Valuing and managing water

People value water for many different reasons. It has economic, cultural, spiritual and even aesthetic (appreciated for its beauty) value. As populations grow, the demand for water increases, yet its supply is limited. People all over the world need to examine how they use water, and put in place measures to conserve and manage it. On the other hand, when rainfall is high, communities in low-lying areas close to rivers need to put in place measures to deal with the opposite problem – floods.

chapter 3

Source 1 The Cascata Golf Club in the Nevada Desert uses 5 000 000 litres of water per day to irrigate its fairways and greens.

3A

How do we value and manage water?

1 Considering that only 2.5 per cent of all water on Earth is fresh water, do you think that the Cascata Golf Club's use of water (see Source 1) is responsible?

2 Why might water have a higher economic value in the Nevada Desert?

3B

How can we overcome water scarcity?

1 What could the managers of the Cascata Golf Club do to use less water?

2 Make a list of strategies that you, personally, could put in place to use less water.

3C

How do we respond to floods?

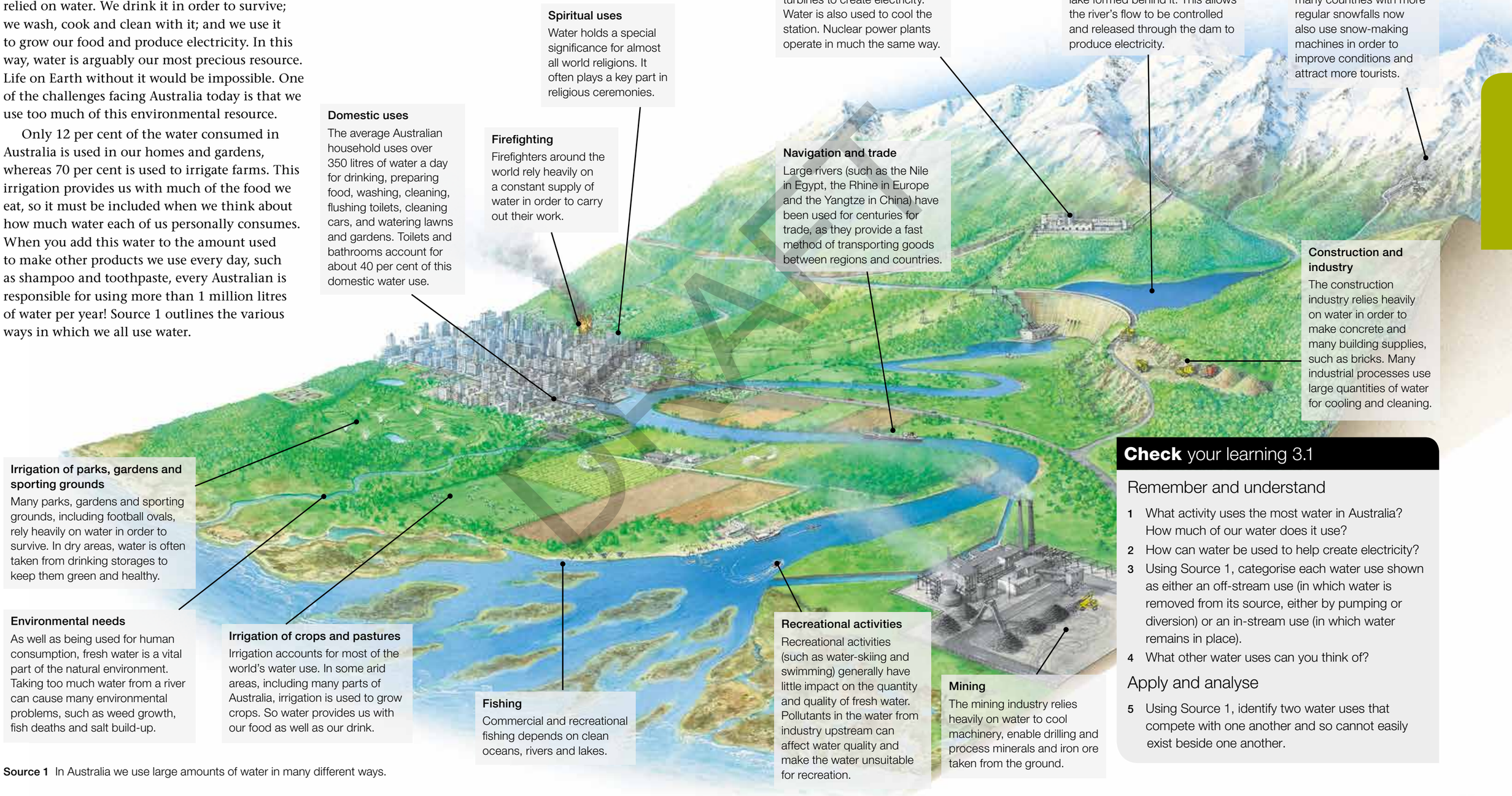
1 The Nevada Desert suffers from permanent drought conditions. Other parts of the world are frequently flooded. What factors do you think might make an area prone to flooding?

2 Suggest two ways that communities in flood-prone areas might plan for floods.

3.1 The importance of water

Since the beginning of human history, we have relied on water. We drink it in order to survive; we wash, cook and clean with it; and we use it to grow our food and produce electricity. In this way, water is arguably our most precious resource. Life on Earth without it would be impossible. One of the challenges facing Australia today is that we use too much of this environmental resource.

Only 12 per cent of the water consumed in Australia is used in our homes and gardens, whereas 70 per cent is used to irrigate farms. This irrigation provides us with much of the food we eat, so it must be included when we think about how much water each of us personally consumes. When you add this water to the amount used to make other products we use every day, such as shampoo and toothpaste, every Australian is responsible for using more than 1 million litres of water per year! Source 1 outlines the various ways in which we all use water.



Source 1 In Australia we use large amounts of water in many different ways.

Check your learning 3.1

Remember and understand

1. What activity uses the most water in Australia? How much of our water does it use?
2. How can water be used to help create electricity?
3. Using Source 1, categorise each water use shown as either an off-stream use (in which water is removed from its source, either by pumping or diversion) or an in-stream use (in which water remains in place).
4. What other water uses can you think of?

Apply and analyse

5. Using Source 1, identify two water uses that compete with one another and so cannot easily exist beside one another.

3.2 Growing the world's grain

Rice is the world's most important food crop and is the main food source for over half of the world's population. Rice production is heavily dependent on water. A semi-aquatic plant, rice is grown in flooded fields. For this reason, rice-growing communities tend to be located in regions of the world with high rainfall. About 90 per cent of the world's rice is grown in Asia, with India and China being the largest producers of rice. Outside of Asia, the USA and Brazil are the biggest producers of rice.

Source 1 Rice seedlings being placed in the rice paddy for planting, Mekong Delta, Vietnam

Source 2 Satellite image of the Mekong Delta in Vietnam. Farming here is dependent on the rich soils and plentiful water of the region.

Rice farming in Vietnam

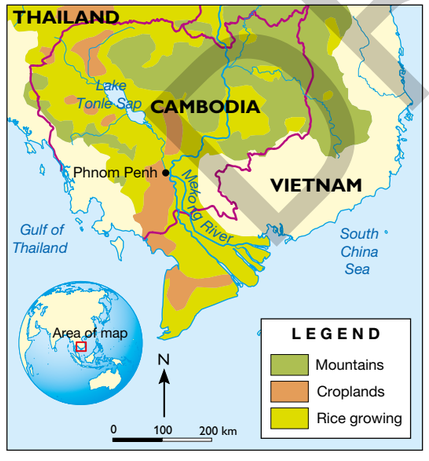
Vietnam is home to some of the world's richest agricultural regions. It is the fifth-biggest producer, the second-largest exporter and the seventh-largest consumer of rice. In Vietnam, 75 per cent of people's daily calorie needs are met by rice.

The Mekong Delta is called the 'rice bowl' of Vietnam, with over half of the country's rice produced there. The delta is formed by sediment (small particles of rock and dirt) deposited by the Mekong River and provides rich soil for farming. The Mekong Delta region is also flood prone, making it perfect for rice production. The rice is grown in flooded fields known as paddies.

Of the 17 million people in the delta region, 80 per cent are employed in rice cultivation. The rice farmers live in houses built on stilts and the roads in the region are located on raised embankments to provide protection from flooding.

Most of the rice produced in Vietnam and other parts of southern Asia is a variety known as Indica rice. Indica rice is a long grain rice that grows well in hot, tropical climates. In recent times, faster growing rice plants have been developed. These new strains of rice mature in 110 days instead of 160, meaning farmers can grow three crops a year instead of two.

MEKONG DELTA: RICE-GROWING REGIONS

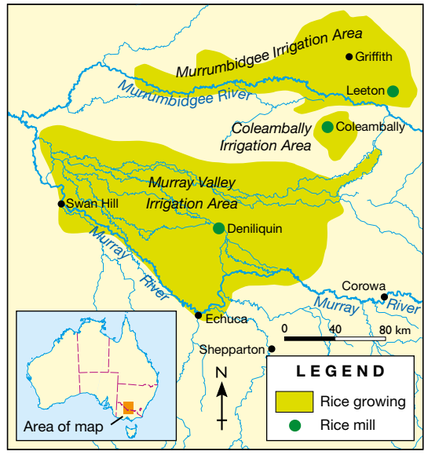


Source 3 Source: Oxford University Press

Rice farming in Australia

In Australia, a variety known as Japonica rice is more commonly grown. This variety of rice grows well in the Australian climate. In a dry country such as Australia, rice farmers have to be very efficient in their use of water (see Source 5). Australian rice growers use 50 per cent less water than the world average to grow 1 kilogram of rice. To ensure water is not wasted, the soil of Australian rice farms needs to be checked and approved to ensure that it can hold water and not allow it to escape below.

AUSTRALIA: RICE-GROWING REGIONS



Source 4 Source: Oxford University Press

Source 5 Australian farmers carefully plough their fields to minimise water wastage. They even use lasers to ensure rice fields are as close to level as possible. Raised levees divide large fields into individual bays to allow farmers to carefully control the flow of irrigation water.

Australia's rice-growing regions include the Murrumbidgee and Murray Valley in south-western New South Wales (see Source 4). These regions are suitable for rice cultivation as they have available water, irrigation infrastructure, large areas of flat land, and suitable soils. Storage and milling facilities for rice have also been established in these areas. The rice industry has been a major contributor to the economic and social wellbeing of people in the towns of these regions.

Check your learning 3.2

Remember and understand

1 What economic value does rice have?
2 How have farmers reduced their water use in rice-growing regions across Australia?

Apply and analyse

3 Compare rice-growing techniques in Australia and Vietnam. How are they similar? How are they different?

Evaluate and create

4 Draw a sketch map of Source 2 to show the location of rice paddies on the Mekong Delta. Mark in the South China Sea and rice paddies (most of the green area on the image).

3.3 Competition for water supplies

Fresh water from rivers is used by people in cities, farms and factories. Competition for this precious economic resource has seen the introduction of dams all over the world to store the water flowing down rivers and ensure a constant supply of water to the people nearby. Because people living along the entire length of rivers depend on them for water, competition also exists between upstream and downstream users. The flow and quality of water available to downstream users depends on how the river is used upstream.

Case study: the Murray River

The Murray River provides an excellent example of what happens when demand for river water threatens to outpace supply. Water from the Murray River has many competing uses, including irrigation, domestic urban water supply, industrial water supply, maintaining the natural environment, recreation, navigation, hydroelectricity and water storage. There are three major water storage dams on the Murray River. There are also 10 weirs (another type of dam) built across the river to slow the river flow and allow towns to access the water. Locks have been built where the water level can be raised and lowered to allow boats to travel from one side of the weir to the other.

