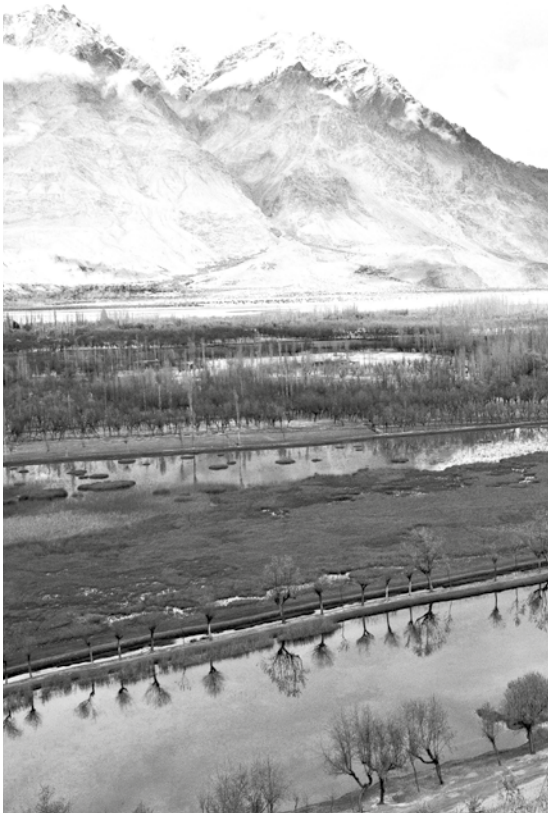
TEACHING GUIDE

ENVIRONMENTAL MANAGEMENT

A Core Text for O Level and IGCSE®

JOHN PALLISTER

SECOND EDITION



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OBJECTIVES

In this chapter you will learn about:

- types of rocks and their formation
- extraction of rocks and minerals for human use
- impact of rock and mineral extraction
- strategies for landscape restoration
- strategies for sustainable use of rocks and minerals

OBJECTIVES

In this chapter you will learn about:

- fossil fuel formation
- energy resources and generation of electricity
- factors affecting energy demand
- conservation and management of energy sources
- impact and management of marine oil pollution

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CHAPTER 3

Agriculture and the environment

20

OBJECTIVES

In this chapter you will learn about:

- soil composition
- what makes soils suitable for plant growth
- different types of agriculture
- techniques used to increase agricultural yields
- impact of agricultural practices
- soil erosion (causes, impacts, and management)
- strategies for sustainable agriculture

CHAPTER 4

Water and its management

27

OBJECTIVES

In this chapter you will learn about:

- global water distribution
- the water cycle
- sources of water supply for people
- water usage, quality, and availability
- multipurpose dam projects
- sources of water pollution
- impact and management of water pollution
- managing water-related diseases

CHAPTER 5

Oceans and fisheries

36

OBJECTIVES

In this chapter you will learn about:

- the resource potential of the oceans
- world fisheries and their exploitation
- exploitation of the oceans (overfishing) and its impact
- management of the harvesting of marine species

CHAPTER 6

Managing natural hazards

41

OBJECTIVES

In this chapter you will learn about:

- five natural hazards and how they affect people
- tectonic hazards: earthquakes and volcanoes
- their causes, impacts, and management
- climatic hazards: tropical cyclones, flooding, and drought
- their causes, impacts, and management

CHAPTER 7

The atmosphere and human activities

49

OBJECTIVES

In this chapter you will learn about:

- the structure and composition of the atmosphere
- atmospheric pollution, its causes and impacts
- smog, acid rain, ozone layer depletion, and enhanced greenhouse effect
- causes, impacts, and strategies for their reduction
- strategies for managing atmospheric pollution

CHAPTER 8

Human population

56

OBJECTIVES

In this chapter you will learn about:

- distribution and density of population
- growth of the human population
- population structure
- managing human population size

CHAPTER 9

Natural ecosystems and human activities

60

OBJECTIVES

In this chapter you will learn about:

- natural ecosystems and how they operate
- natural ecosystems under threat
- causes and impacts of deforestation
- sustainable management of forests
- measuring and managing biodiversity

CHAPTER 10

Techniques for investigation and examination

70

OBJECTIVES

In this chapter you will learn about:

- investigation skills
- methods for local investigations
- examination technique
- command words

Introduction

Environmental Management, Second Edition, is based on the new Environmental Management syllabus (Cambridge O level, 5014; IGCSE®, 0680). The focus of the revised syllabus is sustainable development in a world where the Earth's natural resources and life-sustaining systems are being threatened by increasing human populations and their growing impact.

The revised syllabus covers a broad field of study, drawing upon content from more specialized disciplines, notably biology, earth science, geography, and economics. It begins from the educationally sound premise that students need to have some basic knowledge and understanding of the Earth's natural systems and how they work before they consider the impacts of people, and how these can be managed in a more sustainable way for future generations. The Earth's four great natural systems, lithosphere, hydrosphere, atmosphere, and biosphere, provide the natural resources that people need for survival and economic development.

Although the layout of the new syllabus is totally different from that of the older one, now arranged under nine topics instead of four natural systems, the sequence of study remains the same. What the Earth provides in the way of natural resources is covered first. How these resources are used by people comes second. Third is the impact of human use and development on the environment; important issues such as resource depletion, environmental damage, and pollution are covered here. Finally, the topic is rounded off by a study of management strategies to make future economic growth and development more sustainable.

Therefore, *Environmental Management* is concerned not only with the impact of people on the Earth's resources, but also with the patterns of human behaviour necessary to preserve and manage the environment in a self-sustaining way, so that natural resources will be preserved for the benefit of future generations. Simultaneously, it is recognized that humans live with aspirations of an improved quality of life. A major aim of the syllabus is to demonstrate to students that this does not inevitably have to be to the detriment of the environment. For this reason, the syllabus refers to new methods and technologies to increase output and manage the environment.

The syllabus has been written in a manner which presents students with a global perspective. Of course, most of the decisions that affect the environment are taken by individuals, officials, and governments at local, regional, or national levels. This is why the use of local examples or case studies is encouraged. Opportunities for local studies and investigations are suggested in some of the Activities in the book and under the heading of 'Further study' in this guide. Often it is easier for students to appreciate the nature and seriousness of environmental problems if they have had personal experience of them. It should also make analysis of the merits and difficulties of implementing strategies for their alleviation more meaningful. Students are in a

better position to understand the varied views of local people and conflicting pressures that arise.

The new syllabus specifies case studies, from one to three per topic. The examples chosen for book use cover all syllabus needs. However, students do not have to use the ones chosen in the book; they are not compulsory. If there is a suitable example in the student's home region or country, this can be used instead. Indeed, there are good reasons for doing this. The more local the example, the more it is going to mean to a student. If they have carried out their own study, it puts them in a stronger position to comment upon the success or otherwise of new management strategies.

At all times students should be encouraged to think for themselves about environmental issues and their management, and to express their opinions. It is hoped that the study of *Environmental Management,* Second Edition, will allow them to do so in a more informed manner. Questions included among the Activities invite students to recognize advantages and disadvantages, or costs and benefits, before they are asked to choose and justify the viewpoint they agree with most. These mirror the style used in some examination questions. When it comes to marking student answers, what matters most is the strength of the comment and justification, and not the viewpoint itself, although some viewpoints are easier to support than others.

The theme of sustainable use and development of the Earth's natural resources runs all the way through the syllabus and this book. Students are encouraged to explore the concept that we have not so much 'inherited the world from our parents' but 'borrowed it from our children'. The needs of the present generation should be met without compromising the ability of future generations to meet their own needs.

The book's content is more than sufficient for students to obtain a top examination grade; nonetheless, one should continue to look out for more recent or better local examples and use these in preference, but not in addition, to those in the book. In answering examination questions, students are always allowed freedom of choice for the example or case study used to illustrate the theme under study since none of the case studies in the syllabus specifies a place or an example.

A syllabus grid has been included in this Teaching Guide, with the Environmental Management Syllabus 5014 and 0680 topics and subtopics, followed by learning outcomes. The page numbers refer to the textbook, indicating where these topics are covered.

The syllabus grid will facilitate teachers in following the topics and subtopics and this may also be shared with the students.

It is hoped that the syllabus and book's approach will help students develop important skills, such as environmental awareness, awareness of different opinions held by others, and a willingness to express their own views, supported by knowledge and

understanding of the issues. Students should also review their opinions in the light of new experiences and future technological change. Skills of a more practical nature, notably enquiry, presentation, and analysis, are also part of the syllabus. When possible, students should be encouraged to undertake first-hand local investigations, using basic techniques to observe, record, and classify primary data, as done for biology, geography, or earth science. Secondary sources, such as Internet websites, are also useful as sources of information and data.

In response to requests from teachers, a chapter on Techniques has been added at the end of this new book. The first part is about how to undertake a local enquiry. This follows on from the short section in Topic 9 about methods for investigating and measuring biodiversity. The syllabus refers to both methods of collection (traps, quadrats, transects) and sampling techniques (random, systematic). This is the first time these have been included within the basic syllabus content.

The second part is about examination technique. This is a short guide to question answering for students. Two things are stressed – obey the command word and take note of the number of marks. In some examination questions, source materials, such as data tables, graphs, diagrams, and/or written reports, are provided. There is a technique to answering these questions and several examples are used to show students how best to approach them. Population pyramids and climate graphs are examples of more specialized graphs. They also contain a large amount of information. Often students do not know where to begin. More detailed guidance is given for these to increase the chances of a student identifying the significant information from within them.

It is hoped that students and teachers will both benefit from as well as enjoy the revised and updated content of this book.

Syllabus Grid: Environmental Management, 5014 and 0680

Topic		Learning Outcomes Students should be able to:	Pages
1	**Rocks and minerals and their exploitation**		**1–26**
1.1	Formation of rocks	▪ describe and explain the rock cycle	2–3
		▪ explain the formation of igneous, sedimentary and metamorphic rocks	3–5
1.2	Extraction of rocks and minerals from the Earth	▪ describe methods of extraction: surface mining, subsurface mining	5-7
		▪ discuss factors that affect decisions on extraction	8-11
1.3	Impact of rock and mineral extraction	▪ describe and explain the environmental, economic, and social impacts of mineral extraction	12-19
1.4	Managing the effects of rock and mineral extraction	▪ describe and assess ways to restore landscapes affected by mining	20-21
	Case study	The Eden Project, Cornwall	22-23
1.5	Sustainable use of rocks and minerals	▪ define the terms 'sustainable resource' and 'sustainable development'	24-26
		▪ describe and assess strategies for sustainable use of rocks and minerals	
2	**Energy and the environment**		**27-70**
2.1	Fossil fuel formation	▪ describe the formation of fossil fuels: coal, oil, and gas	29-31
2.2	Energy resources and the generation of electricity	▪ classify energy resources as non-renewable and renewable	31
		▪ describe how non-renewable and renewable resources are used to generate electricity	40-47
		▪ describe environmental, economic, and social advantages and disadvantages of these resources	36-39 48-52
2.3	Energy demand	▪ describe and explain factors that affect the demand for energy	53-56
2.4	Conservation and management of energy resources	▪ describe and explain the ways for efficient management of energy resources	56-59
		▪ discuss research and development of new energy resources	60
2.5	Impact of oil pollution	▪ describe causes and effects of oil pollution on marine and coastal ecosystems	61-64
2.6	Management of oil pollution	▪ discuss ways of reducing oil spills in marine and coastal regions	64-65
	Case studies	Oil pollution in Niger Delta; Deepwater Horizon oil spill, Gulf of Mexico	66-69
3	**Agriculture and the environment**		**71-102**
3.1	Soil composition	▪ describe and explain the composition of various soils	73-74
3.2	Soils for plant growth	▪ describe soils as a medium for growth of plants	74-76
3.3	Types of agriculture	▪ describe the different types of agriculture	77-80
3.4	Increasing agricultural fields	▪ describe the different methods/techniques used to increase agricultural output	80-87

Topic		Learning Outcomes Students should be able to:	Pages
3.5	Impact of agriculture	▪ describe and explain the impact of agriculture on the environment and people	88-91
3.6	Causes and impacts of soil erosion	▪ describe the causes and effects of soil erosion	92-95
3.7	Managing soil erosion	▪ describe and explain the different ways of reducing soil erosion	95-97
	Case study	Soil erosion and desertification, Niger	98-99
3.8	Sustainable agriculture	▪ describe and explain ways of practising sustainable agriculture	100-102
4	**Water and its management**		**103-137**
4.1	Global water distribution	▪ state the distribution of water on Earth and its sources	104
4.2	The water cycle	▪ define and explain the water cycle	105-107
4.3	Water supply	▪ describe the sources of fresh water for human use	108-110
		▪ describe surface water supplies and transfers for use	111-113
4.4	Water usage	▪ know and describe various uses of fresh water	113-115
4.5	Water quality and availability	▪ discuss availability of potable water across the world; define water-rich and water-poor countries; understand and explain difference in accessibility to water	115-118
		▪ potential for water conflict between countries	118-120
4.6	Multipurpose dam projects	▪ describe and assess multipurpose dam projects, their usefulness and impact, and sustainability	120-122
	Case study	Three Gorges Dam—multipurpose scheme	123-124
4.7	Water pollution and its sources	▪ describe the causes and sources of water pollution	125-126
4.8	Impact of water pollution	▪ describe and explain the types of water pollution and their effects	126-128
4.9	Managing pollution of fresh water	▪ describe and explain the ways to manage pollution and improve water quality	128-129
	Case study	Water pollution management: River Clyde; water supply to Punjab villages	130-132
4.10	Managing water-related diseases	▪ know about malaria, a water-related disease; describe and assess ways to control malaria	133-136
		▪ describe how cholera can be controlled	136-137
5	**Oceans and fisheries**		**138-159**
5.1	Oceans as a resource	▪ state the resource potential of the oceans	139-142
5.2	World fisheries	▪ state the distribution of the major ocean currents	142-145
		▪ explain the distribution of major fish populations	
		▪ discuss El Niño's impact on fish stocks along the Pacific coast of South America	145-148
5.3	Impact of the exploitation of the oceans	▪ describe and explain the effects of overfishing—causes and consequences	149-152
		▪ describe how fish farming reduces exploitation of fisheries	152
	Case studies	Fish farming in Chile and Norway	153-155

