families.
- social barriers – such as variations in language, religion and conflict within countries. Conflict is one of the greatest barriers with children in war-torn nations such as Somalia and Syria much less likely to attend school.

Check your learning 4.9

Remember and understand

1   Why do you think Sub-Saharan African children are less likely to attend school than children in other regions of the world?

2   List three social barriers that may determine whether or not a child attends school.

Apply and analyse

3   Examine Source 3. Who do you think has painted this sign on the school wall? What is the purpose of this sign?

4   Compare Source 2, the world map of literacy levels, with Source 1 on page 148, the world map of Gross Domestic Product. Comment on the relationships you see between these two indicators.

5   What is the literacy rate in Eritrea (refer to the 'World statistics' section in your obook)? Compare this with the literacy rate in Australia. Suggest reasons to account for the differences in literacy between these two countries.

Evaluate and create

6   Which of the barriers to education discussed here do you think would be the most difficult to overcome? Give some reasons for your answer.

7   In a small team, develop some strategies to help communities overcome one or more of the barriers to education. Share your strategies with the class.

Global obesity epidemic

As you have learnt, many people around the globe face chronic food shortages and hunger. However, one of the fastest growing public health crises in many countries is obesity. Once only a problem in **developed countries**, obesity has now spread to **developing nations** such as Mexico, China, India and Brazil. The World Health Organization (WHO) estimates that more than 1.4 billion people in these countries are overweight and 500 million of these are obese.

Excessive body weight and obesity are linked to health problems such as heart disease, stroke, arthritis, diabetes and some cancers. Obesity is a leading cause of premature death in many countries and a huge burden on public health resources. It has become such a serious issue that many experts now describe it as the global obesity epidemic.

Source 1 'Global threat waiting area'

Developing geographical questions from media reports

Much of our understanding about events and trends happening around the world comes to us through media reports. These reports can take the form of printed media such as newspapers and magazines, electronic media such as television and radio reports, or new media such as the Internet and mobile phones. News has never been more accessible and plentiful than it is right now. By learning a few simple techniques you can use the news to generate geographical questions to guide your inquiries.

Step 1 Check the source of the news article for reliability and possible bias. Find out who wrote the article and the news organisation that published it. Mainstream media organisations are generally more reliable than smaller ones but this may not always be the case. If possible, use the news company website to investigate possible bias.

Step 2 Work out what type of report you are watching, reading or hearing. Is the information presented being reported as fact or is it an opinion piece? Both are valuable but it is important to know the difference.

Step 3 What is the reporter's main contention or key point? State this in your own words.

Step 4 What information and arguments are used to support the reporter's contention?

Step 5 What evidence does the reporter use to support these arguments? What is the source of this evidence?

Step 6 Look closely at any images or graphics that are included in the report. How do they help to support the reporter's contention and arguments?

Step 7 What further questions does this article raise for you? Good geographical questions open up new lines of inquiry for you to explore. Try using question starters such as 'How many', 'Where does', 'Why does', 'Who is affected', 'What changes does' and 'How should people'.

Apply the skill

1 Use the steps provided to analyse and develop questions about Source 2, 'Obesity epidemic spreads to developing world'.

2 Share your geographical questions with your classmates and build up a class list of questions.

Source 2 Media report 'Obesity epidemic spreads to developing world' from ABC News, 24 July 2012

Obesity epidemic spreads to developing world

The world is getting very fat, very fast and now the obesity epidemic has spread from rich countries to poor and developing countries. It is likely 1 billion people will be obese by 2030.

Fat is being called the new tobacco.

Body weight is not just about vanity, it is about life and death, with obesity increasing the risk of heart disease, type-2 diabetes and some forms of cancer.

So how and why did the problem of obesity explode in places that, not so long ago, counted malnutrition and even famine as major health concerns?

Well it's about increasing wealth, changing diets, genetic programming and aggressive marketing by international food companies.

The most perplexing problem in emerging economies is how they are going to deal with a tidal wave of obesity with relatively scant health resources.

We've canvassed opinion from notable authorities on diet, nutrition and fat issues, and met people in these countries struggling with the consequences of obesity.

It's an eye-opening, sometimes shocking journey.

First stop: Mexico. The biggest killer here is diabetes. In the past 30 years this country has gone from dealing with widespread malnutrition to coping with two thirds of the population growing overweight or obese. One of the main culprits is the super-pervasive spread of soft drinks: Mexicans drink more carbonated beverages per head of population than anyone else in the world. In a country where running water isn't guaranteed and bottled water is expensive, these soft drinks have become a daily dietary staple for everyone from infants to the elderly.

Next is Brazil, where global food giants are moving into every corner of the country, from the big cities to the remote reaches of the Amazon to sell their highly processed products readily and cheaply. Profits and market share are soaring and so is obesity, with another 1 percentage point of Brazil's population joining the ranks of the obese every year.

In India, as incomes have risen so too has weight. But the effects here are even more dramatic than elsewhere because the Indian body type magnifies the effects of obesity. Many have a genetic predisposition to diabetes and heart disease. The situation is so dire that health experts warn a staggering one in two babies born in India today will get type-2 diabetes, delivering future generations the real possibility of widespread disability and early death. India is bracing for an estimated 100 million type-2 diabetes patients.

The final stop on our Globesity tour is China – where the rapid transformation of the economy has been mirrored by massive changes to the consumption of food. Not just the sort of things Chinese are eating but the way they eat. Snacking was a rarity not so long ago. Now it abounds. Thirty years ago the Chinese ate only small amounts of sugar and oil – today they are a big part of the diet and a big part of the reason more and more Chinese are getting bigger and bigger.

Extend your understanding

1 Look closely at Source 1. What point is the cartoonist making about obesity?

2 Select one of the geographic questions from the class analysis of the article, 'Obesity epidemic spreads to developing world'. Use this as a starting point for research into the global obesity epidemic. Report back to the class on what you find during your research.

4.10 Variations in wellbeing within India

Within every country, access to wealth, health care and education varies between states or regions, between different ethnic groups and between rural and urban populations. In the same way that they can compare the wellbeing of one country with another, geographers can also take a detailed look within a country to investigate the variations in wellbeing that exist.

India is a vast, complex and dynamic nation. Its population currently stands at more than 1.2 billion and is growing by about 16 million people a year. It is estimated that India will overtake China as the world's most populous nation by 2030, a position it is unlikely to lose for centuries. As with all nations, there are tremendous variations in wellbeing within India. At one end of society, there are hundreds of millions of poor, subsistence farmers growing just enough food to feed their families. At the other end, there are around 164 000 entrepreneurs and business people classed as super-rich. This means they have investable assets worth more than US$1 million each.

India also has one of the world's largest middle classes, estimated to be about 250 million people.

India is divided up into many different states and union territories. Source 1 shows the range of rankings for these states and territories under the Human Development Index (HDI).

By looking at two states in particular, Kerala and Chhattisgarh, the states with India's highest and lowest rankings in human development respectively, we can see the great contrasts in wellbeing that exist within India.

Wellbeing in Kerala

The south-west state of Kerala is ranked as the having the highest HDI in India. The state has the lowest level of poverty, the highest literacy rates, the lowest population growth rates and the fastest economic growth in the country. In many ways, the state compares favourably with wellbeing in many developed countries.

INDIA: HUMAN DEVELOPMENT INDEX FOR DIFFERENT STATES, 2008
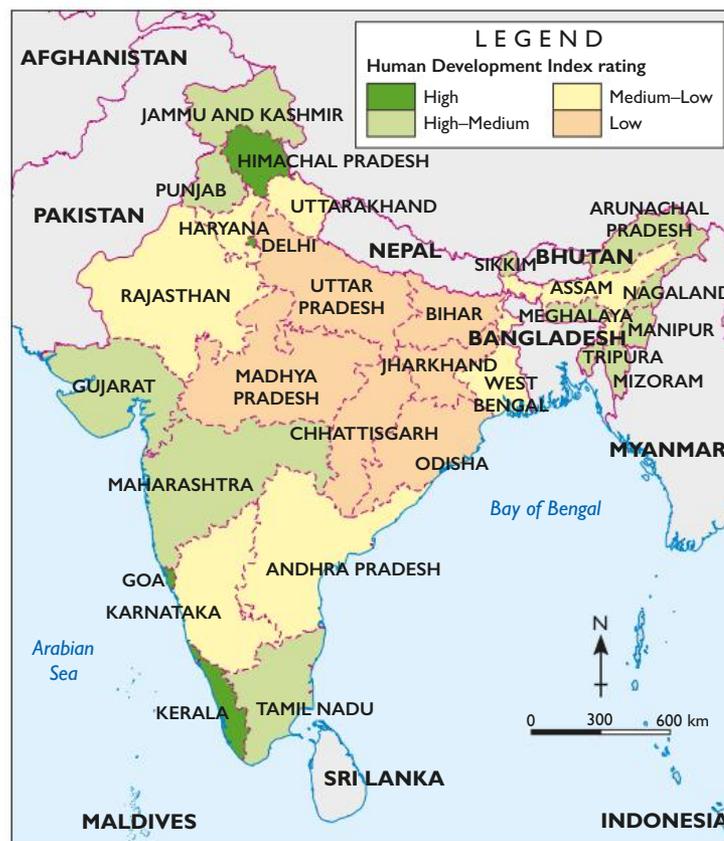
Source 1   Source: Oxford University Press

Source 2   Wellbeing indicators for the states of Kerala and Chhattisgarh, and India (total)

Indicator	Kerala	Chhattisgarh	India
People living in poverty	15%	40.9%	27.5%
Under 5 mortality rate	16.3/1000	90.3/1000	74.3/1000
Underweight children	22.9%	47.1%	42.5%
Literacy rate	93.9%	71%	72%
Houses with no toilet	4.3%	72.9%	49.2%

There are several factors responsible for this comparatively high level of wellbeing. More than 2.5 million people from the state live and work in the countries of the Persian Gulf such as Qatar (see Source 3 on page 149) and each year they send home a combined income of US$6.81 billion. This means their families can afford education and health services. The state was also one of the first to change its laws

so that individual farmers can own land, increasing their incentives to make a profit. Fertile soils and a favourable climate also help to boost agricultural production (see Source 3). Tourism is Kerala's biggest industry, with its attractive backwaters (a chain of lagoons and lakes) and sandy beaches making it popular with tourists.

Wellbeing in Chhattisgarh

The north-east state of Chhattisgarh is ranked as having the lowest HDI in India. The state is two-thirds rural and relatively undeveloped, though it is rich in minerals and has good electricity, steel and cement industries. Forty-five per cent of the population is made up of tribal groups and ethnic minorities, often living in remote forested areas. It has one of the highest rates of poverty and the greatest percentage of undernourished children in the country and high population growth. Schools experience very high dropout rates in Chhattisgarh, particularly in rural areas where children are often needed to work on family farms. People living in the more remote areas of the state often have difficulty accessing opportunities to improve wellbeing such as government aid and medical services. Chhattisgarh has also had its share of social unrest. A large part of Chhattisgarh is under the control of a group known as the Naxalites (see Source 4). This conflict has disrupted economic and social progress in the area.

Source 3 A busy market in Kerala. Markets such as this allow people in the city to get fresh food from rural areas quickly and easily.

Source 4 An armed Naxalite rebel rides past a boy carrying a bow and arrow in the Indian state of Chhattisgarh.

Check your learning 4.10

Remember and understand

1 Make a list of the various factors affecting wellbeing across India.

2 Make a list of the reasons that make it difficult to improve wellbeing in Chhattisgarh.

Apply and analyse

3 Examine Source 1. Describe the pattern of wellbeing in India according to the Human Development Index. Use the names of specific states as well as compass directions in your description.

4 Why are there large variations in wellbeing within India? Use the examples of Kerala and Chhattisgarh in your response.

Evaluate and create

5 Use Source 2 to construct a multiple bar graph contrasting wellbeing in Kerala, Chhattisgarh and India (total). Describe the pattern evident in your completed graph.

4.11 India's rural–urban divide

India has the largest number of people living in poverty in the world. With almost half a billion people living below the poverty line of US$1.25 a day, the country is home to one-third of the world's poor. This poverty is unevenly spread across the country, with significant inequalities in wellbeing between rural and urban areas. People in rural areas are almost twice as likely to be living below the poverty line than people living in urban areas.

As India embarks on a path of economic and social change this gap is narrowing, but there is still some way to go before equality is attained. Source 1 shows some of the key indicators of the rural–urban divide or what some researchers have called 'A Tale of Two Indias'.

Wellbeing in rural India

India is largely a nation of farmers and rural villagers; well over half of the population lives in settlements of no more than 5000 people. For many of these people, life is hard and standards of living are low when compared to people living in urban areas. Indian rural poverty is the result of a range of factors that differ from place to place. These include low food production levels leading to malnutrition; poor infrastructure such as roads, electricity and communication networks; ineffective safety-net programs such as job schemes; and poor access to financial resources such as bank loans and credit. Farmers are also at the mercy of nature. Droughts, floods and widespread land degradation have all contributed to rural poverty.

Poverty is greatest among minority ethnic groups (particularly in degraded forest areas) and marginalised classes of people such as Dalits (also known as untouchables) who make up the lowest class in Indian society according to the Hindu caste system. In communities where coastal fishing is the main source of

Source 2 A young girl collecting dried cow dung to be used as cooking fuel in a rural village in the state of Uttar Pradesh. The state is home to more rural poor than any other in India.

Source 3 New apartments rise above an urban slum in Mumbai, India's largest city.

food, poverty is increasing because overfishing and marine degradation have greatly reduced fish stocks.

Wellbeing in urban India

India is home to some of the world's largest and fastest growing cities. The country has 46 cities of more than 1 million people and three of the world's megacities (i.e. Kolkata, Mumbai and Delhi). Those living in urban areas have greater access to health care which has led to fewer infant deaths and better health in early childhood. Children in urban areas on average also spend more time at school, and achieve a higher level of education. These cities are home to much of the nation's wealth as new opportunities in service industries such as banking and information technology have emerged. These opportunities have led to a growing middle class which has in turn led to improved infrastructure in the cities.

Source 1 Differences in wellbeing between urban and rural India

Key wellbeing indicator	Urban India	Rural India
Population size	402 314 697	818 485 662
Average years of education	7.65	3.94
Total spending per month	1984 rupees	1054 rupees
Improved drinking water access	96%	84%
Improved sanitation access	54%	21%
Skilled medical staff present at birth	76%	44%
Underweight children under 5	33%	46%
Living below poverty line	26%	42%

keyconcept: Place

India's urban slums

Many people in India respond to the inequalities in wellbeing between rural and urban areas by moving from the countryside to the city. Millions of Indians from rural areas have poured into the country's booming cities hoping to leave poverty behind as they seek a better life in the city. The reality for many, however, is that they exchange rural poverty for urban poverty (see Source 3).

For geographers this relates to the concept of place as these people establish new homes in new areas. The new arrivals from the countryside often take up residence in slum areas on land that is considered unsuitable for ordinary housing, often because it is swampy or prone to landslides. Indian cities now contain some of the world's largest slums. Residents build their own homes out of discarded materials and live with the constant fear of eviction as they have no legal right to be there.

Many Indian cities are struggling to provide their citizens with the infrastructure needed for wellbeing such as fresh water, sanitation, reliable access to electricity, schools, roads and hospitals. But it is not all bad news. Packed with people determined to improve their lives and their communities, many slums have become so well established that their infrastructure is often close to the standard in other parts of the city, and usually better than in rural areas.

The biggest struggle for many slum areas, however, is the provision of adequate sanitation. Most homes in the slums do not have a toilet, and the toilets that do exist are often an open pit shared by hundreds of people. While many amenities are often organised and run by the slum dwellers themselves, they rely on city authorities to provide proper sewage disposal. Because the slums are considered to be illegal settlements, authorities are reluctant to invest in sanitation for them.

For more information on the key concept of place, refer to page 6 of 'The geography toolkit'.

Source 4 Access to amenities in slum and non-slum urban households across a selection of Indian cities

City	Tap water		Toilet		Electricity		Mobile phone	
(Percentage of households)	Slum	Non-slum	Slum	Non-slum	Slum	Non-slum	Slum	Non-slum
Ahmedabad	86.2	86.6	61.3	94.6	91.5	98.9	48.8	63.1
Bangalore	84.3	80.2	86.8	97.8	96.6	98.4	71.0	66.5
Chennai	78.2	83.7	91.0	97.4	98.4	99.3	70.0	59.2
Delhi	86.7	89.9	50.6	95.8	97.8	99.6	66.1	63.4
Kolkata	90.8	87.0	92.0	96.2	95.5	96.5	70.1	63.5
Greater Mumbai	96.1	97.3	32.8	75.1	95.6	98.3	76.6	53.5
Pune	98.8	98.4	35.8	90.6	96.2	98.9	73.4	62.0

Source: censusindia.gov.in

Check your learning 4.11

Remember and understand

1 Describe the differences in wellbeing between urban and rural areas in India.

Apply and analyse

2 Examine Source 4. Do the levels of amenities available in the slum and non-slum areas of these Indian cities surprise you? What health or safety issues might be a concern for residents with limited access to some of these amenities?

Evaluate and create

3 Conduct further research on the Internet to complete the following tasks.

　a Compare the inequalities in wellbeing between urban non-slum India, urban slum India and rural India. Write a short report on your findings.

　b Complete an annotated sketch of Source 3. On your sketch label any inequalities in wellbeing that you can identify.

4.12 Wellbeing in Bolivia

By most measures, Bolivia has one of the lowest levels of wellbeing in South America. In the 2012 United Nations Human Development Report, Bolivia is ranked at number 108 in the world in terms of the Human Development Index (HDI). This places Bolivia in a group of countries described as having medium human development. Even so, 60 per cent of Bolivians live below the poverty line, and more than half of these people are described as living in extreme poverty.

Patterns of poverty

Taking a more detailed look at Bolivia's poor, it becomes clear that people in some areas are more likely to be living in poverty than in other areas. As in India, poverty tends to be concentrated in rural areas, where two-thirds of the population is in extreme poverty. In these areas people grow just enough food to feed themselves and their families, with little left to sell. Poverty is also higher among the Indigenous population. Source 1 shows the percentage of

BOLIVIA: POPULATION LIVING BELOW THE POVERTY LINE

LEGEND

Percentage of the population living in poverty

- Over 86
- 67 to 86
- 47 to 67
- Under 47

Source 1   Source: Oxford University Press

Source 2 In rural Bolivia there tends to be low levels of technology, poor infrastructure such as roads, a lack of job opportunities, and less access to services such as schools, doctors and sanitation than in the nation's urban centres.
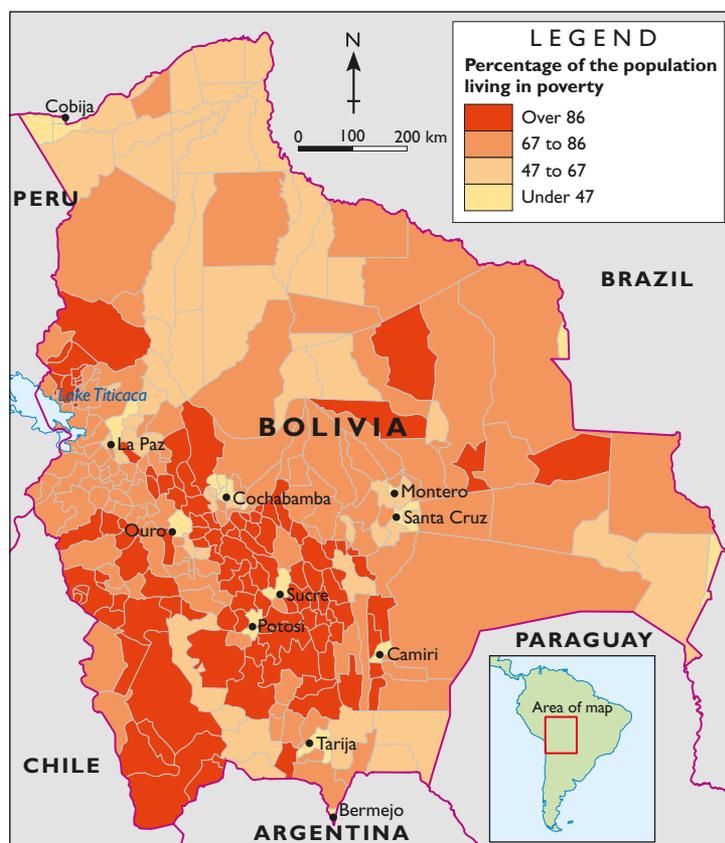
the population in each region of Bolivia living below the poverty line.

This poverty is due to a number of factors, including different levels of employment and availability of resources, varying quality of infrastructure such as roads, schools, hospitals and electricity and high levels of land degradation.

One of the ways in which Bolivians have responded to poverty is to migrate. The most common migration tends to be from rural areas to cities. This has led to a booming urban population and some of South America's largest slums.

Many Bolivians also choose to leave their country and move to other countries, particularly Argentina. About one-quarter of all people born in Bolivia now live in another country. Today, Argentina is home to more than 1 million Bolivians.

Source 3 Around one in five Bolivian children do not complete primary school.

Education

Bolivia spends almost one-quarter of its national income on education. This is one of the highest rates of education spending in Latin America. Despite this, about 1 million Bolivian adults are illiterate and approximately one in five children never complete primary school.

Most of the children who do not attend school live in rural areas where they are needed to work with their parents to help support their families. The result of this is that rural children do not gain the education and skills that could help pull their families out of poverty. Many Indigenous children also drop out of school due to language difficulties. They grow up speaking their Indigenous language but when they attend school all the classes are taught in Spanish.

Health

Many Bolivians face chronic health problems linked to food insecurity. Farm productivity in Bolivia is among the lowest in South America and is still declining in some regions. This is due to a wide range of environmental problems including land degradation, regular flooding and droughts, outdated farming technology and a lack of investment.

Poor harvests have led to widespread malnutrition and almost 5 million people struggle to meet their daily food requirements. Pregnant women and young children are the hardest hit by malnutrition, resulting in underweight children and iron deficiencies. Infant mortality rates are falling as health care gradually improves but they are still the highest in South America.

Rates of diseases such as tuberculosis, malaria and yellow fever are high. This can further lower farm productivity as ill farmers and workers are less able to work to produce food. HIV/AIDS rates are relatively low but increasing.

Source 4 These two boys are among the lucky few Bolivians in rural areas who have access to an improved water source.

Improvements to wellbeing

The Bolivian people and government are working hard to improve their wellbeing. The country has experienced times of political uncertainty and corrupt government but is now in a period of stability. This has encouraged aid organisations such as the World Bank and UNICEF to support the government in its efforts to implement reforms designed to improve wellbeing.

Helping the disadvantaged

Small **non-government organisations (NGOs)** are also making a difference in Bolivia. One example of this is the Foundation for Sustainable Development (FSD) that works with local community organisations in Cochabamba, a city in central Bolivia. FSD volunteers and interns help these organisations to improve health and education services, particularly for disadvantaged groups such as the rural poor, Indigenous people and women. Some examples of the initiatives supported by FSD include a literature and reading group for children and programs to combat malnutrition by training adults in health and cleanliness, nutrition, agriculture and microfinance.

Source 5   An example of an NGO project in Bolivia aimed at improving wellbeing through access to clean drinking water

key**concept:** Scale

Life in Bolivia's cities

Variations in wellbeing can be observed at a range of scales including at the global, national, regional and local scale. An example of a global variation is the classifying of countries according to their level of economic development (see Source 1 on page 148). National and regional variations can be seen in the map of poverty in Bolivia (Source 1). Local variations are those that occur in small areas such as individual suburbs and cities.

La Paz, Bolivia's capital city, has a population of about 2 364 000. The highest capital in the world, La Paz is a spectacular city sitting within a canyon on the Altiplano (also known as the Andean Plateau). Tall, modern office buildings crowd the city centre, while vast urban slums cling precariously to the mountain slopes on the city's edges (see Source 6). These slums are home to up to 1 million people, many of them migrants from the poverty-stricken countryside. About 42 per cent of La Paz's population lives below the poverty line.

Source 6   La Paz valley showing the houses of the poor built on the hillsides and the central business district below

For more information on the key concept of scale, refer to page 11 of 'The geography toolkit'.

skill**drill:** Data and information

Creating multiple-line graphs

Multiple-line graphs are useful tools because they allow geographers to observe and compare changes in data over time. This enables geographers to more easily identify trends and changes in different sets of data gathered in different locations.

Step 1 Construct a set of axes. The years are placed on the horizontal *x*-axis. The years must be evenly spaced out; for example 1 centimetre for every five years. The data being graphed is placed on the vertical *y*-axis and should extend slightly higher than the highest figure being graphed. Once again, the scale must be even; for example 1 centimetre for every 10.

Step 2 Plot the first set of data with a series of small neat dots and join these with a smooth coloured line. Add a label at the end of the line describing the indicator you have graphed.

Step 3 Repeat step 2 for the remaining sets of data. Use a different colour for each line.

Step 4 Add a title and label each axis.

Apply the skill

1 Construct a multiple-line graph to show the changes in wellbeing in Bolivia between 1970 and 2010 using the selected key indicators listed in Source 7.

Source 7 Changes in wellbeing in Bolivia between 1970 and 2010 using selected key indicators

Key indicator	1970	1975	1976	1980	1985	1990	1992	1995	2000	2005	2010
Adult literacy (%)	—	—	63	—	—	—	79	—	86	—	91
Infant mortality rate per 1000 people	141	123	—	108	97	82	—	70	59	49	40
Life expectancy at birth	45	48	—	52	56	59	—	61	63	65	66
Urban population with clean water (%)	—	—	—	—	—	92	—	93	94	95	96
Rural population with clean water (%)	—	—	—	—	—	43	—	48	55	62	69
Urban population with sanitation (%)	—	—	—	—	—	28	—	30	31	33	35
Rural population with sanitation (%)	—	—	—	—	—	6	—	7	8	9	10

Check your learning 4.12

Remember and understand

1 Use the data in Source 7 to comment on the level of wellbeing in Bolivia from 1970 to 2010.
2 What are NGOs and what role do they play in Bolivia?
3 Why do people move from the countryside to the cities of Bolivia? What impact does this migration have on cities?

Apply and analyse

4 Examine the multiple-line graph you constructed in the skilldrill.
   a What general trend do you observe in this graph?
   b Comment on the inequalities in rural and urban wellbeing shown in your graph.
   c Comment on the usefulness of a multiple-line graph for showing the links between sets of data.

5 Examine Source 1.
   a Describe the pattern of poverty at the national scale.
   b Suggest a reason to explain the pattern you have described.

Evaluate and create

6 Use the photographs on these pages to describe inequalities in wellbeing in Bolivia. Which photograph best shows these inequalities? Write a caption for the photo you have chosen that briefly describes the situation.
7 Research one indicator, such as education, that contributes to Bolivia's level of wellbeing. Prepare an infographic that explains how it affects the wellbeing of the Bolivian people.

4.13 Wellbeing in Australia

Each year, the United Nations releases a ranking of countries around the world in terms of their development. This is known as the Human Development Index (HDI). The HDI gives an indication of whether a country is developed, still developing, or underdeveloped based on a range of factors such as life expectancy, education levels, literacy rates, and income levels per capita. It also is a good indicator of the wellbeing of people in certain countries.

In 2015, Australia was ranked 2 out of 188 countries on the Human Development Index. Norway was the only country in the world that rated higher.

Despite the high levels of wealth and wellbeing in Australia nationally, there are still many variations between specific regions, cities, towns and suburbs across our country. Some places may have excellent access to hospitals, schools and recreation facilities together with low levels of crime and poverty. Other places may have poor access to these services as well as higher levels of crime and poverty. Variations in these types of things can be difficult to measure at a local or regional scale because indicators like life expectancy and literacy rates are almost always measured at the national scale.

There are other sources of information, however, that can help geographers measure wellbeing at the regional and local scale. One of these sources is known as the census. In Australia, a census is carried out every five years. Every Australian citizen is asked to provide answers to a series of questions on a whole range of topics. The census gives us a great deal of information about life across Australia, such as the areas with the highest and lowest quality of life (see Source 1).

A quality of life study

In 2014, the Bankwest Curtin Economics Centre (based at Curtin University in Western Australia) released a study of poverty and disadvantage in Australia. Titled

AUSTRALIA: QUALITY OF LIFE RANKINGS BASED ON CENSUS DATA
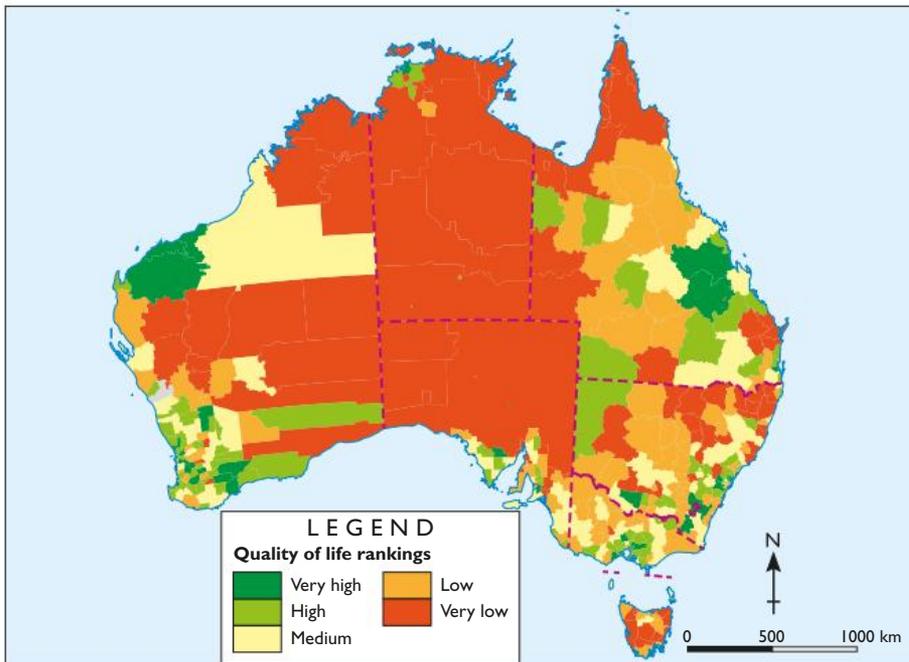
Source 1   Source: Oxford University Press

'Falling Through the Cracks', the study used census data and other research to examine levels of poverty across Australia. It also included an analysis of the groups of Australians most likely to be living in poverty and the geographic locations of these groups.

In this study, households and individuals that receive less than half the average Australian yearly income are defined as living in poverty. It is worth noting that this definition is very different from measurements used in other countries. Using this definition, the researchers found that 12.9% of Australians, around 2.8 million people, are living in poverty.

Spatial variations in wellbeing

The study also found that there were significant differences in the rates of poverty and disadvantage across Australia. The highest rates of income poverty were found in Sydney. Here the rate was about 15 per cent of all residents. The lowest rates of income poverty were in Canberra (see Source 2). Here the rate was around eight per cent of all residents.

When the researchers examined rates of unemployment across Australia, they found other spatial variations in wellbeing. Remote communities in the Northern Territory, Queensland and New South

Source 2 The Bankwest Curtin Economics Centre study found the suburbs of Canberra have the lowest rates of poverty and disadvantage in Australia.

Source 3 Remote communities in the Northern Territory and Queensland were found to have the highest rates of unemployment and educational disadvantage in Australia.

Wales had the highest rates of unemployment (see Source 3), while the ACT and the inner suburbs of our large capital cities, like Melbourne and Sydney, had the lowest rates.

The rural–urban divide

The Bankwest Curtin Economics Centre study, and many others like it, found that people living in rural areas in Australia have lower levels of wellbeing than people living in urban areas. This pattern is repeated

in other developed countries around the world. Studies of health statistics in Australia show that the further away from a major city you live, the less healthy you are likely to be. For example, in rural areas:

• rates of hospitalisation for serious injury or illness are higher
• there are fewer doctors for every 1000 people
• smoking rates and alcohol consumption are higher
• rates of death and serious injury from workplace and road accidents are higher.

Check your learning 4.13

Remember and understand

1 Why is it more difficult to measure, rank and map variations in wellbeing at the local and regional level?

2 List three health concerns that are more serious for Australians living in rural areas than for those living in urban areas.

Apply and analyse

3 Examine Source 1.
   a Which regions of Australia have the highest quality of life?
   b Which regions of Australia have the lowest quality of life?
   c In a carefully worded paragraph, describe the distribution of regions in Australia according to their quality of life rankings using the PQE method. For more information on the PQE method, refer to page 28 of 'The geography toolkit'. Refer to specific towns, cities, regions and states in your description.

4 What barriers do you think exist that make it difficult to improve wellbeing in rural and regional areas of Australia? What could be done to improve wellbeing in these areas?