A series of pumps and pipes carries some of the water from the Murray River to water users in towns, cities and farms many kilometres from the river (see Source 1). One of these pipes carries water from the town of Mannum to Adelaide, 60 kilometres away. The amount of water pumped from the river to Adelaide varies from year to year but can be as high as 90 per cent of Adelaide's water needs in some years.

The agriculture sector is by far the largest user of water from the Murray River. On average, 3780 gigalitres (3780 billion litres) is diverted each year to irrigate farmland to grow crops and raise livestock. Clearing of native vegetation in the river valley has enabled irrigated crops and pastures to be grown, but also forced salty groundwater to the surface and into the river. Along with pesticides and fertilisers, the salty water causes problems for users downstream. Near the South Australian town of Waikerie a system of pumps intercepts some of the salty water before it reaches the Murray River. It is carried in pipes to a 400-hectare lake. It is estimated that this scheme prevents more than 100 tonnes of salt a day reaching the river. Most of the water not used for irrigation is diverted to homes and industries throughout South Australia through six major pipelines (see Source 1). The average amount of water that flows from the Murray River into the ocean near Adelaide is now just 25 per cent of the total natural flow. This is because around 75 per cent of this water is taken out of the river upstream.

MURRAY RIVER AND SOUTH AUSTRALIAN WATER PIPELINES

Source 1 Source: Oxford University Press

Source 2 Oblique aerial photograph of the Murray River at Mannum, South Australia

Source 3 This image was taken in 1981 when the mouth of the Murray River completely closed, creating changed conditions for wildlife and plants in the region.

key concept: Scale

The changing scales of water management

The water in the Murray River is one of Australia's most precious resources but is very difficult to manage. This is mainly because there is so much competition for the water. The water is used by thousands of farmers to produce food and other products for millions of people. Many towns and cities in three different states use the river to supply residents with water for their homes and businesses.

In the past, many upstream water users have only considered their own water needs when taking water from the river. They have not considered how this would impact on people and places downstream. We now know that this local-scale approach to water use damages the health of the river. Water must be managed at the regional scale, considering the needs of all water users and the environment in the entire river basin. For more information on the key concept of scale, refer to page 11 of 'The geography toolkit'.

Check your learning 3.3

Remember and understand

1 What competition is there for Murray River water?
2 What are the two major uses of Murray River water?
3 How have the competing water uses of boating and water storage in weirs been catered for along the Murray?
4 What problems have been caused downstream by upstream usage of the Murray River water?

Apply and analyse

5 Why is it difficult to manage the water resources of the Murray River?
6 In the foreground on the left of the Mannum oblique aerial photograph (Source 2) you can see a small marina and a residential development. Are these developments at a local or regional scale?
7 Examine Source 1.
   a How many pipelines are shown that access water from the river?
   b Use the scale to estimate the distance water travels from Swan Reach to Edithburgh.

Evaluate and create

8 Draw a map of Source 2. Use a legend to show the following features: the Murray River, irrigated farmland, irrigated golf course and sporting ground, a marina for houseboats and the town of Mannum.

3.4 The challenges of managing water

Water is an essential environmental resource that is important for the health of humans and the health of the environment. Different values are often placed on water; for example, water used for economic purposes can also have great spiritual and cultural importance for a community. Competition for water use needs careful management. It is often not easy to come up with solutions. Water management is difficult because:

- it is an essential resource needed by every person on the planet
- it moves through the environment quickly so it is difficult to capture and store
- its availability is not constant – it changes over time and in different locations
- it is a shared resource with many competing uses.

Over the past 50 years the world's population has doubled, and the output from farms and industries has surged to meet increasing demands. The growth in demand and competition for water has put a much greater strain on global water supplies. We need to make good decisions to fairly share the use of water and minimise the impact our water use has on the natural environment.

Source 1 Sewage spills into the Ganges River in the city of Varanasi.

Case study: Ganges River, India

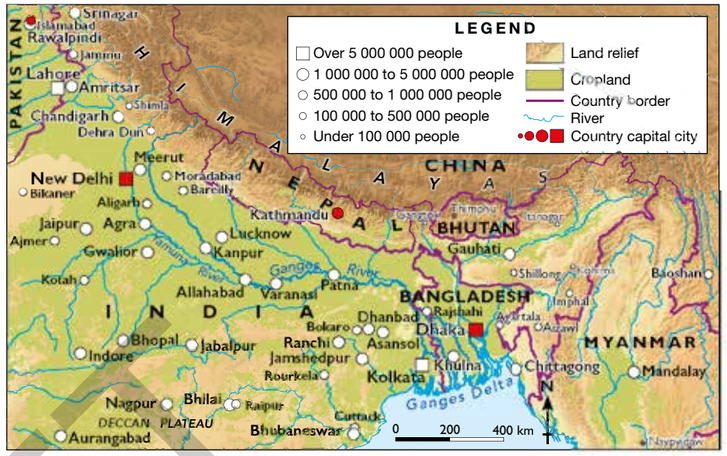
The Ganges River begins high in the Himalayan mountains, and travels across India before flowing east into Bangladesh and into the Bay of Bengal. In total, the river is 2525 kilometres long. The Ganges is worshipped by Hindus, who believe bathing and praying in the river purifies them. This sacred river is also used by millions of Indians who live along its banks and depend on it for their daily needs.

In the last 30 years, India's population has grown to nearly 1.2 billion people; one-third of these people live along the banks of the Ganges. Huge increases in the size of cities, factories and agriculture have put enormous pressure on the river. Irrigation canals siphon off large amounts of water to grow food for the country's increasing population. Untreated **waste-water** is dumped into the river from cities and towns that lack proper sewage-treatment facilities. Around 25 per cent of India's population work in manufacturing and industry. The waste-water and **effluent** from these industries often contain hazardous chemicals. The Ganges is now one of the most polluted rivers in the world.

Overuse and lack of management have meant that India's most sacred river is gradually dying. In Varanasi, a city on the banks of the Ganges in north-eastern India, the bacterial count in the water is 3000 times higher than the safe levels established by the World Health Organization. Polluted water is the main cause of skin problems, disabilities and infant deaths, but many Hindus refuse to accept that the Ganges (or Mother Ganga as they call her) is the source of these problems. 'People have so much faith in this water that when they bathe in it or sip it, they believe it is the nectar of God [and] they will go to heaven,' says a scientist at the Central Pollution Control Board in India.

In 2011, Indian officials signed an agreement with the World Bank for a $1 billion loan to finance a government project that aims to stop the flow of untreated waste-water into the Ganges by 2020.

COURSE OF GANGES RIVER



Source 2 Source: Oxford University Press

Check your learning 3.4

Remember and understand

1 Why is water difficult to manage?
2 List three reasons why water resources are under threat.
3 Look carefully at Source 3.
   a Why have all of these people gathered at the Ganges River?
   b What dangers do they face?
4 List as many competing uses of the Ganges as you can.
5 Why is the Ganges River so difficult to manage?

Apply and analyse

6 Look at Source 2. Why is the pollution of the Ganges a much greater problem in Kolkata than in Kanpur in northern India?
7 How do you think the pollution of the Ganges affects the natural environment around the river?

Source 3 Tens of thousands of Hindu devotees gather on the banks of the holy Ganges River to bathe and offer prayers during Karthik Purnima festival in Patna, India.

3.5 Water and Indigenous Australians

Water is a vital resource valued by both Indigenous and non-Indigenous Australians. Non-Indigenous Australians generally consider water as a natural resource with great economic and aesthetic value. Indigenous Australians on the other hand generally value water for cultural and spiritual reasons. They regard the rivers and waterholes as an inseparable part of their land. Land and water management is a key part of the culture of Aboriginal and Torres Strait Islander peoples.

A spiritual connection with water

Prior to European settlement, most Aboriginal peoples lived in the well-watered coastal areas and along the rivers of the Murray–Darling Basin. Aboriginal people in the arid areas of Australia studied the habits of wildlife to detect water supplies. They mapped the location of water in their artwork. In these maps, spirals identified the location of pools and wells while wavy lines showed the location of running water (see Source 2).

Source 2 In the past, Aboriginal people communicated the location of water resources through symbols on maps (like this one) and through spoken instructions and stories.

Aboriginal people also passed on their knowledge of water resources through stories. The Worrorra people live in the Prince Regent River region of the Kimberley. Their Dreaming (or Lalai) stories tell of the formation of the Prince Regent River.

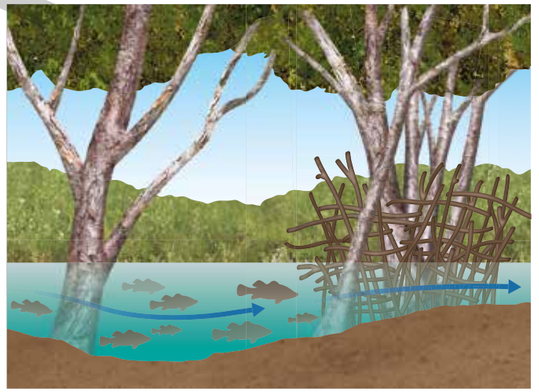
The stories tell of how the Wunggurr snake (a creator) dug a path where the Prince Regent River now flows by travelling from far inland to the sea. Other creator beings called Wandjina then took the animal forms of Rock Cod and Melo (a large sea snail), and created Malandum (the Prince Regent River) by swimming upstream along this path. At what is now called King Cascade Falls, Rock Cod was forced to stop abruptly by the Lalai Bowerbird and thrust herself against the soft mud, where she created a step-like cliff. Today, a waterfall flows over these rocks from the stream above where the Bowerbird lives (see Source 4).

Source 1 Aboriginal links to water in the Kimberley region go back thousands of years. These scenes were created by the Worrorra people on a cave ceiling about 8000 years ago. The scene is said to depict a 'great fish chase', showing figures representing both Rock Cod and Dugong and their Wandjina captors.

Indigenous water management

Traditionally, Aboriginal peoples in drier areas of Australia depended on their knowledge of water sources to survive. They accessed water trapped in waterholes, rocks and tree hollows. They watched the flight paths of birds, such as the zebra finch, to help uncover wells and springs. The long roots of eucalypt trees were followed to find underground water, and water was collected from the morning dew on plants. Indigenous Australians would also enlarge rock holes and chip channels through rocks to divert water into specific holes to increase their access to water. To catch fish, dams were built across narrow creeks using rocks or woven branches (see Source 3).

In modern Australian society, Indigenous Australians have been largely left out of the decision-making process when it comes to managing their traditional water sources. In some remote areas of Australia, many traditional water sources have become unreliable or unusable because station owners have given their cattle access to these important areas without consulting the Aboriginal peoples.



Source 3 An Aboriginal dam made of woven branches designed to catch fish

Urlampe in the Northern Territory, 1330 kilometres south-southeast of Darwin, is home to one of Australia's most remote Aboriginal communities. Allan Rankine of the Urlampe Aboriginal Corporation is responsible for managing the water supply for the community. Allan decides what water the community pumps from the bore and how it will be distributed. Traditionally, Aboriginal land and water management plans are clearly defined and everyone understands and respects them.

Source 4 King Cascade on the Prince Regent River is now a popular tourist destination.

However, Allan and the traditional owners of the area do not have control over all important water resources in the region. The permanent spring that Allan visited as a child has been polluted by cattle. This once valuable water resource is now undrinkable.