Topic		Learning Outcomes Students should be able to:	Pages
5.4	Management of the harvesting of marine species	▪ describe, explain, and assess methods for managing the harvesting of marine species	156-159
6	**Managing natural hazards**		**160-195**
6.1	Earthquakes and volcanoes	▪ identify and discuss major natural hazards	161
		▪ describe and explain the distribution and causes of earthquakes and volcanoes	162-164
		▪ understand and explain the impact and management of earthquakes	164-169
	Case study	Earthquake management in California and Iran: comparison	170-171
		▪ know about valcones, distribution, and strategies for managing impact	172-176
6.2	Tropical cyclones	▪ describe and explain the distribution and causes of tropical cyclones i.e. storms, hurricanes, typhoons	176-178
		▪ describe strategies to manage cyclone impact	178-179
	Case study	Managing cyclone impact in Orissa, India	180-181
6.3	Flooding	▪ understand and explain the causes and impact of flooding	182-183
		▪ describe how the effects of flooding can be managed	183-185
	Case study	Flooding in Bangladesh	186-188
6.4	Drought	▪ describe and explain the causes of drought; identify affected regions	189-190
		▪ learn about the impact of drought and its management	190-192
	Case study	Drought in the Niger	193-195
6.5	Impact of natural hazards	▪ describe and explain impacts on people and the environment—loss of life, property, disease, impact on agriculture, water sources, desertification, etc.	pages listed below
6.6	Managing the impacts of natural hazards	a) tectonic events	164-169
		b) tropical cyclones	178-179
		c) flooding	183-185
		d) drought	190-192
6.7	Opportunities presented by natural hazards	▪ describe and explain the opportunities arising from natural hazards—these have been covered with each type of hazard in the pages listed above	
		▪ managing tectonic impact in more and less economically developed countries (covered in case study)	170-171
7	**The atmosphere and human activities**		**196-223**
7.1	The atmosphere	▪ learn about the structure and composition of the atmosphere	197-199
7.2	Atmospheric pollution and causes	▪ describe and explain the causes, with reference to smog, acid rain, ozone layer depletion, greenhouse effect, and their impact on people and environment	200-201 202-203 205-207 208-209 211-213

Topic		Learning Outcomes Students should be able to:	Pages
7.3	Impact of atmospheric pollution	▪ know about and explain ways of dealing with impact of atmospheric pollution	204-205 207-208 210-211
7.4	Managing atmospheric pollution	▪ learn about the causes and effects of global warming, greenhouse effect	214-216 217-219
		▪ describe and explain ways used by people, governments and individuals to reduce the impact of global warming	220-221
	Case study	New Delhi Smog	222-223
8	**Human Population**		**224-240**
8.1	Human population density and distribution	▪ learn about world population–density and distribution	225-228
8.2	Changes in population size	▪ describe and explain growth curve, and the changes in human populations–birth and death rates	228-230 231-233
8.3	Population structure	▪ describe the population structure in MEDCs and LEDCs; reasons for differences	234-235
8.4	Managing human population size	▪ discuss and assess steps taken to manage population size	236, 239-240
	Case study	China and its 'one child' policy	237-238
9	**Natural ecosystems and human activities**		**241-284**
9.1	Ecosystems	▪ define the terms ecosystem, population, community, habitat, niche	242-245
		▪ describe biotic (living) and abiotic (non-living) components of an ecosystem	245-247
		▪ understand and explain photosynthesis, food chains, food web, trophic levels, ecological pyramids, respiration, and carbon cycle	248-251
9.2	Ecosystems under threat	▪ describe and explain causes and effects of damage to habitat	252-255
9.3	Deforestation	▪ know about and explain causes and effects of deforestation	255-258
	Case study	Deforestation in Indonesia	259-261
9.4	Managing forests	▪ understand and explain the need for managing forests	262-265
		▪ ecotourism	265
9.5	Measuring and managing biodiversity	▪ describe and evaluate methods for estimating biodiversity	266-267
		▪ learn about and understand management strategies for conservation	268-271
		▪ know about the importance of national parks, wildlife reserves, world biosphere reserves	272-275
	Case study	Biosphere Reserve in Guadeloupe Archipelago	276-277
		▪ assess national and international strategies for conservation of species–plants and animals	278-279
	Case study	Conservation of Giant Pandas	280-281
		▪ undersand and discuss ecotourism and its value	282-284

CHAPTER 1

Rocks, minerals, and their exploitation (pages 1–26)

This chapter starts with a study of the natural system, beginning with the three different types of rocks and their formation. It also includes a brief study of the Earth's rock cycle.

After this introduction to the natural resources that the Earth provides, the next section is about the extraction of rocks and minerals from the Earth—in other words, how people extract these natural resources for use in economic activities and for economic development.

The next topic focuses on the impact of rock and mineral extraction, negative and positive, on both the environment and people.

The final two topics are about strategies to reduce the negative impacts of rock and mineral extraction and to allow more sustainable use of rocks and minerals, in order to extend the use of the Earth's finite resources further into the future.

In the Introduction (page 2), a brief outline of the Earth's structure is given as background information for this topic, and for the later study of tectonic hazards (Chapter 6). The importance to people of the Earth's crust is stressed. Despite its small depth, it is the crust which provides useful rocks and minerals, as well as the top layer of soil, vital for agriculture (Chapter 3).

1.1 FORMATION OF ROCKS (pages 2–5)

Syllabus coverage

The rock cycle is about rock and mountain formation and their later destruction by weathering and erosion. In the beginning, all the rock which makes up the Earth's surface came from volcanic activity, i.e. igneous rock. Volcanic activity creating new igneous rock is still widespread today (Chapter 6). Over many millions of years, rocks are broken down and carried away, accumulating in the bottom of oceans, before being compressed into new rock, which is sedimentary rock. Some rocks are changed by great heat and pressure into metamorphic rock. The formation of these three rock types is studied in turn (pages 3–5). By the use of photographs, students are encouraged to recognize differences by observation between these rock types in the landscape.

Key syllabus terms:

rock cycle, igneous rock, sedimentary rock, metamorphic rock

Activities (page 5)

Activity 1 is a summary exercise for which students are expected to select key pieces of information from the text: the use of the table format is suggested to make the summary clear and visual. The purpose of the first part of Activity 2 is simple identification of the four stages in the cycle. The second part should help students to appreciate that the cycle is part of a never ending process of old rock destruction and new rock formation, repeated many times, over millions of years.

Further study
Students should be encouraged to discover and name types of rock found in the home area. What are the main types of rock? How and when were they formed? Are they the same as those found in other parts of the home country? Practical work could involve drawing a field sketch of a local rock outcrop and adding labels to show its main characteristics. Rock samples can be collected, labelled, and displayed.

1.2 ROCK AND MINERAL EXTRACTION (pages 5–8)

Syllabus coverage
The text, supported by sketches, focuses upon the differences between surface (opencast) mining and subsurface (deep) mining. The point worthy of most emphasis is that surface mining has many economic advantages over subsurface mining, notably for ease of discovery and lower cost of extraction. There are also fewer safety issues with mining carried out on the surface. The two Information Boxes are intended to highlight key differences between surface and subsurface mining.

Key syllabus terms
surface mining (including opencast mining), subsurface mining (including deep mining and shaft mining)

Activities (page 8)
Activities 1 and 2 develop the main syllabus focus stated above. Activity 3 requires more detailed observation of the sketch in Figure 1.8 which shows a modern deep mine. There is also the invitation for students to think about, and in some cases use knowledge of, working mines much older than this one, which are far more numerous. Activity 4 again allows the inclusion of a local element, likely to be closer to the student's direct experience. It is most relevant to students living in a country or area with significant amounts of mining.

Further study
Activity 4 provides the opportunity for further study. If students are in a mineral-poor country, the home area or country might need to be broadened out to a world region. If resident in a mineral-rich country, information booklets may be available from a mining company which can be used as source materials, or there may be the possibility of a mine visit.

1.3 FACTORS THAT AFFECT THE DECISION TO EXTRACT ROCKS AND MINERALS (pages 8–11)

Syllabus coverage
The roles of the different factors named in the syllabus are summarized in Table 1.1. Much of the emphasis in the written text is upon supply and demand—whether or not one matches the other. This greatly affects whether or not a mine is viable. Usually the most basic question is 'Can the company make money from mining the mineral there?' However, there is no simple

answer, especially as world market prices fluctuate so greatly, as is shown for the world price of gold in Figure 1.9. Stress to students that, whatever the mineral, similar wide variations in world market prices apply to its extraction.

Key syllabus terms
geology, exploration, accessibility, supply and demand

Activities (page 11)
For Activity 1 (a), students are required to study Figure 1.10 and interpret where mineral exploitation would be most and least likely to occur, based upon geology only. Option C is the only one where opencast mining is possible. Faulting in option A and folding in option B create geological problems for mining. Students could discuss whether it is folding or faulting which will cause the greater problems for mining. In 1 (b) students need to show that they understand that factors other than geology alone may be more important, although the much lower economic costs associated with surface and shallow mining as opposed to deep mining, could be argued as the factor of overwhelming importance.

Activity 2 is about the differences between opencast and deep mining.

Part (a) of Activity 3 is a practical skills exercise. A line graph is the most appropriate technique for showing this data because the oil price is an example of 'continuous data'—there is always a current selling price of oil (just like there is always a current temperature). The line going up and down on the graph provided a visual picture of the great fluctuations in world market price of oil, typical for all minerals. Part (b) requires students to think about the advantages and disadvantages of changing oil prices; this is in advance of the study of fossil fuels in Chapter 2.

1.4 IMPACT OF ROCK AND MINERAL EXTRACTION (pages 12–19)

Syllabus coverage
Mining without some environmental pollution is impossible. The text concentrates on the three types of pollution from mining—land, air, and water. Students should be encouraged to think about, as well as explain, why mining is allowed in National Parks (Figure 1.11) and why mining companies often do little to reduce the environmental impacts of their operations. Figure 1.1, and the Information Box with details about the size of Chuquicamata, show how big mining operations can be, increasing the potential for environmental damage. The Exam Tip about pollution sends a useful message to students: in examination answers, the term 'pollution' should always be qualified by reference to type.

In the text, environmental impacts are followed by reference to impacts on people to cover the 'economic and social impacts of rock and mineral extraction' part of the syllabus. Impacts on people can be positive as well as negative. For the sake of continuity, the negative human impacts are covered first, before the focus switches to the many positive effects of mining for economic growth and development. For many countries, especially developing countries on continents such as Africa, as well as in the Middle East, mining dominates economic activity and exports. For some, it is their main source of foreign exchange (Figure 1.15) and for a few countries, it can be their only source.

The Exam Tip about the meaning of impact is so important for students that it is mentioned again in later chapters. Of the key syllabus terms relating to economic impacts, infrastructure is likely to be the one least understood, which is why it is defined in the Information Box.

The example of Cerro de Pasco (pages 18–19) is included because in extreme ways, it illustrates many of the issues associated with the impacts of large scale mining. Mining offers the only viable economic activity in this area, but some of the impacts on the environment, and more particularly for people, are horrendous.

Key syllabus terms

habitat loss, noise pollution, water pollution, land pollution, air pollution, visual pollution, waste, employment, local economy, national economy, infrastructure

Activities (page 14)

Activity 1 asks students to identify examples to illustrate some of the specific negative environmental impacts of mining that are stated in the syllabus. Activity 2 is a broader question aimed at the main focus of this section.

Activities (page 17)

Activity 1 is the human (social and economic) equivalent of Activity 1 on page 14. Activity 2 will provide students with a simple check list for the advantages and disadvantages of mining. Activity 3 makes students look more carefully at the map of African countries and their dependence on mineral exports. Perhaps the 'three ways' is best approached by first using the size of the percentages, especially those that are more than 90 per cent, and secondly by referring to the significant numbers of countries either with very high dependence on or with more than half their income from mineral exports. Activity 4 invites students to consider the varied reactions from local people, which always arise when proposals to begin or extend mining or quarrying are put forward. Parts (a) and (b) are included to give a context, as well as requiring students to practise their observational skills.

Activities (page 19)

Activity 1 is intended to set the scene. Activity 2 is a repeat of the disadvantages part of Activity 2 page 17, but this time for a specific example (instead of general disadvantages). The most likely position on the line drawn for Activity 3 (a) will be towards the 100 per cent end. However, the most important thing is that it should reflect the explanation given in part (b). Strong economic arguments in (b) could support a position closer to the middle of the line in (a). Activity 4 is an Internet search limited in scope so that it should be quick and easy.

Further study

If no local, regional, or national mining issue exists to be investigated by students, an issue of greater international concern could be a focus for personal investigation, such as proposals to extend the exploration for minerals into environmentally sensitive areas like the Arctic Ocean.

1.5 MANAGING THE IMPACT OF ROCK AND MINERAL EXTRACTION

(pages 20–22)

Syllabus coverage

The focus switches to strategies for restoring landscapes damaged by mining and quarrying. One of the most widespread is landfill, but it has advantages and disadvantages. It does need careful management. Other strategies referred to are bio-mediation, land restoration, and landscaping. Restoration can open up possibilities for new land uses such as reservoirs, lakes, and nature reserves. These can provide new recreational opportunities for people, as the case study for the Eden project in Cornwall (pages 22–23) shows. Note that this is separated out as a case study, to match what is needed for the specified case study for this topic about management and restoration of a mining site after the mine has closed.

Also note that the syllabus wording is 'describe and evaluate strategies' for restoring damaged landscapes. This is why the text contains more than just details of the method. Comments about the method's suitability and use are also included.

Key syllabus terms

mining waste, land restoration, bio-mediation, landfill

Activities (page 21)

Activity 1 tests the syllabus 'describe and evaluate' referred to above. Part (a) is 'describe', part (b) is preparation for 'evaluation', and part (c) is the 'evaluation'. Activity 2 is easier for students to answer; it is similar, but without the evaluation.

Activities (page 23)

Activity 1 requires students to make notes on the case study i.e. reduce the detail / content, and isolate the most important / key points that can be used in examination answers. They are guided through what to do in parts (a) to (c) in line with syllabus wording. (Syllabus wording is often followed in setting examination questions.) Part (a) is about the mine itself, part (b) is the management methods for restoration, and part (c) is the evaluation. Activity 2 is broader, referring to all the different possible uses of old mines and quarries. Part (b) again requires students to consider the worth of the different methods and evaluate with reasons what they consider to be the best and the worst. The choice of methods is less important than the quality of the explanation to justify the choices. Obviously, the better the choice, the easier the justification.

Further study

Is there a disused mine or quarry within the home region? If there is, then land uses after mining can be investigated, and commented upon for their usefulness.

1.6 SUSTAINABLE USE AND CONSERVATION OF ROCKS AND MINERALS (pages 23–26)

Syllabus coverage

Conservation has been added to the topic heading used in the syllabus, because this is why more sustainable use is necessary. Since this is just the first of many syllabus references to sustainability, key definitions have been placed in an Information Box near the beginning. It should make it easier for students to refer back to them when studying later topics. The basic theme is that present rates of mining and mineral use are unsustainable because most mineral resources are finite, some with perhaps surprisingly low life expectancies, as shown in Figure 1.22. Five strategies for sustainable use and conservation are then described and commented upon in turn.

Key syllabus terms

sustainable resource, sustainable development, increased efficiency, recycle, legislation

Activities (page 26)

Activity 1 is about recycling and increased efficiency, two of the main syllabus themes in this section. Activity 2 requires students to study Figure 1.23 more closely. Hopefully they will give A as their answer and explain in terms of lower need for consuming extra resources, such as energy for transport and for recycling the glass in the glass factory. In Activity 3, part (a) is a practical task, part (b) asks for description of what their graph shows, while part (c) tests students' understanding of the environmental benefits of the changes between 2000 and 2014. Activity 4 broadens out the area of study—essentially to look at some of the differences in attitudes between richer developed countries and poorer developing countries. The basic explanation is that greater wealth allows more opportunities for caring for the environment, although it is fair to add that people and local authorities in developed countries often need to be led towards more sustainable methods by pressure from conservation groups, international organizations, and governments.

Further study

Recycling is the most likely topic for local study. What types of waste does the student's family generate? What happens to this waste? How much of it is recycled? Do the authorities provide any recycling services? What improvements could be made?

