# Answers to Workbook questions

## Chapter 0: Key skills in Environmental Management

### Exercise KS.1 Aims and hypotheses testing, experimental design

**1** **a** Soil pH will not affect the growth of plants as measured by their height.

**b** The best way to do this would be to set up a controlled experiment. In this example, the independent variable would be the soil pH and the dependent variable would be the height of the plants. Different dependent variables could be used, such as dry mass of plants or number of leaves.

The design should involve pots of soil in which the soil is identical in every way except for its pH. The pH could be adjusted by the addition of weak solutions of acid or alkaline. The pH achieved should be checked with some kind of pH meter or pH paper. Plants of as near as possible exactly the same age and size should then be planted in pots. These pots should then be kept in identical environments where factors such as light intensity, temperature and relative humidity either do not vary over time or vary in the same way for all pots.

The height of the plants (or mass or leaf number) should be measured over time. The results can be recorded and analysed in a number of ways. One possibility for recording is to plot the height against time for each pH. A possibly more meaningful way of recording results in relation to the hypothesis is to plot the final height against pH. It would then be necessary to look at the graph to see if there was the relationship which will allow the null hypothesis to be rejected.

**c** As pH increases, the trend is the plant height also increases. The plant is 13 cm taller at a pH of 7 than it is at a pH of 2. Acid pHs seem to depress plant growth. The relationship is not a straight line and raising the pH from 4 to 5 has a much bigger effect on plant height than any other single pH unit change. The results strongly suggest that the null hypothesis should be rejected and that we can say that pH does have an effect on the height of this plant.

**2** **a** The presence of heavy-metal ions in irrigation water will cause a reduction in the yield of maize cobs as measured by mass harvested.

**b** independent variable: concentration of heavy metal in irrigation water

dependent variable: mass of maize cobs harvested

**c** the density of maize plants in each of the four plots (that is the number of plants being grown assuming the four plots are the same area)

the age of the maize plants planted in all the plots, which should be the same

**d** the nutrient status of the soil

the drainage of the soil

**e** The maize is grown in the same field which is divided into four plots. This should ensure that the soil is the same in all four plots in respect of its nutrient status and drainage.

### Exercise KS.2 Collecting data

**1** **a** Since the hypothesis mentions the predicted effect of heavy metal on growth rate, the mass of the fish would need to be determined over a period of time. Mass will be determined by weighing the fish on a suitably accurate balance. The choice of balance would be determined by the size of the fish, but since they are likely to be very small at the start of the experiment, a balance that can weigh to at least one place of decimals will probably be needed. The fish would be weighed on a regular basis over time. The regularity of weighing would be determined by the rate at which the fish are growing. In a fast-growing species, measurements may need to be taken once every few days, whereas in a slower growing species, weekly or even monthly measurements may be adequate.

**b** When it is not possible to count all of the individual items for which a result is needed, sampling has to be used. In this case a grid could be used. This could be constructed by ruling horizontal and vertical lines onto a large sheet of paper, which could then be laminated and placed in the bottom of a tray. All the eggs laid by the female could then be poured into the tray and the number of eggs in a random sample of the squares on the grid can be counted. The total is then found and divided by the number of squares sampled. This gives the average number of eggs per square and the total number of eggs can then be found by multiplying this average by the total number of squares. For example, if a 10 × 10 grid were constructed, this would give 100 squares in total. The eggs in 10 of these could be counted, the average number of eggs found, and this average then multiplied by 100. Such a procedure reduces the counting to be done tenfold.

**c** **i** quantitative continuous

**ii** quantitative discrete

**2** **a** open questions: B and D

closed questions: A and C

**b** A better order would be question C, then A, then B and finally D.

It is important to have closed questions at the beginning of a questionnaire. These are easier for the respondent to answer and make them more comfortable. Starting with a very factual question is also a good idea. Then, question A starts to lead the respondent into thinking about their opinion, but still not in an open-ended way. Question B ask them to recount personal incidents, which is then logically followed by D where they asked to suggest where they put the blame for these incidents.

**c** Have you had to go to the doctors with an ailment which s/he has suggested may be due to heavy-metal pollution of the water?

**yes** **no**

(this is a closed question)

Please describe to me the symptoms with which you went to see the doctor.

(this is an open question).

(Many others would be possible.)

## Exercise KS.3 Recording data

**1** **a** 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 𝍸 |||

**b**

| Heavy metal concentration | Number of eggs laid by female at this concentration | | | | | Mean number of eggs laid |
|---|---|---|---|---|---|---|
| | 1 | 2 | 3 | 4 | 5 | |
| 0 | | | | | | |
| 1 | | | | | | |
| 2 | | | | | | |
| 3 | | | | | | |
| 4 | | | | | | |
| 5 | | | | | | |
| 6 | | | | | | |

## Exercise KS.4 Presenting data

**1** **a** Hypothesis 1: a line graph in which the ***x***-axis is heavy-metal concentration and the ***y***-axis is the growth rate. Both variables are continuous. Heavy-metal concentration could take any value, and growth rate could also be any value between certain limits.

Hypothesis 2: In this case, the mean number of eggs laid by a female is a discrete variable. A female cannot lay half an egg, or any other fraction of an egg. This would suggest that a bar chart should be plotted.

**b** The data could be presented as either a pie graph where each sector represented the percentage affected in the stated category, or as a bar chart where each bar did the same.

**c** 122

**d** A histogram would be used as the data is frequency data.

## Exercise KS.5 Analysing data

**1** **a** **i** The trend is that as soil pH increases so does plant height.

**ii** The patterns are that a gradual increase in height occurs between pH of 2 and 4, then, between pHs four and five height increases dramatically. Between pHs five and seven there is not much increase in height at all.

**b** mean: 82

median: 79

mode: 79

range: 34

## Exercise KS.6 Drawing conclusions and evaluating

**1** **a** The data gathered suggest that fish reproduction is reduced by heavy metals. This is supported by data in the table in KS.4 question 1b (page 8). This shows that egg laying was unaffected in only 7% of the species of fish investigated. 70% of the species investigated were significantly or very badly affected.

There are no data to support the rejection or acceptance of the null hypothesis about the effect of heavy metals on fish growth.

**b** The experiment which was carried out does not go beyond a pH of 7. So the experiment could be extended by looking at the effect of pHs of 8 and above.

It is not clear from the results if there were replica plants at each height, although the ***y***-axis says plant height and not mean plant height, suggesting only one plant was measured. If there were no replication, an improvement would be to have, say, five plants at each pH.

# Chapter 1: Rocks and minerals and their exploitation

## Exercise 1.1 The rock cycle

**1** Working from the top of the diagram:

weathering

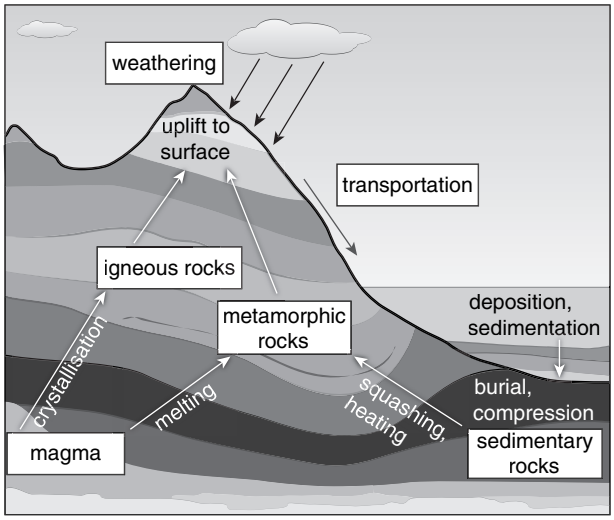
transportation

igneous rocks

metamorphic rocks

magma

sedimentary rocks




**2** There are numerous ways to complete this task – get a fellow student to see whether your version works.

**Q2 Example decision chart.**

(there are numerous solutions and the chart will vary depending on the types of samples used)

**1** Does the rock have lines or strata? If YES go to 2. If NO go to 3

**2** Does the rock have extremely small or invisible grains? If YES go to 4. If NO go to 5

**3** Does the rock contain crystals? If YES go to 6. If NO go to 7

**4 THE ROCK IS SHALE**

**5** Is the rock white or creamy in in colour? If YES go to 8. If NO go to 9

**6** Does the rock contain a lot of white patches? If YES go to 12, If NO go to 11

**7** Does the rock have flat, smoother layers? If YES go to 10, If NO go to 11

**8 THE ROCK IS LIMESTONE**

**9 THE ROCK IS SANDSTONE**

**10 THE ROCK IS SLATE**

**11** Are the grains in the rock larger/course? If YES go to 13. If NO go to 14

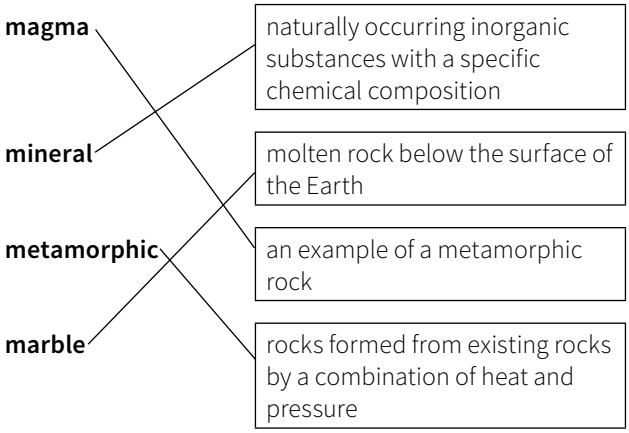
**12 THE ROCK IS MARBLE**

**13 THE ROCK IS GRANITE**

**14 THE ROCK IS BASALT.**

NB Other tests such as using dilute acid on a rock sample is also used scientists to determine the rock type as well as thee visual inspections.

**3**




**4** Sedimentary rocks are formed by the weathering of rock particles. The particles are transported in water and deposited in layers called sediments. These sediments may also include the dead remains of plants and animals (organic matter). The weight of the sediments on the top squashes the layers underneath and causes these lower layers to harden into rock.

## Exercise 1.2 Extracting rocks and minerals

**1** Three methods to find deposits of minerals could include the following.

- Prospecting – looking closely at the surface of the rocks.
- Aerial photography – a form of remote sensing. Aeroplanes or unmanned drones fly over large areas and take photographs which can be analysed for signs of minerals.
- Geochemical analysis – sediment samples are taken from streams or rocks and analysed chemically in a laboratory for signs of useful minerals.
- Geophysical analysis – a use of seismic vibrations into the ground – the frequency of the vibrations that are reflected back help to identify suitable areas for further investigation.

**2 Geology**

The position of the deposits. The depth of the minerals within the soil will impact on the decision whether to surface mine or use a sub-surface method. If the valuable mineral is in strata, the size of the strata may impact the ability to develop tunnels. Similarly, the stability of the rock will affect the choice of method used.

**Environmental impact**

Surface mining causes a large impact on the local area, requiring the removal of overburden and creating large, visible scars in the landscape. This would impact on other industries and local communities. Sub-surface mining will have some impact on the local environment, but much

of the works will be underground, lessening the impact on local vegetation, etc.

The leaching of materials into water supplies would also be an impact. Much will depend on the local situation as to which method has the greatest impact.

**Market price for the minerals**

The price paid for the minerals may make certain types of extraction, with costly processes, uneconomic. Surface mining is often the cheapest method, as is the use of explosives to break up rock. Both of these are likely to have greater environmental impacts than other methods. If the minerals are too expensive to extract, and the company will make a loss by doing so, then they are unlikely to mine at this site (impacting on local employment, etc.).

**3**

| Mine type | Advantages | Disadvantages |
|---|---|---|
| Open pit mining | Easier access to materials.<br>Large size of mines allow easy access of machines and workers. | Large areas of land damaged, looks unsightly, and causes a lot of dust and noise pollution. Produces large amounts of waste rock (spoil). |
| Strip mining | Easy access to the seams of minerals (from the surface). Large machines cut into the edge of the seam removing minerals efficiently and quickly. | Impacts large areas of land. Causes a lot of dust and noise pollution. Large amounts of spoil (waste rock). |
| Drift mining | Access to seams from sloping tunnel (adit) means less costly than making shafts.<br>Majority of overburden left in place. | More technically complex than strip or open cast mining (there is a risk of tunnel collapse). |
| Shaft mining | Reaches minerals not accessible by other methods. Less impact of the surface ecosystem (although still produces waste heaps). | Most expensive method. Risk of tunnel/shaft collapse, poisonous gases, underground fires and explosions. |



## Exercise 1.3 The impacts of rock and mineral extraction

**1** There will be additional employment opportunities for locals within the quarry. The new industry will also provide additional employment in other businesses (either supplying goods or services to the quarry) or meeting the needs of those employed.

The need for transportation will mean an improvement to local infrastructure. Additional workers brought into the area may mean the development of schools and health facilities too. The extraction of stone will also mean that costs of materials for industries, such as local stone masons, will be reduced as transportation of the materials they need will be cheaper.

**2** The development of the quarry will remove farmland which might have been productive.

Additional noise, dust and (possibly) water pollution will have an impact on the local population.

The offer of good wages by the quarry may mean the influx of people into the area seeking employment, which may have an effect on the demand for housing, food, etc.

Quarrying may also affect other industries such as tourism because of the changes it brings to the landscape.

**3** The topsoil would have been removed, so this habitat would be destroyed.

Additional noise may mean some animals or birds may move away.

Changes to the water table will affect natural species that live in the area.

There is a risk of pollution into water systems.

The removal of vegetation will affect the food web and appropriate habitats as species that rely on the vegetation for food and habitat may move from the area.

**4** It is difficult to know the impact of the loss of any species, but it is certain that this plant is part of a larger food web. This larger food web will be affected. The plant may play an important part in the life cycle of another animal (such as being food for the larvae of an insect). The knock-on effect of the loss may be far greater than initially realised.

The small plant may already be endangered, and, if this location is one of its last known growing areas, there is a risk of complete extinction.

**5** While much will depend on the location, it is most likely that shaft mining will have the smallest impact on the local topsoil. Open pit and strip mining are likely to cause the greatest risk of damage to the plant.

## Exercise 1.4 Managing the impact of rock and mineral extraction

**1**

| Potential use | Evaluation |
|---|---|
| Waste disposal site for household waste | Waste management will still provide employment locally. Many countries have a shortage of waste sites.<br>But air pollution, smells and risk of disease would increase. There is a potential of pollution to water sources and the area may still not be suitable to encourage wildlife that lost its habitat when the extraction started back to the area. |
| Naturalising the area by planting trees and sowing wild flower seeds | Encourages the reintroduction of wildlife into the area.<br>But this may provide limited future employment as the area will be unsuitable for food production. It will take many years to return to (something like) its original condition. |
| Conversion of the crater into a race track | Provides local employment to support this industry. May prevent countryside from being developed instead. Race track hidden in the crater, causing less visual and noise pollution.<br>But the site will be unsightly and not provide a natural habitat for animals and plants. |
| Flood the crater for use as a fish farm | A new source of employment to replace the jobs lost by the quarry closing. It will help to meet local food needs.<br>But there is a risk that pollution from the mine could cause water quality issues for the fish. Not all areas have sufficient water supplies to allow for fish farming. |
| Develop a shopping centre in the crater | An alternative form of employment. Lots more people employed than were employed in the quarry. Impact of development hidden, so less visual impact. Local area may become affluent.<br>But: will attract lots of vehicles to the area, impacts on local roads and quality of life. Does not provide a suitable habitat for organisms displaced when the quarrying started. |

**2** There are a number of ways in which materials may be disposed of. The most common is spoil heaps. The mining company needs to check for leaching of toxic materials in drainage water to ensure that toxic materials do not enter the water system and affect animals, plants and humans. Large piles of waste are also at risk from landslides. Monitoring probes could be set up on the spoil heap to check for any movement of the material that could preceed a landslide.