Check your learning 3.5

Remember and understand

1. Where did most Aboriginal peoples live in Australia before Europeans arrived in 1788?
2. Give examples of traditional and modern Aboriginal water management.
3. How are Indigenous and non-Indigenous views of water resources different?
4. Both Aboriginal peoples and Europeans built dams along the Murray River. What impact did each have?

Apply and analyse

5. Look carefully at Source 4.
   - a. What is the spiritual value of this place to the local Indigenous people?
   - b. What value might this site have to a tourist?
6. Look carefully at Source 2.
   - a. Sketch the symbols you think represent water holes and running water.
   - b. Why were maps such as these important to Aboriginal communities?
   - c. Why do you think maps like these are still being produced by Indigenous Australians?

3A rich task

The Aral Sea

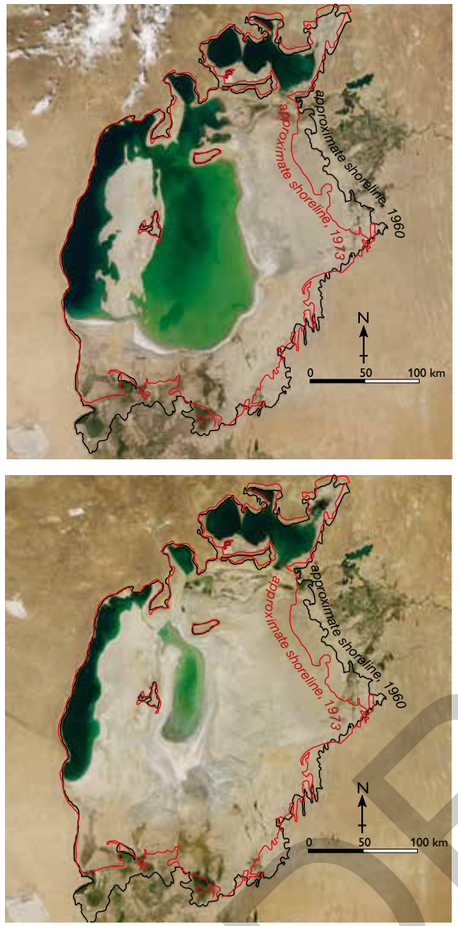
The Aral Sea is located on the border of Kazakhstan and Uzbekistan. In the early 1960s, the two rivers that channelled water to the Aral Sea, the Amu River and the Syr River, were diverted to irrigate areas of the surrounding desert to grow rice, melons, cereals and cotton. From 1960 to 1998, the size of the Aral Sea shrank by 60 per cent, and its volume was reduced by 80 per cent. In 1960, the Aral Sea was the fourth-largest lake in the world. Today, it is the thirty-first largest. Over the same period of time, the lake has also become five times saltier.

The Kara Desert covers about 70 per cent of the land area in Turkmenistan. It is crossed by the 1375-kilometre Karakumski Canal, the second-largest irrigation canal in the world. The canal brought a water supply to the town of Ashkhabad and allowed farming to take place in the desert, particularly cotton growing. Leakages from the canal allowed 50 per cent of the water to escape.

skill**drill:** Data and information

Interpreting satellite images

Satellite images help geographers view large areas of the Earth's surface. Special cameras in orbiting satellites 700 kilometres above the ground record variations in the light reflected on the Earth's surface. Satellite images can show different features on the Earth's surface through colour variations on the image. Sometimes this colour variation is natural but it can also be added by computer to highlight specific features. The natural colour satellite images of the Aral Sea in Source 1 accurately record the shrinking size of the lake from 2000 to 2011.



Source 1 Satellite images of the Aral Sea in 2000 (top) and 2011 (bottom)

Apply the skill

1 Study Source 1.
- **a** Describe how the Aral Sea has changed between 2000 and 2011.
- **b** What colour represents deep water on these satellite images?
- **c** What is the shallowest part of the lake in 2000?
- **d** What type of land surrounds the Aral Sea in 2000 and 2011?
- **e** Use the scale to estimate the length of the longest remaining part of the Aral Sea in 2011.

ARAL SEA BASIN: WATER RESOURCES

Source 2

Source: Oxford University Press

Extend your understanding

1 Look carefully at Source 2.
- **a** What is the name of the longest river that feeds the Aral Sea?
- **b** Where does this river begin?
- **c** Into which canal is most of the water from the Amu River diverted?
- **d** What is this water used for?

2 Look carefully at Sources 1 and 2.
- **a** What was water once used for in this region?
- **b** How has the Karakumski Canal changed this region?

3 The management of the water resources in this region is made more complex because more than one country is involved. Name the countries involved and the ways in which they use water resources in this region.

Source 3 The shore lines of the Aral Sea have receded by 60 to 80 kilometres, leaving behind rusting fishing trawlers that used to fish in its waters. All 20 known Aral Sea fish species are now extinct, unable to survive in the salty water that remains.

3.6 Managing water scarcity

Water is most difficult to manage when there is not enough to go around. Water becomes scarce when the demand for clean water exceeds the available supply. It is one of the biggest issues facing Africa, the second-driest inhabited continent in the world after Australia. Whereas all Australians have access to clean water, millions of Africans face water shortages. Of the 800 million people who live in Africa, more than 300 million live in water-scarce areas.

The main reasons for water scarcity in Africa are:

- a large and fast-growing population
- large areas with low and variable rainfall
- poor water quality
- lack of water infrastructure, such as pipelines.

Water scarcity contributes to the deaths of many African children. Local water sources may contain harmful bacteria that cause diseases, such as typhoid and dysentery. These diseases are spread by drinking and washing in contaminated water.

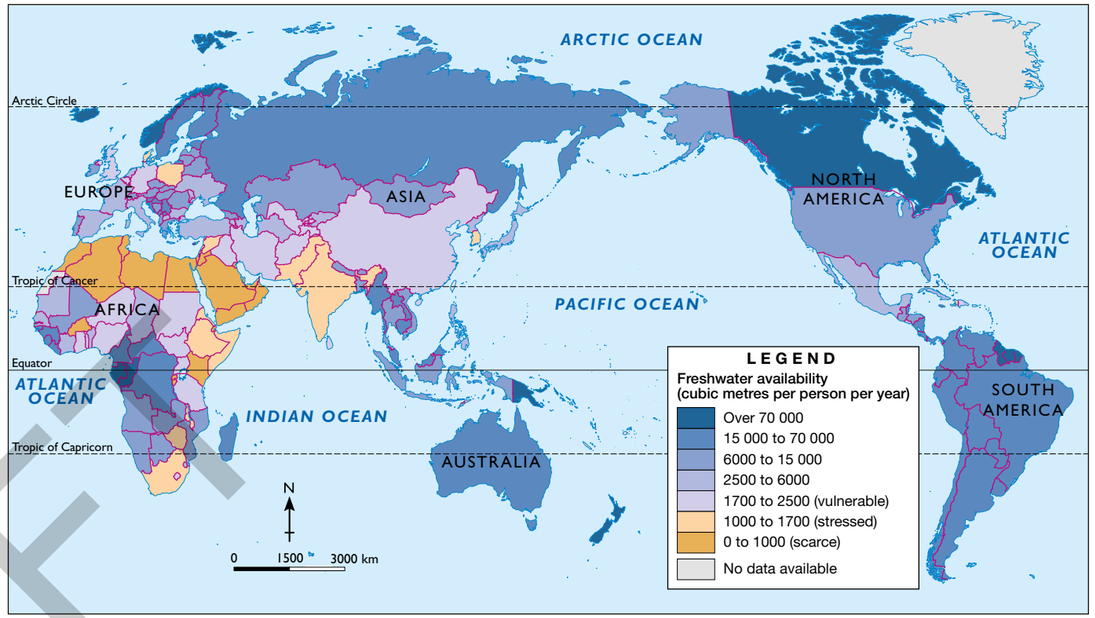
Delivering safe water

The most common solution to water scarcity in African villages is digging a well. A water well is created by digging or boring into the ground in order to reach groundwater in underground aquifers. Clean water from a well stops people catching any water-borne diseases. Providing clean and drinkable water for communities across Africa is a high priority for many of its **developing countries** and international relief agencies, such as World Vision and AusAID.

Source 1 A young girl in Guinea-Bissau enjoys clean water from a new well that has been sponsored by the World Vision aid agency.

Source 2 This woman in Zambia is collecting water from a dried-up river bed half a kilometre from her house. She uses a saucepan to fill the large container, which she will carry on her head or shoulder back to her home.

WORLD: FRESHWATER AVAILABILITY PER PERSON PER YEAR, 2007



Source 3

Source: Oxford University Press

Source 4 A woman fills a water container from a well in the desert in Niger. In most African societies, women are the collectors and managers of the family water supply. African women can spend up to 60 per cent of their day collecting water, especially where water sources are far from the village.

Check your learning 3.6

Remember and understand

1 What is water scarcity?
2 Why is water scarcity such a problem in Africa?
3 What problems does water scarcity cause, especially for women and young children?

Apply and analyse

4 Look carefully at Source 3.
   a Describe the area of Africa that suffers most from water scarcity.
   b Australia is the driest inhabited continent on Earth. Does it have a water scarcity problem? Why or why not?
   c Compare freshwater availability in Australia and New Zealand. Which country has access to more fresh water? Why do you think this might be the case?

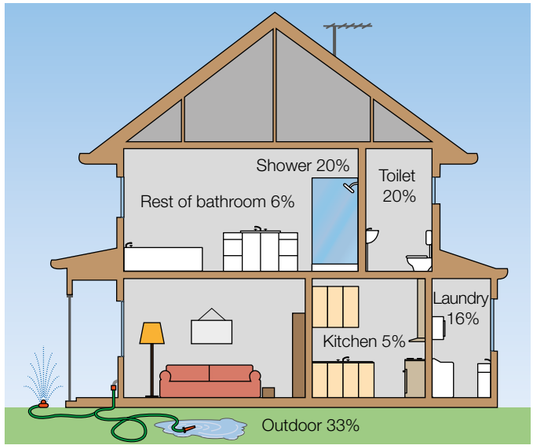
Evaluate and create

5 Create a poster or PowerPoint presentation highlighting the problems of water scarcity in Africa and how it affects people's lives.

3.7 Managing water at home

The easiest way for us to become involved in water management is to understand how we can be more water wise at home. A resource management plan takes into account the range of uses of the resource, the amount of the resource required and the impact of resource use on the environment. Decisions are then made about what is the best and most **sustainable** way to use the resource. Sustainability is an important concept in geography. In order for a resource to be used sustainably there must not be so much used that it affects the ability of the resource to replace itself naturally. Domestic users of water are under more pressure than ever before to manage their water use properly as our water resources become more stressed.

As you have learnt, Australians are among the highest users of water in the world. Nearly half of the domestic water usage occurs in the bathroom. To improve water management in the home we need to select water-saving appliances, capture and recycle water and attempt to use less water. To ensure we have a sustainable supply of water into the future, think about some of the water-saving ideas shown in Source 1.



Source 2 Water use in the home

Bathroom
Take shorter showers and install new water-efficient showerheads that use no more than 9 litres of water per minute (compared with old-style showerheads that use 20 litres per minute). This can save up to 20 000 litres of water per person per year.

Laundry
Only use the washing machine when you have a full load. Redirect the waste-water from the washing machine into a collection bin and use it on the garden, but make sure you use detergents that will not kill your plants.

Outside
Don't use the hose to clean hard surfaces outside; use a broom. Install a plastic pool cover to reduce water lost to evaporation. Install a rainwater tank to use the water that falls on your roof. It can be used to flush toilets, wash clothes and water the garden. Top up the pool with water from the tank.

Kitchen
Don't rinse dishes under a running tap. Ensure the dishwasher is full before turning it on.