Increased efficiency in use of energy is another possible theme. What types of energy does the student's family consume and for what uses? Is the family's consumption increasing? Can anything be done to reduce the family's total consumption while still maintaining its quality of life?

CHAPTER 2

Energy and the environment (pages 27–70)

This chapter starts with a brief study of the formation of fossil fuels. It is followed by a much more substantial section on the use of an increasingly wide variety of energy resources for generating electricity. There is a clear separation between the use of the non-renewable fossil fuels (coal, oil, and gas) plus nuclear energy, and the long list of renewables. Although world energy use of electricity is still dominated by fossil fuels and nuclear resources (Figure 2.6), the use of renewables is increasing everywhere. This is why the study of renewables is given greater prominence in the new syllabus. Seven types of renewables are specified in the syllabus. The approach to study for both non-renewables and renewable sources is the same—description of how they are obtained and how they are used for making electricity, followed by environmental and human (social and economic) advantages and disadvantages.

A brief section on energy demand, mainly reasons for increased world use, is followed by a fuller section on conservation and management of energy resources. This is mainly about reducing consumption, energy conservation, and making fuller use of existing resources. However, it also includes a reference to research and development of new energy resources; this includes a study of fracking, a recent but increasingly important source of additional fossil fuel supplies.

In the final two parts, the focus switches to oil pollution and its impact and management, especially for marine and coastal ecosystems. Two case studies are included to illustrate impact and management of oil pollution. One is the Niger Delta, an area in which pollution has been an issue for many years. The second is the Deepwater Horizon spill in the Gulf of Mexico in 2010, a spill of enormous proportions, which hopefully will prove to be a one-off event.

The Introduction (page 28) is used to give background information about fossil fuels, without which the rapid and great world economic growth and development over the last three centuries would not have been possible. The fact that fossil fuel resources are non-renewable is illustrated in Figure 2.2. The 'life expectancies' for coal, oil, and gas have been progressively extended by new technologies (for example, by deep water drilling and fracking), but eventually all the resources available to be exploited will run out if the present rates of use continue. In other words, this high reliance on fossil fuels is not a sustainable option for the energy needs of future generations.

2.1 FORMATION OF FOSSIL FUELS (pages 29–31)

Syllabus coverage

There is only one syllabus instruction: to describe the formation of fossil fuels. The two characteristics that the formation of coal, oil, and gas have in common are identified first, before individual descriptions are given. Details about the Carboniferous era in the Information Box help to reinforce the non-renewable nature of present day fossil fuel resources.

Key syllabus term

fossil fuels

Activities (page 31)
The main theme, which runs through the four activities, is of similarities and differences between the three fossil fuels in terms of formation, search, and extraction; as the student progresses through the four activities, increased levels of thought and interpretation are required.

2.2 ENERGY RESOURCES AND THE GENERATION OF ELECTRICITY

(pages 31–52)

Syllabus coverage
Underlying this topic of resource use for generating electricity is the contrast between traditional non-renewable energy sources and more recent alternative renewable energy sources. The fact that seven renewable sources are named in the new syllabus is an indicator of their growing importance. Nevertheless Figure 2.6 is placed at the beginning of this section to show that world commercial energy consumption was still, in 2015, dominated by non-renewable sources (fossil fuels and nuclear power), in order to maintain a sense of perspective about relative importance. Then the individual energy resources named in the syllabus are covered in turn. How the resource is used to generate electricity is described first, including, where relevant, the favourable conditions needed for its choice or location, and prospects for great use.

The order of approach is similar, first for the non-renewables, and then for each of the renewables, i.e. individual coverage of the different methods, followed by a more general summary of their advantages and disadvantages.

This is a long chapter with important topics; page summaries might help.

Pages 31–34: All energy resources for the generation of electricity

Pages 34–36: Non-renewable energy resources and electricity generation—thermal fossil fuels (coal, oil, gas); nuclear power

Pages 36–39: Advantages and disadvantages of these non-renewable energy resources

Pages 40–47: Renewable energy resources and electricity generation—hydro-electric power; geothermal; biofuels; wind, solar, tidal, and wave power

Pages 48–52: Advantages and disadvantages of these renewable energy resources

Key syllabus terms
non-renewable, renewable, nuclear power, biofuels, geothermal power, hydro-electric power, tidal power, wave power, solar power, wind power

Activities (page 33)
These three activities are about drawing, using, and interpreting graphs. In Activity 1, the percentages needed for drawing the pie graph are given in Table 2.1. Note that your students would not be required to plot as many segments or such precise percentages under exam conditions. You could suggest that they simplify these percentages to the nearest whole number. In Activity 2 (a), reading from the bottom of Figure 2.6, oil and natural gas combined gives a total

of about 7500 million tonnes; reading from the top, coal is just under 4000 million tonnes, giving a total of about 11,500 out of just over 13,000 million tonnes. The percentage is approximately 87-88 per cent fossil fuel contribution. Asked to do a similar task in an exam, for which it is impossible to read wholly accurate values off the graph, a range of acceptable percentages would be given in the mark scheme, say 86–90 per cent. Certainly the thrust of the answer to 2 (b) should be the continued great importance, or even dominance, of fossil fuels. In Activity 3 (a), statements A and C are essentially true; B is false because oil consumption throughout the period was greater than that of coal. It is always good practice in exam answers to use values in questions based on graphs; this is what part (b) requires students to do.

Activities (page 36)
Activity 1 is general background for electricity production, testing essential understanding as the basis for all that follows in this section. In Activity 2 (a), the automatic response of many students will be to draw a pie graph. However, in this case, the type of graph is not specified, and there is an alternative technique. A divided bar graph is equally valid, and likely to be easier to draw, with greater accuracy, than a divided circle. In 2 (b), the regions with the top three percentages are usually accepted as being part of the developed world; their combined total is over 80 per cent. China has industrialized and developed fast, but is not yet included within the developed world, mainly because its wealth needs to be shared among its large total population.

Activities (page 39)
The energy resource assessment sheet used in Activity 1 can be completed for any of the non-renewable or renewable energy resources. Here it is for nuclear power; in Activity 2 students are asked to complete one of their own for a fossil fuel. Most of the answers are simply right or wrong; nuclear power is not renewable because it relies on a raw material (uranium) as the source of energy, even though the amount of power that can be produced is great compared with the amount of raw material used (a great difference compared with fossil fuels). A few are more subjective; for 'no local environmental problems', in theory the answer should be 'yes' (unlike coal-fired power stations), but occasionally the answer is 'no' because of leaks or explosions. Perhaps a similar line of reasoning would apply to 'safe'. When answering 1 (c), students are given a clue about developing countries by the high level of technology needed; not being cheap would also apply. The worth of the student's own assessment for a fossil fuel in 2 (a) should be assessed in the light of the comments made in part (b), although good comment cannot make a wrong answer into a correct one. In Activity 3, Figure 2.19 acts as a starting point to make students think hard about what is really different between using fossil fuels and non-renewables.

Activities (page 41)
Looking at Figure 2.11, student answers to Activity 1 (a) can be expected to refer to the steep relief, fast-flowing river, and water storage in the lake (reservoir); there is a drop in height of over 600 metres between the lake and the HEP station. Together, these provide the strong force of water needed for driving the turbine. Looking at Figure 2.13, in part (b) relevant favourable features of the climate include precipitation all year, no month with less than 100mm precipitation, high annual total (over 2000mm), winter temperatures above freezing point (meaning no interruption of water availability), and summer temperatures lower than 15°C (so

that rates of evaporation are low). Students are likely to find it easier to use the precipitation data than the temperature data, which is why a student answer in which both are used will be a high level response. Once the assessment for geothermal power is completed in 2 (a), the student can look at three contrasting assessments—nuclear in Activity 1 page 39, their own non-renewable fuel assessment in Activity 2 page 39, and now their own geothermal assessment, which is typical for a renewable energy source. The best answers to Activity 2 (b) will focus on the major differences such as lack of pollution and fewer environmental issues.

Activities (page 44)

Answering 1 (a) requires students to select advantages and disadvantages from the text about biofuels. Answers to part (b) are more subjective. Quality and breadth of explanation in answering are more important than the student's own opinion about whether advantages outweigh disadvantages, or vice-versa. In Activity 2, Drax power station provides a good example of what is happening in many countries, not just the UK, where there is a move away from what is being referred to as 'dirty coal' towards renewables for electricity generation. It shows how both politics and economics are influencing the decisions: electricity made from coal is cheaper than that made from renewables, especially in countries with their own coalfields, but it is the most polluting of all the energy sources used for making electricity. Therefore, government attitude to subsidies and to climate change commitments is of great importance.

Activities (page 47)

Activity 1 is a check on student understanding of basic energy terminology. In Activity 2, the four basic reasons to explain the dominance of wind and solar over tidal and wave power are: better / longer known technology, lower cost, many suitable locations, and small scale schemes. Reference to all four would indicate a really high level of student understanding. There are two aspects to the answers expected in Activity 3. One is the greater power / intensity of the sunlight. The other is that schemes can be small in scale and local; no expensive grid infrastructure of electric cables from a power station many kilometres away is needed. The purpose of part 4 (a) is to force students to make a careful study of the information given about tidal power stations. Having looked at the information, they are in a better position to decide upon the merits or otherwise of tidal power in part (b). Perhaps high cost and potential damage to the environment are the two factors likely to be referred to most frequently.

Activities (page 51)

After the summary section about the advantages and disadvantages of renewables, these are more general activities. In Activity 1, solar and wind (the two renewables in most widespread use) are also the two which are most intermittent because they rely upon current weather. For the other five renewables, output is more predictable. Tide, wave, and geothermal are the most predictable. Large storage facilities are needed to enable HEP stations operate through dry seasons and less predictable periods of drought. For Activity 2 (a), the range of costs for generating electricity, shown in Figure 2.22, need to be treated with a degree of caution. They do vary greatly from place to place, and can change quickly, as when the cost of solar panels from China dropped dramatically. Even so, the main message from the graph is valid: that electricity generated from fossil fuels is generally cheaper than that from renewables. There is also a secondary message, that long and older established renewables (and HEP in particular) are cheaper than more recently developed sources, awaiting further technological breakthroughs,

which need time to happen. Again in answers to Activity 2 (b), the explanation is more important than the actual view expressed by the student towards the continued dominance of fossil fuels. The same comment applies to the student view expressed in Activity 3 (b). The task in part 3 (a) is different, to identify arguments supporting the greater use of wind power, from the comments made, irrespective of whether or not the student agrees with them. Activity 4 brings the study of renewable sources back to the home country and will form the basis for further study of how electricity is generated in the country where they live.

Further study

Act on the Exam Tips on page 52 about the usefulness of references to specific examples in examination answers by investigating energy sources for electricity output in the home country.

Look at the location of the main generating stations—what are the energy sources, are they close to the big cities and main concentrations of people? Calculate the relative percentages contributed by fossil fuels and renewables. Which renewables are being used? Look for their main locations. What are the chances of increased output from them?

A separate investigation would be to keep up-to-date with any news about improvements in technology for power storage; especially important would be any signs of a breakthrough in battery power.

2.3 ENERGY DEMAND (pages 53–56)

Syllabus coverage

There is only one theme, i.e. to examine the factors affecting the demand for energy. The focus is on energy demand (rather than energy supply) for people, industries, and transport. There is a general positive relationship between high personal and national wealth and high energy demand. The only non-human factor which affects demand is climate; in colder climates there is a greater need for energy for winter heating. Increasing world energy consumption also reflects world population growth, in turn increasing the demand for domestic consumption, factory-made goods, and modern means of transport.

Key syllabus terms

demand, domestic, industrial, transport, wealth, climate

Activities (pages 54–55)

It could be a good idea to suggest that students read the guidance about graph interpretation in Chapter 10 before answering Activity 1. Also you could suggest a number of marks for the question, say 3 or 4, in order to guide your students as to the number of descriptive points you expect them to make. Otherwise some will stop after stating 'it has increased' without reference to or use of the values in the graph. Answering 2 (a) requires students to refer to the given page in Chapter 8, Human Population. The answers are 100, 30, 14, 13, 12 and 12 years. The best answers in 2 (b) will refer back to the graph of energy consumption. The purpose of Activity 3 is to reinforce the message that manual labour has been, and is being, replaced by machines, thereby helping to explain the persistent increase in world energy demand.

Activities (page 56)
Activity 1 uses the factors named in the syllabus, which in turn are the factors likely to be named in examination questions. Activities 2 and 3 are intended to make students think 'local', about personal and family use, and comparisons with others in the local area. This can be expected to match the theme of increasing domestic demand, plus the need for more industrial goods and greater use of modern means of transport. Those living in hot climates can be expected to have lower energy use than those in cold climates, unless they are sufficiently wealthy to afford air conditioning, which is very power hungry.

Further study
The scale of Activities 2 and 3 on page 56 can be extended for comparisons of energy use with people living in other parts of the country, or in neighbouring countries, or in a country further afield with a different climate.

2.4 CONSERVATION AND MANAGEMENT OF ENERGY RESOURCES

(pages 56–81)

Syllabus coverage
There is a change in emphasis from a study of individual sources of energy to strategies for their management, including research and development of new energy resources. It may be useful to refer back to the equivalent section in Chapter 1 for the conservation of rocks and minerals, beginning on page 23, with which there are many similarities. This part of the syllabus is also about reducing energy consumption, in the home and in work places, and for motor vehicles. It is also about recycling and re-use of waste materials such as cooking oil for biofuel. Governments and local authorities have a role to play in the education of people and in the provision of recycling facilities. Fracking is the main example of the development of a new energy resource; but it is very controversial, which is why it has been given its own section of text on page 60.

Key syllabus terms
energy efficiency, energy conservation, insulation, fracking

Activities (page 59)
In Activity 1, a table layout is suggested so that information about the key strategies referred to in the text can be selected and presented in summary form—the purpose is to help students identify what is most significant. Activity 2 is more tightly focused on what one business has done for energy conservation and invites students to think about the reasons why all businesses have not done the same. This compliments Activity 2 on page 56 about home energy consumption. Activity 3 here goes to the next stage, in line with the syllabus, and asks about energy conservation in the home and local area—whether it exists, and what more could be done. Activity 4 increases the scale of energy study to the national level—what are the differences between four Asian countries and the energy sources they use for electricity generation?

Activity (page 61)
The activity is only about fracking; it is intended as a summary of the text—what fracking is, what makes it different, and why it is so controversial.

2.5 IMPACT OF OIL POLLUTION (pages 61–64)

Syllabus coverage

This study of the causes and impacts of oil pollution is restricted to marine and coastal ecosystems, where most of the largest oil spills have occurred, whether from off-shore oil extraction, pipelines, or shipping. General coverage here is supported later by case studies of oil pollution in the Niger Delta, and the Deepwater Horizon disaster in the Gulf of Mexico.

Key syllabus terms

Ecosystem, coral reef, offshore oil extraction

Activities (page 64)

Activity 1 requires students to make a more detailed study and assessment of what Figure 2.30 shows about oil pollution. Oil drilling technology has progressed to the point that well blow-outs are rare, but when they do occur, the amount of oil that can be released is potentially great—in theory, up to the amount of oil in the well. Whereas, shipping accidents are more frequent, but the size of the spill is finite, limited to the amount of oil carried by the tanker. Activity 2 requires students to use both information in this section about impacts, and later information specific to the two case studies. They should have little trouble identifying the information that is relevant here, since both case studies also cover the impacts.

