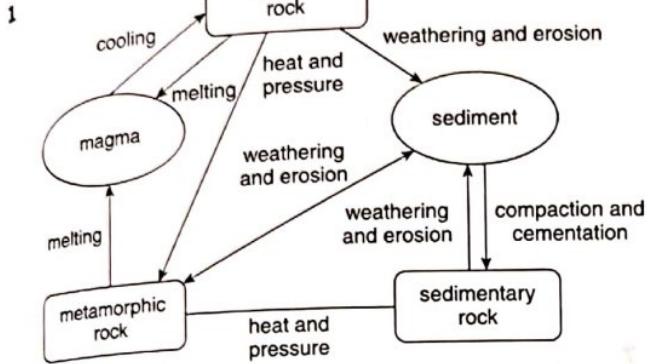


Answers to Self-assessment questions

All questions and sample answers have been written by the authors.

Chapter 1



Description	Rock type
Rocks formed in the sea from particles of eroded rock	Sedimentary
Rocks changed by heat	Metamorphic
Rocks formed from the cooling of other molten rock	Igneous

3 To include:

- size of deposit
- geology
- accessibility of site, transport links (existing or future)
- likely cost benefit (worth of deposits versus costs of extraction)
- safety
- world price.

4 Much less costly to remove overburden than to drill down. Deposits are easier to find on surface. Safety issues may need more consideration and cost more in a sub-surface mine.

5 If it is illegal to mine then the other legal factors are unlikely to have been considered. So, safety requirements will have been ignored, putting anyone in the mine at risk. Environmental laws will also be ignored, so there will be no control on the impact of the

mine. This is likely to include pollution aspects as well as landscape effects.

- 6 Plants are the primary producers in nearly all ecosystems. This means they make all the food that all other organisms in the system rely on. Reduced plant growth will thus mean less food for herbivores and, in turn, for carnivores. They provide more than food though. They also provide habitat for other organisms, including other plants. In addition, reduction in the growth of plants may lead to a reduction in their ability to protect the soil. Soil erosion may be another consequence of the reduction of plant growth.
- 7 The treating of waste *in situ* (on site) will involve much less cost, especially that of transport. The treating of waste *ex situ* (off site) has the advantage of taking any contaminants, which the waste may contain, away to somewhere that is more suitable.
- 8 It will reduce the necessity for mining and extracting more material, which will reduce the environmental effect of these activities. Obtaining materials early always involves the expenditure of energy and it may be that recycling would reduce the energy costs.
- The recycling of waste can create jobs.

Chapter 2

- 1 a $188/22\ 560 \times 100 = 0.83\%$
 b Iceland and the USA are both industrialised (developed), they also both have colder climates so more energy is used in heating and lighting.
- 2 Water is pumped underground where it is heated by the hot rocks. As the water reaches the surface the change in pressure turns the water to steam. The steam turns a turbine, which rotates the generator to produce electricity. The cooling water can then be reheated by the rocks underground.
- 3 Healthy economies produce more goods (more energy used), they also consume more goods (needing greater transport to supply them) and have more wealth to buy non-essential items (using energy in their manufacture). People also travel more in their leisure time.

- 4** Examples could include the following.
- Government forcing a change:
- planning laws on energy use for new buildings
 - banning energy-inefficient designs
 - banning use of energy sources that are particularly polluting, etc.
- Government encouraging change:
- grants to scrap inefficient machinery
 - taxes on fuel (encouraging machines with low running costs and energy use)
 - education
 - providing alternatives such as public transport.
- 5** It might be unfair because it does not take into account:
- climate (the need for heating)
 - geography (distances that have to be travelled)
 - economy (some countries depend on industries that need large amounts of energy)
 - demographics (the age of the population, the rate of growth) and the impact this may have on energy use.
- 6** The largest spills have all happened on land. Oil is not able to spread so widely on land as it does on the sea, where it forms a thin layer. A smaller amount of oil can impact a far larger area at sea.
- 7** Lack of light will kill organisms that photosynthesise (such as marine plants and phytoplankton). These are the producers in the food web. If these are removed, there is an impact on the food supply of all other organisms in this environment. This impact is potentially larger than for those animals that come into direct contact with the oil.

Chapter 3

- 1** Limestone is alkaline so is likely to increase the pH of the soil (make it less acidic).
- 2** At pH 8.0, the following nutrients are less available:
- boron (B)
 - iron (Fe)
 - copper (Cu)
 - zinc (Zn)
 - and, most importantly, phosphorus (P) (because it is needed in larger quantities).

- 3** Reduction in yield. Leaves are discoloured. Older leaves drop off plants prematurely. Plants more prone to pest/disease, crops do not store so well in storage.

	Subsistence	Commercial
Arable	C	A D
Pastoral	E	B
Mixed	F	

- 5** Reasons could include:
- maximising the yield from the crop plants
 - reducing costs by using resources as efficiently as possible
 - improvements to crop quality/reduction in pest and disease problems
 - efficient use of the grower's time.
- 6** Speeding up of the breeding programme, which may take many years if only trial and error is used. The opportunity to introduce a new characteristic that is not naturally found within that organism.
- 7** Use a different insecticide that has a chemical formula different from the original one. Use biological control to reduce the problem without the need for chemicals. Select different varieties in the next season that are more pest resistant.
- 8** Use a range of insecticides on a rota basis to reduce the risk of resistance to any particular one. Use crop rotation to reduce pest numbers. Only spray when absolutely necessary, not routinely.

	Too little irrigation	Too much irrigation
Nutrient availability	Lack of uptake due to insufficient water availability	Leaching of nutrients through the soil so unavailable to crops
Root growth	Stunted growth due to lack of water for essential processes	Risk of root death due to lack of oxygen in the soil (air spaces filled with water)

- 10** There may already be sufficient nutrients in the soil but the plant is unable to access them due to drought. Pest or disease attack might impact on the plant's ability to use the nutrients. The addition of too much fertiliser may damage the plant (damage the roots). The fertiliser added might not contain the nutrient that is in short supply (and an abundance of others).

11 Terracing
Contour ploughing

12 Advantages:

- reduces wind speed
- might provide useful shade for a crop
- might provide a habitat that supports natural predators
- its roots might help stabilise a soil and prevent it blowing away.

Disadvantages:

- might shade the crop and reduce growth
- will compete for water
- makes it more difficult to cultivate fields
- might provide a habitat that supports pests or diseases.

13 Use of (permeable) netting or mesh.

Chapter 4

- 1** Liquid water is found on the surface of the Earth in oceans, lakes and rivers. It is also found inside plants. Water turns from a liquid to a gas, water vapour, in a process called evaporation. The water vapour then condenses to form clouds. Liquid water falls from clouds to the Earth in the process of precipitation. Some of the water is prevented from reaching the ground by plants in the process of interception. Water that reaches the ground may enter it in a process called infiltration. The rest enters rivers by run-off.
- 2** Because it is salty. Consumption of salt water leads to an increased loss of water to rid the body of the salt.
- 3** 3% of all water is fresh. So 0.3% of 3% is surface water. That is $0.03 \times 3 = 0.09\%$. Lakes form 87% of this. That is $0.87 \times 0.09 = 0.0783\%$. Thus less than 0.1% of all water on Earth is in lakes.
- 4** The process of desalination, however carried out, consumes a lot of energy, which is abundant in oil-rich countries.
- 5** Glacial water is unlikely to be important as it exists in regions that are very cold, so it would cost a lot of energy to melt it in order for it to be used. Groundwater requires the drilling or digging of wells, which requires funding and technology. Large numbers of humans are without either the funds or technology to pursue either of these water sources and so rely on surface water.

6

	Advantages	Disadvantages
Environmental	Flood control Creation of habitat for wetland species	People have to be moved The life cycles of fish and other aquatic organisms may be disrupted
Economic	The generation of electricity in hydroelectric power plants Irrigation Tourism and leisure Provides access by boat to otherwise inaccessible areas	Very expensive to set up
Social	Flood control The provision of water	People have to be moved People downstream of the dam may be affected in terms of water supply and the enrichment of soil, which floods bring

- 7** Very simply, all dams over time accumulate silt behind them (in the reservoirs), and when this reaches the height of the water in the reservoir, many of the dam's functions become impossible. For example, if no water flows through the turbines, no electricity can be generated and a reservoir that no longer exists cannot store water or provide a route for boat travel.
- 8** Both typhoid and cholera can be transmitted through contaminated water. This is because they are both caused by bacteria that enter the water. On the other hand, the organism that causes malaria does not live in water. It lives in the body of female mosquitoes, which transmit it to humans.
- 9** Potable water is water that can be drunk safely. Sewage treatment is not normally designed to produce

potable water. However, in more advanced sewage treatment plants a tertiary level of treatment disinfects the water with chlorine. This makes it potable.

- 10** This is because some countries produce large amounts of the gases that cause acid rain in industrial processes. Other countries, hundreds of miles away, may produce only small amounts of these gases. Because the gases enter the atmosphere, winds can blow them from a producer to a non-producer. Scandinavian pine forests were badly damaged by acid rain gases from northern Europe.

- 11** Rain is formed by a process of evaporation of water from surfaces of water bodies. Any contamination by pathogens in that water will be left behind in the water body, and will not be carried in the water vapour. Rain falling on a roof should be relatively pure. Rain that is collected in a pond or lake is much more likely to be contaminated with pathogens.

- 12** Malaria can be treated using certain drugs. Because a vector carries it, mosquito vector eradication would also be suitable.

Both cholera and typhoid are caused by bacteria, which can be carried in human faeces. The best way to control these diseases is improved sanitation. Good sanitation is designed to separate human faeces from the water that humans drink. A clean water supply will be free of these bacteria; in the absence of improved sanitation, this can be achieved through chlorination.

222

Chapter 5

- 1** Both types rely on the movement of seawater to move a turbine, which then generates electricity. In the case of tides, this movement is generated by the gravity of the Sun and Moon, which cause the water to rise and fall twice a day. Wave energy relies on the perpetual movement of the waves caused by wind. Waves are more variable than tidal, which is also more predictable.
- 2** The coast constantly experiences waves. These can be converted into electricity all the time as the turbine in the Islay LIMPET turns the same way whether the wave is coming into the tube or leaving it.
- 3** Sewage pollution makes water unsafe to drink because of the pathogenic bacteria in sewage. These can cause diseases such as typhoid and cholera. Seawater is fairly unlikely to carry such bacteria, although it is possible especially near the coast and river mouths. The main reason that seawater is unsafe

to drink is because of its high level of salt. The salt cannot be excreted by humans without using more water than is gained by drinking seawater. So, drinking seawater will cause dehydration.