Garden
Plant native gardens using local plants that are accustomed to the climate and soil conditions in your area. Use drippers to deliver water directly to the base of the plants where they need it. Avoid sprinklers, which allow water to be blown away and evaporated.

Source 1 A range of simple water-saving ideas

keyconcept: Sustainability

The air shower

Despite living in one of the world's driest places, Australians are among the world's biggest water users. Many scientists believe that our use of water is not sustainable and have looked for ways to increase our water supply or decrease the amount of water we use.

AIR SHOWER SET TO CUT WATER USE BY 30 PER CENT

As Australians become increasingly alert to the importance of using water wisely in the home, CSIRO researchers have found a way to use a third less water when you shower – by adding air.

The scientists have developed a simple 'air shower' device which, when fitted into existing showerheads, fills the water droplets with a tiny bubble of air. The result is the shower feels just as wet and just as strong as before, but now uses much less water.

The researchers, from CSIRO Manufacturing Materials Technology in Melbourne, say the device increases the volume of the shower stream while reducing the amount of water used by about 30 per cent.

Given the average Australian household uses about 200 000 litres of water a year, and showers account for nearly a third of this, the 'air shower' could help the average household save about 15 000–20 000 litres a year. If you extend this across the population, that is an annual saving of more than 45 000 Olympic-sized swimming pools …

CSIRO website

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

Source 3 This cartoon was first published in 2007 during a period of severe drought.

Check your learning 3.7

Remember and understand

1 What does a management plan need to take into account?
2 Which room in the house uses the most water?
3 What is the easiest way of reducing the amount of water and energy used in the shower?
4 Suggest three ways that water can be gathered and reused around the home.
5 Give two examples of how technology can be used to help save water.

Apply and analyse

6 Look carefully at the news article.
  a What have researchers at CSIRO developed to help save water in the home?
  b What water savings do they hope to make?
  c Apply your understanding of the air shower to develop a new water-saving product idea to clean dishes.
7 Look carefully at Source 3.
  a What is the cartoonist suggesting about our management of water in the future?
  b When was the cartoon drawn and what influence might this have had on the cartoonist?

Evaluate and create

8 Create your own water-saving reminder for display in one of the rooms of your house.

3.8 Managing water in Australia's biggest cities

In order to ensure that reliable supplies of safe water are available for use now and into the future, we all need to use water more sustainably. Careful management of our existing supplies and reductions in our consumption will help to achieve this. We also need to remember that people are not the only living creatures on the planet. The interests of all living organisms need to be considered if the natural environment is to be protected for the future.

Source 1 The Warragamba Dam near Sydney is one of the largest domestic water supply dams in the world. It supplies 80 per cent of Sydney's water.

Ensuring reliable water supplies in Australian cities

Over 60 per cent of Australia's population lives in one of our five largest cities – Adelaide, Brisbane, Melbourne, Perth and Sydney – all of which are home to more than a million people. The sites of these cities were chosen in large part because of their reliable rainfall and access to fresh water from neighbouring rivers. However, all of these cities have now outgrown their original water supplies. Large dams have been built to provide a permanent water supply for large towns and cities, but population growth and drought have put enormous pressure on these reserves. As a result, many Australian cities are now looking at a number of strategies to reduce their water usage and ensure they have access to reliable supplies into the future. Some of these options are discussed here.

Option 1: Build more dams

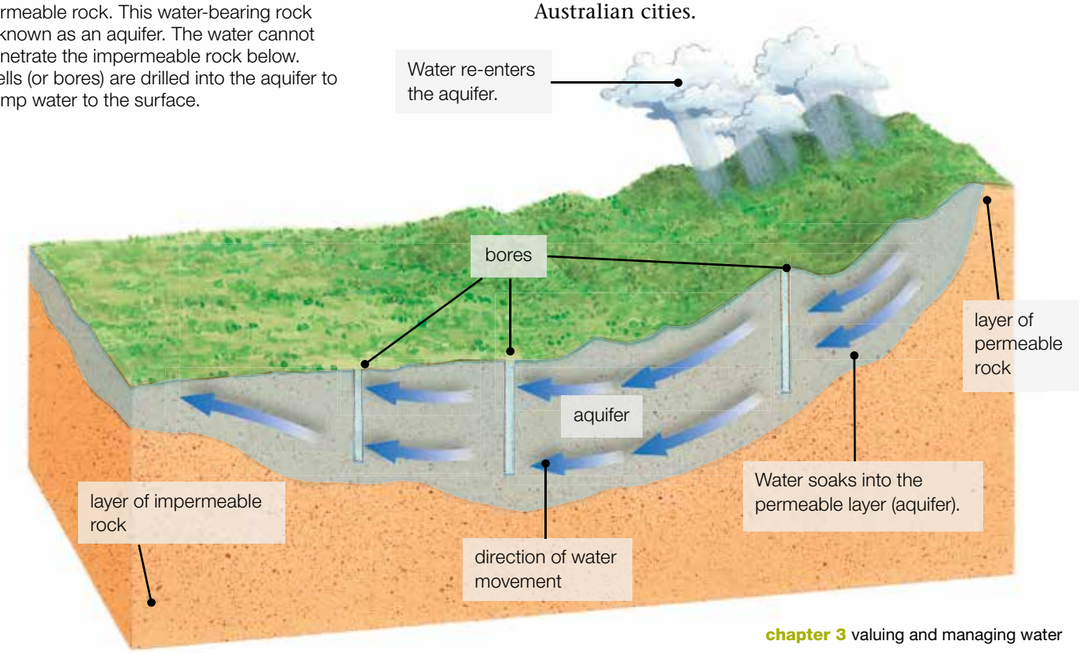
Across Australia, governments are thinking about building more dams to create a reliable water supply for our growing population. Dams can also be used to create hydroelectric power when water let through the dam wall turns a turbine to create electricity.

Option 2: Use underground water reserves

Drilling water bores is a common method used on Australian farms for supplying water for irrigation and animals. Many Australian cities have started to use this method to add to their freshwater supplies. Deep holes, called bores, are drilled down into a layer of rock under the ground that holds water. This layer of rock is called an aquifer. The water is then pumped to the surface (see Source 2). It is also possible to replace the water in the aquifers during wet periods by pumping the water back underground. In this way, aquifers operate as underground dams. In Western Australia, scientists are trialling a method of treating stormwater (rainwater that falls on the hard surfaces of a city, such as roofs and roads) and using it to recharge the aquifers that supply much of Perth's water.

There are large aquifers in many areas of Australia, including beneath Melbourne. Often this water has a high mineral content and must be treated before it can be used for drinking and other household uses. This water could be used for industrial purposes, such as to clean machinery and irrigate crops. This would allow drinking water, currently used for these other purposes, to be added to the city's water supplies. This idea of using lower-quality water for non-domestic purposes has been considered in many Australian cities.

Source 2 Water from rainfall soaks into permeable rock. This water-bearing rock is known as an aquifer. The water cannot penetrate the impermeable rock below. Wells (or bores) are drilled into the aquifer to pump water to the surface.



Option 3: Build desalination plants

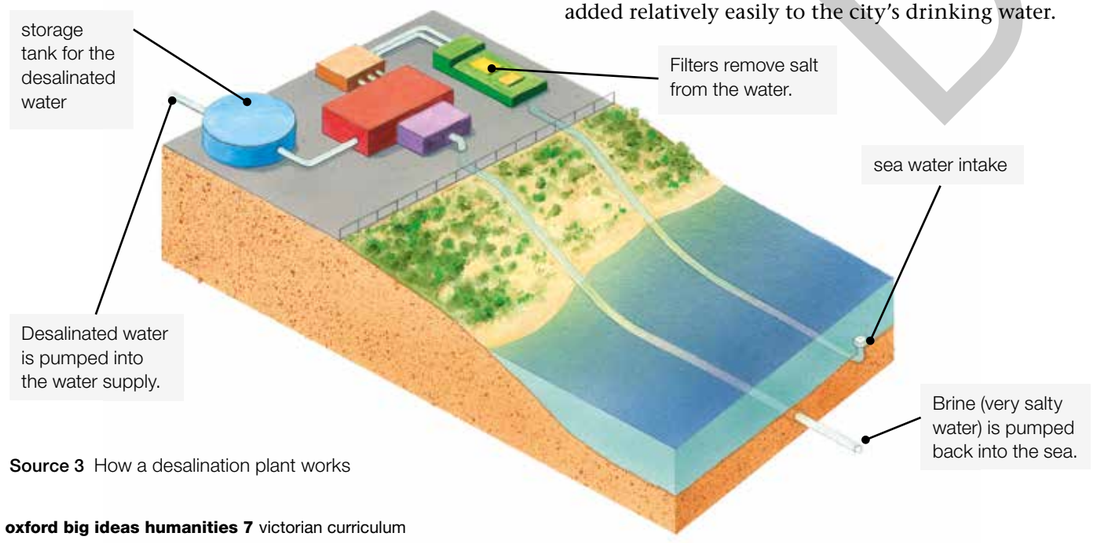
Desalination plants treat sea water to remove from it the salt and other impurities (see Source 3). This process, known as reverse osmosis, turns sea water into fresh water for drinking. As Australia has easy access to a vast supply of sea water, desalination plants are an attractive option for many cities.

There are three main reasons why there are not more of them already:

- Desalination plants cost a lot of money, making the water they produce expensive. The Perth desalination plant, opened in 2006, cost $387 million to build and adds about $44 a year to every consumer's water bills.
- Desalination plants use a lot of electricity and can damage the environment. It has been estimated that the Sydney desalination plant uses as much electricity as 120 000 households. A new power plant had to be built to run it, adding to the cost.
- Desalination plants can damage the environment. They release highly concentrated salt water (brine) back into the ocean, which can harm marine animals.

Option 4: Build water pipelines

Perhaps the simplest method of ensuring a reliable water supply is to move water from areas that have a surplus. This already happens in most Australian cities. Rainwater is collected in catchments in the hills and forests close to cities and piped to treatment plants and then to water users.



Source 3 How a desalination plant works

Source 4 Huge pipes carry water beneath our city streets. Here, pipes are being laid in Brisbane.

One proposal currently involves piping water not just hundreds of kilometres but thousands. For many years, there has been an idea to pipe water from the Fitzroy River in the Kimberley region in north-western Western Australia to the city of Perth. This pipeline would need to be 3700 kilometres long. The cost of transporting water this far through steel pipes is much greater than other options, such as desalination plants, and so this method is unlikely to be used in the near future. It will also cause environmental problems at the source of the water and would require large amounts of energy to build and operate.

Option 5: Capture and store stormwater

Stormwater is collected in pipes and gutters and discharged in the sea or rivers. Rainwater tanks capture this fresh water but cities have not been designed to collect this water on a large scale.

In Adelaide, there is a plan to capture this water through existing pipes and treat it in the current water-treatment facilities. In this way, it could be added relatively easily to the city's drinking water.

Option 6: Recycle and treat waste-water and sewage

Water that leaves our homes is generally unsuitable to be used again. In using the water to clean clothes, dishes and ourselves and to flush toilets we have polluted the water. This water (known as waste-water or sewage) is usually piped to a treatment plant where it is cleaned and purified and then released back into rivers and bays. In some places, notably Singapore and Windhoek (see 2C Rich task on page 70) in Namibia, this water is added to rainwater and piped back into homes and to other water users.

Source 5 At this plant in Singapore, waste-water (sewerage) is processed and then used in industry or blended with rainwater for use in homes.

key concept: Sustainability

Toowoomba says 'No' to drinking sewage

In trying to use our resources sustainably, we sometimes have to change our attitudes and behaviours. While many Australians believe that we should use less water or use water from different sources, it can be difficult to convince people to change. In 2006, for example, the people of Toowoomba were faced with a difficult decision about water.