Evaluate and create

5 Access the 'Falling Through the Cracks' study on the Bankwest Curtin Economics Centre website before completing the following tasks. A link is provided on your obook.
   a Read the section of the report titled 'Geography of disadvantage' and write a short paragraph summarising the findings.
   b Are the reasons for the inequalities between rural and urban populations in Australia similar or different to those in India? Give some reasons for your answer.

4.14 Wellbeing in Indigenous Australian communities

By most measures there are significant differences in wellbeing between Indigenous and non-Indigenous communities around Australia. Indigenous children are twice as likely to be born underweight and twice as likely to die before their fifth birthday than non-Indigenous children. They are also less likely to attend pre-school and much less likely to reach minimum standards in literacy and numeracy while at school. Although almost nine out of every 10 non-Indigenous young adults complete Year 12, it is closer to five out of 10 for Indigenous young adults. The pattern is similar with employment. Only 46 per cent of Indigenous adults are in employment, compared to 72 per cent of their non-Indigenous counterparts. Perhaps the most alarming statistic is that an Indigenous boy born this year can expect to live 11.5 years less than a non-Indigenous boy. For girls, the figure is 9.7 years.

Closing the gap

In 2008, the Australian Prime Minister, Kevin Rudd, apologised to Aboriginal and Torres Strait Islander people affected by the official government policies that separated Indigenous children from their families, a group known as the Stolen Generation. As part of this apology, Prime Minister Rudd also gave a promise 'to close the gap between Indigenous and non-Indigenous Australians on life expectancy, educational achievement and employment opportunities.'

The government's targets were to:

- close the gap in life-expectancy by 2031
- halve the gap in mortality rates for Indigenous children under five by 2018
- ensure access to early childhood education for all Indigenous four-year-olds in remote communities by 2013
- halve the gap in reading, writing and numeracy achievements for Indigenous children by 2018
- halve the gap in Indigenous Year 12 achievement by 2020
- halve the gap in employment outcomes between Indigenous and non-Indigenous Australians by 2018.

By 2013, the early childhood education target had been met and progress had been made in the other areas. However, progress is generally slower than is needed to meet all targets by their set dates. The gap is closing, but slowly.

Source 1
Ntaria school in Hermannsburg, outside Alice Springs in the Northern Territory. Increased government funding has allowed remote schools to offer longer pre-school programs. This has resulted in improved literacy and numeracy as well as improved health as the children are also given healthy lunches.

Measuring happiness

Although statistical indicators such as life expectancy and literacy rates paint a grim picture of low levels of wellbeing among Indigenous Australians, other measures tell a different story. The Australian Bureau of Statistics (ABS) has begun to ask people to assess their own wellbeing by asking questions about their levels of happiness and satisfaction with life in the National Aboriginal and Torres Strait Islander Social Survey (NATSISS). The data collected reveals some interesting trends. Torres Strait Islanders, for example, are much more likely to report feeling happy, full of life, calm and peaceful and having lots of energy than individuals in the broader Australian community (see Source 2).

The NATSISS revealed variations in levels of happiness between different regions. The NATSISS results showed that 79 per cent of Indigenous adults living in these remote areas reported feeling happy some or most of the time. This compares with only 68 per cent of Indigenous adults living in Australia's major cities reporting feeling happy. However, in virtually all other measures, such as school attendance, literacy, health, disease and employment, the most disadvantaged Indigenous communities were those in remote areas. Access to health care, education and employment opportunities are often more limited in remote areas than they are in regional centres and major cities.

Source 3   Happiness among Indigenous Australians in remote areas is higher for those involved in cultural activities than for those who rarely or never attend cultural events.
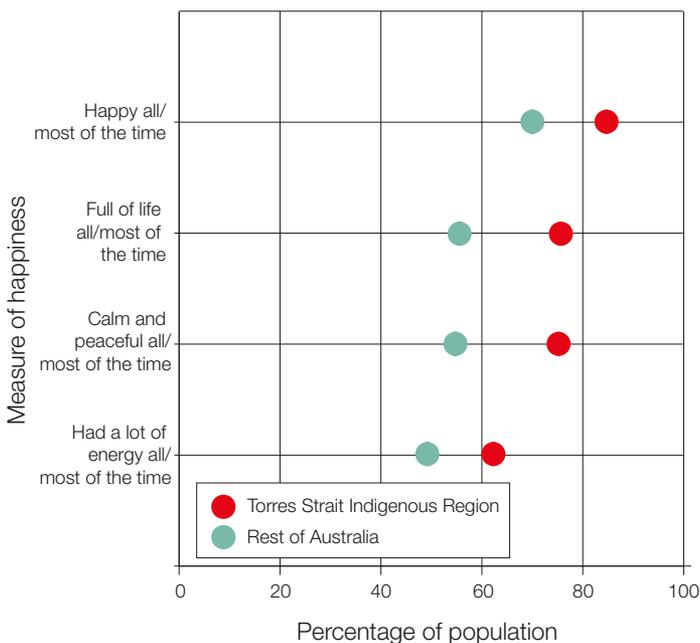
Source 2   Results from the National Aboriginal and Torres Strait Islander Social Survey (NATSISS), 2008

Check your learning 4.14

Remember and understand

1   Summarise life expectancy rates between Indigenous and non-Indigenous Australians.

Apply and analyse

2   Examine Source 2. Write a short paragraph contrasting the levels of happiness between Torres Strait Islanders and the rest of Australia.

3   The 'closing the gap' targets rely on quantitative measures to measure their progress. Why do you think these measures are used rather than qualitative measures (such as levels of happiness and satisfaction)?

Evaluate and create

4   Conduct some further reading on the Internet and complete these tasks.

   a   Why do you think people are happier if they are engaged in cultural and community activities?

   b   Design and conduct a survey that questions people about their level of happiness and the factors that affect their happiness. Include questions about their involvement in cultural and community activities. Write a report on your results in which you outline what makes people happy.

Investigating wellbeing at the local scale

Most studies of wellbeing focus on differences and variations between nations. But there are also variations at the local scale. In this broadsheet you will learn how to use census data to collect and map information about wellbeing in your local area. Based on your completed research and maps, you will then explore some possible reasons for the variations in wellbeing at the local scale.

Step 1 Access the ABS website at www.abs.gov.au. Click on the 'Census' tab at the top of the home page. Then select the 'Data & Analysis' tab on the left, then 'Community Profiles'.

Step 2 This page allows you to access the census data at a wide range of scales, including at the local level. A useful way of working at the local scale for this study is by using postcodes. To access the data for your suburb, enter your four-digit postcode in the 'Community Profiles Search' tool. If more than one option is displayed, choose POA. Click 'Go'.

Step 3 This should open a map of your postcode and allow you to choose one of two spreadsheets. Select 'Basic Community Profile' and open or save this spreadsheet.

Step 4 Use the tabs at the bottom of the spreadsheet to access the 'List of Tables'. This will give you a breakdown of the kind of information available. Select a category you would like to map.

skill**drill:** Data and information

Collecting and mapping census data

A census is held in Australia every five years and the results are processed and published by the Australian Bureau of Statistics (ABS). Geographers often use this information to map data and trends across an area. You can collect data about your local area and map it by following these steps.

Source 2 A screenshot of the postcode map on the Australian Bureau of Statistics Census website

Source 1 There are significant variations in wellbeing in Central Sydney.

Step 5 Click on the category you have decided and record the data for your suburb. Access the same data for your neighbouring postcodes by typing the area or postcode in the field above the map. You can find out what your neighbouring postcodes are by using the interactive map at the Australian Postcode Finder website (see Source 3). Simply enter your four-digit postcode into the search tool at the top of the page and it will zoom into this area. Click on the neighbouring postal areas to find their postcodes and then use the ABS website to access and record data for these postcodes.

Source 3   A screenshot from the Postcode Finder website

Step 6 Once you have collected the data you can map it by constructing a choropleth map. Print out a map of your area. You can use one you have or print the one from the ABS site. Trace a copy showing only the postcode boundaries.

Step 7 Use the data collected from the census to construct a choropleth legend for your map. Divide your data into four or five categories. Use darker shades of a colour for higher values and lighter shades for lower values. For example, your suburb might have fewer people per household (if that was what you chose to map) than the neighbouring suburb. So, you would colour your suburb a lighter shade and your neighbouring suburb a darker shade.

Step 8 Shade your map according to the legend you created in Step 7.

Step 9 Complete your map with BOLTSS.

Apply the skill

1 Complete a choropleth map of variations in median household income in your local area (include at least six suburbs) by collecting information from the ABS website. You can find this data under table B02, *Median Household Income*. Follow the steps to gather your data and map the information.

2 Describe the pattern shown on your completed map.

Extend your understanding

1 Explore and evaluate possible reasons for the variations shown on your map. These will vary from place to place, but here are some possibilities:
- distance from the centre of a large city
- presence of employment opportunities such as factories and shopping centres
- presence of higher educational opportunities such as universities
- presence of transport networks such as railway stations and major roads
- presence of large, shared accommodation areas such as aged-care facilities or school hostels
- presence of geographic features such as a coastline or large park.

Use your knowledge of the local area and street directory maps to evaluate these possible reasons.

2 Collect information from the ABS site and analyse variations in another indicator of wellbeing. Do this for the same suburbs you investigated earlier. You could choose to analyse the number of motor vehicles per dwelling, highest year of schooling completed or percentage of people unemployed.

3 You can also use the census data to explore levels of wellbeing in communities that are not located close to each other. Follow Step 1 in the skilldrill to access the census data and then enter the names of communities in the 'Communities Profiles Search' tool. There may be a few options given as the ABS collects data at a range of scales. The Local Government Area (LGA) is a useful scale when comparing suburbs or country towns but you can compare wellbeing at many scales.
   a Use the Quick Stats to compare wellbeing in Halls Creek, Ku-ring-gai and the LGA in which you live.
   b What have you learnt about variations in wellbeing within Australia?
   c What are the advantages and disadvantages in using census data to describe and compare wellbeing?

Inequalities in wellbeing

There are many reasons for the inequalities in wellbeing that exist between countries. The environment and climate can make a difference, affecting access to fresh water and the ability to grow food. The presence of natural resources such as oil and minerals is also an important source of wealth for countries that influences levels of wellbeing.

The political, economic and social organisation of a country can also have a big impact on its wellbeing. Important factors include the make up of the population, the levels of gender equality and access to technology. One of the most significant factors affecting wellbeing, however, is conflict.

In 2011, fighting between rebels and government troops in Syria broke out destroying more than half of the country's hospitals as well as other vital infrastructure such as roads, electricity, communication networks and factories. All of these factors have resulted in enormous inequalities in wellbeing.

5A
How does the natural environment cause inequality?

1   Refugee camps are often located in regions close to national borders where it can be difficult to maintain a high level of wellbeing. What does Source 1 tell you about the natural environment of this place?

5B
How do human activities cause inequality?

1   Which organisation has responded to the plight of Syria's refugees in this photograph? What assistance does this woman need to help her maintain her wellbeing and that of her children?

2   What problems will she face when the conflict in Syria comes to an end?

Source 1 A Syrian refugee carries her infant with her to wash the family clothes at Zaatari refugee camp in Jordan. She is one of more than 4 million Syrians who have fled the country as the result of a bloody civil war.

5.1 Why wellbeing varies

As you have learnt, wellbeing varies a great deal within and between countries. The factors behind these variations are complex but can be broken up into five main groups: environmental, social, economic, historic and political.

Environmental factors that affect wellbeing include the suitability of the land for agriculture, the climate and whether there are any natural resources present in the landscape. In some places, good growing conditions ensure that food is plentiful and minerals in the ground bring wealth and industry. In other places, poor soils or unreliable rainfall are the key factors that limit people's wellbeing.

Social, economic, historic and political factors are all examples of human factors. Human factors that affect wellbeing include things like population size, cultural norms, laws and rules regulating business and trade, historical events, political systems and wars. In some places, long periods of stability have allowed for great improvements in living conditions. In other places, the wellbeing of people has been affected by ongoing conflict and decades of corruption and persecution. In these cases, people's access to resources such as water, food and health care is limited, affecting their quality of life.

Every region and country around the world has its own unique set of inter-related factors that determine the wellbeing of the people who live there. The key factors that determine a country's level of wellbeing are outlined in Source 1.

Source 2 Norway regularly tops the world ranking in the annual Human Development Index.

Factors that affect human wellbeing

Environmental factors
- Climate
- Land quality and availability of fresh water
- Natural resources
- Relative location

Social factors
- Population size and growth
- Cultural norms such as gender roles

Economic factors
- Trade laws
- Access to trade routes

Historic factors
- Colonial past
- Past conflicts

Political factors
- Political stability
- Level of corruption
- Wars and civil conflict

Source 1 Factors that affect human wellbeing

keyconcept: Place

The two Koreas: a study in wellbeing

The Korean Peninsula is shared by two countries – South Korea and the Democratic People's Republic of Korea (more commonly known as North Korea). Due to their proximity to each other they have similar climates, soils, topography and mineral resources. And yet South Korea is rated as the country with the 12th highest level of wellbeing in the world, while North Korea is 63 places lower at 75th. South Koreans live, on average, 10 years longer and have a gross domestic product (GDP) 18 times higher than their northern counterparts.

These differences cannot be explained by differences in resources but in the ways in which these countries are governed and their resources managed. South Korea is a democracy with a market-driven economy. It has a strong economy with high exports and imports, is highly industrialised with a large urban population and is technologically advanced. South Korea also has relatively low levels of corruption and a free media.

North Korea is a totalitarian state, meaning there is only one political party and no elections. It has little to do with the rest of the world and the economy is strictly controlled by the central government. The population is still largely rural and farming methods are technologically backwards. The North Korean government places a great emphasis on having a strong military and up to one-third of the country's budget goes towards maintaining it. North Korea also has very high levels of corruption and no freedom of the press.

For more information on the key concept of place, refer to page 6 of 'The geography toolkit'.

Source 3 The Korean Peninsula at night

Check your learning 5.1

Remember and understand

1 What are some of the environmental factors that influence wellbeing? Explain the influence that each of these may have on an individual's wellbeing.

Apply and analyse

2 Using Source 2, describe the environmental factors that help to explain Norway's high levels of wellbeing.

3 Using Source 1, explain why Australia has high levels of wellbeing.

4 Examine Source 3. Describe the pattern shown in this **satellite photograph** and explain it in relation to wellbeing.

Evaluate and create

5 Conduct some further research on the Internet to complete the following tasks.

a 'Levels of human wellbeing are mainly the result of human factors rather than natural ones.' Evaluate this statement with reference to some specific examples and discuss your thoughts in small groups of three or four.

b Find and research examples similar to the Korean Peninsula, where neighbouring countries have very different levels of wellbeing – for example Haiti and the Dominican Republic. Outline the reasons for this with reference to the five factors discussed in Source 1. Present your findings in table format.

5.2 Environmental factors and wellbeing

The natural environment provides us with the necessities of life – fresh air, fresh water and food. However, there are wide variations in the availability of these vital resources around the world. Climate also affects the suitability of the environment for sustaining wellbeing.

Variations in water and food security

The most important environmental factors are those that provide us with a reliable supply of clean water and the resources required to grow food. Clean water is provided by regular rainfall and is usually carried along rivers where it is accessed by communities in villages, towns and cities. Fresh water is also used by farmers to irrigate their crops in the production of food.

Because there are natural variations in rainfall, temperature, soil fertility and river flows, food and **water security** vary widely. To get the best crops farmers rely on fertile soils, warm temperatures and other important ecosystem services such as insects and birds to pollinate plants and control pests. The products of human ingenuity such as water pipelines and dams, fertilisers and greenhouses have overcome many of the limitations set by these natural variations but they are costly to build and maintain. The growth in the world's population, particularly in the last 50 years, has placed a strain on the ability of the environment to provide food and water security.

In some places the land has become degraded by human activities such as overgrazing and the unsustainable use of water. This is now affecting the food and water security of millions of people (see Source 1).

Source 1   This girl in Chad sets out from her village on her daily walk to collect water. She lives in the Sahel on the southern fringe of the Sahara Desert where wellbeing is threatened by unreliable rains, infertile soil and a rapidly expanding population.

Case study: food security in India

In some environments, the inability to grow enough food to meet the needs of the population has a major impact on wellbeing. India has a population of about 1.2 billion but across much of the country, environmental conditions are unsuitable for growing food.

These environmental conditions, together with a lack of agricultural technology and poor irrigation, have led to frequent famines. In 2013, a severe drought in the western Indian state of Maharashtra became the worst the region had experienced in four decades. As reservoirs ran out of water, farmers were unable to produce food. Shortages meant people went without.

In the late 19th century, India experienced its worst famines, resulting in the starvation and deaths of millions of rural Indians. These days, India can import food such as rice and grains when food supplies are threatened. However, the imported food is more expensive and the price increases still lead to severe hardship for India's poor.

Source 2 shows some of the major environmental conditions and the effects they have on food production throughout India.

INDIA: MAJOR ENVIRONMENTAL CONSTRAINTS ON FOOD PRODUCTION
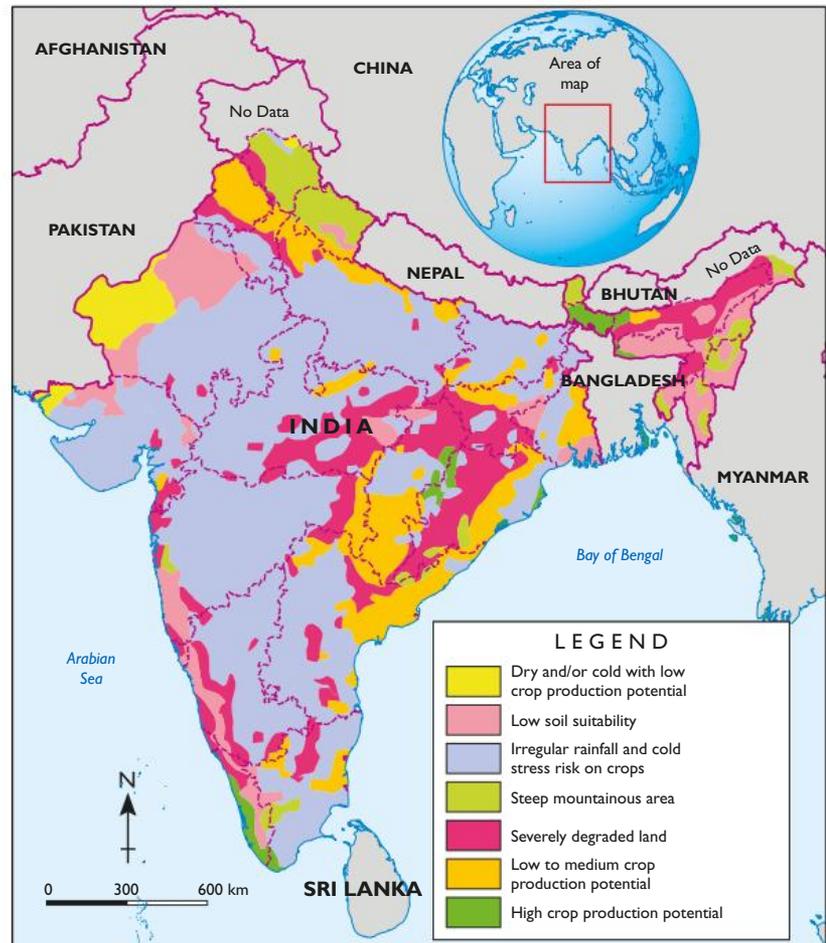
Source 2

Source: Oxford University Press

Check your learning 5.2

Remember and understand

1 Which natural resources are important in providing food and water security?

2 How does the uneven distribution of resources help to explain variations in human wellbeing?

Apply and analyse

3 Compare Source 2 with Source 1 on page 160. Can you find evidence that certain environmental constraints on food production have led to lower levels of human development? Use the names of specific states in your answer.

4 Compare Source 1 with Source 2 on page 176. Describe and account for the differences you can observe in these sources. How might the environmental conditions you see help to explain the differences in wellbeing between these two nations?

Evaluate and create

5 Complete some further research on the Internet to do the following task.

  a Since 1993 a World Water Day has been celebrated by the United Nations to bring attention to an aspect of fresh water supply. Investigate how World Water Day has been used to bring attention to the issue of food security.

  b Present your findings by writing a 250-word report or by summarising the most important details in table format.

5.3 The influence of climate

On a global scale, climate has largely determined where people have lived. Areas that are too cold, too hot or too dry have tended to be sparsely populated, while those with mild temperatures and reliable rainfall have tended to be more densely populated.

As the world's population has increased, however, more and more people have moved into marginal climate regions that were previously considered unsuitable for farming and settlement. By using technology such as irrigation in dry places, these marginal regions have been transformed to support human populations.

Researchers have developed two theories based on these trends in an attempt to explain how climate affects wellbeing.

Theories of how climate affects wellbeing

Theory 1 – Human wellbeing is highest in regions where the climate is neither too extreme nor too comfortable. Supporters of this theory believe that populations living in regions where the challenges presented by climates are not too severe or too comfortable lead to advances in technology that improve wellbeing overall. According to this theory, people in rainforest climates where rainfall and temperature are both perfect for growing crops have lower levels of development because there are few major challenges to their survival and no incentive to change. By comparison, people living in climates that present

WORLD: CLIMATE ZONES

LEGEND

Tropical climates:
- Rainforest. *Hot and wet all year*
- Monsoon. *Hot all year, wet summers, dry winters*
- Savannah. *Mainly hot and wet with some seasonal changes in temperature*

Dry climates:
- Desert. *Hot and dry all year*
- Desert. *Cool and dry all year*

Dry climates:
- Steppe. *Hot all year, low rainfall*
- Steppe. *Cooler, low rainfall*

Temperate climates:
- Mediterranean. *Warm with dry summers*
- Warm with dry winters
- Warm with even rainfall throughout the year

Continental climates:
- Cold with dry summers
- Cold with dry winters
- Cold without a dry season

Polar climates:
- Tundra. *Cold. Warmest month less than 10°C*
- Polar. *Permanent ice and snow*

Source 1

Source: Oxford University Press

Source 2 Farming for food usually requires reliable rainfall and mild temperatures such as here in Pennsylvania, north-east USA.

Source 3 In Afar, northern Ethiopia, people are nomadic and live from livestock farming. Girls are responsible for herding sheep, goats and camels to the pastures while men provide protection.

a number of mid-range challenges will have higher levels of development because they are encouraged to solve these challenges through innovation.

Theory 2 – People who live in marginal climate regions have lower levels of wellbeing because of the difficulties faced in growing enough food or finding enough fresh water. These activities take so much time and effort,

for example spending hours each day collecting water from the nearest water source, that there is no time left to develop ways to move beyond simple survival. Supporters of this theory point to desert regions in Northern Africa and Central Asia as evidence to support their case.

Check your learning 5.3

Remember and understand

1 Why are human populations clustered in certain areas rather than evenly distributed across the world?

2 Use Sources 2 and 3 to describe the very different climates of Afar and Pennsylvania.

Apply and analyse

3 Use the data in the 'World statistics' section in your obook to compare levels of wellbeing in Ethiopia and the USA. To what extent do you believe these differences are due to climatic differences?

4 Why are more people moving to areas that have previously been considered unsuitable for human habitation? Which factors do you think would be most important to drive people to move to an inhospitable area?

Evaluate and create

5 Copy and complete the following table in your notebook. Use the world map at the back of this book together with the data in the 'World statistics' section in your obook to complete column 2.

Then use Source 1 to complete column 3.

Region	HDI ranking 2012	Main climate zone
Northern Africa: Morocco	130	Desert, Mediterranean
Southern Africa: South Africa		
North America: Canada		
South America: Brazil		
Oceania: Australia		
Europe: Germany		
Central Asia: Mongolia		
North Asia: Russia		
South Asia: Pakistan		
South-East Asia: Indonesia		

6 Use the information you have collected in this table to evaluate the theory that levels of wellbeing are highest in regions where the climate is neither too extreme nor too comfortable.

5.4 The influence of climate change

Many regions of the world have seen a dramatic improvement in human wellbeing over the last few decades. Infant survival, literacy rates and life expectancy have all increased. **Climate change**, however, threatens to stall and even reverse many of the gains made in these areas. The main threats from climate change are the greater risks posed to people's health from rising temperatures and the expected fall in food production which may, in turn, lead to lower levels of food security.
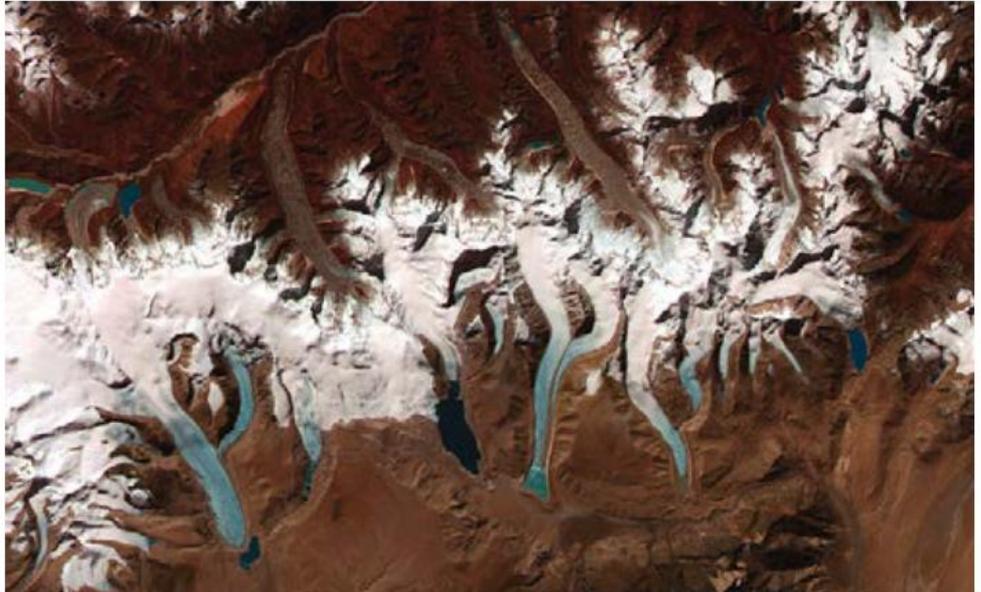
Source 1 A NASA satellite image of glaciers in the Himalayas. The lakes at the end of each glacier are increasing in size as the glaciers reduce in size. This means that less water is stored in the glaciers themselves.

Health threats

The most direct consequence of rising temperatures is more frequent heatwaves and more cases of associated heat stress. Heatwaves are already Australia's deadliest natural disaster, with older people in urban areas most at risk. In 2009, during a heatwave that hit south-east Australia, there were more than 400 heat-related deaths in Melbourne and Adelaide alone. Researchers expect the death toll from heatwaves in Australia to increase fourfold by 2050. Increasing temperatures bring other threats too, with more frequent extreme weather events such as bushfires, droughts, cyclones and floods.

The other major health concern with rising temperatures, and potentially the most catastrophic, is the spread of serious diseases such as malaria and dengue fever. Rising temperatures create suitable living environments for disease-carrying mosquitoes in areas that were previously too cold. Some research estimates that 300 million more people will be affected by malaria by 2080 as a result. In recent years, the numbers of people dying from malaria has been decreasing, thanks to better preventative measures and greater access to treatment. But increasing numbers of victims could overwhelm health systems in poorer countries where they are less able to prepare and recover from health epidemics.

Food security threats

As temperatures rise and rainfall patterns change so will growing conditions. This will affect food security as communities in some regions become unable to produce enough food. Farming areas that are already in dry, warm regions, such as areas surrounding the Sahara and Kalahari deserts in Africa, are expected to see a massive reduction in food production (see Source 2). Worldwide, reductions in grain production are also expected, at a time when world population figures continue to grow. This will send prices for grains higher, making it increasingly difficult for the poor to feed themselves.

The impacts on food security will also be multiplied by changes in water supply. The glaciers of the Himalayas and the Andes supply water to over a billion people in cities and on farms. As the glaciers disappear, the water supply for these people will become less reliable, reducing the ability of farmers to use this supply to irrigate their crops (see Source 1).

Farmland in coastal regions will also be affected. Rising sea levels are expected to flood low-lying land making it unsuitable for farming and causing salt water to intrude further inland.

AFRICA: CURRENT AND POSSIBLE FUTURE IMPACTS OF CLIMATE CHANGE

Northern Africa
- Decreased rainfall in rain-fed and semi-arid areas resulting in shorter growing periods, particularly on the margins of the Sahel
- Increased water stress and decreased run-off in parts

ATLANTIC OCEAN

INDIAN OCEAN

Western and Central Africa
- Impacts on crops with expected production decreases
- Populations living in coastal settlements could be affected by sea-level rises and flooding.
- Loss of mangroves and coastal degradation could have negative impacts on fisheries and tourism.

Eastern Africa
- Increased rainfall in some parts
- Malaria spreading to the highland areas of Ethiopia, Kenya, Rwanda and Burundi
- Impacts on ecosystem decreased levels of biodiversity in the mountain areas. Declining fish supplies in some major lakes

LEGEND

Potential change in cereal crop ouput by 2080

Decrease by 50% or more	Increase by 5 to 25%
Decrease by 25 to 50%	Increase by 25% or more
Decrease by 5 to 25%	Not suitable for cereal crop
No change	

Other potential changes

- The range of species and species location
- Sea level rise and possibly flooding in megacities
- Water availabilty
- Rainfall and storms
- Desert dune shifts
- Changes in human health

N

0   500   1000 km

Southern Africa
- Heightened water stress in some river basins
- Malaria spreading further south
- Dune field movements from northern South Africa to Angola and Zambia
- Food security aggravated by climate variability and change

Source 2

Source: Oxford University Press

Check your learning 5.4

Remember and understand

1 List the ways in which rising temperatures threaten people's health.

2 Name two climatic factors that threaten food security.

3 Why should we be worried about the melting of glaciers?

Apply and analyse

4 Examine Source 2.

   a Which areas of Africa are likely to see the greatest reduction in cereal crop output by 2080?

   b Which areas are likely to see an increase in cereal crop output?

   c What might this mean for the distribution of populations in Africa?

   d What might this mean for food security?

Evaluate and create

5 Conduct some further research on the Internet before completing the following task.

   a Which of the effects of climate change shown in Source 2 do you consider to be the greatest threat to wellbeing? Give some reasons for your answer, supporting your argument with data gathered from at least two secondary sources.

5.5 The influence of natural resources on inequality

Natural resources include a country's mineral, petroleum, timber and hydropower reserves along with any other resources that can be used commercially to improve the wealth of the country and the wellbeing of the country's population. Fossil fuels such as oil, and minerals such as iron ore, copper and diamonds are often in demand around the world. The money raised from the sale of these resources can then be used to improve wellbeing. This is what has happened in the oil-rich nations of the Middle East who now enjoy very high levels of wellbeing.

Variations in mineral wealth

Throughout human history, different minerals have provided people with the means to increase their wellbeing. Ancient people used bronze and iron to make tools and weapons with which they could hunt large prey and increase their food security. In today's world,

oil is a vital commodity. It is used by billions of people for transport, manufacturing, heating and cooking. Oil is found in only a few places on Earth, but often in vast quantities.

Those countries that have reserves of oil are able to mine, refine and sell it to those who do not, thereby giving them an opportunity to generate wealth and increase their wellbeing. Source 1 shows the distribution of oil reserves throughout the world using proportional circles to show the oil reserves available to each country. You can see from this map that the majority of oil reserves are concentrated in a relatively small number of countries. The colour of each country in Source 1 indicates how much oil it uses. If a country needs oil but does not have any oil reserves, they have to buy it from a country that does.

Natural resources are considered of such high value that throughout history, access to them has been a common cause of conflict between countries.