- 4** They are near coasts so it is much easier to fish there. The water is quite shallow, so there is a good supply of sunlight for photosynthesis. The sea receives minerals from the seabed, so in the open ocean the shallow, lit area is too far above the seabed, in most situations, to receive the minerals.
- 5** The normal ocean current system in this part of the world acts to bring minerals to the surface. These minerals encourage the growth of phytoplankton, which are food for fish. When the current system is reversed due to El Niño, this upwelling of minerals stops and phytoplankton numbers fall, thus starving the fish.
- 6** **a** Cold current, dashed lines; warm current, solid lines.
b Both A and B are affected by a north-flowing cold current that serves to stir up minerals from the seabed. These enter shallow waters, where there is plenty of light, and, by the time the currents reach the tropics, it is warm. Water is, of course, abundant, as is dissolved carbon dioxide, so all the requirements for good growth of phytoplankton are present: water, carbon dioxide and light for photosynthesis, and minerals for the manufacture of proteins and other chemicals. Abundant phytoplankton leads to a high population of the fish that feed on them, and the fish that eat the fish that eat the phytoplankton, along the food chain.
- 7** **a** The trend is upwards and, despite El Niños in 1957–58 and 1965–66, this is not affected because the catch is still relatively low. There was a small decline in 1965–66.
b The dramatic fall in 1972–73 was probably caused mainly by the El Niño, but over-fishing is now becoming important so, despite no more El Niños until 1982, the decline continued through these years.
c Once the serious El Niños of 1986–88 were over, the fishery began to pick up, possibly due to measures designed to stop over-fishing, so stocks are recovering.
- 8** Culturing of marine fish is very difficult because the fish need different foods at each life stage, and this is difficult to supply for carnivorous fish, which are

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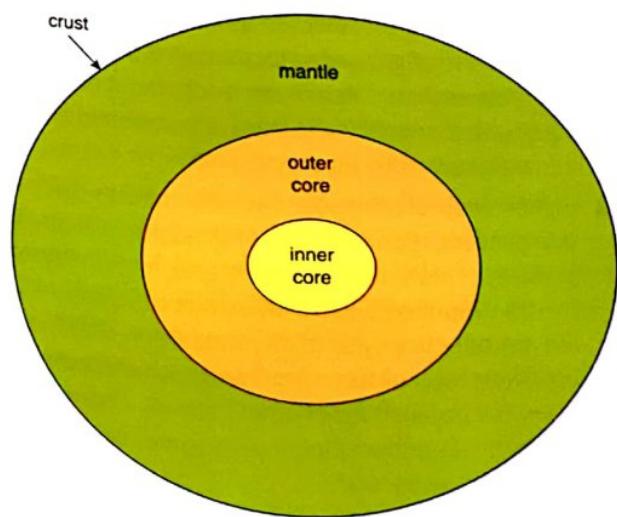
- the ones we like to eat. Farmed fish easily succumb to diseases and parasites. Marine fish farms have negative effects on their surroundings.
- 9 Environment: it could reduce over-fishing and, most especially, the taking of bycatch. Fishers: it is much less risky in terms of danger at sea, and financially as the yield is more predictable. Consumers: The fish may be much less costly than the expensively caught wild fish. There are some suggestions that farmed fish are healthier.
- 10 Each tick mark on the pie is 10%, so there are 60% over-fished and about 6% depleted, which is a total of 66%, which is definitely unsustainable.

Reason for over-fishing	Possible solution
Large destructive nets	Control of net types
Large diamond-meshed nets	Inclusion of square-mesh panels
Large boats	Licensing, restricting
Boats that can stay out at sea for weeks	Licensing, patrols
Satellite location of shoals	Limiting by law
Human population growth	Any measure to reduce this

- 12 The large-scale fishery operation would never have to call in at a port, so it is much harder to monitor the catch being taken compared with the small-scale operation, where inspections can easily be carried out.

Chapter 6

1



- 2 The oceanic crust is younger; heavier; made up of mainly basalt, thinner; it can sink and is renewed and destroyed.
- 3 A slab or piece of lithosphere (crust and upper mantle) that moves.
- 4 Answer will vary depending on where you live.
- 5 Edge or margin of tectonic plates/where plates meet, move apart or move together.
- 6 Convection currents in the magma of the mantle.
- 7 **a** destructive
b destructive
c conservative
d constructive
e destructive
- 8 **a** Friction is created and pressure is released when the oceanic plate is subducted. This takes place in the Benioff zone. At a collision zone earthquakes occur as the two plates move towards each other.
b Pressure builds up as the two plates lock together. When the plates slip the pressure is released in the form of seismic waves.
- 9 **a** At 700 km down the subducted oceanic plate has disintegrated and the magma rises to the surface, where it erupts through a crack or weakness to form a composite or acidic volcano.
b Two plates move away from each other due to convection currents, creating a gap or weakness. Magma rises and erupts through the gap. The basaltic lava may build up and appear above the sea surface as a shield volcano.
- 10 Himalayas = Eurasian and Indian plates
Andes = Nazca and South American plate
Rockies = Pacific and North American plate
- 11 An earthquake is when the ground shakes or moves in sudden jerks. Earthquakes result from a build-up and sudden release of tension, usually along a fault line.
- 12 The focus is where the earthquake begins underground, and the point on the Earth's surface, directly above, is called the epicentre.
- 13 The Richter scale on a seismograph.
- 14 A hole or crack (fissure) in the crust through which magma erupts. It can build up to form a cone-shaped mountain.
- 15 Liquefaction, as this is the only earthquake hazard.
- 16 Lava is magma that erupts at the surface of the Earth.

- 17** Found between 5° and 20° north and south of the equator.
- 18** Ocean temperatures of over 27° (one condition) and water depth over 60 m (second condition) so that there is an increase in evaporation and release of energy. Little wind shear (third condition) to allow vertical development of the storm.
- 19** Sky becomes cloudy, wind speed increases, rain with sunny intervals. Wind speed continues to increase to over 119 km h⁻¹. Large cumulonimbus clouds and very heavy rain. In the eye of the storm the sky is clear, winds are light and there is little rain. Temperatures are warm. After the eye has passed cumulonimbus clouds form again, with the return of heavy rain and strong wind. Wind speed and rainfall decreases. Sunny intervals.
- 20** The energy source (warm ocean) has been removed.

21

Flash response	Slow response
Urban	Forest
Ploughing downslope	Rural
Wet soil	Dry soil
Impermeable rock	Light rainfall
Heavy rainfall	Permeable rock
Rapid snowmelt	Ploughing across the slope

- 22** Answers will vary.

Chapter 7

- 1** gases, gravity, nitrogen, 78.09%, oxygen, argon, carbon dioxide, 0.03%, ozone, stratosphere
- 2** Used by plants in photosynthesis and plants support other life; a greenhouse gas; raw material for carbonaceous skeletons.
- 3** Troposphere
- 4** Troposphere: temperature decreases with height ($6.4^{\circ}\text{C km}^{-1}$) as warming effect of the Earth's surface through conduction and convection diminishes with height.
Stratosphere: temperature increases with height as ozone absorbs incoming ultraviolet radiation.
Mesosphere: temperatures decrease with height as there is no water vapour, dust or ozone to absorb the incoming short-wave radiation.
Thermosphere: temperatures increase as atomic oxygen absorbs ultraviolet radiation.

- 5** Any two of carbon dioxide, methane, CFCs, nitrous oxides.
- 6** The Earth receives incoming short-wave radiation from the Sun. About half of this radiation is absorbed by the Earth's surface, around 20% is absorbed by the atmosphere, and 30% is reflected by clouds and the Earth's surface back into space. As the Earth's surface warms, outgoing long-wave or infrared radiation is released back into the atmosphere. Greenhouse gases absorb some of this radiation and deflect it back to the Earth's surface. These greenhouse gases act like a blanket trapping the radiation.
- 7** CFCs stay in the atmosphere longer than methane (1000 years compared with 12 years) so their impact continues into the future
- 8** When the atmosphere contains gases and substances in harmful amounts.
- 9** 1B, 2D, 3A, 4C
- 10** CFCs
- 11** Smog (smoke and fog) occurs where the burning of fossil fuels in industry, homes and vehicles provides additional particles that act as condensation nuclei for fog to form around.
The enhanced greenhouse effect is where more heat is being retained and there is a warming of the Earth's temperature because of an increase in concentration of greenhouse gases.
- 12** People: breathing difficulties; acidification of groundwater makes water undrinkable and can cause diarrhoea and stomach upsets; aluminium leached from the soil into the groundwater has been linked with pre-senile dementia; limestone buildings are chemically weathered; crop yields decline.
Environment: trees affected as foliage dies; acidification of groundwater damages tree roots; nutrients such as calcium are leached out of the soil; aquatic and animal life in lakes are poisoned and decrease as acidity levels increase.
- 13** Higher levels of ultraviolet radiation causes sun burn, skin cancers, retina damage and cataracts (a disease of the eye that clouds the eye's lens). Immune system can be suppressed. Extra ultraviolet radiation inhibits the reproductive cycle of phytoplankton, which make up lowest layer of some food webs, which could lower the populations of other animals. Changes in biochemical composition makes some plant leaves less attractive as food.

- 14** Impacts will depend on the country discussed but there could be a rise in sea-level, leading to possible forced migration, more erosion and the need for more money to be spent on sea defences. The change in climate could be considered and how it could affect the economy or people's lives.

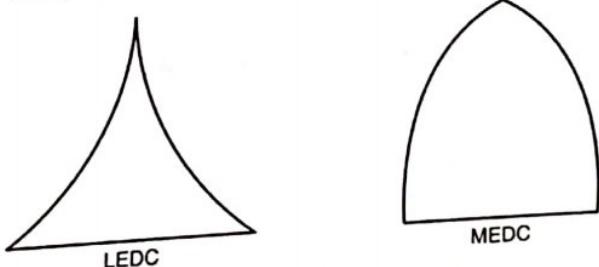
Chapter 8

- 1** Similarities: they both show slow early growth but then fast growth in the middle time period.
 Differences: there is a plateau in the small mammal population, but none in the human population. This is because the small mammal population size is limited by the natural carrying capacity whereas the human population size, so far, is not limited due to constant technological advances in agriculture.
- 2** The livestock are cattle and possibly other animals kept by people. These animals need to feed on plants. The plants are described as consisting of sparse grassland, suggesting there will not be enough food for all the livestock and that their presence may damage the land even further.
- 3** On an island it is likely there will be no natural predators of the herbivore. Other natural checks to population growth, such as disease, may also be absent. The population will thus grow until it is limited by food. Since the food of herbivores is plants, it is likely that this large population will damage these. They may be restricted in growth and fail to reproduce at a rate that replaces losses to the herbivores.
- 4** **a** There could be a disease or wars during this time. The Black Death occurred in the 14th century.
b $6400 \div 1000 = 6.4$ times bigger
c There has been increasingly better medical care, leading to higher survival of both young and old. There has also been a better food supply leading to longer life. Finally there has been better sanitation, leading to higher survival of both young and old due to a reduction water-borne diseases. A fear of old age has led couples to have a large family, so their children can look after them in the future.
- 5** Any two from each side of the table.