Heavy rain could also cause erosion of the heap. Checks could be made on a regular basis on the stability of the heap, checking in particular for areas prone to erosion.

**3** There are a number of reasons for poor and slow growth. These will include the following.

Poor soil structure: trees are planted on waste heaps. The particle sizes of the waste material may restrict the amount of oxygen getting to the tree roots and there may not be natural channels for the roots to penetrate.

Toxins in the soil: although present in low levels, some minerals may be at near toxic levels for trees, slowing down tree growth.

Lack of nutrients: soil has not formed over time and is lacking in key nutrients needed for plant growth.

Shallowness of soil: topsoil has been applied as part of the restoration process, so there is little soil depth for tree roots to penetrate.

Shortage in soil organisms: the soil ecosystem is very complex, and all elements of it work together to make the soil fertile. Some elements of the ecosystem may be lacking, so tree growth is reduced.

Lack of food sources for animals: the lack of vegetation may mean that herbivores (plant-eating animals) have fewer food sources to choose from, and the trees are therefore targeted as food sources far more than would normally be the case.

**4** 1600 × 0.11 = $176

**5** 40% = 0.4

1600 × 0.4 = 640 trees will survive

**6** The manager needs to reduce the number of variables so that (as far as possible) it is the impact of training that is measured.

Therefore the investigation should include:

- a comparison of results between untrained and trained workers
- as large a sample size as possible (i.e. the number of trees planted per worker)
- measurement taken of the same species, of similar size, in the same area, planted in the same way at the same time
- aftercare should be similar
- a review of the results on a regular basis
- the use of a standard way of measuring and recording results.

It may also be possible to look at the success rates of trees planted by a person before training and after training.

## Exercise 1.5 The sustainable use of rocks and minerals

**1**

| | | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|---|
| 1 **R** | E | C | L | A | M | A | T | I | O | N | |
| 2 **E** | X | T | R | A | C | T | | | | | |
| 3 **C** | O | A | L | | | | | | | | |
| 4 **Y** | I | E | L | D | | | | | | | |
| 5 **C** | R | U | S | H | | | | | | | |
| 6 **L** | E | G | I | S | L | A | T | I | O | N | |
| 7 **E** | F | F | I | C | I | E | N | T | | | |

**2** Some metal does not go into waste sites so is missed.

The processing of some materials is too costly and it is still cheaper to extract from the ground.

The refining process is not 100% efficient so some metals are wasted.

Some recycled metals are not of a high enough quality to be re-used.

**3** Any three from these.

- additional legislation
- improve the availability of waste recycling schemes so it is easier to do
- improved education on how to use services, etc.
- ensure products do not used mixed materials or are labelled clearly
- financial incentives (such as a car scrappage scheme where people are able to purchase a new car at a lower price if they arrange for their old car to be scrapped at approved scrapyards, where materials will be recycled where possible)

**4** Any two from these.

- reduction in employment (in an area where mining is important)
- impact of noise or pollution in an area where recycling is taking place
- impact on the local ecosystem by the opening of a recycling facility

# Chapter 2: Energy and the environment

## Exercise 2.1 Fossil fuels

**1** Fossil fuels are not actually made from fossils, but it is a useful term to describe the amount of time it takes to produce them. Fossils fuels are produced from the decay of **plants** and animals. These remains formed **organic** matter that became covered in layers of **sediment**. Over millions of years, and buried deep in the **ground** by the addition of further layers of sediment, the organic material is subjected to high **pressure** and heat. The precise conditions, and the type of animal and plant material available, will determine whether **coal**, oil or natural gas is produced.

**2** While the decay of organic matter is part of the process, the formation of fossil fuels such as coal or oil requires a great amount of time, significant pressure and heat. These three factors are not easily available so new fossil fuels will not be formed from this decomposition for many, many generations.

**3** Fossil fuels are formed under great pressure. This usually occurs due to layers of sediment forming on top of the organic matter (such as in a river bed). Successive layers increase the pressure and will typically turn into sedimentary rock over a long length of time.

## Exercise 2.2 Energy resources

**1**

| Non- renewable energy sources | Renewable energy sources |
|---|---|
| Oil | Geothermal |
| Coal | Hydroelectric |
| Nuclear | Wave |
| Natural gas | Tidal |
| | Wind |
| | Solar |
| | Biofuels |

**2** Wind turns the blades of the turbine. This kinetic energy is converted into electrical energy within the turbine by electromagnetic induction.

**3** Solar power can also be used to heat hot water, reducing the need for other power sources to perform the same task.

**4**

| Issue | Reason given |
|---|---|
| Economic | Loss of land for other economic uses. Loss of other industries used to support the production of energy by non-renewable means. |
| Social | Increase in local population as a result of buildling new scheme brings pressure on roads, schools, etc. Need for more food and water locally. |
| Environmental | Building of the new scheme may cause deforestation, and loss of habitats locally. |

## Exercise 2.3 The demand for energy

**1**

| | Increase | Remain the same | Decrease |
|---|---|---|---|
| A change in employment types in a country from farming to industrial | ✓ | | |
| A downturn in the world economy | | | ✓ |
| Increased average household wages | ✓ | | |
| A warmer than expected winter temperature in a temperate country | | | ✓ |
| The building of a more affordable car in a LEDC | ✓ | | |
| A law meaning power companies must use more renewable sources of energy | | ✓ | |
| An increase in population | ✓ | | |

**2** **a** Greatest users of power (per head of population)

| Rank | Country |
|---|---|
| 1 | Qatar |
| 2 | United Arab Emirates |
| 3 | United States of America |

Smallest users of power (per head of population)

| Rank | Country |
|---|---|
| 10 | Cambodia |
| 11 | Bangladesh |
| 12 | Afghanistan |

**b** The countries are all LEDCs. Households are using less electricity than in a MEDC. Industry and transportation are also less developed so less power is used.

**c** All three are oil-producing countries so the supply of energy is cheaper (and more abundant). They are all rich countries. Industry and infrastructure are also more developed than in LEDCs.

**d** 234.92/3.78 = 62 people

## Exercise 2.4 Conservation and management of energy resources

**1** **Reduce energy consumption**

Use more energy efficient appliances.

Ensure electrical equipment is not left on stand-by mode.

**Reduce energy waste**

Improve insulation of home.

Use of more energy efficient light bulbs (more light, less heat).

**Re-use energy**

Use of waste food products for anaerobic digestion.

Use of heat exchanger (to capture excessive heats produced by occupants). See the Passivhaus case study in Section 2.4 of the Coursebook.

**2** **a** Lighting accounts for 29% of the total energy used.

**b** 16% = 0.16

$120 000 × 0.16 = $19 200

**c** 9% = 0.09

From previous answer, cost of energy to equipment is $19 200

$19 200 × 0.09 = $1728

**d** Answers could include:

Heating costs:

reducing the temperature to which the building is heated by a small amount

improving insulation/reducing heat loss through windows and doors

reducing the temperature when the building is not in use.

Cooling costs:

use natural ventilation rather than air conditioning

only use air conditioning when the building is in use

add shading to windows to reduce heat build-up.

**3** Many renewable sources (such as solar power or wind power) are dependent upon suitable environmental conditions. There need to be back-up systems for when the wind does not blow or it is dark.

**4** Oil (and shale gas) are in decreasing supply and in great demand. The extraction of fuel by fracking will help meet global demand. In addition, these are complex processes and result in the development of jobs locally. The investment in this scheme will mean employment for many years to come.

Fracking is also covered by safeguards from government as part of their licence. To meet these conditions, the risks to the local environment are closely controlled.

**5** **a** The student should choose light bulbs that emit the same light intensity (not the same wattage).

The electricity circuit for each investigation should be identical (either by using the same circuit or three identical systems). Each bulb should be tested for the

same duration. The circuit should contain an electricity meter so that total power consumption can be recorded.

**b** Cost of the electricity used by each bulb is only one factor in overall cost of use. Others include: cost of purchasing the bulb; life expectancy of the bulb; the cost of equipment/labour to replace the bulb.

## Exercise 2.5 Impact of oil pollution

**1**

| | | | | | | | | |
|---|---|---|---|---|---|---|---|---|
| [1]A | C | C | I | D | E | N | T | |
| [2]M | A | R | I | N | E | | | |
| [3]O | F | F | S | H | O | R | E | |
| [4]C | R | U | D | E | | | | |
| [5]O | I | L | | | | | | |
| [6]C | O | L | L | I | S | I | O | N |
| [7]A | I | R | | | | | | |
| [8]D | E | A | T | H | | | | |
| [9]I | N | D | U | S | T | R | Y | |
| [10]Z | E | R | O | | | | | |

Name of the famous oil spill accident: AMOCO CADIZ

**2** Oil tends to float on the top of water and spreads thinly (and widely). A small amount of oil will spread a great distance. On land, oil does not spread as far. Marine organisms have difficulty getting sufficient oxygen after an oil spill as the oil forms a coating on the sea surface.

## Exercise 2.6 Management of oil pollution

**1** Graph to include a plot for 2003 at 7800 billion tonne-miles. The line should also be completed. (The result should show a reduction in this year.)

**2** 1974

**3** Transportation reached a peak in around 1977. There was a sharp decline until around 1985. Since then there has been a gradual increase to around 10 000 billon tonne-miles, which is still less than the peak figure of around 11 500 billion tonne-miles.

**4** The main design change has been the introduction of double-hulled ships. This means that a hole in the outer skin does not mean a release of oil.

**5** The MARPOL treaty did not ban the use of older-style ships, so they were still in use and vulnerable. It is also hard to police the treaty in the middle of the oceans so some illegal dumping may occur. The treaty was not signed by all countries.

**6**

| Method | Advantage | Disadvantage |
|---|---|---|
| Booms | No use of chemicals, the oil slick is contained. | Does not work in rough sea conditions. Large booms needed to capture large slicks. |
| Skimming | Does not use chemicals (which might also harm the environment). | Not particularly effective in rough seas. Oil is not contained and may still be spreading. |
| Detergent | Disperses oil slicks more rapidly than other methods. Can be applied in most weather conditions. Can be applied over large areas by aircraft. | Detergents may damage marine life. Bioaccumulation (build-up of the chemical in the food chain) of the detergent may occur. |

# Chapter 3: Agriculture and the environment

## Exercise 3.1 The composition of soil

**1** Soil is a **habitat** for plants and other organisms. The **four** main components of soil are: **mineral** particles, the **organic** content, air and water. The proportion of air in the soil will depend on the size of the **pores** in the soil and the amount of water in the soil at any particular time. In drought conditions, the amount of air will **increase** and water content **decrease**. The mineral particles occupy the largest volume of the soil and are formed from the parent rocks by **weathering** and erosion.

**2**

| Particle | Size of particle (mm) | Texture (when moist) |
|---|---|---|
| Sand | 2.0–0.02 mm | gritty |
| Silt | 0.02–0.002 mm | silky |
| Clay | <0.002 mm | sticky |

**3** The different particles will separate out at different rates. The largest particles (sand) will fall to the bottom, the silt particles will fall next, but after such a short length of time the smallest particles (clay) are still likely to be suspended in the water. They will take many hours to separate out completely.

## Exercise 3.2 The components needed in soil for plant growth

**1**

| | | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|---|
| [1]P | H | | | | | | | | | |
| [2]O | R | G | A | N | I | C | | | | |
| [3]T | E | X | T | U | R | E | | | | |
| [4]A | I | R | | | | | | | | |
| [5]S | A | N | D | | | | | | | |
| [6]S | I | L | K | Y | | | | | | |
| [7]I | R | O | N | | | | | | | |
| [8]U | N | A | V | A | I | L | A | B | L | E |
| [9]M | I | N | E | R | A | L | | | | |

Plant nutrient : Potassium

## Exercise 3.3 Understanding the availability and effect of soil nutrients

**1** Calcium (Ca), Magnesium (Mg)

**2** Somewhere around pH 6.5

**3**

| Plant nutrient | Symptoms of deficiency include |
|---|---|
| Nitrogen (N) | Slow growth, yellowing leaves (oldest first). |
| Phosphorus (P) | Leaves dull with blue-green colour. Leaves fall early. |
| **Potassium (K)** | Poor-quality fruits and seeds, leaves with brown edges. |
| Sulfur (S) | Yellowing of leaves (youngest first). |
| **Calcium (Ca)** | Death of plant tissues. Poor fruit storage. |
| Magnesium (Mg) | Yellowing of leaves between the leaf veins. Early leaf fall. |
| **Iron (Fe)** | Yellowing of leaves between the veins (youngest leaves first). Failure to flower. |
| **Copper (Cu)** | Dark green leaves become twisted and withered (young leaves first). |
| **Zinc (Zn)** | Leaves show poor development, might only grow to a very small size. |
| Boron (B) | Leaves misshapen and malformed. Hard 'woody' areas in fruits and other storage organs. |

## Exercise 3.4 Comparing the use and properties of clay and sandy soils

**1**

| | Advantages | Disadvantages |
|---|---|---|
| Clay soil | f. Larger water holding capacity. | c. Risk of getting waterlogged.<br>d. Soil goes very hard when dry. |
| Sandy soil | a. Excess water drains easily.<br>e. Soil is easier to cultivate.<br>g. Soil warms up quicker (as holds less water). | b. Nutrients leach through the soil more easily. |

**2** A sandy soil is easier to cultivate and warms up more rapidly (as it holds less water).

**3** Clay soils are more suited as they will hold more water (less watering needed in the summer) and less prone to nutrient leaching. Therefore, there are more nutrients available for the crop to produce a heavy yield.

**4** The combined total of the clay and silt fractions is 25% meaning the soil will be 75% sand; a very high percentage. This will mean that plant roots will be able to penetrate easily, but the water holding capacity will be low. The particles have a lot of air spaces, so the soil will be easy to cultivate but not very stable. Nutrients will be easily leached through the soil with the water. The lack of water will mean the soil will warm up quickly too.

**5** **a** Ensure all seeds are planted at the same time / have the same amount of time to grow.

Grow in same volume of soil.

Keep all three jars in same light/ temperature.

Provide all jars with adequate water (so this is not the limiting factor).

Measure total root length at the same point in time.

**b** Three from:

Use more replicates.

Ensure the investigation uses the same variety of soybean.

