Growing food

It may surprise you to learn that most of the world's people, including you, eat grass. It has been estimated that there are about 50 000 edible plants in the world, but of these, just 15 species provide 90 per cent of the world's food. Three types of plants, in particular, make up well over half of all food eaten each year and they are all types of grass: wheat, rice and corn. Every day, foods from at least one of these types of grasses will be consumed in different countries all over the world.

These hillsides in southern China have been terraced, or had flat 'steps' cut into them, to create flat land for growing rice, which is the most important staple food for more than half the world's population. Rice, like wheat and corn, grows in the grasslands regions of the world. Grasslands around the world share similar climate and vegetation features and are therefore known as a single biome.

1.1 What are the world's biomes?

1 Grasslands are an important biome for producing food. There are about seven other main biomes on Earth. How many can you name?

2 Grasslands have a climate that supports the growth of grass. What do you think are some of the features of this climate?

1.2 Why do some biomes produce more food than others?

1 What features of the landscape in this photograph make this a productive area for the growing of food?

2 Virtually all of Australia's rice is grown on the flat river plains of southern New South Wales. How will rice farming in this region differ from rice farming in southern China?

chapter 1

Source 1.1 These mountainsides in China have had 'steps' cut into them to create flat areas for growing rice.

1.3

What are the environmental impacts of food production?

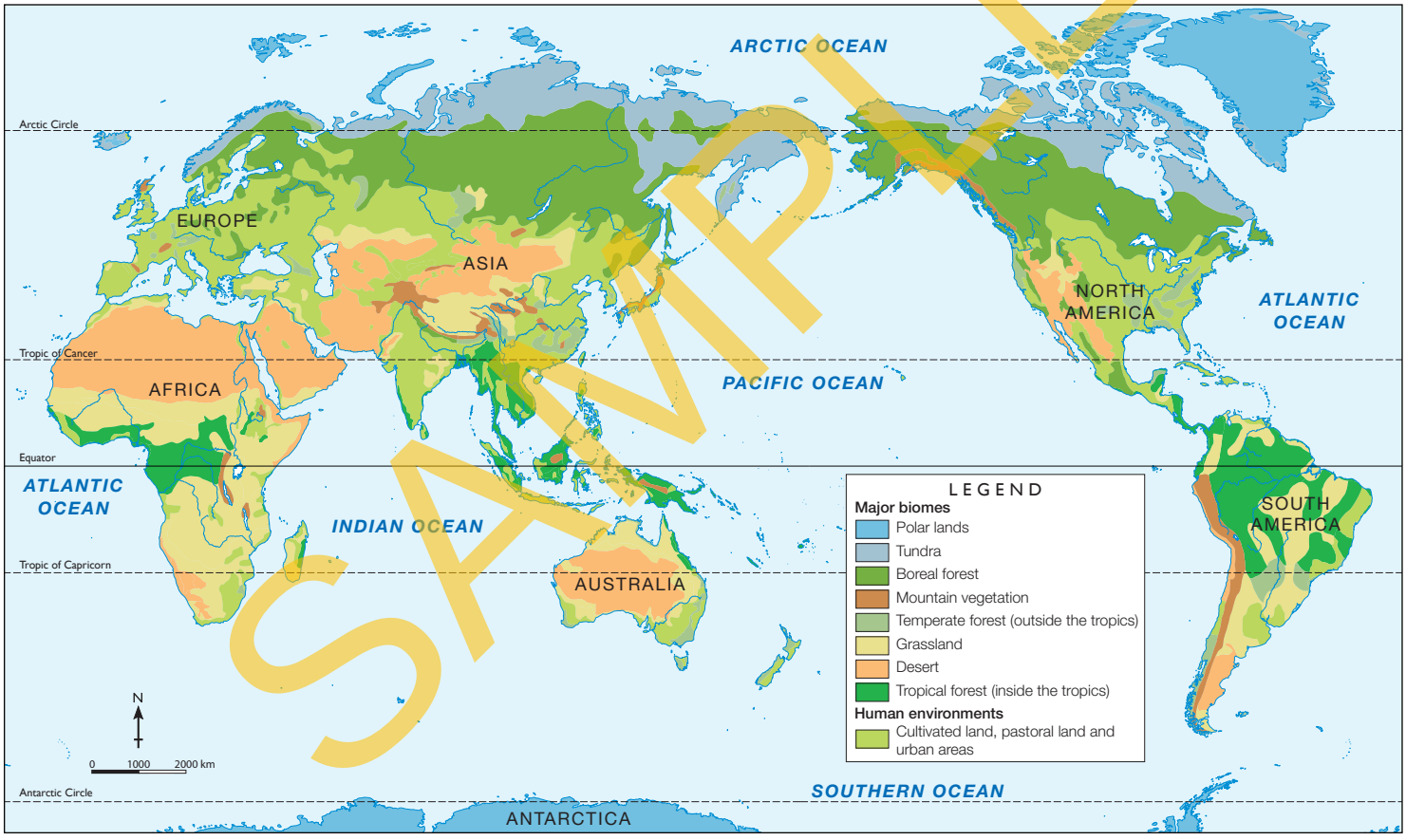
1 Describe the ways in which farming in this region of China has changed the natural features such as the shape of the land, the natural vegetation, the soil and the water.

1.1 What are the world's biomes?

The world's biomes

In order to better understand the Earth's natural and human environments, geographers divide the Earth's surface into a number of distinct regions. Each region has particular features that make it different from other regions. One region may be hot and rainy most of the time, for example, and another might be dry and cold. This means the plant and animal life found there functions, adapts, and interacts according to the conditions of the region they inhabit. Regions defined by landscapes that share similar climates and types of vegetation in this way are known as **biomes**.

WORLD: BIOMES



Source 1.2

Source: Oxford Atlas

Polar lands | Tundra | Boreal forest | Mountain vegetation | Temperate forest | Grasslands | Desert | Tropical forest

Source 1.3 A red-eyed tree frog in the rainforest of Panama in Central America is one of the many species that lives in this rainforest biome.

In some biomes, such as **tropical forests** and **grasslands**, there is an abundance of life. This is because the conditions favour a huge variety of species. A recent study of a Colombian **rainforest**, for example, found 596 bird species, 150 different species of amphibians and more than 200 species of mammals. Scientists estimate that there are more than 100 000 insect species per hectare in this rainforest and more tree species in a single hectare here than there are in the whole of North America. This explosion of life is due to the year-round high temperatures and rainfall in the region.

At the other end of the scale are the **tundra** and the **polar lands** which are the coldest biomes. The tundra biome circles the North Pole. Tundra, meaning 'treeless plain', has short growing seasons, very little plant diversity and very low temperatures. Antarctica, twice the size of Australia, contains virtually no native land species. Only two flowering species of plants exist on the continent and the largest native land animal is a 1-centimetre-long wingless midge. There are no native mammals, amphibians or trees in Antarctica. It is simply too cold, too dry and too windy for plants and animals to flourish.

In the **mountain vegetation** biome, too, cold conditions determine plant life and the animals that live there. Plants in the mountain vegetation biome tend to be low and hug the ground to preserve warmth. The mountain vegetation biome has a long winter period, and animals that live in these areas need to be able survive the cold and the exposure to UV radiation.

Check your learning 1.1

Remember and understand

1 What is a biome?
2 Why is there such an abundance of life in a rainforest?

Apply and analyse

3 Where are the world's tropical forests located? Why do you think they are located in these places?
4 Describe the distribution of biomes in Australia.

Evaluate and create

5 Design a world tour that includes at least one visit to each type of biome. Research where you will go using a map that shows the world biomes, then list the countries you would visit on this tour. Include some of the activities you might do at each place, based on the biome's climate and geographical conditions.
6 Work with a partner to rank the world's eight major biomes from 'home to most species' to 'home to least species'. Compare your list with other groups. Were there some rankings you all agreed on? Were there others where there was little agreement?

Boreal and temperate forests

Boreal forest biome

The largest biome on land is not the hot **desert** or treeless tundra – it is the **boreal forest** biome. Boreal forest, sometimes called **coniferous forest**, is composed of coniferous, evergreen trees that have needle-like leaves and cones, like pine cones. This biome is characterised by having a low number of species of plants when compared to other forests in more temperate regions or in the tropics.

The boreal forest biome covers vast areas in the Northern Hemisphere, between the Arctic tundra and the north of Europe, Asia and North America. While the climate in these regions is not as harsh as that experienced in the polar lands or on the tundra, it is still cold enough to limit the number of plant and animal species that can survive, and winter is long. In fact, the boreal forest's longest season is winter. Average temperatures fall to about -15°C and snow is common. In summer, which lasts only one to three months, temperatures climb towards 20°C and humidity is relatively high. The plants and animals that survive in this biome must be able to handle great variations in rainfall and temperature, as well as large areas of permanently frozen ground and poor soils.

Threats to the forest

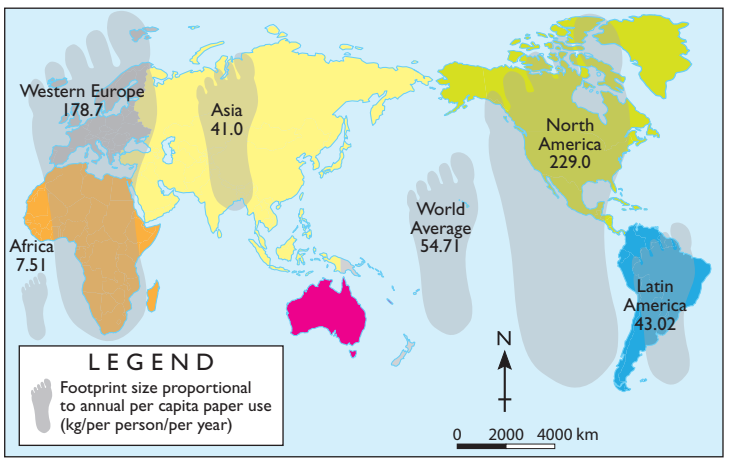
Boreal forests have provided many important resources for people both in the past and the present. Historically, wood for construction, heating and cooking came from boreal forest trees. More recently, boreal forests have supplied the increased global demand for cheap wood and paper, spurred by population growth and a change in global markets.

However, many boreal forests are under threat. One of the main threats to the boreal forest biome is the clearing of trees to make way for oil and gas exploration. It is estimated that huge reserves of petroleum products lie under the forests, and the ever-increasing demand is pushing exploration into these areas.

In Canada and Russia, forests are logged extensively and many are being attacked by insect plagues and acid rain. Forests are also at risk from bushfires during the summer period. Climate change is causing some forest areas to spread further north. Rising temperatures in the Arctic region have seen the edge of the boreal forest slowly advancing northward, replacing tundra in some places.

Source 1.4 This Canadian paper mill is situated by a large body of water. Paper is made by pulping woodchips from logs and mixing the pulp with water.

WORLD: AVERAGE PAPER CONSUMPTION



Source 1.5 Source: Oxford University Press

Source 1.6 The spectacular deciduous trees in the town of Bright in Victoria's high country are mainly oaks and elms, native to England half a world away.

Temperate forest biome

Between the tropics and the cold polar regions is a large zone that is neither excessively hot nor excessively cold. For this reason it is called the temperate zone. The forests that grow in the temperate zone experience a range of seasonal climate conditions. In winter, temperatures may fall below freezing and in summer they can climb above 40°C. In some temperate forests, rain falls reliably throughout the year. In others, there are more distinct wet and dry seasons.

Most of the world's population lives in the temperate zone and this has had a huge impact on the **temperate forest** biome over time. As the world's population spread and grew, temperate forest biome areas gradually became smaller. Cities were formed on land that was once covered in forest, and trees were cut down to clear land and to provide fuel and building materials. The forests gradually disappeared from these places. This happened in Europe, then in Western Asia and North America. Currently, little temperate forest remains in some of these places.

However, as explorers set out from Europe to colonise new lands, they often carried with them seeds and saplings of the trees with which they were familiar. They planted these in the places they travelled to, such as Australia, New Zealand and South Africa, and in this way temperate forest trees were spread around the world.

Check your learning 1.2

Remember and understand

1 Describe the temperature variations experienced in the boreal forest biome.

2 How have trees from temperate forests spread around the world?

Apply and analyse

3 What are some of the differences between boreal and temperate forests? What are some of the similarities?

4 Use the map in Source 1.2 to compare the distribution of temperate and boreal forests.

5 Why do you think the consumption of paper has increased dramatically in the last 50 years? What influence has this growth in demand had on the world's forests?

Evaluate and create

6 Examine Source 1.5, showing the average consumption of paper by person in each continent.

- a Who are the biggest paper users? Who are the smallest?
- b Australian consumption is not shown on this graphic. Draw the size you estimate Australia's paper footprint to be compared to one other continent. Explain how you decided on the size of Australia's footprint.

The grasslands biome

In places where it is too dry for forests and too wet for deserts lies a biome dominated by shrubs and grasses – the grasslands biome. In some places, regions that are part of this biome are also known as **prairies**, **steppes** or **savannas**. In Africa the grasslands are often referred to as savannas. In the United States of America they are often called prairies, and in parts of Siberia and south-eastern Asian, they are alternatively known as steppes.

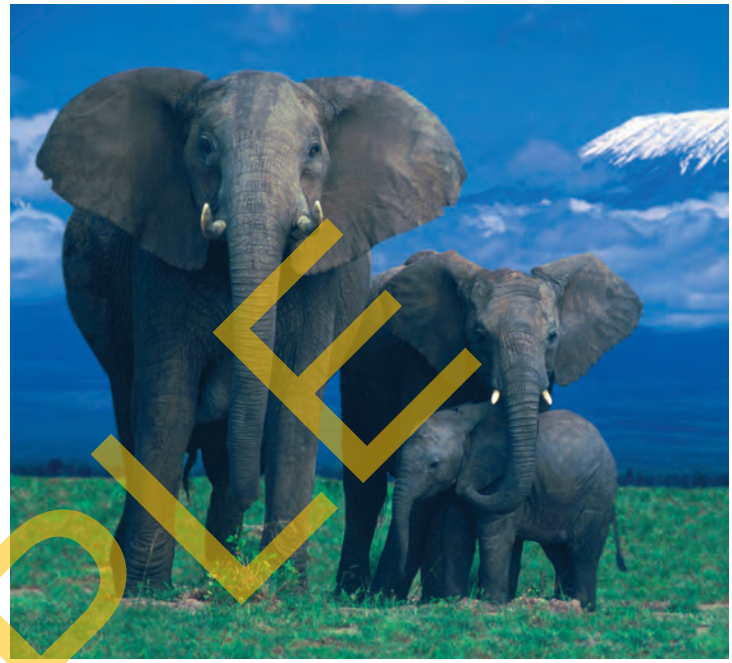
Much of the world's food and fibre comes from plants and animals that live in the world's grasslands. Rice, wheat and corn, all grasses, provide the bulk of the human population's food, and many animals which are farmed to provide meat and milk also live in the grasslands biome.

Much of Australia can be considered grassland and many of our native animals, such as kangaroos, wallabies and wombats, thrive in this biome.

In Africa, too, grasslands dominate, covering more than half the continent. In this landscape the grassland is dotted with individual trees, providing little cover for the wildlife that live there.

These grasslands support a variety of plant-eating mammals as well as predators that feed off them. The animals living here have developed an amazing array of physical and behavioural changes to adapt to the challenges of the open environment. The zebra's stripes, for example, make it difficult for a predator to see it clearly. The giraffe, one of the larger kind of grasslands inhabitant, has evolved in such a way that its long neck allows it to source food at the tops of trees. Many other animals that live in the grasslands are nocturnal, allowing them to avoid the main heat of the day and venture out at night to hunt and gather food. These animals include the prairie dog, barn owl, and gray wolf which scout for food at night. Smaller mammals also venture out in the cool of the night, often when the moon is full or near full, to allow them to better spot animals that may be seeking them out as prey.

Many grasslands around the world have changed greatly over time. Some of these changes are the result of human activities, such as introducing grazing animals to a grasslands environment. Grazing animals such as cattle, sheep and goats compete with native species for food and often trample the ground, damaging the roots and soil structure.



Source 1.7 Elephants on the savanna

Source 1.8 An Asian steppe

Source 1.9 A Bison on the prairie

key**concept:** change

The American prairie

The prairies of North America were once dominated by Indigenous American tribes, such as the Cheyenne, Apache and Comanche tribes.