2.6 MANAGEMENT OF OIL POLLUTION (pages 64–65)

Syllabus coverage

There are two aspects to the management of oil pollution. One is to do everything possible to reduce the chances of an oil spill happening. The second is to have plans in place to react quickly and efficiently when an oil spill has occurred. Oil spill accidents can be reduced by good management, but totally preventing them is never going to be possible, which is why strategies for minimizing the impacts are important.

Key syllabus terms

MARPOL, double-hulled tankers, booms, skimmers

Activities (page 65)

Activity 1 requires student explanation about the advantages of double hulls for tankers. Activity 2 is about the methods used for reducing the impacts, including an assessment of their environmental strengths. Activity 3 is an open-ended question, which could be asked for all types of pollution.

Further study

For the next major oil spill that affects coastal ecosystems and is reported in the international news media, students can be asked to keep a log of key details from sources such as TV reports and the Internet, as the basis for a short case study. Students should be reminded that it is good policy to devise headings related to syllabus needs, such as location, size of spill, causes, impacts on coastal ecosystems, and attempts made to reduce the effects of pollution.

For students living in countries with coastal wetlands, such as mangroves, there may be other opportunities for local study. The advantages of protecting coastal wetlands, such as natural flood control, and purifying agents for removing toxic wastes, can be assessed in relation to the advantages predicted from clearance and land reclamation.

CASE STUDIES

A Oil pollution in the Niger Delta region of Nigeria (pages 66–67)

This is an example of a coastal region with long-term and continuing oil pollution, with frequent pipeline leaks and the more occasional well blow-outs. The impact on the local area has been high, but any management to stop the leaks and clean up polluted environments has been slow and inadequate.

Activities (page 67)

In Activity 1, guidance is given for making notes to identify key points from the text, i.e. specific information of the type that is most likely to be useful in examination answers. Activity 2 requires students to look ahead to the Deepwater Horizon case study and to identify similarities and differences between the two oil spills. Activity 3 gives students a chance to assemble all the information, from text and case studies, to meet fully the needs of syllabus topic 2.5 about impacts of oil pollution.

B Deepwater Horizon oil spill, Gulf of Mexico, 2010 (pages 68–70)

In contrast to the first case study, this is a one-off event, significant because it is the world's largest accidental oil spill. Only the deliberate destruction of oil wells and tankers during the Gulf War of 1991 has produced a larger spill (Figure 2.31). The big contrast with the first case study is the management of the spill: it was immediate with huge financial resources supporting it. It illustrates well the use of the strategies for minimizing the impact named in the syllabus.

Activities (page 70)

Activity 1 is examination use orientated (as for Activity 1, page 67). The purpose of Activity 2 is to make students appreciate that there is often a difference in perception of the seriousness of the effects of a disaster between immediate and short-term, compared with long-term and permanent.

Further study

Has there been a coastal oil spill in your home country or region? If so, put together a case study for that pollution event to use in an exam, instead of one of the book examples. Use the same headings as those used for case studies here.

CHAPTER 3

Agriculture and the environment (Pages 71–102)

The first two units in this chapter are about soils as the medium for plant growth, upon which all types of farming depend. For most farmers 'the answer lies in the soil'. Soil composition is dominated by the presence of mineral particles, namely sand, silt, and clay. The two extremes of soil, sand and clay, are named in the syllabus; however, the best agricultural soil is loam—a balanced mixture of sand, clay, and silt, with a healthy pH value between 5.5 and 8.0.

This is followed by the study of types of agriculture. Two classifications are used. One is for the actual types of farming: crop farming (arable), livestock farming (pastoral), or both crops and animals kept on the same farm (mixed). The second classification is economic: whether the main focus is upon feeding the farmer and his family (subsistence) or upon growing crops and keeping animals for sale (commercial).

Agricultural output has been increasing everywhere. In many parts of the world it has managed to keep up with the rapid world population growth of the last 100 years. The use of many of the techniques named in the syllabus for increasing crop yields, such as chemicals for fertilizers, insecticides and herbicides, mechanization, and new seeds, began on commercial farms in developed countries. Now their use has spread far and wide to commercial farms in developing countries, and even to subsistence farms in some countries. Some of the named techniques, such as rotation and irrigation, have been used for many centuries in all parts of the world, both rich and poor. During the last century, improvements in technology for both water storage and distribution have allowed a massive increase in the amount of irrigated land used for farming. Other techniques to increase yields are more recent, or new and experimental, such as genetically modified crops and hydroponics.

Increased agricultural output comes at a cost to both the environment and people. One of the most serious, and most widespread, impacts of more intensive farming practices is soil erosion. Two chapter units are devoted to causes, impacts, and management strategies for its reduction. The final unit is about strategies for making agricultural practices more sustainable. Some involve going back to using strategies which have stood the test of time, over many centuries, such as crop rotation and use of organic fertilizers. Others are the result of modern agricultural scientific research, such as the development of pest-and drought-resistant varieties of crops.

For this chapter, the Introduction (page 72) is background information about soil instead of syllabus content. References to soil profile could be useful to local investigations of soils; pits or cuttings on the sides of roads are usually the best places for students to see the normally invisible sub-surface soil horizons. Description of the leaching process helps to explain why soil fertility declines so quickly once the surface cover of vegetation is cleared. Therefore it is relevant to the big section on soil erosion.

3.1 SOIL COMPOSITION (pages 73–74)

Syllabus coverage
This is the basic introduction to soils. The focus is on the four basic constituents of soil—mineral particles (sand, silt, and clay), organic matter, air, and water.

Key terms
mineral particles, particles, organic content

Activities (page 74)
The four Activities cover basic syllabus content; students also need to make use of information in the Introduction relating to soil profile and leaching. In Activity 1(d), the approximate percentages of the four soil constituents shown in Figure 3.4 are 47–48 per cent for minerals, 25 per cent for each of air and water, and some 2 or 3 per cent for organic. These closely match what is in the accompanying text. Explanation as to why these percentages are not fixed is also given in the text.

Further study
Undertake a local soil investigation. Seek out a location where a soil profile is exposed, for instance on the sides of a river, or a cutting at the side of a road or track, or at the top of a quarry. Make a sketch of the profile. Try to identify, name, and describe the horizons.

3.2 SOILS FOR PLANT GROWTH (pages 74–76)

Syllabus coverage
The theme is what soil provides for plant growth—minerals (nitrates, phosphates, and potassium), organic content (animal manure, compost, and fertilizers), a moderate pH value (preferably between 5.5 and 8.0), and good texture (a mixture of sand, silt, and clay particles for balanced air and water content, and drainage). Together these should make for ease of cultivation and high output.

Key syllabus terms
mineral ions, pH value, sandy soil, clayey soil

Activities (page 76)
Activity 1 is a check on the definition of three key syllabus terms. Activity 2 focuses on that part of the syllabus which requires description of the differences between a sandy soil and a clay soil. Activity 3 (a) begins with a straightforward practical task, followed by a written part about loamy soils, not actually named in the syllabus, but which are better for plant growth than sandy or clayey soils.

Further study
In preparation for the study of the next topic, students could be asked to undertake a short investigation of farming in their home country. Where are the main farming areas? Locate them on a map. What are the soils like in the areas farmed? How and why are they better than soils in other parts of the country?

3.3 DIFFERENT TYPES OF AGRICULTURE (pages 77–80)

Syllabus coverage

The syllabus does no more than ask for the basic differences between arable, pastoral, and mixed farming to be described, and then likewise for subsistence and pastoral. No individual farming types are specified for study. This suggests that nothing more than passing references to examples of farming types are expected.

Key syllabus terms

arable farming, pastoral farming, mixed farming, subsistence farming, commercial farming

Activities (pages 79–80)

Activity 1 is organized as a table to link farming types referred to in this section to the five key syllabus terms. Adding a location is good practice because it makes it more precise. In Activity 2, although the questions based on the photograph in Figure 3.14 are quite specific, be aware that there is guidance about what makes for good photographic description in Chapter 10. The herding in the foreground clearly shows subsistence farming; crop cultivation in the background is on a large enough scale to suggest that it could be commercial, although there is no definite proof of this. As always, student explanation is more important than the actual label given to the farming type. Activity 3 encourages local study—positive factors for those living in agricultural countries, negative for those who do not.

Further study

Any further investigation of agricultural types would be an extension of Activity 3.

3.4 Agricultural techniques to increase yields (pages 80–87)

Syllabus coverage

Although not included in this part of the syllabus (it is part of Chapter 8), the first paragraph gives students the context to explain why so much effort has gone into increasing food output—the great and continuous increase in world population. The techniques for increasing agricultural output, named in the syllabus, are described in turn, although not in the same order as listed in the syllabus. Comment is directed at how they have allowed farm output to be increased. The order of coverage is irrigation, fertilizers, and pesticides linked under the headings chemicals, mechanization, and selective breeding of plants and animals (including the Green Revolution). After a break for Activities on page 84, coverage of techniques continues with genetically modified organisms and controlled environments (greenhouses and hydroponics), and ends with one of the oldest and best, crop rotation.

Key syllabus terms

crop rotation, fertilizers, irrigation, insecticide, biological control, herbicide, fungicide, selective breeding, genetically modified organisms, hydroponics

Activities (page 84)

In Activity 1, the spider diagram in Figure 3.16 highlights five problems for farmers, which reduce food output from their land. Students are required to examine each one in turn, explaining in (a) why it reduces output, and describing in (b) the techniques to solve or reduce the problem. For drought, students can refer to irrigation and drought resistant varieties of seeds; for plague of locusts, insecticide; for bad weather at harvest time, mechanization; for infertile sandy soils, fertilizers; and for fast growing weeds, herbicides and perhaps biological control. Activity 2 is specific to the Green Revolution, selective breeding of new plant seeds before the more recent development of GM crops. Since these high-yielding varieties of seeds have been used for a longer time, both the advantages and disadvantages associated with their use are easier to discuss.

Activities (page 87)

Activities 1–4 relate to GM crops. Activity 1 is what they are; Activity 2 comments on the dominance of the USA, the home country for GM crops, with 44 per cent of total world area; Activity 3 is why higher yields can be expected from them; and Activity 4 discusses why people hold different views about growing GM crops. In Activity 5 (a), the two cereal crops would be alternated with beans and clover in a four-year rotation. The basic answer to 5 (b) is that different crops use, as well as replace, different minerals from and into the soil.

Further study

Earlier investigations into types of farming in the home country or region can be continued by a study of the agricultural techniques used to increase yields. Make a list of the techniques referred to in this section; place a tick or a cross against them according to whether or not they are used in the study area. For the ones used, name the types of farming and their locations. For the ones not used, give the main reasons for their lack of use. Are any others likely to be used in the near future?

3.5 THE ADVERSE EFFECTS OF MODERN AGRICULTURAL PRACTICES

(pages 88–91)

Syllabus coverage

Most of the impacts from using the new techniques are environmental. These are listed under three headings, lettered A–C in Figure 3.20. The impacts separated out individually in the guidance notes in the syllabus have been re-organized into just three groups: overuse of chemicals, overuse of irrigation water, and over-cultivation. Each one is covered in turn in the text which follows. Notice that they all begin with the prefix 'over-', suggesting human mismanagement as a cause, the result of trying to produce more and more from the land. Impacts on humans are less clear-cut and are covered in a shorter section after the Activities on page 90. Rich farmers owning large commercial farms are better placed to take up new techniques than poor subsistence farmers with only small plots of farmland.

Key syllabus terms

overuse, mismanagement, salinization, waterlogging, soil erosion, cash crop

Activities (page 90)
Activities 1 and 2, using slightly different tasks, are focused on two of the widespread problems, eutrophication and salinization. Similar questions could have been set for other environmental impacts covered in the text. Activity 3 is different. This is to make students read more carefully the news report for the Indus Valley in Figure 3.24. As is commonly done in exam questions based upon written reports, students are asked to identify problems under three separate headings—environmental, economic, and political—before explaining why each has arisen.

Activities (page 91)
For Activity 1, students already have a flow diagram in Figure 3.25 to guide them when switching the focus to poor farmers becoming poorer, instead of rich farmers becoming richer. Their answers can be expected to contain a mixture of opposite statements and new comment. In Activity 2, the focus is on monoculture: why it is more common on large farms than small farms, and why it causes more environmental problems than crop rotation.

3.6 SOIL EROSION: CAUSES AND IMPACTS (pages 92–95)

Syllabus coverage
This section has a clear layout—describe the causes of soil erosion first, and then explain the impacts. The text begins with a general definition of soil erosion and then makes clear that this is another example of a natural process speeded up by human activities. Natural soil erosion is most likely to occur in dry environments, and where the land is mountainous and slopes are steep. Humans clearing the land in these areas risk causing the highest rates of erosion. Bad farming practices, such as overcultivation and overgrazing, and increasing population pressure are also responsible for making soil erosion a growing environmental problem. Both the environmental and economic consequences of soil erosion are serious. Environmental consequences include loss of habitats, desertification, and silting of rivers. Human impacts are displacement of people, malnutrition, and in extreme cases famine.

Key syllabus terms
over-cultivation, overgrazing, habitat loss, desertification, malnutrition, famine

Activities (page 93)
To answer both parts of Activity 1, students need to look back to the Introduction (page 72). In Activity 2, population pressure is the most likely answer to part (a), steepness of slopes to part (b), bad farming methods to part (c), and increased water and soil flow as well as silting up of the river in part (d). Another relevant point for answers to part (c) is that field boundaries go up and down the slope, increasing the likelihood of surface runoff and soil movement downslope.

Activities (page 95)
In Activity 1, Figure 3.27 shows a clearance in the forest on a steep slope, with clear signs of the effects of water run-off during rainstorms, taking the topsoil with it. The aim of Activity 2 is to get students to identify the key points under the five headings suggested in parts (a) and (b), so that the information about desertification is organized in a manner which should make it

easier for them to remember, and then use, in an examination. Activity 3 is another opportunity for students to examine how applicable all this general information (about soil erosion) is to their home country or world region.

Further study
Activity 3 can form the basis for extended individual investigation.

3.7 SOIL EROSION: MANAGEMENT STRATEGIES (pages 95–97)

Syllabus coverage
The long list of strategies in the syllabus is organized under three sub-headings. **Mechanical methods** involve a change in the land and farming landscape; examples are terraces and bunds, which alter the shape of the land surface, and contour ploughing and windbreaks, which affect the appearance of the fields and surrounding areas. **Changes in farming practices** usually involve ways of keeping as much of the surface covered for as long as possible. Mixed cropping, inter-cropping, crop rotation, and adding organic matter are examples. **Community solutions** often involve a package of measures, in which tree planting usually plays a part.

Key syllabus terms
terracing, contour ploughing, bunds, windbreaks, mixed cropping, inter-cropping

Activities (page 97)
In Activity 1, for the seven syllabus strategies highlighted in bold in the text above, students are asked to show that they know what each one is and how it works. For Activity 2 (a), the two methods are terracing and planting trees. In 2 (b), the area marked 3 is in the middle of the main cultivated area, where the slopes are slightly less steep; reference to good farming practices is perhaps the best way to answer this question. The main aim of Activity 3 is to get students to name and explain methods of conservation which are useful in the area that was previously used to show the effects of soil erosion. On the final sketch, in the answer to part (c), we can expect to see woodland planted on the upper slopes above the farming area, windbreaks between some of the fields, terraces on the steeper slopes within the farmed area and greater crop variety inside the fields.