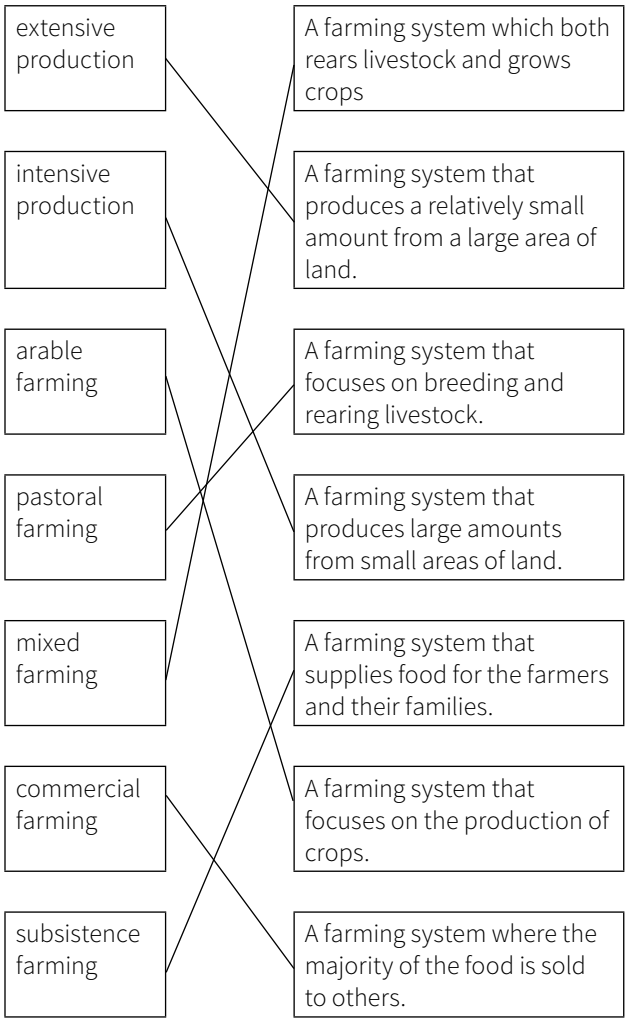
Wider investigation with more soybean varieties.

Ensure all soils have the same water content at the start of the experiment.

Ensure soils have the same nutrient content.

## Exercise 3.5 Classifying types of agriculture

**1**




**2** The pressure to increase profit in commercial agriculture (as is commonly seen in Western countries), has meant a smaller range of items are produced on a farm. The aim of a commercial farm is to generate income which can be used to buy other items, whereas a subsistence farmer is producing food for their own family.

Maximising profit has also meant farms have often specialised into arable or pastoral production rather than mixed farming, as the investment in machines or equipment required to do mixed farming is very costly.

## Exercise 3.6 Improving agricultural yield

**1** Three from:

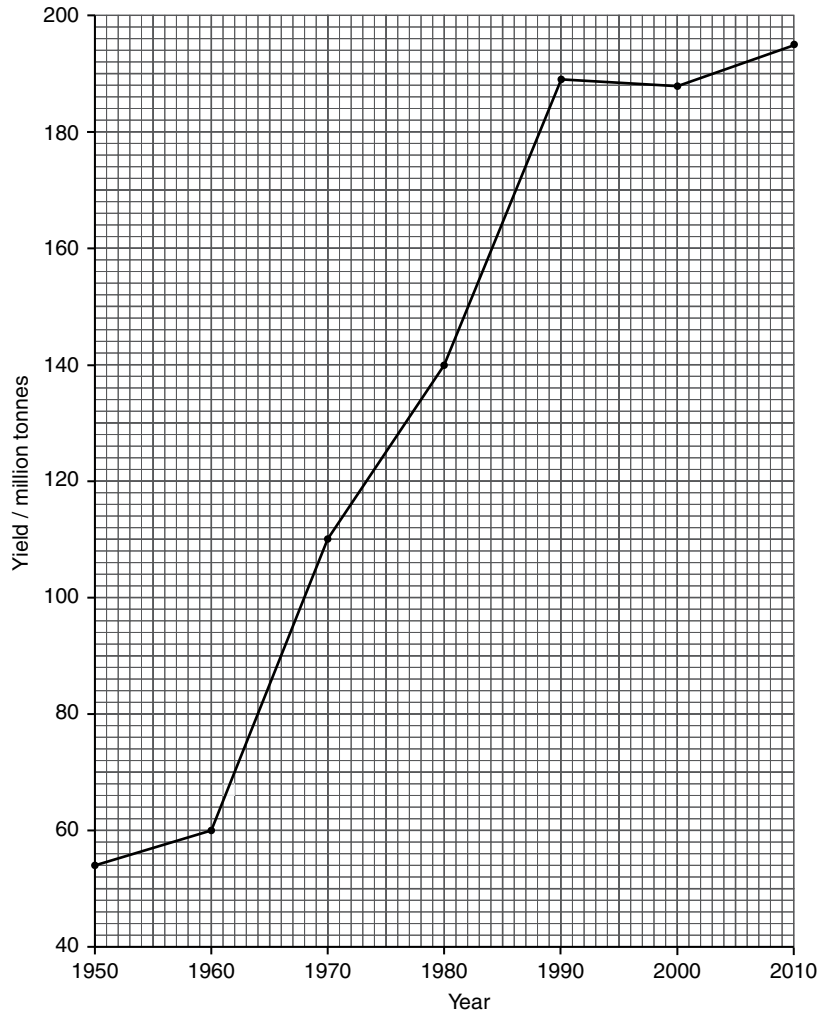
improved efficiency in use of non-renewable resources

to meet the needs of a growing population

excess food is a useful commodity to export, making the country richer

improving yield means less land is needed for food production, allowing land to be used for other purposes (e.g. urbanisation).

**2**




**3** Increase in yield since 1950, the maximum yield being 2010. The increase was initially rapid, but has started to slow down. From 1990 to 2000, the yields were nearly identical.

**4** In 2000 the weather might not have been as suitable for the rice crop.

There could have been an increased incidence of pests/ disease.

(NOTE: This question is related to yield as it is not impacted by the area of rice grown.)

**5** Calculated by:

$$\frac{\text{yield in 2010} - \text{yield in 1950}}{\text{yield in 1950}} \times 100\%$$

Therefore

$$\frac{195 - 55}{55} \times 100\%$$

$$\frac{140}{55} \times 100\% = 254.5\%$$

An increase of 255 %

**6** **a** crop rotation

Crop rotation reduces the build-up of pest and disease problems in a plot as the crop is not available in the next season for the pest or disease to continue their life cycle, so the pest or disease dies out. Some crops also provide nutrients for future crops (legumes produce nitrates, useful for future leafy crops). Some crops require deep cultivation for harvesting, meaning the land is already suitable for the next crop.

**b** irrigation

Additional water may be required by certain crops to complete their life cycle. It is often very important once fruit/seeds have been set, as irrigation may increase yield. Shortage of water will impact on a plant growing and may make it susceptible to pest or disease.

**c** plant breeding

Selective breeding allows farmers to use varieties with improved characteristics which impact on yield. This might mean a shorter growing season (so two crops could be grown in one year), increase in grain/fruit

size, or shorter crops (which are less likely to be blown over). They may also be more pest resistant, or drought tolerant, meaning an improved yield in poor growing conditions.

**d** pesticides

Control of pests and diseases will mean a decrease in attacks on the plants (increasing yield), ensuring a harvest is achieved (where in certain conditions it might not occur) and also reducing the spoilage of crops in store.

**e** herbicides (weed killers)

Weeds compete with the crop for water, nutrients and light. They may also be a source for pests and diseases. Controlling weeds will have an impact on all these factors.

**f** mechanisation

The use of machines will allow areas to be cultivated more efficiently, including, perhaps, areas that it would not be possible to cultivate by hand. Harvesting will also be more efficient, meaning less crop is wasted.

**g** genetic modification

Genetic modification is more than just selective breeding. It allows the breeder to select characteristics that are not naturally within the plants, allowing the plants to grow in hostile conditions, or to be resistant to pests. Herbicide resistance may also allow a breeder to use these chemicals on the crop. GM may also increase the nutrient value of the harvested crop.

## Exercise 3.7 Controlling the growing environment

**1** Light: managed by use of supplementary lighting or shading (to cut out light)

Temperature: use of heating pipes to increase temperature, ventilation will help reduce temperature

Nutrients: use of fertilisers on the soil, use of liquid nutrients as part of a hydroponic system, monitoring the nutrients closely by computer.

Water: use of irrigation systems (often linked to a soil moisture sensor), hydroponic systems supply water at all times.

Growing media/soil: soil sterilisation to kill soil-borne pests and diseases, analysis of soil structure, use of artificial growing media such as rockwool



## Exercise 3.8 Impacts on the environment

**1**

| Production input | Name of potential problem | Definition of the problem |
|---|---|---|
| fertilisers | eutrophication | **Leaching of nutrients into rivers and lakes. Nitrates and phosphates cause blooming (growth) of algae. Their death causes oxygen depletion by decomposing bacteria. Aquatic organisms die due to lack of oxygen.** |
| irrigation | **salinisation** | The increase in salt levels in the soil. This prevents plants from absorbing water efficiently through their roots. |
| **pesticides** | resistance | The lack of effectiveness of chemicals to kill plant pests due to over-use and mutation of the pests. |
| mechanisation | soil compaction | **Reduction in air spaces in the soil reduces irrigation, and reduces the oxygen reaching plant roots. Soil organisms also affected. Overall reduction in fertility.** |
| irrigation | soil capping | **Hard crust forms on the soil surface preventing easy absorption of water. There is a greater risk of rainwater running off.** |
| keeping grazing animals at high density | **overgrazing** | Reduction in amount of vegetation, loss of plant species, lack of plant roots causes erosion. |
| mechanisation | deforestation | **Less natural vegetation (due to need for machines to operate efficiently). This might cause erosion of the soil as well as destruction of habitats.** |

## Exercise 3.9 Managing soil erosion

**1** All continents are affected. Very few areas are described as having stable soil. Very degraded soil is mainly in the Northern hemisphere. Only large patches of stable soil are in North America and Asia.

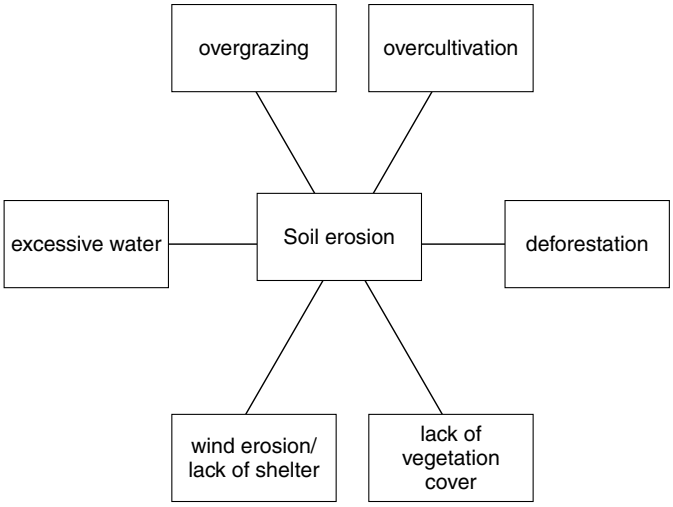
Answer could also name specific regions/ countries.

**2** These areas have been used less for agriculture: the climate does not support it, so they have been left untouched. Smaller population densities in these areas. Still natural forest, etc.

**3**

| | |
|---|---|
| Impacts in the field | • Loss of crop/yield<br>• Harder to use mechanisation<br>• Loss of topsoil/ damage to soil structure |
| Impacts downstream | • Silting up of water courses/rivers<br>• Increase risk of flooding / mudslides/damage to houses<br>• Impact on infrastructure<br>• Leaching of nutrients/ contamination of water supplies |

**4**




**5** Farmers need to cultivate land efficiently if they are to maximise its yield. If the techniques used result in the loss of the **topsoil**, fertility is lost. One way in which the impact of erosion on a steep slope may be reduced is by **terracing**. This reduces the speed of the water and allows it to **infiltrate** into the soil. Contour ploughing works on a similar principle, the ridges and troughs following the **contours** of the land. The use of **bunds**, artificial banks at the edges of growing spaces, will also help hold back water.

Wind erosion may also be reduced by planting natural vegetation at the edges of fields to act as wind breaks. These act as **permeable** barriers which reduce the speed of the wind. There are numerous other ways of helping to reduce erosion. Leaving soil covered with the vegetation from a crop, for example, will mean that soil is retained by the **roots** of the plants. Bare soil increases the risk of erosion. Lack of topsoil may increase the risk of desertification in an area, increasing **famine** and malnutrition to the local population.

**6** Circled: animal manure, composted plant material, food waste, recycled paper, dead leaves

## Exercise 3.10 Sustainable farming

**1** **C** Using processes that allow the use of the same resources for future generations.

**2**

| Issue | Explanation |
|---|---|
| Pest and disease control | Crop plants in a plot change in each growing season, so there is no food supply for the pest or disease. |
| Soil cultivation | Harvesting a deep-rooted crop means soil is already (part) cultivated for a crop that needs deep cultivation. |
| Fertiliser use | Legumes provide nitrates to the soil from nitrogen-fixing bacteria in their roots for other crops. |
| Improved human diet | Range of produce grown, providing a wide range of nutrients and minerals in a person's diet. |
| Reduction in crop over-supply | Range of crops grown meaning less of a glut of one item. |

**3** Trickle drip irrigation: supplying water directly to the roots of the plant.

Buried clay plot: water added to the clay pot, water seeps out into the soil as needed to the roots of the plant.

Computer-controlled systems: used in glasshouses. Probes used to monitor water content of the soil and plants, irrigating only when necessary.

Other techniques such as mulching will also reduce water loss from a soil.

**4** While all fertilisers may cause risk of leaching, organic fertilisers are often bulky and nutrients need to be broken down by other organisms before they are available to plants. This means the release of nutrients is more gradual. The bulky organic matter will also add humus to the soil, improving soil structure and holding more water. The humus content will also support a wide range of soil organisms, helping longer term fertility.

Bulky organic matter (such as animal manure) is often available locally (and a waste product), so transportation costs are lower and less waste needs to be disposed of.

**5** There is a great pressure for farmers to increase yield. This has (so far) been met by an increase in efficiency

of traditional systems. The predicted growth in world population will need a further significant increase in yield. The use of genetic modification could help achieve this and reduce the risks posed by an increased use of other technologies such as further increased use of fertilisers (which may cause eutrophication) and increased use of pesticides (which could affect food webs and the wider ecosystem).

Genetically modified crops might also have lower inputs (meaning less transport costs for fertilisers, etc.). Genetic modification might also mean more nutritious foods, leading to a reduction in malnutrition, and the ability to grow crops in poorer soils and more hostile conditions.

The introduction of pest resistance may give higher yields, as well as less wastage of food whilst being stored.