Push	Pull
Drought/famine	Good supplies of food whatever the weather
Poverty	Well-paid jobs
Poor links with outside world	Good roads
Poor services	Hospitals, schools, water, electricity
Work on the land only, subsistence	Factory/shop/office work for a wage
Desertification	No comparable pull factors
Sea-level rise	No comparable pull factors
Seasonal weather events such as monsoons, cyclones, etc.	No comparable pull factors

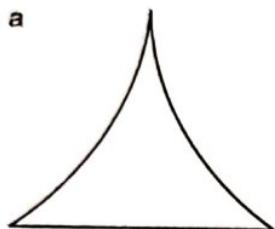
- 6** If birth rate is greater than death rate then we would expect growth, but if emigration + death rate is greater than immigration + birth rate the population will decline.
- 7** The size is the number of individuals in a named area. This area may be a country, a town or any other defined region. Density expresses the size on a per unit area basis. The area is not merely named but its size is known.
- 8** **a** $\frac{325\,127\,634}{33,77} = 9\,627\,706 \text{ km}^2$
b Vatican City
- 9** Because the most dense does not have a very large population but a very small area. (It is Monaco with 37 620 people at a density of $18\,812 \text{ km}^{-2}$. This is because the area of the country is only 2 km^2 .)
- 10** The dependent members are those such as children and the elderly and disabled. These people do not produce and are supported by those who do, the independent members.

11

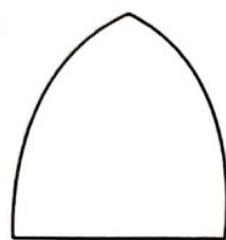


- 12** Because both the birth and death rates of boys are different from that of girls. The populations of the two sexes are thus different from the start of life.

13 a



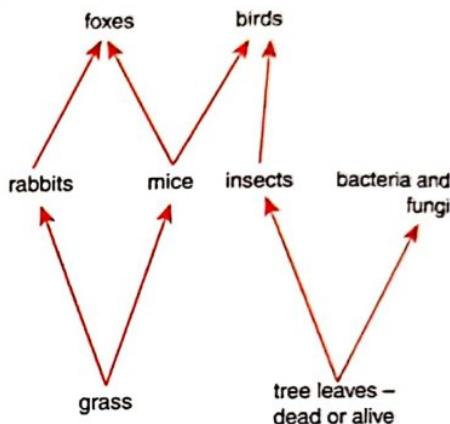
b



Chapter 9

- 1** It might be that grazers in the field will not allow it to live there. Plants in the field may compete for light and stop it growing there. It could be due to soil water content, which may be much less as the area becomes more open. Soil pH is likely to be higher in the field due to the lower amount of fallen leaves, which, when they rot, produce an acid.
- 2** An ecosystem contains a number of species of animals and plants each of which has a population, lives in a particular habitat and occupies a niche. They all live together in a community.
- 3** **a** In the woodland ecosystem shown, all the energy for life comes from the Sun. The energy is in the form of light and is trapped by plant leaves in a process called photosynthesis. This produces the gas oxygen and uses the gas carbon dioxide. The food that is made in this process is then converted into everything that the plant needs. Organisms like plants that make food are called producers. Also in the woodland are pictures of some consumers, they are:
squirrels, birds, insects, deer, mice, foxes, rabbits.
Some of the consumers are predators, such as the foxes and some birds. Both the animals and the plants use the food they either eat or make to supply energy for their lives. This energy is released in a process called respiration. This process also releases the gas taken in by plants.

- b** All the living things in the picture live in a particular habitat:
the mice live in the grassland
the birds live in the trees
bacteria live in the soil.
Some abiotic (physical) factors are shown in the picture. These are:
(Sun)light, water (as rain), carbon dioxide in the air, rocks
One food chain in the picture is grass → rabbits → foxes,
another is leaves → insects → birds.



The one animal not shown on this web is the squirrel.

There are five populations of animals in this woodland, deer, rabbits, foxes, squirrels and mice. In addition there will be many populations of insects and birds of different species. All the animals in the woodland live in a community.

- c i** Fox, ground-living medium-sized predator
Birds, tree-living small predators

- ii** Mice and rabbits for grass

- iii** Fox

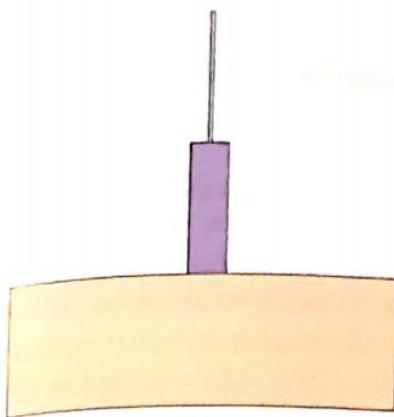
- iv** Trees pollinated by insects

- 4** The atmosphere

- 5** Sugars, proteins

- 6** Both processes involve the breakdown of organic material, which releases energy and produces water and carbon dioxide. Both need oxygen. Decay is always the breakdown of organic matter in dead plants and animals and is carried out mainly by bacteria and fungi. Respiration happens both in bacteria and fungi during decay but also inside the bodies of all living things.

7



b i $3000 \div 40\,000 = 0.075 \times 100 = 7.5\%$

ii $450 \div 3000 = 0.15 \times 100 = 15\%$

8 b iv

c ii

d i

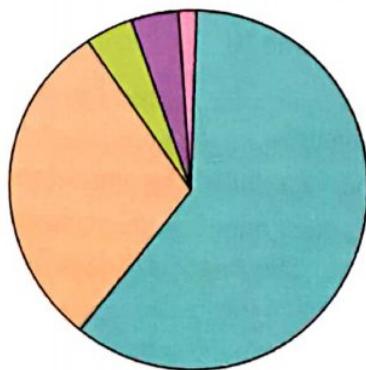
9 Modern crop plants lack variety and we may need some of the genes in wild plants in the future, for example in the event of severe climate change. Some of the genetic diversity may lead to the production of chemicals that may have uses for humans, for example in medicines or as pesticides.

10 Decrease in incidence of the water-borne diseases. Reduced habitat for aquatic plants and animals. Increased food production if the land is used for agriculture.

11 a It is likely to decrease it (a little) as the mature forest is carbon neutral but the fast-growing palm trees are a carbon sink.

b The biodiversity is likely to decline as the mature forest will have many species of trees, other plants and associated animals. The oil palm plantation will have only the oil palm trees and a very few other plants and associated animals.

12 a

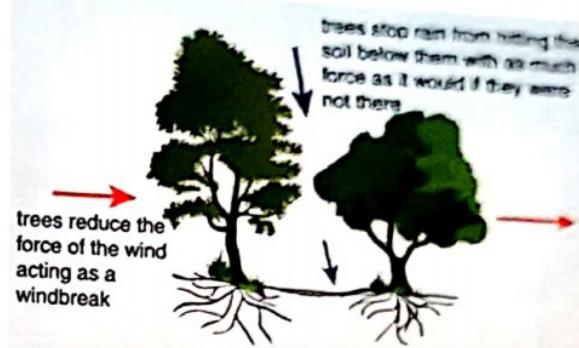


b $30\% \text{ of } 14\,285 \text{ km}^2 = 0.3 \times 14\,285 \text{ km}^2 = 4285.5 \text{ km}^2$

13 Meets: Staying in local accommodation helps local people. The whales are likely to be looked after (conserved) as they form the resource from which money can be made. Whales mainly live in natural areas, only a very few are kept in captivity.

Does not meet: The travel involved, both to the area and on the boat trip, will probably involve the burning of fossil fuels, which has negative effects on the environment.

14



15 • Trees enrich the soil

- They provide food for animals and people
- They provide firewood for people
- They protect the soil from erosion
- The animals provide the farmer with food, including milk
- The animals enrich the soil

16 In an extractive reserve local people are given some of the responsibility of managing the land and have the right to remove products from it. In the core area of a biosphere reserve no extracting of products is allowed, only monitoring and maybe some research.

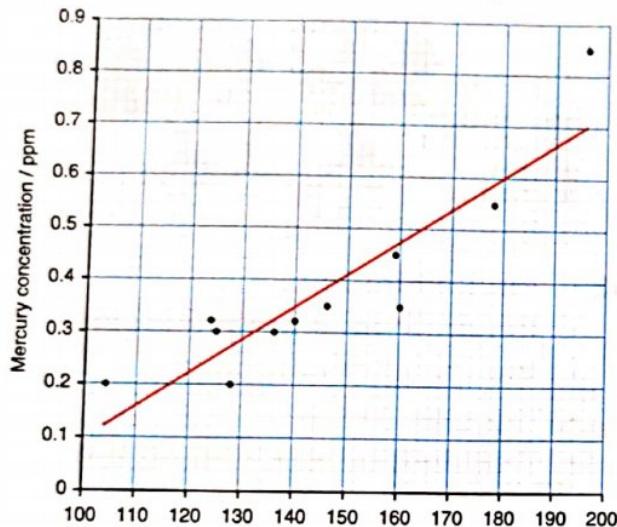
17 Animals do not produce a naturally hardy stage like the seeds produced by many plants. So, animals must be bred generation after generation in order to keep them alive in captivity but plants can be preserved as seeds for many years.

Answers to End-of-chapter questions

All exam-style questions and sample answers have been written by the authors. In examinations, the way marks are awarded may be different.

Chapter 1

- 1 a Correct axes labels. [2, one for each axis]



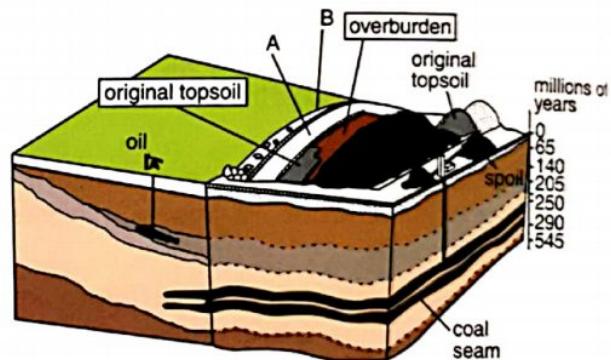
- b As the fish get longer the concentration of mercury gets higher. [1] This is probably because longer fish are older fish. [1] This in turn means that they will have eaten more over their lifespan. [1] If what they ate was contaminated with mercury this could have accumulated in their bodies over those years. [1] Smaller younger fish would have accumulated less. [1]
- c No more than about 130 mm long. [1]
- d It could be concluded that the mine is unlikely to be the source. [1] As far as 100 km from the lake mercury levels in the river are undetectable. [1] It is likely that the mercury comes from the air, as the only other possible source. [1]

- 2 a Ore [1]

- b 1 tonne of aluminium is gained from 5 tonnes of bauxite. [1] This would leave 4 tonnes of waste. [1] 25 tonnes would produce 5×4 tonnes = 20 tonnes. [1]
- c 1 tonne from 5 tonnes of ore, so 25 tonnes would need 25×5 tonnes of ore = 125 tonnes. [1]
- d Pollution by caustic soda, which would raise pH in any water courses it entered. [1] This material is hot so that would also cause problems in the

environment. [1] To provide the electric current for the smelting, electricity is needed and its generation may cause environmental issues, depending on the source of the power. [1]