WORLD: THE LOCATION OF OIL AND THE RATE OF OIL USE
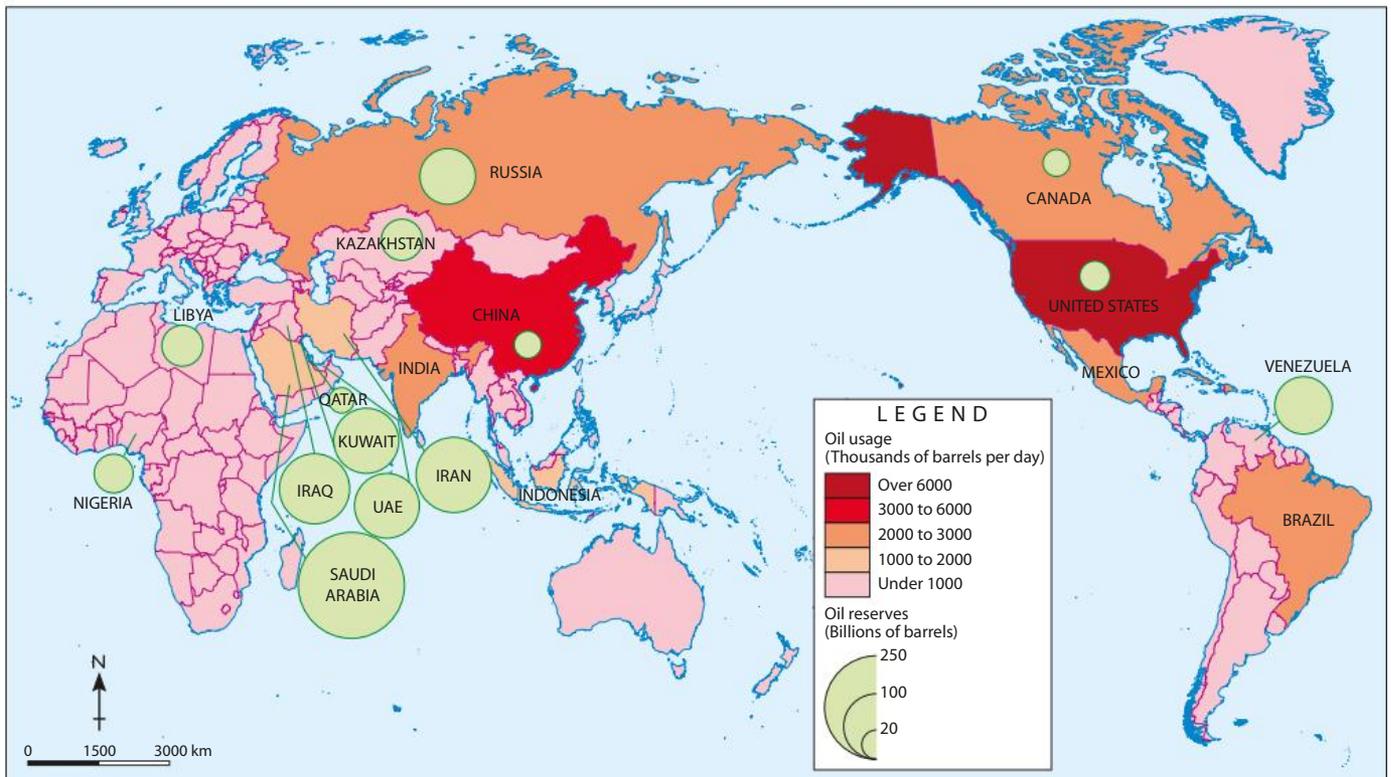
Source 1

Source: Oxford University Press

keyconcept: Interconnection

Natural resources and colonisation

As Western nations developed and their populations grew in the 16th and 17th centuries, their need for resources increased beyond what could be provided within their national borders. European powers such as Spain, England, Portugal and the Netherlands sent explorers out to the unknown regions of the world in the hope of finding resources and riches that they could use. They colonised vast areas of the Americas, Africa and the Pacific, often taking the wealth of the countries they colonised to increase their own wellbeing. In many cases, this had devastating results for the Indigenous people in these colonies.

Millions were taken as slaves or put to work extracting minerals and other natural resources from the ground. Countless others were killed in conflicts or died from Western diseases against which they had no natural immunity. Valuable resources such as timber and minerals were taken, and the Indigenous social and political systems were destroyed.

Some people would argue that a form of colonisation still continues today, as companies from wealthy countries develop and sell the resources of poorer nations. Thanks to profits from oil, Nigeria now has Africa's second-largest economy. Much of this wealth comes from multinational companies such as Royal Dutch Shell extracting Nigeria's oil. Shell currently produces 21 per cent of Nigeria's exported oil.

For those living near Shell's oil plants in the Niger Delta, there have been more negatives than positives as a result of the oil industry. Oil spills, loss of agricultural land and environmental degradation have left those in surrounding villages poorer than ever.

For more information on the key concept of interconnection, refer to page 9 of 'The geography toolkit'.

Source 2   Royal Dutch Shell's oil plant in Bonny, Nigeria. Shell began operations in Nigeria in 1937. Today more than 1000 Nigerian wells operated by Shell produce more than 600000 barrels of oil a day, virtually all of it exported.

Check your learning 5.5

Remember and understand

1   What do individuals and communities use oil for?

2   How can natural resources influence a country's wellbeing?

Apply and analyse

3   Examine Source 1.

a   Which 10 countries have the world's largest oil reserves?

b   Use the data in the 'World statistics' section of your obook to order the 10 countries with the largest oil reserves according to their Human Development Index (HDI) rankings.

c   Can you see a direct relationship between large reserves of oil and high levels of wellbeing as shown by the HDI rankings? Write a paragraph describing this relationship.

d   Discuss why access to important natural resources such as oil does not always lead to improved levels of wellbeing.

4   What is colonisation? How does this help to explain variations in human wellbeing?

Evaluate and create

5   Conduct some further research on the Internet before completing the following tasks.

a   Use Google Earth to explore the town of Bonny in Nigeria.

b   Find the location of the photograph in Source 2.

c   Comment on the variations in buildings in this town and the conclusions that can be drawn about relative wealth and wellbeing.

d   Use the ruler function to estimate the size of the oil and gas plant.

e   What evidence can you find of environmental change as a result of this plant?

5.6 The influence of location on inequality

Differences in human wellbeing cannot be explained by variations in climate and the distribution of natural resources alone. While control over reserves of natural resources was the main source of wealth and power hundreds of years ago, it tends to be less of a factor in today's world. In our increasingly globalised world, vast quantities of goods, services, people, finances and ideas move quickly between countries. As a result, countries with few natural resources can increase their wellbeing by engaging in these flows of goods and services.

Some of the highest levels of wellbeing are enjoyed by people living in places without the natural resources such as large areas of land suitable for agriculture or vast mineral reserves. For these people, their location and ability to trade are the key to their wellbeing.

Access to trade routes

All of the world's great empires were built partly on their ability to transport goods and people. Large volumes of goods were usually transported by water. Ancient Egyptians used the Nile River, the Greeks and Romans used the Mediterranean Sea, and the British used the oceans of the world for trade. Countries and empires with ports close to major shipping routes had a natural advantage.

Little has changed in the ways goods are transported today. The United States, for example, has been able to maintain high levels of wellbeing for centuries through its ability to trade from large ports on its west, east and south coasts. China, one of the world's fastest growing

WORLD: MAIN SHIPPING ROUTES AND LARGEST CONTAINER PORTS
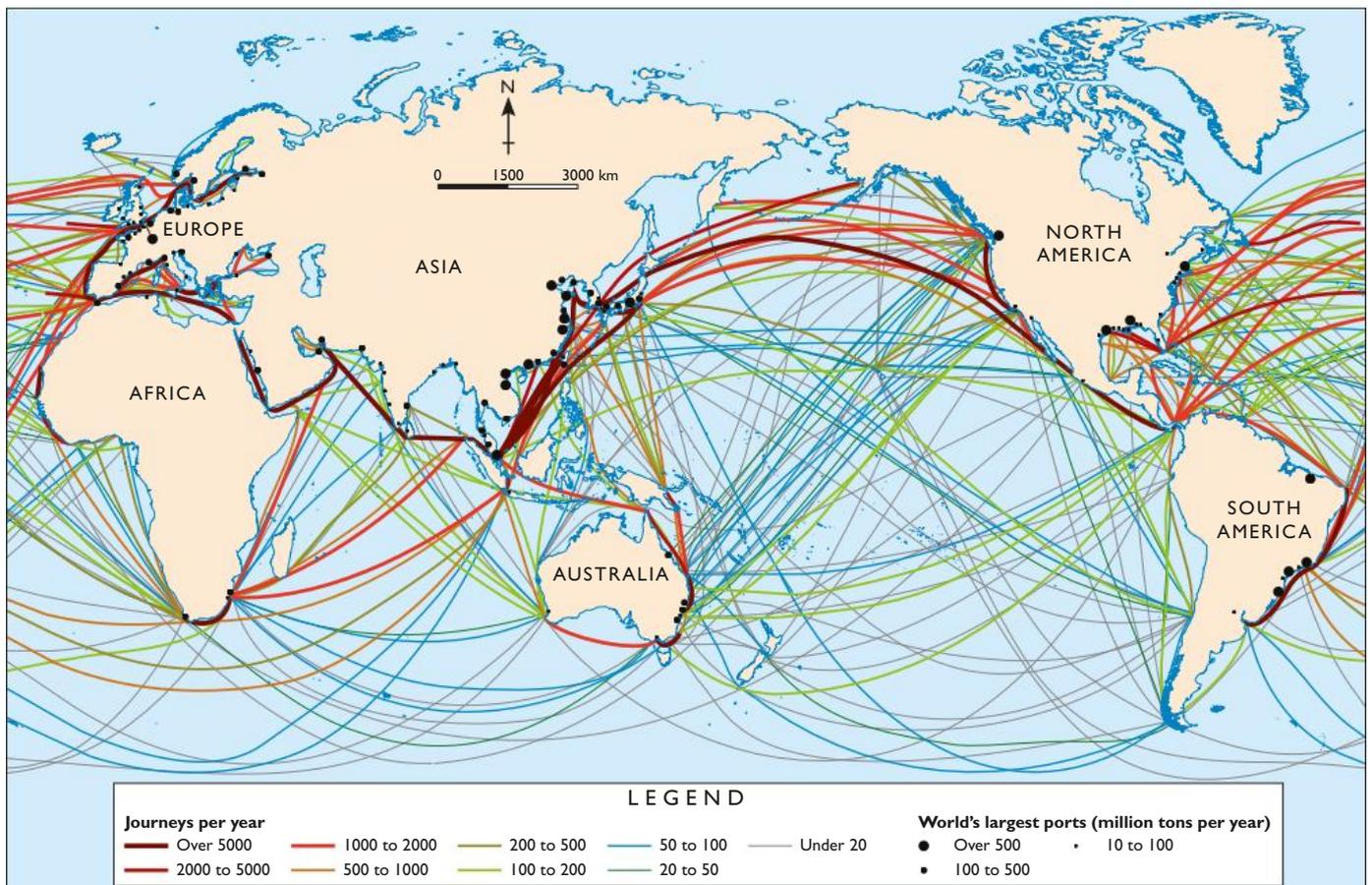
Source 1

economies, is the world's largest exporter and second largest importer. Six of the world's eight busiest ports are located in China and an estimated 121 million shipping containers pass through them every year. China is using trade from its many ports as a way to improve the wellbeing of hundreds of millions of its citizens.

keyconcept: Interconnection

Singapore and the importance of location

Singapore is one of the world's smallest countries with few natural resources. Most of the land area is used for urban development, so little remains for food production; there are no significant rivers and no mineral reserves. And yet, Singapore has one of the world's highest levels of wellbeing with an average life expectancy of over 84 years and one of the world's highest levels of GDP per person. Singapore's wealth is based largely on its geographic location at the tip of the Malay Peninsula.

Ships moving between the world's major exporters and importers have used the port of Singapore as a trading centre for hundreds of years. The Port of Singapore is connected through shipping to more than 600 ports in 123 countries around the world, making it the 'gateway to Asia'. This central location has enabled Singapore to thrive in other global industries. Singapore also imports raw materials which it turns into valuable commodities such as electronic and telecommunication goods for export. Lastly, the country is home to major oil refineries and other mineral treatment plants and is a major centre of finance.

For more information on the key concept of interconnection, refer to page 9 of 'The geography toolkit'.

Source 2 An oblique aerial photograph showing part of the Port of Singapore

Check your learning 5.6

Remember and understand

1 How does Singapore's location help to explain the high levels of wellbeing there?
2 How can countries with little in the way of natural resources work to improve their wellbeing?

Apply and analyse

3 Use the 'World statistics' section in your obook to describe overall levels of wellbeing in Singapore.
4 Examine Source 1.
   a Describe the location of the busiest shipping routes.
   b Design the course of a container ship that travels from Beijing, around the world, and back to Beijing following the busiest shipping routes. Use an atlas to make a list of the ports and countries where your ship would dock.

c Use the 'World statistics' section in your obook to explore the levels of wellbeing in the countries where your ship would dock.
   d What does this map tell you about the advantages of coastal nations in accessing trade?
   e How does this map help to explain the high levels of wellbeing in the USA, China and Singapore?

Evaluate and create

5 Conduct some further research on the Internet before completing the following task.
   a In small groups, brainstorm all the ways in which location influences a country's wellbeing. Source some images that illustrate your ideas and create a PowerPoint presentation explaining these links.

Prisoners of geography

The movement of goods and produce by sea puts cities situated on ports and trade routes at a distinct advantage when it comes to improving levels of wellbeing. Singapore and Hong Kong, for example, are rated as having levels of development that place them in the world's top 20 nations. Both are small islands with few natural resources but their location on major shipping routes and large natural harbours have allowed them to build thriving economies.

Source 1   Niger, one of the world's poorest nations, lies 600 kilometres from the nearest ocean. Virtually all goods and people must enter and leave the country by road. Less than 4000 kilometres of road in the country is paved.

Other nations find their geographical location puts them at a distinct disadvantage. Wellbeing in landlocked nations such as Mongolia, Afghanistan, Niger, Ethiopia and Bolivia is hindered by a lack of access to the sea. Virtually all goods into and out of these places must travel by land, making them significantly more expensive.

This situation is compounded if goods must travel through neighbouring countries with poor transport infrastructure, corruption or conflict. A United Nations study revealed that landlocked countries do worse than their maritime neighbours in each aspect of the HDI ranking – income, life expectancy and education.

skill**drill:** Data and information

Calculating a wellbeing index

A wellbeing index is a valuable tool that can be used to rank a group of countries being studied for example, by placing them in order from the country with the highest wellbeing to the one with the lowest. Follow these steps to develop a wellbeing index for some of the world's landlocked countries.

Step 1   Draw up a grid with 10 columns using the headings set out below (these are your key indicators) and a row for each country you are ranking. This could be done on paper or using a spreadsheet in Microsoft Excel. Using a world map as a guide, list your countries in the first column. Select a range of landlocked countries from different continents for an even spread.

Country	Infant mortality rate	% below poverty line	Life expectancy	GDP per capita	Access to clean water	Literacy rate	Total	Average	Final rank
Bolivia									
Mongolia									
Niger									

Step 2   Rank the countries from the lowest infant mortality rate to the one with the highest. For example if you have 20 countries the highest score would be 20 and the lowest would be 1. If two or more countries have the same infant mortality rate, they score the same ranking. Record these rankings in the column headed 'Infant mortality rate'. For those countries where the data is unavailable do not include them in the ranking.

Step 3   Repeat this step for the 'Percentage of the population living below the poverty line' (column 3).

Step 4   Repeat this step for 'Life expectancy' (column 4) but this time, the highest life expectancy scores 1 and the lowest scores 20.

Step 5   Repeat for 'GDP per capita' where the highest is ranked 1 (column 5).

Step 6   Repeat for 'Access to clean water' where the highest is ranked 1 (column 6).

Step 7   Repeat for 'Literacy rate' where highest is ranked 1 (column 7).

Step 8   Add the total score for each country and record this in column 8.

Step 9   Calculate the average score for each country. Divide each country's total score by the number of indicators for which they have valid data. Record this average score in column 9.

Step 10 Rank the countries based on these average scores. The country with the lowest average score will be the first ranked country. Record these ranks in the final column. You have now completed a wellbeing index of countries based on these six indicators.

Apply the skill

1   Calculate a wellbeing index for 20 of the world's landlocked countries (see Source 2).

2   Comment on the level of wellbeing of people living in landlocked countries based on your wellbeing index.

3   Examine the 'World statistics' section in your obook. List the 10 countries in the world with the lowest HDI rankings. How many of these are landlocked countries?

Extend your understanding

1   Calculate a wellbeing index for the countries of South America. How do the two landlocked countries score on your index?

2   Bolivia has no coastline but maintains a navy of approximately 5000 sailors (see Source 3). Research the history of Bolivia's access to the Pacific Ocean to find out why this country has a navy.

WORLD: LANDLOCKED COUNTRIES

Landlocked Countries (2013)
Afghanistan, Andorra, Armenia, Austria, Azerbaijan, Belarus, Bhutan, Bolivia, Botswana, Burkina Faso, Burundi, Central African Republic, Chad, Czech Republic, Ethiopia, Hungary, Kazakhstan, Kosovo, Kyrgyzstan, Laos, Lesotho, Liechtenstein, Luxembourg, Macedonia, Malawi, Mali, Moldova, Mongolia, Nepal, Niger, Paraguay, Rwanda, San Marino, Serbia, Slovakia, South Sudan, Swaziland, Switzerland, Tajikistan, Turkmenistan, Uganda, Uzbekistan, Vatican City, Zambia, Zimbabwe.

LEGEND
Landlocked country

0   2000   4000 km

Source 2   Source: Oxford University Press

Source 3   Members of the Bolivian navy

5.7 Human factors and wellbeing

In section 5A, you learnt about some of the ways in which the natural environment can influence human wellbeing and result in inequalities between countries. In this section, we will concentrate on the human factors that affect wellbeing. These human factors are a combination of different social, economic, historical and political factors. Changes in the size of populations, inequalities between different groups in society, political instability and conflict are all examples of human factors that affect wellbeing.

Demographics and changes in population

The number of people living in a country is always changing. In some countries the population is growing rapidly and in others it is declining. The rate at which populations change is largely related to changes in wellbeing.

Demographics is a term used by geographers to describe the quantifiable statistics of a population (or smaller groups within it). Looking at statistical data on population can help to identify trends in population patterns and predict future trends that could affect wellbeing within a country.

Countries tend to pass through a series of stages in terms of population change. By observing these changes in many countries over a long period, geographers were able to develop the **demographic transition model** (Source 1).
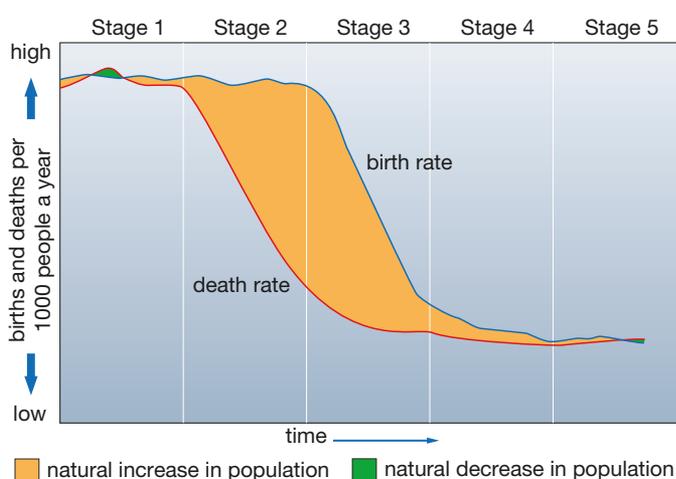
Looking at population trends

Many developing countries around the world today, particularly in Africa and Asia, are currently in stage two according to the demographic transition model. Death rates have fallen dramatically as better health care, sanitation and the provision of fresh water have improved the health and life expectancy of millions of people. Improvements have also been made in the care offered to women giving birth and of their newly born children. Millions more babies are now surviving into adulthood as a result of these improvements.

While these improvements have led to people enjoying longer, healthier lives, they have also created a problem. In these countries, there is currently a gap (or lag) between the fall in the death rate and a fall in the birth rate, so populations are growing rapidly (see Source 1). As a result, the population of Africa, for example, is expected to double in the next 40 years to more than 2 billion.

In contrast, many developed countries in regions such as North America and Western Europe have reached stages four and five in their demographic transition. Birth rates have now fallen to such an extent that some of these countries are facing an overall

Source 2   The population of Nigeria increases by 2.6 per cent per year. Already home to 170 million people, its population is predicted to exceed 400 million by 2050. The population of its capital, Lagos, is expected to triple to over 30 million inhabitants in the same time period.

Source 1   The demographic transition model

decline in their populations. The reasons for this fall differs between countries but there are some common factors. A general improvement in living conditions, high use of contraception and other family planning methods, high rates of education and work participation amongst females and a movement from rural living to large cities all seem to be contributing factors to the falling birth rates.

Case study: China's one-child policy

Perhaps the most famous attempt by a country to reduce its birth rate has been China's 'one-child policy'. Introduced in 1979, its aim was to reduce the rate of population growth in the world's most populous country. Couples in China were encouraged to have only one child, although the policy was unevenly applied across the country. One-child families were given better access to education, health care, jobs and houses while those that had more children were fined and lost access to important social services.

The policy has been successful in reducing China's growth rate and has likely resulted in 300 million fewer births since it was implemented in 1979. But there have also been a range of unintended consequences which are now causing concern.

In China, people prefer to have sons rather than daughters, as boys traditionally support their parents

Source 3 A mother in Shaoyang plays with her son in front of a family planning poster.

in their old age. As parents could only have one child, many were ensuring that this was a boy. In some cases, this involved using an ultrasound machine to determine the sex of the foetus, and aborting the pregnancy if it was a girl. In other cases, baby girls were abandoned or sent to orphanages. This has led to a large imbalance between the sexes in some parts of China with 13 males born to every 10 females.

China's one-child policy began to be formally phased out in 2015.

Check your learning 5.7

Remember and understand

1 Why can it be useful to analyse statistical data on population?

2 Why have death rates fallen in many developing countries over recent times?

Apply and analyse

3 In what ways would the demographic transition model be useful for geographers studying population trends?

4 Use the 'World statistics' section in your obook to find the birth and death rates for Australia, Afghanistan, Italy and Timor-Leste (East Timor).

 a Which of these countries would you describe as having a rapidly expanding population, which is relatively stable and which has a declining population? Explain your answers.

 b In which stage of demographic transition is each of these countries? What challenges do planners in Italy and Timor-Leste face?

5 What was China's one-child policy designed to do? Describe its results in terms of the demographic transition model.

Evaluate and create

6 Conduct some further research before completing the following task.

 a What messages do you think are being communicated on the billboard shown in Source 3? Do some extra research to investigate the issues surrounding family planning in China and its impacts on Chinese people. Share your research in groups of three or four and summarise your findings.

5.8 Changes in population structure

Population structure is a term used to describe the different groups in society that together make up the total population. Geographers often identify groups according to their age and sex. One of the most useful tools that geographers use to study a country's population structure is called a **population pyramid**. Population pyramids graph the population of a country in age segments (shown in the central axis). Males and females are shown separately – males are always shown on the left of the pyramid and females on the right.

How population affects wellbeing

Population pyramids help geographers to identify trends in populations. The overall shape of the pyramid can indicate whether a country's population is growing, contracting or remaining relatively stable. Countries with a rapidly growing population tend to have pyramids that are wide at their base and narrow at their top (Source 2).

Countries with a population that is growing slowly have a different shaped pyramid (Source 3). The base is much narrower because birth rates and fertility rates are lower. In these countries, much of the population is of working age.

Countries with a declining population tend to have a population pyramid that looks like an inverted pyramid (Source 4). In these countries, the birth rate is low so the base of the pyramid is very narrow. There is usually a large group of people over 60 years of age as life expectancy is high and death rates are low.

Source 1 The population of Italy is ageing and declining due to a very low birth rate.
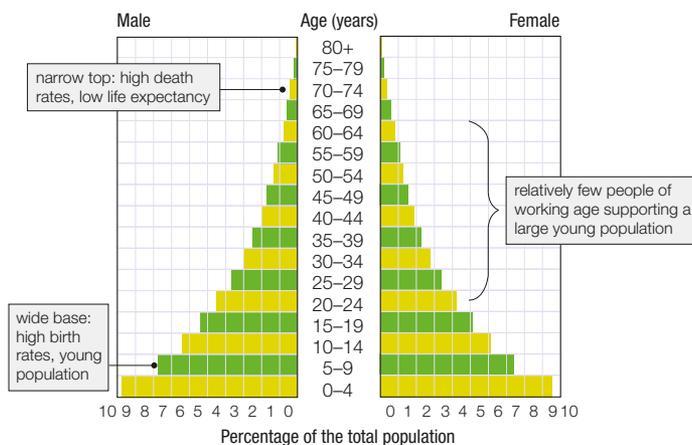
Source 2 The population pyramid for Niger, an example of a rapidly growing population
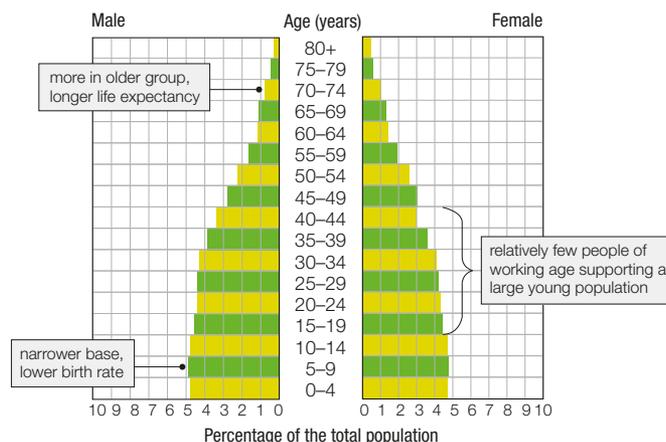
Source 3 The population pyramid for Indonesia, an example of a slowly growing population

Source 4 The population pyramid for Italy. An example of a declining population

skill**drill:** Data and information

Constructing a population pyramid

You can construct your own population pyramid by following these steps. Population pyramids are fairly simple to construct but accuracy is very important so take your time. For more information on population pyramids, refer to page 23 of 'The geography toolkit'.

Step 1 Draw the horizontal axis (the *x*-axis) which will show the percentage of the population. Leave a gap in the centre similar to the population pyramids shown in Sources 1–3. Your age ranges will go in this space.

Step 2 Add the scale 0 to 10 on each side, working from the centre outwards. Label your *x*-axis 'Percentage of the total population'.

Step 3 Add the centre axes (the *y*-axes) as per the population graph in Source 2. Label the *y*-axes 'Age (years)'. Remember that males are always shown on the left and females on the right, label the left side 'Male' and the right side 'Female'.

Step 4 Mark the scale on the *y*-axes. You will need to allow for 20 rows.

Step 5 Add the labels for each age group span in the centre space. Start with 0–4 at the bottom and increase in intervals of four years until you reach 100+.

Step 6 Transfer information from your data set onto your population pyramid. Draw bars in for each age group's data. Use a ruler and sharp pencil. Make sure that each bar is exactly the same width.

Age	Males (%)	Females (%)
0–4	3.3	3.2
5–9	3.3	3.1
10–14	3.1	2.9
15–19	3.2	3.0
20–24	3.6	3.4
25–29	3.7	3.7
30–34	3.7	3.7
35–39	3.3	3.3
40–44	3.5	3.5
45–49	3.3	3.3
50–54	3.2	3.3
55–59	3.0	3.1
60–64	2.7	2.8
65–69	2.4	2.5
70–74	1.8	1.8
75–79	1.3	1.4
80–84	0.8	1.1
85+	0.6	1.2

Source 5 The population of Australia, 2015

Step 7 Lightly shade each bar using two alternating colours so the graph is easy to read. Add a title.

Apply the skill

1 Construct a population pyramid for Australia in 2015 using the data from Source 5.

2 Add three labels to your Australian population pyramid, similar in style to those on the three population pyramids shown in Sources 2–4 describing three key features of the structure of Australia's population.

Check your learning 5.8

Remember and understand

1 Describe the appearance of a population pyramid for a rapidly growing population.

2 Which of the population pyramids shown on these pages represents the most rapidly growing population?

Apply and analyse

3 Use the 'World statistics' section in your <u>o</u>book to list the fertility rates in Niger (Source 2), Indonesia (Source 3), Italy (Source 4) and Australia. What link can you make between the shape of the pyramids of these countries and their fertility rates?

Evaluate and create

4 Using the four population pyramids (Italy, Niger, Indonesia and Australia) as a guide, match each country with its current position in the demographic transition model (Source 1 on page 190).

5.9 Population growth and inequalities in wellbeing

The countries in which poverty levels are the highest are generally those that have the most rapid increases in population and the highest fertility levels.

United Nations Population Fund

The populations of most countries around the world are increasing. In some countries, such as Australia and the United States, the population is growing slowly, and in other countries, such as Niger and Uganda, it is growing rapidly. Populations grow when the number of arrivals from births and immigration is greater than the number of departures from deaths and emigration. In most cases, the growth of a country's population is largely determined by the **fertility rate**.

Many people living in countries with a rapidly growing population experience difficulties accessing vital services. These include access to education, food, safe drinking water, electricity, communications and transportation. Access to health services such as hospitals, doctors and medicines is also much lower than in countries with slowly growing or declining populations. Infant mortality and maternal mortality (mothers dying due to pregnancy or childbirth problems) are also much higher in rapidly growing populations. This is largely because many births in these countries are not attended by health professionals.

WORLD: TOTAL FERTILITY RATE
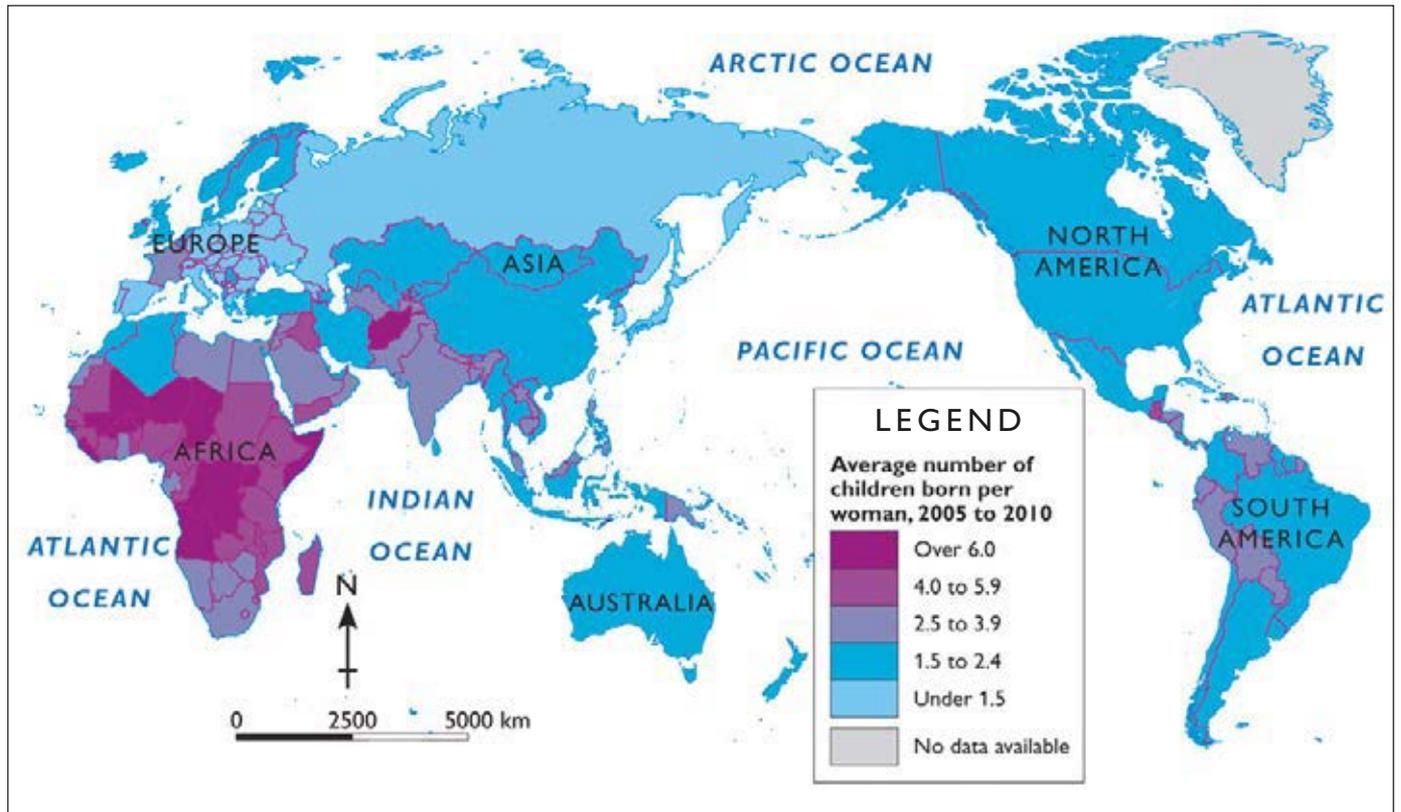
Source 1

Source: Oxford University Press

Gender inequality and fertility rates

Gender inequality fuels population growth. Where women are denied full legal, social and economic rights, such as education, secure livelihoods, property ownership and credit, they are forced to rely on childbearing for survival, status and security.