The Comanche lived in the grasslands in the region which now includes Texas, Oklahoma and Kansas, in the United States. They were typical of many of the Indigenous tribes of North America. As their main food source was bison, they followed the great herds across the plains, as the bison travelled to find the best grazing. When the bison stayed in one location to eat the plentiful grass, the Comanche set up temporary villages. Then they moved with the bison when better grazing lands were needed. The bison provided more than food for the Comanche, their hides were used to make clothing and the distinctive pyramid tents, called tepees.

Source 1.10 With the arrival of the horse, tribesmen could hunt bison more easily.

Source 1.11 It is estimated that 30 million bison lived in North America in the 1500s. Within 400 years this had fallen to about 1000. In this photograph, taken in the 1870s, a pile of bison skulls waits to be crushed for fertiliser.

Some tribes hunted bison by building fences from fallen logs, then herding the bison into a small area where they were killed with arrows and knives. Herding massive animals such as bison was difficult for tribesmen on foot. However, life for Native Americans changed dramatically with the arrival of European explorers, and their horses, about 400 years ago.

Many tribes, including the Comanche, quickly realised the potential of the horse in their culture and soon became expert horsemen. As well as being faster and more nimble than a bison, the horse had one other great advantage for the grasslands tribes. Like bison, horses are grazing animals that eat grass. This meant that the tribes could move easily across the plains following the gradual movement of the bison herds, the grasslands now feeding both bison and horses.

But as European ranchers moved across the prairies through the 16th to 19th centuries, the numbers of Native Americans and their way of life gradually disappeared. Much of the vast grasslands of the prairie were turned into grazing land and farmland by the European settlers. However, the open plains remain an iconic image of American history and the American pioneering spirit.

For more information on the key concept of change, refer to section GT.1 of 'The geographer's toolkit'.

Check your learning 1.3

Remember and understand

1 Why is the grasslands biome important for human populations?

2 What changed the grasslands of North America?

Apply and analyse

3 Examine the map in Source 1.2 showing the distribution of the world's biomes.
   - a Describe the distribution of grasslands in each continent.
   - b What relationship do you notice between grasslands and human environments such as cultivated land and urban areas?
   - c Why does this relationship occur?
   - d Examine the three images of grasslands (Source 1.7, Source 1.8 and Source 1.9) from different parts of the world. In which countries do you think each of these photographs was taken? Give some reasons for your answers.

Evaluate and create

4 Compare the images of the grasslands with the pictures of deserts that appeared on page 15. What are some of the main differences between the two biomes? Explain why these differences occur.

The tropical forest biome

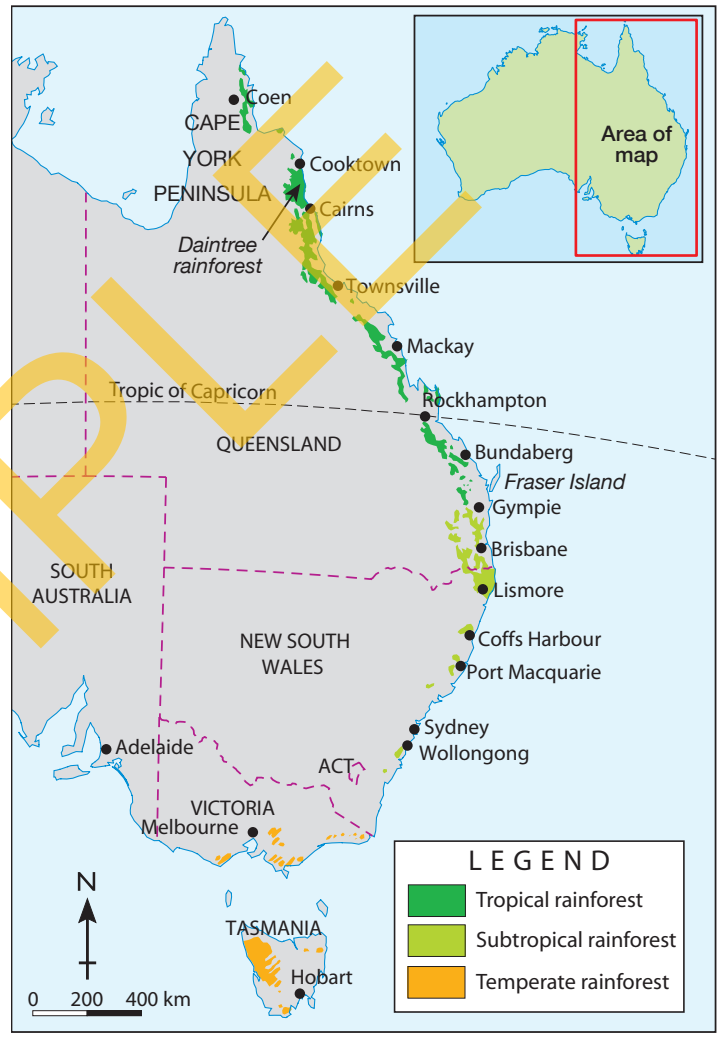
It is estimated that about half of all the plant, animal and insect species in the world live in tropical forests. Many of these are amongst the wettest places on Earth and are therefore known as rainforests. They can be considered to make up the world's richest biome and the abundance of life can be astounding. In Brazil, for example, researchers found that a single pond contained more fish species than exist in all of Europe's rivers. In Peru, a single tree was found to contain forty-three ant species; this is more than the total number in all of the British Isles. One hectare of South American rainforest may contain over 750 different types of trees and one-fifth of all of the world's birds live in the Amazon rainforest. This explosion of life is due to the ideal growing conditions that occur in the tropics.

These places experience the most stable climate conditions on the planet with virtually no seasonal changes in rainfall, temperature or available sunlight throughout the year. Most days are the same in the rainforest: hot and wet. It rains virtually every day, often in torrential downpours. The temperature hovers between about 26°C and 32°C all year round.

Australia's rainforests

Though much of Australia was once covered in forest, now there are only a few small pockets near the east coast (see Source 1.12). Rainforests now make up only 2.5 per cent of Australia's remaining native forest. This surviving forest, however, is a real Noah's Ark for many plant and animal species, many of which exist nowhere else in the world. There are more than 1000 species of plants in Australian rainforests, of which about 700 exist nowhere else. These plants support thousands of insect species, hundreds of reptile and bird species and nearly 90 different types of mammals. The subtropical rainforests of New South Wales and Queensland are also internationally recognised for their direct links to the world's first flowering plants, which occurred about 100 million years ago.

EASTERN AUSTRALIA: RAINFOREST REGIONS



Source 1.12 Source: Oxford University Press

Source 1.13 Tropical rainforests cover the slopes of many Queensland mountains and experience Australia's highest rainfall. The Daintree forest near Port Douglas is the oldest continuously surviving rainforest in the world.

The gifts of the rainforest

Rainforests have provided humans with many resources for thousands of years. These resources are known as **ecosystem services**. Rainforests provide many services, including the ones described in Source 1.14.

Ecosystem services

About 80% of the plants we eat began in the world's tropical rainforests. Potatoes, corn, rice, avocadoes, oranges, bananas, coffee, chocolate and hundreds of other foods are rainforest plants.

About 25% of the drugs we use to treat illnesses, from leukaemia to headaches, come from rainforest plants.

Rainforest plants take in carbon dioxide and produce oxygen. The Amazon rainforest alone is thought to produce about one-fifth of the world's oxygen.

Rainforests regulate the Earth's temperature and rainfall, and hold much of the world's fresh water.

Rainforests in Africa, Asia, South America and Australia are home to Indigenous peoples.

Products such as toothpaste, golf balls, rubber tyres, paints, cosmetics, steroids and cork are all made from rainforest plants.

Source 1.14 A scarlet macaw flies over the world's largest rainforest – the Amazon. The Amazon provides many ecosystem services.

Source 1.15 Temperate rainforests are found in the temperate climate zone. Like tropical rainforests, they receive an abundance of rain and take in high amounts of carbon dioxide. However, they do not have the same levels of biodiversity as the tropical rainforests. The temperate rainforests of Tasmania and Victoria are characterised by ferns covering the ground and tall trees, some of them amongst the world's tallest.

Check your learning 1.4

Remember and understand

1 Use the map showing the world's biomes (Source 1.2) to describe the distribution of the world's tropical forests.

2 What are some of the links between the world's climate and rainforests?

Apply and analyse

3 Describe the distribution of Australia's rainforests. Refer to particular places and states and use compass directions in your answer.

4 What are some of the differences between tropical and temperate rainforests?

Evaluate and create

5 Why do you think the amount of rainforest in Australia has decreased so much? Consider both natural processes and human activities.

6 What information from these pages would you use to explain the importance of rainforests?

7 Clearing of rainforests for farming, mining and urban development makes the tropical forest biome one of the world's most endangered.

a How might the clearing of a rainforest impact on people who live in it or nearby?

b How might it impact on people living in places that are further away?

Going with the flow in the rainforest

A rainforest, like all **ecosystems**, is a very dynamic place. Complex relationships between the climate (including rainfall, temperature, wind, humidity and sunlight), the shape of the land, soils, plants and animals have developed over millions of years and keep the rainforest alive and flourishing. A change to any part of the ecosystem can have devastating consequences for the whole ecosystem. The cross-section in Source 1.16 shows some of the flows of energy (intangible sources of power or nutrition) and matter (tangible sources of power or nutrition) that exist in a rainforest.

Changes in the rainforest

It might seem logical that rainforests must have a deep rich layer of soil to support the great trees and other plants that flourish there. However, this is not the case. The heavy rain washes the nutrients of the soil deep into the ground where the roots of the plants cannot access them. The rainforest trees are able to survive in these soils because they have developed wide-spreading roots and because the warm temperatures in the tropics allow leaf litter – dead plant material that has fallen to the ground – to be quickly recycled into plant nutrients.

When the rainforest plants are cleared to make way for farms, these nutrients are quickly lost and the soil becomes exposed to the heavy rain and tropical sun. Farmers often find, contrary to expectation, that their plants do not thrive in these conditions as the soil provides few nutrients which the plants need.

skill**drill**

Creating a flow diagram

Geographers use **flow diagrams** to show the movement, sequence or stages in a process. Flow diagrams can be created by adding text and arrows to an image, or by creating text boxes from scratch, joined by arrows to describe the flow of a process.

You can create a flow diagram by following these steps.

Step 1 Decide on a process you want to describe. For example, you might want to describe the life of an apple, from seed to compost stage.

Step 2 Jot down the steps you wish to highlight in the process. Try to keep each step clear and separate.

Step 3 Create a text box for each step, and write or insert your text in each box.

Step 4 Link each step with an arrow showing the direction of the process. Read through your diagram to make sure the steps you have included are logical and that you haven't missed any important parts of the process you are aiming to describe.

You can also create a flow diagram by adding your arrows and text to an existing image, following the process described here.

Apply the skill

1 Use the steps above to construct a flow diagram of your own. Use the picture and labels of the rainforest from Source 1.16 to describe the flow of energy and matter that would occur between the different elements of the rainforest and the plants and animals that inhabit it.

Check your learning 1.5

Remember and understand

1 Look at the illustration of the rainforest in Source 1.16 and identify an interaction that takes place between animals and plants.

2 What effect do you think there would be on the rainforest ecosystem if this interaction no longer occurred?

Apply and analyse

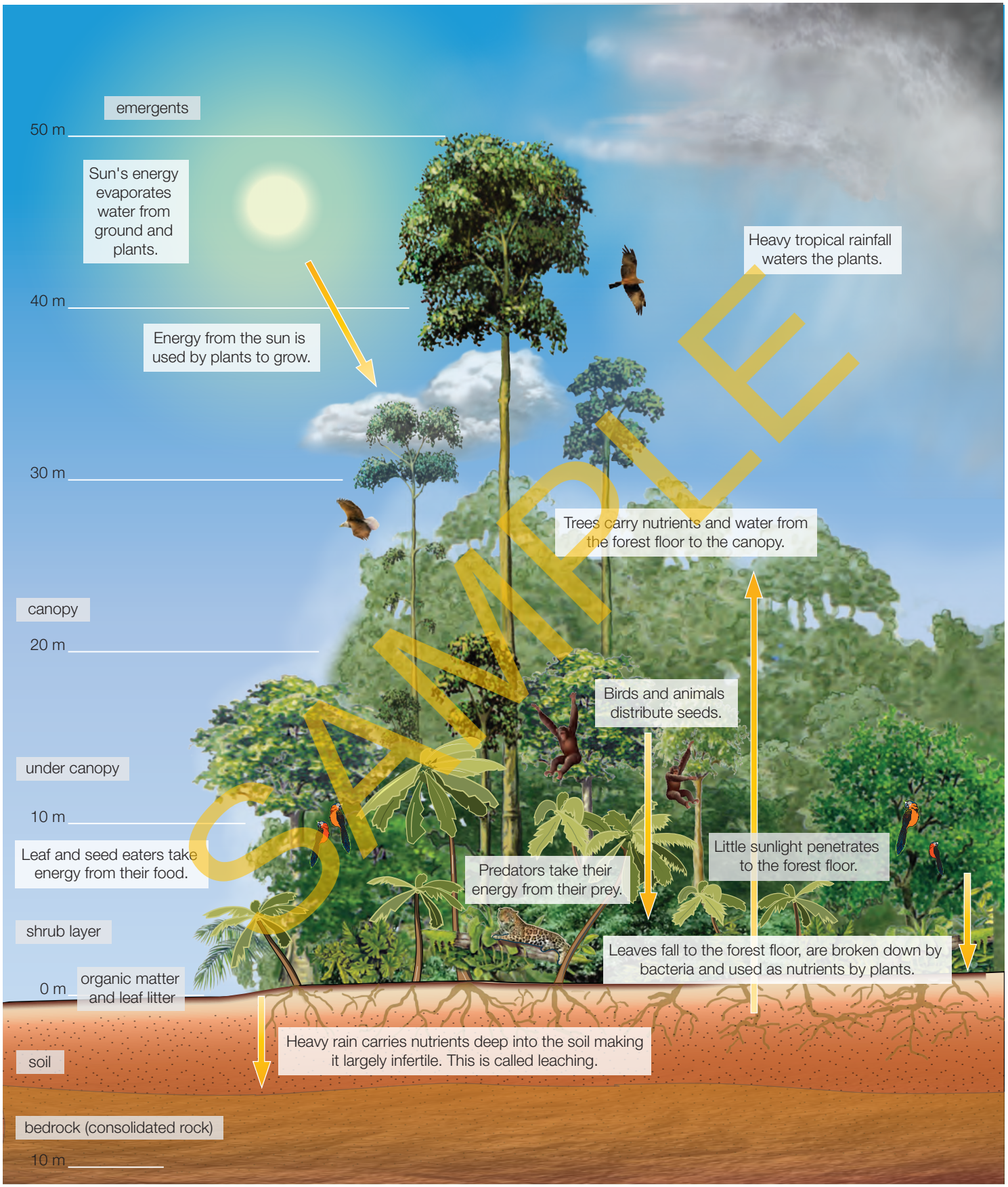
3 Why are rainforest soils poor in nutrients?

4 How have rainforest trees adapted to the poor soils in the rainforest?

5 Describe how water is moved through the rainforest.

Evaluate and create

6 What changes of movement in energy and matter would result if the trees and vegetation in Source 1.16 were cleared to make way for farming land? Consider the living and non-living inhabitants of the ecosystem.



Source 1.16 Cross-section of a tropical rainforest

Australia's biomes

Australia is one of the world's largest countries. The northern part lies in the tropics, while Tasmania reaches towards Antarctica in the south. The sheer size of the land mass which spreads across much of the Earth's southern latitudes means that there is a wide variety of biomes in Australia.