# Chapter 4: Water and its management

## Exercise 4.1 The distribution of water on Earth

**1** 3% is fresh water so 97% is saline.

97% = 0.97

0.97 × 1.4 billion $km^3$ = 1.358 billion $km^3$

**2** Total water on Earth = 1.4 billion $km^3$

Water vapour in Earth's atmosphere = 13 000 $km^3$

1.4 billion $km^3$ = 1 400 000 000 $km^3$

$$\frac{\text{Water vapour in Earth's atmosphere}}{\text{Total water on Earth}}$$

$$= \frac{13\,000}{1\,400\,000\,000} = 9.3 \times 10^{-6} = 0.00093\%$$

## Exercise 4.2 The water cycle

**1** Some rainfall does not reach the ground because it is **intercepted** by trees and plants.

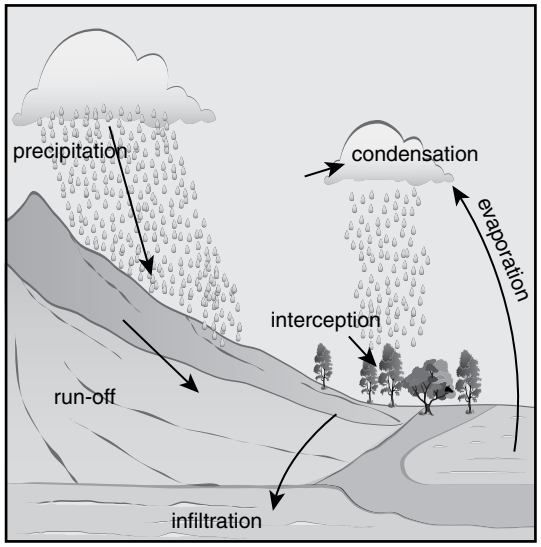
Some rainfall flows over the surface and ends up in streams and rivers. This is called **surface run-off**.

Some rainfall re-enters the atmosphere in a process called **evaporation**.

Some rainfall seeps into the ground, which is called **infiltration**.

**2** The water molecule leaves the ocean by **evaporation** and enters the atmosphere. Here, water droplets form by **condensation**. The water droplets make clouds. The droplets may then fall to Earth in **precipitation**. The water can enter the soil by **infiltration** and be taken up by **roots** of **plants**. The molecule may then leave the plant by evaporation, condense into clouds again and fall as precipitation, this time back into the sea.

**3** **a** and **b**




**4** Water in spaces in rocks and the soil.

**5** Through-flow is the horizontal movement of water through soil.

Ground-water flow (base flow) is the horizontal movement of water through rock.

**6** It would be expected to increase due to the impermeable surfaces of the roads, paved areas and buildings. This means the water could not infiltrate and so would run-off.

## Exercise 4.3 Why humans need water

**1** For example

Industrial: cooling in power stations

Domestic: washing clothes

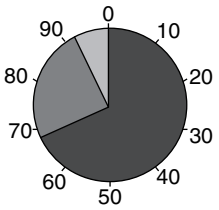
Other answers are possible.

**2** Agree: If the water was not potable due to bacteria in it, these bacteria or other disease-causing organisms would not be taken up by plants and so would not get into humans who eat the plants.

Disagree: If the water is not potable due to having poisonous chemicals in it, these may be absorbed by plants and then get into humans who consume the plants.

**3**

| | |
|---|---|
| irrigation | 68 |
| domestic | 7 |
| industry | 25 |



## Exercise 4.4 The main sources of fresh water for human use

**1** An aquifer

**2** A bank-side reservoir would not contain potable water. A service reservoir would contain potable water.

**3** Limestone, sandstone

**4** Artesian aquifer

**5** Desalination is the name given to any process that removes salt from seawater to make it potable. Distillation is one of the methods by which desalination can be achieved.

**6** Distillation uses more energy than reverse osmosis (RO); in this respect RO is more sustainable. RO is probably more efficient than distillation (Distillation is 10 to 30% efficient, RO is 30 to 50% efficient). Brine is produced as a waste product in both.

## Exercise 4.5 Availability of safe drinking water around the world

**1** The country may be too poor to actually treat the water to make it safe. It also may be too poor to collect the water in the quantities needed for the population.

**2** Physical water scarcity is a situation in which there is not enough water for human needs.

Economic water scarcity is a situation in which there is enough water available, but the money does not exist to extract or treat enough of it.

**3** Sanitation refers to keeping dirty water separate from drinking water. Water treatment is carried out to turn water that is not safe to drink into potable water.

**4** The percentage without access has gone from 23% to only 9%, so it has more than halved, going down by 14%. This is probably due to a big expenditure of money by governments, aid agencies and others on water-treatment facilities in the countries where access was least good in 2000.

## Exercise 4.6 Multipurpose dam projects

**1** There are benefits to building dams but there are problems too. Cheap electricity should become available when the dam is built and devastating flooding may be controlled by the dam. On the other hand, people may lose their homes and there may be a rise in the incidence of water-related disease.

**2** It is on a river not long after the river has emerged from very high mountainous terrain. This means the river will be fast flowing and thus be an excellent source of the power needed to drive turbines to generate hydroelectric power. It is also quite near two large cities, so the electricity generated can be quite easily taken to where it is needed.

**3** hydroelectric power (HEP), flood control, reservoir for tourist activities

## Exercise 4.7 Water-related diseases

**1** adult female mosquito

**2** The larvae (young stages) live in water where the female lays her eggs. The flooded rice fields provide a highly suitable environment for the larvae. The water is more or less still, which makes it an even better environment for mosquitoes to breed.

**3** **a** spraying inside huts kills the vector, the mosquito

**b** sleeping under nets will stop the vector from biting sleeping humans at night, when the vector is most active

**c** covering water with oil will kill the larvae, which come to the surface of the water to breathe. The larvae won't be able to take air at the surface of the water. Oil would also stop females laying eggs in the water.

**4** Using drugs to kill the *Plasmodium* parasite.

**5** The water may contain bacteria that cause disease.

**6** cholera and typhoid

## Exercise 4.8 Disposing of human waste safely and delivering potable water to people

**1** Sewage can harbour disease-causing organisms which may get into humans if the sewage is allowed to mix with drinking water.

**2** Sewage is treated to reduce the amount of **organic** material. If this is not done before the sewage is sent to a river, then **bacteria** will break it down, producing a biological **oxygen** demand. To make river water potable, it is passed through a water **treatment** plant. The water is filtered to remove **larger** particles. It is disinfected with **chlorine** to kill **bacteria**.

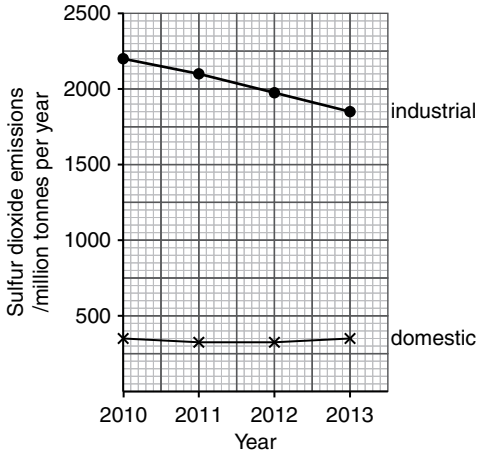
## Exercise 4.9 Pollution of water by industry

**1** It is likely that the factory was carrying out a process that caused it to dispose of mercury-contaminated substances into the river. This did not cause immediate problems because, although poisonous, the mercury was initially at such low levels it did not constitute a problem. Eventually though, due to biomagnification, it reached toxic levels in fish, causing their death.

**2** Eating fish caught from the river may cause mercury to build up in the villagers' bodies to levels at which it became poisonous to them.

## Exercise 4.10 Acid rain

**1**




**2** Industrial goes down, domestic hardly goes down at all. An increase in wealth might suggest that industrial activity would have increased and it would be expected that sulfur dioxide emissions might also rise. The fact that it fell suggests that this developed country has taken steps to limit these emissions. This may include the use of alternatives to fossil fuels which emit the gas when burnt for energy production. Another possibility is that strategies are in place to remove the gas from the emissions. This might include scrubbers in chimneys and desulfurisation.

**3** Sulfur dioxide and oxides of nitrogen dissolve in water in the atmosphere to form sulfuric and nitric acid respectively.

**4** 67 + 19 + 2 + 2 + 6 + 8 + 28 + 16 + 7 = 155 million tonnes

**5** 7

**6** (155 + 11) – 41 = 125 net amount affecting Sweden

so percentage = $\frac{11}{125} \times 100 = 8.8\%$

**7** Sweden receives sulfur dioxide and $NO_x$ from other countries but also exports these gases to elsewhere as well.

## Exercise 4.11 Eutrophication

**1** X nitrate, phosphates

Y sewage, nitrates, phosphates

Z oxygen

**2** The weir serves to stir the water, which helps to dissolve oxygen in it, which leads to fish returning.

**3** Sugar waste will not stimulate algal growth.

The algae do not use up oxygen. They actually produce it. It is the decomposition of the dead algae which uses up oxygen.

**4** Take equal volumes of water from each lake. Place these in as suitable container. Add to each container a known number of duckweed plants. Place the two containers under the same source of light and at the same temperature. Count the number of duckweed plants over a period of a few days, enough to allow a change in number to occur. Calculate the rate of change in duckweed plant numbers. This result forms a baseline for each lake.

Now set up the same experiment but with the water from each lake enriched with nitrate at the same concentration for each. Again, count the number of duckweed plants over a period of time which would be sufficient to show a significant change in both samples. Calculate the new rate of change in duckweed numbers. Compare the rates of change under enrichment with that in un-enriched water.

# Chapter 5: Oceans and fisheries

## Exercise 5.1 The resource potential of the oceans

**1** Products:

food in the form of fish and shellfish, etc.

oil

building materials

Services:

tourism

transport

**2** Seawater contains 35 parts per thousand of salt. This is more than humans can tolerate and it has to be removed from the body. This is done by urination, and more water is excreted than is gained by drinking seawater in the first place.

**3** The sea is best for transporting very heavy goods where there is low urgency for their delivery. The air can transport relatively light goods very quickly.

**4** 17.8 ÷ 1034.3 × 100 = 1.7 %

**5** Coral reefs are found in the tropics both north and south of the equator and are particularly concentrated in the Caribbean, the Red Sea, the Indian Ocean and off the east coast of Australia.

**6** 22 500 ÷ 254 = 88.6 times

**7** Sihwa Lake Tidal Power Station = 293 000 000 ÷ 254 = US$1.15 million per megawatt.

The Three Gorges Dam = 37 000 000 000 ÷ 22 500 = US$1.64 million per megawatt.

So, the Three Gorges costs US$0.49 per megawatt more than the Sihwa Lake Tidal Power Station.

## Exercise 5.2 World fisheries

**1** Protein

**2** All fish rely either indirectly or directly on plants or plant-like organisms for their food. Most rely on tiny microscopic green algae called phytoplankton. These organisms can make food in photosynthesis using energy from sunlight. However, sunlight cannot penetrate very deep into water. So phytoplankton are most abundant in shallow water.

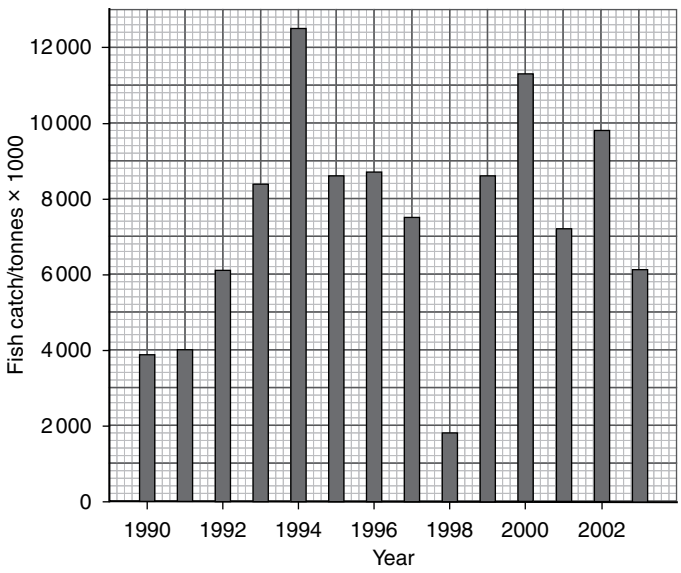
In addition to light, carbon dioxide and water, phytoplankton need some minerals. These tend to sink to the bottom of the sea and so are not available in the surface water where there is light. In some regions, though, upwelling brings the minerals to the surface. So in the shallow waters with upwelling, phytoplankton have everything they need. The fish which feed on the phytoplankton, and the fish which feed on fish which feed on phytoplankton, are also found here.

**3** Carbon dioxide is very soluble in water.

**4** Continental shelf

**5** Although there is a large continental shelf region on both sides of India, because there are warm currents there is not much upwelling and so phytoplankton numbers are limited by a lack of minerals.

**6**




**7** It could have been that there was a very significant El Niño around that time. An alternative explanation is that there was a very much increased fishing effort that year. The latter explanation seems unlikely as this would need a major investment in equipment and personnel, which would still be around in subsequent years. So El Niño seems the more likely explanation.

## Exercise 5.3 Exploitation of the oceans: impact on fisheries

**1** Fish which are the wrong size, sex or species.

**2** Difference in weight = 5.1 – 3.2 = 1.9

Percentage difference in weight = 1.9 ÷ 5.1 × 100 = 37.3%

**3** An increase in demand for fish.

The use of bigger boats.

The use of bigger nets.

**4** The main food fish from the sea are carnivorous species. This means that they are part of complex food webs and it is difficult for humans (as fish farmers) to supply them with all the different species that they eat. In addition, many carnivorous fish change their feeding habits as they age. This makes providing them with food even more difficult.

## Exercise 5.4 Strategies for managing the harvesting of marine species

**1** If the mesh size is large then small, juvenile fish can escape through the larger mesh. This means that the number of fish available to grow to adult size and then reproduce is increased.

**2** Sustainability is any strategy to use a resource in a way that ensures the possibility of its continued use in the future. Allowing juvenile, non-reproductive, fish to grow to adult size ensures that fishing can continue in the future but also carry on in the present.

**3** A quota is a limit on the amount and type of fish that can be caught. It is usually backed by the law and patrolled by some kind of government organisation who have the right to board vessels and inspect the fish catch.

**4** Governments try to protect fish stocks by setting limits on the numbers caught, called a **quota**. Another strategy involves closing the fishery down for part of the year. This is referred to as a **closed season**. Finally, fishermen can be prevented from operating in certain areas, called protected areas, which are often the main **breeding** area for the fish.

**5** No matter how potentially useful a strategy might be, it is only as good as how well it is enforced and respected. Because, for many people, fish are their main source of food and income, the incentive to ignore or avoid laws is great. Worldwide, there are millions of fishermen and a very much smaller number of people trying to control them. It is not difficult to fish in areas which should not be fished, to catch fish which are smaller than the limit that has been set, and to under declare the size of catch.

**6** **a** The survey will have to be done using a sampling method. Since the sea cucumber is a slow-moving, bottom-living animal, quadrats would be a suitable sampling method. The quadrats chosen would need to be of a suitable size which depends on the size of the sea cucumbers and their density on the seabed. Quadrats should be positioned randomly on the seabed. Laying out a grid in the area to be sampled and choosing quadrat positions with random number tables could do this. The data required is numbers of sea cucumbers in a defined area. The quadrat constitutes a defined area and so numbers within this simply need to be recorded. A suitable number of quadrats would need to be used to get a representative sample. The location and date of all samples would need to be recorded.