Lakshmi Puri, Assistant Secretary-General of UN Women, 2011

Many researchers believe that the lower status of women, particularly in developing countries, contributes to higher fertility rates as women with lower levels of education tend to have more babies. In turn, higher fertility and larger families make it even more difficult for women to attend school or to participate in the workforce and in government.

Inequality between women and men is both a cause of inequality in wellbeing and one of its effects. Societies in which women have a lower status in education, employment and government tend to have lower levels of wellbeing than those with less or no gender discrimination.

Source 2 Niger is the only country in the world where the average number of children born to each woman (known as the fertility rate) is greater than seven. Of the 15 countries with the highest fertility rates, 14 are in Sub-Saharan Africa. The other country is Afghanistan.

Source 3 The adult literacy rate for Yemen is 43 per cent for females and 79 per cent for males.

Check your learning 5.9

Remember and understand

1 What is meant by maternal mortality?

2 What might be a cause of higher rates of infant and maternal mortality in countries with rapidly growing populations?

3 What is the fertility rate in Australia? Name three other countries with a similar fertility rate.

4 Explain the links between gender inequality and population growth in your own words.

5 What sort of services are difficult to access in countries with rapidly growing populations?

Apply and analyse

6 Examine Source 3.
  a Estimate the proportion of girls and boys in this school in Yemen.
  b How does this help to explain the gap in literacy levels between males and females in Yemen?

7 Examine Source 1.
  a Use the PQE method to describe the pattern shown on this map. For more information on the PQE method, refer to page 28 of 'The geography toolkit'.
  b Compare this map to the world maps showing the proportion of population living in poverty (Source 2 on page 144), GDP per capita (Source 1 on page 148), hunger levels (Source 1 on page 152) and literacy rates (Source 2 on page 156). For each map write a one-sentence summary of the similarities that you notice.
  c Based on the summaries you have written, what is the most significant link between fertility rates and human wellbeing?

5.10 Gender and inequalities in wellbeing

Throughout much of the world today there are **gender inequalities**. For example, if you are a woman, you are more likely to be living in poverty and unable to read or write. You are more likely to be a refugee and subject to gender-based violence. You are also less likely to be in government, to be employed or to own property.

As we have learnt, there are certain key indicators that can be used to measure wellbeing. Three important ways to assess gender equality in a country are by measuring women's participation in education, the workforce and government. It is these three things that are essential to raising the status of women and providing opportunities for better jobs, higher levels of wealth and female-friendly government policies.

Gender inequality in education

In many countries around the world, boys outnumber girls in schools particularly at secondary school level (see Source 1). The gap is wide throughout South Asia, for example, where the number of girls attending secondary schools is low compared to boys – only 75 girls for every 100 boys. This gap is a reflection of gender-based discrimination in societies where sons are often considered more important than daughters. Poverty also has an effect on this inequality. In India, for example, girls from poorer families who do attend school at all, attend inferior schools that teach nothing more than basic literacy and numeracy. Higher levels of schooling cost money and poor families are more willing to invest in their sons than their daughters.

Gender inequality in government

In every country of the world, less than half of the representatives in national parliaments are women (see Source 2). Globally, women make up only 18 per cent of the world's elected officials. The Scandinavian countries and Iceland have the highest number of women in government, with Spain, South Africa and Argentina also having better than average numbers. Low levels of representation in government can make

WORLD: GENDER PARITY FOR ENROLMENTS IN PRIMARY AND SECONDARY EDUCATION

LEGEND
Gender parity for enrolments in primary and secondary school education
- Achieved for primary only
- Achieved for secondary only
- Achieved for both
- Not achieved for either
- No data available

N

0   2000   4000 km

Source 1   Source: Oxford University Press

WORLD: PERCENTAGE OF WOMEN IN NATIONAL GOVERNMENTS

LEGEND
Percentage of seats held by women in national parliaments
- Over 40
- 30 to 40
- 20 to 30
- 10 to 20
- Under 10

N

0   2000   4000 km

Source 2   Source: Oxford University Press

çit difficult for gender equality laws such as universal education to be discussed and enacted.

## Gender inequality and job opportunities

Women own about 1 per cent of the world's resources and earn one-tenth of the world's income. In many places around the world their participation rates in the paid workforce are much lower than men's (see Source 3). The Middle East and North Africa have the lowest levels of female participation in the workforce. Even in the

developed world, where women's participation is high, women tend to earn less than men and occupy lower-level positions.

In many of the places where women have low participation rates in the paid workforce, they are instead doing unpaid agricultural work. Approximately 60 per cent of women in developing countries work in farming. These women work long hours every day on family farms that produce just enough food to support their families. They also perform most of the domestic chores such as collecting wood and water, caring for children and preparing food.
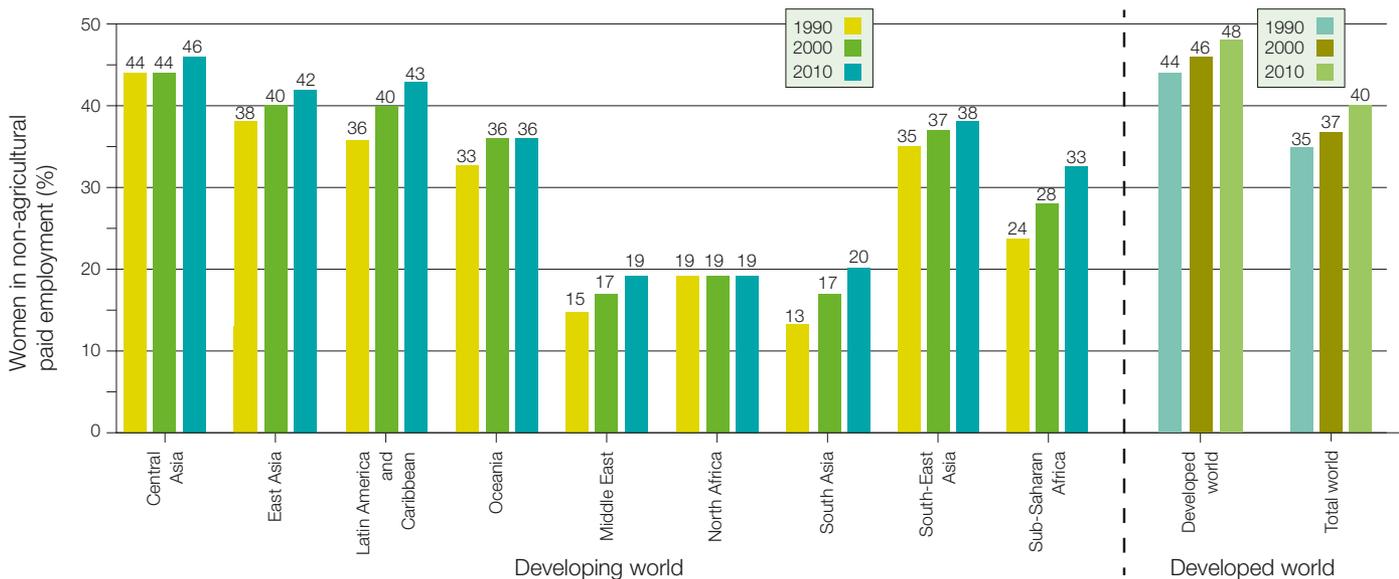
Source 3   Percentage of employees in non-agricultural employment who are women

Check your learning 5.10

Remember and understand

1   Define the term 'gender inequality' in your own words.

Apply and analyse

2   Examine Source 1.

   a   In which regions of the world has parity (equal numbers) of male and female students been achieved for both primary and secondary education?

   b   Use the map in Source 1 on page 194 showing fertility rates to comment on the fertility rates in the regions you listed in (**a**).

   c   What relationships can you see between education parity and fertility?

3   Use the sources provided to compare the regions of Europe and Sub-Saharan Africa in terms of:

   a   parity in education

   b   women in non-agricultural employment (note: Europe is included as part of the 'Developed world')

   c   the percentage of women in government.

Evaluate and create

4   Conduct some further reading before completing the following tasks.

   a   Research gender equality and inequality in Australia. Focus on issues such as employment, wage levels, number of seats in parliament and education.

   b   Present your findings as a written report. Remember to acknowledge the sources of the data you use in your report.

5.11 Technology and inequalities in wellbeing

Technology is a very broad term used to describe a range of different tools, machinery, techniques and systems to solve a problem or achieve a goal. From the times of earliest human societies, people have strived to find new and better ways of growing food, accessing water, treating medical problems and improving sanitation. All of these technological developments were designed to improve wellbeing. Over the last 200 years, there have been many significant advances in technology that have fundamentally changed the way we live and work. These advances have had enormous impacts on societies. Some of the biggest changes occurred during the Agricultural Revolution of the 18th century and the Industrial Revolution of the 19th century.

These revolutions, however, were concentrated in Europe and the United States and their impacts were greatest in the parts of the world now known as the developed world. The people of Europe may have been living with the benefits of these revolutions for generations but in many Asian and African countries, they are still using farming methods not seen on Europe's farms for hundreds of years.

Case study: differences in dairy farming technology

Differences in the availability and use of technology between the developed world and the developing world can be seen clearly in these examples of dairy farming in Laos and New Zealand.

The woman shown in Source 1 is a farmer in Laos. She is bringing her herd of four cows to a small shed leaning against her house. She will spend the next hour or so milking the cows by hand into a bucket. This will provide enough milk for her family to be able to make their evening and morning meals. The cows will stay in the shed overnight and be milked in the early morning. During the day they will be able to wander across the countryside but will be accompanied by one of the children of the family whose daily task is to make sure the cows are fed, keeping the child out of school. Their droppings will be collected and used for fertiliser, fuel for the cooking fire or mixed with straw and used

for mud bricks. On some days, the larger cow will be used to plough the family rice field, pulling a plough through the mud.

The farm in Source 2 is also a dairy farm. The family ride motorbikes to herd the cows into a mechanised milking shed. Suction cups are attached to the cows' udders and the milk is pumped into large storage tanks ready for collection by a refrigerated milk tanker later in the day. Because the milking is mechanised, the farmer and one other worker are able to milk 1200 cows twice a day, producing much more milk than the farmer and his family can consume. The milk is sold to the local dairy factory where it is treated and used to supply the needs of the people in towns and cities throughout the South Island of New Zealand.

Source 1   A dairy farm in Laos, 2012

Source 2   A dairy farm in New Zealand, 2012

Information and communications technology (ICT) and wellbeing

Technology is always moving forward. We are currently experiencing a kind of information revolution in which the growth and spread of ideas and knowledge is occurring much more rapidly than at any time in the past. To a large degree this is being fuelled by advances in information and communications technologies (ICT).

ICT has the potential to improve the wellbeing of people throughout the world. Already, the information revolution has made it easier for businesses on opposite sides of the world to work with each other. It has also allowed Western companies to access cheaper labour in developing countries by outsourcing jobs overseas. The outsourcing of jobs in call centres and IT services, for example, has provided new employment opportunities and increased wellbeing in countries such as India and the Philippines. The spread and influence of the information revolution throughout the world, though, remains uneven (Source 3).

WORLD: INTERNET USE AND POPULATION

LEGEND
Large population with many IP addresses
Small population with many IP addresses
Large population with few IP addresses
No Data
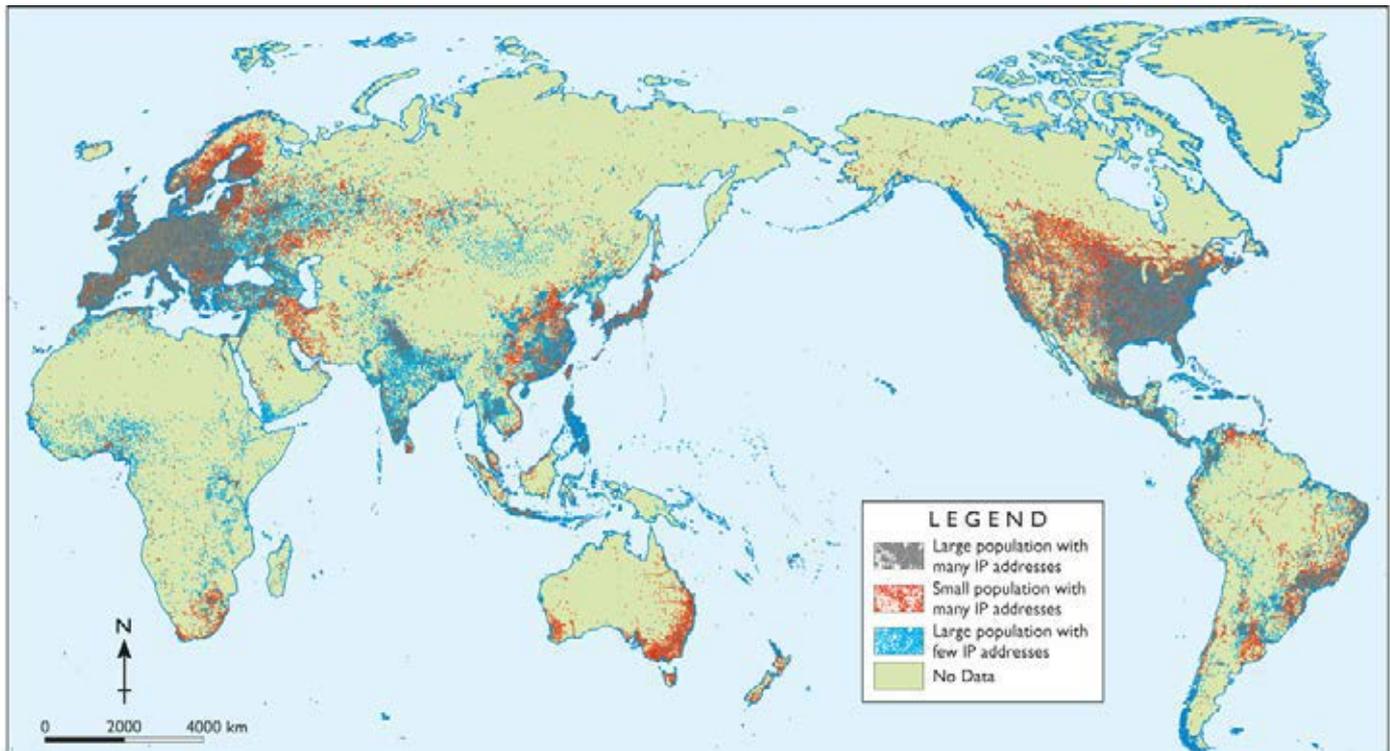
Source 3   Source: Oxford University Press

Check your learning 5.11

Remember and understand

1   What is technology?

2   In which areas do humans seek to improve wellbeing through the use of technology?

3   How has the outsourcing of jobs by Western countries improved wellbeing in India and the Philippines?

Apply and analyse

4   Compare Sources 1 and 2.

   a   Comment on the levels of technology used by dairy farmers in these two places.

   b   Use the 'World statistics' section in your obook to compare levels of wellbeing in these two countries.

5   Examine Source 3.

   a   Describe the general pattern of Internet use on this map.

   b   Compare this map to Source 1 on page 144 showing HDI rankings around the world. What links do you notice between the HDI rankings and Internet traffic?

   c   How would you account for these links?

5.12 Politics and inequalities in wellbeing

Politics is a term used to describe all of the activities associated with governing a country or region. Thomas Jefferson (1743–1826), third President of the United States and principal author of the Declaration of Independence, was a gifted politician. According to Jefferson, good governments were those that protected the rights of individuals, encouraged economic freedom, promoted happiness and listened to the will of the people. Although Jefferson died almost 200 years ago, his beliefs still hold true. Governments wield enormous power over their citizens. Some are good, while others are bad. Regardless of this, they are all responsible for influencing levels of wellbeing among their citizens.

Source 1 In some countries, such as South Sudan, children are forced into conflict and become child soldiers. Some groups, including Amnesty International, argue that 'the right to refuse to kill' should be added to the list of basic human rights.

The Universal Declaration of Human Rights

On 10 December 1948, the United Nations General Assembly adopted the Universal Declaration of Human Rights. After World War II, the newly formed United Nations decided to set an international agreement of basic human rights that should be made available to all. The idea was that those in power would be responsible for ensuring that the human rights of their citizens were protected to the best of their government's ability.

This was the first time in history that the nations of the world had listed the basic human rights to which all human beings are entitled. The Declaration now underpins many laws to protect basic human rights all around the world. These rights include:

- the right to equality, life, freedom, security, equality before the law, a fair public hearing, be presumed innocent until proven guilty, move freely, seek asylum in another country, marriage, family, own property, freedom of opinion, peaceful assembly, free elections, social security, desirable work, rest, adequate living standards, education and to share in scientific advancements
- freedom from discrimination, slavery, torture, arbitrary arrest, interference with privacy, religious persecution, state or personal interference in the above rights.

Government corruption

Many researchers believe that the abuse of political power is the leading cause of poverty and inequality in the world today. In particular, they point to the corruption that exists in many developing nations where those in power use their position for their own benefit rather than the benefit of the country.

Source 2 ranks the countries of the world according to the level of economic freedom. This data is compiled by scoring nations on various indicators including the level of corruption, labour freedoms and property rights.

Government corruption usually leads to the repression or punishment of any individual or group that speaks out against the government. In some cases,

WORLD: LEVELS OF ECONOMIC FREEDOM

Source 2

LEGEND
Level of economic freedom
- Free
- Mostly free
- Moderately free
- Moderately unfree
- Repressed
- No data available

Cuba Most repressed nations
Aust Freest nations
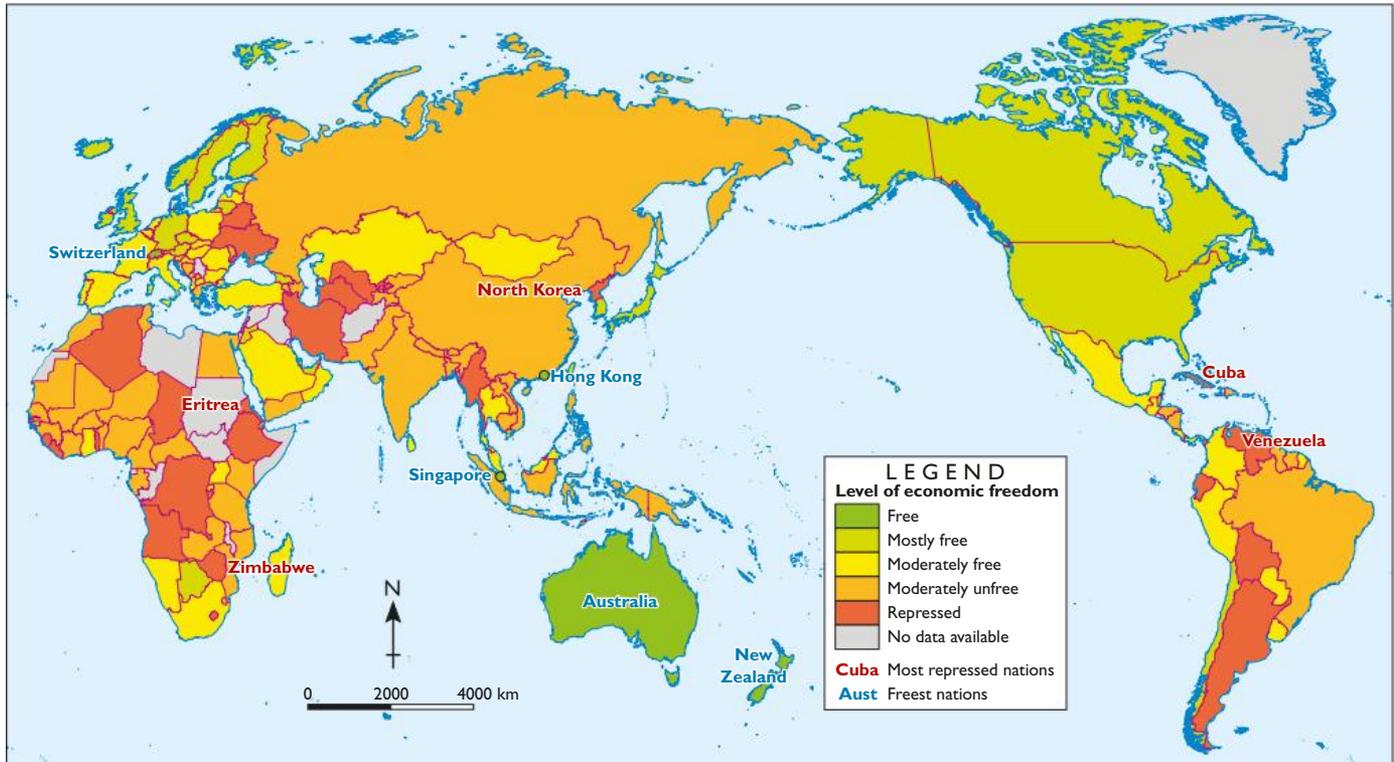
Source: Oxford University Press

Source 3   North Korea is one of the world's most repressed nations. It is very difficult to access data for North Korea but it is estimated that more than one-quarter of North Koreans live below the poverty line. Despite this, it is believed that up to one-third of the annual budget is spent on the military under a policy known as 'songun' or putting the military first.

the struggle between different political groups within a country can result in civil war and ongoing conflict, an example of this is the current civil war in Syria. Along with environmental degradation, corruption and conflict are the two factors most likely to halt or reverse upward trends in improved wellbeing, affecting people's health, education and economic activity.

Check your learning 5.12

Remember and understand

1   Describe Jefferson's idea of good government.

2   How can corruption and conflict within a country affect the wellbeing of its people?

Apply and analyse

3   In which regions of the world are people most repressed?

4   In which regions are people most free from repression?

5   Access the full list of rights and freedom outlined in the Universal Declaration of Human Rights online. Discuss with a partner how it would influence wellbeing if these rights were adopted as law in every country in the world.

Evaluate and create

6   Using Source 2 and an atlas, select four countries from each level of the five levels of economic freedom. Use the 'World statistics' section in your obook to research the HDI ranking of each of these 20 countries. Construct a scatter plot comparing the level of economic freedom in each country with its HDI ranking. Describe the pattern shown.

5.13 Conflict and wellbeing

Wars and civil conflicts are complex events. There is rarely, if ever, a single factor that causes them. An intricate set of social, historic and physical factors lie behind one group of people or nation attacking another. The costs of war are immense both in terms of human life and economic resources. For a country to go to war there must be enormous perceived benefits to the winner of that war. Often these benefits are resources that will impact positively on the wellbeing of the victorious party. These may include oil, areas of desirable land, or access to water.

Why conflicts happen

Countries go to war for many reasons. They may see the opportunity to gain more land or more valuable resources, or they may want to remove a potential security threat. They may go to war for religious reasons, or to fight a rival ethnic group.

Source 2 shows the reasons for the 396 conflicts recorded in 2012 by the Department of Political Science at the University of Heidelberg, Germany. In their annual report on global conflict, the university also classifies conflict as peaceful disputes over politics or borders (low intensity), conflicts involving infrequent fighting (medium intensity) and conflicts involving constant fighting (high intensity).

Studies consistently show that few conflicts are fought solely over natural resources. Indeed, of the 396 conflicts in 2012, only six were considered to
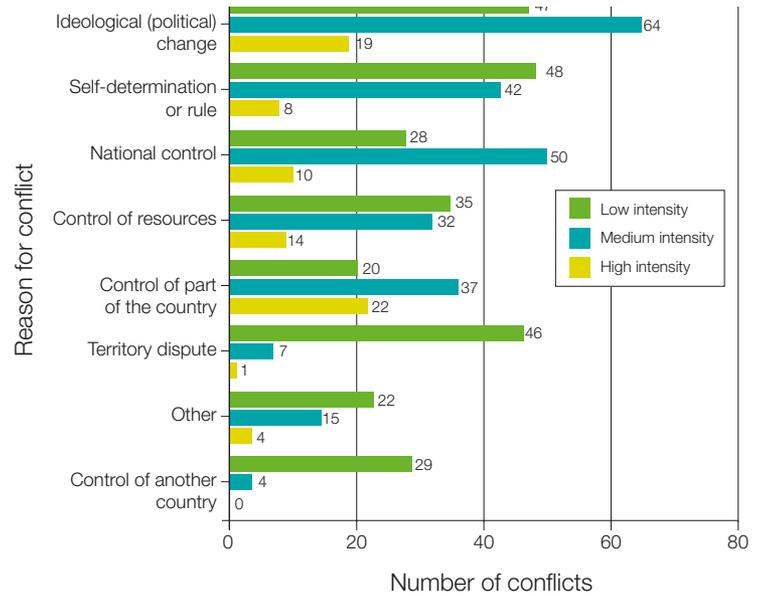
Source 2 The major causes of conflict in 2012 worldwide

be fought purely on this basis. And yet, about 40 per cent of all civil wars in the last 60 years have partially involved struggles for control of natural resources, including at least 18 violent conflicts since 1990. Many of these are in Sub-Saharan Africa where rebel soldiers loyal to different warlords fight to gain control of valuable mineral resources. Income earned from mining these resources is used to fund further fighting, often for other reasons such as the control of part of the country or attacks on neighbouring countries.

Source 1 The Rwandan genocide which resulted in more than half a million deaths and the displacement of millions more was fought, in part, over the control of land, a valuable resource in this densely populated region of central Africa.

Case study: water wars

One of the most valuable resources in many parts of the world today is fresh water. Disputes over its control have occurred for thousands of years and many analysts believe that this will accelerate in the future as water resources become scarcer and populations continue to grow. Water wars follow the trends of most disputes over resources: they tend to be within, rather than between, countries, and the tension over the resource is usually not the only cause of the conflict.

In recent times, there have been conflicts over the water resources of the Aral Sea in central Asia, the Tigris, Euphrates and Jordan rivers in the Middle East and the Nile and Okavango rivers in Africa. There is also ongoing tension between Pakistan and India, partially over the the rivers in the Kashmir that feed into the Indus River basin. The Arab–Israeli War in 1967 (also known as the Six-Day War) was fought, in part, for control of the Golan Heights, an important water source for both Israel and its neighbour Syria. The area was seized by Israel at the end of the war and the Golan Heights now supplies one-third of the nation's water. The Darfur conflict in Sudan, which started in 2003, is sometimes called the 'world's first climate change war', as different ethnic and religious groups fight for control of dwindling water resources.

Source 3 India and Pakistan have fought sporadically for control of the territory of Kashmir since 1947. Part of the dispute is over the water that flows from India into Pakistan – a valuable resource in this region. Pakistan accuses India of diverting much of this water before it reaches Pakistan. India denies this.

Check your learning 5.13

Remember and understand

1 What were the three most common reasons for armed conflict in 2012?

2 Why do some analysts believe that more wars in the future will be fought over water?

Apply and analyse

3 Examine Source 2.
   a Add up the total number of reasons for war shown here.
   b Explain why this number is higher than the total number of conflicts (396).
   c High intensity conflicts were most commonly fought for what reason? Give some possible explanations for this.
   d Estimate what percentage of conflicts involved a battle for resources.

4 Use an atlas to describe the course of the Indus River. Where is the river's source? How does this help to explain the six-decades-long tension between India and Pakistan?

5 Use an atlas to describe the course of the Okavango River. How might this help to explain ongoing tension between Namibia and Botswana?

6 Examine Source 3. How has conflict impacted on the wellbeing of these people?

Evaluate and create

7 Conduct some further Internet research before completing this task.
   a Prepare a short speech examining the statement, 'Scarcity leads to conflict'. Provide evidence from these pages and your own research to agree or disagree with this statement.

5.14 The lasting impacts of conflict

Conflict at any scale and any intensity almost always has wide-ranging and long-term impacts on human wellbeing. Countries can take decades to recover from the impacts of war, preventing people from accessing opportunities to improve their wellbeing. Source 1 lists some of the common effects of high-intensity conflicts.

Source 1 Impacts of conflict at the personal, local, regional and national scales

Impacts at the personal scale:
- reduced quality of life
- reduced ability to makes choices about lifestyle
- loss of life
- impact on personal dignity and human rights
- impact on health and a reduced ability to access appropriate care
- loss of connection to other people in other regions
- individuals forced to fight
- targeted attacks on schools reduce the opportunity to have an education
- greater incidence of sexual violence.

Impacts at local and regional scales:
- decreased access to land, leading to food insecurity
- collapse of systems such as transport, food supply and local government
- fewer job opportunities
- breakdown in transport and communication networks
- displaced people put stress on infrastructure such as water and health systems in neighbouring places
- unsustainable use of natural resources to fund the conflict
- loss of productivity due to labour shortages.

Impacts at the national scale:
- environmental degredation, e.g. forest clearing and landmines
- food insecurity and dependency on aid
- refugees flee to other countries
- decline in national economy and less public spending as money is spent on conflict
- neighbouring nations often increase their military spending
- less spending on education (21 developing countries spend more on arms than on education)
- military spending results in less financial aid for developing countries.

Source 2 Girls prepare to sleep in an NGO shelter in Gulu, Uganda. There are about 20 000 night commuters that sleep in Gulu town every night, some walking hours from their home villages. They do this to escape the lasting impacts of conflict. The girls are afraid of being abducted by the Lord's Resistance Army (a militant group of rebels fighting for control of Uganda). The Lord's Resistance Army has been accused of widespread human rights violations including murder, mutilation and child sex slavery.

Case study: landmines

Landmines are explosive devices that are triggered by a weight pressing on them – most commonly from someone stepping on them or a vehicle driving over them. Placed during wartime, landmines are used to destroy enemy vehicles, kill enemy soldiers and make roads and other areas impassable.

But the impacts that landmines can have on a country's wellbeing last long after the end of the war. Landmines kill and injure civilians and livestock, not only during the conflict but long after it has finished. Landmines also contribute to land degradation and can significantly limit the areas that can be used for farming.
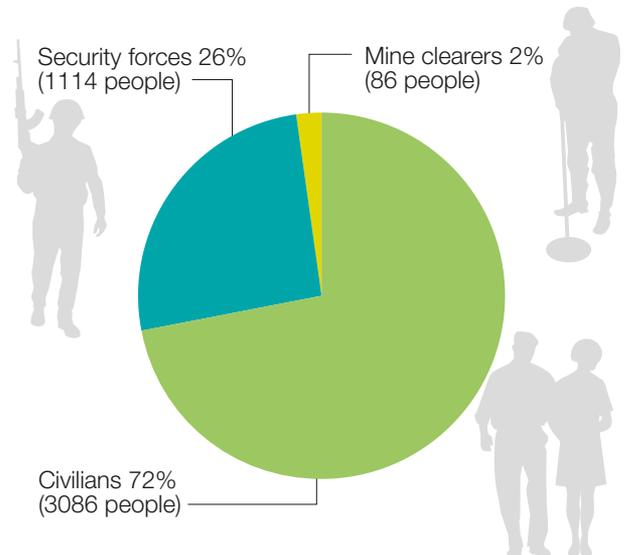
The Landmine and Cluster Munitions Monitor (an organisation that carries out research and monitoring into the consequences of landmines) estimates that 59 countries are affected by landmines and that there are more than 4000 casualties a year as a result of landmines exploding (see Source 4). In 2011, for example, 1320 people were killed by landmines and 2907 were injured. Approximately one-third of these victims were children.

The countries with the most landmines are those currently involved in conflict such as Iraq and Afghanistan and in recent conflicts such as Angola, Somalia and Bosnia-Herzegovina. However, older conflicts have also left terrible marks on some countries. Cambodia still has up to 10 million landmines from the Cambodian Civil War and the border wars which followed in the 1970s. It now has one of the highest rates of physical disability of any country in the world (see Source 3). Egypt also has an estimated 23 million unexploded landmines, relics from World War II and conflicts with Israel in the 1960s and 1970s.

While landmines can be located with metal detectors and defused, this is a costly, dangerous and technically advanced task. A mine can be purchased on the black market for US$3 but may cost US$1000 to remove.

Source 4 Worldwide landmine casualties (injuries and deaths) in 2011 (divided by military and non-military)

Security forces 26% (1114 people)
Mine clearers 2% (86 people)
Civilians 72% (3086 people)

Source 3 A landmine victim learns how to farm without legs in a rehabilitation centre in Cambodia.

Check your learning 5.14

Remember and understand

1 What are some of the impacts of war at the national scale?

2 What are landmines?

Apply and analyse

3 Access the latest annual report of the Landmine and Cluster Munitions Monitor.

   a Which countries used landmines in the last year? Map these countries on an outline world map.

   b What advances were made in clearing landmines?

   c Where does Australia rank in terms of the size of its landmine stockpile?

4 Which impacts of conflict listed in Source 1 could apply to landmines?

5 Why are children often the group most impacted by war?

Evaluate and create

6 Conduct some further Internet research before completing this task.

   a Construct a flow diagram showing how impacts at the personal scale can become impacts at the national scale and vice versa.