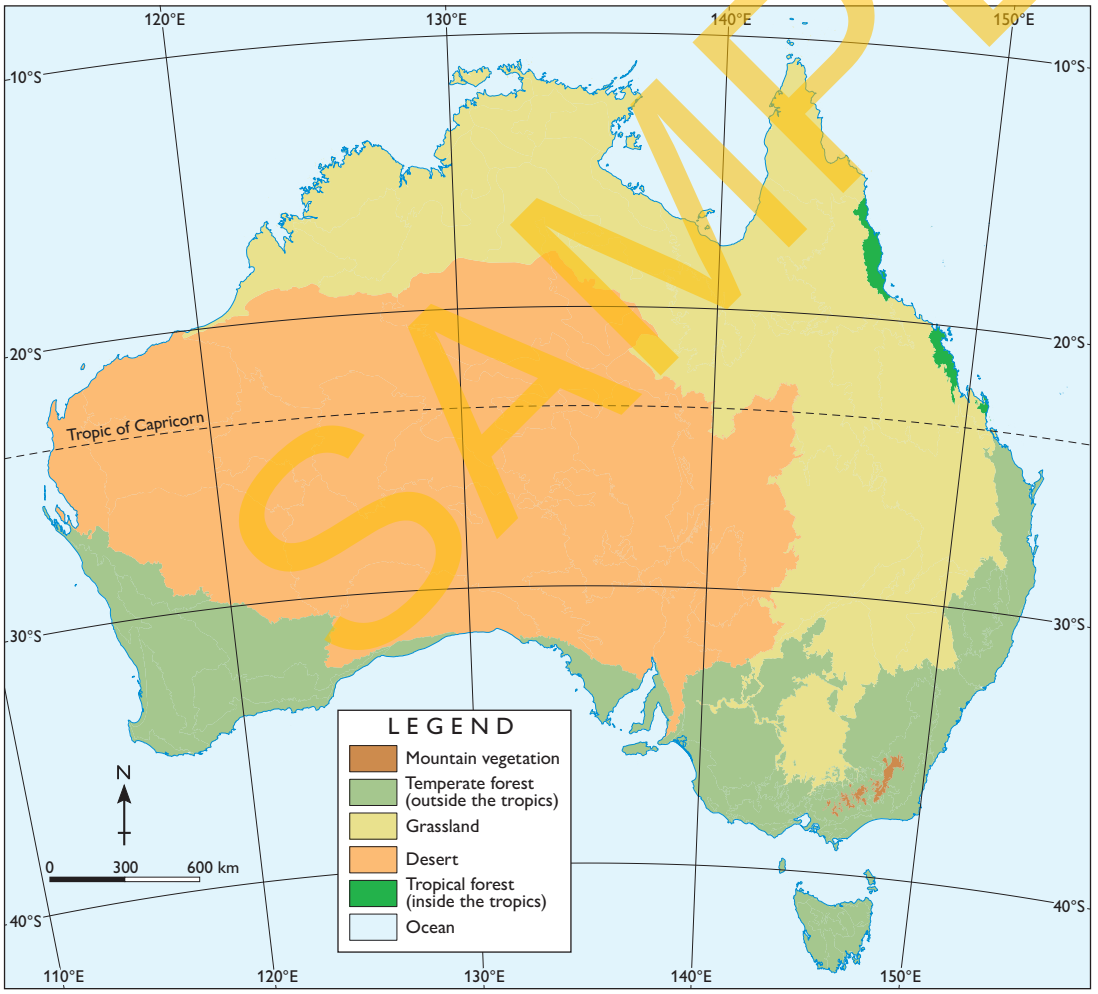
Many of Australia's original biomes have been changed by human activities. More than half of Australia's total land area is now used for food production, particularly sheep and cattle farming, covering 430 million hectares of land. This has resulted in significant changes to vegetation, land and water across much of the country. The following map shows Australia's original biomes before they were changed by human activities.

Australia's deserts

Australia is the second driest continent in the world, after Antarctica. The combined area of the ten biggest Australian deserts makes up about 18 per cent of the total land area of our 'wide brown land'. We can also describe Australia as arid or semi-arid because 70 per cent of the continent receives less than 500 millimetres of rainfall each year. This low rainfall has resulted in large desert areas across much of Australia.

Many people think of deserts as being entirely composed of large sand dunes, with the occasional date palm or cactus the only sign of life. This image may come from movies, or pictures they have seen of deserts around the world.

AUSTRALIA: BIOMES



Source 1.17

Source: Oxford University Press

Source 1.18 About one-third of Australia's total land area is used for cattle farming.

Source 1.19 Different Australian desert landscapes: spinifex grass in the Great Sandy Desert (top); acacia trees in the Great Victoria Desert (middle); stony plains in the Simpson Desert (bottom)

However, while the Sahara Desert in Africa does have date palms and sand dunes and most North American deserts have cactuses, there are variations within the desert biome. Some desert areas in Australia have large areas of red dunes, for example, but some are covered in vast areas of stones, called gibber plains.

In most of Australia's desert areas, grasses and low shrubs dominate the landscape (see Source 1.19). In the tropical deserts north of the Tropic of Capricorn, Spinifex and tough Mitchell grass cover much of the ground. South of the tropics, woodland deserts are more common, with tough acacia trees, such as the mulga and witchetty bush, in evidence.

Check your learning 1.6

Remember and understand

1 Why is there a wide variety of biomes in Australia?

2 What is the dominant natural biome where you live? Describe some of the ways in which this has been altered by human activities.

Apply and analyse

3 Compare Australia's biomes in Source 1.17 with the world's biomes in Source 1.2 and answer the following questions.

- **a** Which biomes do not exist in Australia?
- **b** Give a reason for each of these biomes being 'missing' in Australia.
- **c** How has latitude influenced the distribution of biomes in Australia?

Evaluate and create

4 The world biomes map (Source 1.2) shows large areas of desert, while the three images in Source 1.19 show us that there are significant variations in landscape within the desert biome.

- **a** What are the limitations of describing places according to their dominant biome?
- **b** Why do you think there are such variations within the desert biome?
- **c** Research one of the other biomes to find out if such variations exist in that biome's regions too.
- **d** Construct a collage or create a PowerPoint display of Australia's major biomes. Include at least one image of each biome.

1.1 big**ideas:** broadsheet

The Kokoda Trail

Papua New Guinea is a country with vast areas of rainforest. The forest covers the slopes of rugged mountain ranges such as the Owen Stanley Range. The Kokoda Trail crosses this range and was the location of fierce battles between the Australian and Japanese armies in World War II. The area is notable for steep mountainsides, dense rainforests and heavy rainfall. This turns the trail into a sea of mud and makes progress along it very difficult. Many Australians attempt to walk the trail every year to achieve personal goals, which perhaps include gaining an appreciation of the difficulties faced by the soldiers during the war.

skill**drill**

Estimating gradient and aspect on topographic maps

Estimating gradient (angle of the slope) and aspect (direction of the slope) is an important skill for geographers to master.

Estimating gradient

Using a topographic map, it is possible to estimate the gradient between two points, by following these steps.

Step 1 Determine the height of the two points. For example, Owens Corner (186, 530) is at 600 metres and The Gap (241, 588) is at 2190 metres.

Step 2 Estimate the difference in height between these two points (known as the rise). 2190 – 600 = 1590.

Step 3 Estimate the straight line distance (known as the run) between these two points using the line scale. This is 40 km or 40 000 metres in this example.

Step 4 Divide the rise by the run and multiply this by 100: (2190/40 000) x 100 = 5.5% slope.

Estimating aspect

The aspect refers to the compass direction that the slope is facing. This is also simple to work out by following these steps.

Step 1 Using the information we found out when estimating the gradient we can tell that the terrain slopes down from The Gap (at 2190 m) to Owens Corner (at 600 m).

Step 2 Imagine an arrow from The Gap to Owens Corner and estimate the direction of this arrow using the north arrow. This arrow would be pointing south-west. The aspect therefore is south-west.

Apply the skill

1 Estimate the aspect and gradient of the slope between The Gap and Kokoda (241638).

2 Is this slope less steep or steeper than the slope between Owens Corner and The Gap?

3 Estimate the gradient and aspect for the slope between The Gap and Mt Kenevi (266584).

4 Estimate the gradient and aspect for the slope between The Gap and Mount Victoria (197635).

5 Provide three pieces of evidence that this landscape is very rugged and mountainous.

6 Estimate the total length of the Kokoda Trail from Owens Corner to Kokoda.

Extend your understanding

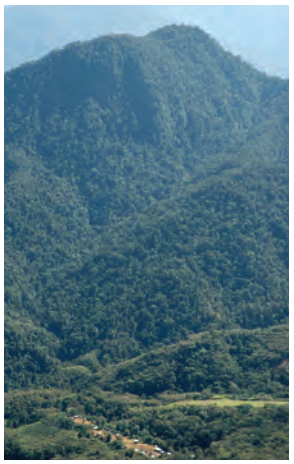
Conduct some further research on the Kokoda campaign and then complete the following tasks.

1 Which of the world's major biomes are shown on this map of the Kokoda Trail area?

2 What is the relationship between forest and terrain in this environment?

3 Explain why you think this relationship occurs.

4 Research the Kokoda campaign that took place between July 1942 and January 1943. Focus on the ways in which the natural environment (landforms, forest and rainfall) influenced the soldiers and the campaign.



Source 1.20 The rugged terrain of the Owen Stanley Range, Papua New Guinea

PAPUA NEW GUINEA: KOKODA TRAIL

Source 1.21

Source: Oxford Atlas

1.2 Why do some biomes produce more food than others?

Where our food comes from

For many people in the world, the question of where their food comes from is easy to answer. Throughout the developing world, particularly in developing areas of Africa and Asia, the majority of food comes from what people grow or gather. People in these places spend much of their time planting, growing and harvesting crops or looking after a few animals, like sheep, goats or cows. These activities provide them with virtually all of their food requirements, from milk and meat to grains such as rice, wheat or corn. The crops they grow and the animals they raise are influenced by a wide range of factors but mainly by the climate in which they live.

In developed countries like Australia, the question of where food comes from is much more difficult to answer.

In fact, very few people across the developed world would be able to tell you where their food comes from.

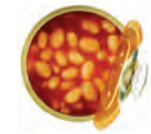
WORLD: ORIGIN OF SOME COMMON SUPERMARKET FOODSTUFFS

1 Cornflakes, Wales

2 Apple sauce, Belgium

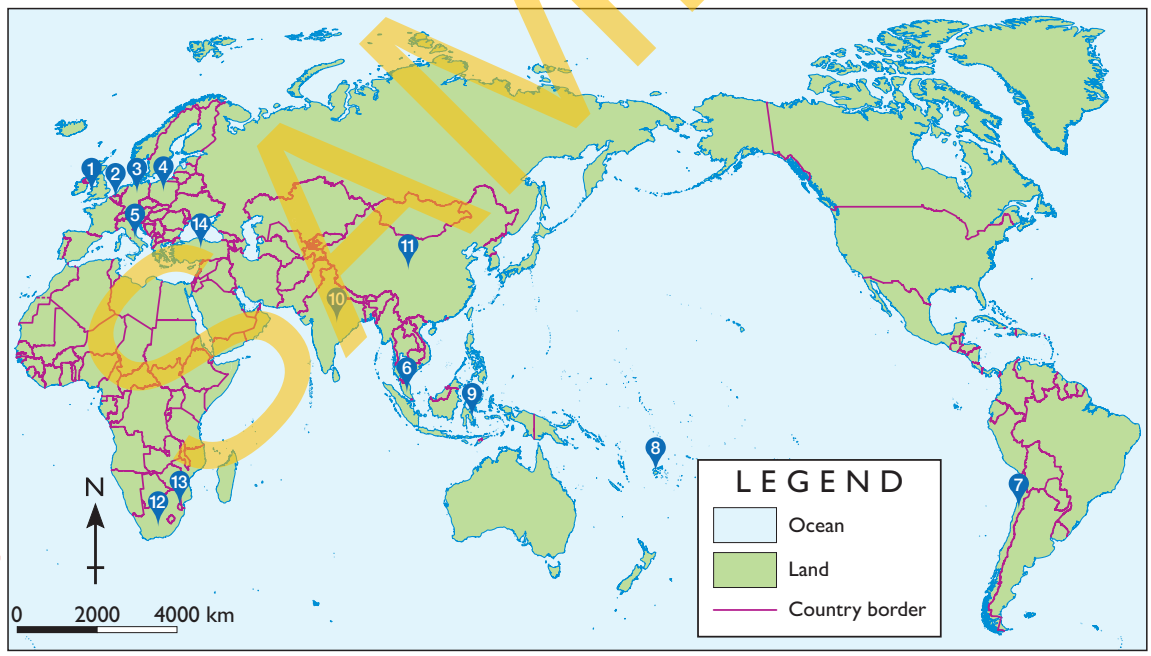
3 Chocolate hazelnut spread, Germany

4 Strawberry spread, Poland



5 Baked beans, Italy

14 Dried sultanas, Turkey



6 Instant noodles, Malaysia

13 Fruit salad, Swaziland

7 Peach halves, Chile

Source 1.22

Source: Oxford University Press

12 Crumbed fish fillets, South Africa

11 Frozen cut beans, China

10 Pickled onions, India

9 Pineapple slices in natural juice, Indonesia

8 Choc mint slice biscuits, Fiji

This is because most people in these countries spend little or no time growing food. They rely on people in other places to grow food for them. Many Australians, for example, buy their food at a supermarket. But where does a supermarket get this food from? Labels on food give some indication, but these can be misleading at times.

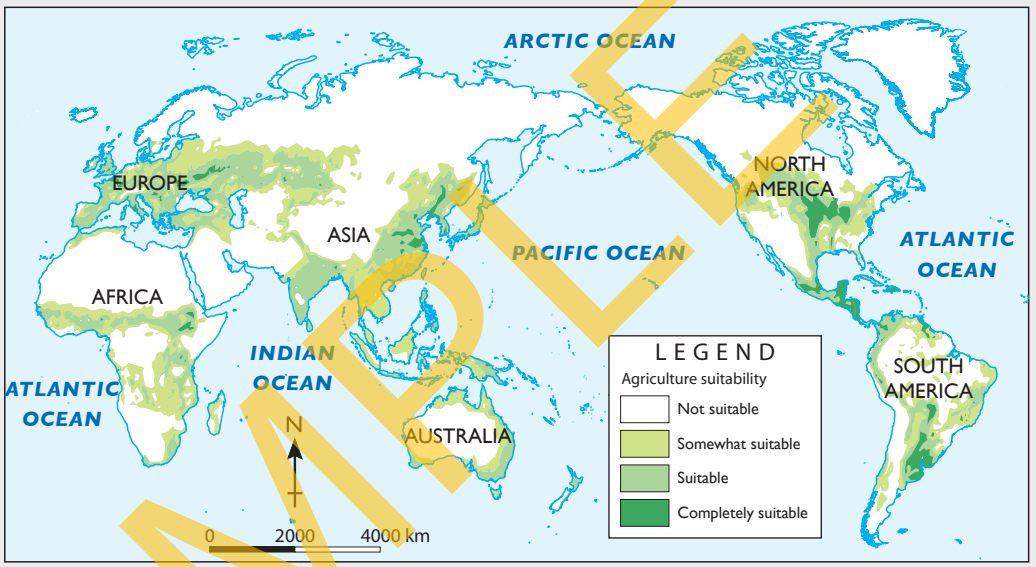
In a recent study, the origin of the home brand products sold in large supermarkets was studied in detail. The researchers found that about 50 percent of Coles' products and 38 per cent of Woolworths' products were made or grown in Australia with the rest coming from overseas. Source 1.22 shows the origin of some common foods sold in Australian supermarkets.

key**concept:** space

Agricultural suitability

Limitations of climate such as extremes in temperatures or low rainfall mean that many regions cannot support farming. Other areas may have low soil fertility, be covered in rainforest, be too mountainous or covered in ice caps. This means that the world's farms are concentrated in certain areas where the soil, climate and availability of water make farming possible. Source 1.23 ranks regions of the world in terms of their suitability for agriculture (i.e. completely suitable for agriculture to not suitable at all). Geographers use the key concept of space to better understand the patterns formed by agricultural use to make recommendations for the future.

WORLD: AGRICULTURAL SUITABILITY



Source 1.23

Source: Oxford University Press

For more information on the key concept of space, refer to section GT.1 of 'The geographer's toolkit'.

Check your learning 1.7

Remember and understand

1 Why is it difficult for people in developed countries to know where their food comes from?

2 Using the scale provided, work out which supermarket item shown in Source 1.22 has travelled the furthest distance to be sold in your town or city?

Apply and analyse

3 Examine Source 1.23 cafefully.

a Explain why each of the white areas in the following regions and countries may be unsuitable for agriculture: Australia, South America, North Africa, Greenland, Central Asia.

b Compare the map showing areas of the world suitable for agriculture to the world biomes map (Source 1.2). Make some general statements about which biomes are most suitable for agriculture. Explain why you think this is the case.

Evaluate and create

4 What factors would be considered when making a map like Source 1.23 that show areas that are most or least suitable for farming?

5 Conduct research online to work out why Australian supermarkets source a large proportion of their products from overseas.