- e The ore is usually strip mined, so the first step would be replacement of the overburden. [1] The addition of fertilisers [1] and then the planting of suitable vegetation would follow this. [1]
- 3 a Sedimentary [1]
- b A deep shaft is drilled down into the hill above the coal seam. [1] This allows workers and machinery to be lowered to where the coal seam is located. [1] The coal is then dug out from the seam with machinery and transported to the surface through the same or a different shaft. [1]
- c Coal, between 290 and 250 million years. [1]
Oil, about 205 million years. [1]
- d [2, one for each box]

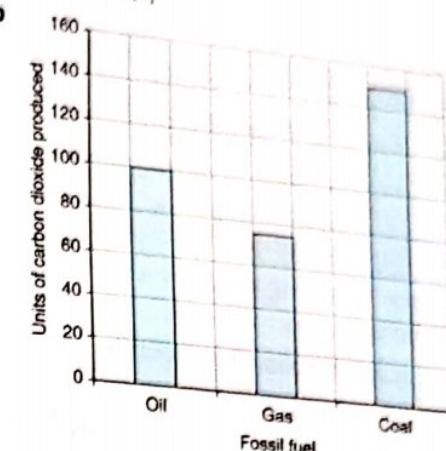


- e The spoil heap is covered in the overburden [1] and then the original topsoil. [1] After this fresh soil (A) is added [1], which may be fertilised. [1] Finally, plants (B) are placed in the soil. [1]
- 4 a 1980, discovery
1993, peak production
2010, exhaustion [2 for all three, 1 for one or two correct]
- b The mineral was being mined at an increasing rate [1] and there would have been job losses [1] and plans to close the mine down. [1]
- c In the world outside the mine substitutes for the mineral could have been found. [1] In addition, products made from the mineral may have been recycled, so reducing demand for freshly mined supplies. [1]

Chapter 2

- 1** Uranium lasts a long time, so although non-renewable it will last hundreds of years. [1] It does not produce carbon dioxide in power generation. [1] It is a reliable source of energy once installed (unlike wind/solar) and not reliant on new supplies arriving (like fossil fuels). [1]
- 2** Advantages: less space in land fill, reduces the amount of methane (a greenhouse gas that is produced by composting). [1]
Disadvantages: toxic fumes in the atmosphere may affect health, adds to carbon dioxide in atmosphere, impacting climate change. [1]
- 3** Any four from:
- Risk of toxins from fracking entering the water table.
 - The mixture of chemicals used are toxic and may affect local residents.
 - Fracking uses a lot of water, which may reduce availability for other purposes.
 - Noise pollution, so fracking in an area will affect the local community.
 - Natural areas will be destroyed when new drills are developed.
 - Fracturing of lower levels of rock may be a cause of additional earth tremors.
 - Loss of land for other employment opportunities (tourism, farming, etc.) [4]
- 4** Any three from:
- Not all countries may have agreed.
 - Not all ship captains are honest and may not abide by the rules.
 - Difficult to police large oceans.
 - Difficult to identify who has produced any pollution found. [3]
- 5** Any three from:
- Oil will affect the food web and access to light.
 - Toxic effects of the oil on the reef.
 - Reef is also affected by detergent chemicals used to clean up/disperse the oil.
 - Machines in the area might cause physical damage to the reef. [3]

- 6** **a** Bar graph [1]



- c** The table only shows the carbon dioxide that is produced. [1] You also need to consider other pollutants such as sulfur dioxide and nitrogen oxides [1] which contribute to acid rain. [1]

Chapter 3

- 1** **a** Mineral particles [1]
Organic content [1]
Soil water [1]
Air [1]
- b** A drought will have no impact on the amount of mineral particles or organic content in the soil. The use of water by plants and evaporation will reduce the proportion in the soil, increasing the amount of air present. [1]
- 2** Changing the pH will affect the ability of the plant's roots to take up the nutrients it needs. The change may increase or decrease their availability. [1]
- 3** Any three from:
- Introduction of new high-yielding varieties, such as rice cultivar IR8.
 - Improvements to irrigation.
 - Development and use of pesticides.
 - Improved farming education and knowledge.
 - Increased mechanisation. [3]
- 4** Any two from:
- Less build-up of pests and diseases as a different crop is occupying the same soil space the following year.

- Use of different types of crops means that nutrients are less likely to be wasted.
 - Inclusion of legumes adds nitrogen to the soil.
 - Different cultural techniques for different crops improve soil structure. [2]
- 5** Any three from:
- Use of trickle-drip or clay-pot irrigation.
 - Rainwater harvesting, collection and storage of water for future use.
 - Use of mulches to reduce evaporation from the soil.
 - Use of more drought-resistance crops.
 - Only apply when weather/soil conditions demand it. [3]
- 6** Any two from:
- Excess nutrients might harm the crop (root death, toxicity).
 - Risk of nutrients leaching into water supplies (resulting in eutrophication).
 - Fertilisers in water supply might be harmful to humans (blue baby syndrome).
 - Excess fertilisers also waste money for the farmer. [2]
- 7** Ability to grow a second crop might mean more food/income. [1] If a crop is a legume it might help provide nutrients for the main crop. [1] The risk of complete crop failure is spread if two crops are grown. [1]

Chapter 4

- 1** The Earth has about 1.4 billion km³ [1] of water. The majority of this (about 97%) is in the oceans. [1] The rest is called fresh water [1] and is found in rocks, where it is called groundwater [1], frozen in the poles [1] and glaciers [1] and as surface water [1] in rivers, lakes and swamps.
- 2** Supply of water [1]
HEP [1]
Flood control [1]
Water supply [1]
- 3** Both typhoid and cholera are water-related diseases and both are caused by bacteria [1]. Malaria, however, although water related is caused by *Plasmodium* [1]. Both cholera and typhoid have symptoms of diarrhoea

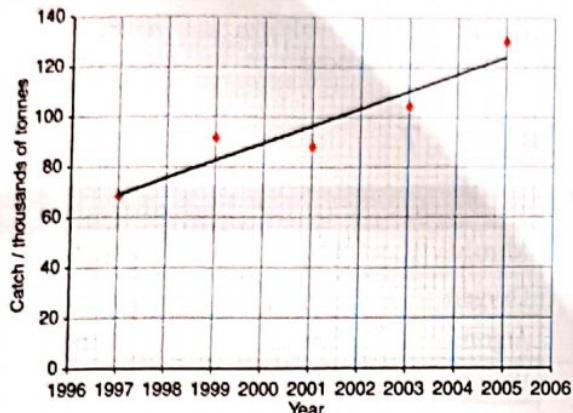
[1] and vomiting [1] but typhoid also causes a skin rash and abdominal pain. [1]

Some diseases can be prevented by vaccination but of malaria, cholera and typhoid only cholera [1] and typhoid [1] have vaccines available. Of the three water-related diseases, malaria [1] causes the most deaths worldwide.

- 4** Primary treatment involves processes that remove large particles and silt. [1] Secondary treatment involves the removal of organic matter [1] and some of the bacteria in the sewage. [1]
- 5** The decomposition of organic matter [1] from dead algae or sewage [1] is carried out by bacteria, [1] which use up large amounts of oxygen. [1]
- 6** **a** At D the effluent is untreated and will contain a large amount of organic matter. [1] The effluent will also contain high numbers of bacteria from humans. [1] At E the effluent is treated and so will contain much less organic matter and fewer bacteria.
- b** This is because the sewage treatment plant will have removed most of the organic matter from D [1] by filtering and settlement [1] and the action of aerobic bacteria. [1] The number of bacteria from humans will have decreased because of competition with the bacteria in the sewage works [1] together with unsuitable environmental conditions. [1]
- c** Sulfur dioxide [1] and an oxide of nitrogen. [1]
- d** The factory has a tall chimney so the gases do not enter the atmosphere until they are high up. [1] Air movements (wind) will carry these gases away from the factory and lead to acid rain in the distant forest. [1]
- e** The run-off from the field contains minerals such as phosphate and nitrate from fertilisers. [1] These minerals lead to rapid growth of algae in the estuary. [1] When these algae die they are decomposed by oxygen using bacteria. [1] The oxygen level in the water will then fall. [1] Living organisms in the estuary that require oxygen will decline. [1] In addition living organisms higher up the food chain will suffer from a lack of food. [1] This is called eutrophication. [1]

Chapter 5

- 1 a** Axes right way round [1], axes labelled correctly with units [1], all points plotted correctly [2].



- b** If assume a straight line of best fit, as shown on Figure 5.22: 90 000 tonnes in 2000. An acceptable line of best fit [1], correct answer based on that line [1].
- c** 2005 is $131 - 68 = 63$ tonnes [1], so this an increase of $63 \div 68 \times 100 = 92.6\%$ [1]
- d** This may be due to an increased fishing effort [1], more people fishing [1] or improvement in methods. [1] It could be a combination of any or all of these factors.
- 2 a** Sunlight, water, carbon dioxide [1]
- b** Minerals [1]
- c** The currents moving up from the seabed carry the products of the decay of organisms, which have fallen to the bottom of the sea after death. [1] These products include many minerals. [1]
- 3 a** Mangroves provide an important habitat for other organisms [1] so their clearance will cause a loss of this habitat [1] and therefore genetic depletion. [1] They also protect the coast so this would cause problems if large areas were cleared for ponds. [1]
- b** As long as the creation of pools is not clearing big areas of mangroves things may be OK. [1] Sites that do not support populations of important mangroves might be sought. [1] The ponds could be used for a while and then allowed to recolonise while they are cleared in new areas. [1]

4

Food type	Feed Conversion Ratio	
Salmon	1.2	[2]
Beef	8.7	[2]
Pork	5.9	
Chicken	1.9	[2]

- b** Agree in that the salmon (which is a marine fish) shows the best food conversion ratio [1]. This means you can get more protein from it for a unit mass of food than any of the, non-marine, foods listed [1]. However, salmon is only one kind of marine fish so the conclusion is limited to that [1].
- c** World fish catch has levelled off at under 100 million tonnes 20 years ago [1]. It would seem to be unlikely that it will grow again, and indeed it may fall in the future [1]. Farming of fish may provide a substitute for this lack of growth [1].