5.15 War in Darfur

Darfur is a **semi-arid** and **arid** region of western Sudan in northern Africa. It borders the countries of Chad, the Central African Republic and the world's newest country, South Sudan (which gained its independence from Sudan in 2011). Sudan has been in a state of almost continual conflict since it was granted independence from Britain in 1956. The most recent conflict (commonly referred to as the War in Darfur) began in 2003 when several armed rebel groups attacked Sudanese army units, police stations and a military airfield after accusing the government of favouring Sudanese Arabs and suppressing non-Arab Sudanese.

The government army, along with an armed Arab group, the Janjaweed (literally 'evil men on horseback') responded by attacking unarmed civilians in the Darfur region. Targets of the attacks tended to be non-Arab Sudanese of black African descent, most of whom were poor subsistence farmers. Hundreds of villages were bombed with military aircraft before the Janjaweed attacked, slaughtering and raping tens of thousands of people and laying waste to huge areas of farmland. Some claim that the Janjaweed attacks were not random but targeted at particular ethnic groups.

An estimated 2.7 million people – one-third of Darfur's total population – fled the conflict to other parts of Sudan and to Chad. This created a second crisis, as malnutrition and disease soon swept through the temporary camps of the refugees, killing thousands of people. It is difficult to know exactly how many people died as a result of the War in Darfur but estimates place the number at about 300000.

The underlying reasons for this conflict are complex and interconnected. In Darfur, communities feel separated and isolated by differing religious beliefs and ethnic backgrounds, a lack of involvement in the political process and poverty. Distrust and hatred of other groups often boils over into conflict. In addition to these reasons, some analysts also believe that the War in Darfur is a fight for dwindling resources, particularly water and arable land.

Source 1 An oblique aerial photograph of the burned-out village of Gaz Amir in eastern Chad. The village was destroyed in 2007 in revenge attacks after attacks by the Janjaweed.

Source 2 The victims of the War in Darfur in a refugee camp in eastern Chad

keyconcept: Interconnection

The world's first climate change war?

A United Nations study in 2007 found that changing rainfall patterns and desertification in the region was forcing people to move south into areas where they came into conflict with communities of differing ethnic and religious backgrounds. The report found that climate change was creating 'unavoidable pressure on people through migration, displacement, food insecurity and impoverishment, possibly ending in conflict.' It also stated that this could trigger other wars in Africa. Other experts point to the long-running political and ethnic tensions along with a rapid increase in the number of guns as the main causes of the conflict.

Source 3 shows the movement of the 400 mm isohyet (a line drawn on a map, which connects places that receive the same amount of rainfall and separates places that receive different amounts of rainfall). Here, this line joins together all places that received 400 mm of rain in a year. Places north of this line in Sudan receive less than 400 mm of rainfall a year, making farming very difficult.

For more information on the key concept of sustainability, refer to page 10 of 'The geography toolkit'.

SUDAN: THE CHANGING LOCATION OF THE 400 MM ISOHYET

Source 3

Source: Oxford University Press

Check your learning 5.15

Remember and understand

1 Name the two resources thought to be a contributing cause of the War in Darfur.
2 List the various factors that have contributed to conflict in Sudan since it was granted independence.

Apply and analyse

3 Look up the location of Sudan in an atlas. Write a short paragraph describing the location of Sudan.
4 Examine Source 3.
   a Describe the pattern of land cover in Sudan.
   b Describe the change in rainfall patterns between 1929 and 2003 using the PQE method. For more information on the PQE method, refer to page 28 of 'The geography toolkit'.
   c Estimate how much more of the country received less than 400 millimetres of rain per year in 2003 compared with 1929.
   d Explain how this change may have helped to trigger the War in Darfur.
5 Locate the Darfur region in Source 2 on page 183. (showing predicted changes in cereal crop output by 2080). What is the predicted change for the Dafur region? How might this fuel future conflicts in the region?

Evaluate and create

6 Divide into small groups and discuss how this conflict is likely to have affected the wellbeing of individuals and communities in both Sudan and Chad. Summarise your findings and present them in a table. Use the column headings 'Effects on the wellbeing of individuals' and 'Effects on the wellbeing of communities'.

5.16 Conflict and refugees

During periods of armed conflict, many people are forced to leave their homes and seek safety elsewhere. If they cross into another country they are referred to as **refugees**. If they remain within their home country but away from where they live, they are referred to as **internally displaced persons (IDP)**.

The number of refugees and IDPs around the world changes constantly depending on the number of places involved in conflicts. In 2011, about 37 million people were forced to leave home because they feared for their safety. More than 26 million of these were IDPs. Almost half of all refugees are in Asia, whereas most IDPs are in Sub-Saharan Africa and South America. Colombia alone accounts for almost one-fifth of the world's IDPs (see Source 1).

The wellbeing of refugees

Life as a refugee is hard. Many refugees have witnessed or been victims of persecution, torture or sexual violence. As most refugees flee from one developing country to another, they often find that the country to which they have fled is unwilling or unable to offer them much assistance. In many cases they are forced to live in temporary camps set up by refugee agencies such as the United Nations and International Red Cross. These camps are often in places where access to essential services such as a reliable water supply, food security, sanitation and health care is very limited.

The United National High Commission on Refugees (UNHCR) sets minimum standards for refugees living in camps. Not all refugee camps are able to meet these very basic standards (see Source 2).

WORLD: REFUGEES AND INTERNALLY DISPLACED PERSONS IN MID-2014
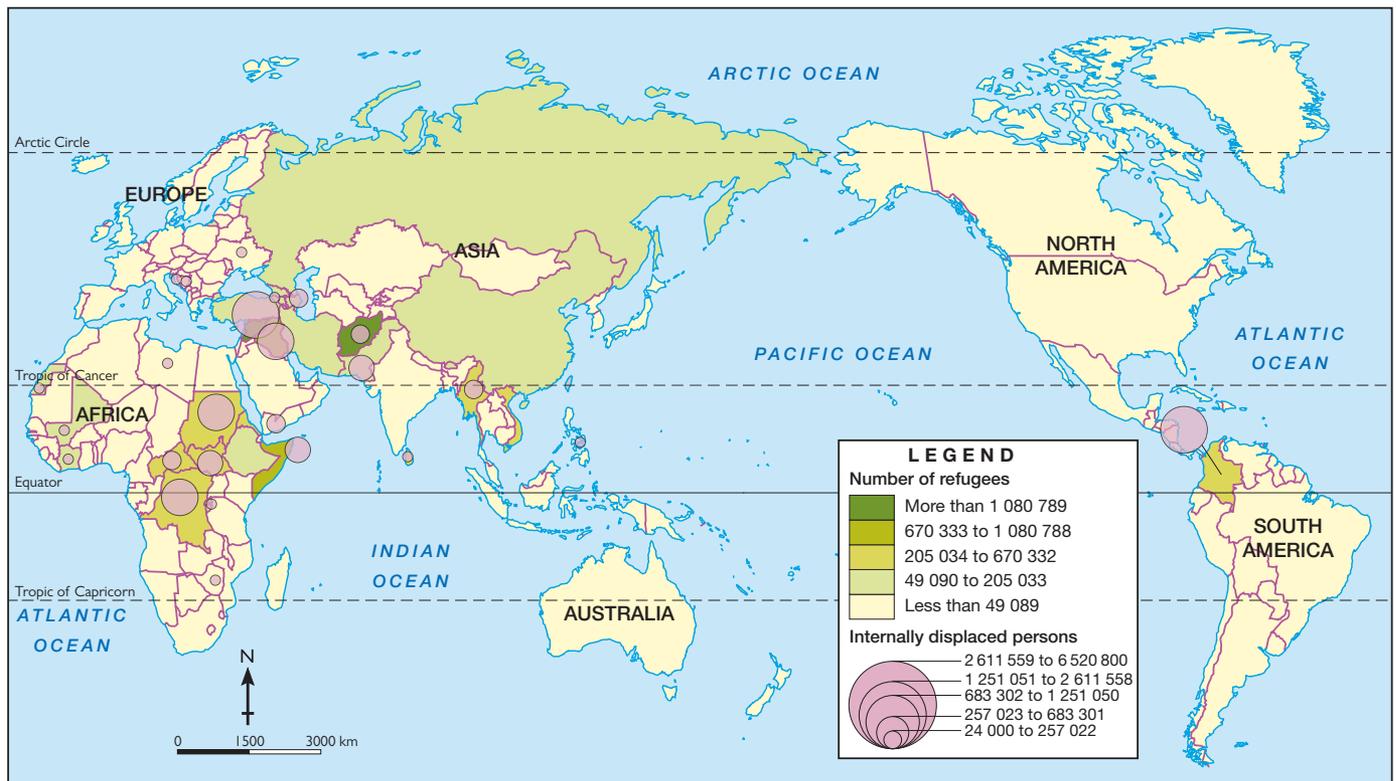
Source 1

Source: Oxford University Press

Source 2 Study of people in refugee camps able to access services at the UNHCR minimum standard

Essential service	UNHCR minimum standard	Kenya	Tanzania	Uganda	Nepal	Bangladesh	Thailand
People receiving food aid	100% of eligible people	100%	99%	100%	84%	100%	100%
Kilocalories per person per day	2100 kcal	2100 kcal	2114 kcal	1521 kcal	1785 kcal	2158 kcal	2472 kcal
Water per person per day	20 litres	26 litres	18 litres	14 litres	24 litres	24 litres	30 litres
Population within 200 m of tap	100%	93%	76%	50%	100%	100%	100%
Families with toilets	100%	95%	7%	58%	24%	59%	90%
Households with adequate housing	100%	78%	13%	93%	3%	100%	100%
People per health facility	10 000	14 193	13 672	8847	13 694	12 111	11 408
Qualified or trained teachers	80%	76%	11%	70%	Not known	51%	54%

Source: United National High Commission on Refugees, 2009

Case study: life in Dadaab refugee camp

Dadaab refugee camp in Kenya is located approximately 100 kilometres from the Kenya–Somalia border. It is one of the world's largest refugee camps, housing more than 350 000 refugees, most fleeing conflict in nearby Somalia.

Source 3 Women collect drinking water at Dadaab refugee camp in Kenya.

Source 4 A Somali woman prepares food for her family in a makeshift shelter.

Check your learning 5.16

Remember and understand

1 What is the difference between a refugee and an internally displaced person (IDP)?
2 Why are living conditions often poor in refugee camps?

Apply and analyse

3 Use Sources 3 and 4 to describe wellbeing in Dadaab refugee camp, Kenya.
4 Examine Source 1.
   a Use the PQE method to describe the distribution of refugees on a global scale. For more information on the PQE method refer to page 28 of 'The geography toolkit'.
   b Approximately how many refugees and IDPs are in each of the six countries listed in Source 2?
5 Examine Source 2.
   a Compare living conditions between refugee camps in Asia and Africa.
   b Using evidence from the table, which refugee camp do you think has the worst living conditions?
   c Describe the variations between camps with regard to toilet facilities.

Evaluate and create

6 Construct a scatter plot comparing Gross Domestic Product per capita and kilocalories per person within refugee camps in the six countries listed in Source 2. Describe and account for the pattern shown in your completed graph. GDP per capita data is available in the 'World statistics' section in your obook.

Demographic change in Japan

The population of Japan has undergone significant change over the last 60 years. In 1950, 7 per cent of all Japanese people were over the age of 60 and life expectancy was 59 years. By 2010, more than one-quarter were over 60 and life expectancy was the highest in the world at more than 83 years.

Source 1 Until her death on 1 April 2015, Misao Okawa was officially the oldest woman in the world. She was born on 5 March 1898 and was 117 years old at the time of her death. Only five other people in the world have ever lived as long.

There are many factors responsible for these changes. At the end of World War II, returning soldiers were keen to marry and start families. The result was a baby boom where the birth rate rose dramatically for about five years. When this group started working, in the 1970s and 1980s, they brought about an economic transformation that made Japan one of the world's wealthiest countries. This wealth was used to improve wellbeing and has improved life expectancy.

The other important demographic change has been a fall in the birth rate. Japanese families are now amongst the world's smallest. This has led to an overall decline in the size of the population. The population currently sits at around 126 million. Researchers estimate that the population will fall to 95 million by 2050. This has obvious implications for the economy and for the care of the growing elderly population.
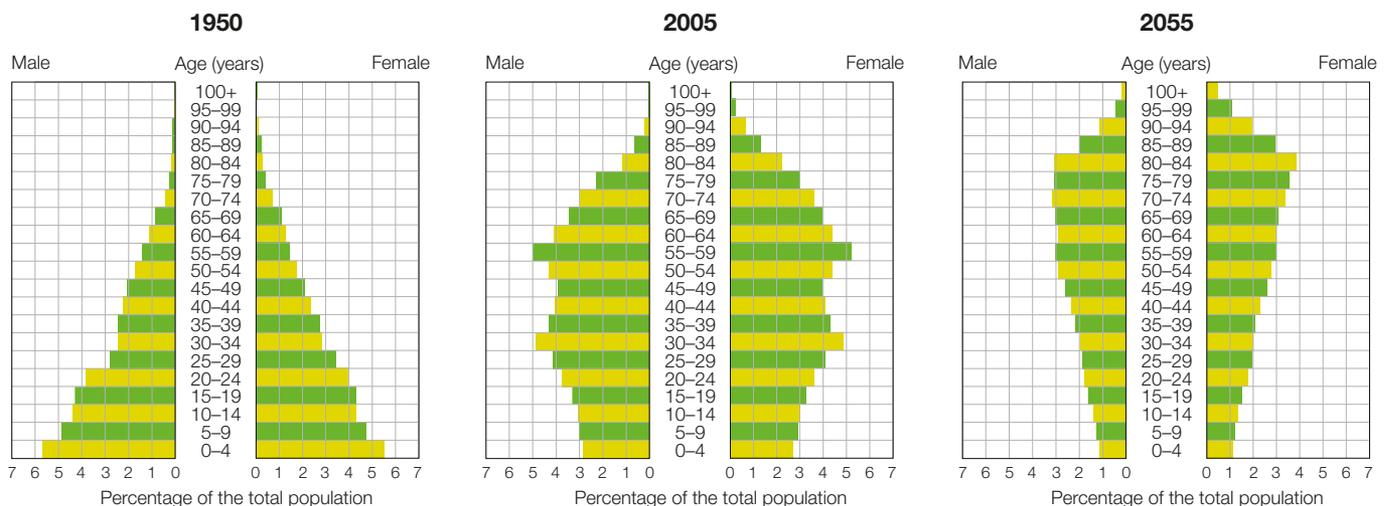
Source 2 Population pyramids for Japan showing the population in 1950 (left), 2005 (middle) and the expected population in 2055 (right).

Source 3 Key population indicators for Japan from 1950 to 2010

	1950	1955	1960	1965	1970	1975	1980	1985	1990	1995	2000	2005	2010
Life expectancy	59.3	65.8	67.8	70.3	72.1	74.4	76.2	78.3	79.0	79.8	81.3	82.3	83.2
Fertility rate	3.51	2.47	2	1.98	2.1	2	1.78	1.72	1.57	1.41	1.32	1.3	1.36
Total population (millions)	82	88	92	97	NA	NA	NA	119	122	124	125	126	126
Population aged 60+ (%)	7.7	8.0	8.8	9.6	10.6	11.7	12.8	14.6	17.4	20.4	23.3	26.5	30.5

Source 4 Birth and death rates for Japan from 1953 to 2008

	1953	1958	1963	1968	1973	1978	1983	1988	1993	1998	2003	2008
Birth rate per 1000 population	23.75	18.04	17.11	17.79	19.03	15.21	12.81	11.19	9.87	9.44	8.92	8.20
Death rate per 1000 population	9.389	7.926	7.381	6.907	6.62	6.25	6.276	6.461	7.514	7.013	7.884	9.149

skill**drill:** Data and information

Constructing a multiple-line graph

Multiple-line graphs are useful tools for displaying and comparing a range of data. They are constructed in much the same way as normal line graphs but extra lines are added to show the trends in multiple data. Follow these steps to construct a multiple line graph:

Step 1 Construct a set of axes. As line graphs usually show change over time, the years are commonly placed on the horizontal axis (*x*-axis). Using an even scale, such as one centimetre for every 10 years, divide and label the *x*-axis. Now draw the vertical axis (*y*-axis). Ensure that the *y*-axis has a scale that suits all the data that you are plotting and will fit the highest number in the data set.

Step 2 Plot the first set of data using a neat, coloured dot. Join these dots with a neat line, using the same colour. At the end of the line, write the title of the data. Alternatively, use a legend.

Step 3 Repeat step 2 for each set of data. Use different colours for each line.

Step 4 Give your completed graph a title.

Apply the skill

1   Construct a multiple-line graph showing the changes in life expectancy, total population and the percentage of the population aged over 60 in Japan between 1950 and 2010.

2   Describe the patterns shown in your completed graph.

3   How are these changes reflected in the three population pyramids?

4   Construct a multiple-line graph showing the changes in birth and death rates between 1953 and 2008.

5   Compare your completed graph with the demographic transition model in Source 1 on page 190. Which stage of demographic transition is Japan currently in?

Extend your understanding

1   Japan is not the only country with a declining and ageing population. Examine Source 5 showing world population growth and describe the location of those countries with –1.0 to 0 per cent growth.

2   Select one of these countries (other than Japan). Research the structure of the population of this country. A useful starting point is the CIA World Factbook, available online.

3   What are some of the similarities and differences between your chosen country and Japan in terms of:

   a   fertility

   b   population over 60 years of age

   c   the reasons for population change.

WORLD: POPULATION GROWTH
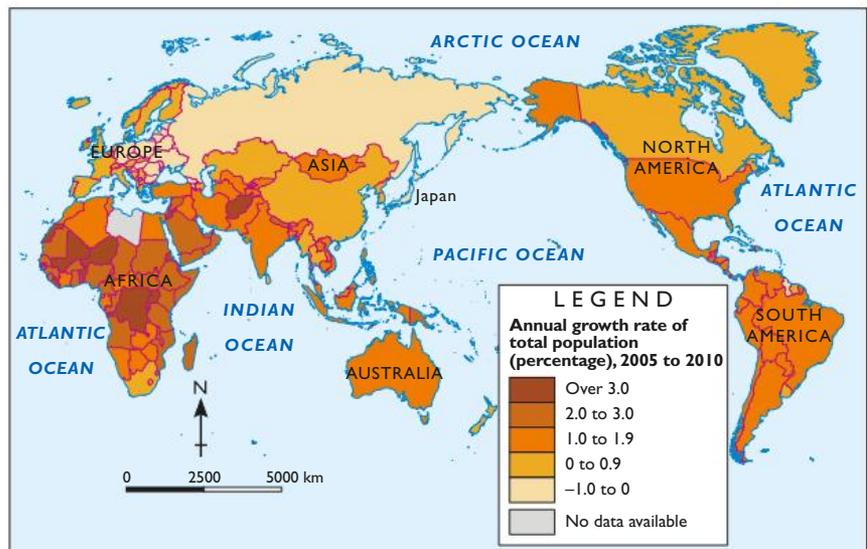
Source 5

Source: Oxford University Press

Improving wellbeing

All over the world, the wellbeing of millions of people is slowly improving. From local projects to global initiatives, inequalities between rich and poor in many areas are being addressed.

Since 2000, around 600 million of the world's poor have moved above the poverty line, more than 1 billion have gained access to safe drinking water, millions of girls have attended school for the first time, millions more babies have survived beyond their first year of life, and the rates of infection for deadly diseases have all fallen. These improvements are due to the hard work of many different organisations and agencies – from small not-for-profit groups to huge multi-national non-government organisations. Thanks to the financial support of government grants, contributions from the business community, and donations from ordinary citizens, these organisations are able to continue their work improving levels of human wellbeing for those who need it most.

6A

How can we improve wellbeing?

1 How might training in crop development help the women in Source 1 to improve their wellbeing?

2 What do you know about the United Nations Millennium Development Goals? What questions could you ask to help you find out more?

6B

Who is working to improve wellbeing?

1 Have you heard of any groups that are working to improve wellbeing in Australia? What about improving wellbeing on the global scale?

2 In 2013, the Australian government budgeted $5 billion of aid to overseas countries. Brainstorm ways that this aid could improve wellbeing in a country such as India.

Source 1 Women in India receiving training from the International Fund for Agricultural Development (IFAD) on sustainable agricultural practices and crop-growing techniques

chapter

6

6.1 Improving wellbeing

At a meeting of the United Nations (UN) in 2015, representatives of all 193 member countries present agreed to a set of goals designed to end poverty, protect the planet from unsustainable development, and ensure that all people on Earth enjoy a high level of wellbeing by 2030.

The Sustainable Development Goals (2015–2030)

A total of 17 goals, known as the **Sustainable Development Goals (SDGs)**, were created and agreed to by all (see Source 1). Of these 17 goals, seven relate specifically to reducing inequalities in human wellbeing. These are listed below:

- Goal 1: End poverty in all its forms, everywhere
- Goal 2: End hunger, achieve food security and improved nutrition and promote sustainable agriculture
- Goal 3: Ensure healthy lives and promote wellbeing for all at all ages
- Goal 4: Ensure inclusive and quality education for all and promote lifelong learning
- Goal 5: Achieve gender equality and empower all women and girls
- Goal 6: Ensure access to water and sanitation for all
- Goal 10: Reduce inequality within and among countries.

The Millennium Development Goals (1990–2015)

While many of these SDGs might seem almost impossible to achieve, the United Nations has a track record of success in this area. Between 1990 and 2015 the UN ran a project known as the **Millennium Development Goals (MDGs)**. Over the 15 years of the Millennium Development Goals, much was achieved. Perhaps the greatest achievement of the MDGs was the reduction in the rate of people living in extreme poverty. In 1990, nearly half of the population in the world's developing regions was living on less than $1.25 a day. By 2015 this rate had fallen to 14 per cent, meaning that more than a billion people had been lifted out of poverty during this time.

Source 1   The 17 Sustainable Development Goals agreed on by the United Nations in 2015.

Progress towards achieving the MDGs was tracked using 60 indicators of wellbeing (see Source 2). Many countries, including Australia, use these goals and the SDGs as a framework for allocating funds to their overseas aid programs.

Check your learning 6.1

Remember and understand

1 What were the aims behind the creation of the Sustainable Development Goals?

2 What do countries like Australia use these goals for?

Apply and analyse

3 Examine Source 2 summarising the final progress towards the MDGs in 2015.
  a Which targets were the closest to being achieved?
  b Which targets were the furthest from being achieved?
  c Why do you think this is?
  d How did Oceania and Southern Asia compare in their progress?

Evaluate and create

4 Use the Internet to complete these tasks:
  a Using a series of boxes and arrows explain how three or more of the SDGs are linked to each other.
  b Compare the 8 MDGs with the 17 SDGs. What new goals have been added by the United Nations? Why do you think these have been added?

Source 2
A chart summarising the final progress towards the United Nations Millennium Development Goals in 2015

Millennium Development Goals: 2015 Progress Chart

United Nations Member States gathered together at the start of the new millennium to shape a broad vision to fight poverty and combat numerous issues hampering development progress. The vision was translated into eight Millennium Development Goals and has remained the world's overarching development framework for the past 15 years. This framework, set to expire in 2015, includes time-bound goals, targets and indicators to monitor progress on extreme poverty and hunger, education, gender equality, child survival, health, environmental sustainability and global partnerships.

This chart presents the final assessment of progress towards selected key targets relating to each goal. The assessment provides two types of information: progress trends and levels of development, which are based on information available as of June 2015. The colour shows progress made towards the target and the text in the box shows the present level of development. For most indicators, 2015 projections are used to assess progress; for a few indicators that do not have 2015 data or projections, the latest available data of 2013 or 2014 are used.

	Africa		Asia				Oceania	Latin America and the Caribbean	Caucasus and Central Asia
Goals and Targets	Northern	Sub-Saharan	Eastern	South-Eastern	Southern	Western			

GOAL 1 | Eradicate extreme poverty and hunger

Reduce extreme poverty by half	low poverty	very high poverty	low poverty	moderate poverty	high poverty	low poverty	—	low poverty	low poverty
Productive and decent employment	large deficit	very large deficit	moderate deficit	large deficit	large deficit	large deficit	very large deficit	moderate deficit	small deficit
Reduce hunger by half	low hunger	high hunger	moderate hunger	moderate hunger	high hunger	moderate hunger	moderate hunger	moderate hunger	moderate hunger

GOAL 2 | Achieve universal primary education

Universal primary schooling	high enrolment	moderate enrolment	high enrolment	high enrolment	high enrolment	high enrolment	high enrolment	high enrolment	high enrolment

GOAL 3 | Promote gender equality and empower women

Equal girls' enrolment in primary school	close to parity	close to parity	parity	parity	parity	close to parity	close to parity	parity	parity
Women's share of paid employment	low share	medium share	high share	medium share	low share	low share	medium share	high share	high share
Women's equal representation in national parliaments	moderate representation	moderate representation	moderate representation	low representation	low representation	low representation	very low representation	moderate representation	low representation

GOAL 4 | Reduce child mortality

Reduce mortality of under-five-year-olds by two thirds	low mortality	high mortality	low mortality	low mortality	moderate mortality	low mortality	moderate mortality	low mortality	low mortality

GOAL 5 | Improve maternal health

Reduce maternal mortality by three quarters	low mortality	high mortality	low mortality	moderate mortality	moderate mortality	low mortality	moderate mortality	low mortality	low mortality
Access to reproductive health	moderate access	low access	high access	moderate access	moderate access	moderate access	low access	high access	moderate access

GOAL 6 | Combat HIV/AIDS, malaria and other diseases

Halt and begin to reverse the spread of HIV/AIDS	low incidence	high incidence	low incidence	low incidence	low incidence	low incidence	low incidence	low incidence	low incidence
Halt and reverse the spread of tuberculosis	low mortality	high mortality	low mortality	moderate mortality	moderate mortality	low mortality	moderate mortality	low mortality	moderate mortality

GOAL 7 | Ensure environmental sustainability

Halve proportion of population without improved drinking water	high coverage	low coverage	high coverage	high coverage	high coverage	high coverage	low coverage	high coverage	moderate coverage
Halve proportion of population without sanitation	moderate coverage	very low coverage	moderate coverage	low coverage	very low coverage	high coverage	very low coverage	moderate coverage	high coverage
Improve the lives of slum-dwellers	low proportion of slum-dwellers	very high proportion of slum-dwellers	moderate proportion of slum-dwellers	moderate proportion of slum-dwellers	moderate proportion of slum-dwellers	moderate proportion of slum-dwellers	moderate proportion of slum-dwellers	moderate proportion of slum-dwellers	—

GOAL 8 | Develop a global partnership for development

Internet users	moderate usage	low usage	high usage	moderate usage	low usage	high usage	low usage	high usage	high usage

The progress chart operates on two levels. The text in each box indicates the present level of development. The colours show progress made towards the target according to the legend below:

- ■ Target met or excellent progress.
- ■ Good progress.
- ■ Fair progress.
- ■ Poor progress or deterioration.
- ■ Missing or insufficient data.

For the regional groupings and country data, see mdgs.un.org. Country experiences in each region may differ significantly from the regional average. Due to new data and revised methodologies, this Progress Chart is not comparable with previous versions.

Sources: United Nations, based on data and estimates provided by: Food and Agriculture Organization of the United Nations; Inter-Parliamentary Union; International Labour Organization; International Telecommunication Union; UNAIDS; UNESCO; UN-Habitat; UNICEF; UN Population Division; World Bank; World Health Organization - based on statistics available as of June 2015.

Compiled by the Statistics Division, Department of Economic and Social Affairs, United Nations.

6.2 Improving wellbeing for women and children

The Millennium Development Goals have a strong emphasis on improving the wellbeing of women and children. Women and children are particularly at risk from the effects of poverty as their status in many societies is lower than that of men. On top of that, giving birth in developing countries comes with high risks of health complications and death. Improving maternal health and reducing child mortality are two key millennium goals.

Fertility rates in the developing world

Fertility rates are higher in the developing world than in the developed world. Source 1 on page 194 shows that fertility rates are particularly high in Africa, the Middle East and South Asia, where the birth rate ranges from three to over six children per woman.

Source 1   Two boys return from the fields in the west African nation of Cape Verde.

There are many reasons why women in these countries have so many children. These reasons generally relate to the woman's culture, history, religion, status and beliefs. In many cultures, children are seen as a household's greatest asset. Children perform important tasks such as fetching water, collecting firewood and working in the fields. They are also a form of security, as children are often expected to look after their parents when they get old and become unable to look after themselves.

Another possible reason why women in developing nations have a high fertility rate is that they are aware that not all of their children will survive into adulthood. **Child mortality rates** are particularly high in Africa, with the worst levels recorded in Mali (106 deaths per 1000 births), Somalia (101) and the Central African Republic (95). The highest rate of deaths in the world is 119 deaths per 1000 births in Afghanistan. Australia records only 4.5 deaths for every 1000 children born.

Lack of access to contraception is another possible reason behind high fertility rates in the developing world. Research shows that up to 200 million women worldwide would delay or prevent pregnancy if they could, but they are not able to use or access effective contraception.

Family planning

One way of improving maternal health and reducing child mortality is to actually reduce the number of times a woman goes through childbirth. This is referred to as family planning. Fewer children means more resources for those children who are born, leading to improved health (see Source 2). In countries where the central government develops a program of family planning – often with external aid and help from non-government organisations (NGOs) – a falling birth rate has tended to follow.

While talking about reproduction has long been a taboo subject in some societies, these barriers are gradually being broken down. At thousands of clinics across the developing world, mothers are educated

Some of the key benefits of effective family planning

- Smaller families mean better health and education for each child.

- Higher rates of condom use reduce the likelihood of individuals contracting HIV and AIDS.

- Average income increases as smaller families share their income between fewer people.

- Women with fewer children have greater education and employment outcomes.

- Smaller families have higher rates of infant survival and healthier, better nourished children.

- Fewer pregnancies mean fewer deaths due to pregnancy and birth complications and fewer unsafe abortions.

- The cost of social services is reduced, particularly the cost of health care and infrastructure such as water provision and schools.

Source 2 The benefits of family planning

about proper infant nutrition, babies are weighed and immunised, women are counselled about having their first babies later and then spacing subsequent births further apart, and contraceptive options are provided. Educating women about using condoms has been particularly important, as their use can also stop the spread of diseases such as HIV/AIDS.

Check your learning 6.2

Remember and understand

1 What is family planning?
2 In what ways does family planning help to improve human wellbeing?

Apply and analyse

3 Examine Source 3. It shows a family planning clinic in Kenya set up by Marie Stopes International. Use the Internet to research this organisation. What do they do? In which regions and nations are they most active? What are some of their success stories?
4 Write a paragraph explaining how an effective family planning program can help to reduce infant deaths in a country.

Evaluate and create

5 Use the key concept of scale to think about the benefits of family planning shown in Source 2. Categorise these benefits in order from the personal scale to the global scale.
6 Classify the reasons why families are larger in poorer nations than in richer nations using the SHEEPT method. For more information on the SHEEPT method refer to page 28 of 'The geography toolkit'.
7 Use the Gapminder website to explore the link between contraceptive use and income.

Source 3 A family planning clinic in a busy Kenyan marketplace

6.3 Improving access to education

Education has shaped my life and the history of my country. I grew up in a society ravaged by war and mired in poverty. Schools had been destroyed. My classes were held in the open under a tree. We had no desks, chairs or other basic necessities. The Republic of Korea was on its knees, but education enabled the country to stand tall again … Even in the worst circumstances, education helps to give children confidence to face the future. As Secretary-General of the United Nations, I want every child, without exception, to have the same opportunity that I had.

Ban Ki-Moon, Secretary-General of the United Nations, 2012

One of the United Nations' goals is to improve the political profile of education around the world. In fact, the United Nations Secretary-General Ban Ki-Moon has personally led the Global Education First Initiative. Launched in September 2012, the initiative includes, among other aims, the Educate-a-Child program. This program seeks to get all children into schools and bring high quality learning to children who have no access to formal schooling. This is seen as the key factor to improving the living conditions and future wellbeing of millions of children.

The benefits of education

Many social researchers believe that the key to improving human wellbeing around the world, particularly in poorer communities, is to improve participation rates in education. Their studies show that education allows individuals to break the cycle of poverty and live healthier, longer lives.

The benefits to society are multiplied when girls are able to access an education at the same rate and level as boys. Studies show that mothers who have attended school have a lowered risk of their babies falling victim to infant mortality, have fewer children and earn more than mothers who are less educated. Children born to these women are 50 per cent more likely to live past the age of five and have much lower rates of HIV infection than children born to less educated mothers.