Making decisions on a farm

Every year, famers in different countries around the world make decisions about what crops they will grow and what animals they will raise on their properties. Before they make any decisions, they must consider a number of competing factors. They need to consider their own level of experience as a farmer, the types of machinery and help they have available, the cost of grain, the amount of rain forecast, the quality of the soil, the estimated price they will be paid for the crops they produce and how they will transport them to market. Broadly speaking, all of these competing factors can be divided into two main categories:

- environmental factors
- technological and economic factors.

Examples from each of these categories are provided in Sources 1.24 and 1.25.

Source 1.24 A range of environmental factors that need to be taken into account when making decisions on a farm

Source 1.25 A range of technological factors that need to be taken into account when making decisions on a farm

Check your learning 1.8

Remember and understand

1 How does the climate in a particular place influence farming practices there?

2 Name three soil properties that might influence successful crop growth.

Apply and analyse

3 Most farmers continue to practise the same type of farming year after year. Why do you think this is the case?

4 Select one of the environmental factors discussed in and explain how an individual farmer may improve or adapt to this factor on his or her Source 1.24 farm.

Evaluate and create

5 Consider all of the environmental, technical and economic factors discussed in Sources 1.24 and 1.25. Rank the factors a farmer needs to take into consideration from most to least important. Give a reason for each of your three top-ranked factors.

The importance of climate

More than any other factor, climate (especially rainfall and temperature) determines the type of farming that is practised in a given location. Some crops, such as rice and sugar cane, require warm temperatures and a reliable supply of water. Other types of farming, such as sheep and camel farming, can tolerate a wider range of temperatures and water supply (see Source 1.26). Farmers who share a similar climate, therefore, tend to practise the same type of farming. This leads to large regions of the Earth's surface being farmed in the same way.

In some places, farmers are able to use technology to overcome some of the limitations of climate. Many Australian farmers, for example, use water from rivers and dams to **irrigate** their crops rather than relying on natural rainfall. Others pump water from natural underground water storages called **aquifers**. Others use greenhouses so they can control the temperature and humidity, allowing crops such as flowers and vegetables to grow throughout the year.

Source 1.26 A nomadic farmer herds his camels in Ethiopia.

skill**drill**

Comparing patterns on maps

One of the most common ways that geographers analyse and explain the world around them is by looking for patterns in geographical data. For example, comparing patterns on maps they can examine the relationship between climate and farming.

To compare patterns on two maps, follow these steps:

Step 1 Look carefully at the first map, particularly the title and legend, so that you understand exactly what it shows.

Step 2 Repeat this for the second map.

Step 3 Look at each map carefully and note regions where there seems to be a correlation (relationship). For example, in Sources 1.27 and 1.28 one correlation would be: 'little or limited agricultural use' on the agricultural regions map (Source 1.27) relates to hot desert on the climate zones map (Source 1.27).

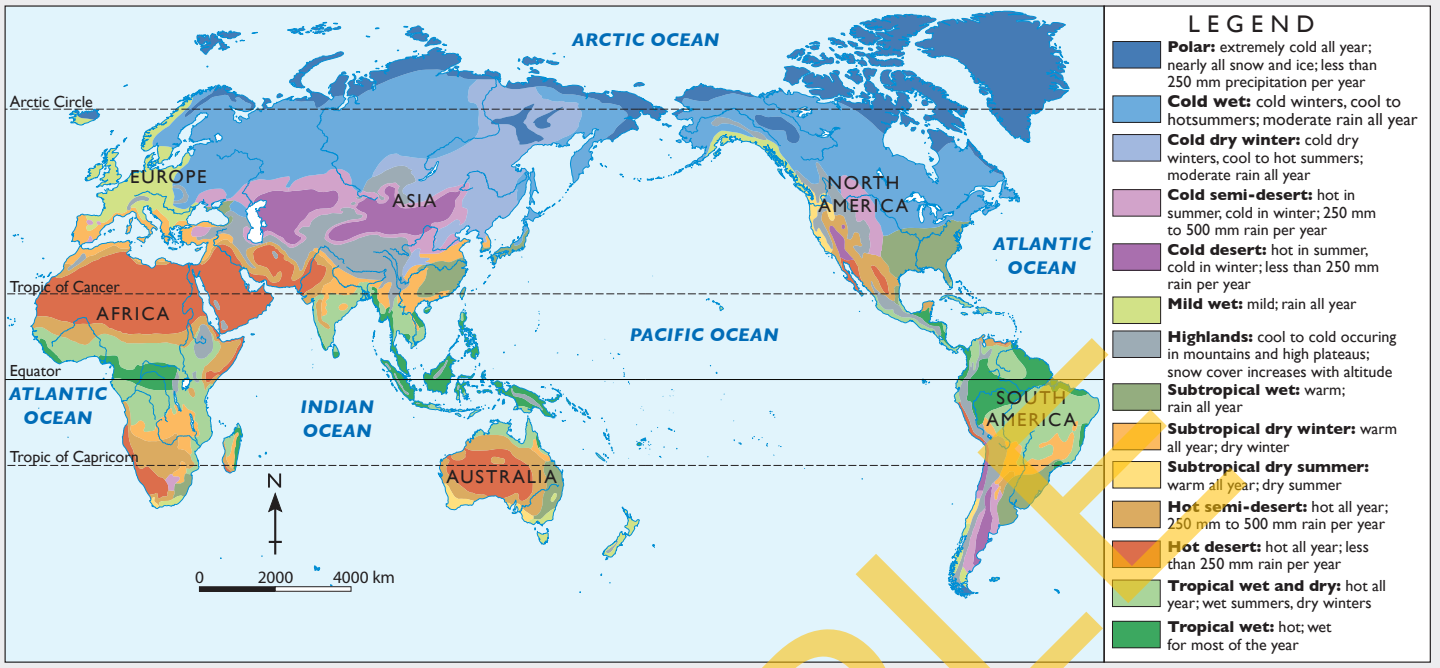
Step 4 Use an atlas map to find out the names of the places where this association occurs.

Step 5 Make a statement that sums up your associations. For example, rice farming is dominant in places with a subtropical climate such as north-east India and southern China where it is warm all year and has a dry winter.

Apply the skill

1 Use Sources 1.27 and 1.28 to account for the distribution of:
   - **a** dairy farming
   - **b** commercial – extensive livestock farming
   - **c** the pattern of agriculture in South America.

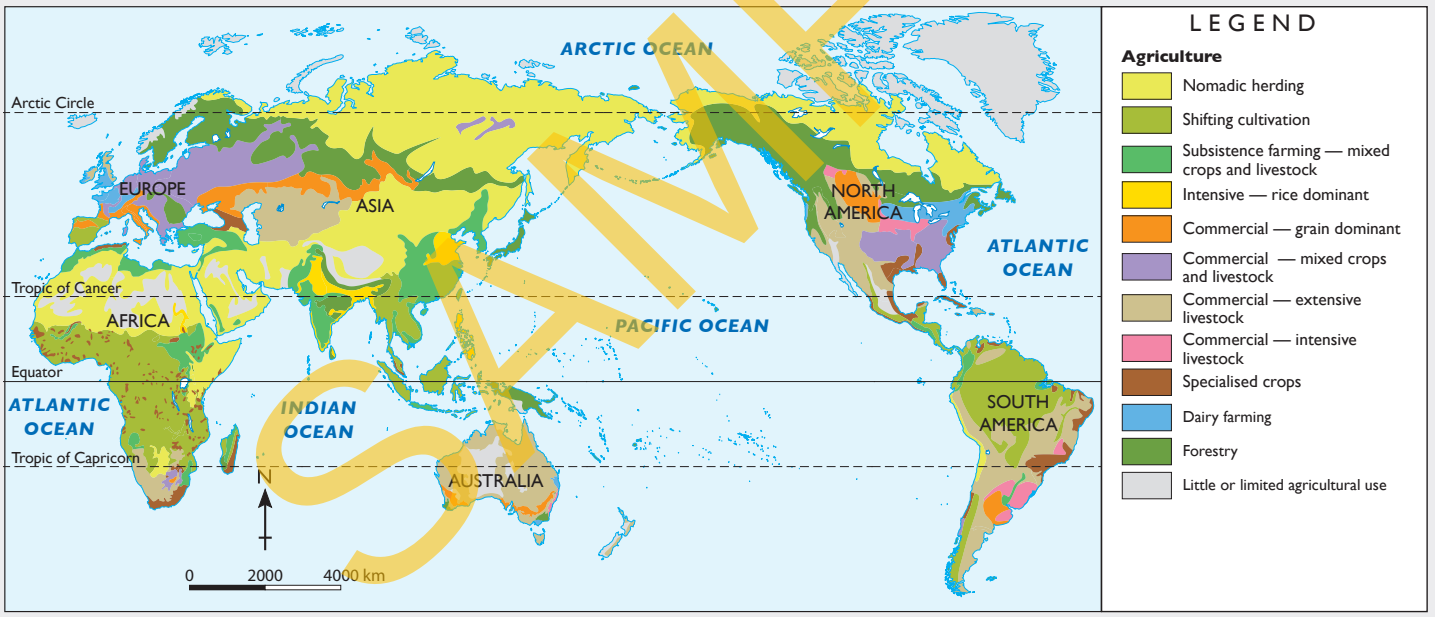
WORLD: CLIMATE ZONES



Source 1.27

Source: Oxford University Press

WORLD: AGRICULTURAL REGIONS



Source 1.28

Source: Oxford University Press

Check your learning 1.9

Remember and understand

1 How does the climate of particular places influence the type of farming practised there?

2 How do some farmers overcome the limitations of climate?

Apply and analyse

3 How might a farmer overcome the limitations of frost?

4 Describe the distribution of nomadic herding in the world. Account for this distribution using Source 1.27.

Soil – more than just dirt

Many parts of the Earth's surface are covered in a thin, fragile layer of soil. Plants grow in this soil that feed every animal on Earth, including you. But what is soil and how are plants able to use it to grow?

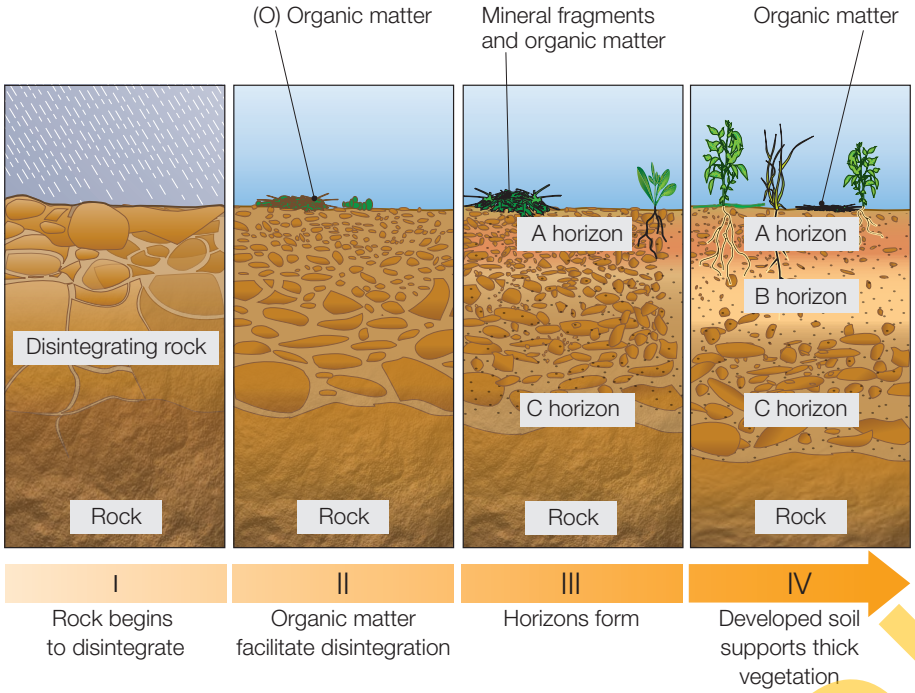
Soil is a mixture of air, water, broken-down rock, and organic material such as tiny animals and plants. Soil is a non-renewable resource – it takes thousands, even millions of years to form. The first step is the gradual breaking down or weathering of rock. Rock weathers because it is subjected to physical forces and processes such as freezing and thawing, the expansion of roots, or because the rocks rub against each other in a stream or river. Movement of ice in a glacier, the flow of water in a river or ocean, or the force of wind can all cause rocks to weather.

Rocks are also weathered by chemical changes that occur. Water can dissolve minerals found in rocks, reacting and forming new minerals which may then break down the rock itself. Oxygen also combines with some minerals to wear away rocks and the slightly acidic nature of rain can also help to dissolve rocks (see Source 1.29).

As rocks break down into finer and finer particles the minerals within them become available to plants. Seeds carried onto weathered rock by wind, water, animals and birds are able to germinate and send roots down into the new soil. As plants die and leaves fall onto the soil they decompose and add to the fertility of the soil. This allows other plants to flourish in the soil.

Over time, soils form layers known as **horizons**. These can be seen where a road has been cut through a hillside. By examining the horizons, soil scientists and farmers are able to determine how best to farm different areas. The horizons are labelled using letters so they can be easily identified and compared. From top to bottom, the horizons are O (organic matter), A, B, C and Rock (see Source 1.30). Some soils may have all the horizons, while others may have only one or two horizons. By identifying which of the horizons are missing in the soil, the farmer will know how and when to treat it. For example, if the soil is lacking organic matter, **mulch** can be added to increase mineral content and prevent water loss through evaporation.

Source 1.29 Like all rocks, Uluru is under attack from physical and chemical weathering. The desert soil in the foreground would be partly made up from weathered rock particles. Only shrubs and grasses are able to grow in this soil.



Source 1.30 The development of soil horizons over time

Source 1.31 Fertiliser containing nutrients such as nitrogen and phosphorus is usually spread using a tractor or truck.

Australia's soils

Australian farmers have to overcome the many challenges of a variable climate, with its extremes of droughts and floods. Perhaps the greatest challenge faced by Australian famers is the condition of the soil. As one of the world's oldest continents we also have some of the oldest soils on Earth. The constant weathering over millions of years has washed away many of the important nutrients and minerals and our soils are amongst the world's poorest.

As well as being much less fertile than other soils around the world, many of our soils are also much saltier than in other places. This is because much of the continent was once covered by ocean, and though the water has receded, the salt remains. Much of our soil is also composed of clay either at the surface or just below the surface. This restricts water drainage into the soil and makes it difficult for the roots of plants to penetrate.

Australian soils therefore are generally low in nutrients, thin and easily eroded. Australian farmers have developed many ways of dealing with these limitations. The most obvious of these is adding nutrients and chemicals to the soil that are missing (see Source 1.31). Farmers regularly test their soil and will add fertiliser containing those chemicals that their plants need. As crops grow they draw these nutrients from the soil and so farmers must continue to replace them, often applying fertiliser annually.

Check your learning 1.10

Remember and understand

1 Why are Australia's soils generally low in nutrients?
2 Why is soil an important natural resource?
3 Why do many farmers need to replenish the nutrients in the soil with fertiliser annually?

Apply and analyse

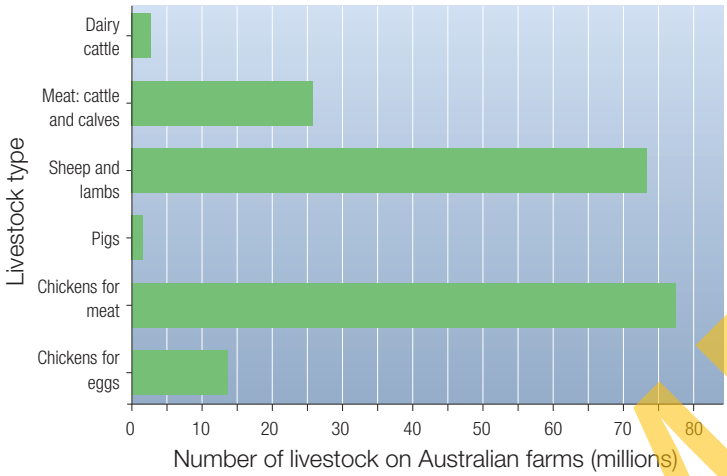
4 Look at Source 1.29. What physical forces do you think are weathering Uluru?
5 Is soil a renewable or non-renewable resource? Give some reasons for your answer.