Chapter 6

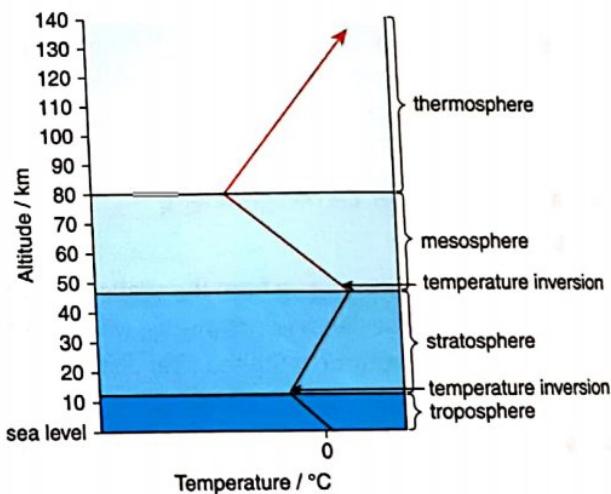
- 1** The Earth is made up of three [1] layers. The outer layer is called the crust [1] and is divided into the oceanic crust [1] and the continental crust. [1] The top layer floats on the mantle, [1] which is semi-molten. Molten rock is called magma. [1] Convection currents [1] are formed in this layer by very high temperatures. The core is the third layer and extends from 2900 km to 6370 km down.
- 2 a** Destructive [1]
- b** Destructive [1]
- c** Constructive [1]
- d** Constructive, destructive, conservative [1]
- e** Constructive [1]
- f** Destructive [1]
- g** Constructive [1]
- 3 a** Thick covering of ash [1]; ash covering buildings, cars, crops [1]; death of livestock, crops, possibly people [1]; lack of food [1]; collapse of roofs [1]; weight of ash brings down power lines [1]; lack of drinking water [1]; transport disruption [1]; breathing problems [1]; ash can block out sunlight [1].
- b** Not possible [1]: unpredictable eruptions [1], cannot predict where deposits will land [1], cannot stop it happening. [1]
- Possible [1]: spray water on lava [1], roof adaptation [1], diversion channels [1], protecting people by hazard mapping [1], warnings [1], education [1], evacuation [1], training emergency services. [1]
- 4** Impact of storm surges [1], high winds [1], heavy rainfall causing flooding [1]. Other impacts could be spread of disease [1], loss of crops and livestock leading to famine [1], landslides destroying buildings. [1]

- 5 a Drought is when there is a lack of rain over a long period of time. [1]
 b Droughts can occur anywhere in the world. [1]
 c Droughts in the Sahel region of Africa occur when the ITCZ is prevented from moving northwards. [1]
 d Drought is associated with high pressure systems. [1]
 e El Niño brings droughts to Australia and floods to South America. [1]
- 6 Short-term problems: contaminated water leading to diseases [1]; crops and livestock destroyed leading to starvation if a poor country [1]; disruption to transport routes. [1]
 Long-term problems: homelessness, so people may move away from the area [1]; cost of rebuilding [1]; losses to the economy as businesses may be forced to close down [1]; in richer countries very expensive to have insurance cover. [1]
- 7 For statement [1]: Higher population density can lead to rapid spread of disease and food shortages. [1] More people living in temporary accommodation. [1] Urban areas are more at risk from earthquakes because of higher population densities, so greater building densities and more deaths through collapsed buildings. [1] More potential for fires as gas pipes fracture. [1]
 Against statement [1]: Buildings in urban areas may be better protected from earthquakes and more able to survive tropical storms. [1] Emergency services are greater in number and hospitals more accessible. [1] Rural areas can become isolated and aid slow to arrive, leading to famine and lack of medicines. [1] However, rural areas may suffer more in drought as farmers lose their livelihood. [1]
- 8 a 1.30 am [1] 7 pm [1] 7.3 [1] 7.8 [1] 34 [1] 661 [1] 1500 [1] 30 000 [1]
 b The place in the Earth's crust where the earthquake starts is the Focus [1]
 The place on Earth's surface above the focus is the epicentre [1]
 c Japan – the plates move parallel (sideways) past each other causing friction. [1] The plates get locked together and pressure builds up. [1]
 Ecuador – plates move towards each other because of convection currents in the mantle which causes forced movement of rock against rock. [1] The oceanic plate is forced down under the continental plate, which is known as subduction, and pressure and friction trigger earthquakes in the Benioff zone. [1]
- d Predicted aftershocks would be a reason for people to refuse to return to their homes. [1]
 e Any two items from the following list, with a suitable explanation, one mark for each: tents for shelter, clothing, food, medicine, clean water, chemical toilets, sniffer dogs

Chapter 7

Gas	Formula	Abundance
Nitrogen [1]	N ₂	78.09%
Oxygen	O ₂ [1]	20.95% [1]
Argon	Ar [1]	0.93% [1]
Water vapour [1]	H ₂ O	0.2–4% [1]
Carbon dioxide	CO ₂	0.03% [1]
Methane [1]	CH ₄	Trace
Ozone	O ₃ [1]	0.00006%

- 2 Temperature line [1], temperature inversion label. [1]



- 3 a Vehicle emissions [1], factories and industries releasing gases and chemicals [1], power stations burning fossil fuels. [1]
 b Acid rain and weathering of limestone buildings [1], smog, puts tourists off [1], poor visibility [1], delays for transport, e.g. planes [1], breathing difficulties and other health problems [1], dirt on washing. [1]
 c Chemical sprays [1], methane from cattle [1], burning vegetation [1], emissions from vehicles. [1]

	Enhanced green-house effect	Ozone depletion
Type of radiation involved	Long-wave (infrared) radiation [1]	Short-wave (ultraviolet) radiation [1]
Atmospheric layer that absorbs the radiation	Troposphere [1]	Stratosphere [1]
Direction of travel of radiation when absorbed	From the Earth [1]	Towards the Earth [1]
Example of a pollutant gas	Carbon dioxide [1]	CFCs [1]
Action of pollutant gas	Traps outgoing radiation and so causes an increase in temperature [1]	Creates chlorine, which reacts destructively with oxygen [1]
International agreement to combat problem	Paris Climate Conference [1]	Montreal Protocol [1]

- 5 Answers could discuss rising sea levels [1], loss of homes [1], forced migration [1], financial costs of defending coasts from erosion [1], rising temperatures leading to changes in agriculture [1], more droughts and less water resources [1], changing habitats and loss of biodiversity. [1]
- 6 Some LEDCs may want to develop industry and therefore do not want to reduce harmful emissions. [1] LEDCs may not have the money to implement strategies to reduce pollution. [1] Some governments believe that some strategies will not be popular with voters or industry and may harm economic growth. [1] A lack of monitoring. [1]

Chapter 8

- 1 This is because more boys than girls are born [1] and men die younger. [1]
- 2 Density is the number of people in a known area [1] expressed as the number area^{-1} (such as km^2). [1] Distribution tells us where people live. [1]

- 3 This is because, although Russia has 142 098 [1] people its area is vast at 17.1 km^2 [1], giving a density of only $\frac{142\ 098}{17.1} = 8.32 \text{ people km}^{-2}$ [1]
- 4 Because Tuvalu has a very small area of only $\frac{9916}{30} = 330.39 \text{ km}^2$ [1] housing its 9916 people. [1]
- 5 a The percentage of babies and children up to four years old decreases from 11.5% of the overall population in 2006 to 7.9% in 2026. [1] The largest increase is in the age range from about 30 upwards, for example people aged 40–44 increase from 5.8% in 2006 to 7.3% in 2026. [1] However, the rate of increase slows above 70 years old with an increase from 2.6% to 3.7%. [1] So, the population is beginning to age. [1]
- b They could transfer funding from care for the young, such as nursery and normal schools, to care for the elderly. [1] They are also likely to need to increase provision of various forms of health care for the ageing population. [1] This may mean both dealing with illness but also improving preventative medicine. [1]

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Chapter 9

- 1 If agree: It is true that biofuel comes from plants that have only just taken the carbon they contain from the atmosphere. When the next crop is grown the following year, the carbon emitted when the biofuel is burned will be taken in again by this next crop. [1] So, within 2 years carbon in will equal carbon out. [1]
If disagree: While all the above is true, the land used for growing these crops could be used for growing food, [1] which is in short supply in large areas of the world. [1]
- 2 All ecosystems (except those in the deep sea) rely on organic chemicals, mainly sugars, for their continuation. [1] These substances are made in photosynthesis using light from the Sun [1] that is trapped by chlorophyll. [1]
- 3 a Between 150 and 20 years ago there was a huge reduction in area of wetland. No wetland was found in the south 20 years ago. The biggest loss was in the east. [1] Between 20 years ago and today there has been a slight increase. [1] One area has reappeared in the south [1] and the western area has nearly doubled in size. [1]

- b** To conserve the wetland that remains some kind of nature reserve could be established. [1] This would attract money for the preservation of the area, possibly compensating landowners for not draining their land. [1] To extend the wetlands it is likely that the government or some private (maybe charity-funded) organisation would need to buy land that has been previously drained. [1] They would then need to remove the drainage infrastructure and do whatever else was necessary to bring wetland back.
- 4** The fact that they eat the same food suggests that they may compete [1] for it when together. [1] Species A is clearly more adapted to living in colder water than B. [1] So, when they are together B outcompetes A in the warmer water regions and is the only one when found there. [1]
- 5** **a** Second tropic level or primary consumers. [1]
b That living things are very different in size, [1] so 15 trees are not equivalent to 15 sapsuckers. [1] This means that few trees can support thousands of sap suckers. [1]

c energy in 15 trees

$$\text{mass of 15 trees} = 15 \ 000 \text{ kg} \quad [1]$$

$$\text{so energy in 15 trees} = 15 \ 000 \ 000 \times 5 \text{ kJ} = \\ 75 \ 000 \ 000 \text{ kJ} \quad [1]$$

energy in sapsuckers

$$\text{mass of sapsuckers} = 8 \ 500 \ 000 \times 0.01 \text{ g} = 85 \ 000 \text{ g} = 85 \text{ kg} \quad [1]$$

$$\text{energy in sapsuckers} = 8 \times 85 \ 000 \text{ kJ} = 680 \ 000 \text{ kJ} \quad [1]$$

energy in insect eating birds

$$\text{mass of insect eating birds} = 350 \times 5 \text{ g} = 1750 \text{ g} = 1.75 \text{ kg} \quad [1]$$

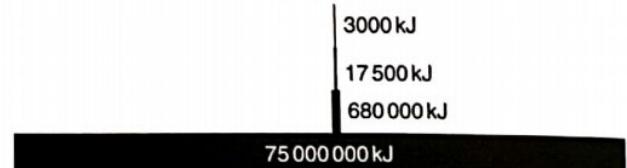
$$\text{energy in insect eating birds} = 1750 \times 10 \text{ kJ} = 17500 \text{ kJ} \quad [1]$$

energy in predatory birds

$$\text{mass of predatory birds} = 3 \times 100 = 300 \text{ g} = 0.3 \text{ kg} \quad [1]$$

$$\text{energy in predatory birds} = 300 \times 10 \text{ kJ} = 3000 \text{ kJ} \quad [1]$$

Correct figure [2]



Answers to Case study questions

All questions and sample answers have been written by the authors.

Chapter 1

The Antamina Mine in Peru

- 1 The ore is valuable and in demand so even though transport costs will be high the mine should still be profitable.
- 2 Rainfall and melting snow will dissolve some minerals. Sediments and dissolved minerals will move down the mountainsides and collect in the valleys. This water will be toxic to many organisms and will flow away from the mine.
- 3
 - a Further deposits have been found and the productive life of the mine has been extended by many years.
 - b It is too difficult to cover bare rock on steep slopes. The exposed rock will weather over time and may release less harmful substances. The location is so remote that the visual scar on the landscape will not be seen.