Case study of Niger in the Sahel: soil erosion and desertification

(pages 98–99)
The African Sahel is a good example to use in order to illustrate the processes of soil erosion and desertification, because it is the largest area repeatedly affected. Niger is one of the poorest countries within the Sahel, which magnifies the effects of these processes on its people. Use of Niger as a named example links in with references to the same country and region in other topics, which is why the text includes cross references to Chapters 6 and 8.

Activities (page 99)

In Activity 1 students are guided into converting a flow diagram about the general causes of soil erosion and desertification into a more specific diagram referring to why they are happening in Niger. Activities 2 and 3 require students to look at what can be done to reduce soil erosion, and then evaluate why methods implemented may not be as successful as hoped for.

Further study

- Is your home country, or world region, at risk from desertification?
- If yes, why and what measures are being taken to stop its spread?
- If no, why not? Are natural or human factors more important for explaining this?

3.8 STRATEGIES FOR SUSTAINABLE AGRICULTURE (pages 100–102)

Syllabus coverage

This is a summary section for the topic of agriculture around the theme of sustainability. Three of the six strategies for sustainable agriculture named in the syllabus have already been adequately covered in previous sections. Page cross-references for these are given in Figure 3.34. The new text here focuses on the other three strategies—managed grazing, trickle drip irrigation, and rainwater harvesting.

Key syllabus terms

organic fertilizer, managed grazing, trickle drip irrigation, rainwater harvesting

Activities (page 102)

Four of the six strategies are covered in Activity 1. Students are asked to give a brief definition for each one in part (a), as they may well be asked to do in an exam, before describing how they contribute to making agriculture more sustainable in part (b). Part (c) requires them to think about why they are not more widely used. The other two strategies are covered in Activities 2 and 3; the questions about trickle drip irrigation and rainwater harvesting are similar to those in Activity 1, but tailored to the individual strategy. Activity 4 is an investigation into how widespread the use of rainwater harvesting in the home region or country is.

Further study

The type of investigation for the home region or country put forward in Activity 4 for rainwater harvesting can be done for any of the other five strategies for sustainable agriculture, particularly if their use is more widespread in the home country.

CHAPTER 4

Water and its management (Pages 103–137)

Water is vital to life on Earth, but it usually comes as something of a surprise when people learn that as little as three per cent of all the water on Earth is freshwater, and that most of this is stored as ice in glaciers and ice sheets rather than being readily available for human use. The water cycle, beginning with precipitation from the atmosphere, and ending with evaporated water vapour condensing to form rain-bearing clouds in the atmosphere, is one of the Earth's great natural systems.

As for water supply for human needs, another quarter of all the freshwater on Earth is stored underground; some, but not all, is available for human use from aquifers, springs, and wells. Overall there is a great reliance on surface water, from melting glaciers and rivers, and from natural and human surface stores in lakes and reservoirs. Desalination plants, using advanced technology, convert sea water into fresh water in places where other sources of supply are inadequate for local demand, but at a high cost.

As for water use, people living in wet climates and in highly urbanized countries are unaware that about 70 per cent of the world's water supplies are used in farming, mainly for growing crops to supply the world's ever-growing population. Since higher percentages of people work in farming in developing countries than in developed countries, there can be significant variations between countries in the way water is used. There are other significant variations within and between countries—in domestic water use between rich and poor, in water quality between urban and rural areas in developing countries, and in water availability between water-rich and water-poor countries. To try to satisfy the world's growing demand for water, grand multi-purpose dam projects are to be found on all inhabited continents, the largest and most recent being the Three Gorges Dam in China.

More domestic and industrial water use, intensive farming with the greater use of chemicals, and rapid urbanization have all contributed to a great increase in water pollution in rivers, lakes, and seas. This pollution is having serious environmental impacts on water organisms and food chains. Inadequacies in sewage and water treatment, especially in large developing world cities, increase the risk of infectious diseases spreading through densely populated areas. Managing and reducing the pollution of fresh water sources is one of the main challenges for governments and local authorities everywhere, but particularly in developing countries.

This topic is rounded off by a unit about managing water-related diseases, with particular reference to malaria and cholera.

4.1 GLOBAL WATER DISTRIBUTION (page 104)

Syllabus coverage

This topic is covered in the Introduction. The global distribution of water is dominated by salt water in the oceans (97 per cent of water on Earth). Of the remaining 3 per cent that is freshwater, most is stored in ice sheets or underground. Only 0.02 per cent of the freshwater on Earth is found in rivers at any one time, but worldwide they are the main source of water supply for people.

Key syllabus terms
ice sheets, glaciers, groundwater

Activities (page 104)
Activity 1 is a practical task that requires making of three graphs. Here students are given a choice between the two types of graphs which can be used for showing percentages. The three graphs together should highlight how freshwater supplies for human use are in limited supply. This would be the best conclusion in answers to Activity 2 after students have described what each graph shows.

Further study
Undertake an investigation of the different water stores in the student's home country—their locations, sizes, and relative importance.

4.2 THE WATER CYCLE (pages 105–107)

Syllabus coverage
The focus is entirely on describing and interpreting the water cycle. The water cycle is a natural system with inputs (precipitation), stores (on the surface and underground), flows (rivers), transfers (evaporation), and outputs (precipitation formation in the atmosphere) which continue the cycle. What drives the system is solar heating. Changes in surface land uses, caused by human actions, affect how the water cycle processes operate. For example, the most widespread land use changes have been the destruction of natural forests and growth of urban areas, resulting in increased rates of surface runoff and lower rates of infiltration and evaporation.

Key syllabus terms
water cycle processes: precipitation, interception, surface runoff, infiltration, through-flow, groundwater flow, evaporation, transpiration, condensation

Activities (page 107)
Activity 1 is a check on student understanding of the differences between pairs of water cycle processes. The answers in Activity 2 are 1 precipitation, 2 surface runoff, 3 interception, 4 infiltration, 5 groundwater flow (note that 4 and 5 together make up through-flow), 6 evaporation, 7 transpiration (note than 6 and 7 together make up evapo-transpiration), and 8 condensation. Simple data given in Activity 3 illustrates how runoff is affected by human changes in land use. Students are most likely to draw a bar graph in (a); this should emphasize in a visual way the size of the changes. When explaining in (b), students are required to apply their general understanding to this particular example.

4.3 WATER SUPPLY (pages 108–113)

Syllabus coverage

In this section there is a clear but narrow focus on where the fresh water used by people comes from—either from underground (aquifers and wells), or from the surface (rivers and reservoirs), or from sea water after removing the salt (in desalination plants). In the textbook, underground sources are first in the order of coverage, and then desalination, including a specific reference to the example of Saudi Arabia. Finally, the most important one—surface water supplies and transfers—is given a longer section of its own. Within this third section, there is reference to the specific example of the Indus River management system. Further on, the case study of the Three Gorges Dam (pages 123–124) provides additional example-based information. This section cannot be effectively studied without student understanding of key syllabus terms, including terms relating to rock characteristics (previously referred to in relation to the anticline oil trap in Chapter 2). This is why they have been assembled in the Information Box on page 110.

Key syllabus terms

aquifer, well, reservoir, desalination plant

Activities (page 110)

Activity 1 is an exercise to check students' understanding of why and where water can be obtained from underground. The surface outcrop of porous / permeable rock at A allows the aquifer to be refilled by precipitation. The closer the aquifer layer to the surface, the less deep any well needs to be to reach stored water. D or E would be the better for a well than F, C, and B, because the lower part of the aquifer, which will hold more water for longer, can be reached more easily and cheaply. When assessing the worth of a labelled diagram, as in Activity 2, the labelling is as important as the diagram itself. If both drawing and labelling are well done, the explanation will barely be needed. Activity 3 requires students to look at the example of Saudi Arabia which highlights the type of problem facing many other countries in dry climates—underground stores are being used up faster than they are being replenished. Saudi Arabia is luckier than some in that its oil wealth allows it to use one of the more expensive solutions—desalination plants. Examples of suitable graphs that the students might use include bar graphs for precipitation and water demand, and any one from pie graph, divided bar graph, or pictograph for percentage of water use by sector.

Activities (page 113)

For Activity 1, further information about dam building in mountainous areas was given in Chapter 2 in the renewables section for HEP. It could be a good idea to refer students back to that section before answering Activity 1. One of the main purposes of Activity 2 is again to make students look in more detail than they otherwise would at a specific example. The River Indus and its tributaries are good examples of managed rivers; river management is the main theme for this activity.

Further study
The same or similar headings to those used in Activity 3 (a, b, c, d) can be used for a case study based on the home country, or for another country instead of Saudi Arabia. Providing students with headings in advance of undertaking investigative work usually increases the quality of the final report.

4.4 WATER USAGE (pages 113–115)

Syllabus coverage
Again the focus is clear and narrow, this time on the different ways people use fresh water. It is customary to divide water use into three sectors—domestic, industrial, and agricultural. Big differences in water use exist between developing countries in Asia with large populations to feed, in which 90 per cent or more water use is for agriculture, and developed countries in Northern and Western Europe where under 20 per cent is used for farming. There are variations within both developed and developing countries. The USA stores and uses more water in agriculture than do countries in Europe. The massive scale of industrial growth in China since 1990 has led to a big increase both in industrial use as a percentage of the total use, as well as in the overall amount consumed.

Key syllabus terms
Domestic, industrial, agricultural

Activities (pages 114–115)
Activity 1 is another practical task to represent visually the world percentages for sector use, stated near the beginning of this section. Data for water use is given for four Asian countries and the UK and USA in Activity 2. This allows both similarities and differences in water usage between countries to be explained. The percentages for North America in Figure 4.11 are different from other continents and therefore worthy of study in Activity 3. If desired, part (b) can be modified so that North America can be contrasted with the student's home continent. Activity 4 brings the scale down to the personal level and encourages students to consider their own family's water consumption levels.

Further study
Undertake an investigation of the water supply in the student's home town or region. Each member of the class could be required to complete a spreadsheet or questionnaire about water uses in their family: class data could be collated, and similarities and differences commented upon.

4.5 WATER QUALITY AND AVAILABILITY (pages 115–120)

Syllabus coverage
Some countries are described as water-rich; they have plentiful fresh water supplies. Others are water-poor, mainly countries located in areas with low annual rainfall totals. There are two main themes in this section. First, as demands for water increase everywhere, there is an increased

potential for water conflicts within and between countries, especially in water-poor regions of the world such as the Middle East, and in parts of South Asia and Africa. Secondly, what is taken for granted in developed world countries, such as ready access to safe drinking water, is a major issue in many developing countries, especially in rural areas.

Key syllabus terms
safe drinking water, water conflict

Activities (page 118)
The purpose of Activity 1 (a) is to highlight visually two contrasting distributions—water-poor countries concentrated in the Middle East and Africa (low rainfall, but quite well-populated), water-rich countries predominantly located in South America (high rainfall and low overall densities of population), plus the north of North America, Europe, and Asia (Canada and Russia). By highlighting the poorest and richest, this should help to simplify for students the otherwise complex world distribution of water-rich and water-poor regions. Activity 2 enables the national and regional situation to be examined within the global perspective. Activity 3 will provide a summary graph (probably a bar graph) for the gap between urban and rural areas for clean water access. In order to answer Activity 4, students have the spider diagram in Figure 4.16 as their guide. Their labels should be a mixture of reversed statements from Figure 4.16 and new content.

Activities (page 120)
These three activities are focused on the 'potential for water conflict' part of the syllabus. For helping with answers to Activity 1, students have just drawn a map to show that the Middle East is the one of the world's most water-poor regions. Saudi Arabia has already been used as an example of a country with water issues since demand outstrips supply. For answering Activity 2, information about the Indus Water Scheme was given in Figure 4.9 and the accompanying text. For Activity 3 (a), all the information needed is on the maps, in the text and in the Information Box, as the basis for informed explanation in 3 (b).

Further study
Activity 2 on page 118 gives the lead. Opportunities for extension investigations, such as exploiting new sources as well as any economic, social, or environmental issues arising from doing this, are likely to exist more for students living in countries / world regions that are water-poor.

4.6 MULTI-PURPOSE DAM PROJECTS—HOW SUSTAINABLE ARE THEY?

(pages 120–124)

Syllabus coverage
The focus is solely on large dam projects, including choice of location, impacts, and assessment of their sustainability. Incorporated in this section is the case study of a named multi-purpose dam scheme (Three Gorges Dam). The syllabus separates out the impacts into environmental,

economic, and social. What these terms mean, and the importance of looking for both positive and negative impacts, are referred to in Information Boxes and Exam Tips in other places in the book. Make use also of the information about dams given in the HEP section in Chapter 2.

Key syllabus terms
multi-purpose dam, environmental, economic, social, sustainability

Activities (page 122)
Activity 1 requires students to identify advantages / benefits (or in syllabus language, positive impacts) and disadvantages / costs (i.e. negative impacts) from building large dams. In line with syllabus wording, students are asked to separate these out according to whether they are environmental, social, or economic. Parts (c) and (d) require an evaluation of the relative strengths of these impacts; again, the quality of the explanation is more significant than the actual choice made. Activity 2 requires favourable site factors for dam location to be recognized. Activity 3 is about ways to make dam projects more sustainable. Activity 4 follows up one of the proposals for increased sustainability (more but smaller dams) and asks students for their views on this.

Activities (page 124)
The five activities lead students into selecting information most likely to be useful to them in their exam answers. Activity 1 is the definition of a key syllabus term. Activity 2 is about the advantages hoped for by the Chinese government. Activity 3 requires identification of the negative impacts under the syllabus headings of social, economic, and environmental. Activity 4 asks for a summary assessment of the dam's overall sustainability. Activity 5 gives the outline headings for student investigation of a dam project in their home country or region.

Further study
The syllabus allows total freedom of choice for the case study of the named multi-purpose dam scheme. Students are not required to use the Three Gorges Dam in exam answers. Instead they can use a national or regional example, for which Activity 5 give the guidelines for investigation.

4.7 WATER POLLUTION AND ITS SOURCES (pages 125–126)

Syllabus coverage
Three sources of water pollution are itemized in the syllabus—from domestic waste, industrial processes, and agricultural practices. Note how these match the three headings for water usage.

Key syllabus terms
sewage, industrial processes

Activities (page 126)
Activities begin with the recognition of natural and human water stores (glaciers, lakes, rivers, and reservoirs) from Figure 4.21 in part (a). Next is water usage in (b), showing all three sectors (domestic, industrial, and agricultural). In part (c), the further upstream letter H is placed, the better; whereas the lower downriver the position of L is, the better—preferably below the water

returning from agricultural areas, which lie downstream from the settlement and industry. The better the locations of H and L on the sketch, the more convincing the explanation in (d) is likely to be.