Evaluate and create

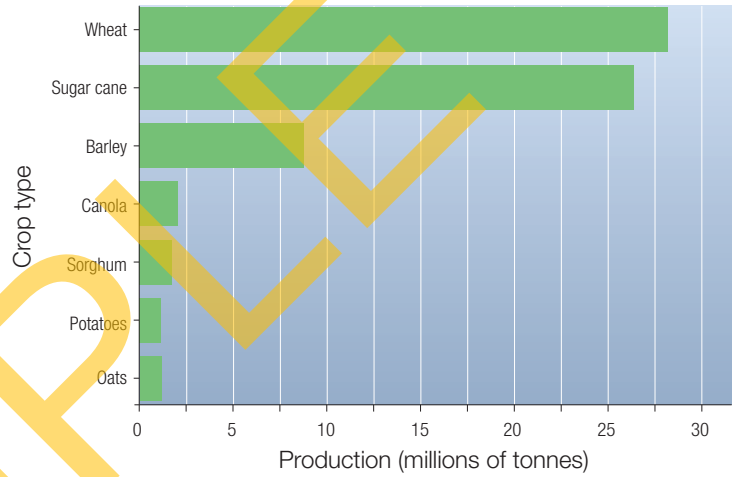
6 Construct a flow diagram with boxes and arrows describing how soil is formed.
7 Explore the soil profile in your local area. Look for a place where a stream has cut down into the soil or a cutting has been made for a road or railway. Sketch the soil profile and see how many of the horizons you can identify. Compare your profile to stage IV in Source 1.30. What are the similarities and differences?

Food production in Australia

There are more than 135 000 farms in Australia. They can be classified in many different ways, for example those that grow crops and those that raise livestock. Another way a farm can be classified is by how large it is in relation to the amount of food or fibre it produces. Farms that require large areas of land – to provide pasture for sheep or cattle, for example – fall under the classification of **extensive farming**. On the other hand, farms such as poultry farms or those that grow vegetables, can produce large volumes of food or fibre in a small area, and are classified as **intensive farming**.

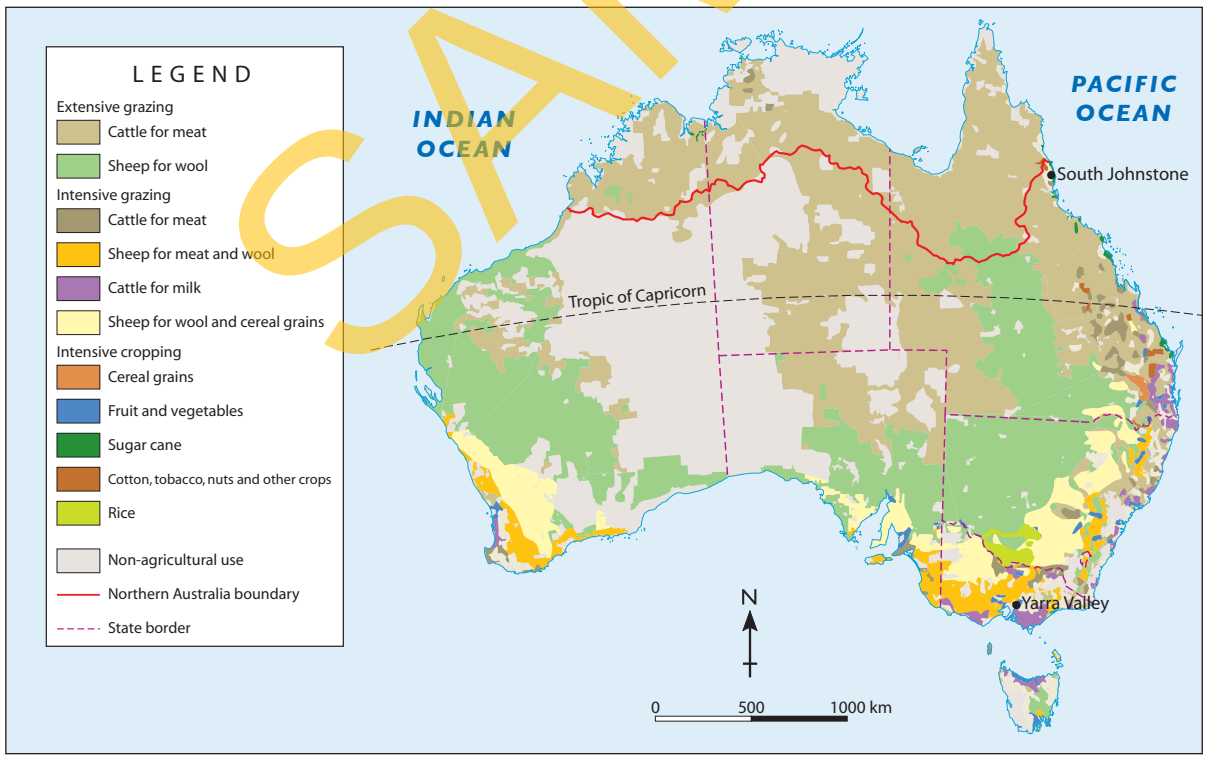


Source 1.32 This graph shows the number of livestock on Australian farms by type.



Source 1.33 This graph shows the crops grown on Australian farms by type each year.

AUSTRALIA: LAND USAGE



Source 1.34

Source: Oxford University Press

Should we grow more food in northern Australia?

Farming in northern Australia, like farming everywhere, is determined by environmental factors, particularly temperature, soil fertility and water. The soils in the north are among the world's oldest and have been subject to monsoonal downpours for millions of years. This has **leached** many important minerals out of the soil making them relatively infertile. Much of the soils of the north is arid or semi-arid and the rain that does fall tends to be seasonal rather than all-year round. These factors make intensive farming difficult. Cattle farming, therefore, dominates in northern Australia, covering 90 per cent of the land area and accounting for 30 per cent of the nation's total cattle.

Several government task forces have identified the water that lies in rock layers (known as aquifers) beneath northern Australia as the key to expanding intensive agriculture. They have suggested that small-scale intensive farming using groundwater has the potential to triple the amount of cropland in the north from the current 20 000 hectares. An example of this type of farming (known as mosaic agriculture) is shown in Source 1.37.

Source 1.35 Cropping of sugar cane is carried out near South Johnstone in north Queensland.

Source 1.36 Victoria's Yarra Valley is a significant sheep grazing area.

Source 1.37 These circular fields in northern Australia are an example of pivot-circle irrigation using groundwater from aquifers.

Check your learning 1.11

Remember and understand

1 Describe the main differences between intensive and extensive farming.
2 What are some of the limiting factors for further intensive farming in northern Australia?

Apply and analyse

3 Examine Sources 1.36 and 1.37. Classify each of these farming types as either intensive or extensive farming.
4 Select one of the farming types shown in Source 1.34.
   a Describe its distribution in Australia.
   b Brainstorm the environmental factors that help to explain this distribution.
5 Using Source 1.34, explain why do you think fruit and vegetables are often grown near large cities?

Evaluate and create

6 Describe the current distribution of farming types in northern Australia.
7 Using the information provided, together with additional research, classify each of the livestock types in Source 1.32 and crop types in Source 1.33 according to whether they are examples of extensive or intensive farming.

High-tech farming

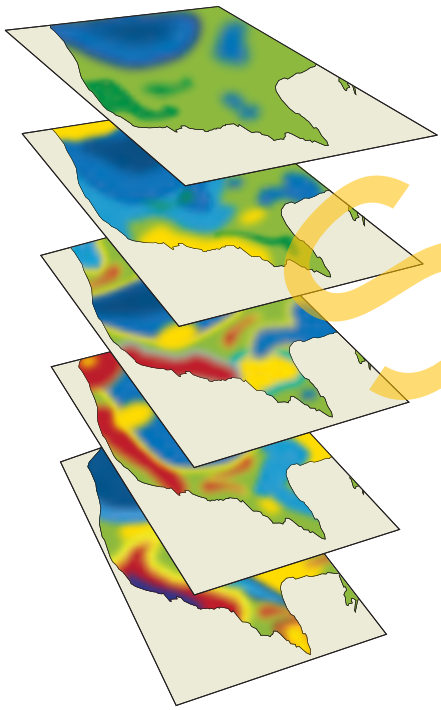
Modern technologies have changed farming methods and made many farms in Australia and around the world more efficient and more productive. The use of technologies such as computers, satellites, remote sensors, geographic information systems (GIS) and global positioning systems (GPS) has allowed some farms to go 'high-tech'. Some Australian farmers are using pilotless planes (known as drones) to keep watch on their soils, plants and water, while others are tracking their sheep and cattle with sensors implanted in the animals' ears or in electronic collars. Technology continues to advance farming operations, increasing the fruitfulness and longevity of crops and improving the breeding conditions of cattle.

Precision farming

On every farm there are wide variations in natural features such as slope, soil fertility, soil moisture and drainage. There may also be different soil conditions in different spots on the farm – past farming practices may have taken minerals from some parts of the farm but not others. Each farm and each field is therefore a patchwork of different soil and water features. Often, however, all parts of the field or farm are treated in the same way, despite being a 'patchwork' of different conditions and levels. This means that some parts of each farm are less productive than other parts.

A new farming system known as **precision farming** is beginning to change this old method to bring about better economic and environmental outcomes. Sensors mounted on satellites, planes and helicopters collect large amounts of data on many aspects of the environment including rates of plant growth, minerals in the soil and soil moisture. Using GPS, this data is then converted to detailed maps of each farm showing, for example, areas of high crop yield and areas with a lower yield (see Sources 1.38 and 1.39).

This information is then available to the farmer to make decisions about better and more precise irrigation and fertilisers and the choice of crops and the times to plant and harvest them. Using precision farming tools such as layered maps and GPS, farmers can determine precisely the best places to plant. They can identify where the soil is richer in minerals, so they can grow better crops. Rows of soil used in previous years where minerals have been depleted can be avoided.



Source 1.38 Layered maps using GPS data can clearly show farmers different elements they need to consider.

Source 1.39 Using precision farming tools such as layered maps and GPS, farmers can determine precisely the best places to plant their rows of crops.

Source 1.40 Milking time at Gala dairy farm in Coleraine, Tasmania and not a farmer in sight!

Case study: Robots on the farm

Gala dairy farm near Coleraine in Tasmania may look like most other dairy farms in Australia – cows contentedly munch on green grass for most of the day and then head to the shed to be milked. But this farm is like no other dairy farm in the world because these cows milk themselves, with help from a robot or two. Once the cow arrives in the dairy, overhead cameras and a Wi-Fi linked sensor guide robotic arms to clean the cow's teats and attach suction cups. An electronic collar identifies each cow and allows their milk production to be monitored and recorded.

The cows stand on a rotating circlular platform while being milked and are rewarded for coming to the dairy with a small feed of grain and access to a paddock of fresh grass. Because cows can choose when and how often they wish to be milked, milk production on the farm is up 20 per cent from the traditional method of milking cows twice a day.

Check your learning 1.12

Remember and understand

1 What is precision farming?
2 Why are the cows in Source 1.40 wearing collars?

Apply and analyse

3 Is Gala farm an example of precision farming? Give some reasons for your answer.
4 Why is GPS an essential part of precision farming?
5 What are some of the advantages of robotic milking for the farmer and what are some of the disadvantages?
6 Explain why precision farming can help to make farming more sustainable.

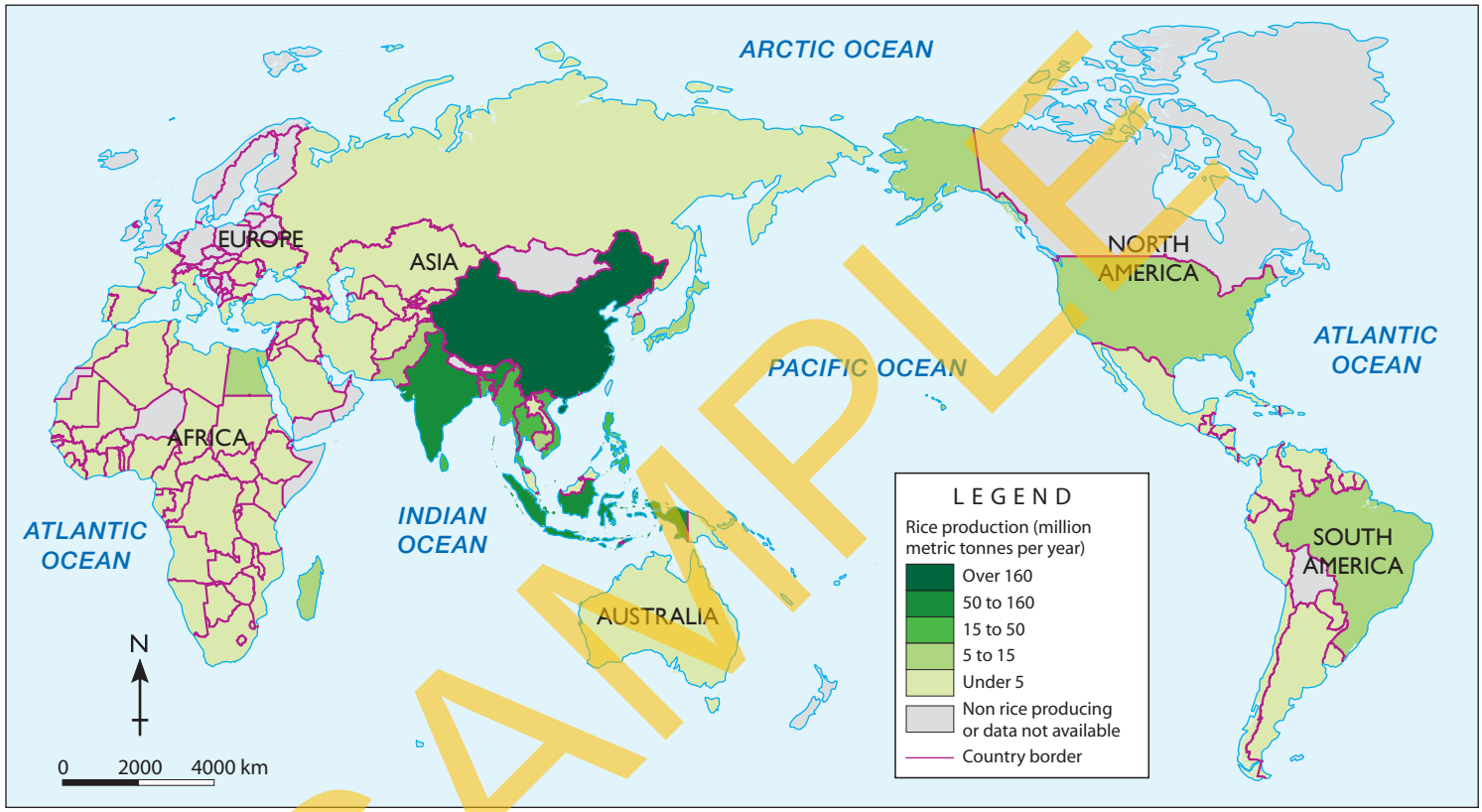
Evaluate and create

7 Using ideas from Source 1.40 and online research, invent a machine that shears sheep. Remember that each sheep is slightly different from every other sheep so your machine needs to take this into account. Draw a labelled sketch of your shearing machine.

Rice – the grain of life

Rice is one of the world's most important crops. It supplies about one-fifth of all **calories** consumed by humans and is the main food eaten in more than 30 countries. About 700 million tonnes of rice is produced around the world every year. Around 90 per cent of this is grown in Asia. China's production of rice alone accounts for almost one-third of the world's total annual rice production.

WORLD: RICE PRODUCTION



Source 1.41

Source: Oxford University Press

skilldrill

Describing patterns on choropleth maps

The map in Source 1.41 is a **choropleth map**. Geographers use choropleth maps to 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'. You can describe the pattern on choropleth maps by following the PQE (Pattern–Quantify–Exceptions) method. For more information on the PQE method refer to section GT.2 of 'The geographer's toolkit'.

Step 1 Read the title and examine the legend carefully so that you understand what the map is showing.

Step 2 Describe the general pattern that is apparent on your map. Use the names of continents and large regions.

Step 3 Quantify your description of the pattern by giving the names of specific countries and the mapped data related to these countries.

Step 4 Point out any exceptions to the general pattern that you have described. For example, this may be a country that produces a lot of rice despite being far away from any other major rice-producing country.

Apply the skill

1 Describe the pattern of global rice production using Source 1.41 the PQE method.

Rice growing methods

Rice growing occurs in many different environments – from the sides of the world's highest mountains to coastal river deltas. Rice is grown in areas that flood every year and in other places where rain is far from reliable. Because of these variations in climate and environments, it is possible to identify four main systems of rice growing.

1 **Irrigated rice:** Irrigated ecosystems account for about three quarters of global rice production. Irrigated rice is grown in fields, called rice paddies, where series of embankments and terraces are built to control the flow of water across the fields. This system is most common in East Asia, particularly Indonesia, Vietnam, the Philippines and Thailand.