**b** The largest decrease occurred in 2002: 0.21 sea cucumbers $m^{-2}$.

**c** Every year in the graph shows the same pattern of fewer sea cucumbers after the fishing season than before. This is not surprising, as the sea cucumber population probably would not have had time to recover from the fishing. Every year also shows the same pattern of an increase in sea cucumber numbers between the end of fishing and the beginning of the next fishing season.

**d** There appear to be two trends. There is a general rise in sea cucumber numbers between 1999 and 2002 and then a fall in numbers between 2002 and 2005.

**e** The tanks are of different sizes and the description does not say how many young sea cucumbers were placed in the tank at the start of the experiment. It is important that the initial density of young sea cucumbers is the same in both tanks at the beginning. It would be best to have tanks of the same size with the same number of young sea cucumbers placed in each. Another factor which varies between the two tanks as shown is the flow rate of seawater. When the tanks are the same size, the inlet and outlet pipes should also be the same size to ensure equal flow. The description does not state how much food was placed in each of the tanks. The best way to control this variable will be to provide the same mass of food in each tank. The experiment has not been repeated, so another suggestion would be to have at least three replicates of both tanks, six tanks in all. It might also be sensible to have a look at a wider range of diets than just two. Finally, the experiment does not have a control which would be best done by having a tank in which the young sea cucumbers were given no food but had to rely on that in the seawater flowing through the tank.

**f** Both show an increase in mass over the 45 days of the experiment. The increase in mass of the sea cucumbers fed on shrimp starter as a food starts straightaway whereas over the first 15 days those fed on chicken manure showed no mass gain at all. The growth rate from day 15 to day 30 is the same in both sets of sea cucumbers. But after 30 days those fed on shrimp starter as a food grew faster than those fed on chicken manure again. These differences in growth rate meant that after 45 days, sea cucumbers fed on shrimp starter as a food were over twice as heavy as those that were fed on chicken manure.



# Chapter 6: Managing natural hazards

## Exercise 6.1 Definitions

**1** lithosphere

**2** destructive

**3** fold mountains

**4** basaltic

**5** oceanic

**6** oceanic trench

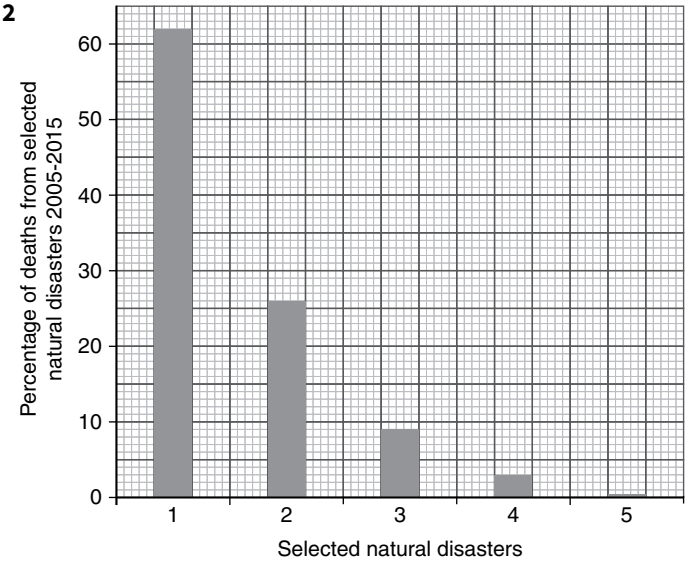
**7** composite

## Exercise 6.2 Comparing natural hazards, focusing on volcanoes

**1** In each case, you need to divide the number of deaths by remove 663 080 and multiply the result by 100 to find the percentage you need for the final column.

| Natural disaster type | Number of deaths 2005 to 2015 | % of deaths from selected natural disasters 2005 to 2015 |
|---|---|---|
| Earthquakes | 411 090 | 62 |
| Volcanoes | 463 | 0.1 |
| Tropical Storms | 170 251 | 26 |
| Floods | 60 855 | 9 |
| Droughts | 20 421 | 3 |

**2**




**3** Only some volcanic eruptions are violent.

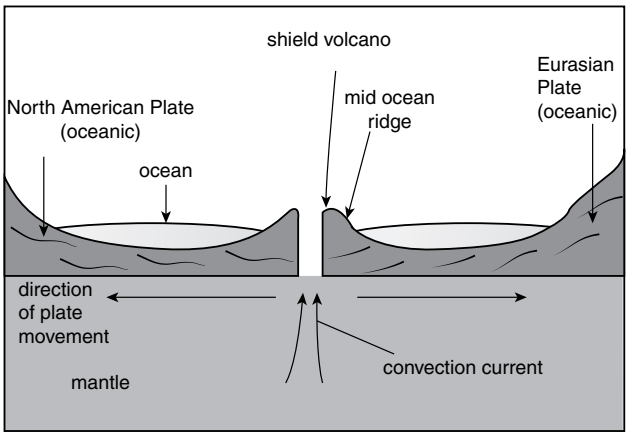
Volcanoes can give out warning signs, for example, ash and gas, small tremors, bulges.

People have time to prepare with volcanoes.

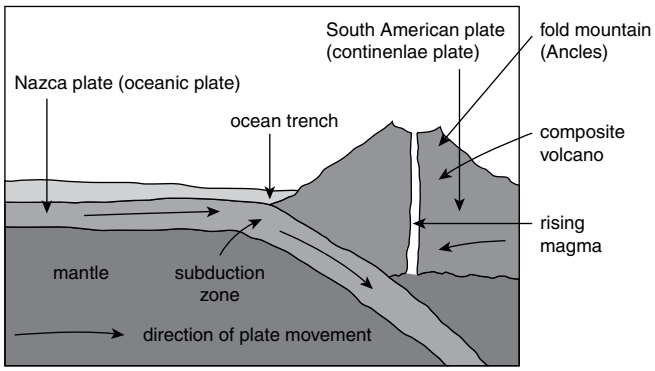
People have time to evacuate with volcanoes.

Some volcanoes are monitored for possible eruptions.

**4**




**5**



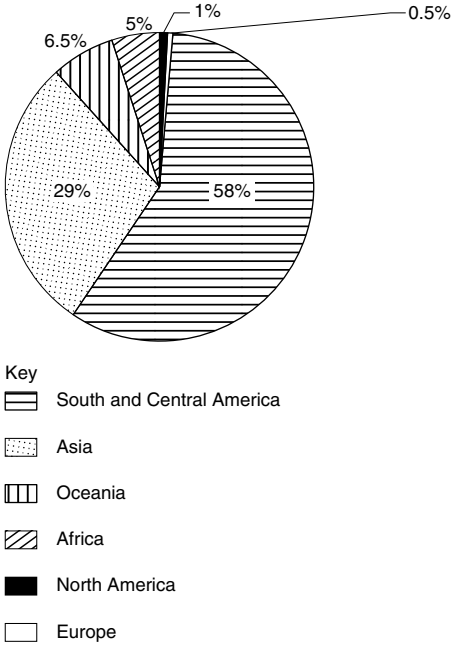

**6** A = ash cloud

B = crater

C= vent

D = magma chamber

**7**




**8** **Regions:** Central and South America and Asia

**Reasons:** More composite volcanoes because of destructive plate boundaries.

The eruptions are unpredictable and violent.

Higher population density.

Many people are subsistence farmers and farm near volcanoes because of fertile soil.

Climate – monsoon rains can trigger lahars.

Less money to spend on prediction and responses so more deaths from injuries, starvation, disease and lack of clean water.

**9**

| Primary cause of death | Number of deaths |
|---|---|
| lahars | 28 110 |
| pyroclastic flows | 8466 |
| gas | 1700 |
| ashfall | 300 |

**10** Four from:

Lack of clean water.

Lack of food as crops and livestock destroyed.

Lack of suitable shelter.

Transport disruption.

Livelihoods lost.

**11** Strategies can include: prediction, preparation, dealing with the event, responses after the event.

**12** Population density in affected areas.

Jobs in farming.

Idea of prediction – lasers, monitoring gases, movement of magma.

Idea of preparation – early warning systems.

Perception of danger – awareness, education.

Type of eruption- explosive and non-explosive.

Type of magma – thick, sticky = more violent basaltic = gentle eruption.

MEDC or LEDC – ability to react.

**13** Family or friends live there or they have always lived there and don't want to move.

Impossible to move away due to lack of money.

Don't perceive any danger as volcano hasn't erupted for a long time or they don't think it will happen to them.

Lack of space due to population pressure.

Jobs in tourism such as souvenir seller or guide.

Fertile soils are created which produce high crop yields.

Scenery can be spectacular and is worth the risk of staying.

Geothermal power can supply a cheap form of power.

Mining minerals such as sulfur, diamonds and gold.

Symbolic or religious icon.

## Exercise 6.3 Flooding and management strategies

**1** floodplain

**2** impermeable

**3** afforestation

**4** infiltration

**5** interception

**6** Flooding is when the **discharge** of a river exceeds the capacity of the river's channel. When this occurs the river overflows the banks and covers the adjacent floodplain.

**7** Links should be as follows.

| | |
|---|---|
| deforestation | If trees are removed there is less interception and infiltration. |
| previous weather | The more saturated the soil the less infiltration can take place. |
| rock type | Impermeable rock leads to greater overland flow. |
| relief | Steeper gradients lead to faster overland flow. |
| heavy rainfall | The infiltration capacity is quickly exceeded and overland flow takes place. |
| urbanisation | Concrete and tarmac are impermeable and lead to more overland flow. |

**8** Very heavy rain

**9** Lack of interception.

Lack of leaf litter which slows the movement of water into the soil.

No trees to absorb soil moisture.

Ground becomes hard and compact leading to an increase in overland flow.

More sediment is washed into the river channels reducing capacity.

**10** Deaths much higher in Malawi. 276 died in Malawi compared to 19 in France.

**11** Effects are usually longer lasting and more severe in an LEDC compared to an MEDC because of the lack of financial resources to deal with a flood before, during and after an event. LEDC more dependent on aid for recovery.

MEDC can afford better flood defences and are likely to have better flood warnings.

People can be evacuated when warnings are given.

Population may be more dense in an LEDC.

In an LEDC more people depend on farming as a livelihood. Loss of crops and livestock can lead to food shortages and force migration.

Diseases can spread more quickly in an LEDC due to inadequate medical facilities and infrastructure.

**12** The floods may deposit fertile silt.

Water washes away sewage.

Can flood the land when you need it to grow rice.

Opportunity to build better house.

Flood defences built.

**13** Hard engineering strategies are **structures** that are constructed to try to **control** the river. Examples of hard engineering are **dams** and **flood walls**. Soft engineering works with the river and its drainage basin and uses **natural** processes. Examples include **afforestation** and **land use zoning**.

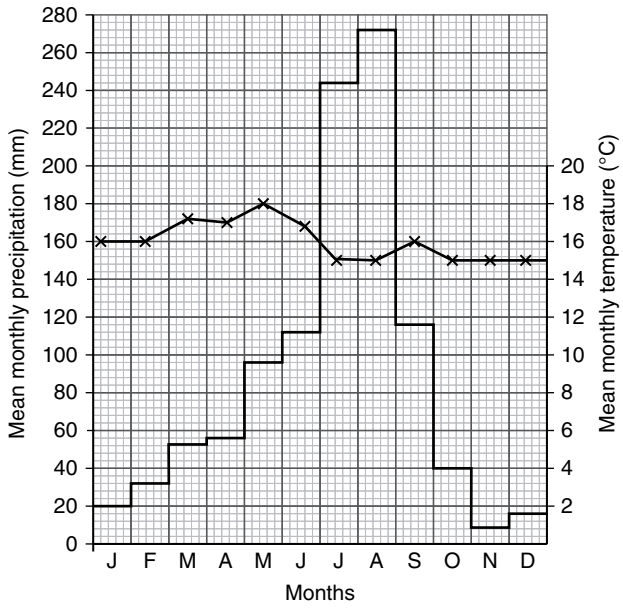
**14** Answers can be yes or no.

Yes – Strategies can be long lasting and effective in a short period of time after construction. Schemes such as dams are multipurpose, for example, fishing, tourism and electricity. Levees can be used for transport routes. People may ignore warnings and not evacuate.

No – Expensive and not sustainable. Often construction relies on aid. Visual pollution and reservoirs behind dams may displace people or flood farmland and wildlife habitats. Eventually the reservoirs will silt up and reduce deposition of silt on farmland. Money would be better spent on flood warnings, evacuation procedures, for example, flood shelters, improving infrastructure. Soft engineering strategies may be more appropriate to the skills of local people and encourage wildlife.

## Exercise 6.4 The impacts of drought

**1**




**2** 1065 mm

**3** 3°C

**4** November to December – lowest amount of precipitation for crops and livestock

**5** **a** Comparison – failure of spring rains in Ethiopia and lack of rain in California between 2011 and 2015.

Contrast – In Ethiopia the drought was made worse by El Niño and in California higher temperatures resulted in a lack of snowmelt.

**b** In Ethiopia crop and animal loss can lead to malnutrition and deaths. People are forced to sell off livestock and migrate. They are dependent on emergency food aid.

In California the loss of crops is reported as a financial loss. No lives are in danger and some of the impacts are on non-essential activities such as golf courses. Solutions are water restrictions and desalination plants.

**6** Groundwater supply water pump, rain water storage tank, percolation ponds, buildings of bunds, afforestation, etc.

## Exercise 6.5 The impacts of tropical cyclones

**1** Tropical cyclones are **low** pressure weather systems that produce winds of **119** km per hour or greater. They develop in the tropics between the latitudes **15°to 30°** north or south of the equator where the surface ocean temperatures are greater than **27** °C. In the northern hemisphere the winds rotate around an area of calm called the **eye** in a direction that is **counter-clockwise**. Tropical cyclones are called **typhoons** if they form over the north west Pacific Ocean.

**2** Ocean location where sea warms up to at least 27°C. Ocean depth of at least 60m. Rising air currents leading to condensation of water vapour. Formation of cumulonimbus clouds and area of deep low pressure.

**3** February, August

**4** 20.3%

**5** July to October

**6** Twenty tropical storms on average hit the Philippine islands each year. Typhoon Lando started as a tropical storm in the **Philippine Sea** and moved in an **westerly** direction. It became a typhoon on the 16th October with wind speeds of **119-165 kms** per hour but passed over the Philippines slowly, north of the city of Manila, across the island of Luzon. Over 300 mm of rain fell across the island over 2 days. The monthly average is usually 182 mm.The typhoon then moved **north** and was downgraded to a tropical storm on **19th October**.

**7** Typhoons happen frequently (on average twenty a year), authorities had advance warning of typhoon, country is very vulnerable to the effects of typhoons, closest land area to the source region.

**8** Dangers of flooding from storm surge, heavy rain leading to flash flooding. Mudslides in the mountains. Houses destroyed, people drowned.

**9** Providing people with food as crops destroyed.Rebuilding transport routes for emergency aid. Restoring electricity power so people can cook and rebuild. Provide people with fresh water. Finding and burying bodies to reduce spread of disease.