Over the past 40 years the Chinese government has made a real effort to get more children into education for longer periods. This push has included increasing the education levels of girls. Educating girls has had many benefits for Chinese society. Educated women generally want smaller families and make better use of reproductive health and family planning services to achieve their desired family size (see Source 1). Educated women contribute more to the economy and help increase economic growth. With China's booming economy, China now has 68 per cent of women in paid employment. This is a higher rate than Australia (which has 59 per cent).
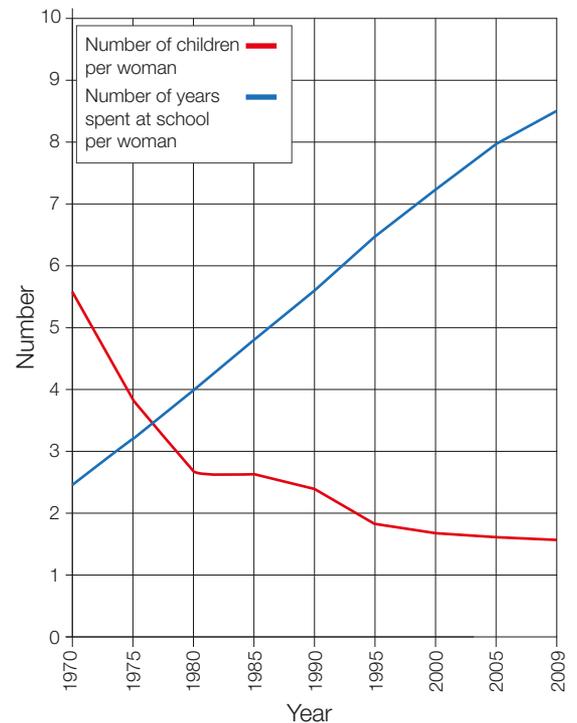
Source 1 Education levels and fertility rates for women in China aged between 15 and 44 years


Source 2 A Chinese government poster from the 1970s encourages girls to 'Learn science and build the country'.

Successful schools

As well as getting all children into schools, the United Nations Global Education First Initiative is also interested in improving the standard of schooling that children receive and creating a positive school environment. Too many schools in the developing world currently have poorly trained teachers and not enough books or other resources to teach with. Too many children are also going to school hungry, which is affecting their ability to learn. Source 3 shows the standards and features that the United Nations would like all schools worldwide to achieve.
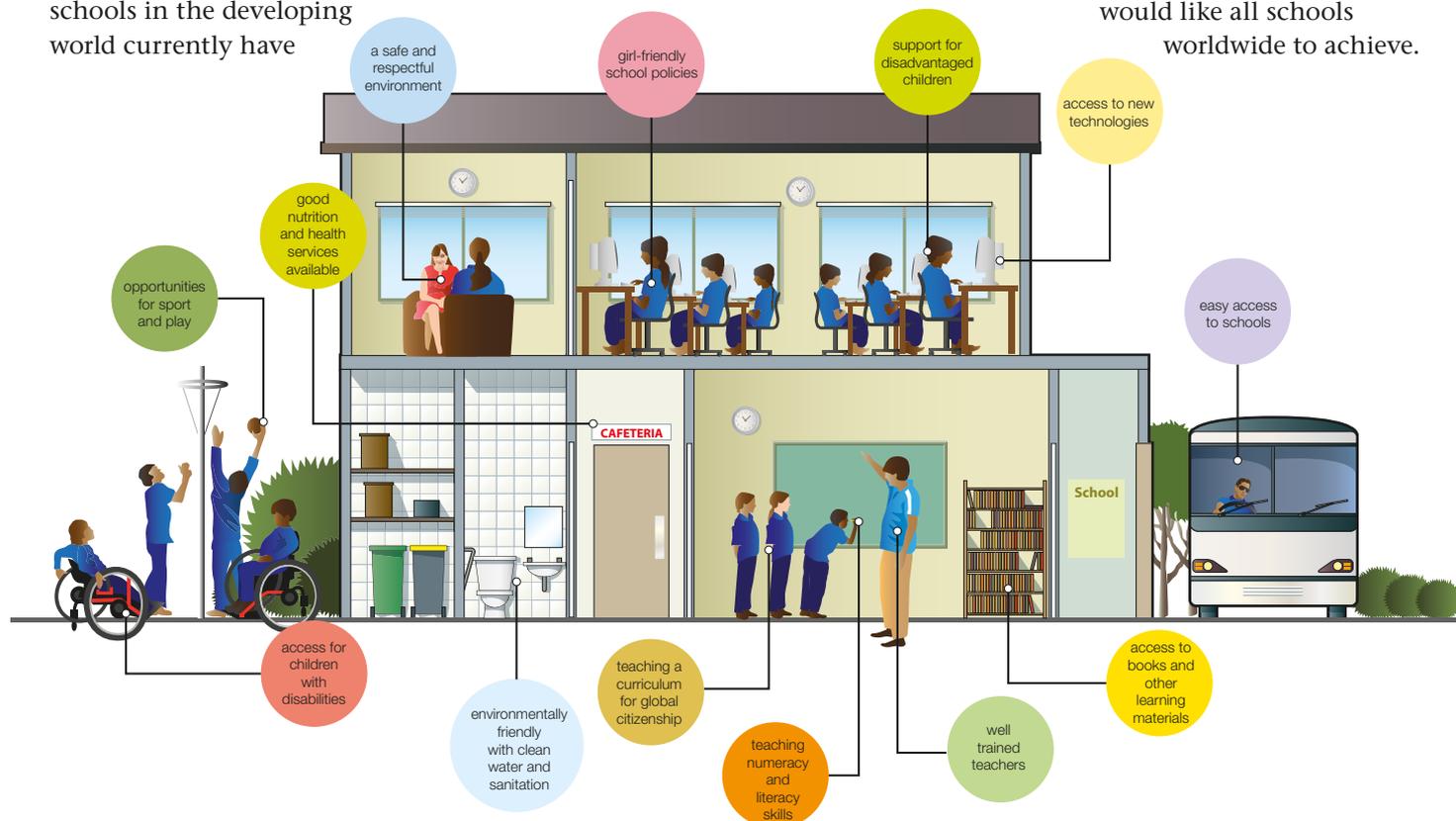
Source 3   The main features of successful schools according to the United Nations Global Education First Initiative

Check your learning 6.3

Remember and understand

1   What are some of the links between education and wellbeing?

2   Explain why educating girls can help to improve wellbeing for everyone in a community.

Apply and analyse

3   'Education provides much more than the opportunity to read, write and count.' Explain this statement using examples from Source 3.

4   Examine Source 1.

   a   Describe the change in the education of women in China between 1970 and 2009.

   b   How is this linked to the poster in Source 2?

   c   How has the fertility rate changed in the same period?

   d   How is this linked to the one-child policy implemented over the same period?

Evaluate and create

5   Using Source 3 as a guide, design a poster that promotes one of the advantages of gaining an education.

6   Mahatma Gandhi, a leader of the Indian nationalist movement in the early 20th century, once said 'Educate one man, you educate one person, but educate a woman and you educate a whole civilisation'. What do you think he meant by this? Do you agree? Write a paragraph outlining your thoughts.

6.4 Improving wellbeing in Australia

Australia has one of the highest levels of wellbeing in the world. In the 2013 United Nations Human Development Report, Australia was ranked as having the second highest HDI in the world behind Norway. Australians can expect to go to school for longer and to live longer, healthier lives than virtually any other nationality. While data such as this is welcome news regarding our position in the world, it can hide the inequalities that exist within our nation.
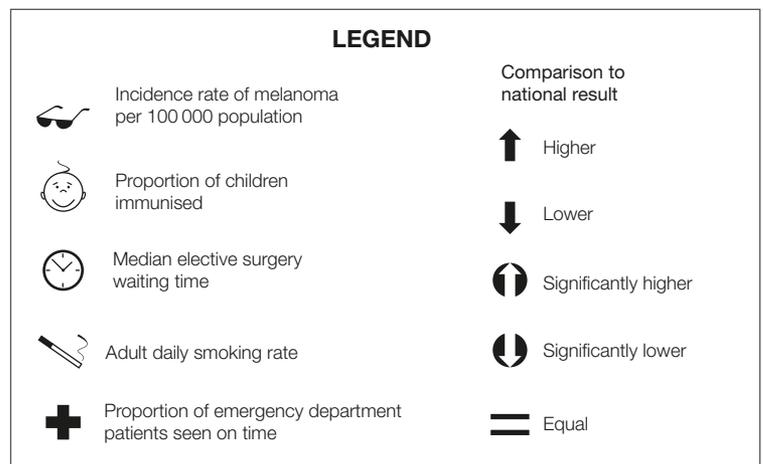
There are significant variations in wellbeing, for example, between rural and urban Australia and between Indigenous and non-Indigenous Australians. A number of government and non-government groups are working to reduce these variations.

Inequalities in health

Studies show that there are significant differences in the health of different groups of Australians. People from poorer households are less likely to be physically active, to visit a dentist or medical specialist, or to have a medical test such as a skin cancer check or mammogram to detect breast cancer. They are more likely to smoke and to be obese or overweight. As well as inequalities due to income, studies have also found health inequalities relating to location, ethnicity and age. Source 1 shows some of the health inequalities that exist between Australia's states and territories.

Inequalities in education

There are similar trends in education to those exhibited in health areas. Children from poorer households are less likely to attend early childhood education and less likely to go to university than children from wealthier

LEGEND

Incidence rate of melanoma per 100 000 population

Proportion of children immunised

Median elective surgery waiting time

Adult daily smoking rate

Proportion of emergency department patients seen on time

Comparison to national result

↑ Higher

↓ Lower

◐ Significantly higher

◑ Significantly lower

= Equal

	ACT	NSW	NT	QLD	SA	TAS	Vic	WA	National
🕶	44.7 ↓	47.9 ↓	34.6 ◑	67.5 ◐	39.5 ◑	49.4 ↑	39.0 ◑	49.2 ↑	48.8
👶	90.6% ↑	89.7% ↑	88.1% ↓	90.3% ↑	87.0% ↓	90.0% ↑	91.1% ↑	86.0% ↓	89.6%
🕐	76 ↑	47 ↑	33 ↓	29 ↓	38 ↑	38 ↑	36 =	29 ↓	36
🚬	15.7% ◑	19% ↓	21.1% ↑	21.6% ◐	20.2% ↑	24.3% ◐	17.3% ↓	17.3% ↓	19.1%
✚	58% ↓	74% ↑	52% ↓	66% ↓	71% ↑	59% ↓	70% ↑	59% ↓	68%

Source 3 Health inequalities between states in Australia.

households. They also have less access to information technology such as broadband Internet, particularly in rural and remote regions. Students in rural areas generally have a more restricted choice of subjects to study and are less likely to finish high school.

The rural–urban divide

In many areas of wellbeing in Australia there is a rural–urban divide. There are fewer education and employment opportunities in rural areas and less access to health services and medical care. People in rural areas are more likely to suffer from chronic health conditions such as diabetes and heart disease and die earlier than those living in towns and cities. They are also at a higher risk of injury from work and car accidents.

Reducing inequality

Governments have tried to reduce these inequalities in wellbeing in Australia in two main ways:

- Targeted programs that focus on a particular problem or issue. For example, campaigns to reduce smoking or to encourage people to have health checks.
- General programs to maintain and lift the wellbeing of the entire community. The National Disability Insurance Scheme and Medicare which ensure people can access care regardless of their financial situation are examples of these.

Case study: Rural Health Education Foundation

There are many people working in a range of fields to improve wellbeing in Australia. One of these groups was the non-profit organisation the Rural Health Education Foundation (RHEF). In a similar way to the Royal Flying Doctor Service, the RHEF aimed to use modern technology to reduce the gap between rural and urban health.

The mission of the RHEF was to 'improve the health outcomes of people in remote and rural Australia by providing quality accessible health education to health professionals and their communities'. The foundation, which was funded by government and private donations, produced and broadcast health education programs on its own free-to-air digital TV network called the Rural Health Channel, which could be accessed by 250 000 households across Australia.

Programs covered a wide range of topics of importance to people living in remote and rural regions such as Indigenous eye disease, tropical diseases and

Source 2   A RHEF film-making team

farming health hazards. Doctors and other health professionals could access the programs easily and therefore stay up to date with current advances in medicine.

The RHEF ceased operating in 2014 due to the withdrawal of government funding. All RHEF-produced programs are available as podcasts, on DVD and online.

Check your learning 6.4

Remember and understand

1   In what ways do people in rural areas have lower levels of wellbeing than people in urban areas?
2   What did the Rural Health Education Foundation do to help reduce these inequalities?

Apply and analyse

3   Examine Source 1.
    a   List the seven statistics that are significantly lower or higher than the national average.
    b   Describe the results of this survey for your home state or territory.

Evaluate and create

4   Rank the states and territories of Australia from those that performed best in the health survey in Source 1 to those that performed worst.
5   One of the difficulties for governments in reducing inequalities in wellbeing is being able to evaluate the effectiveness of individual programs. How could the effectiveness of the RHEF TV channel be evaluated?
6   Access RHEF online and list the programs available on the Rural Health Channel. Watch one of the programs available online and write a brief review, outlining how useful you think it would be for the target audience.

6.5 Improving the wellbeing of Indigenous Australians

As you have learnt, studies show that the wellbeing of Aboriginal and Torres Strait Islander Australians is well below that of other Australians. A United Nations official described the standard of health in Indigenous communities in Australia in some respects as being worse than in developing countries. A range of government and non-government groups are working to close the gap between Indigenous and non-Indigenous Australians in a range of important areas.

Improvements in health

Chronic diseases such as heart attacks and diabetes are responsible for about 70 per cent of the health gap between Indigenous and non-Indigenous Australians. The Federal government, in partnership with local health services, is working to:

- encourage Indigenous people to have regular health checks
- train health workers in the techniques of managing chronic diseases such as diabetes and arthritis. This includes giving advice on such things as the health benefits of increased physical activity and stopping smoking (see Source 1).
- make medicines and treatments more affordable to Indigenous patients
- increase the number of Indigenous Australians working in the health sector
- build more hospitals and health centres in Indigenous communities
- improve the quality and range of foods available in the shops in Indigenous communities
- provide mobile health facilities that visit remote communities and target dental, eye and ear problems
- change the type of fuel sold in many remote petrol stations to make it unsuitable for sniffing to reduce the rates of this type of substance abuse
- improve the mental health of Indigenous people. One initiative is called Link Up and helps Indigenous people trace and contact those family members who were forced to move as part of the Stolen Generation
- increase participation of Indigenous children in sport and recreation

Source 1 Rates of smoking for Indigenous Australians are twice that of non-Indigenous Australians. Anti-smoking campaigns aim to reduce these rates. Similar campaigns aim to reduce alcohol use during pregnancy.

- strengthen cultural ties within communities through the support of language and the arts
- upgrade and maintain airstrips in remote communities to provide better access to emergency health care.

The responses outlined here are targeted at improving the health of Indigenous Australians. There are also responses aimed at the other six key areas that are seen as vital to closing the gap between Indigenous and non-Indigenous Australians: early childhood, schooling, healthy homes, economic participation, safe communities and leadership.

Case study: Cathy Freeman Foundation

Responses to wellbeing issues often involve a partnership between governments and non-government organisations (NGOs). One such response is the work being done by the Cathy Freeman Foundation to improve the wellbeing of children on Palm Island. Olympic champion Freeman established the foundation in 2007 to help address some of the key problems facing this remote Indigenous community. These problems include high unemployment, low literacy and life expectancy rates and very high rates of ear disease and hearing loss. As nearly two-thirds of the population is under the age of 20, the foundation focuses on education, particularly reducing the truancy rate which can be as high as 55 per cent.

Key components of the foundation's strategy are public recognition of children who attend school and achieve good outcomes, sport and recreation programs that encourage children to attend school, increased numbers of teacher's aides, school camps to the mainland for those children who attend school regularly, and scholarships to students to attend private schools in mainland Queensland. The foundation has had great success in reducing truancy, improving literacy levels and improving the future employment prospects of hundreds of Indigenous children.

Source 2 Cathy Freeman helps Craig Evers ride his new bike on Palm Island. The bike was donated by the Cathy Freeman Foundation.

Check your learning 6.5

Remember and understand

1 Explain what the Cathy Freeman Foundation is doing to improve the wellbeing of Palm Islanders.

2 What did a United Nations official have to say about Indigenous health in Australia? Why do you think he made this comment?

Apply and analyse

3 Select one of the strategies aimed to improve the health of Indigenous Australians and explain:
   a the aims of the strategy
   b how the effectiveness of the strategy could be measured.

4 Cathy Freeman is not the first celebrity to become involved in projects aimed at improving wellbeing. Angelina Jolie, Bob Geldof and Bono are other well-known examples. Why do you think celebrities often become involved in this type of work?

5 Use an atlas to describe the location of Palm Island. Describe how the location of this community may help explain the high rates of unemployment.

Evaluate and create

6 Visit the Cathy Freeman Foundation website. Prepare a report on one of the five programs that are helping to improve wellbeing.

7 Design a poster that encourages children on Palm Island to attend school.

The wellbeing of refugees in Australia

Many refugees and asylum seekers arrive in Australia after fleeing conflict, violence or persecution in their home countries. They have often had long journeys to get here, and potentially spent years in refugee camps waiting to be resettled in another country. Some also make the dangerous journey to Australia by boat.

Refugees and asylum seekers often have low levels of wellbeing. The process of fleeing their home country and waiting for resettlement has prevented them from receiving full health care and education. They may have suffered trauma in their home countries, and may experience culture shock on their arrival in Australia.

Listed below are some facts and figures about immigration levels to Australia including refugee and asylum seeker arrivals.

- According to the United Nations High Commissioner for Refugees (UNHCR), at the end of 2011 an estimated 42.5 million people worldwide were considered forcibly displaced due to conflict and persecution, including 15.2 million refugees, 895 000 asylum seekers and 26.4 million internally displaced people.
- In 2011–2012, 7379 people who arrived by boat lodged applications to be considered as refugees in Australia. Once they have been determined to be refugees they can then apply for a permanent visa to remain here. The top four countries of origin were Afghanistan (3179), Iran (1553), Sri Lanka (825) and Pakistan (618). 4766 visas were granted in the same year, many of these to refugees who had arrived several years earlier.
- In 2011, Australia received 3 per cent of asylum applications made to the world's developed countries. The USA received 17 per cent and France 12 per cent.

Source 1 This photo taken on 27 June 2012 (provided by Australian Maritime Safety Authority) shows a boat bound for Australia carrying around 150 suspected asylum seekers. Shortly after the image was taken the vessel sank at sea about 24 kilometres off the coast of Christmas Island. Most passengers of the boat were rescued, but one body was recovered.

Issues of wellbeing for refugees arriving in Australia include:

- difficulty accessing appropriate health care and other public services. Language barriers also often require the use of interpreters
- many newly arrived refugees lack family and friends in Australia and face isolation in their new communities
- before coming to Australia, many refugees have lived for years with only limited access to food, both in terms of amount and variety, leading to poor nutrition.

skill**drill:** Data and information

Constructing an infographic

An infographic is a method of presenting complex information using graphics such as pictures, maps and graphs so that it can be interpreted quickly and easily by an audience. Infographics are often used by groups in society to make a point about a current event or situation. Source 2 is an infographic created by the Australian community action group GetUp!. It is intended to show that the number of refugee arrivals in Australia are the result of conflicts rather than changes in government policy in relation to refugees.

Step 1 Decide on the issue that you are presenting in your infographic and the point you wish to make about it.

Step 2 Research the issue you are presenting. Look for information that supports your point of view. As with all information, check that it is reliable. If using the Internet, for example, information from government (.gov), educational institutions (.edu) and organisations (.org) tends to be more reliable than information from commercial sites (.com).

Step 3 Think carefully about how your information can be presented as images rather than as numbers or complex lists. Look at the infographic in Source 2 and other infographics online for some ideas. Simple pictures tend to work better than complex ones.

Step 4 Think carefully about how you are going to set the information out on the page. Remember that people tend to read infographics in the same way they read a book – left to right and top to bottom. Some infographics use the idea of a journey to present their information and join together key pieces of information with roads, railway tracks or arrows.

Step 5 Put all of this together neatly. You may like to use an online program such as 'infogr.am' or 'easel.ly' to create your infographic. Alternatively, you can use coloured markers, print outs of images, paper and glue.

Apply the skill

1 Design and present an infographic using the facts and figures provided on the number of refugee arrivals to Australia from different parts of the world. You can do your own research or just use the figures presented here.

2 When completed, look closely at your classmate's infographics. Which techniques used by others did you find best presented the data in a visual way?

Extend your understanding

1 Research the numbers of asylum seekers in Australia's regional processing centres on Christmas Island, Nauru and Manus Island in Papua New Guinea. Find out how long they have been seeking asylum and where they have come from. Present this information using infographic techniques.
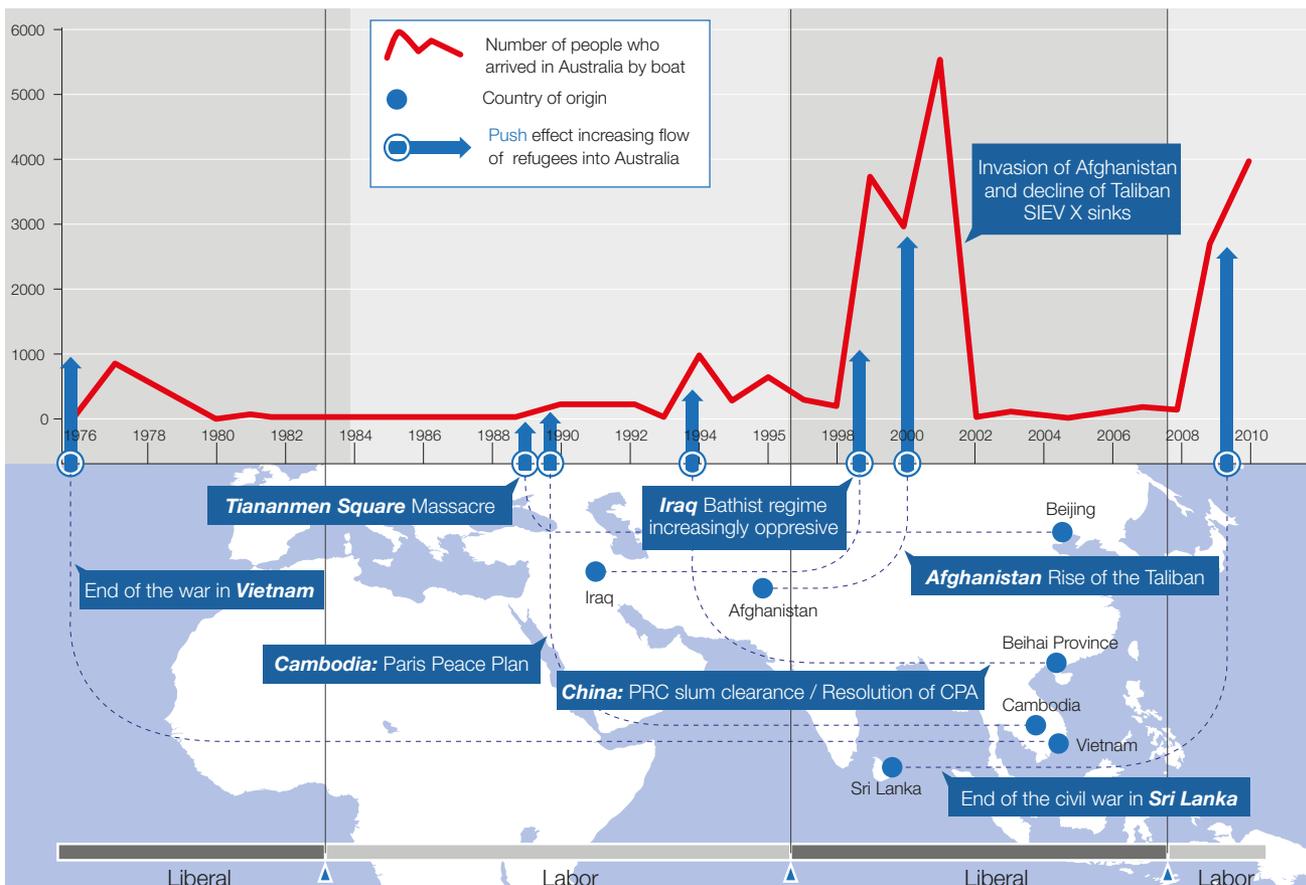
Source 2 'Why refugees come to Australia' – an infographic prepared by the organisation GetUp!   Source: GetUp!

6.6 Organisations working to improve wellbeing

As we have learnt, the United Nations (UN) has a huge interest in improving wellbeing across the globe with its Millennium Development Goals. But the United Nations does not work alone. It works with individual governments and not-for-profit organisations, each of which set their own goals and develops their own programs. In this section, we will investigate the work of the UN and a range of other organisations working to improve wellbeing.

The role of the United Nations

The United Nations was founded at the end of World War II in 1945, to encourage countries to work together and maintain peace. Since that time it has grown into a vast organisation with multiple agencies working towards the key goals of 'maintaining international peace and security, developing friendly relations among nations and promoting social progress, better living standards and human rights'.

The United Nations has 193 member countries. These countries provide the funding to operate the UN's agencies and programs. Four key areas for the United Nations are peace and security, development, human rights and humanitarian aid.

Peace and security

The United Nations has continued with its initial aim of promoting peace and security among the nations of the world. It provides assistance in areas such as disarmament, mine clearance, counter-terrorism and peacekeeping forces as well as encouraging nations and communities in conflict to work towards a peaceful resolution.

Development

United Nations programs throughout the developing world are aimed at reducing poverty and improving the wellbeing of billions of people. In terms of promoting economic development, the UN works with countries to promote trade between countries and to build stable governments.

Source 1　UN peacekeepers pass groups of people fleeing conflict in the Democratic Republic of the Congo.

Source 2　The United Nations works to provide free universal education, particularly among groups who have found this difficult to access. This includes the young girls of Pakistan.

Human rights

The United Nations seeks to uphold the values of the Universal Declaration of Human Rights throughout the world. Since the creation of the Universal Declaration of Human Rights in 1948, the UN has adopted several further declarations. These include conventions aimed at ending discrimination against women (in 1979) and further protecting the rights of children (in 1989). In 2006, the rights of Indigenous people were described in a further declaration. This aims to allow Indigenous groups to protect and strengthen their cultural identity.

The United Nations works towards ending violence against children, human trafficking, and the use of sexual violence as a weapon of war. It also promotes the freedom of Indigenous people to determine their own futures. The United Nations believes that every child has the right to an education.

Humanitarian aid

In those regions where food security is an issue, the United Nations works to improve farm productivity and provide food in times of famine. It also provides refuge for millions of people fleeing conflict in refugee camps and aid to those suffering from the impacts of disasters.

Check your learning 6.6

Remember and understand

1. What was the initial aim of the United Nations?
2. What types of discrimination is the United Nations now dedicated to eliminating?

Apply and analyse

3. Conduct research to find out more about the World Food Programme and answer the following questions:
   a. Which areas received assistance from the World Food Programme in 2013? How many malnourished children received special nutritional support in 2013?
   b. Which countries received emergency support in the past year? What was the cause of the emergency?
   c. Who are the top five donor countries that support the World Food Programme?

Evaluate and create

4. Using Source 1 as a starting point, do some further research on UN peacekeepers in the Democratic Republic of the Congo and write a short news article about their role.

Source 3 The World Food Programme provides aid to almost 100 million people a year in over 70 countries.

6.7 IFAD: Helping to improve wellbeing in India

The International Fund for Agricultural Development (IFAD) is an agency of the United Nations. It was created in the mid-1970s in response to a number of famines across Africa. The goal of the agency is 'to empower poor rural women and men in developing countries to achieve higher incomes and improved food security.' IFAD are active in poor rural communities throughout the world, particularly in the Asia–Pacific, Africa, Latin America and Caribbean regions.

IFAD's work in India is focused on groups identified as being the most disadvantaged among the nation's rural poor – women, tribal groups, small farmers, landless people and unemployed youth. There are currently several IFAD sponsored projects in operation across India directly benefiting more than 4 million households (see Source 1).

INDIA: LOCATION OF IFAD'S PROJECTS

1 This project aims to change farming practices in the hilly region of north-eastern India to increase food security (see the key concept box 'Farming in north-eastern India').

2 This project aims to reduce rural poverty particularly among tribal groups by providing micro-loans (small loans to encourage small-scale business ventures among the poor so they can become self-supporting and improve their wellbeing) and investments in new farming projects.

3 These vast projects, helping more than 1.2 million households, aim to increase the status of women through self-help groups and financial assistance, often in the form of microloans.

8 One of the nation's most disadvantaged tribal groups is being assisted to develop systems of local self-government, increase rural productivity, manage resources more sustainably and develop alternative sources of employment.

7 This project is promoting changes in farming methods along with new job opportunities in rural tourism.

6 Severe food insecurity and extreme poverty are being addressed by changing farming methods and moving to more sustainable practices such as organic farming, water conservation and fruit and vegetable production.

4 Coastal communities in this area are still trying to recover from the effects of the 2004 Boxing Day tsunami. This project is designed to aid this recovery.

5 In this harsh, arid landscape poverty is often the result of water and food insecurity. Projects in this region aim to provide jobs outside of farming to people so they are less affected by variations in rainfall.

LEGEND
Project type
- Community resource management
- Tribal empowerment
- Women's empowerment
- Strengthening livelihoods
- Relieving poverty
- Agricultural

AFGHANISTAN · CHINA · PAKISTAN · NEPAL · BHUTAN · BANGLADESH · MYANMAR · INDIA · Bay of Bengal · Arabian Sea · SRI LANKA · MALDIVES

Area of map

0   300   600 km

Source 1

Source: International Fund for Agricultural Development (IFAD)

keyconcept: Sustainability

Farming in north-eastern India

Food insecurity in the hilly regions of north-eastern India has recently increased as the result of a growing population combined with unsustainable farming practices. Traditionally, farmers in this region used slash-and-burn farming techniques where a patch of forest was cut down, burned and used until the soil became infertile. The farmer would then move to a fresh patch of forest. But as the population increased, this sort of farming resulted in huge losses of forest, soil erosion and a fall in food production. Widespread food and water insecurity followed.

IFAD encouraged farmers to terrace their hillsides and protect their forests (see Source 3). This is a much more sustainable approach to farming. Soil erosion and forest clearing both fell dramatically resulting in a wide range of improved wellbeing outcomes for hundreds of thousands of people. The changes achieved better food security from crops, increased fish populations in the streams and rivers of the forests and more varied diets for the farmers. As the terraced farms require less labour to maintain, a wider range of jobs have been developed, incomes have increased,

children are more likely to attend school and infant mortality rates have fallen.

For more information on the key concept of sustainability, refer to page 10 of 'The geography toolkit'.

Source 3   Rice terraces in Meghalaya, north-eastern India

Source 2   IFAD works to improve the lives of people in poor rural areas such as this woman in India.

Check your learning 6.7

Remember and understand

1   What is IFAD and what does it aim to do?
2   What particular groups are the most disadvantaged in India?

Apply and analyse

3   Describe the ways in which IFAD aims to reduce rural poverty by increasing food security.
4   Explain how the agricultural technique of terracing can help improve human wellbeing.

Evaluate and create

5   Construct an **overlay map** of India to explore the relationship between levels of wellbeing there and the location of IFAD projects. Use the HDI map of India in Source 1 on page 160 as a base map and the data in Source 1 as the overlay. When you have completed your overlay map, describe the relationship between HDI and IFAD projects.

6.8 The government and foreign aid

In the 2015–2016 budget, the Australian government provided about $4 billion in overseas aid. Most of Australia's aid is spent on countries in the Asia–Pacific region, particularly Indonesia, Papua New Guinea and the small island nations in the Pacific.

Aid is given to poorer countries to improve the lives of those living in poverty and to make the countries in the Asia–Pacific region more stable. Not only does this aid help improve wellbeing in the region, it also supports Australia's economic and security interests by helping to build stronger, healthier countries in our region.

Aid is also given to countries outside the Asia–Pacific region when there is a humanitarian disaster such as famine or war. Source 1 shows the top 25 recipients of aid from Australia in 2015–2016.

What does foreign aid do?

Aid is delivered to these countries in a number of ways.
- Money is given to aid organisations such as World Vision that do work at the community level.
- Emergency aid, such as that provided after the Asian tsunami, is often provided in the form of food supplies, fresh water and medical teams.
- The Australian government works with other governments to assist in the delivery of important services such as policing and hospitals.

The sorts of aid programs that receive funding from the government are wide-ranging. There are programs that are directly improving the health of communities and saving lives. These include providing safe water and sanitation where it is not available, maternal and child health services and disease prevention (see Source 2).