2 **Rainfed rice:** Many farmers in low-lying areas in countries such as Bangladesh, Myanmar (Burma) and Thailand rely on natural rainfall rather than irrigation to water their rice crops. Annual monsoonal rains may cover their fields with 50 centimetres of water into which they plant their crops. This is known as the rainfed lowland system of rice growing. These farmers face many challenges to produce a reliable crop, notably poor soil quality and unreliable rain.

3 **Upland rice:** In West Africa, Central and South America, and highland regions of Asia, upland rice growing dominates. Usually grown beside other crops, productivity is generally low as soils are often poor and little or no fertiliser is used. Rainfall may be unreliable and erosion of the hillsides may be a problem in some areas, as the rice fields do not usually have embankments to control the flow of water.

4 **Flood-prone rice:** In some flood-prone zones in Cambodia, Vietnam and Myanmar (Burma) a rice crop may be grown in areas characterised by periods of flood and drought. The rice grown is tolerant to being covered by water but yields tend to be low and unreliable.

Source 1.42 In upland areas many farmers first clear the land, often by slashing and burning.

Source 1.43 Rice paddies near Longsheng, China

Source 1.44 A comparison of the productivity of four different rice systems

System	Yield (tonnes/ hectare)	Crops (per year)	Productivity (tonnes/ hectare/year)
Irrigated rice – rice grown using irrigation systems for water	5.0	2.5	12.5
Rainfed rice – rice growing system that relies of rainfall for water	2.5	1	2.5
Upland rice – rice grown in rainfed lowland fields that is prepared and seeded when dry	1.0	1	0.12
Flood-prone rice – rice grown in areas prone to extreme flooding and drought, typically low-yield	1.0	1	1.0

Check your learning 1.13

Remember and understand

1 What type of rice growing system is being used in Source 1.43?

2 How would the farmers in these fields control the flow of water to their crop?

Apply and analyse

3 Which is the most productive system of of rice growing? Why do you think this is the case?

4 Why do you think upland rice growing is not as productive as the other systems?

Evaluate and create

5 In small groups, discuss the environmental impacts of growing rice. Present a report of your conclusions, using headings such as 'Impacts on water, soil, landforms and natural vegetation'. Which of the four rice growing systems do you believe impacts the natural environment the most?

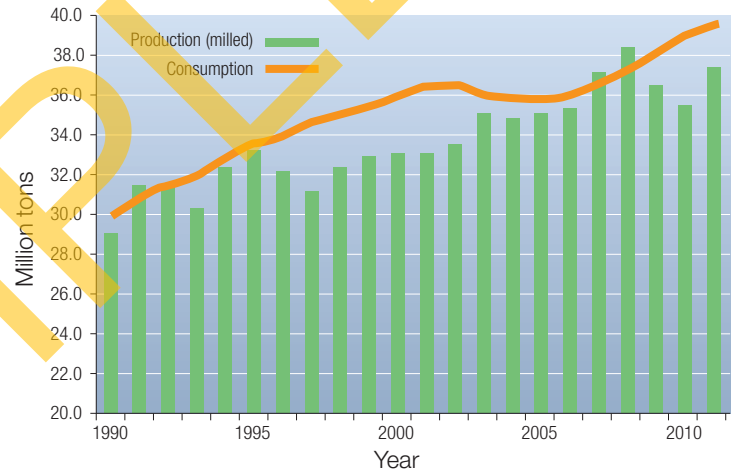
Rice growing in Java

The Indonesian island of Java is one of the world's most populated islands and one of the most densely populated places on Earth. It is home to almost 150 million people. The Javanese people have developed a way of life that uses the island's natural resources to provide them with ample food. Java is a volcanic island with abundant rainfall, and eruptions over millions of years have produced fertile soil for the growing of crops such as rice.

In fact, Java is home to some of the world's most productive rice fields. Over three-quarters of Javanese farmers grow rice, mostly in small family-owned fields of less than one hectare (0.01km^2). Farmers tend to live in villages and towns and walk every morning to their rice fields. Everyday tasks are determined by the season. Most rice farmers in Java are able to grow two crops throughout the year but on more fertile ground some farmers are able to grow three. Fertiliser is usually added to the soil to complement its natural fertility.

In recent years, Java's population has grown faster than increases in rice production and this has meant that the island has had to import rice from other Asian countries. As Java's population continues to grows there is greater pressure on the rice farmers to become more productive. There is also an increased competition for land. Agricultural scientists are working hard to find solutions to Java's stalled increases in crop yields but they face serious issues:

- Farmers tend to be poorly educated and have little money to invest in new technologies.
- Farm sizes are declining because land is divided between family members after the death of a farmer.
- 100 000 hectares (1000km^2) of rice paddies have been lost, they have been used to grow other crops such as palm oil, or to build houses and factories.
- Little government money is spent on improving and repairing irrigation systems.
- There are few qualified experts to advise farmers how to increase crop yields through the introdcution of new varieties of rice and pest control.



Source 1.46 Rice production and consumption in Indonesia between 1990 and 2011

JAVA: RICE GROWING AREAS

Source 1.45

Source: Oxford University Press

Source 1.47 Mount Merapi is one of Java's 45 volcanoes.

skill**drill**

Constructing an annotated field sketch

Geographers use field sketches as a way of capturing impressions immediately and directly. While on a field trip to examine an environment in detail you may be asked to complete a field sketch. It is often a good idea to practise field sketching from a photograph before the field trip. The method for drawing a field sketch is the same as sketching from a photograph. Follow these steps:

Step 1 Draw a border of the correct shape.

Step 2 Using a pencil, lightly sketch the main landscape lines. If there is a horizon in the scene put this about one-third from the top of the frame.

Step 3 Add detail to your sketch. Annotate or label those parts of the scene that you consider most important.

Step 4 Add some shading and colour. Don't try to copy every subtle colour of nature, just give a hint of the right colour.

Step 5 Label your sketch with the location and date.

Apply the skill

1 Follow the steps provided to complete a field sketch of Source 1.47. On your sketch, label key natural and managed features of the environment.

Check your learning 1.14

Remember and understand

1 How is the island of Java able to support so many people?

Apply and analyse

2 Examine Source 1.47.
   - a Describe the pattern in Indonesia's rice production between 1990 and 2011.
   - b Describe the pattern in consumption over the same period.
   - c Explain why Indonesia has become a rice importer in recent years.
   - d What relationships are there between the natural environment and the growing of rice in Java?

3 The farmer in Source 1.47 is using water buffalo rather than a tractor to plough his fields. What would be the advantages of using buffalo? What would be the disadvantages? How might his methods of farming change if he was given a tractor?

Evaluate and create

4 Imagine that the Australian Government has decided to give aid to Indonesia to increase its annual rice yield. Write a letter to the Foreign Minister outlining how you think this money should be spent.

Growing rice on the world's driest inhabited continent

There are about 1600 rice farms in Australia and virtually all of them are in southern New South Wales and northern Victoria. This region is suitable for the growing of rice because of several key environmental factors. The most important of these is the availability of water. Rice farmers in the region irrigate their crops with water from nearby rivers – the Murrumbidgee and the Murray. The soil is also ideal for rice growing as the heavy clay that is present stops water from seeping away. Year-round warm temperatures help the rice to grow and the flat land makes flood irrigation possible.

Although Australian rice growers are the most productive in the world, rice is a controversial crop in this country. Some people feel that growing rice is not a sustainable use of Australia's river water. They argue that the natural environment is suffering because water is being taken from the rivers. Supporters of the rice industry believe that rice is a valuable export crop and that Australian rice farmers are becoming better at using less water to grow more rice.

skill**drill**

Estimating the size of features on a map

Estimating the size of features on a map is an important skill for geographers. You can use the scale of maps to estimate the area covered by certain features. If the feature is a regular shape such as a triangle, circle or rectangle you can apply the skills and formulas you have learnt in mathematics.

If the shape of the feature you are studying is irregular, a grid can be used to estimate its size. For example, on Source 1.50, a grid with squares representing 20 km x 20 km has been drawn. If your map does not have a grid like this already, you can draw your own. You might like to do this onto a piece of tracing paper that you can then place on top of the map.

Step 1 Count the number of grid squares in which the mapped feature you want to estimate fills the entire square. Write this number down.

Step 2 Now count the number of grid squares that contain some, but not all, of the mapped feature. Take this number and divide it by two.

Step 3 Add these numbers (the result from Step 1 and the result from Step 2) together.

Step 4 Multiply this number by the area of each square. In the following map each square is 20 km x 20 km, or an area of 400 km^2.

Source 1.48 These formulas can be used to estimate the size of differently shaped features on a map.

Shape of feature	Formula
Triangle	The base x the height, divided by two
Circle	π (approximately 3.14) x radius squared. The radius is the distance from the centre of its circle to the edge.
Square and rectangle	Width x length

Apply the skill

1 Follow the steps provided to estimate the areas of the three main rice-growing regions shown in the map in Source 1.50.

Source 1.49 Rice fields and the main irrigation canal near Leeton, NSW

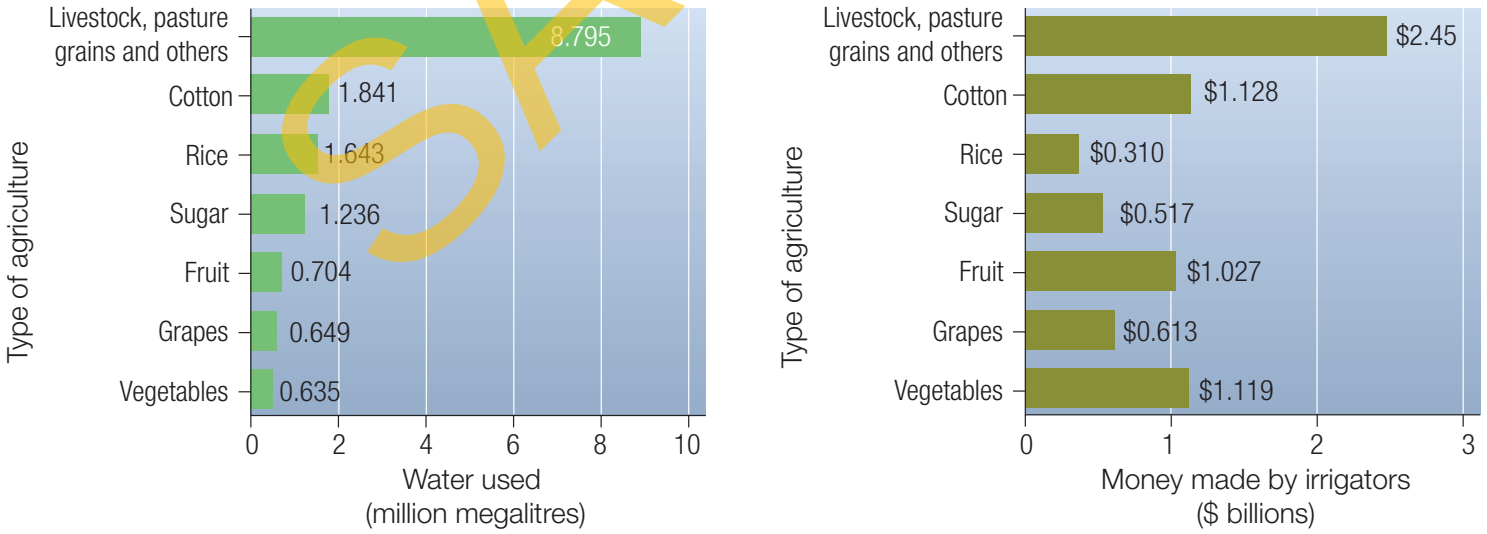
NEW SOUTH WALES: RICE GROWING REGIONS

Source 1.50 Source: Oxford Atlas

Extend your understanding

Conduct some further research on rice growing in Australia and then complete the following tasks.

1. Describe and account for the relationship between rivers and rice-growing regions.
2. Compare the photograph of the rice-growing area in Java (Source 1.47) with the rice-growing region of Australia (Source 1.49). Make a list of all of the differences that you can find. Discuss with a partner why these differences occur. Consider both natural and human factors in your discussion.
3. Examine Source 1.51. What do these two graphs tell you about the relationship between rice crop profitability and water usage? What questions could you ask to assess if Australian rice growers are using water sustainably? Write a few paragraphs exploring the link between rice growing and water usage in Australia.



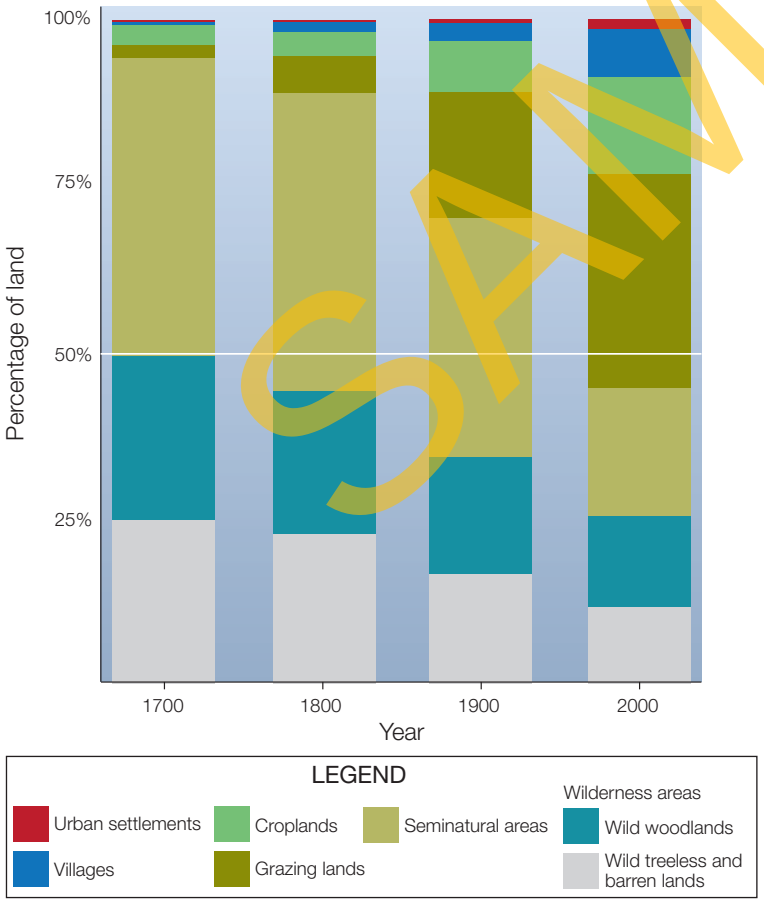
Source 1.51 Graphs showing the amount of water used for agriculture in Australia (left); and the money made from these types of agriculture (right).

1.3 What are the environmental impacts of food production?

Changes to the natural environment

The last 300 years have seen more extensive change to the Earth's biomes than in any other period in the Earth's history. Over half of the world's land area that is considered habitable has now been converted into farmland or housing to provide food, fibre, shelter and fuel to the world's people – and this area is expanding.

All around the world the natural biomes of forests, grasslands, tundra and even deserts are being converted into farms. In some places, large corporations are converting the land but in most places it is the work of small-scale farmers, each motivated by the need to provide food for their own families. Source 1.52 shows the extent of biome change around the world since 1700.



Source 1.52 Changing land use patterns worldwide between 1700 and 2000

Source 1.53 Some of the changes made to a landscape in China that is being used for farming.

Check your learning 1.15

Remember and understand

1 How much of the world's habitable land area has been converted into farms?

2 Name three potentially negative impacts that farming can have on the environment.

3 List two changes made on the Chinese farm in Source 1.53 that involve altering irrigation practices.

Apply and analyse

4 Examine Source 1.52.

- **a** Describe the change to the amount of wilderness areas from 1700 to 2000.
- **b** Use the world biomes map (Source 1.2) to classify the wilderness areas remaining today.
- **c** Which types of land use has increased the most. Why do you think this is the case?
- **d** The labels for Source 1.53 are in four different colours. Suggest a title for each set of colours.

Evaluate and create

Do some further research on the Internet to complete these tasks.

5 Examine the image of a Chinese farming landscape as shown in Source 1.53. Describe the landscape as you think it would have been before people arrived in this valley.

6 The labels on this image focus on the ways in which people have changed the landscape. What are the underlying causes of these changes?

7 Compare the changes made on the farm in Source 1.53 with the technology used in Source 1.40. What differences in productivity do you think the two farms might experience?