At that time, Toowoomba's three dams had fallen to critical levels. The town council proposed a radical solution. The town would treat its sewage to a high level, store the treated sewage in a dam for three to five years and then add it to the town's freshwater supplies.

The supporters of the scheme pointed out that this is exactly the system used successfully in parts of California and Singapore, and that the technology exists to treat the sewage to a safe, clean, drinkable level. The opponents of the scheme called it 'drinking poo' and voiced concerns about the town's reputation as a tourist centre and about potential health hazards.

The campaigning was fierce for months before the vote. In the end, 62 per cent of Toowoomba's population voted 'no' to the proposal, leaving the council in the difficult position of having to find other sources of fresh water.

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

Check your learning 3.8

Remember and understand

1 In your own words, describe what a sustainable resource is.
2 List five different ways that governments might investigate to find extra water resources for growing cities.
3 When a new dam is built across a river, what problems are caused for people and wildlife upstream from the dam?
4 How can aquifers be used to provide and to store water?
5 What are the advantages and disadvantages of desalination?
6 Where does the water that you use at home come from? Where does it go when you are finished using it?

Apply and analyse

7 What plan for recycling did Toowoomba residents oppose? Do you think the recycling plan was a good idea?
8 Why doesn't Perth pipe water from wet places in Western Australia?

Evaluate and create

9 For the capital city in your state, complete the following activities:
   a Research the city's current water supply. Which of the water supply methods described here does it currently use?
   b Which of these methods do you believe should be used to add to this water supply?
   c What impacts would these new methods of water supply have on the natural environment and the cost of water?

3.9 New ways of thinking about water

As global pressure on water resources increases, water experts are beginning to think of water in new ways. New terms for describing types of water and usage have been devised, including virtual water, and blue and green water. This new thinking is designed to promote a better understanding of the ways in which people use water and will help to make water usage more sustainable.

Virtual water

The amount of water used to produce a good or service is called virtual water. This includes the water used to grow crops or raise animals as well as the water needed in processing these crops and animals into products. Experts coined the term 'virtual water' because we cannot actually see how much water went into producing the goods and services we consume every day. For example, 15 000 litres of water are needed to produce just 1 kilogram of beef. This 15 000 litres of water is known as virtual water.

It is often impossible to move real water between water-rich countries and water-poor countries. It is, however, relatively simple to transport virtual water in the form of goods, such as meat and wheat. This helps to support water-poor countries with their water needs.

Source 1 One kilogram of rice contains 1500 litres of virtual water, making it one of the world's thirstiest crops.

Blue water and green water

Historically, water suppliers have focused on the capture and supply of blue water (that is, water in storages, such as lakes, rivers and acquifers) over green water (that is, rainwater stored in the soil as soil moisture). Green water is the water that remains in the soil to be used by plants. Farmers in dry regions, such as the interior of Australia, need to understand how to manage both their blue water resources and their green water resources. Installing a rainwater tank to collect and store water for later use is an example of blue water management. Adding a layer of mulch to slow the evaporation of water from the soil is an example of green water management.

Water footprints

The total amount of water you consume each year is known as your **water footprint**. This includes the real water you consume (by drinking, bathing and cleaning) and the virtual water you use through your consumption of goods and services. The total volume of water used by everyone who lives in a country, including the water used to produce exported goods, is the national water footprint.

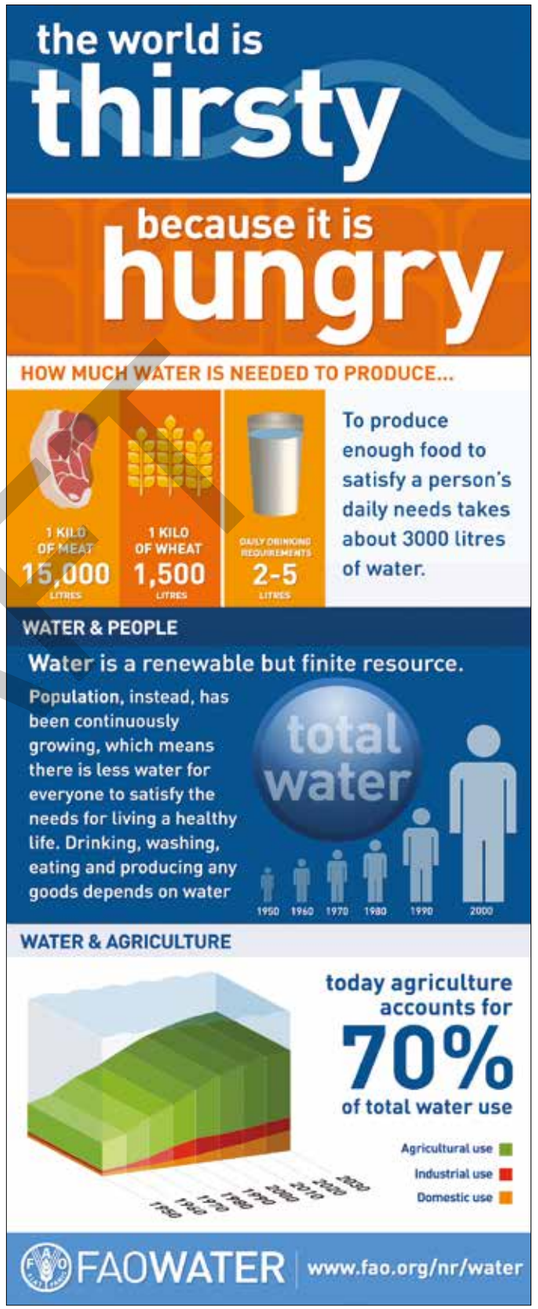
The size of a country's water footprint is largely determined by the country's:

- climate, especially the amount of rainfall and evaporation
- farming methods, especially how efficiently water is used
- production and consumption of crops
- general consumption and production patterns.

Countries where people eat lots of beef and rice and buy many manufactured goods use more water than countries where people eat mainly vegetables and have few personal goods.

Australians are one of the world's biggest water users. It is estimated that Australia's population will increase to about 35 million by 2056 and this will place a great strain on an already stressed water-supply network. Experts believe that Australia's capital cities, for example, will need 76 per cent more water by 2056 than is currently supplied.

The good news is that Australians have embraced new water-saving measures. Despite the population of Australia increasing by 7.7 per cent between 2003 and 2009, the amount of water used by households actually fell by 12 per cent. This is due largely to water restrictions in many capital cities and the use of new technologies, such as dual-flush toilets and water-saving showerheads.



Source 2 A poster from the United Nations that uses the idea of virtual water to communicate a message

Check your learning 3.9

Remember and understand

1. What is virtual water?
2. What is the difference between blue water and green water?
3. Why is it important to understand virtual water when working out your water footprint?
4. How can an understanding of virtual water help water-rich countries to decide what to produce and export?

Apply and analyse

5. Source 2 states that the world is thirsty because it is hungry.
   a. What does this mean?
   b. What evidence is presented to support this idea?

3B rich task

The Wodaabe nomads

Communities in extreme environments develop ways of life that allow them to survive and thrive. In the south-eastern part of Niger, in Africa, live the Wodaabe people. They live in a desert region where water is often scarce and feed for their cattle is in short supply. In response to these conditions they have become **nomads** and rarely stay in one place for more than 10 days. They follow the seasonal rains across the desert as rain brings grass for the cattle; this takes them on a route they have followed for hundreds of years.

The seasonal migrations of the Wodaabe take them from the clay plains near Lake Chad to the sandy soils away from the lake. Over the last few decades the lake has become smaller as other communities in the area have used its water for irrigation. This has meant that the Wodaabe's have had to change annual migration routes. The reduction in the size of the lake has meant that more grass is able to grow on land that was once covered in water, but it has also meant that freshwater supplies have become less reliable.

Source 1 Packing up the homestead to follow the rains

Source 2 Climate data: Nguigmi, Niger

Months	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Rainfall (mm)	0	0	0	1	5	11	55	100	15	1	0	0
Temperature (°C)	21	24	28	31	33	33	31	30	30	29	25	22

skill**drill:** Data and information

Understanding flow maps

Flow maps show the movement of things from one place to another (for example, people or goods). Flow maps can be simple or complex. They can show the movement of one group of people around a small area or compare the movement of many different goods around the world. Depending on what they are showing, flow maps use arrows of different colours and sizes. These arrows help the person making the map show different things moving around and the numbers of these things. Here are some steps that will help you understand flow maps:

Step 1 Read the title of the map carefully, as this will tell you exactly what is being shown.

Step 2 Look at the legend on the map. This will tell you what the different coloured arrows on the map are showing and provide you with extra information that you may need (like the time of year this movement happens).

Step 3 Look for patterns in the movements shown on the map. Are the movements related to changes in the weather, to the time of year, to political or economic factors or all of these things?

Step 4 Once you have identified the pattern being shown, try to explain the reasons for it.

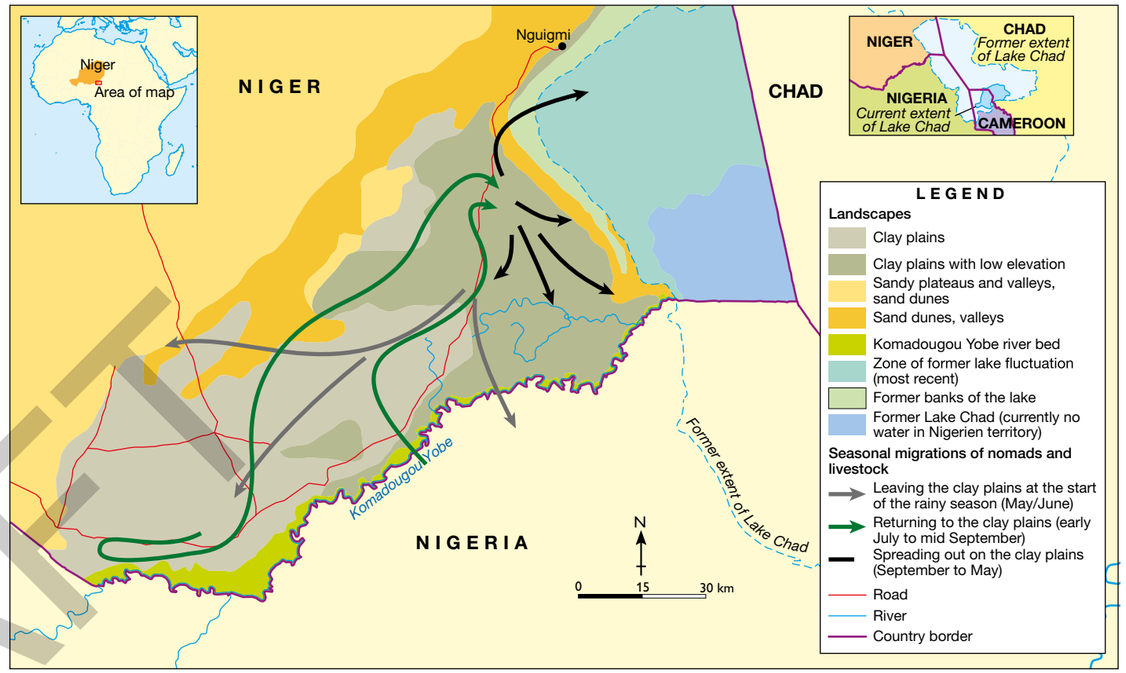
Apply the skill

1 Describe the movement of the Wodaabe during the months of May and June.

2 Where do the Wodaabe travel to from the beginning of July to mid September?

3 In your own words, explain the pattern being shown in Source 3.

SOUTH-EASTERN NIGER: NATURAL ENVIRONMENTS AND SEASONAL MIGRATION ROUTES OF THE WODAABE



Source 3 Source: Oxford University Press

Source 4 Young men of the Wodaabe tribe

Extend your understanding

1 Clay plains with low elevation are the best areas for the Wodaabe to graze their cattle in the dry season. Why? Describe the location of the clay plains with low elevation.