Chapter 2

Biofuels: the future of fuels or a misguided technology?

- 1 Bioethanol will mean the country is not dependent on supplies from other countries, reducing risk if there is political conflict, global price rises, a shortage of global supply. It may also be a crop with a value if exported.
- 2 It's a renewable source of energy. Fairly low technology. Different crops are suited to different regions. Absorbs carbon dioxide.
- 3 Bioethanol crops might be better suited to their land. The crop might be more profitable than food crops.

A house that needs no energy. Is it possible?

- 1 The house will only use 10% of the standard house's energy ($1.5 \text{ dm}^3 \text{ m}^{-2}$, rather than 150 dm^3).

- 2 So few houses have been built in this style because
 - it is new technology
 - not many people have the skills to build them yet
 - they are very expensive to build
 - the savings made do not outweigh the costs of building.
- 3 There will always be some energy loss, and the use of solar panels, etc., is only effective in certain weather conditions.

Chapter 3

The impact of wind erosion

- 1
 - Unexpected drought over a number of years.
 - Soil particles were light (less water) so more easily blown about.
 - Large areas ploughed up, few windbreaks.
 - Cultivating the soil broke it up into smaller sized components.
 - Deep-rooted grasses no longer there to hold the soil.
- 2 Farmers had bought the land and wanted to grow crops to make a profit from their investment. No central control as to what was grown (and how)
- 3
 - Starvation
 - Need for large quantities of people to relocate
 - Loss of jobs
 - Impact on local ecosystem: limited topsoil, few plants, and associated impact on food web.
- 4 It prevented the land from being used for arable production and allowed it to return to grassland.

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Flower power

- 1
 - a This is a (large-scale) commercial arable farm: the bulbs are being sold for profit rather than food (commercial) and there are no animals involved in the production (arable).
 - b (From Figure 3.18) There is a lack of windbreaks to slow the wind speed down. The area is very flat. (From the text) There is a large amount of organic matter that is easily blown away when dry.

- 2**
- The wind might cause the chemicals to be blown into other areas (drift).
 - Rain will cause them to run-off into the water courses (drainage channels).
 - Pesticides might affect other animals not intended to come into contact with the pesticides as it moves in the drainage water.
 - Excess nutrients in the water can cause ecological damage through eutrophication.

3 For:

- The way the country is governed does not tell farmers what to do, it would remove some of their freedom
- The farmer aims to make as much money as possible, growing bulbs is more profitable.
- Selling good abroad (exporting) is good for the economy of the country, these are valuable goods that are demanded around the world.

Against:

- (Worldwide) food is in short supply, using the best land would increase yields.
- Control of what people grow would mean there was less waste (as products would not be left unsold).
- The supply of food is too important to be left to chance and 'market forces', governments should take responsibility for feeding the world population.

2 **a** A dam must remain intact or else a huge amount of water can be sent very suddenly down the valley causing the loss of lives, property and habitats. An earthquake could cause the dam wall to break and so the area must be monitored for this, and if there is to be a problem then action will need to be taken to strengthen the wall or release some water in a controlled fashion. Evacuation of people living downstream of the dam might need to happen.

b Sedimentation behind the dam will cause the water flow to slow down and this will lead to a decrease in the production of electricity and so economically the dam is less efficient.

3 **a** Local people can benefit from the production of jobs in the building and maintenance of the dam. They might also be provided with electricity that they did not have before, or their supply might reduce in cost. They have access to the stored water for irrigation or domestic use. If the dam encourages tourists they will benefit financially. Also they themselves might be able to use the reservoir for recreation. On the other hand it appears that the gates are opened in a fashion to suit the dam authority and not the local people. This means that the supply of water is intermittent and they are not provided with it necessarily at the best times. Fish populations have been negatively affected and so the local people will have less food from fish. Also farmers have seen a decrease in the fertility of their soils.

b The country will benefit from the revenue acquired by the selling of electricity and this may not be to the local people. They also gain funding internationally from foreign investments. However, the dam will have cost a lot of money and it may not pay this investment back to the government completely. The improvement in infrastructure allows other businesses to thrive in the country. Lower unemployment saves the country money. Tourists will bring in extra income to the country as a whole. Improved drinking water will save money for health care.

Chapter 4

A multipurpose dam on the Ramganga River at Kalagarh, India

- 1** A large project such as this requires a major amount of planning and maybe an environmental impact survey will be carried out. Major investment and funding will need to be acquired both within the country and internationally, maybe grants from several organisations will be needed and the building might have to be phased as funding becomes available. Workers will need to be recruited, building materials and equipment will need to be brought in and agreements will need to be worked out with local people, especially any landowners who will need to be relocated and compensated.

Chapter 5

The Newfoundland cod fishery

- 1 The area is on shallow water where a warm current meets a cold one. All this combines to provide conditions highly suitable for the growth of phytoplankton. That is plenty of light and carbon dioxide, together with minerals forced upwards from the seabed by the currents.
- 2 a The catch shows a slow but fairly consistent rise from 1850 until about 1958. Between these dates catches rose by about 150 000 tonnes, from 100 000 to 250 000. At this point the catch rose steeply to 800 000 tonnes by 1967. It then fell away just as rapidly to more or less zero in the early 1990s.
- b Peak is 800 000 tonnes and in 1976 it is 120 000 tonnes, so the fall is $800\ 000 - 120\ 000 = 680\ 000$. So percentage fall is $680\ 000 \div 800\ 000 \times 100 = 85\%$.
- c 1941
- 3 There is a small region of the Grand Banks area called Smith Sound. In recent years scientists have found that cod stocks here have done well there. They think it might be possible that these fish will migrate and lead to a recovery of cod over the whole of the region.

Questionnaire

- a Are you or were you involved in fishing in the Grand Banks?

Yes/No

- b If yes, for how many years?

1	>1	>10	>20
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- c How long do you think it might be before cod fishing can restart in the Grand Banks?

never	now	next year	in the next ten years
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sometime but a long way off

Chapter 6

Hurricane Patricia: the impact of a tropical cyclone

- 1 a Between 5° and 20° North so sufficient Coriolis force to provide spin, and warm ocean temperatures above 27 °C to produce high rates of evaporation. Formed in October because ocean temperatures are at their highest then in the Northern Hemisphere.

- b On 20 October it started off in the eastern Pacific and moved westwards. On 22 October it started to veer north-west, and on 23 October north-east.
- c Jalisco
- 2 a Regular storm warnings, storm shelters were opened, people were evacuated, electricity was shut off and the army, navy and police were deployed.
- b Risk of loss of life and injury, damage to buildings by strong winds and storm surge, no electricity, water supply contaminated by sewage and salt water so fear of disease.
- 3 a Transport: airports closed, highway 200 blocked, roads washed away. Infrastructure: electricity shut down, power poles and transmission towers blown down. Water supply contaminated.
- b Tourists were evacuated so loss of earnings in the resorts. Tourist industry may have been damaged as people are scared to visit. 24 000 hectares of crops destroyed so a loss of income and jobs. Banana crop destroyed so impact on export earnings. Large cost (69 million US\$) of rebuilding.
- c Landfall was in a rural area with a low population density. It was a compact storm so did not cover such a large area of Mexico. It rapidly lost strength as it passed over the Sierra Madre mountains and very little impact from a storm surge as the coast is mountainous.

Chapter 7

Acid rain in China

- 1 Two clusters below pH 4.5 on the coast and in the south-east. The pH levels of 4.5 to 5.6 are also found on the coast and in the south-east. The reason for this is the concentration of population in cities such as Shanghai and along the coast leading to high vehicle ownership, industries and power stations. The west and north of China have lower levels of above 5.6 because of lower population densities.
- 2 a Acid rain results from burning fossil fuels in factories and power stations, which releases sulfur dioxide and nitrogen oxides into the atmosphere. Vehicle emissions add further nitrogen oxides. This is dry deposition. If these gases mix with rain droplets in the atmosphere, weak solutions of nitric and sulfuric acids are created that can then

be moved by winds. These solutions will eventually fall to Earth as acid rain and can occur at some distance from the source. This is wet deposition.

- b** Yes, because acid rain can be carried by winds long distances from the source, across international borders.
- 3** Use more renewable energy: burn less fossil fuels and reduce amount of acid rain gases. Encourage cleaner traffic and less of it: less vehicle emissions. Flue gas desulfurisation: reducing amounts of acid rain gases.

Chapter 8

The one-child policy in China

- 1 a** About 20 000 000
- b** 1.7 billion
- 2** The realisation that a lot of people were becoming dependent and fewer independents were available to look after them. The disproportion between the numbers of men and women, in the sense of too many men. It is difficult to make the policy work in rural areas.
- 3** Due to the very powerful totalitarian government that was in a position to control virtually all aspects of national life.

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Chapter 9

Mayan Biosphere Reserve, Guatemala

- 1 a** The local people will gain an income in many ways from the tourists attracted to the area. They will be able to guide, transport and accommodate tourists as well as sell local produce and products.
- b** The world at large will benefit by having a very biodiverse area, which may contain many as yet unknown beneficial organisms, conserved.

- 2** As long as the take from hunting remains below the sustainable level the birds can be taken and conserved at the same time. This is because living things are not a finite resource, like gas or oil, but reproduce. Careful setting of quotas and closed seasons should allow hunting without exterminating the birds.
- 3** This would need sampling techniques. The exact requirements would determine which. If a study was needed into the effect, for example, of a road or train line on plant or sessile animal populations, quadrats with transects may be the best way to do it. If you wanted to see how some form of development in part of the forest had affected animals, random sampling in that area, using nets and pit-fall traps, would be best.

Scarlet Macaw

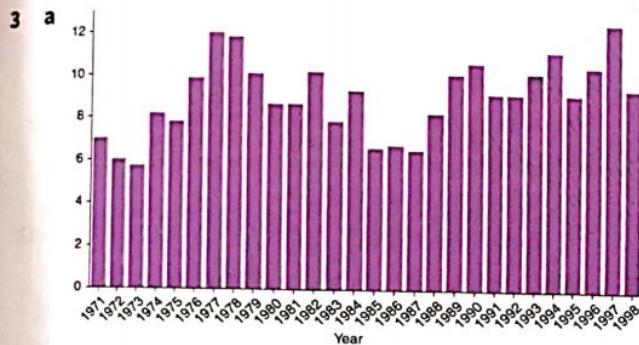
- 1** In 1990, the peak was 230 birds. In 1994, the peak was 195 birds. Over 4 years 35 birds were lost, which is $35 \div 4 \text{ birds } y^{-1} = 8.75 \text{ birds } y^{-1}$
- 2** Before management began in 1994, macaw numbers were down to about 220 (we do not know when the one value for numbers in Figure 9.27 was taken). During management, numbers rose to nearly 230 by 1997 and by 2000 had reached around 263. Numbers did then fall to about 227 in 2003 but this is still above pre-management levels.
- 3** Likely because this species is iconic and much sought after by birdwatchers, a very common group of ecotourists. Tourism is hugely important in Costa Rica so anything that attracts them is worth keeping in the wild.