Changing vegetation

Farmers make many changes to the natural environment in order to grow crops and raise farm animals. The greatest changes are made to the natural vegetation. Forests are cut down, burnt and replaced with a single plant species, wetlands and swamps are drained and vast areas of native grasses are replaced with crops such as wheat and rice.

Changes to forests

Around the world about five million hectares of forest is converted for agricultural use every year: an area about two-thirds the size of Tasmania. Most of this change takes place in tropical forests, particularly in South America and Africa. Few forests in regions such as North America and Australia have been converted to farmland in recent years, largely because most of the forest has already disappeared. In Australia, for example, around 50 million hectares of forests and woodland have been cleared for farming or affected by logging since European settlement began.

In the developing world, there is a strong link between **deforestation** and poverty. Millions of people who live below the poverty line and struggle to meet their daily food requirements are becoming small-scale slash-and-burn farmers. They use a machete to slash the undergrowth in forests and then set it alight to clear the land. Seeds are thrown into the warm ashes and in this way a forest has been converted into a farm. The types of farm animals that small scale farmers raise, such as goats and dogs, push deeper into nearby forest areas to forage for food. Over time as soil fertility declines, the farmers and their animals move into a new patch of forest and begin the process again. In Madagascar, for example, where 80 per cent of the population lives in poverty, only 10 per cent of the natural forest remains.

Source 1.54 A woman in Madagascar plants a food crop on a burnt hillside.

MADAGASCAR: DEFORESTATION AND POVERTY LEVELS

Source 1.55 Source: Oxford University Press

Greening the desert

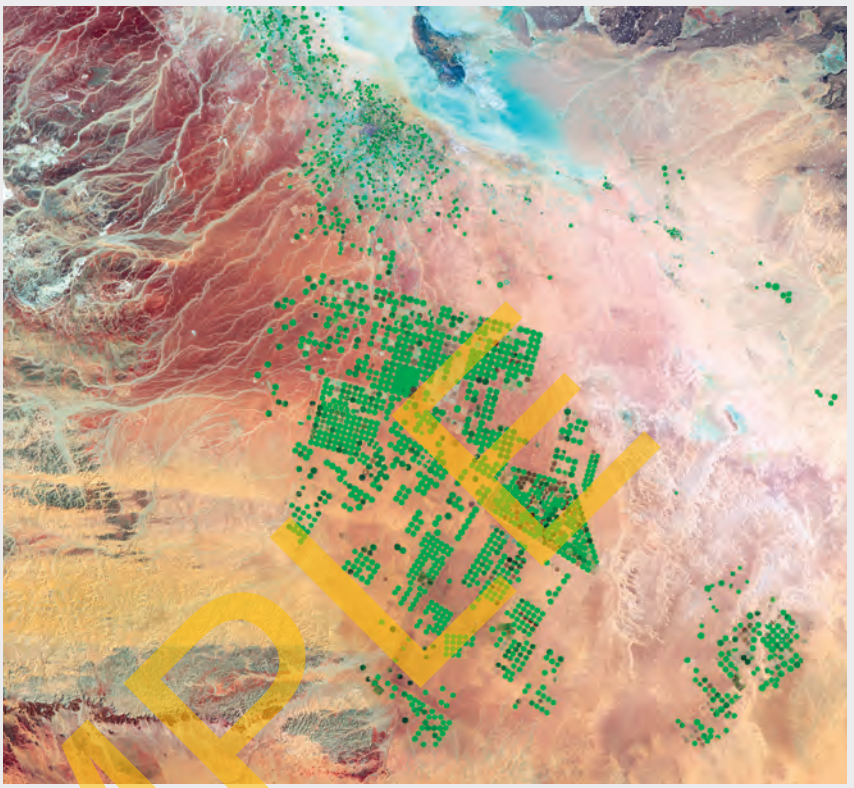
The types of changes being made to tropical rainforests and grasslands in South America and Africa for agricultural use are also being made to biomes in other parts of the world. In Saudi Arabia for example, sections of the desert have been transformed into farmland for the purpose of growing crops.

Only a few centimetres of rain fall naturally in the Saudi Arabian desert each year, but crops can still be grown there thanks to large **aquifers** deep beneath the Earth's surface. These aquifers contain water that was trapped between layers of rock during the last Ice Age. They also store water that has fallen as rain over hundreds of thousands of years.

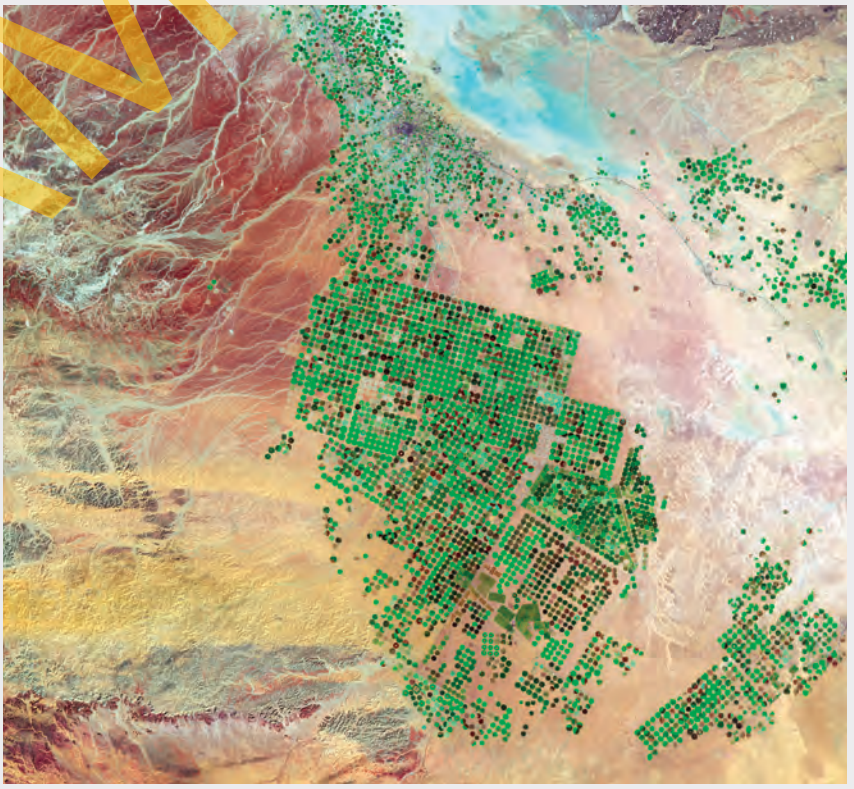
In Saudi Arabia, water is extracted from the aquifers by drilling deep into the ground under the desert floor and pumping it to the surface. Once on the surface, the water is pumped through circular sprinkler system. This is known as centre-pivot irrigation. Sources 1.58 and 1.59 show the dramatic increase in centre-pivot irrigation in Saudi Arabia from 2000 to 2012. These satellite images show healthy vegetation in bright green, dry vegetation in orange and barren soil in pink. Each circular field shown in green is approximately one kilometre wide.

Because of the increasing rate at which water is being used, geographers and environmental scientists now believe that this type of farming has become unsustainable – both environmentally and economically. In time, supplies of water in the aquifer will become totally depleted as they are being used far more quickly than they can be replenished. The high cost associated with accessing water from the aquifers also means that crops grown in this way will soon become too expensive to buy.

For more information on the key concept of sustainability refer to section GT.1 in 'The geographer's toolkit'.



Source 1.58 Satellite image of the Saudi Arabian desert in 2000



Source 1.59 Satellite image of the Saudi Arabian desert in 2012

Changes to grasslands

Because the world's most important food crops – rice, wheat and corn – are grasses, they grow best in the world's grasslands biome. However, clearing of native grasses to plant these crops can have, devastating effects on the natural environment. Across much of Australia, North and South America, Asia and Africa, native grasses have been cleared and replaced by these three crops to provide food.

This farming then has a further impact on the biome. Because the rice, wheat and corn crops are harvested for human consumption, none of the nutrients from the plant material is returned to the soil. As a result, the soil fertility falls. This means farmers need to add chemical fertilisers to the soil, which further changes its composition. This can impact on the ability of the soil to hold water and can pollute waterways and coasts. Pesticides used to control weeds and insects also pollute the air, soil and water and may kill native plants and animals. Exposed soil becomes vulnerable to erosion by wind and rain and is washed away. Clearing of native grasses to make way for farming has many flow-on effects.

Source 1.56 Fields of wheat have replaced native grasslands across much of central USA.

Source 1.57 Conversion of the world's natural grasslands

Case study regions	Existing grasslands (% of natural cover)	Estimated conversion of natural grasslands (%)		
		Crops	Cities	Other
North American prairie	9.4	71.2	18.7	0.7
South American savanna	21	71	5	3
Asian steppe	71.7	19.9	1.5	6.9
Sub-Saharan Africa grasslands	73.3	19.1	0.4	7.2
South-west Australian grasslands	56.7	37.2	1.8	4.3

Check your learning 1.16

Remember and understand

1 Describe the link between poverty and deforestation in your own words.

2 Is the scene in Source 1.56 a natural or human environment? Give evidence from the source for your answer.

Apply and analyse

3 Carefully examine Source 1.54.
- a List the changes that you can see to the soil, vegetation and water that have taken place in this environment.
- b Add changes that are likely to have occurred that you cannot see.
- c Why has this farmer made these changes to the landscape? What are her likely motivations? Compare these to the likely motivations of the farmer who has changed the grasslands environment shown in Source 1.56.
- d Examine Source 1.55. Describe the variations in forest cover between regions of low poverty and regions of high poverty.

4 Examine Source 1.57.
- a What is the most common land use that replaces grasslands around the world?
- b Which region has converted the most grassland? Suggest a reason for this.

Evaluate and create

5 Use an ICT chart tool such as Microsoft Excel to construct pie graphs for the conversion of grasslands in Australia, North America and Sub-Saharan Africa. Describe the differences between these three regions as shown in your completed pie graphs.

Changing water

Water is one of our most important resources, and agriculture is by far the greatest consumer of water around the world. About 70 per cent of the available water supply is used for agriculture, mostly for irrigation. Once water has been used to grow crops and given to animals to drink, it is, of course, returned to the environment. However, the farming process can change the quality of the water significantly, making it unsuitable for other uses and for the natural environment.

Water pollution from farming

The water that is used on farms eventually flows through soil and rocks into nearby streams and rivers. Bare soil that is not protected by plants and held together by their roots can be washed away in the process, causing streams to become so cloudy that sunlight cannot reach the stream bed. This often kills many aquatic plants and animals.

Fertilisers such as nitrogen, phosphorus and animal manure can also end up in lakes and rivers, causing algae to grow out of control. This starves the water of oxygen and creates 'dead zones' in the water. Upon entering water sources, pesticides used in farming to control insects and weeds can poison fish and native animals, as well as killing the plants that create their habitats.

Source 1.60 This Filipino farmer is spraying his rice crop with a pesticide to control insect pests. His fields drain into Laguna Bay, which is one of the world's most polluted water bodies and also home to a large freshwater fishing industry.

Changing natural water flows

In many places, rivers are dammed to create a large reservoir of water which can be used for irrigation. In the last 50 years the amount of water held in dams has quadrupled and the volume of water taken from rivers and lakes has doubled. Most of this water is used for farming. The reduced volume of water in the rivers creates major problems for the natural environment and for downstream users. In the lakes near the mouth of Australia's Murray River, for example, the water can be five times saltier than the sea partly because so much water has been extracted for farming that the river cannot flush out the naturally occurring salt.

Check your learning 1.17

Remember and understand

1 How might the farmer shown in Source 1.60 impact on the quality of fresh water?

2 How can fertilisers that are used on a farm eventually reach and kill fish?

Apply and analyse

3 Examine Source 1.58.

- a Each of the agricultural fields in these images is about 800 metres squared in area. Estimate the area covered in 2000 and in 2012.
- b What impact will this change have over time on the volume of underground water in this region?
- c Can you think of the environmental impacts that would result from irrigating using water that has been extracted from under the ground?

Evaluate and create

4 Draw a sketch of a river flowing through a farming region. On your sketch show five different ways in which the farms impact on the quality or quantity of water in the river.

5 Discuss some ways in which the impacts shown on your sketch could be reduced.

Wearing out the soil

Source 1.61 The most highly erosion-prone soil in the world is said to be found at China's Loess Plateau.

In many places around the world, soils are being degraded to such an extent that the amount of food that can be grown is in decline. It is estimated that about two billion hectares of land have been affected in this way, an area that is home to about one-fifth of the world's population. **Soil degradation** occurs because human activities impact on the soil's ability to support plants and animals. These activities include clearing forests to make way for farms and towns, increasing the numbers and density of farm animals, poor irrigation practices and over farming growing so many crops that the natural nutrients of the soil are removed and not replaced.

Soil degradation takes many forms. At its worst, the soil is broken down and washed away (see Source 1.61). It is estimated that 75 billion tonnes of fertile soil is lost this way each year. This is largely as a result of forest clearing that allows fragile soils, particularly on sloping land, to be attacked directly by heavy rain. Without the roots of forest plants that help bind the soil together, soil is washed away. In other places, nutrients in the soil such as nitrogen and potassium have become so depleted that the soil lies barren, unable to support plant life.

In Australia, soil degradation often takes the form of **salinity**. Salinity is a condition where the amount of salt causes problems in the soil, and impacts on the environment. There are two types of soil salinity:

- primary salinity, which is a natural condition that develops in the landscape over time, secondary salinity. Secondary salinity is caused by human impact.

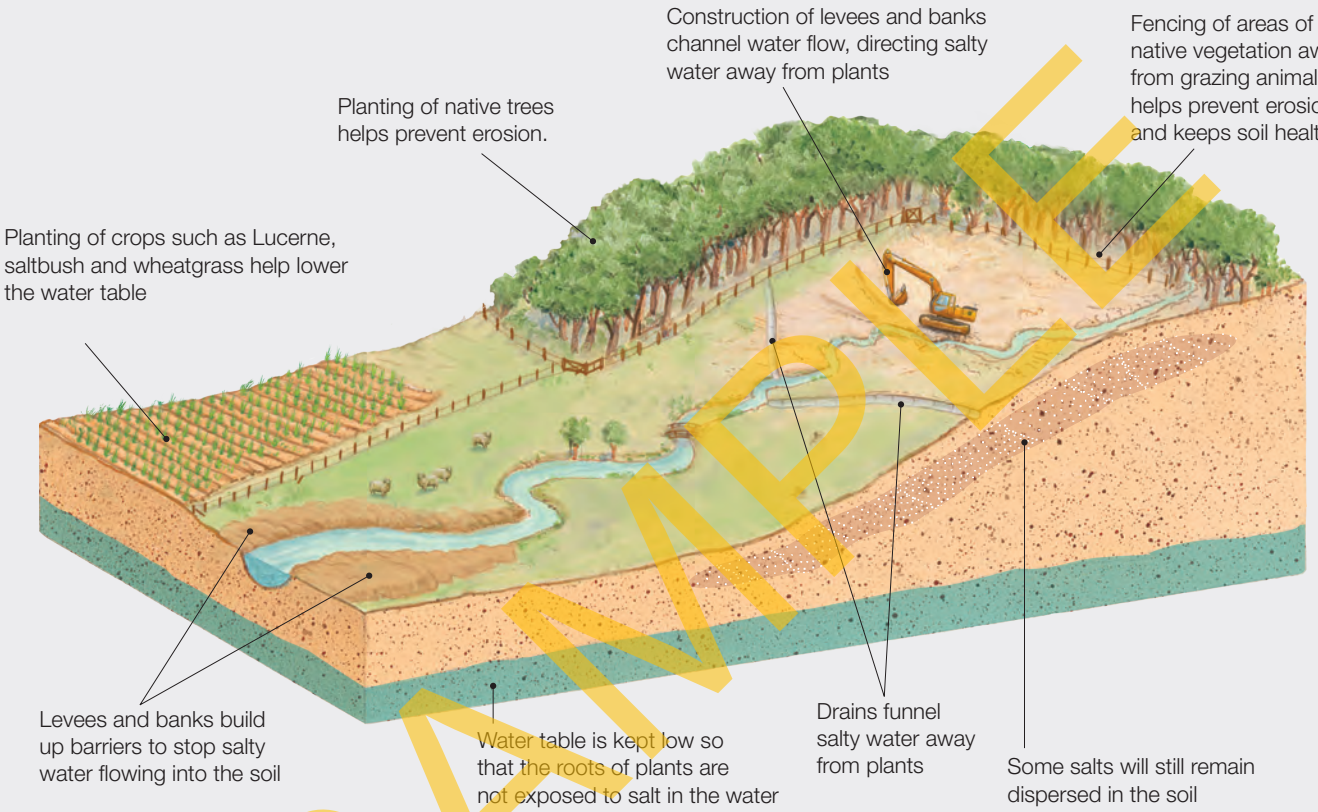
Human impact is related to the irrigation of soil to grow crops. Salts in the irrigation water are left in the soil, and eventually the soil becomes too salty for plant life to survive. Secondary salinity also occurs when trees that have deep roots are removed by humans to make way for crops with short roots. Salt held in the **water table** is then able to move up to the soil's surface, killing virtually all plant life. Approximately 2 million hectares of Australian farming land is degraded in this way (see Source 1.62).