2 Construct a climate graph for Nguigmi in Niger using climate data provided in Source 2.
- **a** When is the rainy season?
- **b** When is the dry season?

3 Would you describe the Wodaabe as **voluntary migrants**?

4 Source 1 shows a Wodaabe family packing their belongings, to follow the rains. Describe their possessions. How many donkeys would your family need to move?

3.10 Why rivers flood

Natural factors

Put simply, rivers flood because they are forced to carry more water than they can hold. This process is like filling a glass from the tap but leaving the tap dripping into the glass after it's full. Every river, like every glass, can only hold a certain amount of water. This is known as its carrying capacity. Heavy rain or a collapsed dam can cause a river to exceed its carrying capacity and force it to burst its banks. As a result, water covers the surrounding land.

The soil carried by the river is spread across the surrounding land. Over millions of years and thousands of floods, the land near the river is slowly built up and, appropriately, is called a floodplain. Billions of people around the world choose to live on these floodplains because of the fertile soil, flat land and ready supply of fresh water. The world's floodplains support billions of people, many of whom live with the constant threat of floods.

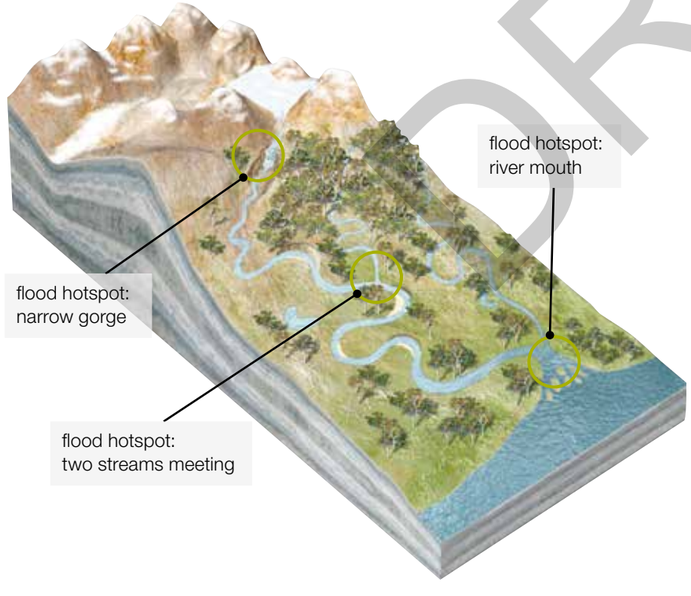
Source 1 A flood is a natural event, but becomes a disaster if humans are adversely affected by it.

Human factors

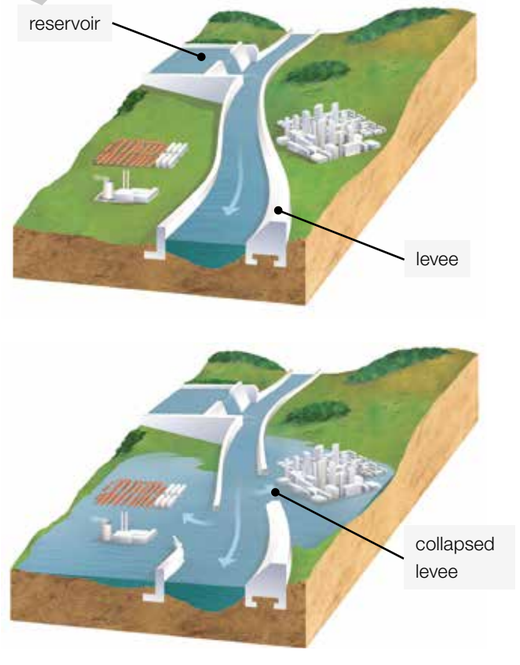
Some human activities make rivers more likely to flood, endangering both natural and human environments. Clearing the natural vegetation, such as trees and plants, growing on the sides of hills may result in more water flowing into rivers instead of being used by these trees and plants. Replacing natural environments (such as forests, grasslands, wetlands and soil) with hard surfaces (such as concrete and roads) also means that water does not soak into the ground; instead, it flows across it. The presence of so many communities, towns and cities also increases the flood risk. Rivers naturally flood. In areas where there are no humans this is considered a natural process, but in areas where there are lots of people, these natural events turn into potential and real disasters.

In some places, large artificial banks known as stopbanks or **levees** have been built to help protect communities from floods. While they help defend the community from small floods they sometimes make the effects of a large flood much worse. The river runs faster and deeper between the levees and is able to carry more water. During a major flood the water may have nowhere to go if it meets an incoming tide or storm surge at the river mouth. The water then banks up behind the levees and may spill over into surrounding areas.

If the levee collapses from the strain of holding back the floodwaters, this can result in catastrophic flooding as the water floods through a narrow gap with terrifying force. This occurred in the US city of New Orleans in 2005 when Hurricane Katrina brought torrential rain and a storm surge up to 9 metres high. Levees protecting much of the city collapsed and more than 1800 people were killed.



Source 2 Rivers tend to flood in particular places, shown here as hotspots.



Source 3 A levee before and after its collapse

Source 4 The first of many giant sandbags is lowered by helicopter to close a hole in a levee following Hurricane Katrina in New Orleans, USA.

Check your learning 3.10

Remember and understand

1. What is a floodplain and why do so many people live on them? Do you live on a floodplain?
2. What is a levee and how can it reduce flooding in some areas?
3. List some of the human activities that may contribute to flooding. Select one of these and explain why it may lead to a flood. You may wish to use a sketch in your explanation.

Apply and analyse

4. Explain why floods are more likely at each of the hotspots shown in Source 2.
5. Do you think that the attempt to repair the levee in Source 4 will be successful? Give some reasons for your answer.
6. Examine a map of Australia online or in your atlas that shows our largest cities and towns. List the Australian cities of over 1 million people that are located on floodplains at the mouth of rivers. What is the largest town or city that you can find that is *not* located in one of these hazardous places? What does this tell you about the flood threat in Australia?

Evaluate and create

7. Why do levees sometimes make the effects of flooding worse? Design a flood protection system that you believe would work better than a levee. Conduct some more research to assist you in designing your system. Sketch your design and label the key features.

3.11 Floods in Australia

Most towns and cities in Australia are located close to rivers, but some experience more floods than others. This is due to a combination of important geographical factors, particularly rainfall patterns and river geography. As you have already learnt, different places experience different types of rainfall but there are also different types of rivers. Australia is the world's flattest continent, so generally our inland rivers flow, and flood, slowly. Those that flow from the mountains to the sea, however, tend to flow and flood more quickly and this can be devastating for the people who live beside them.

AUSTRALIA: FLOODS

Source 1

Source: Oxford University Press

Inland rivers

The rain that falls on inland Australia flows into one of our many inland river systems. Some of these never reach the sea as they flow into large salt pans, such as Kati Thanda (Lake Eyre). Once a decade or so, enough rain falls in central Australia to fill Kati Thanda, creating Australia's largest lake. The rivers that flood these inland regions and fill the lake move very slowly, giving people time to prepare for them. Farming communities and towns may be isolated for weeks if roads are covered by floodwaters but few lives are lost in these slow-onset floods.

Some of our inland rivers, however, can be deadly. Much of the rain that falls in inland eastern Australia flows into the Murray–Darling river system and eventually reaches the sea near Adelaide. Some of the rivers in this system can rise quickly with little warning. The deadliest flood in Australia's history, for example, occurred when the Murrumbidgee River destroyed the small New South Wales town of Gundagai in June 1852. Swollen by torrential rain, the river rose and washed away all but three of the town's houses. Eighty-nine people lost their lives, and many more were saved from the floodwaters by local Aboriginal men.

In southern New South Wales and northern Victoria, floods may be caused by summer thunderstorms or by a series of cold fronts sweeping in from the south. These fronts, created when warm air is forced above cold air, may bring heavy rain along the southern coast and into much of the southern Murray–Darling Basin.

Source 2 The Diamantina River, shown here flowing past Birdsville in western Queensland, carries floodwaters to Kati Thanda several times a decade.

Source 3 In early 2011, about one-quarter of Victoria was affected by major flooding. In some inland towns, such as Charlton, the floodwaters took many weeks to recede.

Coastal rivers

Most of Australia's most devastating floods occur on our coastal rivers, particularly along the eastern coast. During summer, tropical cyclones and thunderstorms often dump heavy rain on the eastern slopes of the Great Dividing Range (see Source 1). This rain fills the short, fast-flowing rivers in the area to bursting point, causing rapid-onset floods. Towns and farming communities at the foot of the ranges, such as Clermont and Toowoomba, are most in danger.

Check your learning 3.11

Remember and understand

1. Why do Australia's inland rivers flow slowly? How does this affect the types of floods that occur in the interior?
2. Seven Australian floods have resulted in more than 30 fatalities. Where and when did they occur?

Apply and analyse

3. Which areas of Australia are most at risk from dangerous floods? Why?
4. What questions could you ask to investigate the flood risk in your local area?
5. What do you notice about the temperature of the sea and the risk from tropical cyclones?
6. In what ways does the Great Dividing Range influence the flood risk in eastern Australia?
7. Fourteen of the 15 most disastrous floods in Australian history occurred more than 50 years ago. Do you think this means that we are experiencing fewer floods or are there other explanations for this? Discuss this with a partner and brainstorm the possible explanations.

3.12 How floods affect people and places

Major floods can have devastating effects on different regions all over the world. In large cities, hard concrete and asphalt surfaces mean that very little water soaks away through the soil. Instead, roads can quickly turn into rivers, with terrifying results.

In farming regions whole crops can be uprooted and washed away, along with much of the rich topsoil. Expensive farming machines and equipment can be damaged or destroyed by floodwaters and livestock can also be lost.

In some countries, floods lead to widespread famine and starvation, with large death tolls. In Pakistan in 2010, nearly 2000 people died from flooding and 17 million people were affected.

Source 1 Volunteers remove flood debris from houses in the Brisbane suburb of Fairfield on 16 January 2011.

Source 2 A Pakistani farmer and his family became stranded by floodwaters in 2010 and were left without food and medical supplies. The biggest challenge they faced, however, was a lack of fresh, clean water.

Source 3 In flat regions, such as western Victoria, floodwaters can make farming impossible for months at a time.

Source 4 This beetroot farm in the Lockyer Valley in Queensland had huge quantities of valuable topsoil washed away in 2011.

Source 5 These villagers in Pakistan compete for food supplies being dropped by an army helicopter after severe flooding in 2010.

Check your learning 3.12

Remember and understand

1 What are some of the ways in which people's health can be affected during floods?
2 Why does it cost so much to clean up after floods?
3 Study Source 1.
   a Who are the people in the photograph and what are they doing?
   b Where has all the rubbish come from?

Apply and analyse

4 Study Source 2.
   a How can the people shown possibly be suffering from a lack of water?
   b How might food aid reach this family?
5 What are some of the short-term and long-term effects of flooding?
6 Which of the flood effects shown on these pages do you believe will have the most lasting impact? Give some reasons for your answer.

Evaluate and create

7 Study Source 5. Imagine you have been sent into this region to report on the effects of the flood. Write a report on the effects on the people who live in this area. Present it as a newspaper report or as a script for a television news report.