Answers to Extended case study questions

All questions and sample answers have been written by the authors.

Chapter 1

- 1 Even though ore was left in the mine, the cost of extracting it would have been greater than its worth.
- 2 1 000 000 000 extracted
1 331 372.7 tonnes of metal obtained (= sum of copper 1 299 978 tonnes, molybdenum 31 000 tonnes, gold 31.7 tonnes, silver 336 tonnes and rhenium 27 tonnes)
So mass of waste = 1 000 000 000 - 1331 372.7 =
998 668 627.3 tonnes
Percentage waste = $998\ 668\ 627.3 \div 1\ 000\ 000\ 000 \times 100$
= 99.87%



- b i The trend is mainly upwards, with a rise from just over 6 mg kg⁻¹ wet mass to nearly 12 mg kg⁻¹ wet mass, which is almost double.
- ii The mining of copper at the Island Copper Mine on Vancouver Island has so far (in just 7 years of operation) led to a doubling in the level of copper in the commercially important Dungeness crab. This is both a commercial and environmental disaster. Commercial for those who depend on the crab for their livelihood and environmental for everyone else. It is a clear example of bioaccumulation as the crab is a top predator in the delicate marine food web of which it is a part. If this trend continues it is likely to wipe out this source of income and be a harbinger of major problems in Rupert Sound.
- iii The conclusions reached in the 1978 report have, thankfully, been proved wrong. After an

initial doubling of copper load in just 7 years, the levels fell for the next 10 (with some minor deviations along the way). More recent trends have been slightly upwards but the evidence of over 20 years of monitoring suggests that the concerns expressed in 1978 are unlikely to be well founded.

- c *Metacarcinus magister* is a top predator and as such will show evidence of higher levels of copper very early on in the mining process.

Chapter 2

- 1 • Poor route planning (avoiding the ice but too close to the reef).
• Inexperience of the driver.
• Single-hulled vessel.
• Lack of information about the hazards in the area (possible).
- 2 • Direct toxic effect from contact.
• Swallowing oil.
• Eating prey covered in oil.
• Bio-accumulation (build-up of poisons over time).
• Lack of oxygen to breathe in the water.
- 3 Lack of employment as tourism affected. Fish stocks (and associated industries) also lost.
- 4 Any three from:
• Better sonar/radar to look for obstructions.
• More staff on duty.
• Better trained staff.
• Emergency equipment kept in port to deal with spill more quickly.
• Use of double-hulled ships.
- 5 We still need oil in large quantities and there could be shortages if we do not exploit it here. Drilling has already occurred so stopping now would not be reversible. Lessons have been learnt from the *Exxon Valdez* and good systems are now in place. There is little other employment in the area. Stopping the oil industry will have major economic effect for the region.

Chapter 3

1	Commercial farming Arable Intensive
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- 2 Sugar cane provided them with an additional food to consume. Plants were close together, which ensured there was a large supply.
- 3 a Cane toads are found in the north-east of Australia, spreading from the coast.
b Approximately 35% of Australia may be affected.
c Some parts of the country will have unsuitable climatic conditions (e.g. too cold, too dry).
- 4 Lack of predators, able to out-compete native animals for food and space. Have a toxic liquid on their skin. Mobile.
- 5 How effective the toads were at controlling the target beetles. What other animals the toad would eat. Environmental impact study: impact on native wildlife.
- 6 • Pesticides may affect a wide range of wildlife.
• Long-term effects of pesticides are not known.
• Biological controls have a narrow range.
• No unwanted chemicals on foods, etc.
• They are naturally occurring animals.
• If the biological control has a narrow prey range, they will also reduce in numbers as the pest does.
- 7 The virus is a natural organism and can be transmitted from toad to toad without the need for each one to be captured for treatment. The virus will only effect toads and not other animals.
However: there is a risk of the virus affecting other animals we are not yet aware of, and the death caused by the virus might be cruel (because it takes the animal a long time to die).
- 8 Solutions could include:
• new types of pesticide
• genetically modified sugar cane that is pest resistant
• use of traps to capture the beetles.

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Chapter 4

- 1 a Haiti did not have any incidence of cholera for nearly a century so it seems reasonable to suggest that the cholera bacteria was brought in from somewhere. A group of aid workers had entered Haiti from Nepal. The strain of bacteria was identified to be similar to a Nepalese one. The aid workers had their camp on the Artibonite River and

the camp toilets leaked into the river. The cholera bacteria are carried in faecal material, which would have been in the sewage from the toilets.

- b The map shows that there is an area in South America where there has been an outbreak of cholera. There is a land route up through South America and across Central America into North America. From here there is a relatively short stretch of water across to Haiti. Cholera bacteria could have been carried up along this route by animals or human carriers.
- 2 The installation of latrines will ensure that faecal material from humans, which might contain the cholera bacteria, will be removed and so not be allowed to infect drinking water. Thorough cooking of food will kill off bacteria that might have infected the food after being in contact with water (maybe from washing). This will then mean that cholera bacteria will not infect humans. Hand washing will remove bacteria that might have got onto the skin after using latrines, and so reduce the chance of cross-infection that way.
- 3 a 15 November, 100–15 300
b 7 November, 500
- 4 The lowest number in 2014 was 1000.
The peak in 2012 was 15 200 (or whatever the answer given in 3a).
The reduction was 14 200.
The % was therefore $14\ 200/15\ 200 \times 100 = 93\% (93.42)$.
- 5 In 2015 the number of cholera cases was constant for the first 3 months, and then there was a gradual decline until July, when there was a slight increase.
- 6 The peak in cholera cases in 2012 coincided with a peak in rainfall. This can be explained by the mixing of sewage with drinking water due to flooding causing sewage to over-flow out of sewers and ditches.
- 7 There is evidence for and against the statement that Haiti has managed to control cholera.
For:
• The peak in 2012 of 15 300 has been reduced to a low of 1000 in 2014.
• Reduced by 93%.
• Even the peak in 2014 of 7500 is lower than that in 2015, at 15 300.
• The total for 2014 was 27 388 and this was already a reduction of 90% of the peak of 2011.
• Haiti has taken the action of using more latrines, and providing education about cooking food and washing hands.

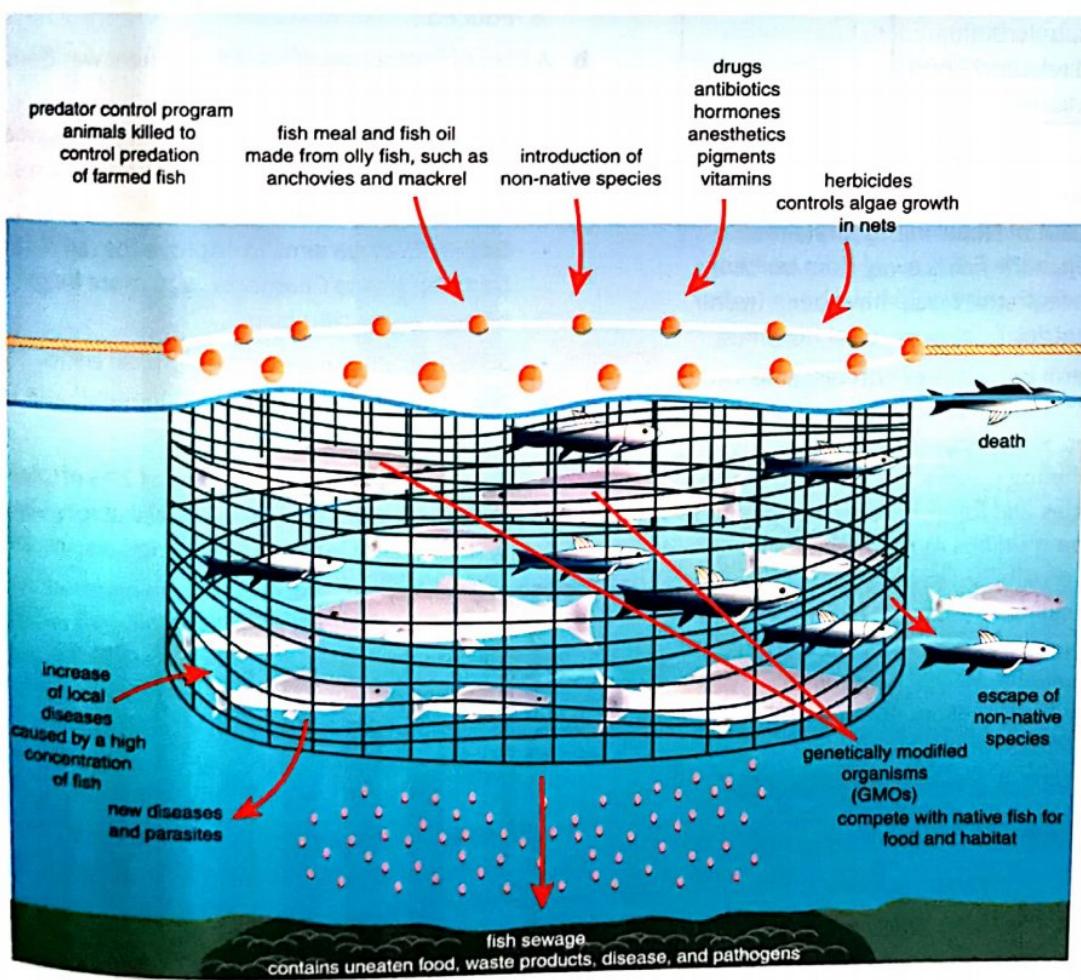
Against:

- There appears to have been an increase in August 2105.
- There are still fluctuations in the rainy season.
- Haiti has not tackled its sanitation problems, it says that in 2014 inadequate sanitation still existed and partly caused the rise in late 2014, and so the likelihood of cholera spreading is still possible.

Chapter 5

- 1 a Norway is 33%, Chile 31% and the rest of Europe 19%, which is 83%, so the rest have 17% of the market.
b Around 1985, as before this date salmon were not being farmed.
- 2 The wild ones are likely to expend much more energy in searching for food and avoiding predators in the wild environment.

3



Chapter 6

- 1 At Nepal the Indian plate is colliding with the Eurasian plate. It is a destructive plate boundary. New Zealand has many earthquakes because the Pacific plate meets the Indo-Australian plate. At Christchurch these plates slide past each other.
- 2 Nepal is on a collision zone between the Indian and Eurasian plates. Earthquakes occur when friction builds up and is released. Christchurch is on a conservative plate boundary where the two plates slide past each other. Earthquakes occur when the two plates lock together and then suddenly slip.