Source 1.62 Soil salinity near Renmark, South Australia

Managing salinity

Many Australian farmers, particularly in Western Australia, have responded to the threat of soil salinity by changing the ways in which they farm the land. Some of these changes have been more successful than others but all are designed to use the soil in a more sustainable way. Source 1.63 shows some of the strategies used by farmers to combat soil salinity. The most successful strategy used so far appears to be lowering the level of the water table which keeps salt in the water away from plants.

For more information on the key concept of sustainability, refer to section GT.1 of 'The geographer's toolkit'.



Source 1.63 A range of responses and strategies can be used to tackle salinity

Check your learning 1.18

Remember and understand

1 What is salinity? Why is it considered to be a cause of soil degredation?

2 How does forest clearing lead to soil degradation?

Apply and analyse

3 How has the farmer in Source 1.64 managed salinity on his farm?

4 Select one of his strategies and comment on its potential effectiveness.

5 Examine Source 1.62 showing soil erosion in Northern China.

a What evidence is there that this is a farming area?

b How has farming changed the soils in this place?

c Compare this image to the image of rice terraces seen in Source 1.47. Both these areas have been farmed in the same way but one has experienced soil erosion while one has not. Brainstorm the possible reasons for these differing outcomes.

Evaluate and create

6 The eroded soil in Source 1.62 was once some of the most fertile soil in the world. Describe and sketch a system that would help to slow or reverse soil erosion in this place.

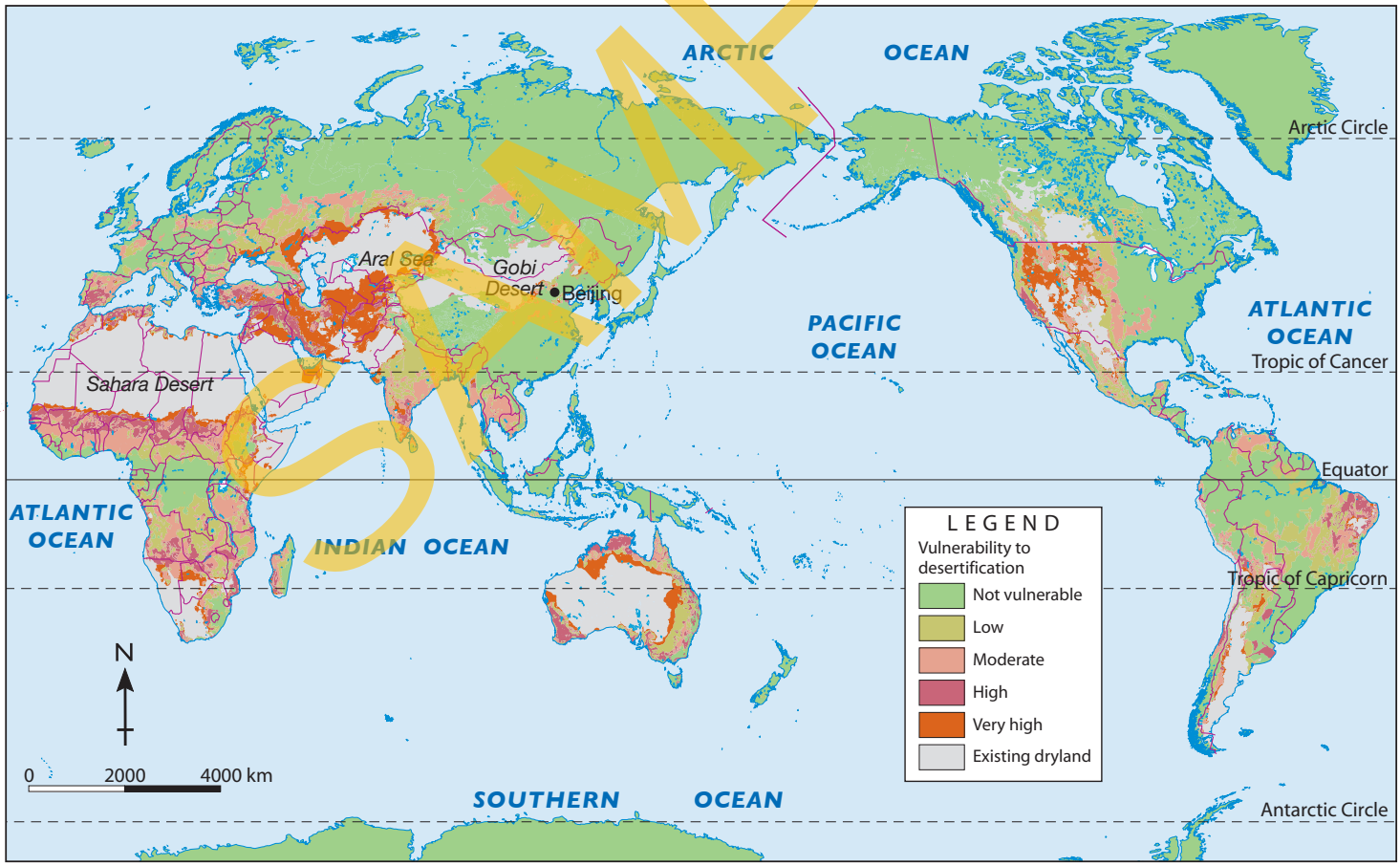
Spreading deserts

The food security of people who live in the world's dryland areas is under threat from a process known as **desertification**. As a result of desertification, once-productive land has become too infertile, too salty or too heavily eroded to continue to support the way of life previously experienced in those areas. According to the research by the United Nations Desertification Convention released in 2013, there are currently 168 countries at risk from desertification.

There are many human activities that can lead to desertification but they are all related to the overuse of the land and water in vulnerable regions. This includes overgrazing by animals such as cattle and goats, the removal of forest cover, the use of trees and shrubs for firewood, extracting water from the ground, poor irrigation practices and growing crops on marginal farming land (land which is difficult to cultivate). Natural factors including drought can also contribute to desertification.

The United Nations currently estimates that the food security of about 250 million people around the world is directly affected by desertification. They believe that the food security of a further one billion is also threatened. There are many effects of desertification sandstorms, crop losses, famine, environmental refugees and conflict are all direct or indirect results of desertification. About 12 million hectares of land are lost every year to desertification, which is about twice the size of Tasmania. It is estimated that this results in an annual loss of 20 million tons of grain. Most of this occurs in developing regions in Central Asia and Sub-Saharan Africa, further contributing to food insecurity in those regions.

WORLD: DESERTIFICATION VULNERABILITY



Source 1.64

Source: Oxford University Press

key**concept:** environment

The Green Wall of China

Over the next few decades, the Chinese government has plans to plant over one billion trees in an attempt to halt the advance of the Gobi desert productive farmland across vast areas of China. Nicknamed the Green Wall of China, this line of trees is expected to extend for 4480 kilometres and cover 4 million square kilometres on the desert margins.

Despite some local success stories, not all experts are convinced the wall will halt desertification. In fact, some geographers argue that it may even add to desertification, over the longer term as the trees require large amounts of water to help them grow.

For more information on the key concept of environment, refer to section GT.1 of 'The geographer's toolkit'.

Source 1.65 A line of trees on the edge of the Gobi Desert in China helps to protect crops from being covered in sand.

Check your learning 1.19

Remember and understand

1 What is desertification? What are some of the direct and indirect results of desertification?
2 Name three human activities that can lead to desertification.
3 How does desertification lead to food insecurity?

Apply and analyse

4 Using Source 1.66, describe the global pattern of desertification. Ensure you name specific countries, regions and continents in your description.
5 What is the spatial association between existing dry lands and areas vulnerable to desertification? Explain why this spatial association exists.
6 How do you think desertification may lead to wars between countries or civil conflicts within countries?

Evaluate and create

7 In what ways might climate change be a leading cause of desertification in some regions of the world?
8 How effective do you believe the line of trees shown in Source 1.67 will be in stopping the advancing sand dunes of the Gobi Desert? Give some reasons for your answer.

The environmental impact of changing diets

The diets of many people around the world is changing and this is having significant impacts on the environment. As the wealth and wellbeing of people in countries such as China and India increases, the diets of people in those countries is gradually changing. With greater wealth, many people in India and China are moving from a diet based almost entirely on grains and plants to a diet with more protein from meat and dairy products. Food production industries are also changing to meet this new and growing demand.

Source 1.66 A new KFC store opens in China at the rate of about one per day.

skill**drill**

Analysing secondary geographical data and drawing conclusions

It is important for geographers to be able to correctly interpret data that has been collected and represented by other people. They often need to use secondary data sources to draw conclusions and draw conclusions about what they have found. By following these steps you will learn to interpret a range of secondary data sources (e.g. graphs, tables, reports) and use it to reach conclusions about your investigation.

Step 1 Once you have gathered a range of secondary data sources for your investigation, look at each source carefully.

Step 2 For each source of information, write down two or three key facts that are presented.

Step 3 Try to summarise the key focus of each data source in one or two sentences. Identify any patterns or exceptions that you notice.

Step 4 Pay particular attention to the title, the date of the data and its source. Is the information contained in the source is already dated, is it still relevant, or is it commenting on a situation or place at a particular point in time?

Step 5 Remember to check the information on graphs carefully. Pay particular attention to ranges of figures and make sure that you understand the classifications. Are things being measured in kilograms or tonnes, for example? If the figures in one source are in kilograms and in tonnes in another, you will need to convert the figures to the same units of measurement in order to understand and compare them.

Step 6 Remember to think about bias – ask why the author has written the piece of information. Are they trying to influence opinion on an issue? Are you getting the complete picture? Try to find a range of sources on the same subject to ensure you have the most complete data available.

Step 7 Compare the facts and figures you have summarised. It may be helpful to use the PQE method to do this.

Step 8 Use your notes to reach your own conclusion about the key question or issue that you are exploring. Support your conclusion with information from the data.

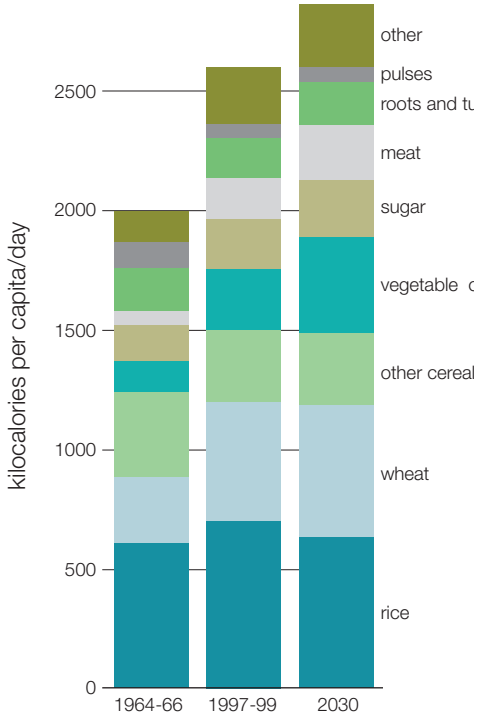
Step 9 Present your conclusion to an audience. This may be done verbally, graphically or in a written form. Whatever form you choose, make sure you use the evidence you have gathered to support your conclusion.

Apply the skill

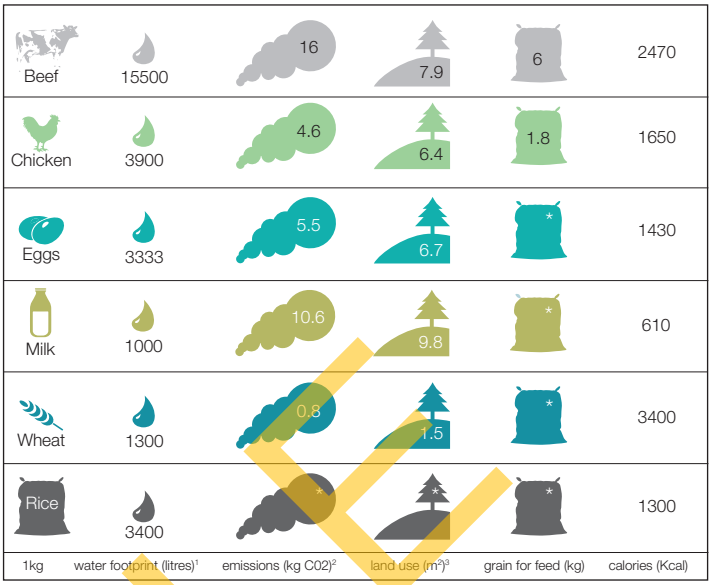
1 Examine the information presented in Sources 1.67, 1.68 and 1.69 and follow steps provided to draw a conclusion about the environmental impact of changing diets.

2 Which information best supports your conclusion?

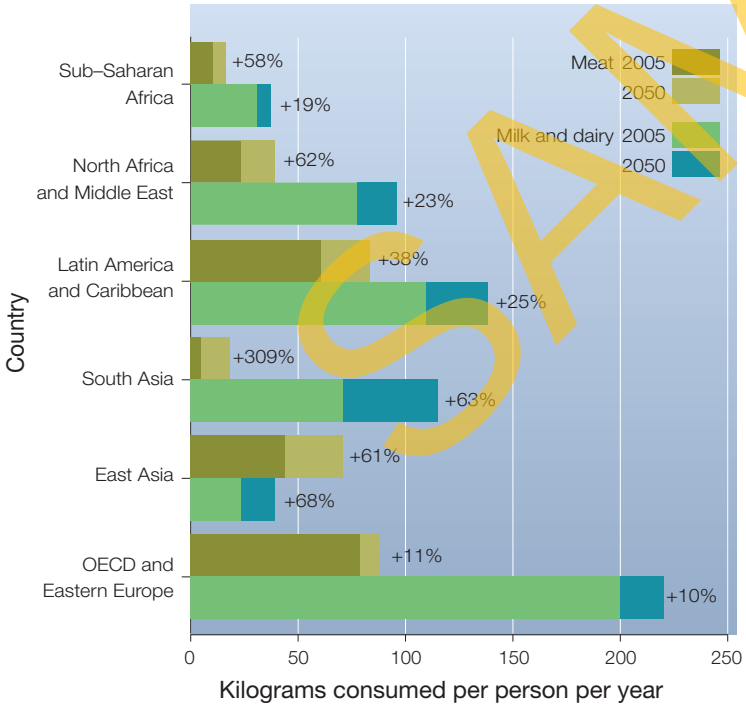
3 What other information would you need to further support your conclusion and where could you find this information?



Source 1.67 A compound column graph showing observed and predicted changes in the human diet between 1964 and 2030.
Source: http://www.unep.org/pdf/foodcrisis_lores.pdf



Source 1.68 The ecological footprint of different food types



Source 1.69 Projected changes in meat and dairy consumption from 2005 to 2050
Source: http://ccafs.cgiar.org/bigfacts/dietary-change/

Extend your understanding

1 Use the information presented here to suggest ways in which people in developed countries such as Australia could reduce the environmental impacts of their diets.

2 Design an advertising campaign to communicate your findings to the Australian public.

Here are some facts you might consider:

- Meat consumption is expected to increase from 39 kg/person/year in 2009 to over 52 kg/person/year by 2050 (FAO, 2006).
- By 2050 50% of cereal grown may be used to feed animals for human consumption (UN report, 2011).
- Currently, 33 per cent of total farming land is used for producing animal feed (UN report, 2011).
- The production of animal protein must be more than tripled if the projected global population of 9 billion people in 2050 were to consume meat and dairy at current North America and Europe levels (Consultative Group on International Agricultural Research report, 2012).
- Today, the number of urban residents is growing by nearly 60 million every year. By 2050, the urban population will almost double to 6.4 billion people. Almost all urban population growth in the next 30 years will occur in cities of developing countries (World Health Organisation, 2013).

Source: Oxford University Press