**10** Same information recorded, gives a representative sample

**11** Selected at random or systematically, specific location for a fixed time, only one person per household, from list such as phonebook, suitable age range for respondent

**12** 35,2

**13** Didn't want to leave property and possessions, didn't hear warnings, fear of possessions being stolen, didn't think impact would be too severe, elderly relatives can't move

**14** How old are you? Are you male or female? What features in the area do you consider vulnerable in the event of a typhoon? Etc.

**15** Stay indoors away from windows and glass doors – avoid injury from broken glass caused by strong winds

Ensure a water supply – fill large containers- a supply of clean water to reduce risk of water contamination and disease

Listen to the radio or watch tv- to prepare to evacuate

Store enough food to last for a few days- avoid hunger as crops/livestock destroyed and infrastructure for supplies destroyed

**16** Ideas could be poverty and wealth, degree of preparedness, level of technology, disaster relief, improved forecasting, structure of buildings,efficiency and organisation of the authorities, level of technology.

## Exercise 6.6 A review of natural hazards

**Across**

**1** tsunami
**6** lahar
**7** lithosphere
**8** aid
**9** storm surge
**12** epicentre
**14** core
**15** basalt
**16** fold
**17** constructive

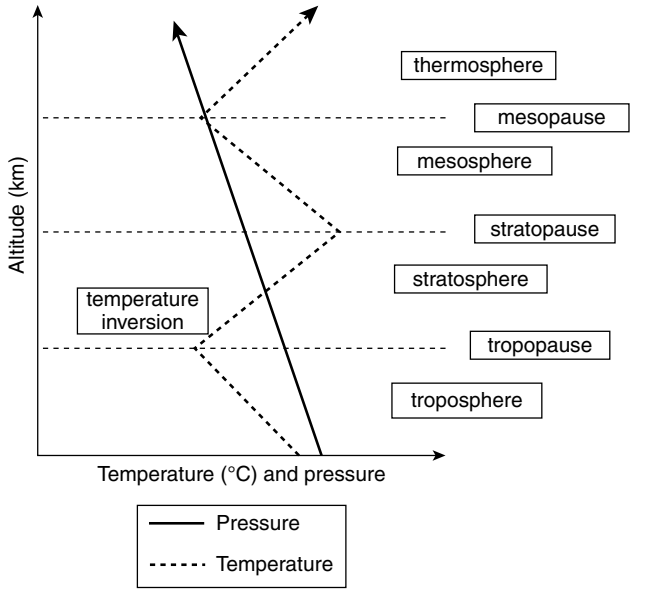
**Down**

**1** tropical storm
**2** subduction
**3** levee
**4** liquefaction
**5** earthquake
**10** shield
**11** eye
**13** typhoon

# Chapter 7: The atmosphere and human activities

## Exercise 7.1 The structure and composition of the atmosphere

**1**




**2**

| Statement | Letter |
|---|---|
| This gas is used by plants in photosynthesis. | B |
| Ultraviolet radiation is absorbed by this gas. | D |
| The most abundant gas in the atmosphere and a product of volcanic eruptions. | E |
| This gas is produced by photosynthesis and is used in respiration. | A |
| Keeping cattle can increase the level of this gas. | I |

**3**

| Pollutants | Smog | Photo-chemical smog | Acid rain | Ozone depletion | Global climate change |
|---|---|---|---|---|---|
| Chlorine from CFCs | | | | ✓ | |
| Sulfur dioxide and nitrogen oxide | | | ✓ | | |
| Carbon dioxide, tropospheric ozone, CFCs, methane | | | | | ✓ |
| Nitrogen oxide, tropospheric ozone, VOCs | | ✓ | | | |
| PM10 | ✓ | | | | |

## Exercise 7.2 Global climate change

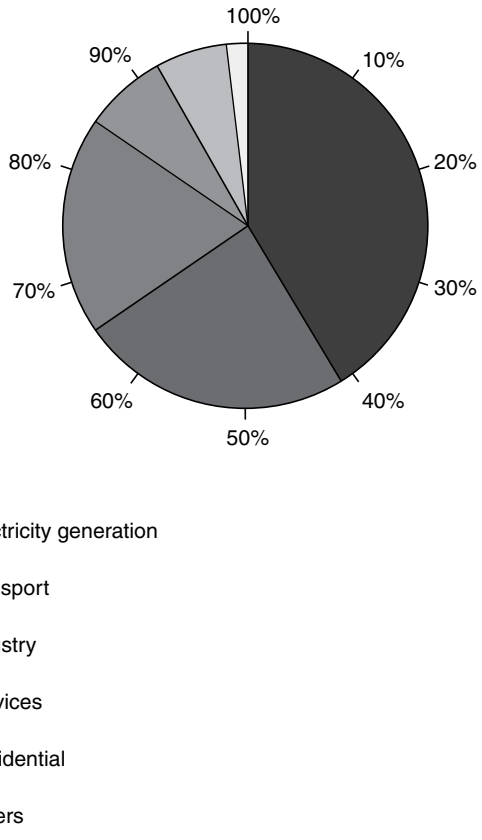
**1** Radiation from the Sun is called **short-wave** radiation. Almost half of this radiation is **absorbed** by the Earth's surface and makes the Earth warmer. **Long-wave** radiation is **emitted** by the Earth. This radiation is **absorbed** by greenhouses gases such as **carbon dioxide** and the atmosphere heats up.

**2** There is a positive correlation. As carbon dioxide emissions increase, so do average surface temperatures. In 1980 carbon dioxide emissions were about 315 ppm and the temperature anomaly was –0.10°C. By 2013, carbon dioxide emissions were 395 ppm and the temperature anomaly was 0.65°C.( A positive correlation does not 'prove' a causal relationship between the two variables – though most scientists agree that there is one here)

**3** Seasonal changes of photosynthesis, respiration rates and decay.

**4** Increase in carbon dioxide can lead to increase in temperature because of increased absorption by carbon dioxide of the long-wave or infrared radiation that is emitted from the Earth.

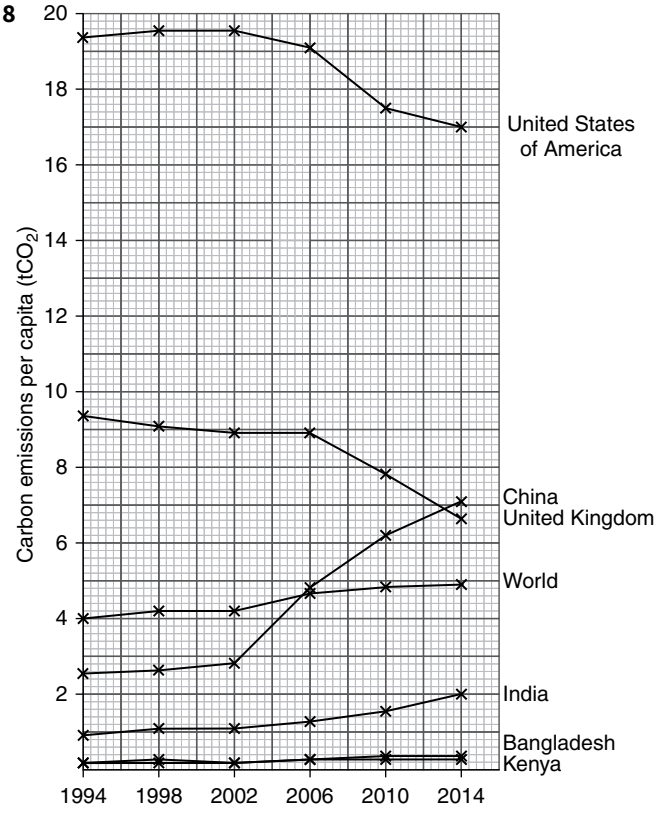
**5**




**6** transport and electricity generation

**7** methane, nitrous oxides

**8**




**9** LEDCs on the graph have lower values than MEDCs. For example, in 1994, India had 0.9 tonnes $CO_2$ per person compared to USA with 19.4 tonnes $CO_2$ per person. MEDCs values are declining, LEDCs are increasing.

**10** $8\frac{1}{2}$

**11** 3

**12** LEDCs increasing industrial development, increasing population and burning of fossil fuels for cooking. In LEDCs there is less investment in non-renewable fuels than in MEDCs. There is more car ownership in LEDCs. MEDCs have tighter controls on emissions than LEDCs.

**13** Low-lying countries are likely to flooded and, if the country is densely populated, people and resources will be affected. This could lead to forced migration into cities and the resulting problems of overpopulation. Malnutrition and famine may occur as land and crops are flooded. Some MEDCs may have to spend money on extra defences against coastal erosion and rising sea levels. Disappearance of glaciers and ice sheets could reduce water supply (and affect the skiing industry of a country). Impacts of tropical cyclones would be more frequent and intense. Countries at a low level of economic development find it harder to cope with such problems as they lack the necessary financial resources.

**14** Your answer should focus on the various international conferences such as the Rio Earth Summit, Kyoto Protocol, Paris Climate Conference, etc. You will not get any credit for mentioning Montreal Protocol.

## Exercise 7.3 Ozone depletion

**1** Thinning of the ozone layer leading to depletion over a large area, especially over Antarctica. The natural seasonal thinning was made worse by certain human activities.

**2** An upward trend with fluctuations.

**3** CFCs

**4** Use in aerosol sprays, fire extinguishers, air conditioning, refrigerators, etc.

**5** CFCs are broken down by UV radiation and chlorine is released. Chlorine reacts with ozone, depleting the ozone layer.

**6** Increased ultraviolet radiation can lead to sunburn, cancers (skin), retina damage, cataracts, leaf damage, plankton damage, reduced immunity.

**7** Montreal Protocol (1987) reduced or banned use of CFCs. Alternative materials and processes used, e.g. pump action sprays. More responsible waste disposal or recycling, e.g. draining CFCs from refrigerators.

**8** CFCs stay in the atmosphere for 1000 years.

## Exercise 7.4 The causes, impacts and management of smog

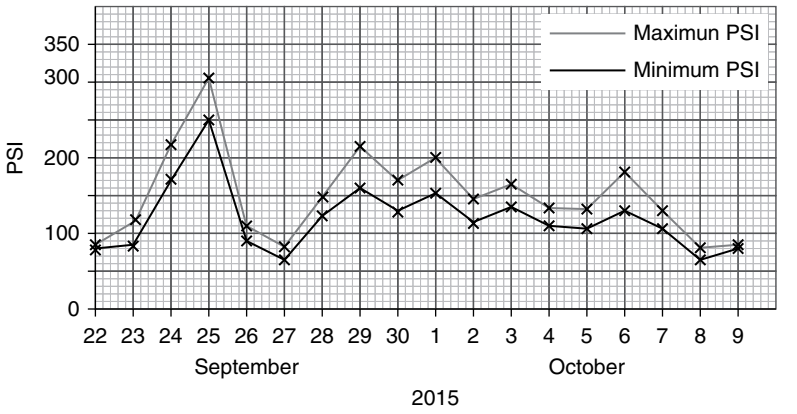
**1** Smog covered Malaysia, Singapore and the Indonesian islands of Sumatra and Kalimantan. The densest areas were to the west of Sumatra and southern Kalimantan.

**2** 1.3 million $km^2$

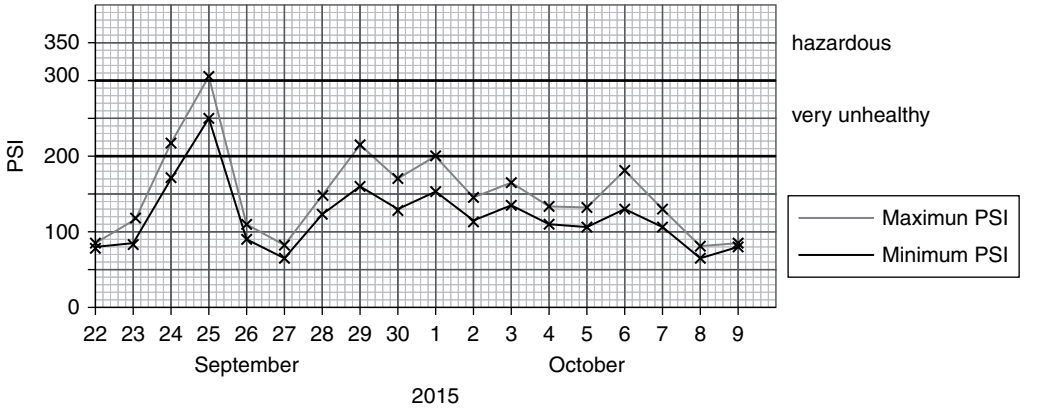
**3** North/North East because of the direction of the prevailing wind.

**4** Forest fires in Sumatra and Kalimantan

**5**




**6**






**7** 1 day

**8** 4 days

**9** 8 October as PSI values start to fall

**10** 27 September – pollution levels may have dropped because of a change in the wind direction or a thunderstorm and rain

**11** Four from:
health problems – breathing difficulties, eye irritation, asthma attacks
traffic disruption – flights cancelled, poor visibility on the roads
financial impact – reduction in tourism, loss of crop productivity and trade
schools closed
cancellation of major sport events.

**12** More car ownership as people need cars/road transport. As cities get larger, there is a greater distance to travel. Increasing affluence so people can afford cars. Weak enforcement of air pollution laws. In some urban areas in LEDCs, increasing size of population and cooking using air-polluting fuels such as charcoal or wood.

**13** Forest fires: deployment of 21 000 troops, cloud seeding and helicopters water bombed. Retention basins for water. Farmers provided with assistance to pursue alternative practices of forest management. An on-line land registry to identify those responsible for starting the fires, companies encouraged to sign zero deforestation pledges. The Singapore government fined companies up to $1.6 million if guilty of causing the smog. The government also established a smog early warning system via mobile apps and the internet and has an education programme so people know how to protect themselves during a smog event, e.g. face masks or to stay indoors and avoid strenuous activity.