4.8 IMPACT OF WATER POLLUTION (pages 126–128)

Syllabus coverage

This is a longer section about how water pollution affects people and the environment. Coverage in the text begins with the syllabus reference to global inequalities in sewage and waste treatment. Variations in sewage treatment between rich and poor countries, and between urban and rural areas, are much wider than those for clean water supply. A high risk of infectious diseases is a direct consequence of inadequate waste and sewage treatment. Water courses contaminated by biological and chemical waste, and the accumulation of toxic substances, from agriculture and industry, also have serious consequences for human health. Natural ecosystems are badly affected. Nitrates and phosphates released from agricultural land are leading to more eutrophication in rivers and lakes; industry is also contributing to the bioaccumulation of toxic substances in food chains. At the end of the section is a passing mention of acid rain; here, there is a cross reference to Chapter 7, where its causes and effects are covered in detail.

Key syllabus terms

infectious diseases, typhoid, cholera, bioaccumulation, acid rain, eutrophication

Activities (page 128)

In 1 (a), the percentages with access to sanitation are 90 per cent urban and 40 per cent rural. In 2 (a), the answers are: (i) 1.8bn (ii) 3.8bn, and (iii) 5.6bn. In 2 (b), the percentage of the total without access to sanitation in 2010 is 68 per cent. When it comes to answering part (c), visually on the graphs there does not seem to be too much difference in the relative percentages for with and without access for the three dates, which can be confirmed by further calculation (about 35 per cent, 31 per cent and 32 per cent with access on the three dates). What is different is that there are greater numbers of people without access because population totals in the developing world have grown so fast. Activities 3 and 4 are about the causes and effects of two of the pollution impacts on natural ecosystems, namely eutrophication and bioaccumulation. Activity 5 encourages investigation of a local river or stream.

Further study

It is likely that most students will live no great distance from a water course or a water source which is polluted and can be investigated using fieldwork techniques. Sometimes, a sudden increase in levels of water pollution downstream can be noticed, in which case separate surveys can be made above and below this point to investigate differences and causes.

4.9 MANAGING POLLUTION AND IMPROVING WATER QUALITY

(pages 128–132)

Syllabus coverage

Having dealt with causes and impacts of water pollution, the focus switches to strategies for improving water quality. Syllabus guidance is restricted to improved sanitation, treatment of sewage, and pollution control legislation. In the text, a broader view is taken than that in the syllabus by referring to water conservation and more efficient use, as well increasing water supply by desalination. This allows some of the key issues mentioned earlier in the chapter to be referred to again as a summary for the topic of water.

The second case study for Topic 4, about pollution in a named body of water, is based on the River Clyde. The Clyde changed from being relatively clean to badly polluted in 50 years; for another 100 years, domestic sewage and industrial wastes kept the river lifeless. Even so, with legislation in place, and finance, expertise, and determination, it took nearly 30 years to bring the river back to life. Although most examples of river improvement schemes are found in the developed world, they provide a model for what could be done to rivers in developing countries, should both the desire and the economic resources exist.

In developing countries, it is more likely that resources and aid are being channelled into providing clean water, especially in rural areas, where (as we have already seen) provision lags behind urban areas. The example of improved clean water supply in the Punjab—before and after—shows that in some places there are hopeful signs for change and improvement.

Key syllabus terms

improved sanitation, sewage treatment, pollution control

Activities (page 129)

Activity 1 is definitions of key terms. Activity 2 is about desalination, drawing upon content earlier in the chapter as well as here.

Activities (page 132)

Activity 1 is based on the case study of the River Clyde. The emphasis is upon checking that students are aware that similar improvements can be done in rivers in other parts of the world. Activities 2 and 3 are based around the example of the Punjab. Headings are suggested in Activity 3 to give some structure to the students' answers; hopefully, this should help them identify key points, potentially useful in future examination answers.

Further study

For students living in developing countries, a local case study of water improvements can be investigated.

4.10 MANAGING WATER-RELATED DISEASES (pages 133–137)

Syllabus coverage

This section follows from the risk of infectious diseases, one of the impacts of water pollution named in the syllabus in topic 4.8. The first and longest part is about attempts to control the spread of malaria; this is followed by a shorter part doing the same for cholera. The different strategies to eradicate these two water-related diseases are described and evaluated.

Key syllabus terms

vector control, chlorination

Activities (page 136)

The three activities cover all aspects of the study of malaria—life cycle, strategies for control, and an evaluation of the effectiveness of these strategies.

Activities (page 137)

These three activities do the same for cholera.

Further study

Are malaria and / or cholera present in your home country or world region?

If yes—your investigation might include:

A Location and distribution, areas most badly affected, areas little affected

B Strategies used to try to control it

C Effectiveness of these—reasons for their success or failure

If no—why are they not a problem in your home country or world region?

CHAPTER 5

Oceans and fisheries (pages 138–159)

Oceans cover 70 per cent of the Earth. They are full of life. For many of the world's coastal communities, fish is the staple food, rather than rice, maize, or wheat. Oceans moderate the Earth's temperatures and supply moisture for precipitation. Onshore winds are often rain bearing winds; they bring the monsoon rains upon which many Asian farmers depend. Landlocked countries are much drier; and without access to ocean transport routes connecting the world, many have lower levels of economic development than neighbouring countries with coastlines.

Oceans are a great resource for humans, but their resources are more difficult for humans to exploit than are land resources. The most obvious resource is fish. Major world fisheries are found where continental shelves are wide and cold ocean currents are present.

Unfortunately, most of the major world fisheries are suffering from over-exploitation of this resource. The size of fish stocks varies from year to year due to natural causes, such as the change in direction and strength of ocean currents, as in El Niño years off the coast of Peru. However, humans have continued to fish the oceans as if fish were an unlimited resource. This explains the urgent need for management and control of marine fishing in every major fishery.

One alternative to marine fishing is marine fish farming. Where practised, success has been mixed. It has certainly increased supplies of salmon for worldwide distribution and sale, but fish farm wastes have polluted coastal waters and impacted upon the natural habitat.

For this topic, the Introduction is an introduction to the oceans in general and to life in the oceans in particular. A marine ecosystem is illustrated in Figure 5.2 showing examples of marine food chains from the same trophic* levels.

*trophic levels: ecological term for living creatures that share the same function in the food chain and get their food from the same source.

5.1 RESOURCE POTENTIAL OF OCEANS (pages 140–142)

Syllabus coverage

This is a brief introduction to the many and varied resources of the oceans before the fisheries become the focus for the rest of the topic. Food is top of the list. Travel by sea was always easier than travel by land; oceans remain the world's highways for transporting bulky goods. Use of other resources, such as beaches for tourism and potable water from desalination is quite recent. Wave and tidal energy is still at the research and development stage (Chapter 2). Resources which people can use are concentrated on the continental shelf, which is why it is used to round off this section.

Key syllabus terms

resource potential, wave energy, tidal energy, tourism, transport

Activities (page 142)

The reasoning behind Activity 1 is that students ought to know the names and locations of major oceans and seas before they can interpret world maps in a meaningful way. World maps included in the next section are of major fishing grounds and ocean currents. In Activity 2, students are referred back to Figure 5.2 for the massive importance of phytoplankton in marine ecosystems—its availability controls the size of fish stocks available to humans. Activity 3 follows on, referring students back to the Information Box in the Introduction and the knock-on effects of any changes in nutrient availability throughout the food chain. The purpose of Activity 4 is to get students to think about why ocean resources are more difficult to exploit than land resources. Students should be familiar with oil traps and drilling for oil from coverage in Chapter 2. Oil drilling is an activity which takes place both on the land and in the sea.

Further study

For students living in countries with a coastline, investigate how many of the ocean resources named in Figure 5.3 are present in their region. Give the headings, and list the uses and their locations below them.

5.2 WORLD FISHERIES (pages 142–148)

Syllabus coverage

The text follows the syllabus by focusing on ocean fisheries—locating them, and giving the environmental and human reasons for their distribution. It is supported by a world map of major fishing grounds (Figure 5.5), which shows a domination in temperate waters, close to large centres of population, where a wide extent of continental shelf exists. In addition, ocean currents are an important part of the explanation for the distribution of world fisheries. They are shown in Figure 5.6. The syllabus states that 'names are not needed' (in other words, there will not be an exam question testing knowledge of names and locations); what is important is the global pattern and locations in relation to major fisheries. However, it is useful to know place names, hence they have been named on the map; some are referred to later, particularly the Peruvian (Humboldt) current during coverage of El Niño.

Peru is a major fishing nation (Table 5.1), but the periodic changes caused by El Niño events cause a great decline in marine catches. Direct comparisons between El Niño and normal years can be made by using the maps and information in the text. Although no one seems to understand fully why it occurs, it is a natural phenomenon that keeps on repeating every few years. In some years, notably 1982–3, 1997–8 and 2016–7, the effects were much worse. It causes major changes in climate and fish stocks along the coast of Peru. Its effects on other countries are more variable, but it does lead to droughts in areas normally wet and floods in areas normally dry on other continents.

Key syllabus terms

cold ocean current, warm ocean current, El Niño, continental shelf

Activities (pages 144–145)

Part (a) of Activity 1 is only about describing what the map shows; there should be no attempt to explain. Explanation for what the map shows is needed only in part 1 (b). (It could be worthwhile advising students to look at the 'Command words' section in Chapter 10 before answering.) Relevant descriptive points for (a) include that most of the 'major fishing areas (see map key) are located in the northern hemisphere, there is only one south of the Equator off the coast of Peru; fishing grounds are wider and larger in the north. Most of the 'other important fishing areas' (see map key) are in the southern hemisphere, and they are smaller in area and width except for fishing grounds north of Australia and around the islands of Indonesia. Activity 2 is potentially a long activity. You could shorten it for your students, and still maintain its value, by suggesting that only the top six countries are used. All three of the different fishing areas identified in part (c) are still represented within the top six. The answers to Activity 3 are obtained by students looking at the relationship between the volume of fish landed and the populations. On this basis, countries such as Peru, Chile, and Norway are likely to be exporters of their marine catches, while the likes of China, India, and Indonesia, with their big populations, are likely to consume all that is caught.

Pages 145–148 cover the issues of decline in fish stocks, and the El Niño effects on the Pacific, particularly on Peru. Figure 5.7 A, B, C, and D shows why Peru's location is ideal for high fish stocks. Figure 5.9 A, B shows the El Niño impact on the same region, devastating both land and sea, and affecting the climate as well.

Activities (page 148)

Headings are suggested in Activity 1 to help with recognition of the differences between the 'normal' (Figure 5.7) and 'El Niño' years (Figure 5.9). In Activity 2, the focus is on the economic effects of an El Niño year in Peru. Activity 3 asks for the student's opinion: the explanation should be considered more important than the view itself.

Further studies

1 Investigation—Importance of fishing in your world region
   - **A** Look at the FAO website. Note down the marine catches for your country and those close to it.
   - **B** How important is marine fishing in your region compared with other parts of the world? Explain your answer.

2 Investigation—Impacts on Peru of the El Niño event in 2016–7
   - **A** Explore websites on the Internet to discover how Peru was effected.
   - **B** Were the effects as bad as those described in the book for 1997–8? Briefly explain your conclusion.

5.3 OVERFISHING AND ITS CONSEQUENCES (pages 149–155)

Syllabus coverage

Overfishing is a growing problem and a major international issue. It may be relevant to only a limited number of countries, but it can have great economic and social effects for them. One of the main causes of overfishing, improvements in technology, is covered in detail. The potential consequences for future fish stocks and for coastal fishing communities are enormous.

One of the impacts of overfishing and lower catches has been the growth of fish farming of marine species, predominantly salmon. When successful, this has the potential to reduce the exploitation of marine fisheries and to give more time for natural stocks to recover. The two specified case studies for this topic are about fish farming, and are included here. They are salmon fishery in southern Chile and cod fishery in Norway. Included in them are references to locations, favourable factors for set up, environmental impacts, issues of management, and an assessment of potential.

Key syllabus terms

overfishing, target species, bycatch

Activities (page 152)

Drawing the line graph for world marine fish catches in Activity 1 (a) should highlight the difference between the steady increase from 1959 up to about 1989, after which catches have levelled out or even fallen in some years. For answering 1 (b), some guidance to students about how to describe graphs like this is given in Chapter 10. Activity 2 focuses on the way in which new technology has caused overfishing. Activity 3 begins with a statement; it is used as a trigger to get students to explain why, what was once considered to be a plentiful renewable resource, is now a scarce resource in many locations. The investigation in Activity 4 is not as central to the syllabus, but stopping whaling has been an important environmental issue for at least 30 years, and raises issues of broader significance to the study of human use of ocean resources.

Activities (page 154)

Activity 1 covers essential details about fish farming: what it is, which species are farmed, why fish farming has grown and what the problems are. Activity 2 requires students to select the main points from the case study of salmon farming in Chile, and then make brief notes for easier revision of this case study at a later date.

Activities (page 155)

Activities are similar for fish farming in Norway, and have the same purpose as those for the Chile case study. Headings, adapted to suit this particular case study, are again given to provide guidance and an ordered framework.

5.4 MANAGEMENT OF THE HARVESTING OF MARINE SPECIES

(pages 156–159)

Syllabus coverage

The focus is on strategies for management of ocean fisheries—describing them, explaining how they work, and evaluating their effectiveness. Using fishing quotas is the most widespread strategy; however, it is worth emphasizing to students that a package of measures might produce better results and be more sustainable in the long term. Iceland is one of the few countries that has preserved its fish stocks at reasonable levels by careful management, although not without opposition from fishermen. In general, strategies have had only limited success, partly due to weak enforcement of the regulations. Even in developed countries with many regulations and fisheries patrol boats, as the example of the EU shows, fish stocks have continued to decrease. It took until 2015 for North Sea cod and haddock stocks to recover to sustainable levels. Can they be maintained? There may be international agreements in place, but implementation and monitoring are always the key issues.

Key syllabus terms

mesh size, pole and line fishing, quotas, closed seasons

Activities (page 158)

Activity 1 is simply about naming and describing three management strategies. Activity 2 requires students to do more. Activity 2 (a) is diagrams only. It is important that the labels are for the *disadvantages* of purse seine nets and the *advantages* of rod and line. Part (b) is the written part, an evaluation of the difficulties of bringing changes increasing sustainability versus the economics of tuna fishing by using nets.

Activities (page 159)

Activity 1 is a visual way to name and bring together all the problems for implementing ocean fisheries management strategies. Activity 2 relates to the example of the EU and its attempts to manage North Sea fish stocks. Good answers describing the graph in part (a) will comment on the trend of the lines, and then support their answers by referring to and using values from the graph. Good answers to part (b) can be expected to refer to fish stocks becoming so low by the late 1990s that they had fallen below replacement levels. Perhaps answers to part (c) can develop the theme of economic interests of fishermen in conflict with the scientific evidence.

Further study

If ocean fishing is a significant economic activity in your home country or world region, it may be possible to investigate the existence, or otherwise, of strategies for its long-term preservation. If strategies do not exist, or are not enforced, what are the reasons? Are environmental groups campaigning for controls?

CHAPTER 6

Managing natural hazards (Pages 160–195)

Five natural hazards are named in the syllabus. Earthquakes and volcanoes are tectonic hazards; tropical cyclones, flooding, and drought are climatic hazards. In the syllabus, the causes of each of the five hazards are separated out, whereas impacts and management are applied generally to all five. In the book, a different order is used; causes, impacts, and management are covered together for each hazard in turn. It is hoped that this is a more student-friendly approach. While, clearly, there are similarities between impacts (such as loss of life and reduced farm output), and management (such as the need for advance planning), the likely impacts and management priorities are different for each one.