Source 1 Where we give aid – top 25 recipients 2015–2016

Country	Australian ODA $(million) (2015–16)	Human Development Index value 2015
Papua New Guinea	554.5	0.505
Indonesia	375.7	0.684
Solomon Islands	175.9	0.566
Pacific Regional Programs	120.0	—
Sub-Saharan Africa	95.9	0.475 (average)
Timor-Leste	95.3	0.595
Vietnam	89.6	0.666
Cambodia	89.0	0.555
Afghanistan	84.6	0.465
Philippines	83.0	0.668
East Asia Regional Programs	66.0	—
Myanmar	62.8	0.536
Vanuatu	60.5	0.594
Bangladesh	59.8	0.57
Fiji	57.8	0.727
Pakistan	55.7	0.538
Middle East & Nth African Programs	47.1	—
Palestinian Territories	42.8	0.677
Laos	37.9	0.575
Samoa	36.8	0.702
Southern & Western Asian Programs	32.8	—
Nepal	31.4	0.548
Tonga	30.2	0.602
Sri Lanka	28.9	0.757
Kiribati	27.9	0.59

Source 2 These women are registering their children for health checks at an Australian-funded clinic in East Timor.

Source 3
Australia provides funding for schools throughout the Asia–Pacific region including here in Laos.

Source 4
This organic farm in the Philippines is supported by Australian aid.

Source 5
An Australian electoral officer helps the Solomon Islands police force provide security in a general election.

Source 6
A Queensland Fire and Rescue team inspect an earthquake-damaged building in Padang, Indonesia.

There are programs that address inequalities by increasing access to education, helping people with disabilities and empowering women (see Source 3).

There are programs that support sustainable economic development, improve food security and employment and reduce the negative impacts of environmental change (see Source 4).

There are programs that help other governments to improve their security, justice and human rights (see Source 5).

There are also humanitarian aid and disaster response programs for communities impacted by crisis situations and natural disasters (see Source 6).

Check your learning 6.8

Remember and understand

1 Why does Australia provide aid to overseas communities and countries?

2 Name three concerns that are addressed by aid programs.

Apply and analyse

3 Why do you think that the Australian government does not simply send money to the leaders of each country?

4 Select one of the photographs showing Australian aid at work. Imagine that you are one of the people receiving assistance. Describe the ways in which the aid you receive has improved your wellbeing.

Evaluate and create

5 Construct a scatter plot using the data provided in Source 1. It shows the amount of aid given to each country and the HDI value for each of these countries. Use your completed scatter plot to test the theory that Australia gives the most aid to the poorest countries.

6 Construct a choropleth map of the top 25 recipients of Australian aid. Use your completed map to test the theory that Australia gives more aid to countries in our region than to countries further away.

6.9 The role of NGOs

While governments are important sources of aid that help to improve wellbeing, there are also hundreds of **non-government organisations (NGOs)** with a similar aim. NGOs range from vast international groups such as World Vision and the Red Cross to very small NGOs with only a few members working to make a difference in a single community. What NGOs do have in common, however, is that they are non-profit organisations, meaning all their money goes to support their work, and they all depend on donations from governments or private individuals and companies to fund their work.

Here we look at two organisations:

- *Médecins Sans Frontières* – an organisation that responds to emergency situations with medical assistance
- Bangladesh Rural Advancement Committee – an organisation that works to reduce the causes of inequalities in wellbeing around the world.

Médecins Sans Frontières (Doctors Without Borders)

Médecins Sans Frontières (MSF) was founded by 13 French doctors in 1971 to deliver 'emergency aid to people affected by armed conflict, epidemics, exclusion from health care and natural disasters'.

They are currently active in 68 countries, many of them with unstable governments. In 2011, MSF took part in 436 programs, of these 271 were in Africa (see Source 2). MSF believes strongly in drawing attention to human rights violations and the lack of adequate responses to emergencies by governments in the areas in which they work. This does not always make them popular and means that virtually all of their funding must come from individual donations rather than from governments.

Source 2 Top 10 countries with the largest MSF programs, 2014

	Country	Type of emergency
1	South Sudan	Armed conflict, refugees
2	Democratic Republic of the Congo	Armed conflict, epidemic (malaria)
3	Central African Republic	Armed conflict, refugees
4	Haiti	Natural disaster, epidemic (cholera)
5	Sierra Leone	Epidemic (ebola)
6	Afghanistan	Post conflict, emergency health
7	Niger	Hunger, epidemic (malaria)
8	Liberia	Epidemic (ebola)
9	Ethiopia	Armed conflict, refugees, epidemic (tuberculosis)
10	Iraq	Post conflict, refugees
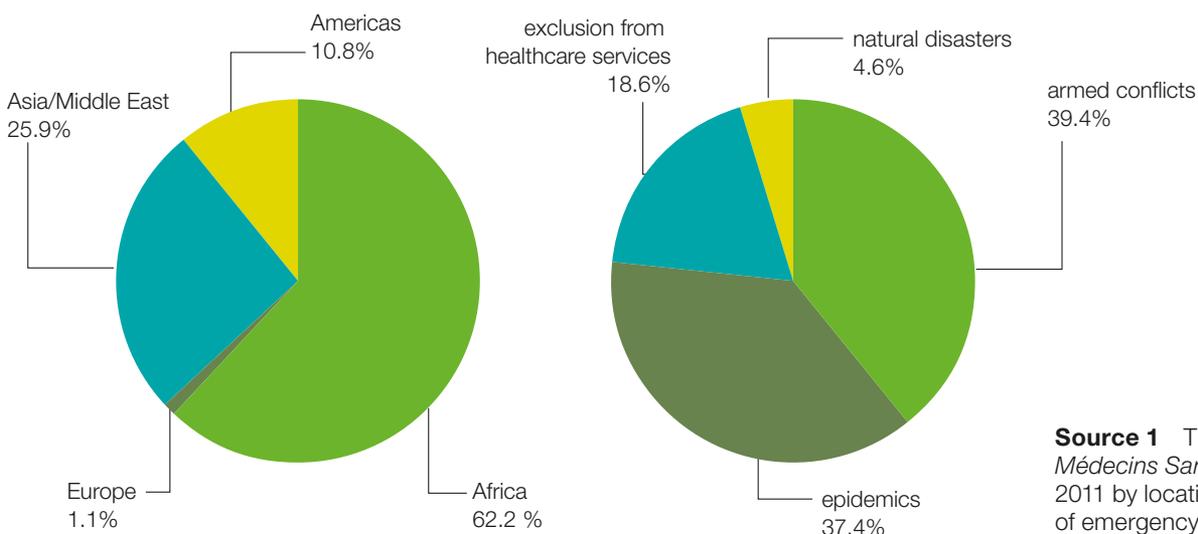
Source 1 The programs of *Médecins Sans Frontières* in 2011 by location (left) and type of emergency (right)

Source 3 MSF volunteers often work in dangerous conditions.

Source 4 BRAC works to improve opportunities for women in Bangladesh and throughout the world. This volunteer is training local women to act as nurses and health advocates for their villages.

Bangladesh Rural Advancement Committee (BRAC)

The Bangladesh Rural Advancement Committee (BRAC) was founded in 1972 to alleviate poverty by providing micro-credit to the poor of Bangladesh. Micro-credit allows the poor to access small loans – as small as $20 – to allow individuals to finance projects such as machinery repair, hiring a new labourer, purchasing a sewing machine or shoe-repair kit so that they can start their own small businesses. The loan is then repaid with minimum interest.

From these small beginnings, BRAC is now the world's largest NGO. It has over 100 000 employees and helps to improve the wellbeing of around 126 million people, mainly in Bangladesh but also in 10 other countries in Asia and Africa. In addition to offering micro-loans, BRAC now also provides education to millions of children, public health programs aimed at reducing child mortality, services for the disabled, disaster relief and Internet connections to thousands of rural communities.

Check your learning 6.9

Remember and understand

1 What are the aims of *Médecins Sans Frontières* (MSF)? Why do they receive very little funding from governments?

2 What is micro-credit and what does it provide to the poor?

Apply and analyse

3 Examine Source 2.

   a Which of the countries listed is the odd one out in terms of its location?

   b Select one of the top 10 countries supported by MSF. Use the 'World statistics' section in your obook to prepare a report on wellbeing levels in this country.

   c Suggest how MSF could help address some of the wellbeing issues in this country.

   d Visit the MSF website and use the international activity report page to research the type of assistance given by MSF in this country.

   e Share your findings with your classmates and compare the assistance given by MSF in the country you chose with countries that others chose.

4 Visit the BRAC website. Use the 'Where we work' tab to explore the countries in which BRAC is active and the types of assistance they provide in each country. Summarise your findings and present them in table format.

Charity

Many NGOs, including those you have learnt about in this chapter, are funded by donations from individuals and private companies. Donations vary from place to place depending on a wide range of variables including income. Of course, giving money to help other people is only one type of charity. Many people also give their time as volunteers. This can be of great assistance to others and can help to increase their level of wellbeing. Most of the doctors who work with MSF, for example, donate their time to work in areas where they are needed.

Source 2 shows the percentage of the population who donate money to charity in 20 selected countries.

Source 1   One of the world's largest charity organisations was started by Microsoft founder Bill Gates, one of the world's wealthiest men. The Bill and Melinda Gates Foundation has donated more than $25 billion to improve the wellbeing of people around the world. In this photograph Bill and Melinda Gates are chatting to Tatomkhulu-Xhosa, a South African man who is living with tuberculosis.

skill**drill:** Data and information

Creating proportional circles maps

A proportional circles map is able to show the differences in the size or extent of various factors within a country or region graphically. This allows the data to be represented visually and understood quickly. A proportional circles map is commonly used to represent figures including imports, exports, or population. To draw a proportional circles map use the following steps. You will need a ruler and a compass.

Step 1   On an outline map of the world locate each of the places you wish to include in your proportional scale and mark them with a small dot.

Step 2   Choose an appropriate scale range for your map. If you were looking at population figures of big cities, for example, you might choose a scale that goes up by 500 000 people each time. Keep your data within a scale of five different values, so that you end up with a maximum of five different sized circles.

**Step 3**   Construct a scale on a horizontal line that is relatively short (about 5 cm), or the circles will become too big. Do this by dividing the scale into even values, starting at 0 and placing line markers every 2.5 or 5 mm. For example, at 2.5 mm mark 500 000, at 5 mm mark 1 000 000, and so on.

Step 4   Place the point of your compass on the horizontal line at 0 and the pencil of your compass on the horizontal line at the first marker point on your scale. Use the compass to draw a circle. This will be the radius size of the proportional circle for your first value.

Step 5   Create a legend for your map and draw a circle for your first value following Step 4. Enter the value next to the circle.

Step 6   Repeat steps 4 and 5 until you have circles for all your values entered into your legend.

Step 7   Now map your data. Set the compass to the radius size that matches the appropriate value. Draw the proportional circle on the map at the spot you marked in Step 1.

Step 7   Repeat these steps for the remaining dots on your map. As you draw your map you may find that some circles overlap. Label each circle with the name of the city.

Step 8   Complete your map with BOLTSS.

Apply the skill

1   Create a proportional circles map using the data provided in Source 1 on page 230 relating to the amount of aid given to countries by the Australian government in 2015–2016.

WORLD: CHARITABLE GIVING INDEX
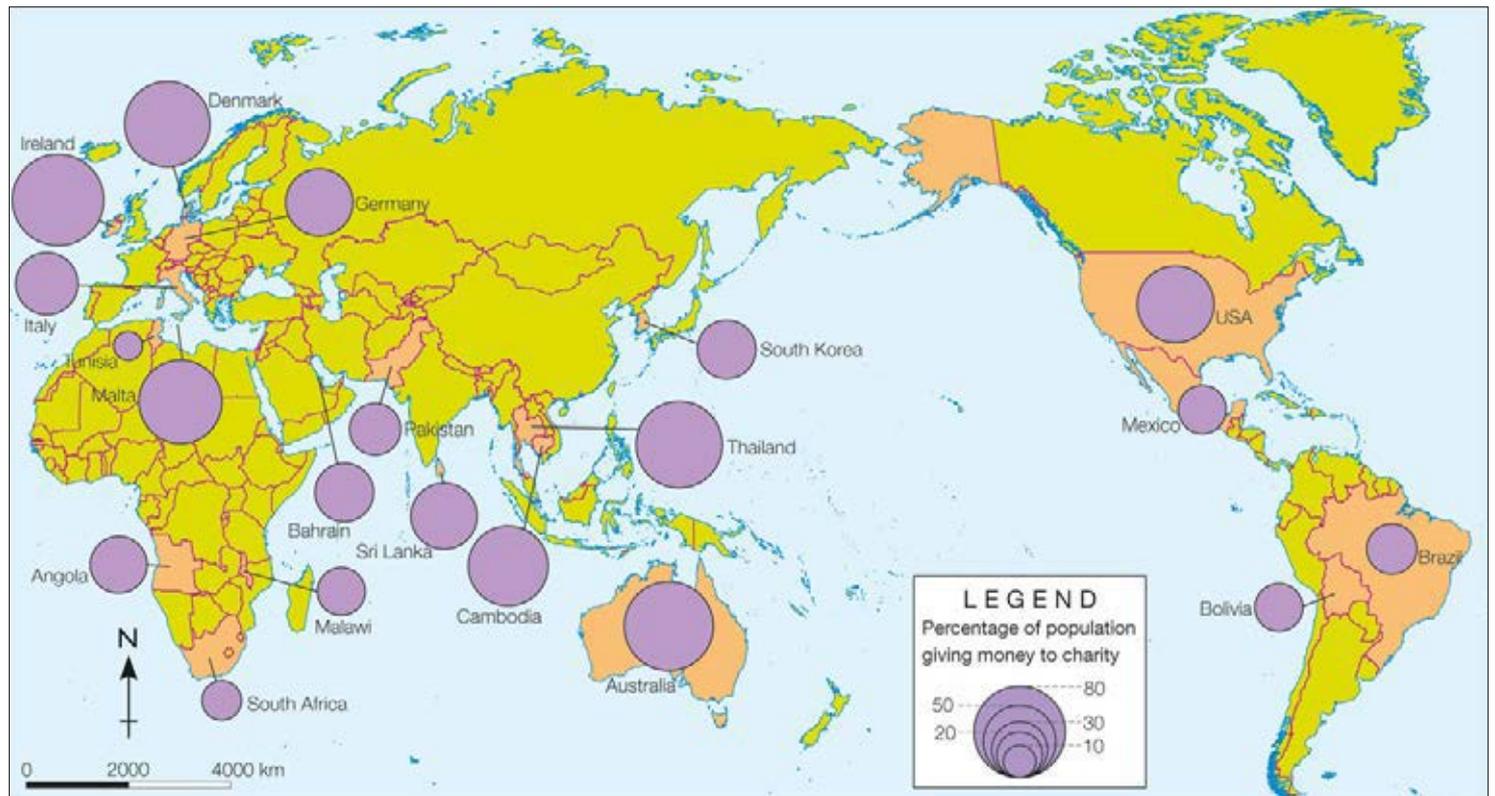
Source 2   Source: Oxford University Press

Extend your understanding

1   Examine Source 2.
    a   List the 10 countries on this map with the largest percentage of population who give money to charity.
    b   Compare this map to the GDP world map in Source 1 on page 148. Describe any links that you can find between charitable giving and GDP.
    c   In a recent study of charitable behaviours, Australia ranked 2nd for donating money, 12th for volunteering and 10th for helping a stranger. Do you find these rankings surprising? Give some reasons for your answer.

2   Source 3 shows another technique that relies on the size of features to communicate a message. What similarities and differences do you notice between the two patterns shown on these maps?

3   Use the Internet to research the Bill and Melinda Gates Foundation. Select one of the areas where this aid organisation helps and describe what the foundation does in this area.

WORLD: INTERNATIONAL FOOD AID
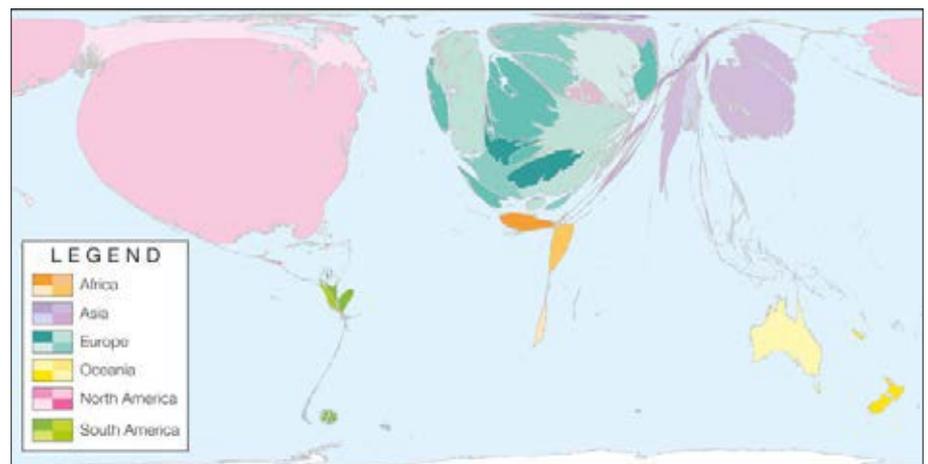
Source 3   Source: Oxford University Press

Glossary

A

annotate   to add notes that explain, comment or clarify

aquifer   an underground water supply consisting of a layer of rock or other permeable materials that hold water

arid   a term used to describe land and climate conditions that are too dry to support vegetation

atmosphere   all of the gases that surround the Earth

B

bar graph   a graph that shows information as a series of horizontal bars

biodiversity   the variety of living organisms (i.e. plants, animals, bacteria and fungi) found in an environment

biological pollutant   a term used to describe the negative effects of invasive species (such as bacteria, parasites and invasive plants and animals) that do harm to an environment

biome   a large area of the Earth that is home to similar plant and animal communities that have adapted to a particular environment over time (e.g. desert, forest, grassland, etc.)

biosphere   all living things on Earth (i.e. plants, animals, humans and other organisms)

breakwater   a wall constructed out into the sea to help prevent waves from reaching the coastline and causing erosion

C

cartogram   a type of map that is distorted to show a representation of statistical data (e.g. access to water, rates of obesity, etc.) rather than land area

change   a key concept in geography: the dynamic nature of all processes on Earth, whether slow or fast, small or large

chemical pollutants   a term used to describe a range of heavy metals, oils, pesticides, industrial chemicals and salts that do harm to the environment

child mortality rates   a measure of the number of deaths among children under five years of age per 1000 children born

choropleth map   a map that shows changes in particular data or characteristics across an area (e.g. population density, GDP per capita, etc.) by using shades of the same colour (e.g. light green through to dark green)

climate change   a change in global or regional climate patterns; in particular a change apparent from the mid to late 20th century onwards and attributed largely to the increased levels of atmospheric carbon dioxide produced by the use of fossil fuels

climate graph   a combination bar and line graph that shows the rainfall and temperature of a given place; also known as a climograph

coastal degradation   the deterioration of a coastline due to natural effects (such as erosion) or human effects (such as pollution)

complex map   a type of map that displays more than one set of data or information

compound column graph   a type of column graph that features two or more sets of related data at the same time so that they can be compared; information provided in each column is sub-divided for further comparison

confluence   the place or junction where two rivers meet

contour line   a line on a map (e.g. topographic map) joining points of equal height above or below sea level; contour lines can also be used to show the steepness of the land on a map

correlation   a statistical measure that indicates the extent to which two or more variables are related or interlinked

culture   a term used to describe the shared characteristics (e.g. language, food, religion, beliefs, etc.) of a population or group of people

D

deforestation   the removal of trees and other plant life from a forested area, either by cutting down or burning; usually carried out to clear the land for farming

demographics   the statistical data of a population or of particular groups within a population, especially those related to average age, gender, income, education level, etc.

demographic transition model   a geographic model designed to help explain changes in populations over time, especially the transition from high birth and death rates to low birth and death rates as countries becomes more developed

deposition   the laying down of solid material that has been eroded and transported from another part of the Earth's surface

desertification   the transformation of fertile land into relatively dry desert

developed country   an industrialised country with a well-developed economy and relatively high standard of living that is able to support the needs of its citizens (*see also* developing country)

developing country   a non-industrialised (i.e. largely agricultural) country with a relatively fragile economy and low standard of living that is not always able to support the needs of its citizens (*see also* developed country)

Digital Terrain Model (DTM)
a topographic illustration (or digital model) that uses a range of data to generate a 3-D representation of the Earth's surface

dot distribution map a type of map that uses dots or other shapes to show the location and size of particular features

E

economic (adjective) a term used to describe a range of issues relating to employment, income and trade

ecosystem a complex community made up of living organisms that interact with each other and with their environment; an abbreviation for 'ecological system'

ecosystem services a term used to describe a range of important resources, processes and benefits that healthy ecosystems provide to humans; there are four categories of ecosystem services: 1. **sources** (or provisioning services) such as providing food and materials, 2. **sinks** (or regulating services) such as purifying air and water, 3. **services** (or supporting services) such as seed dispersal and nutrient cycling, 4. **spirituality** (or cultural services) such as spiritual enrichment and recreation

ecotourism a form of responsible and sustainable tourism that involves travel to areas of natural or ecological interest with the goal of conserving the environment and improving the wellbeing of the local people

environment a key concept in geography: a specific place on Earth and all the things, both animate and inanimate, that are there

erosion the wearing away of the Earth's surface by wind, water or ice

estuary a wide tidal mouth of a river

extinction the dying out and complete disappearance of a species (e.g. plant or animal)

F

false colour image an image that depicts an object or area in colours that differ from those seen in nature; false colour images use colours that are different or more exaggerated than those shown in standard photographs, in order to make the thing being shown easier to interpret

fertility rate a statistical measure of the average number of children that all women in a particular area or population will have throughout the course of their lives; expressed as births per 1000 women

fieldwork geographical study that takes place outside the classroom at the site of inquiry

flow diagram a diagram that shows the sequence or stages in a process

flow map a type of map that shows the movement of objects (e.g. people or goods) from one place to another

food insecurity a term used to describe a condition in which not all people have access to enough safe nutritious food to sustain a healthy life (*see also* food security)

food security a term used to describe a condition in which all people at all times have access to enough safe nutritious food to sustain a healthy life (*see also* food insecurity)

fossil fuel a fuel made from the decomposed (fossilised) remains of plants and animals that lived millions of years ago (e.g. coal, oil, gas)

G

gender inequality unequal treatment of individuals within a society based on their gender, whether male or female

Geographic Information System (GIS) a software application designed to capture, store, manipulate, analyse, manage and present all kinds of geographical information

geographical sketch a sketch focusing on those parts of the environment relevant to the geographic study; often completed in the field but also from photographs

Global Positioning System (GPS) a device that uses satellites to accurately pinpoint the location of an object on the Earth's surface (e.g. a car, satellite navigation device, mobile phone) and provide data and directions to help with navigation

global warming a gradual increase in the overall temperature of the Earth's atmosphere generally attributed to the release of greenhouse gases such as carbon dioxide, CFCs and other pollutants into the atmosphere

grasslands a biome of wide open spaces, where the vegetation is dominated by grasses; sometimes called a prairie, steppe or savanna

greenhouse gas a gas, such carbon dioxide, that absorbs radiation from the Sun's rays trapping heat in the Earth's atmosphere

Gross Domestic Product (GDP) the total monetary value of all the goods and services produced by a country over a specific time period (usually a year)

ground level photograph a photograph taken from ground level (i.e. the photographer is standing on ground level and camera lens is parallel to the ground)

groyne a man-made barrier that juts out from a beach into the water, built to prevent erosion of the beach from the power of destructive waves and longshore drift

H

Human Development Index (HDI) a tool developed by the United Nations to grade and rank the social and economic development of the world's countries in order from most to least developed; used as a measure of human wellbeing

hydrosphere   all of the water on Earth (i.e. in solid, liquid and gaseous forms)

I

infant mortality   a statistical measure of the proportion of children in an area or population under the age of 12 months who die; expressed as deaths per 1000 live births

interconnection   a key concept in geography: the relationship between all things, both animate and inanimate, and all processes, both natural and human

Internally Displaced Person (IDP)   a person who has been forced to flee their home to escape conflict, but who remains within their own country's borders

invasive species   a plant, animal or other organism that is not native to an area, and whose introduction has negative effects on its new environment

irrigation   the watering of otherwise dry land by artificial means (e.g. pipes, ditches, sprinkler systems) to help in the growing of crops

L

land reclamation   the process of creating new land from oceans, bays, harbours and estuaries by dumping rocks, silt from the sea bed or other materials into the water

landfill   a method used to dispose of rubbish by burying it; also used to describe the place where rubbish is buried

landform   a natural geographical feature or shape that appears on the Earth's surface (e.g. dune, hill, valley, beach and cave)

life expectancy   a statistical measure of the average number of years a person in an area or population can expect to live; expressed in years

line graph   a type of graph that displays data as a line

literacy rate   a statistical measure of the percentage of people in an area or population that can read and write

lithosphere   the outer rocky layer of Earth (i.e. crust)

location   a place or position on the Earth's surface

longshore drift   the process that moves sediment in a zigzag pattern along a beach by wash and backwash of waves approaching the shore at an angle

M

map   a simplified plan of an area shown from directly above the area (i.e. plan view)

N

national park   an area of natural beauty which is protected by law for the use of the general public and the protection of the environment

non-government organisation (NGO)   any not-for-profit organisation independent of the government which is organised and administered on a local, national or international level; NGOs often rely on the support of volunteers

O

oblique aerial photograph   a photograph of an object or area taken from a high point (i.e. a hilltop or aircraft) on an angle that is neither horizontal (see ground level photograph) nor directly above (see vertical aerial photograph)

ocean acidification   the ongoing decrease in the pH level (a measure of acidity and alkalinity) of the Earth's oceans, caused by the uptake of carbon dioxide from the atmosphere by the water

overlay map   a type of map that uses information on a piece of transparent paper or plastic (known as an overlay) placed over a base map; used to show the relationship between features or processes taking place on the Earth's surface

ozone layer   a layer of ozone high in the atmosphere that protects the Earth from harmful amounts of the sun's rays

P

physical map   a type of map that shows the locations and names of physical features of the Earth, such as mountains and rivers

physical pollutants   a term used to describe a range of substances (e.g. particles of soil, chemicals, plastic bags, cigarette butts and other rubbish) that do harm to an environment

place   a key concept in geography: a part of the Earth's surface that is identified and given meaning by people

political map   a type of map that shows the locations and names of built features of the Earth, such as cities, roads, dams and railways

pollution   any substance that is released into the environment that causes damage

population pyramid   a type of graph that displays the percentage of males and females in a region or population grouped by age

primary data   data collected first-hand for a geographical inquiry by the person conducting the inquiry (e.g. survey data, hand-drawn maps or photographs)

Q

qualitative data   any information that can be recorded in words (e.g. Uluru is very large)

quantitative data   any information that can be recorded as numbers (e.g. Uluru is 3.6 kilometres long)

R

radial pattern   a pattern with its features spreading out like spokes on a wheel

rainforest   a dense forest area found in tropical areas with warm temperatures and heavy rainfall

raw material   the basic organic resources from which things are made; often used to refer to the Earth's natural materials such as oil, wood and water

refugee a person who travels from one country to another country to escape the effects of a natural disaster or conflict or to avoid persecution

relief the variations in elevation (height) of areas on the Earth's surface; on maps, the relief of an area (e.g. the hills and valleys) are often shown more clearly by shading rather than by using contour lines alone

S

salinity a measure of the amount of salt present in the soil

satellite image an image of an object or area taken from a satellite orbiting above the Earth's surface

savanna a biome of wide open spaces, where the vegetation is dominated by grasses; sometimes called a prairie, steppe or grassland

scale a key concept in geography: the level at which a geographical inquiry take place – personal, local, regional, national or global

scale (mapping) a system used to give an indication of distances on a map and the corresponding actual distances in the real world (e.g. line scale, written scale, ratio scale)

scatter plot a type of graph that shows two sets of data by plotted points along two axes, the pattern of which shows their correlation; also called a scatter graph or scattergram

secondary data data used for a geographical inquiry not collected by the geographer conducting the inquiry (e.g. textbooks, atlases and government websites)

semi-arid a term used to describe land and climate conditions that only receive enough rainfall to support limited vegetation (*see also* arid)

services one of the four categories of ecosystem services (also known as supporting services); processes that take place in the environment that support life (e.g. seed dispersal and absorption of carbon dioxide by trees and oceans

sinks one of the four categories of ecosystem services (also known as regulating services); processes that take place in the natural environment that absorb waste (e.g. microorganisms in the soil and water breakdown waste from humans and animals)

sources one of the four categories of ecosystem services (also known as provisioning services); these are natural products that can be used or converted by humans for use (e.g. wood from trees)

space a key concept in geography: the way things are arranged on the Earth's surface

spatial variation a term used to describe differences in the way built and natural features (e.g. towns, cities, rivers, mountain ranges, farming regions) are arranged on the Earth's surface

spirituality one of the four categories of ecosystem services (also known as cultural services); a sense of wellbeing and spiritual connection offered by the environment (e.g. aesthetic appreciation of certain landscapes, deep connections to the land)

spit a curved build-up of eroded material that forms at the mouth of a river

sustainability a key concept in geography: the ongoing capacity of Earth to maintain all life

sustainable development goals a set of 17 goals developed by the United Nations in 2015 that are designed to end poverty, protect the Earth from unsustainable development, and improve the wellbeing of all people

T

thematic map a type of map that shows details of a particular topic or data set (e.g. land use or the distribution of resources)

topographic map a type of map that shows the shape of the land, its relief and landforms

V

vertical aerial photograph a photograph taken from a high point directly above the object or area being photographed (i.e. plan view)

W

water scarcity a term used to describe a lack of sufficient water to meet the demands of an area or population

water table the highest underground level at which the rocks and soil in a particular area are completely wet with ground water

weather map a type of map that show conditions in the Earth's atmosphere, such as air pressure, wind speed, wind direction, and warm and cold fronts

wellbeing the ability of human beings to access the things they need in order to live happy and healthy lives (e.g. food, water, education, safety and security)

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Acknowledgements

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World statistics

Country	Population	Male/female life expectancy (years)	Birth rate (per 1000 people)	Death rate (per 1000 people)	Fertility rate (births per woman)
OCEANIA					
Australia	22 262 501	79/84	12.47	6	1.78
Cook Islands	10 447	71/77	16.18	—	2.49
Fiji	896 758	68/73	21.92	5.66	2.65
Kiribati	103 248	60/66	30.2	7.85	4.04
Marshall Islands	69 747	69/73	30.7	4.49	3.59
Micronesia, Federated States of	106 104	69/73	23.1	4.46	2.89
Nauru	9434	61/68	23.9	6.42	2.85
New Zealand	4 365 113	78/82	13.94	7.05	2.1
Niue	1229	—	—	—	—
Northern Marianas	51 170	74/79	21.97	3.05	2.24
Palau	21 108	68/75	11.2	7.89	1.82
Papua New Guinea	6 431 902	64/68	27.57	6.67	3.62
Samoa	195 476	69/75	28.06	5.79	4.16
Solomon Islands	597 248	71/76	27.69	3.77	3.52
Tonga	106 322	68/73	19.84	5.02	2.25
Tuvalu	10 698	67/72	23.11	6.95	2.91
Vanuatu	261 565	62/66	21.53	7.55	2.5
ASIA					
Afghanistan	31 108 077	44/45	38.37	17.83	5.6
Armenia	2 974 184	69/77	12.65	8.39	1.36
Azerbaijan	9 590 159	63/71	17.62	8.3	2.04
Bahrain	1 281 332	73/78	17.01	4.29	2.5
Bangladesh	163 654 860	58/63	24.68	9.23	2.74
Bhutan	725 296	65/67	20.07	7.39	2.38
Brunei	415 717	74/78	18.2	3.29	1.91
Cambodia	15 205 539	60/64	25.73	8.08	3.04
China	1 349 585 838	72/76	14	7.06	1.79
Cyprus	1 155 403	75/80	11.32	6.4	1.45
East Timor (Timor-Leste)	1 172 390	65/70	26.25	5.98	3.28
Georgia	4 555 911	73/80	10.66	9.65	1.44