3.13 Preparing for floods

Floods are part of the natural cycle of many rivers, so it is almost impossible to prevent them entirely. There are, however, many steps that we can take to lessen the impact of floods on people and places. These can be grouped into three categories. First, we can predict where and when there will be flooding so people have time to prepare. Second, we can ensure that people, homes and communities in flood-prone regions are prepared. Finally, when a flood does strike we can respond quickly and efficiently to save lives and make the affected area safe.

How do we know floods are coming?

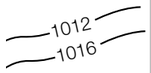
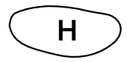
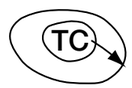
Floods in Australia are caused by heavy rain. To predict where and when heavy rain will fall, **meteorologists** use thousands of observations from radar, weather balloons, satellites and other sources. They use their observations to forecast the weather and inform the public about upcoming weather events. This includes issuing flood alerts and warnings.

The basic tool of weather prediction is a weather map. Weather maps show what is happening to the air in the atmosphere. Air rises and falls and this movement is measured with a **barometer** as air pressure. Air rises when it is heated and sinks when it is cooled. Because the Earth is spinning, the rising and sinking air also spins. We feel this spinning air as wind. Water droplets in rising air may cool and join together to create rainfall.

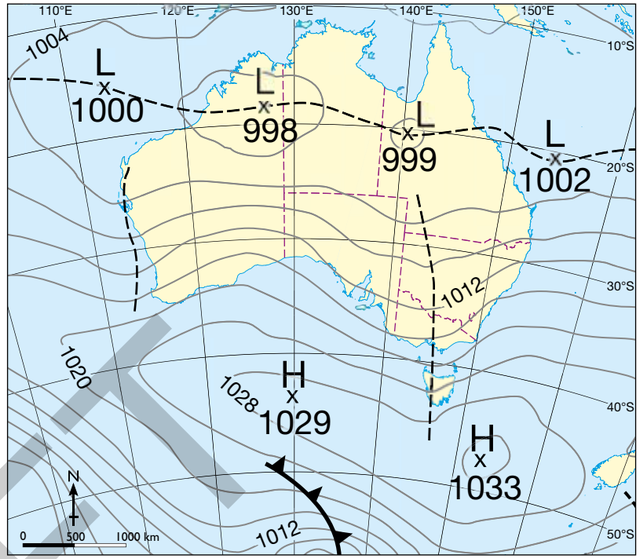
Source 1 Toowoomba in Queensland during the January 2011 floods, the deadliest floods in more than 70 years

Weather maps show the air pressure as a series of lines and help meteorologists make predictions about temperature, wind and rainfall. Although they may appear confusing at first, the symbols on a weather map are codes and, as with all codes, once you know the secret, you can read the message.

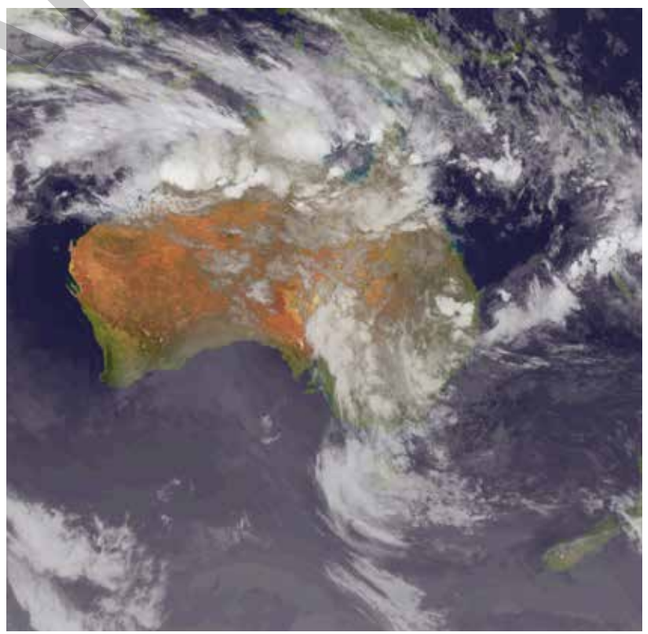
Source 2 Weather map symbols

Symbol	Name	Explanation
	Isobar	A line connecting places with the same air pressure; the closer together the isobars, the stronger the wind.
	High pressure cell	Air rotates anticlockwise around a sinking air mass; conditions are warm and dry.
	Low pressure cell	Air rotates clockwise around a rising air mass; conditions are cool and wet.
	Cold front	A line showing where cold air moves into an area and forces warm air to rise, cool and cause rain; cold fronts move in the direction of the arrowheads.
	Warm front	A line showing where warm air moves into an area, rises and cools; this often produces light rain and showers.
	Trough line	A long area of rising air often brings a line of rain and sometimes thunderstorms.
	Rainfall	On some weather maps, shading is used to indicate a region where rain is likely to fall.
	Tropical cyclone	Air rises rapidly and rotates clockwise with a calm centre; conditions are extremely windy and wet, and flooding is likely; cyclones move in the direction of the arrow.

AUSTRALIA: WEATHER MAP, 10 JANUARY 2011



Source 3 Source: Bureau of Meteorology



Source 4 Satellite image of Australia on 10 January 2011

Source 5 The Bureau of Meteorology issues flood warnings that are broadcast on television and other media.

Check your learning 3.13

Remember and understand

1. What are three things that people can do to lessen the impacts of floods?
2. What is a cold front?
3. How could Source 3 be used to lessen the impacts of flooding?
4. North-eastern Victoria experienced heavy rain and major flooding on 10 January 2011. What was the cause of this rain?
5. On 10 January 2011 it was a windy day in Perth. From which direction did the wind blow? Do you think Hobart was windier or calmer than Perth on that day?

Apply and analyse

6. What relationship do you notice between clouds and trough lines when comparing the satellite image (Source 4) with the weather map (Source 3).
7. Source 3 is a weather map that shows the situation on the day on which devastating floods hit the Lockyer Valley in south-eastern Queensland. What type of weather can this region of Queensland expect to receive in the next few days?

3.14 Managing floods

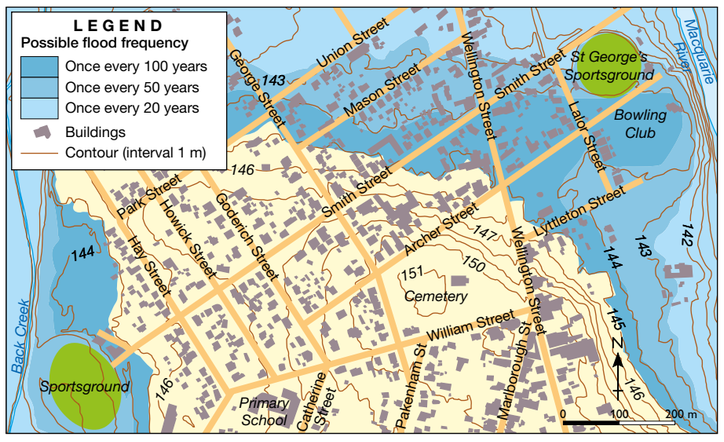
Individuals living in flood-prone areas should be prepared for a flood. The government department responsible for managing disasters, Australian Emergency Management, recommends following the three steps outlined in Source 3.

At the regional level, there are a number of ways that local communities can prepare for a flood. Some of these involve changing the physical environment to reduce the flood risk. Flood engineers and local councils examine the local environment and consider the impacts of previous floods when designing flood-protection strategies.

Case study: Longford, Tasmania

The town of Longford in the north-east of Tasmania sits at the junction of two rivers (the Macquarie River and the South Esk River) on a relatively flat floodplain. Heavy rain can swell the two rivers and when they meet, the waters spread across the plain. This can bring severe flooding to nearby towns, such as Longford and Perth, and to the city of Launceston, which sits at the mouth of the South Esk. In 1929, floods submerged parts of Longford under metres of water and made 4500 people homeless.

The people of Longford have responded to this flood risk. Using records of floods in the past, flood engineers have estimated the areas likely to be flooded once every 20 years, once every 50 years and once every century (see Source 1). This allows the local council to consider rules about building in these places, residents to prepare their flood plan, and engineers to design systems to control the flooding.



Source 1 Source: Oxford University Press

Source 2 A temporary levee put in place during a flood in Longford, Tasmania in 2011

Source 3 Disaster management steps

Ask	Find out about floods in your local area. Have there been floods before and, if so, was your house or area affected?
Learn	Find out how the flood warning system works. The Bureau of Meteorology issues flood watches, flood warnings and severe weather warnings. They use terms such as minor, moderate, major, localised and flash to describe flooding. You should learn what these mean.
Plan and prepare	Put together a flood plan that describes what you will do in the event of a flood. Keep a list of emergency phone numbers, prepare an emergency kit (including important documents to take with you if you evacuate) and take into account people with special needs, such as the elderly or disabled.

Based on this and further investigations, a levee has been constructed beside the river junction at the northern end of the town. Made of soil and rock, the levee is 4.5 kilometres long and is designed to stop floodwaters from entering the town. It has been designed to cope with the type of flood that Longford receives once a century. Large steel gates have been placed in the levee wall to allow creeks to flow to the main rivers when there are no floods. There are also temporary flood levee walls stored in Longford that can be quickly erected in a major flood.

skill**drill:** Data and inftormation

Communicating your findings

When geographers have completed an inquiry it is important that they tell other people about what they have found. For example, a geographer studying the impacts of a major flood in Longford should communicate the results of their inquiry to the local council and perhaps also to local residents.

There are a few steps to follow when communicating your results:

Step 1 Think about the type of audience you will be communicating your findings to. Think carefully about who needs to know your results.

Step 2 Consider the purpose of your communication. What are you trying to achieve? This may differ according to your audience. You may, for example, be trying to convince a trained flood engineer at the council to install a levee, or you may be warning a family holidaying at the local caravan park.

Step 3 Decide on the most effective means of reaching your audience. This will differ depending on the audience. For example, the engineer may need information such as **land use maps** and rainfall data, whereas the family may need a simple brochure outlining what they should do in case of a flood. Depending on the audience your report may be verbal; it may use sound, pictures or video; it may use maps; or it may be a written report.

Step 4 Use the results of your investigation to reach your chosen audience.

Apply the skill

1 Identify the different groups of people in Longford that would be interested in the findings of a geographical inquiry into flooding there.

2 What would be the most effective ways of communicating your findings to each of these groups? Why?

3 Design a brochure to be given either to campers arriving at the Longford Riverside Caravan Park or to local residents. Follow the steps provided to inform campers or residents about the flood risk in the region and the ways in which they should respond if there is a flood.

Source 4 Steel gates are installed in the levee at Longford, Tasmania.

Check your learning 3.14

Remember and understand

1 Describe how a levee can help reduce flooding.

2 Why is Longford at risk of flooding?

3 How would each of these people use the floodplain map of part of Longford North in Source 1:
- a flood engineer
- a person moving to Longford and intending to build a house
- a farmer who uses the land next to the river.

Apply and analyse

4 You are listening to the radio when a flash-flooding alert is issued for your local area. In teams of three, brainstorm the five most important items in a flood emergency kit. Compare your list with your classmates' lists. Were there any items that all teams named?

5 Examine Source 1.
- a How often are floods expected to affect the Longford Bowling Club?
- b Approximately how many buildings are affected once every 20 years?

3C rich task

Grantham floods, Queensland

In January 2011, the deadliest floods in Australia in over 70 years struck south-eastern Queensland. Beginning in late 2010, a combination of a tropical cyclone and heavy monsoon rains soaked Queensland's river catchments. The period from October to December 2010 saw some of the highest rainfalls on record for Queensland (see Source 2).