What this means is that there are no separate headings in the text for syllabus Topics 6.5 (The impacts of natural hazards), 6.6 (Managing the impacts of natural hazards), and 6.7 (Opportunities presented by natural hazards). Instead, content in these three sections is covered as it applies to the individual hazards. In fact, when looking down the further guidance column in the syllabus, most of it is arranged hazard by hazard. In the syllabus guidance for Topic 6.7 (Human opportunities presented by natural hazards), only flooding and volcanoes are mentioned. This is not surprising because it is hard to find anything good to say about the impacts of earthquakes, tropical cyclones, and drought!

Before starting to deal with the different hazards, the Introduction (page 161) is used as background for all of them. It begins with a definition of a natural hazard. Then some of the similarities and differences between them are highlighted. The final block of Activities at the end of this chapter (page 195) is about all the five hazards; the questions require understanding of some of the similarities and differences between them for impacts and management.

6.1 PLATE TECTONICS: EARTHQUAKES AND VOLCANOES

(Pages 162–176)

Syllabus coverage

The structure of the Earth is described in the Introduction to Chapter 1. The Earth's crust is divided up into large and small plates (Figure 6.3); the world distributions of earthquakes (Figure 6.4) and volcanoes (Figure 6.14) can only be explained in relation to plate movements, with tectonic activity concentrated on the plate boundaries. Plate boundaries are shown and explained in Figure 6.5. All three world maps are the same size, deliberately, so that the global distributions shown can be compared more readily.

Earthquake strength is measured on the Richter scale. The impacts of earthquakes are entirely negative. It is possible to sub-divide the impacts into primary effects (immediate due to shaking of the ground) and secondary effects (what happens in the minutes, hours, and days after the earthquake). Areas at risk of earthquakes are well known, but the earthquake event itself cannot be predicted. This is why good management needs to be directed at advance preparation, such as making buildings earthquake-resistant and training emergency rescue teams. This is usually

more easily done in rich (developed) countries; the case study on pages 170–171 highlights the differences in earthquake management between California and Iran after earthquake events of the same magnitude.

There is a big element of unpredictability about volcanic eruptions, such as when the volcano will come back to life, for how long, and how big the eruption will be. Unlike for earthquakes, there can be warning signs. Volcanoes are landscape features. Damage can be widespread and long-lasting as the example of Montserrat (Figure 6.18, page 174) shows. And there can also be positive impacts for people—some of the world's best soils for farming are of volcanic origin.

The comparison of earthquakes of the same magnitude in California and Bam (pages 170-171) is the specified syllabus case study for the tectonic part of the topic.

Key syllabus terms

Earth's structure—crust, mantle, core

plate boundaries—constructive, destructive, conservative

negative impacts—infrastructure damage, tsunami, landslide, trauma

positive impacts—geothermal energy

Activities (page 164)

The purpose of Activity 1 is to try to make the world map of tectonic plates more accessible to students by confining the question to tectonic plates in that part of the world where the student lives. What is happening along plate boundaries is what matters, which is the focus of Activity 2. Activity 1(b) draws attention to the main example of a conservative plate boundary, the one between the North American and Pacific plates. In Activity 3, by asking students in part (a) to make a tracing first, it is hoped that students can see better the closeness of the relationship between plate boundaries and earthquakes. The final part of the activity brings the students' attention back to their own world region.

Activities (page 167)

Activity 1 is to make the students look more closely at what Figure 6.6 shows about earthquake shock waves. The information which forms the basis for answering Activity 2 (a) is contained in Table 6.1; answers should begin with 'little damage for magnitude 4.5', and progress to 'much damage for 6.5', and to 'widespread and serious damage for 8.5'. Good students can be expected to use the text as well as the table, and suggest types of damage likely to occur. In part (b), while the damage to the big building in the foreground is substantial, perhaps there does not appear to be the widespread destruction all around that might be expected after a magnitude 7. 8 earthquake.

Activities (page 169)

Activity 1(a) is to highlight the difference between the primary and secondary impacts of an earthquake. Parts (b) and (c) are to send the message that what is expected does not always happen in practice. Earthquakes and their effects are simply unpredictable. Activity 2 is to emphasize how tall buildings can potentially be 'made safe', although in earthquake zones

where building techniques are not as advanced, the general rule is to build low. Activity 3 has its origins in the notices present in many hotels in earthquake-prone locations, 'What to do in an earthquake', which give instructions to guests such as

- Do not use lifts
- Use the emergency stairways
- Do not smoke
- Leave the building as quickly as possible
- Assemble in an open space
- If you cannot leave your room, stand under the door frame or lie under a table.

Activities (page 171)
In Activity 1 (a), the similarity is that they were the same magnitude (6.5); the difference was in impacts, both for loss of life and damage to buildings. The answers to parts (b) and (c) can be found in the newspaper report; all the factors to explain are human ones. In Activity 2, there is information about emergency relief supplies after an earthquake. (Many of them are equally appropriate in the aftermath of other natural disasters as well.) Activity 3 is like a summary for the whole section on earthquakes. The best answers will have three parts to them—information supporting the statement that greater earthquake strength leads to more loss of life; then examples of high earthquake strength leading to low loss of life; and finally comment about whether or not the students agree with the given statement.

Activities (pages 174–175)
In describing the world distribution of active volcanoes in Activity 1 (a), students need to home in on the general pattern by giving named examples of where large numbers are found in lines, instead of looking only at the locations of named volcanoes. Hopefully, they will begin by describing the line of volcanoes around both sides of the Pacific Ocean—up the western sides of North and South America, and linking across to island countries in Asia such as Japan, the Philippines, and Indonesia (the Pacific Ring of Fire). Then they can look for smaller concentrations such as in the middle of the Atlantic Ocean or more isolated ones such as Hawaii in the middle of the Pacific. When describing a distribution, it is also relevant to refer more briefly to named parts of the world without active volcanoes. Of course, this uneven distribution is related to locations close to plate boundaries compared with areas in the middle of the large plates, but it is not until part (d) that any explanation is asked for. A suitable, named example in part (b) would be where the North American and Eurasian plates are diverging in the middle of the Atlantic Ocean, forming volcanoes in Iceland (located in the north-west corner of this Pacific-centred world map). There is a much greater choice of suitable examples in (c), such as in the west of South America where the Nazca and South American plates are converging to form Chile's many volcanoes (such as Osorno). Montserrat is used as an example in Activity 4, while Activity 5 requires students to comment on the different reactions of people living on the island to the damaging eruption.

Activities (page 176)
The command words in Activity 1 are precise. Identify three strategies by naming them, and then say something about them by describing what they do. Activity 2 is a comparison of best management techniques between earthquakes and volcanoes.

Further study

A Following on from Activities 1 and 3, page 164, a study can be made of the likelihood of tectonic activity affecting the student's local area / world region. A sufficiently large area should be covered so that areas with different levels of risk are included.

B If you live in an area with an earthquake risk, students can investigate the preparations made and emergency procedures in place, and assess how adequate they appear to be. Questionnaires can be distributed to a sample of local people to discover their levels of awareness about the earthquake risk.

C After a major earthquake or volcanic eruption, students can investigate from media reports on websites whether the loss of life could have been smaller than it was.

6.2 CLIMATIC HAZARD: TROPICAL CYCLONES (pages 176–181)

Syllabus coverage

Despite having local names, all tropical cyclones have common origins, irrespective of whether they occur in the Indian, Pacific, or Atlantic Oceans. All form over warm tropical waters, at the time of the year when sea water temperatures are at their highest, before moving away from the Equator. As they move, their tracks are affected by the Earth's rotation from west to east, and by the shape of the land masses. Source regions, tracks followed, and coastal areas affected are shown in Figure 6.21.

Powerful tropical storms have devastating impacts on coastal regions where they first hit land; impacts decrease with distance away from the coast as the system loses its supply of warm sea water, which is its driving force. Impacts listed in the syllabus, and referred to in the text and examples, are flooding, loss of life, financial losses, damage to buildings and infrastructure, loss of crops and habitats, and water-related diseases. In this era of weather satellites, the formation and movement of tropical storms can be tracked so that preparations can be made in advance, although there is still an element of unpredictability about exactly where they will make landfall and how strong they will be. They are too powerful for humans to do anything other than manage their arrival by making efficient preparations.

The case study about managing the effects of a tropical cyclone (pages 180–181) refers to the two big cyclones which hit the Indian state of Orissa in 1999 and 2013. It is a good example to use because it shows that, in the intervening 14 years, the Indian authorities showed that they had learnt lessons after the devastating losses suffered in 1999. Better management resulted in lower loss of life in 2013.

Key syllabus terms

other names for tropical cyclones: tropical storm, hurricane, typhoon

impacts: damage to infrastructure, contamination of water supplies, water-related diseases

management: monitoring, disaster preparation, emergency shelters, international aid

Activities (page 178)
Activity 1 is about named locations—for the source regions in (a) and for areas most affected in (b). Activity 2 is about causes—their formation near the Equator in warm and deep tropical waters, and why coastal areas are most affected by the strong winds and heavy rain.

Activities (page 181)
In Activity 1 (a) students are asked to select evidence from Table 6.3, which supports the assertion that the poor suffer more than the rich from natural disasters. Reasons for this are needed in part (c); they revolve around more and better strategies for prevention of loss of life, like the ones the student is asked to describe in part (b). Activity 2 is about the case study of the two Orissa cyclones, for which many similarities are shown in wind strength, types of damage to buildings, and crop losses for farmers. In part (b), the big difference is the death toll, under 100 in 2013 compared with more than 10,000 in 1999. The main reason for the big fall was difference in attitude, both of the Indian authorities and the local people.

Further study
After a recent tropical cyclone event, students can be asked investigate its impacts using news reports from the Internet. Suggested headings for organizing their work are; (a) date and place, (b) physical features of the cyclone (e.g. wind strength, rainfall amounts), (c) loss of life, and (d) amount and type of damage.

6.3 CLIMATIC HAZARD: FLOODING (pages 182–188)

Syllabus coverage
The text for flooding follows the established pattern of causes, impact, and management. River floods are regular natural events, often annual events during the wet season or season of snow melt in the mountains. In some areas the likelihood of flooding has been increased by human actions; people (not deliberately) increase runoff when they clear forests and build settlements with hard surfaces. This has consequences for the increased frequency and severity of river floods. Exceptional natural events can cause widespread damaging floods such as storm surges from tropical cyclones and tsunamis after earthquakes.

The impacts of flooding are looked at in terms of immediate, short-term, and long-term effects. Many of the world's big rivers are managed, given their importance for water supply; flood control is usually a factor in the decision to build large, multi-purpose dams. Rivers are also monitored so that when river levels are rising, advance flood warnings can be issued. River discharge is shown on graphs known as storm hydrographs, shown in Figure 6.26. The steeper the rising limb, and the shorter the lag time between peak rainfall and peak discharge, the quicker the river will flood and the shorter the time for warning people living in areas at risk from flooding.

The case study is flooding in Bangladesh, chosen because of the country's high flood risk. Although the causes of flooding are overwhelmingly physical, there is a human contribution. As the country's population continues to grow, the effects of flooding become more serious

and affect more people. In the final section, students are introduced to the concept of 'hard engineering', i.e. people using major construction works in an attempt to control the effects of natural hazards.

Key syllabus terms
saturated soil, compacted soil, urbanization, storm surges, storm hydrograph, silt

Activities (page 182)
Activities 1 and 2 test the 'describe and explain the causes of flooding' part of the syllabus. In both, the causes of river flooding and sea flooding are separated. They are different. In the guidance notes in the syllabus, the first four bullet points relate to causes of river flooding, the last two to causes of sea flooding.

Activities (page 185)
The answers to Activity 1 (a) are steep rising limb and short lag time. Hopefully, students will gain the confidence to look at the same two elements if a storm hydrograph like this, or one that is shallower and wider suggesting lower flood risk, is included in an exam question. To answer 1 (b), students need to think about what people can do with a few hours' notice and make suggestions such as moving livestock to higher ground and taking the family to emergency shelters further away from the river. Activity 2 (a) is a practical task. Ideally, the two graphs will be kept as similar as possible (same size circle, segments in the same order) for easy comparison. The clear message in part (b) is that trees reduce runoff and lower the flood risk. This is because trees keep rates of evapo-transpiration and groundwater seepage high.

Activities (page 188)
The purpose of Activity 1 is to make students summarize the causes of flooding by using a table and a sketch map as alternatives to written explanation. Activity 2 highlights hard engineering and its possible disadvantages (which relates back to an earlier comment about the disadvantages of building large dams). Activity 3 provides the opportunity to investigate a more local example of a flood. Activity 4 is a summary question, giving good students a greater opportunity for some extended writing.

Further study
Investigate the occurrence of floods in the students' home country / world region. How regular are they? When and why are they most likely to occur? What kinds of damage do they cause? Has there ever been an exceptional flood? Do floods seem to be occurring more frequently than they used to? Or are they less frequent?

6.4 CLIMATIC HAZARD: DROUGHT (pages 189–195)

Syllabus coverage
The text for drought follows the same order of causes, impacts, and management. Emphasize to students that drought is not the same as dry season; it is only in years when the dry season continues much longer than normally expected that dry weather causes a drought. Areas of

the world most at risk from the failure of wet season rains are shown in Figure 6.30. Largest of all is the Sahel in Africa. It is within this belt that the country used in the case study for drought, Niger, is located. The effects of El Niño years are felt well beyond coastal Peru (Chapter 5); worldwide effects of the 1997–8 El Niño event in Figure 6.31 show the occurrence of droughts in Asia, Africa, and the Americas. Many believe that climate change (Chapter 7) is a factor of increasing importance for explaining the frequency and intensity of droughts.

Put together the impacts of drought listed in the syllabus—death of organisms, water sources dry up, decline in crop yields, starvation, increased soil erosion, desertification, decline in air quality, and increased risk of wildfires—and it is easy to understand why drought is the biggest killer of people of all the natural hazards (Figure 6.32). Unlike the others, it is not the sudden immediate impact that causes the deaths; instead it is worsening food shortages over a period of months or occasionally years. Soil erosion and desertification mean that the land will never again be as good for farming as it once was.

In poor countries (where most of the major droughts occur), management for drought is difficult. In the past, with lower population totals, surpluses were built up in the good years for use in drought years. Now there is increasing reliance on international aid. It is easier to raise international funds after a severe event such as an earthquake than it is for an event which goes on for months or years. Giver fatigue sets in.

Key syllabus terms
drought, ENSO (El Niño Southern Oscillation), climate change, soil erosion, desertification, international aid

Activities (page 190)
Activities 1 and 2 test the 'describe and explain the causes of drought' part of the syllabus. Since only five areas of drought are identified in Figure 6.30, it can be expected that students will refer to all of them when answering Activity 2 (a), as well as describing the big difference in the size and extent of the Sahel compared with the others.

Activities (page 192)
In Activity 1, students have Table 6.5 (page 184) as a guide for what they are expected to do. However, for the impacts of drought, expect the immediate impacts to be few and the long term impacts to be many. The purpose of Activity 2 is to make students realize that loss of life is the most important impact of drought; next they need to explain why this is the case. Activity 3 should bring out the difficulties for poor farmers just to survive in a drought. Activity 4 is about international aid. Emergency aid during the drought period is desperately needed, but the only longer term solution is development aid, which will increase the ability of local people to get through the next drought on their own.