Male/female literacy rate (% of people who can read and write)	Doctors per 100 000 people	Access to clean water (% of population)	Infant mortality (deaths per 1000 live births)	GDP per capita (US$)	Poverty (% of population below the poverty line)	Human Development Index ranking 2012
99/99	247	100	4.75	38 500	—	2
—	118	94	16.9	9100	—	—
95/92	45	47	11.58	3800	25.5	96
—	23	65	43.48	5300	—	121
94/94	47	87	25.45	2500	—	—
91/88	—	94	26.1	2200	26.7	117
—	77	—	9.25	5000	—	—
99/99	213	97	4.92	27 700	—	6
—	200	100	—	5800	—	—
97/96	—	99	6	12 500	—	—
93/90	158	85	13.14	8100	—	52 equal
63/51	5	39	45.9	2300	37	156
99.5/99.5	28	88	24.22	4700	—	96 equal
—	13	70	19.03	2600	—	143
99/99	29	100	11.58	4600	24	95
—	—	—	18.43	1600	—	
—	14	60	49.45	4800	—	124
43/13	20	39	153.14	800	36	175
99.5/99	370	92	20.21	5900	26.5	87
99.5/98	363	77	54.6	9900	11	82
88/84	272	—	15.09	38 400	36.3	48
54/41	30	74	59.02	1600	23.2	146 equal
60/34	2	62	49.36	6200	—	140
95/90	114	—	12.27	50 100	35	30
85/64	16	41	54.79	1900	2.8	138 equal
95/86	142	77	20.25	6500	—	101
99/96	230	100	9.7	21 200	42	31
—	10	58	40.65	2400	31	134
100/100	456	82	16.22	4500	25	72 equal

world statistics

Country	Population	Male/female life expectancy (years)	Birth rate (per 1000 people)	Death rate (per 1000 people)	Fertility rate (births per woman)
India	1 220 800 359	65/67	21.72	7.6	2.68
Indonesia	251 160 124	68/73	18.84	6.25	2.31
Iran	79 853 900	70/73	17.17	5.72	1.71
Iraq	31 858 481	69/71	30.09	5.03	3.86
Israel	7 707 042	79/83	19.77	5.43	2.75
Japan	127 253 075	79/86	7.64	9.45	1.21
Jordan	6 482 081	79/81	27.38	2.61	3.46
Kazakhstan	17 736 896	63/73	16.6	9.39	1.88
Kuwait	2 695 316	77/79	21.79	2.31	2.76
Kyrgyzstan	5 548 042	65/74	23.44	6.91	2.65
Laos	6 695 166	54/59	33.96	10.76	4.41
Lebanon	4 131 583	71/76	17.1	6.03	1.85
Malaysia	29 628 392	71/76	22.24	5.02	2.95
Maldives	393 988	72/76	14.55	3.65	1.9
Mongolia	3 226 516	65/70	21.05	6.12	2.23
Myanmar	48 137 741	61/66	16.97	9.14	1.89
Nepal	30 430 267	64/67	23.18	6.97	2.64
North Korea	24 720 407	61/67	14.82	10.52	1.96
Oman	3 154 134	72/77	34.79	3.65	5.53
Pakistan	193 238 868	64/67	25.89	7.21	3.43
Philippines	105 720 644	68/74	26.01	5.1	3.27
Qatar	2 042 444	74/77	15.61	2.46	2.45
Saudi Arabia	26 939, 83	74/78	28.55	2.47	3.83
Singapore	5 460 302	79/85	8.82	4.66	1.09
South Korea	48 955 203	75/82	8.93	5.94	1.21
Sri Lanka	21 675 648	73/77	16.26	6.13	1.99
Syria	22 457 336	72/77	25	3.72	3.12
Taiwan	23 299 716	75/81	8.99	6.76	1.14
Tajikistan	7 910 041	62/69	26.9	6.83	2.99
Thailand	67 448 120	71/76	13.38	7.12	1.65
Turkey	80 694 485	70/74	18.66	6.1	2.21
Turkmenistan	5 113 040	65/71	19.69	6.31	2.22
United Arab Emirates	5 473 972	74/79	16.02	2.11	2.42
Uzbekistan	28 661 637	69/75	17.58	5.29	1.95
Vietnam	92 477 857	69/74	17.73	5.98	1.98
Yemen	25 408 288	61/65	35.32	7.46	5

Male/female literacy rate (% of people who can read and write)	Doctors per 100 000 people	Access to clean water (% of population)	Infant mortality (deaths per 1000 live births)	GDP per capita (US$)	Poverty (% of population below the poverty line)	Human Development Index ranking 2012
73/48	60	86	50.78	3100	17.8	136 equal
94/87	13	77	29.97	4000	18	121 equal
83/70	89	94	35.78	12 900	25	76
84/64	66	81	44.65	3600	25	131
98/98	367	100	4.22	28 400	23.6	16
99/99	212	100	2.79	32 600	—	10
95/85	236	97	17.38	5300	14.2	100
99.5/99	388	86	25.73	11 400	12.1	69
94/91	180	—	8.97	55 800	—	54
99/98	239	77	31.26	2100	40	125 equal
77/61	35	51	77.76	2100	26	138 equal
93/82	236	100	21.82	11 500	28	72 equal
92/85	71	99	15.87	14 700	5.1	64 equal
96/96	92	83	29.53	4200	16	104
98/97	263	62	39.88	3400	36.1	108 equal
94/86	36	78	47.61	1200	32.7	149
63/35	21	90	47.61	1200	24.7	157
99/99	329	100	51.34	1800	—	—
87/73	167	80	16.88	20 300	—	84
63/63	80	91	67.36	2600	24	146 equal
92/93	115	85	20.56	3300	32.9	114 equal
89/89	264	100	12.66	121 400	—	36
85/71	137	90	11.57	20 300	—	57 equal
97/89	150	100	2.31	50 300	—	18 equal
99/97	157	92	4.26	27 700	15	12
92/89	55	79	18.57	4500	23	92
86/74	53	93	16.69	4700	11.9	116
—	—	—	5.35	30 200	0.95	—
99.5/99	201	59	41.03	1800	60	125
95/90	37	99	17.48	8100	9.6	103
95/80	156	96	25.78	11 200	17.11	90
99/98	249	72	45.36	6700	30	102
76/82	169	100	12.7	41 800	19.5	41 equal
99.5/99	265	82	23.34	2800	26	114 equal
94/87	56	85	22.26	2900	12.3	127
70/30	33	67	58.4	2500	45.2	160

world statistics

Country	Population	Male/female life expectancy (years)	Birth rate (per 1000 people)	Death rate (per 1000 people)	Fertility rate (births per woman)
EUROPE					
Albania	3 011 405	75/81	15.29	5.55	2.01
Andorra	85 293	80/85	10.35	5.89	1.33
Austria	8 221 646	77/83	8.65	9.98	1.39
Belarus	9 625 888	65/77	9.71	13.86	1.24
Belgium	10 444 268	76/83	10.15	10.44	1.65
Bosnia and Herzegovina	3 875 723	75/82	8.85	8.63	1.25
Bulgaria	6 981 642	69/77	9.15	14.31	1.41
Croatia	4 475 611	72/79	9.64	11.75	1.42
Czech Republic	10 162 921	74/80	8.83	10.74	1.24
Denmark	5 556 452	76/81	10.54	10.22	1.74
Estonia	1 266 375	67/79	10.37	13.42	1.42
Finland	5 266 114	75/83	10.38	10.07	1.73
France	65 951 611	78/84	12.57	8.56	1.98
Germany	81 147 265	76/82	8.18	10.9	1.41
Greece	10 772 967	77/82	9.45	10.51	1.37
Hungary	9 939 470	69/78	9.51	12.94	1.35
Iceland	315 281	79/83	13.43	6.85	1.9
Ireland	4 775 982	76/81	14.23	7.75	1.85
Italy	61 482 297	77/83	8.18	10.72	1.31
Kosovo	1 847 708	—	—	—	—
Latvia	2 178 443	67/78	9.78	13.62	1.3
Liechtenstein	37 009	77/84	9.75	7.39	1.52
Lithuania	3 515 858	70/80	9.11	11.18	1.23
Luxembourg	514 862	76/83	11.73	8.44	1.78
Macedonia (FYROM)	2 087 171	72/77	11.97	8.83	1.58
Malta	411 277	77/82	10.36	8.38	1.51
Moldova	3 619 925	67/75	11.12	10.78	1.27
Monaco	30 500	76/84	9.1	12.74	1.75
Montenegro	653 474	—	11.14	8.63	—
Netherlands	16 805 037	77/82	10.4	6.48	1.66
Norway	4 722 701	77/83	10.99	9.29	1.78
Poland	38 383 809	72/80	10.04	10.05	1.28
Portugal	10 799 270	75/82	10.29	10.68	1.49
Romania	21 790 479	69/76	10.53	11.88	1.39
Russia	142 500 482	59/73	11.1	16.06	1.41

Male/female literacy rate (% of people who can read and write)	Doctors per 100 000 people	Access to clean water (% of population)	Infant mortality (deaths per 1000 live births)	GDP per capita (US$)	Poverty (% of population below the poverty line)	Human Development Index ranking 2012
99/98	115	96	18.62	6200	25	70
100/100	364	100	3.76	44 900	8	33 equal
—	366	100	4.42	39 400	6	18 equal
99.5/99	478	100	6.43	11 600	27.1	50
99/99	423	100	4.44	36 600	15.2	17
99/94	142	98	9.1	6300	25	81
99/98	366	99	17.87	12 600	14	57 equal
99/97	247	100	6.37	17 600	17	47
99/99	358	100	3.79	25 100	—	28
99/99	359	100	4.34	36 200	12.1	15
99.5/99.5	333	100	7.32	18 800	19.5	33 equal
100/100	330	100	3.47	34 900	—	21 equal
99/99	341	100	3.33	32 800	6.2	20
99/99	344	100	3.99	34 200	11	5
98/94	500	—	5.16	32 100	—	29
99.5/99	304	99	7.86	18 800	8.6	37
99/99	377	100	3.23	39 800	—	13 equal
99/99	294	—	5.05	42 200	4.2	7 equal
99/98	370	—	5.51	30 200	—	25
97/87	—	—	—	2500	35	—
99.5/99.5	314	99	8.77	14 500	—	44
100/100	—	—	4.25	122 100	—	24
99.5/99.5	395	—	6.47	15 500	4	41 equal
100/100	273	100	4.56	77 600	—	26 equal
98/94	255	—	9.01	9000	28.7	78 equal
91/93.5	388	100	3.75	23 900	—	32
99.5/98.5	266	92	13.13	2400	29.5	113
99/99	581	100	5	30 000	—	—
—	203	93	—	9800	7	52 equal
99/99	371	100	4.73	39 000	10.5	4
100/100	377	100	3.58	59 300	—	1
99.5/99.5	194	—	6.8	17 800	17	39
95/91	344	—	4.78	21 700	18	43
98/96	192	57	22.9	11 500	25	56
99.5/99	431	97	10.56	15 200	15.8	55

Country	Population	Male/female life expectancy (years)	Birth rate (per 1000 people)	Death rate (per 1000 people)	Fertility rate (births per woman)
San Marino	32 448	77/85	9.68	8.55	1.36
Serbia	7 243 007	71/77	9.19	13.86	1.38
Slovakia	5 488 339	71/80	10.6	9.53	1.35
Slovenia	1 992 690	73/81	8.97	10.62	1.28
Spain	47 370 542	77/84	9.72	9.99	1.31
Sweden	9 119 423	79/83	10.13	10.21	1.67
Switzerland	7 996 026	78/84	9.59	8.59	1.45
Ukraine	44 573 205	62/75	9.6	15.81	1.26
United Kingdom	63 395 574	76/81	10.65	10.02	1.66
AFRICA					
Algeria	38 087 812	72/76	16.9	4.64	1.79
Angola	18 565 269	37/39	43.69	24.08	6.12
Benin	9 877 292	58/60	39.22	9.45	5.49
Botswana	2 127 825	62/62	22.89	8.52	2.6
Burkina Faso	17 812 961	51/55	44.33	13.3	6.28
Burundi	10 888 321	56/59	41.76	10.14	6.33
Cameroon	20 549 221	53/55	34.1	12.2	4.33
Cape Verde	531 046	68/75	23.5	6.22	3.07
Central African Republic	5 166 510	44/45	32.75	17.84	4.14
Chad	11 193 452	47/49	40.86	16.09	5.31
Comoros	752 288	61/66	35.23	7.57	4.84
Congo	4 492 689	53/55	41.37	12.01	5.84
Congo, Democratic Republic of	75 507 308	53/56	42.63	11.63	6.2
Djibouti	792 198	58/63	26.34	8.53	2.92
Egypt	85 294 388	70/75	25.43	4.88	3.05
Equatorial Guinea	704 001	61/63	36.52	9.49	5.08
Eritrea	6 233 682	60/64	34.2	8.43	4.72
Ethiopia	93 877 025	53/58	43.66	11.55	6.12
Gabon	1 640 286	52/53	35.57	12.76	4.65
Gambia	1 883 051	53/56	37.8	12.21	5.04
Ghana	25 199 609	59/61	28.74	9.13	3.68
Guinea	11 176 026	56/59	37.52	11	5.2
Guinea Bissau	1 660 870	46/50	35.97	15.79	4.65
Ivory Coast	20 617 068	55/56	32.11	10.78	4.12
Kenya	44 037 656	57/58	36.64	9.72	4.56
Lesotho	1 936 181	41/40	24.14	22.2	3.06

Male/female literacy rate (% of people who can read and write)	Doctors per 100 000 people	Access to clean water (% of population)	Infant mortality (deaths per 1000 live births)	GDP per capita (US$)	Poverty (% of population below the poverty line)	Human Development Index ranking 2012
97/95	4735	—	5.35	41 900	—	—
99/94	199	93	6.75	10 400	6.5	64 equal
99.5/99.5	312	100	6.84	21 100	21	35
99.5/99.5	240	100	4.25	28 200	12.9	21 equal
99/98	330	100	4.21	33 700	19.8	23
99/99	328	100	2.75	36 800	—	7 equal
99/99	397	100	4.18	41 600	—	9
99.5/99	313	96	8.98	6400	37.7	78 equal
99/99	230	100	4.85	35 400	14	26 equal
79/60	113	85	27.73	7100	23	93
83/54	8	53	180.21	8800	40.5	148
48/23	4	67	64.64	1500	37.4	166
80/82	40	95	12.95	12 100	30.3	119
29/15	5	61	84.49	1200	46.4	183
67/52	3	79	64.86	300	68	178 equal
77/60	19	66	63.34	2300	48	150
86/69	49	80	41.35	3900	30	132
65/33	8	75	80.62	700	—	180
41/13	4	42	98.69	1500	80	184
64/49	15	86	66.57	1000	60	169
90/78	20	58	79.78	4200	—	142
81/54	11	46	81.21	300	—	186 equal
78/58	18	73	58.33	2800	42	164
83/60	243	98	27.26	6000	20	112
93/80	30	43	81.58	36 100	—	136 equal
70/48	5	60	43.33	700	50	181
50/35	3	22	80.8	900	38.7	173
74/53	29	88	51.78	13 700	—	106
48/33	11	82	68.84	1300	—	165
66/50	15	75	51.18	1500	28.5	135
43/18	11	50	65.22	1100	47	178 equal
58/27	12	59	99.82	600	—	176
61/39	12	84	68.06	1700	42	168
91/80	14	61	54.7	1600	50	145
75/95	5	79	77.4	1500	49	158

world statistics

Country	Population	Male/female life expectancy (years)	Birth rate (per 1000 people)	Death rate (per 1000 people)	Fertility rate (births per woman)
Liberia	3 989 703	41/43	42.25	20.73	5.79
Libya	6 002 347	75/80	25.13	3.41	3.08
Madagascar	22 599 098	61/65	38.14	8.14	5.14
Malawi	16 777 547	49/51	41.68	14.23	5.59
Mali	15 968 882	50/54	46.44	14.96	6.62
Mauritania	3 437 610	58/63	34.11	9.16	4.45
Mauritius	1 322 238	71/78	14.41	6.59	1.81
Morocco	32 649 130	72/79	19.72	4.74	2.27
Mozambique	24 096 669	42/41	37.98	20.07	5.18
Namibia	2 182 852	52/51	22.51	13.3	2.69
Niger	16 899 327	51/54	51.6	14.83	7.75
Nigeria	174 507 539	46/48	36.65	16.56	4.91
Rwanda	12 012 589	55/58	38.06	10.57	5.12
Sao Tome and Principe	186 817	67/70	38.54	5.8	5.33
Senegal	13 300 410	57/61	36.84	9.75	4.95
Seychelles	90 846	68/78	15.87	6.93	1.93
Sierra Leone	5 612 685	53/58	39.08	12.22	5
Somalia	10 251 568	48/52	43.7	15.55	6.52
South Africa	48 601 098	50/48	19.93	16.99	2.38
Sudan	34 847 910	50/52	33.74	12.94	4.48
South Sudan	11 090 104	60	29.9	21.2	5.54
Swaziland	1 403 362	48/48	28.09	15.03	3.32
Tanzania	48 261 942	51/54	34.29	12.59	4.46
Togo	7 154 237	57/62	36.49	8.95	4.79
Tunisia	10 835 873	74/78	15.42	5.2	1.72
Uganda	34 758 809	52/54	47.84	12.09	6.77
Zambia	14 222 233	39/39	40.24	21.34	5.15
Zimbabwe	13 182 908	46/45	31.49	16.19	3.69
NORTH AMERICA					
Antigua and Barbuda	90 156	73/77	16.59	5.94	2.07
Bahamas	319 031	67/72	16.41	7.16	2
Barbados	288 725	72/76	12.55	8.41	1.68
Belize	334 297	66/70	27.33	5.8	3.36
Canada	34 568 211	79/84	10.28	7.74	1.58
Costa Rica	4 695 942	75/80	17.43	4.34	2.14
Cuba	11 061 886	75/80	11.13	7.24	1.61

Male/female literacy rate (% of people who can read and write)	Doctors per 100 000 people	Access to clean water (% of population)	Infant mortality (deaths per 1000 live births)	GDP per capita (US$)	Poverty (% of population below the poverty line)	Human Development Index ranking 2012
74/42	3	61	138.24	500	80	174
92/72	125	71	21.7	14 600	7.4	64 equal
75/62	29	46	54.2	1000	50	151
76/50	2	73	86.01	900	53	170
53/40	8	50	115.86	1100	36.1	182
59/43	11	53	63.42	2100	40	155
88/80	106	100	12.2	12 400	8	80
66/40	51	81	29.75	4600	15	130
63/33	3	43	105.8	900	70	185
87/83	30	87	45.51	6400	34.9	128
43/15	2	46	116.66	700	63	186 equal
76/61	28	48	94.35	2400	70	153
76/65	5	74	67.18	1000	60	167
92/78	49	79	37.12	1400	54	144
51/29	6	76	58.94	1700	54	154
91/92	151	88	12.3	19 400	—	46
47/24	3	57	81.86	900	70.2	177
50/26	4	29	109.19	600	—	—
87/86	77	88	44.42	10 000	50	121 equal
72/50	30	70	82.43	2300	40	171
40/16	—	56	69.97	900	50.6	—
83/81	16	62	69.74	4400	69	141
77/62	2	62	69.28	1400	36	152
75/47	4	52	56.84	900	32	159
83/65	134	93	22.57	8000	7.4	94
77/58	8	60	64.82	1300	35	161 equal
87/75	12	58	101.2	1500	86	163
94/87	16	81	32.31	200	68	172
—	17	91	16.25	18 100	—	67 equal
95/96	105	97	14.84	29 800	9.3	49
99.5/99.5	121	100	12.29	18 500	—	38
77/77	105	91	23.07	8200	33.5	96 equal
99/99	191	100	5.04	38 400	10.8	11
95/95	132	97	8.77	11 300	16	62
99.5/99.5	591	91	5.82	9700	—	59 equal

world statistics

Country	Population	Male/female life expectancy (years)	Birth rate (per 1000 people)	Death rate (per 1000 people)	Fertility rate (births per woman)
Dominica	73 286	73/79	15.73	8.2	2.09
Dominican Republic	10 219 630	72/76	22.39	5.28	2.76
El Salvador	6 108 590	69/76	25.31	5.47	3
Grenada	109 590	64/68	21.32	6.09	2.23
Guatemala	14 373 472	68/72	27.98	5.11	3.47
Haiti	9 893 934	59/62	29.1	8.65	3.81
Honduras	8 448 465	69/72	26.28	4.96	3.27
Jamaica	2 909 714	72/75	19.68	6.43	2.25
Mexico	116 220 947	73/79	19.71	4.8	2.34
Nicaragua	5 788 531	69/74	23.25	4.3	2.57
Panama	3 559 408	74/80	20.18	4.66	2.53
St Kitts and Nevis	51 134	70/76	17.67	8.05	2.26
St Lucia	162 781	74/79	15.1	6.8	1.84
St Vincent and the Grenadines	103 220	72/76	15.27	6.91	1.98
United States of America	316 668 567	76/81	13.83	8.38	2.05
SOUTH AMERICA					
Argentina	42 610 981	73/80	17.94	7.41	2.35
Bolivia	10 461 053	64/70	25.82	7.05	3.17
Brazil	201 009 622	68/76	18.43	6.35	2.21
Chile	17 216 945	74/81	14.64	5.84	1.92
Colombia	45 745 783	71/78	18.09	5.22	2.22
Ecuador	15 439 429	72/78	20.77	4.99	2.51
Guyana	739 903	62/70	18.31	7.34	2.48
Paraguay	6 623 252	73/78	28.17	4.46	3.75
Peru	29 849 303	69/73	19.38	6.14	2.37
Suriname	566 846	71/77	16.8	5.51	1.99
Trinidad and Tobago	1 225 225	68/74	14.36	8.11	1.72
Uruguay	3 324 460	73/80	13.91	9.09	1.92
Venezuela	28 459 085	71/77	20.61	5.12	2.48

Male/female literacy rate (% of people who can read and write)	Doctors per 100 000 people	Access to clean water (% of population)	Infant mortality (deaths per 1000 live births)	GDP per capita (US$)	Poverty (% of population below the poverty line)	Human Development Index ranking 2012
94	50	97	13.65	10 200	30	72 equal
87/87	188	95	25.96	8200	42.2	96 equal
83/78	124	84	21.52	6000	30.7	107
—	98	95	13.23	12 700	32	63
75/63	90	95	27.84	5200	56.2	133
55/51	25	54	59.69	1300	80	161 equal
80/80	57	87	21.68	4200	59	120
84/92	85	93	15.22	8300	14.8	85 equal
92/90	198	97	18.42	13 200	18.2 (47+ if asset based rather than food based)	61
67/68	37	79	25.02	2800	48	129
92/91	150	90	12.67	11 900	28.6	59 equal
—	110	99	13.94	18 800	—	72
89/91	517	98	13.43	10 900	—	88
96/96	75	93	15.14	18 100	—	83
99/99	256	100	6.22	46 400	12	3
97/97	301	96	11.44	13 800	13.9 (non government estimate 30–35)	45
93/81	122	85	44.66	4600	60	108
88/89	115	90	22.58	10 200	26	85 equal
96/96	109	95	7.71	14 700	18.2	40
90/91	135	93	17.37	9200	49.2	91
92/90	148	94	20.9	7300	38.3	89
99/98	48	83	39.11	3900	—	118
95/93	111	86	24.68	4100	32	111
96/89	117	83	28.62	8600	44	77
92/87	45	92	18.81	8800	70	105
99/98	79	91	29.93	23 300	17	67 equal
98/98	365	100	11.32	12 600	27.4	51
93/93	194	83	21.54	13 200	37.9	71

world statistics

WORLD: POLITICAL

ARCTIC

ATLANTIC OCEAN

INDIAN OCEAN

SOUTHERN OCEAN

ANTARCTICA

Oceans and major labels:

Svalbard (Norway), Jan Mayen (Norway), Kalaallit Nunaat (Greenland) (Denmark), Reykjavik, ICELAND, Faroe Islands (Denmark), NORWAY, SWEDEN, FINLAND, Oslo, Stockholm, Helsinki, Tallinn, ESTONIA, Riga, LATVIA, LITHUANIA, Vilnius, Minsk, BELARUS, Moscow, RUSSIA, Astana, KAZAKHSTAN, Ulan Bator, MONGOLIA, Beijing, NORTH KOREA, Pyongyang, Seoul, SOUTH KOREA, JAPAN, Tokyo

UNITED KINGDOM, Dublin, IRELAND, London, DENMARK, Copenhagen, POLAND, Warsaw, Berlin, GERMANY, Paris, FRANCE, UKRAINE, Kyiv, ROMANIA, Bucharest, BULGARIA, Sofia, GREECE, Athens, ITALY, Rome, PORTUGAL, Lisbon, Madrid, SPAIN, Gibraltar (UK)

Algiers, Tunis, TUNISIA, Tripoli, Rabat, MOROCCO, Madeira Islands (Portugal), Canary Islands (Spain), Western Sahara, ALGERIA, LIBYA, EGYPT, Cairo

TURKEY, Ankara, CYPRUS, Nicosia, SYRIA, Damascus, Baghdad, IRAQ, JORDAN, Amman, GEORGIA, Tbilisi, ARMENIA, Yerevan, AZERBAIJAN, Baku, Tehran, IRAN, SAUDI ARABIA, Riyadh, OMAN, Muscat, YEMEN, Sana'a, Asmara, ERITREA, DJIBOUTI, Djibouti

UZBEKISTAN, Tashkent, TURKMENISTAN, Ashkhabad, TAJIKISTAN, Dushanbe, KYRGYZSTAN, Bishkek, AFGHANISTAN, Kabul, Islamabad, PAKISTAN, New Delhi, INDIA, NEPAL, Kathmandu, BHUTAN, Thimphu, BANGLADESH, Dhaka, CHINA, MYANMAR, Naypyidaw, Yangon, Hanoi, LAOS, Vientiane, THAILAND, Bangkok, CAMBODIA, Phnom Penh, VIETNAM, TAIWAN, Taipei, PHILIPPINES, Manila

MAURITANIA, Nouakchott, MALI, NIGER, Niamey, CHAD, N'Djamena, SUDAN, Khartoum, BURKINA FASO, Bamako, Ouagadougou, GUINEA, Conakry, NIGERIA, Abuja, CENTRAL AFRICAN REPUBLIC, Bangui, SOUTH SUDAN, Juba, ETHIOPIA, Addis Ababa, SOMALIA, Mogadishu, Monrovia, LIBERIA, CAMEROON, Yaounde, CONGO, Libreville, GABON, Brazzaville, DEMOCRATIC REPUBLIC OF CONGO, Kinshasa, UGANDA, Kampala, KENYA, Nairobi, RWANDA, BURUNDI, TANZANIA, Dodoma, SEYCHELLES, Victoria, COMOROS, Moroni

ANGOLA, Luanda, ZAMBIA, Lusaka, MALAWI, Lilongwe, MOZAMBIQUE, ZIMBABWE, Harare, NAMIBIA, Windhoek, BOTSWANA, Gaborone, Pretoria, Maputo, SWAZILAND, Mbabane, LESOTHO, Maseru, Bloemfontein, SOUTH AFRICA, Cape Town, MADAGASCAR, Antananarivo, MAURITIUS, Port Louis, Reunion (France)

SRI LANKA, Colombo, MALDIVES, Male, Chagos Archipelago (UK), BRUNEI, Bandar Seri Begawan, MALAYSIA, Kuala Lumpur, SINGAPORE, INDONESIA, Jakarta, Christmas Island (Australia), Cocos Islands (Australia), TIMOR-LESTE (EAST TIMOR), Dili, PALAU, Melekeok, FEDERATED STATES OF MICRONESIA, Palikir, NORTHERN MARIANAS, Saipan, Guam (USA), PAPUA NEW GUINEA, Port Moresby

AUSTRALIA, Canberra, Lord Howe Island (Australia), Macquarie Island (Australia), Heard Island (Australia), Amsterdam (France), St Paul (France)

Ascension (UK), St Helena (UK), Tristan da Cunha (UK)

Legend:

1 **Luxembourg** – Luxembourg	18 **Montenegro** – Podgorica	34 **Ivory Coast** – Yamoussoukro
2 **Netherlands** – Amsterdam	19 **Serbia** – Belgrade	35 **Ghana** – Accra
3 **Belgium** – Brussels	20 **Kosovo** – Pristina	36 **Togo** – Lome
4 **Switzerland** – Bern	21 **Macedonia*** – Skopje	37 **Benin** – Porto-Novo
5 **Andorra** – Andorra-la-Vella	22 **Albania** – Tirane	38 **Equatorial Guinea** – Malabo
6 **Monaco** – Monaco	23 **Malta** – Valletta	39 **Sao Tome and Principe** – Sao Tome
7 **Liechtenstein** – Vaduz	24 **Lebanon** – Beirut	40 **Rwanda** – Kigali
8 **San Marino** – San Marino	25 **Israel** – Jerusalem	41 **Burundi** – Bujumbura
9 **Vatican City**	26 **Kuwait** – Kuwait	42 **Belize** – Belmopan
10 **Czech Republic** – Prague	27 **Bahrain** – Manama	43 **Jamaica** – Kingston
11 **Slovakia** – Bratislava	28 **Qatar** – Doha	44 **St Kitts and Nevis** – Basseterre
12 **Austria** – Vienna	29 **United Arab Emirates** – Abu Dhabi	45 **Antigua and Barbuda** – St John's
13 **Hungary** – Budapest	30 **Senegal** – Dakar	46 **Dominica** – Roseau
14 **Moldova** – Kishinev	31 **Gambia** – Banjul	47 **St Lucia** – Castries
15 **Slovenia** – Ljubljana	32 **Guinea Bissau** – Bissau	48 **Barbados** – Bridgetown
16 **Croatia** – Zagreb	33 **Sierra Leone** – Freetown	49 **St Vincent and the Grenadines** – Kingstown
17 **Bosnia and Herzegovina** – Sarajevo		50 **Grenada** – St George's

*Former Yugoslav Republic of Macedonia

Map of the Americas and Pacific region

Grid references (top): G 180° | H 150°W | I 120°W | J 90°W | K 60°W | L 30°W | M 0° | N 30°E

Oceans and labels:

O C E A N

P A C I F I C   O C E A N

A T L A N T I C   O C E A N

Arctic Circle
Tropic of Cancer
Equator
Tropic of Capricorn
Antarctic Circle

Places and countries:

- Kalaallit Nunaat (Greenland) (Denmark)
- ICELAND — Reykjavik
- Alaska (USA)
- CANADA — Ottawa
- St Pierre and Miquelon (France)
- UNITED STATES OF AMERICA — Washington DC
- Bermuda (UK)
- Azores (Portugal)
- CAPE VERDE — Praia
- Hawaii (USA)
- Socorro Island (Mexico)
- Clarion Island (Mexico)
- MEXICO — Mexico City
- BAHAMAS — Nassau
- Havana — CUBA
- HAITI — Port-au-Prince
- DOMINICAN REPUBLIC — Santo Domingo
- GUATEMALA — Guatemala City
- HONDURAS — Tegucigalpa
- San Salvador
- EL SALVADOR
- NICARAGUA — Managua
- COSTA RICA — San Jose
- PANAMA — Panama City
- Clipperton (France)
- 42 43 44 45 46 47 48 49 50
- TRINIDAD AND TOBAGO — Port of Spain
- Caracas — VENEZUELA
- GUYANA — Georgetown
- SURINAME — Paramaribo
- French Guiana (France)
- COLOMBIA — Bogota
- Quito — ECUADOR
- Galapagos Islands (Ecuador)
- PERU — Lima
- BRAZIL — Brasilia
- La Paz — BOLIVIA — Sucre
- PARAGUAY — Asuncion
- CHILE
- San Felix (Chile)
- Rapa Nui (Easter Island) (Chile)
- Juan Fernandez Islands (Chile)
- Santiago
- URUGUAY — Montevideo
- Buenos Aires — ARGENTINA
- Falkland Islands (UK)
- South Georgia (UK)
- ANTARCTICA

Pacific:

- MARSHALL ISLANDS — Majuro
- NAURU — Yaren
- South Tarawa — KIRIBATI
- SOLOMON ISLANDS — Honiara
- TUVALU — Funafuti
- SAMOA — Apia
- American Samoa (USA)
- VANUATU — Port Vila
- FIJI — Suva
- NIUE — Alofi
- TONGA — Nukualofa
- COOK ISLANDS — Avarua
- French Polynesia (France)
- Pitcairn Island (UK)
- New Caledonia (France)
- Norfolk Island (Australia)
- NEW ZEALAND — Wellington
- Chatham Islands (New Zealand)
- Auckland Islands (New Zealand)
- International Date Line

LEGEND

Symbol	Description
—— (line)	Country border
- - - (dashed line)	Disputed country border
●	Country capital city
Azores (Portugal)	Dependency

N (compass)

0   800   1600   2400 km

SCALE 1:80 000 000 at 40°N and S

1 centimetre on the map measures 800 kilometres on the ground.

Modified Times Projection

Grid references (bottom): G 180° | H 150°W | I 120°W | J 90°W | K 60°W | L 30°W | M 0°

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