**14** D C B E A

**15** Random sampling (using a random number table) or stratified sampling (along a transect)

**16** To collect enough particles. Easy to collect the next day. Allows easy comparison of sites.

**17** One from:
The size of sticky tape squares. The height above ground level. Same type of sticky tape.

**18** Fewer sites. Not representative of the whole town. Only one recording time.

**19** More sites. Covers more of the town. Larger quantity of data. Covers more time.

**20** Ideas could include traffic count, wind speed, land use.

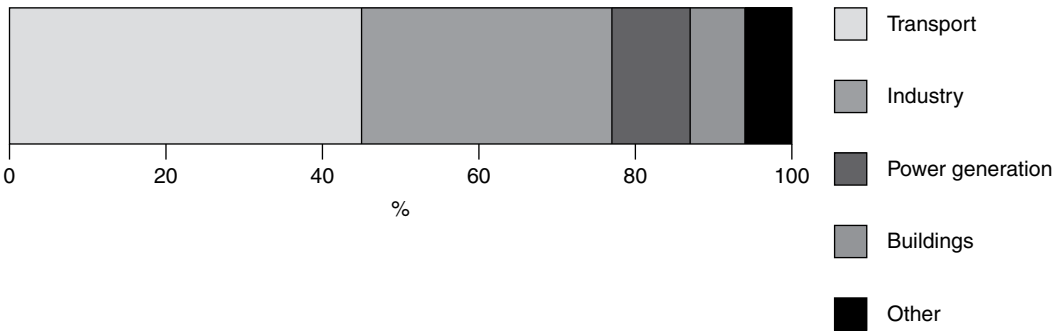
## Exercise 7.5 The causes, impacts and management of acid rain

**1** Volcanic eruptions

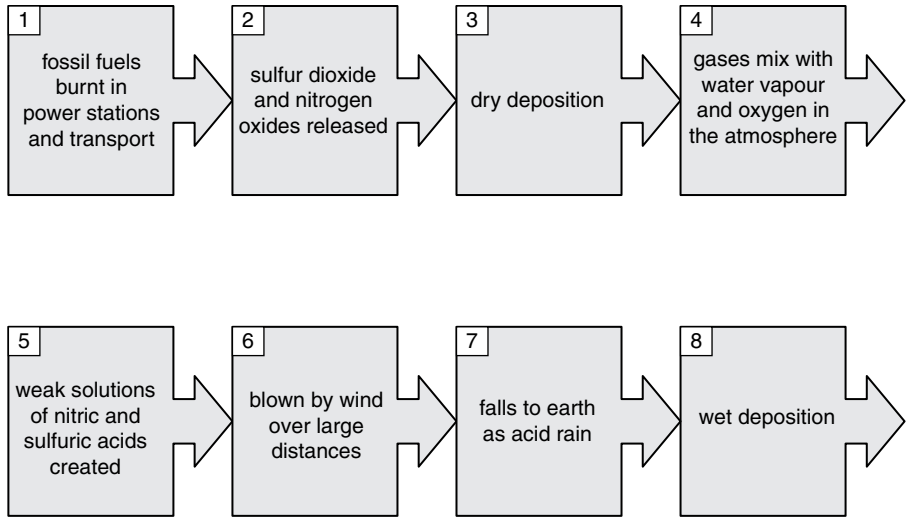
**2** Power generation

**3** 32%

**4**




**5**




**6** 2.5

**7** Yes. When pH values are low there is a low number of fish species (pH 4 = 7 fish species) whereas as the value increases the number of species increases (pH 7= 297). At pH 8 the number of species start to decrease again.

**8** for example, weight of fish, length of fish

**9** crop yields decline, foliage on vegetation destroyed, acidification of groundwater damages tree roots, calcium leached out of soil leading to mineral deficiency

**10** In 1985 high concentration in northeast USA, less on west coast, clusters around urban areas.

In 2014 concentration levels fallen, higher levels in mid-west compared to1985. Less in south east, higher around some urban areas.

**11** Renewable energy, legislation, monitoring, flue gas desulfurisation, public transport policies, car sharing, walking, fitting catalytic converters

**12** Strategies need money and equipment: these are not always available in LEDCs. LEDCs want to industrialise. As standard of living increases in LEDCs, more energy is used, for example, increase in car ownership in LEDCs. Renewable energy is expensive for LEDCs. There is more monitoring in MEDCs and policies adhered to.

## Exercise 7.6 A review of atmospheric pollution

**Across**

**1** smog
**3** photochemical
**5** carbon dioxide
**8** troposphere
**9** primary
**11** acid rain
**12** mesopause
**13** volatile organic compounds
**14** chlorofluorocarbons
**15** sulfur dioxide

**Down**

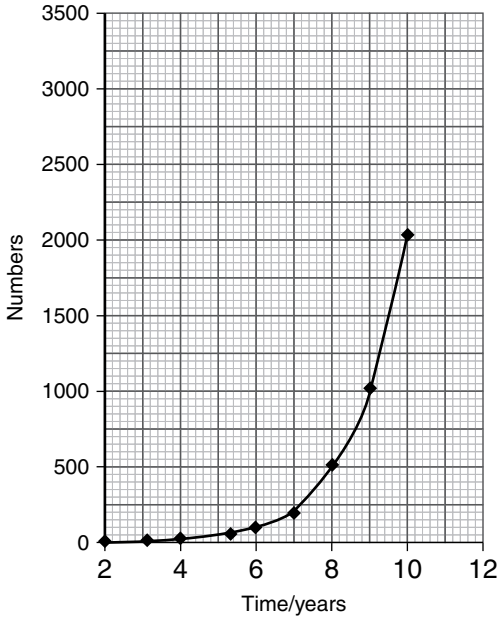
**1** stratosphere
**2** gravity
**4** temperature inversion
**6** recycle
**7** shortwave
**10** ozone

# Chapter 8: Human population

## Exercise 8.1 Changes in population size

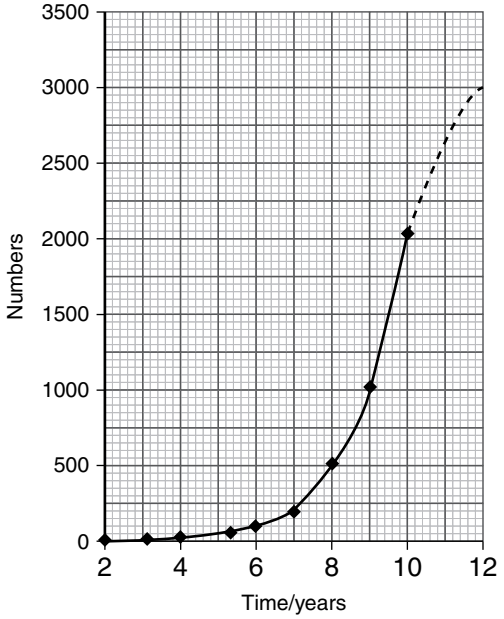
**1** A pair of animals, male and female, is introduced into an area. They produce four young, two males and two females. The parents die after 1 year. The population will now number **4**. If these four young produce four young for each pair, and then die, the population will be **8** after 2 years. If the pattern repeats itself, the population will be **64** after 5 years, 512 after **8** years and **2048** after 10 years.

**2**




**3** exponential

**4**




**5** **a** 60

**b** 1 billion

**c** **i** 2 billion in 1930, 4 billion in 1975,

**ii** Answer will depend on answer to first part but about 35 years.

**d** Low: will not double

Medium: will not double

High: 75 years

**e** It could be improved medical treatment and improved sanitation.

**6**

| Population | Birth rate per year | Death rate per year | Increase / decrease per year | Increase / decrease percentage |
|---|---|---|---|---|
| 1 000 000 | 10 000 | 5000 | Increase by 5000 per year | Increase by 0.5% |
| 10 000 000 | 50 000 | 30 000 | Increase by 20 000 per year | Increase by 20 000 / 10 000 000 = 0.2 % |
| 5 000 000 | 80 000 | 60 000 | Increase by 20 000 per year | Increase by 20 000 / 5 000 000 = 0.4 % |
| 20 000 000 | 150 000 | 100 000 | Increase by 50 000 per year | Increase by 0.25 % |
| 15 000 000 | 100 000 | 115 000 | Decrease by 15 000 | Decrease by 0.1 % |

**7** **a**

| Push | Pull |
|---|---|
| A Not enough jobs | B Attractive climate |
| C Poor medical care | E Better educational opportunities |
| D Desertification | F More services and amenities |
| G Drought | H Better job opportunities |
| J High levels of pollution | I Political freedom |
| K Poor housing | |
| L War | |

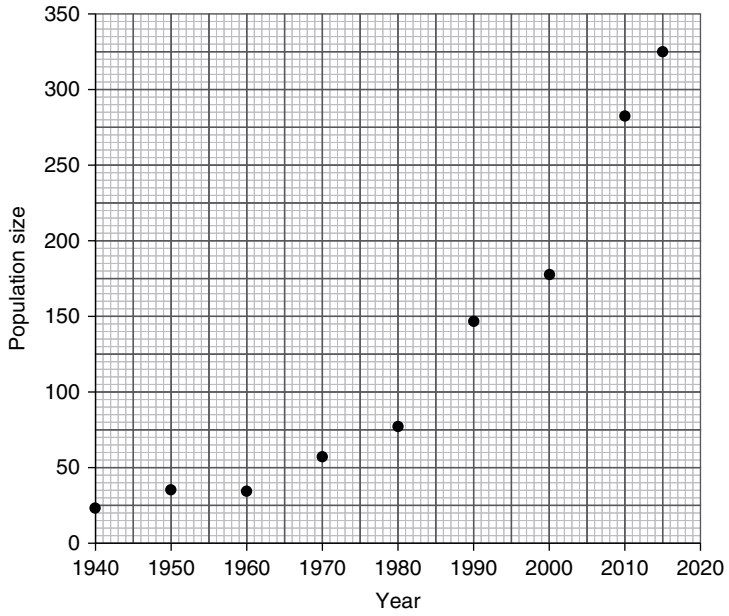
**b** Push, as rural poverty is often very severe in such places.

An argument could be made for pull too.

**8** Loss of employment in river fishing and farming is a push factor. It is unlikely that things will get any better as silt deposits are no longer happening and the soils are being damaged by salt. Firewood collection is unsustainable. There will also be pull factors as cities can always offer things which rural environments cannot.

**9 a** b > d

**b**




**c** By making counts of the birds in flight on migration. By counting nests and birds in Canada.

**d** The 2000s

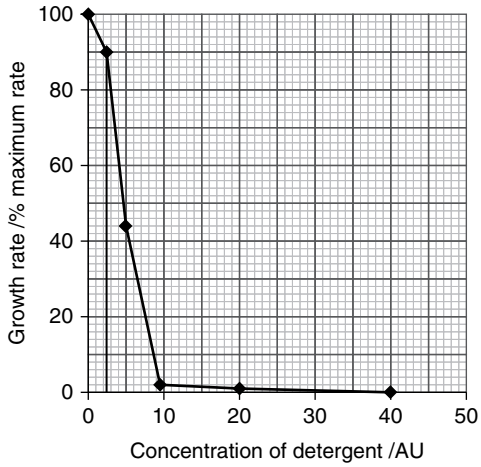
**e** Increase is 329 – 22 birds = 307 over 75 years so rate is 307 ÷ 75 = 4.09 birds/year$^{-1}$.

**10 a** The strength of the solutions made up are not specified. Detailed instructions as to what mass or volume of the disinfectant should be added to plain water need to be given. In addition, no range of concentrations to be used has been specified. The size of the drop of the algal suspension added to each concentration of disinfectant is not specified. A specific volume needs to be suggested and this same volume should be added to all the concentrations.

There is no mention of control variables, for example temperature, and how it would be maintained at a constant value throughout the experiment. This could be done by placing the cultures in each of the disinfectant concentrations in an incubator held at a constant temperature. The value of temperature should be suggested.

**b** The overall trend is that as more disinfectant is added, algae grow less well. The effect is quite small at low concentrations of less than 5 AU. Between 5 and 10 AU algal growth is almost entirely stopped. Above 20 AU there is no growth at all.

**c** Populations are reduced by over 10% at a concentration above 2AU so the maximum limit would be <2AU.




## Exercise 8.2 Human population distribution and density

**1** The highest populations are in the South-East of Asia. There are very few people in far North and far South. Western Asia and Europe also have very high populations.

**2** Density = 203 657 210 ÷ 8 520 000 = 23.9 people per km$^2$

**3** Density of Bangladesh = 160 411 249 ÷ 147 570 = 1087 people per km$^2$

so Bangladesh is 1087 ÷ 23.9 = 45.5 times that of Brazil.

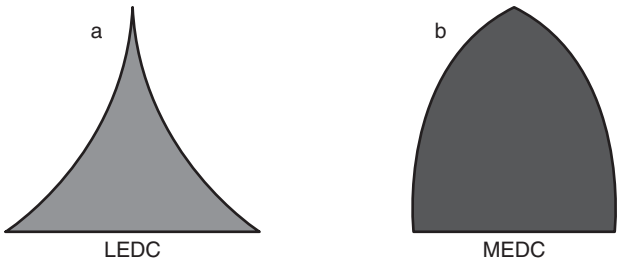
**4**

| Province | Area (km²) | Population | Density (people/km²) |
|---|---|---|---|
| Heredia | 2 657 | 433 677 | 163.2 |
| Cartago | 3 124 | 490 903 | 157.1 |
| San José | 4 966 | 1 404 242 | 282.8 |
| Limón | 9 189 | 386 862 | 42.1 |
| Alajuela | 9 757 | 885 571 | 90.8 |
| Guanacaste | 10 141 | 354 154 | 34.9 |
| Puntarenas | 11 266 | 410 929 | 36.5 |

The highest density is that of San José and the lowest Guanacaste.

## Exercise 8.3 Population structure

**1**




**2** The United States has a very large number of older people over 70 whereas Kenya has only very few, about one fifth that of the USA, as a percentage. Over 20% of the Kenyan population is under 5; in USA it is only 8%.

**3** The dependents are the individuals who are either too young to be economically active, or too old. Others who may be in the economically active age range may be ill or in some other way unable to be active.

**4** A population pyramid shows the age and gender structure of a population. A pyramid of numbers shows the number of organisms at each trophic (feeding) level in an ecosystem.

**5** **a** 13.7 million

**b** Number = 6.2 million; so percentage = 6.2 ÷ 128 × 100 = 4.8%

## Exercise 8.4 Managing human populations

**1** An educated woman is more likely to have a career, which means that they are likely to have fewer children.

Both women and men may better understand the consequences for themselves and society of having many children.

Education tends to lead to later marriage and thus fewer children.

**2** Family planning covers all the ways in which people and authorities think about how many children to have and when to have them. Contraception is one aspect of family planning. It involves techniques to prevent the conception of a baby.

**3** People tend to have more children when death rates are high because the children act as an insurance policy and a pension for the parents, so it is vital that some survive until adulthood to perform this role.

**4** If the population of a country is declining, then a pro-natalist policy would make sense.

**5** In MEDCs there is a high standard of living. Rather than children providing support in later life, their upbringing and education cost a lot of money. The state tends to provide support in later life with pensions and other measures, thus reducing the incentive to have many children.

# Chapter 9: Natural ecosystems and human activity

## Exercise 9.1 The ecosystem

**1** **ecosystem:** all the living things (biotic components) together with all the non-living things (abiotic components) in an area. These biotic and abiotic components interact with each other.

**population:** the total number of all individuals of the same species in an area.

**community:** all the species characteristic of a particular ecosystem.

**habitat:** the place where the population of the organism lives, finds food and reproduces.

niche: the role of a species within the ecosystem.

**2** Examples are:

biotic: oak tree and deer

abiotic: light intensity and humidity

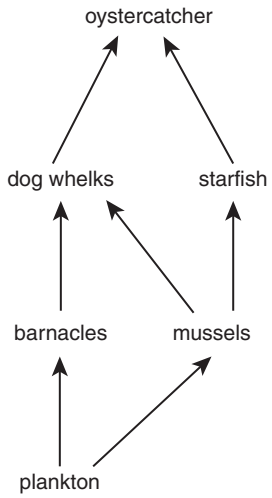
**3** 2 5 8 11

**4** food chain

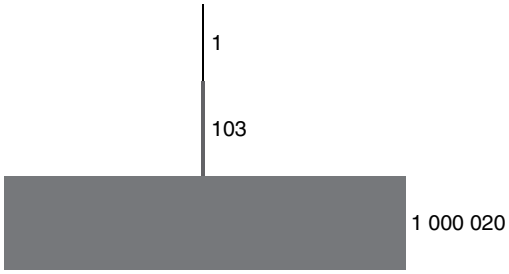
**5** pyramid of numbers

**6** food web

**7**



**8**




**9** The primary producers are plankton. These occur in millions and are microscopic.

**10** photosynthesis

**11** The components listed allow the plant to make only carbohydrates. The plant also needs proteins, for which it needs nitrogen and sulfur, and other compounds such as chlorophyll, for which magnesium is needed.