	Nepal	Christchurch
Date of earthquake	Saturday 26 April 2015	Tuesday 22 February 2011
Time	11.56 a.m.	12.51 p.m.
Magnitude on Richter scale	7.8	6.3
Depth of focus	11 km	5 km
Distance of nearest city from epicentre	Kathmandu 80 km	Christchurch 10 km
Short-term impacts	Avalanches, blocked roads, buildings destroyed, infrastructure destroyed, airport shut down. Food, medicine and water in short supply. 9000 died and 23 000 injured	185 died. Buildings collapsed in the city centre. Suburban residents were evacuated. No electricity or water for 7 days

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- 4 Both earthquakes occurred during the day. People were awake and able to respond more quickly to the earthquake. In the case of Nepal in the rural areas people were working in the fields away from buildings that collapsed. The death toll would have been higher at night in both countries.
- 5 In Nepal the long-term impacts are homelessness, and lack of schooling for children as schools destroyed. Dealing with injuries. Slow recovery and rebuilding process. People suffering trauma. Lack of food initially as no storage facilities and following crop not planted. Isolation of rural communities as road rebuilding takes time. Impact on tourism as people are scared to visit and historic buildings destroyed. In Christchurch impacts are on economy as people worried about visiting. Cost of rebuilding. Mental issues with survivors. Less long-term consequences as able to rebuild quicker and finances available.
- 6 Suggestions from predict, prepare and protect list.
- 7 Refer to Figure 6.14, e.g. cross-bracing.

Chapter 7

- 1 a Nitrogen dioxide, particulates and benzo(a)pyrene

Source	Nitrogen dioxides	Particles PM10	Benzo(a)pyrene
Transport	85%	23%	12%
Domestic	9%	56%	21%
Industry	6%	21%	67%

- c Nitrogen dioxide: transport

Particle PM10: domestic

Benzo(a)pyrene: industry

- 2 a Temperature inversion

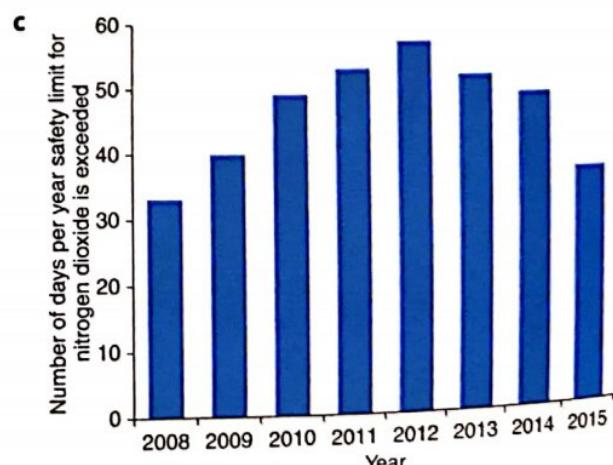
- b 2000 m

c The steep sides of the valley trap the pollution if there is high pressure. In winter, more domestic fires are used for heating.

- 3 a People become ill and take time off work, health care costs, tourists stop visiting the valley and so income is reduced..

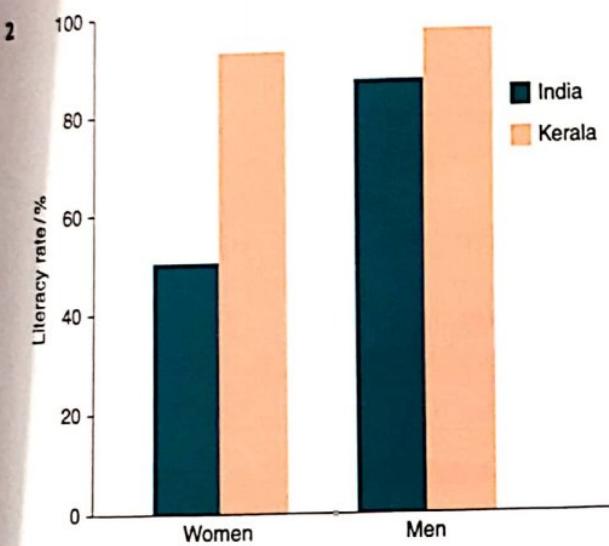
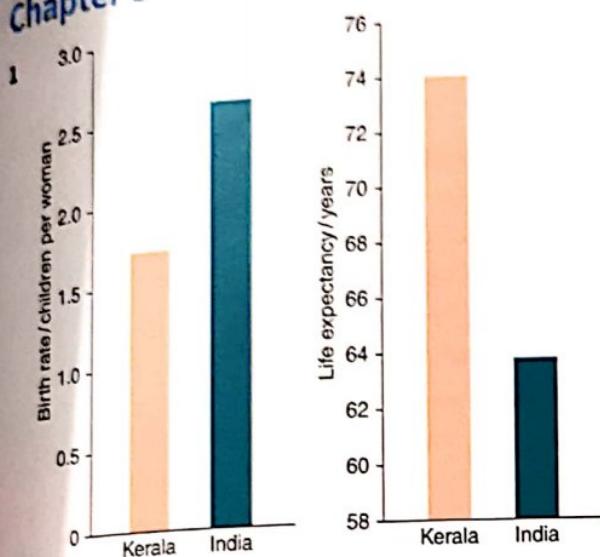
- b A Plan of Protection of the Atmosphere was devised in 2010 to reduce pollution.

- Public transport is free in the valley and carries up to 3 million people each year. Many buses are electric.
- Grande Genève aims to improve the rail network from Geneva to Chamonix, with more freight being transported by rail.
- 50% discount for electric cars in car parks.
- Pedestrianisation of areas in Chamonix and an increase in cycle lanes.
- Tax reductions and a local grant of 20% of total costs for homeowners who install sustainable heating systems, particle filters, solar panels and insulation.



d) 2012 had the most days (57) when nitrogen dioxide levels exceeded safe limits. Since then the number of days have decreased so the strategies could be said to be effective.

Chapter 8



- 3 Women gain more status and thus have more control within their family. This in turn allows them to have a say in the number of children in the family. Specific education about birth control again gives women some control over the number of children. Educated women are more likely to get jobs and have less time for child rearing.
- 4 The period over which a woman can bear children is limited. In most cases it would end at about 50. A later marriage therefore reduces the number of years over which a woman can have children, which leads to fewer children.

- 5 a) In Kerala, the fall in birth rate was $5.6 - 1.7 = 3.9$.

$$\text{This is } \frac{3.9}{5.6} \times 100 = 69.6\%$$

In India in general the fall in birth rate was

$$5.6 - 2.6 = 3.0 \text{ This is } \frac{3.0}{5.6} \times 100 = 53.6\%$$

- b) The case study states that 'it is thought that each year of female education reduces birth rates by 10%. So, a fall of nearly 70% in Kerala would take 7 years and of nearly 54% in India would be just over 5 years.'

- 6 The number of children has gone down. For example, up to age 9 there were about 7.6 million in 1991 but only 4.8 million in 2021. The number of older people has grown. Over 60s was 3.4 million in 1991 but 7.3 million in 2021. (Many other comparisons could be made.)

- 7 The population of Kerala is beginning to age and this brings its own problems. Hospitals may have enough places but they may be of the wrong kind, the emphasis shifting from care of young pregnant women and children to that of older people. Previous investment in schools and teachers will now become redundant as the population of young people falls.

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Chapter 9

- 1 Plants will colonise it after it has been left and these will die and decompose. This will add mineral nutrients to the soil. These will, over time, build up to sufficient levels to grow crops again.

2 a) $5 \times 1.25 = 6.25 \text{ g}$

b) $5 \times 0.75 = 3.75 \text{ g}$

- 3 The soil on the island is mainly red (laterite) due to high iron levels. Deforestation and subsequent soil erosion is washing this red soil into the rivers, which finally deposit it in the sea around the coasts. This loss of soil has worrying possible consequences for the environment, agriculture and the people. Gradually, the land will become useless for the growth of even the hardiest of plants, as it may end up as bare rock. This may be reversed but only over thousands of years.

- 4 In 18 years the pattern would be:

- 2 years of crop growth at $900 \text{ kg ha}^{-1} \text{ year}^{-1} = 1800 \text{ kg}$
- then 4 years of no crop
- then 2 more years as above = 1800 kg
- then 4 more years no crop

- this is 12 years, so this can happen one more time, giving a further 1800 kg.
 - so the total in 18 years would be $3 \times 1800 = 54 \text{ kg ha}^{-1}$.
- 5 The huge size and poor road infrastructure of the island, much of it being very isolated. Also, the fact that most of the people rely on the land for their survival
- and it is hard to stop them using it when it is basically means life or death to them.
- 6 They may use animals as food. The animals may attract ecotourists so there could be a loss of potential income if they are lost. Some of the animals may be important in the functioning of the ecosystems on which the people rely.

Answers to Practical activity questions

All questions and sample answers have been written by the authors.

Chapter 2

How well do materials reduce heat loss?

- 1 Adding an insulation layer slows down heat loss (meaning less energy is needed to replace this heat).
- 2 Jar B shows that heat loss is reduced most by a thick insulation layer. It also shows that the effect is not simply because the jar is no longer transparent.
- 3 The jar would stay hotter longer by using extra insulation (a warmer outside temperature will also have an impact).

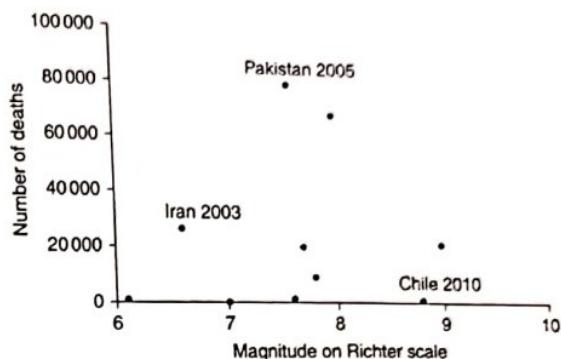
Chapter 6

Interpreting storm hydrographs

- 1 Hydrograph A = 3 h. Hydrograph B = 12 h.
- 2 Hydrograph A has a shorter lag time; higher peak discharge; more rapid response to the storm; discharge falls quicker after peak
- 3 Hydrograph A = urban drainage basin. Hydrograph B = rural, wooded drainage basin.
- 4 Hydrograph A because there is a short lag time so the water in the form of overland flow reaches the river very quickly.

Finding out whether there is a relationship between two sets of data

- 1 Pakistan 2005
- 2 Japan 2011
- 3 No correlation between magnitude of an earthquake and the number of deaths. Supporting data from two contrasting earthquakes.



Axes need to be labelled.

- 4 Ideas such as variation in population and building density; level of development; location of epicentre; time of earthquake; level of preparation; danger of aftershocks; long-term effects such as lack of shelter, water and spread of disease.

Chapter 7

Testing the effect of different levels of acidity on the germination of seeds

- 1 To compare results against a 'baseline' and to see if the effects were due to changes in pH level.
- 2 Temperature, number of seeds, age of seeds, size of Petri dish, light.
- 3 Average length of root (mm).
- 4 Increase pH range, increase sample size, more time for growth.