By early January, many Queensland rivers were in flood. Thousands of homes, businesses, schools and farms were damaged or destroyed and roads and railway lines were cut – but the worst was still to come.

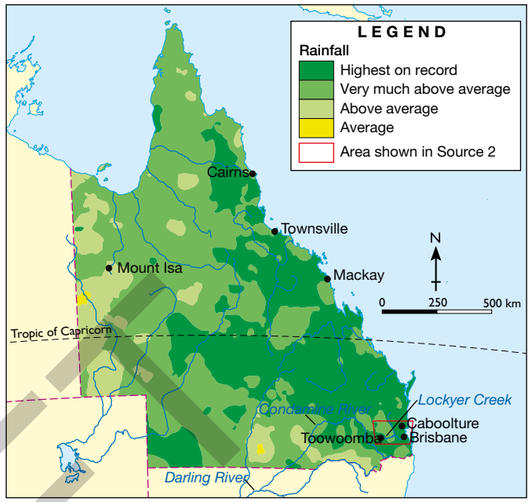
On 10 January 2011, a severe thunderstorm dumped more than 60 millimetres of rain on the Queensland city of Toowoomba in an hour. The storm caused flash flooding. As the thunderstorm moved east across the Lockyer Valley it continued to dump heavy rain. When combined with the run-off from Toowoomba, the already swollen creeks in the area could not cope. As the floodwaters moved down the Lockyer Valley with great speed and terrifying force, they slammed into the towns of Withcott, Murphys Creek, Helidon, Grantham and Gatton (see Source 1). A survivor described the flood as 'a wall of water', as creeks rose up to 15 metres above their normal level in a few minutes.

Thirty-five people died in the floods. More than 78 per cent of Queensland (an area bigger than France and Germany combined) was declared a disaster zone, with more than 2.5 million people affected. Floodwaters also affected the Bremer and Brisbane Rivers, with Ipswich and some Brisbane suburbs also flooding.

In Grantham, a small rural community in the Lockyer Valley, houses were swept away in the flood and people trying to escape in their cars were also caught. Twelve people died in Grantham as a result of the flood and 130 homes were damaged or destroyed.

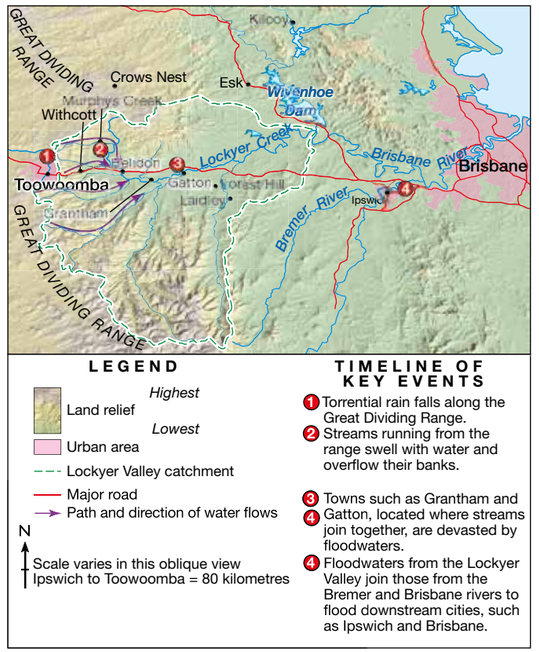
Source 1 This image taken on 10 January 2011 shows floodwaters raging through a popular shopping area of Toowoomba. The floodwaters moved down the Lockyer Valley over the next few days, devastating the towns of Withcott, Murphys Creek, Helidon, Grantham and Gatton.

QUEENSLAND RAINFALL, OCTOBER TO DECEMBER 2011



Source 2 Source: Oxford University Press

LOCKYER VALLEY FLOOD, JANUARY 2011



Source 3 Source: Oxford University Press

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

Locating places on topographic maps

The grid lines, called eastings and northings, that are placed on topographic maps are very useful. They allow geographers to locate places very accurately and they also help them to communicate the location of places and things to other people easily.

Each line on the grid is given a two-digit number. The lines that run vertically (up the map) are called eastings (because the numbers increase as you move east). The lines that run horizontally (across the map) are called northings (because the numbers increase as you move north). The eastings and northings are shown clearly in Source 6.

There are two ways in which grid lines are used in geography – the first is called area referencing (AR) and the second is called grid referencing (GR).

Area referencing (AR)

An area reference will help you identify the general location of a place or feature on a topographic map. Area references have four figures and they will tell you that a place or feature on a map is located within a certain area. Once you locate that area, you need to search it for the exact location of the feature.

Follow these steps to help you communicate the location of a feature using a four-figure area reference:

Step 1 Pick a feature on the map that you want to locate (or communicate the location of to somebody).

Step 2 Put your finger on the bottom left-hand corner of the square in which the feature is located. The two-digit number of this easting line will give you the first two digits in the area reference. The two-digit number of the northing line will give you the second two digits in the area reference. For example, in Source 6 the Grantham sports ground can be found in the area AR2149.

Grid referencing (GR)

A grid reference will help you identify the specific location of a place or feature on a topographic map. Grid references have six figures and they will tell you exactly where a place or feature on a map is located on a topographic map.

Follow these steps to help you communicate the location of a feature using a six-figure grid reference:

Step 1 Pick a feature on the map that you want to locate (or communicate the location of to somebody).

Step 2 Put your finger on the bottom left-hand corner of the square in which the feature is located. The two-digit number of this easting line will give you the first two digits in the grid reference. For example, the first two digits for the location of the RFS (Rural Fire Station) building are 22.

Step 3 Now estimate the number of tenths that your feature is located between the first easting line and the one to the right of it. For example, if it is halfway between the lines it will be five-tenths. This number will become the third number in the GR. In the case of the RFS building, this number is 3. This means that the first three digits of your grid reference will be 223.

Step 3 Next, place your finger at the bottom left-hand corner of the square in which your feature is located. Follow the northing line to the side of the map to find out what the fourth and fifth digits in the area reference will be. For the RFS building, these are 49.

Source 4 The railway bridge located near the town of Grantham during the floods in January 2011

Step 4 Now estimate the number of tenths that your feature is located between this northing line on the bottom and the one on the top. This number is 8. This is the sixth (and final) number in the grid reference.

Step 5 The six-figure grid reference for the RFS building is therefore GR223498.

Apply the skill

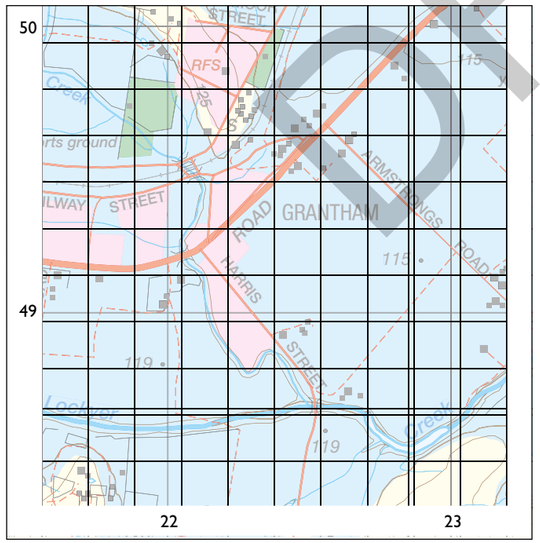
1 Use Source 6 to complete the following table:

Map feature	Four-figure area reference	Six-figure grid reference
Abattoir	1948	195483
		222498
Building at the sports ground		
Railway line crossing Sandy Creek		

Extend your understanding

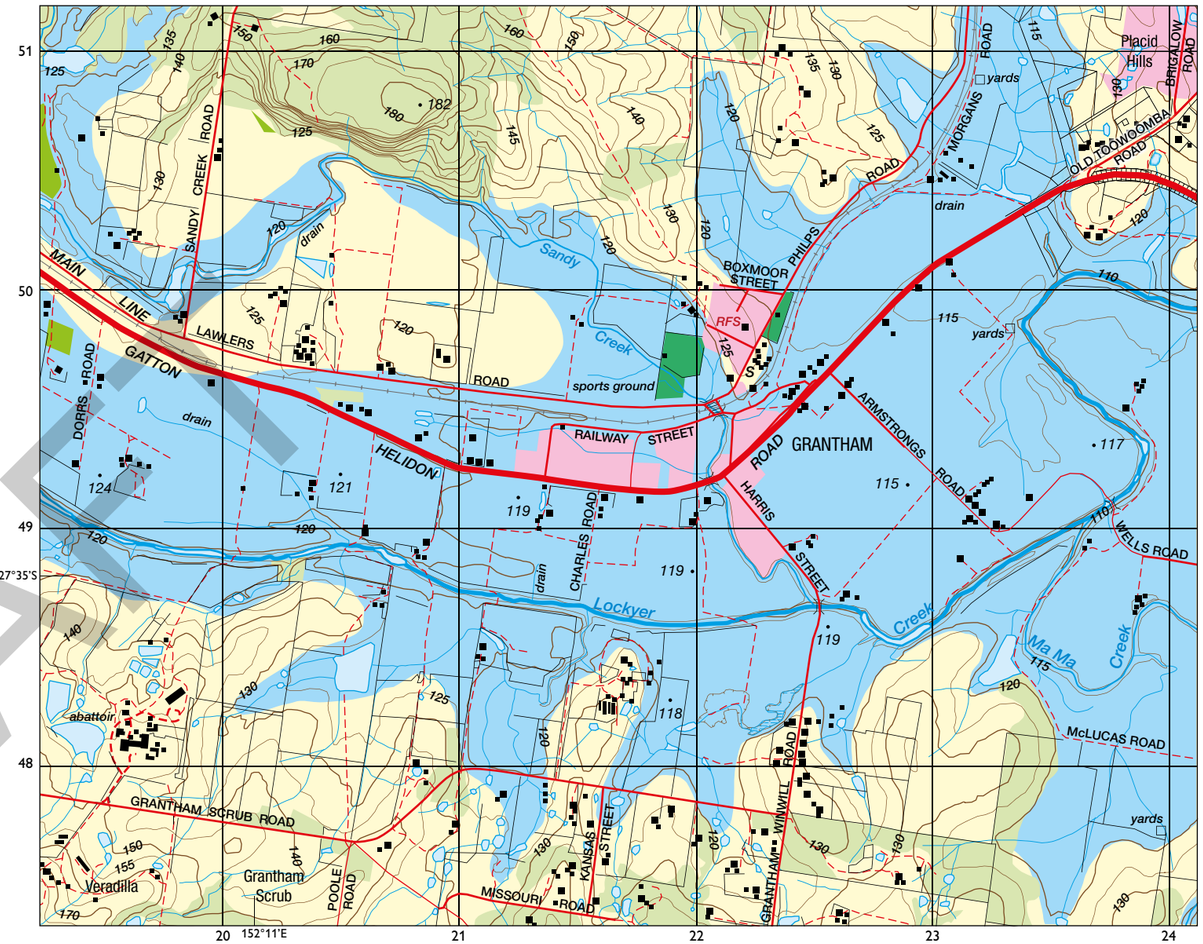
1 The rail bridge shown in Source 4 is located at GR221495 on the map. On which creek is this bridge located? In which direction is this creek flowing?

2 Following the flood in 2011, many Grantham residents built new homes in the town at GR240510. Why is this area less likely to flood than the town of Grantham?



Source 5

GRANTHAM TOPOGRAPHIC MAP SHOWING 2011 FLOODWATERS



Source 6

Source: Oxford University Press