**12** **a** pollination, **b** competition, **c** predation

**13** It absorbs light energy, which causes carbon dioxide and water to react together to make sugars.

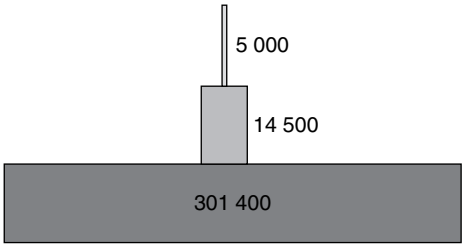
**14**

| Organism | Mass of one specimen | Energy content / kJ per gram | Total energy in area / kJ |
|---|---|---|---|
| barnacle | 50 mg | 6 | 0.05 × 6 × 1 000 000 = 300 000 kJ |
| mussel | 10 g | 7 | 10 × 7 × 20 = 1 400 kJ |
| dog whelk | 5 g | 5 | 5 × 5 × 100 = 2 500 kJ |
| starfish | 0.5 kg | 8 | 500 × 8 × 3 = 12 000 kJ |
| oystercatcher | 0.5 kg | 10 | 500 × 10 × 1 = 5 000 kJ |

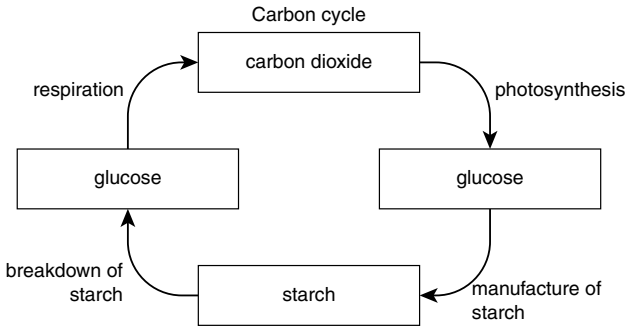
primary consumers (barnacles and mussels) = 301 400kJ

secondary consumers = (dog whelks and starfish) = 14 500 kJ

tertiary consumer = oystercatcher = 5 000 kJ




**15**




**16** **a** In photosynthesis, carbon dioxide and water are combined to make glucose and oxygen. In respiration, glucose is broken down in the presence of oxygen to form carbon dioxide and water.

**b** In photosynthesis, the energy used to combine carbon dioxide and water comes from visible light. In respiration, the energy is released from glucose in the form of chemical energy and heat energy.

**17** Competition is defined as a process in nature when two organisms require the same resource which is in limited supply. In this case water and oxygen are both needed, but are not likely to be limited in a fast-flowing stream. So the two animal species will most likely be in competition for food.

## Exercise 9.2 Estimating biodiversity in ecosystems

**1** A transect line should be laid out at right angles to the ant trail. Quadrats can then be laid out on this line at regular intervals. The size of the quadrat would need to be chosen and this would depend on the size of the trail, which is not known. The quadrats can be used to estimate the number of plants at each point or their percentage cover. This information could be recorded for each quadrat and then presented as a bar chart with quadrat position along the bottom and percentage cover or numbers up the side for each plant species.

**2** Biodiversity refers to the range and number of species and ecosystems within an area. It also refers to the genetic variety within species.

**3** If one area of vegetation subject to treatment A was to be compared with another area subjected to treatment B, random number tables could be used to provide coordinates to locate quadrats in each area.

**4** a-B

b-B

c-C

d-A

**5** A grid could be set up to isolate the meadow area within the trees. Quadrats can then be placed, using random number tables to find coordinates in the grid where the quadrats will be placed.

**6** **a** The transect at position A runs through vegetation which is all the same because it is at the same distance from the forest. Transect at position B runs from the area furthest from the forest into the forest edge. This means that B will give a much better idea of the effect of forest removal on biodiversity.

**b** From the map, the transect at B is 240 m long so 12 quadrats would be needed to have one every 20 m.

**c** Species A is abundant, species B and C are frequent and species D is occasional.

**d** Species A appears in 76 squares, species B appears in 26 squares, species C appears in 33 squares and species D appears in 16 squares.

Using another method, where the square is only counted if the species covers half or more of it, species A is found in 59 squares, Species B is in 15 squares, species C is in 23 squares and species D is in 6 squares.

You may have done this exercise in a different way.

**e**

| Quadrat number | 1 | 2 | 3 | 4 | 5 |
|---|---|---|---|---|---|
| Distance from start / m | 0 | 20 | 40 | 60 | 80 |
| Species A | | | | | |
| Species B | | | | | |
| Species C | | | | | |
| Species D | | | | | |
| Species E | | | | | |
| Species F | | | | | |
| Species G | | | | | |
| Species H | | | | | |

**f** The area in question could be thought of as being divided into just two regions. One is that where the trees have been removed and the other where they have not. A grid could be set out in each region and then quadrats placed using random number tables. Plant abundance would be ascertained in each quadrat and then averages for each species would be worked out and compared for each site.

## Exercise 9.3 The causes and impacts of habitat loss

**1** 0.02% = 0.0002

50 000 000 × 0.0002 = 10 000 species

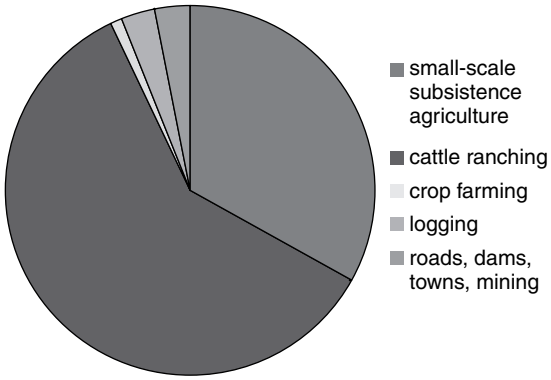
**2** Wetlands provide habitat for certain species, they help in flood control and can be used for recreation.

**3** To provide agricultural land, to provide land to build on. Wetlands are also drained to reduce the incidence of diseases caused by vectors which breed in water, such as malaria, where the vector is the mosquito.

**4** Various forms of pollution, including leached pesticides, may lead to the destruction of organisms within a wetland and, ultimately, the habitat itself.

**5** 1 290 000 ÷ 8 000 000 × 100 % = 16.12 %

**6**




**7** Agricultural practices are small-scale subsistence agriculture, 33%, cattle ranching, 60%, crop farming, 1%.

So total affected = 33 + 60 + 1 = 94%

**8** Genetic diversity may lead to the production of chemicals that may have uses for humans, such as those used in medicines or those used as pesticides.

## Exercise 9.4 The causes and impacts of deforestation

**1** For making products such as furniture. For making paper. To generate heat energy as fuelwood.

**2** 0.52% = 0.0052

18 857 = 0.0052 × total area

total area = 18 857 ÷ 0.0052 = 3 626 346.154 $km^2$

**3** protected 12%

unprotected 24%

**4** The data suggests that the building of roads leads to deforestation. If no other measures are taken, deforestation in unprotected areas is over 50% more than in protected areas, as far as 2km from the roads. It is still over 10% at 10 km distance from roads. However, if the forest is protected in some way, the percentage deforestation can be virtually halved at any distance from the road.

**5** The leaves, branches and even trunks of trees will intercept a lot of the rain which falls on an area. This reduces its power to erode the soil. Any rain that does reach the ground is likely to infiltrate rather than run-off if the ground is covered in leaves and substantial humus. Finally, the roots of the trees bind the soil, making it less likely to be washed or blown away.

**6** If the change of use of land was from mature forest to agricultural land, or even urbanisation, the uptake of carbon dioxide by the trees would be reduced. This would lead to a rise in carbon dioxide levels in the atmosphere.

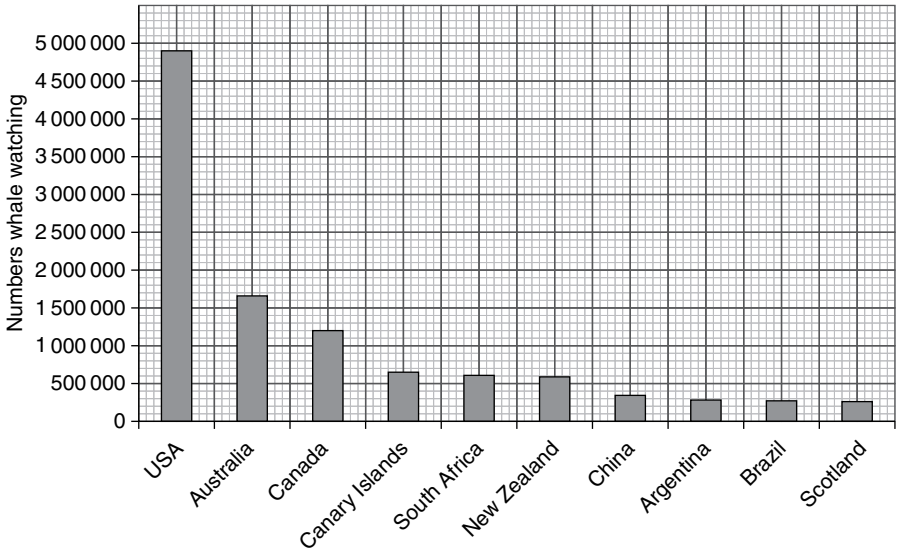
**7** The trees in the mature forest carry out both photosynthesis, which takes in carbon dioxide, and respiration which produces it. If there is more photosynthesis than respiration, this means the forest is not yet mature. In a mature forest, respiration and photosynthesis are equal and therefore no carbon dioxide is gained or lost from the atmosphere in a net sense.

## Exercise 9.5 The need for the sustainable management of nature

**1** A carbon sink is an area which absorbs more carbon dioxide than it produces. An immature forest is a carbon sink. A carbon store is an area in which a lot of carbon is locked up, for example, in massive tree trunks and branches. A mature forest is a carbon store.

**2** transpiration

**3**




**4** 10 429 998 ÷ 12 977 218 × 100 % = 80.4 %

**5** Tourism has grown at a more or less steady rate over 16 years. In this time the number of tourists has doubled from about 500 million to 1 billion. Slowest growth was between 2000 and 2003 and there were slight falls in the period between 2002 and 2003 and between 2008 and 2009.

**6** Increased tourism will mean more travel so this will lead to increased carbon dioxide emissions. At the tourist sites, there will have been habitat loss due to the provision of hotels and other facilities, which will lead to the removal of natural vegetation. The increased numbers of people in these areas will also have given rise to more water pollution.

**7** The problems caused by travel can be reduced by carbon offsetting and the use of more environmentally friendly methods of transport.

Ensure that recycling is encouraged at resorts.

Designate areas in which tourists are not allowed to visit.

## Exercise 9.6 Strategies for conserving the biodiversity and genetic resources of natural ecosystems

**1** It means that when these plants and animals are harvested now, it is to meet the needs of the present, without compromising the ability of future generations to meet their needs.

**2** In agroforestry, trees are pruned and the material is used to improve the soil and to provide nutrients to the crop. If the tree is a legume, these nutrients will include nitrogen. Nutrient recycling and the suppression of weeds provided by the trees combine with cropping on the same land. This allows the land to be farmed for much longer than would otherwise be possible.

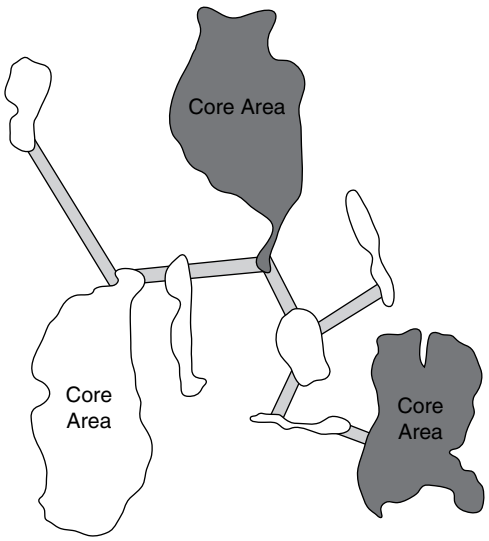
**3** 1310 ÷ 590 = 2.22 times

**4** The variety of plants in the area will lead to a greater biodiversity, both of other plants and the animals they directly or indirectly support. This in turn makes the environment more stable and prolongs its usefulness to the farmer. The legumes will add nitrate to the soil which will lead to an increase in crop yield. The cover of mixed vegetation will help to reduce soil erosion and degradation.

**5** A corridor will allow plants and animals access to a greater range of resources. It will also allow a much wider range or breeding opportunities for both plants and animals. This will lead to greater genetic diversity and more chance of species surviving.

**6** A seed bank will require much less work and take up much less space than cultivating plants over many generations. In this way it will cost much less to set up and run. It will insulate the plants from the vagaries of the weather and guard against reproductive failure.

**7**




**8** A reserve which finds a balance between destroying an area for short-term benefit and stopping all economic activity. The latter would conserve wildlife but would have an unacceptable effect on the local people who live there.

**9** A: core zone

B: buffer zone

C: manipulation zone

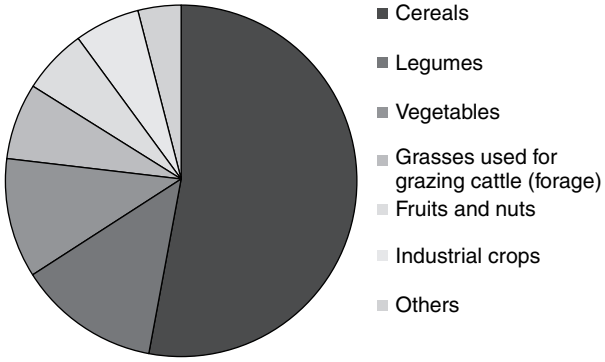
**10** Biosphere reserves are mainly concentrated in the tropics in the west, but in Europe and central Africa in the middle. In the east, the reserves are again found in the tropics. There are very few reserves in Australia (in fact only one) and in the far north and south.

**11** 70 ÷ 20 = 3.5 per country

**12** $\frac{70}{669} \times 100 = 10.5\%$

**13** The studbook allows anyone wanting to breed from the animals to make sure that close relatives are not allowed to mate and produce offspring. This avoids inbreeding which would lead to a reduction in genetic diversity. This helps the species to survive.

**14 a**




**b** The area is cold, which will render the seeds dormant. The sleeve protects the seeds from even major geological and climatic events. The airlock prevents the entry of microbes, which may cause disease in the seeds. Norway is a relatively politically stable country so there is little likelihood of political unrest, which may threaten the security of the seeds. This is further ensured by the remoteness of the site.