Activity (page 194)
This is reducing the length of text to notes for case study use in an examination. As elsewhere, the headings most likely to be used in examination questions are stated for guidance.

Activities (page 195)

These are summary activities about all five natural hazards. The theme running through Activity 1 is that poor people in the developing world are far badly affected by natural hazards, than are rich people in the developed world. Activity 2 requires students to state total percentages and think about reasons why climatic hazards lead to more deaths than tectonic hazards. In Activity 3, students are asked to identify the two natural hazards which are named in the syllabus for presenting opportunities for people, and then explain more. Activity 4 (a) is about the immediate scale of a natural hazard event (which is not always related to the loss of life caused), and what humans can do to manage such events. Parts (b) and (c) require students to think about natural hazards as a whole and evaluate them.

Further study

Investigate the occurrence of drought in the students' home country / world region. How often do they occur? When and where are they most likely to occur? What are their impacts? Why are other parts of the country / region less likely to be affected by drought?

CHAPTER 7

The atmosphere and human activities (Pages 196–223)

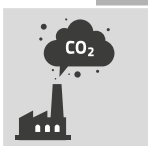
This chapter begins with a brief introduction to the atmosphere as the greatest natural system on Earth, before describing the structure and composition of the atmosphere in more detail. At the end of the Introduction, it is pointed out that the presence of carbon dioxide in the atmosphere, tiny as it is comprising only 0.03% by volume, is what provides the natural greenhouse effect.

After this, the layout and order in the book diverges from that in the syllabus. Topics 7.2 and 7.3 about causes and impacts of atmospheric pollution, as well as parts of Topic 7.4 about managing atmospheric pollution, are combined. Instead, the four types of atmospheric pollution named in Topics 7.3 and 7.4 (smog, acid rain, ozone layer depletion, and enhanced greenhouse effect / climate change) are separated out and studied individually. There is a short general introduction to the causes and impacts of atmospheric pollution in Table 7.2 on pages 200-201. After this, the causes, impacts, and management strategies for the four named types of atmospheric pollution are examined in turn. The chapter is rounded off with a general, broader summary about managing atmospheric pollution.

7.1 INTRODUCTION: THE ATMOSPHERE (pages 197–199)

Syllabus coverage

The structure of the atmosphere is described on pages 197–198, and its composition on page 199. Of all the terms in the final guidance column of the syllabus, troposphere, stratosphere, oxygen, carbon dioxide, water vapour, and the ozone layer are far more significant to study in this chapter than are mesosphere, thermosphere, nitrogen, and argon.



Key syllabus terms

troposphere, stratosphere, ozone layer, natural greenhouse effect

Activities (page 199)

In Activity 1, the pie graph will provide students with a simple visual image of the dominance of oxygen and nitrogen in the atmosphere, while in Activity 3 students are asked to focus on those gases that are present in small percentages, and to explain their importance. In between, Activity 2 is about the characteristics of the lower atmosphere: what happens in this part of the atmosphere has most relevance to surface systems and life on Earth.

7.2, 7.3 and part of 7.4: ATMOSPHERIC POLLUTION: CAUSES AND IMPACTS (pages 200–219)

Summary of how people are changing the atmosphere, and the consequences (pages 200–201)

This is general background before coverage of the four specified types of atmospheric pollution.

Activities (page 201)
In Activity 1, students are simply asked to identify from Table 7.2 the five main causes of air pollution and then list possible effects of air pollution on people's health, ecosystems, water supply, and food production. The five causes are burning fossil fuels, deforestation, bare ground surfaces, wastes burnt off in factories, and the use of chemicals. At this stage, nothing more than headings, in five lists, are needed; no further elaboration is expected. In Activity 2 (a), Figure 7.4 shows forest trees being burnt after a wide area of land has been cleared for cultivation in the interior of Brazil. To answer 2 (b), students can look at Table 7.2; here deforestation is named as a cause of increased carbon dioxide and decreased water vapour in the atmosphere.

Smog: causes and impacts (pages 202–203)
Smog, a term created by combining smoke and fog, is an urban problem most associated with traffic. In some cities, industry and coal-fired power stations make big contributions as well. All big urban areas suffer from it, but some cities have long been notorious because physical factors of their location (relief and climate) favour the concentration of pollutants instead of their dispersal. It is an increasingly serious problem in some Asian cities, notably Beijing and Delhi. When an atmospheric inversion of temperature occurs, typically during calm, high pressure weather conditions, pollutants are trapped and accumulate to extreme levels near the ground surface, causing serious health problems, especially for the vulnerable (children and elderly people).

Key syllabus terms
smog, vehicle emissions, temperature inversion

Activities (page 203)
Activity 1 is about traffic emissions and their impacts as the main cause of smog. Activity 2 is about inversion of temperature—what it is in (a), where and when it occurs in (b) and how it increases atmospheric pollution in (c).

Further study
Students living in urban areas have plenty to investigate. Official data may be available if the city authorities monitor levels of air pollution and types of pollutants. Results can be compared with those from other big cities. Traffic surveys can be undertaken along different roads (for example, a main road in the centre and a side street) and/or at different times of the day (for example, rush hours and off-peak) to identify 'pollution hot-spots' or 'pollution-pockets'.

Smog: strategies to improve urban air quality (pages 204–205)
During periods of bad smog, city authorities in Delhi are forced into emergency action with temporary restrictions on car numbers entering the city, and temporary closures of heavy industries, the two major causes of smog. Longer term strategies are needed to reduce general pollution levels. Making catalytic converters compulsory on vehicle exhausts, using cleaner fuels and improving public transport are the three strategies most widely used.

Key syllabus term
catalytic converter

Activities (page 205)

Activity 1 (a) is about smog reduction strategies in big cities; by examining the strengths and weaknesses of the three chosen strategies in part (b), students are in effect doing an evaluation of their effectiveness. For Activity 2 (a), it is most likely that students will draw a bar graph; although not quite as appropriate a technique, a line graph would also give a visual image of the changes in this example. For 2 (b), the main trend is downwards, with the sharpest decrease from 1994 to 1997. Answers needed for the explanation in 2 (c) can be found in the text with the reference to cleaner burning gasoline. In part (d) students can refer to continuing high car ownership and people's love of their cars, and in the case of Los Angeles, physical conditions which favour pollutant accumulation in the lower atmosphere. Activity 3 gives students the opportunity to examine a more local and familiar example.

Further study

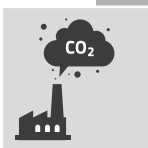
Students to investigate transport changes and improvements in the urban area where they live.

A Public transport—any recent changes? New buses? Fuel changes? Metro system? If nothing new, why not?

B Traffic congestion—survey of the most congested places. Any new road-building projects to take traffic out of the city? If no changes, why not?

Acid rain: causes and impacts (pages 205–207)

Acid rain: strategies to reduce its impacts (pages 207–208)



Acid rain is caused by emissions of sulphur dioxide and nitrogen oxides into the atmosphere. Of all the sources, coal-fired power stations are the most responsible. In some developed countries, such as the UK, the use of what is described as 'dirty coal' to generate electricity has been much reduced and is being replaced by clean renewables (Chapter 2). However, in developing countries such as India and China, with huge coal resources of their own and increasing demands for power, coal remains the dominant power source. Increased levels of acidity in soils and lakes can have devastating effects on natural ecosystems. While flue gas desulphurization (FGD) will reduce amounts of sulphur emitted from coal-fired power stations, the only effective long-term solution is to cut emissions of the damaging gases.

Key syllabus terms

acid rain, acidification, flue gas desulphurization

Activities (page 208)

The three activities follow the order used in the syllabus and text by testing students' understanding of causes in Activity 1, impacts in Activity 2 and management strategies in Activity 3. In Activity 3 (b), students are referred back to the study of Energy in Chapter 2 so that they are in a better position to comment on (or evaluate) the success of these strategies in part (b) and (c).

Further study

Is acid rain a problem or issue in the student's home country? Why or why not? Should it be an issue?

Ozone layer depletion: causes and impacts (pages 208–209)

Ozone depletion: strategies for ozone recovery (page 210)

An isoline map is used to illustrate the winter and spring thinning of the ozone layer over Antarctica. (Isolines are lines linking places with the same value; perhaps the best known example of an isoline map is a contour map.) The causes are well understood and are shown in Figure 7.11. The Montreal Protocol is the international agreement which has encouraged many industrial countries to adopt strategies to phase out the use of CFCs. There appears to be a higher level of international agreement over this issue than for many others, probably because alternatives are already available at a cost which is not prohibitive. Although the Protocol has had its critics (Figure 7.13), the news in 2016 from scientists working in Antarctica was good, as they discovered that at last the ozone hole was beginning to shrink.

Key syllabus terms

ozone layer, ozone depletion, chlorofluorocarbons (CFCs), ultraviolet radiation

Activities (page 210)

Activity 1 follows the approach used in many examination questions—students first interpret from a map or diagram, then explain the causes using their own knowledge, and thirdly make comments in relation to a common theme such as the 'need for international action'. In Activity 2, students are required to show an understanding that different viewpoints are always likely to exist over any international issue, although the latest scientific news quoted at the end is likely to tip the balance towards a favourable view.

Further study

Keep up to date; check the Internet for scientific updates from Antarctica about the size of the ozone hole.

Enhanced greenhouse effect: causes and impacts (pages 211–216)

Effects of global warming (pages 214–216)

Figure 7.14 gives the statistical support, which shows we are living through a time when the Earth's surface is warming up. The majority of people now believe that human activities are at least partially responsible for the high releases of greenhouse gases, mainly from the burning of fossil fuels (Table 7.3, page 213). When the greenhouse effect is referred to as the 'enhanced effect', this is saying that a natural process is being speeded up, (with human activities the most likely cause). The Exam Tip about student confusion between the greenhouse effect and the hole in the ozone layer is repeated, because in examinations an unbelievably high proportion of students confuse the effects of the two. The belief that the 'hole' allows higher rates of surface heating, so causing global warming, is widespread among students of this age group.

The effects of global warming can already be measured. Ice sheets in Greenland are thinning. From time to time, as in mid-2017, enormous blocks of ice break off the Antarctic ice sheet, forming huge icebergs in the surrounding ocean. Glaciers are retreating and thinning in every mountain area. Sea levels are 18 cm higher than they were 100 years ago. Governments and people on low-lying islands, like the Maldives, are worried. Although the effects of global

warming cannot yet be measured, more people are becoming convinced that global warming is affecting atmospheric circulation, increasing the frequency and severity of climatic hazards such as floods and droughts.

Key syllabus terms

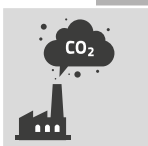
greenhouse effect, enhanced greenhouse effect, greenhouse gases, climate change

Activities (page 213)

The main purpose of Activity 1 is to increase student understanding of the greenhouse effect. Although required to draw the same diagrams as in Figure 7.15, students are expected to add more labels. The labelling will show up the level of student understanding. Activity 2 requires description from Figure 7.14; good answers will be supported by the use of values from the graph for the size of differences between dates and for variations in the overall trend. In Activity 3, students are required to identify the different human causes of increased greenhouse gas emissions and organize them under the three headings given in the question. A good answer to Activity 4 will make use not only of the data in Table 7.3 (homing in on the number of years that some CFCs can stay in the atmosphere, which makes their contribution relatively greater than percentage alone would suggest), but also the previous section on the thinning of the ozone layer.

Activities (page 216)

Figure 7.17 will be the main source of information for answering Activity 1. For (a), the top two regions for carbon emissions per head are North America and Europe, which house developed world countries; the other four regions, with significantly lower emissions, mainly house developing countries. Developed world countries (USA, Australia, and the UK) are shown to have high emissions per head. For answers to part (b), emissions per head in the Middle East are clearly higher than those in developing world continents (South America, Asia, and Africa). What is more remarkable are the extremely high emissions of some Middle Eastern countries, notably Qatar and Kuwait which emit more than twice the amount per head as even the USA. In Activity 2, some additional information about the possible consequences of global warming is given in Figure 7.21; this increases the content available to students for drawing up their lists in part (a). There is the opportunity in part (b) to identify the most likely effects for the student's own country or world region. A country's location and relief are the key to answering part (c).



Further study

The most likely areas for further investigation should be suggested from answering Activity 2 (b).

Enhanced greenhouse effect: strategies to deal with its causes and impacts (pages 217–219)

The problems encountered in persuading governments to follow the Kyoto Conference guidelines for carbon emissions, and the way later conferences have led to little agreement among all involved, illustrate the difficulties of implementing international agreements when cheap alternatives are not readily available. As part of the search for alternatives to fossil fuels, real progress has been made since 2012 with reducing the cost of electricity generation from renewables (Chapter 2). Renewables, and the hope for a future breakthrough in battery storage,

seem to offer the best chance for reducing levels of carbon emissions. Other strategies, some old such as nuclear power, and some newer, like carbon capture and storage, still have their supporters, but any rapid expansion in their future use is more questionable.

Key syllabus terms
carbon capture, carbon storage

Activities (page 219)
Global climate change is an issue that generates lively debate; a wide spectrum of views is given in Figure 7.23. Students are asked to explain in Activity 1 why views coming from different countries are so diverse. Strategies for reducing carbon dioxide emissions are the focus in Activity 2. Activity 3 is an invitation for students to express their own views and support them with explanation. Usually there is a close relationship between topic knowledge and the quality of explanation in answers to this type of question.

Further study
As an extension activity, students can be asked to prepare reports to support the views expressed by one or more of the conference delegates in Figure 7.23. Also they can investigate the views and policy of their own government (plus other interested parties in their own country).

7.4 MANAGING ATMOSPHERIC POLLUTION (pages 220–221)

Syllabus coverage
Eleven strategies to reduce the effects of atmospheric pollution are listed in the syllabus and shown in Figure 7.25. Apart from people doing as much as they can to reduce personal energy consumption (energy efficiency in the syllabus), most efforts are the responsibility of administrators (governments and urban authorities). A few types of atmospheric pollution, which have global causes, such as enhanced greenhouse effect and ozone depletion, require international agreements to encourage individual governments to act. Although many of the international climate change meetings have not been successful in achieving their aims, at least they have increased awareness of the harmful consequences of human actions.

Key syllabus terms
carbon footprint, energy efficiency

Activities (page 221)
To find all the answers for Activity 1, students will need to look back through the current chapter text as well as Chapter 2. One or two were also mentioned in earlier chapters; using the index will help. In Activity 2, students are required to match management strategies and causes of atmospheric pollution. Activity 3 is another chance to think about how much, if anything, is being done to reduce atmospheric pollution in their home country.

Case study: New Delhi–Atmospheric pollution (pages 222–223)

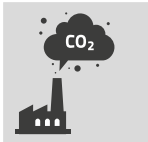
New Delhi is often ranked at the top of urban atmospheric pollution league tables. This makes it a good choice for this topic's case study–the causes, impact, and management of a specific example of atmospheric pollution. The causes are the same as for most of the other big Asian cities–non-stop population growth, expanding size of the urban area, increasing numbers of cars, buses and trucks, and low emissions standards and controls.

Poor air kills; the estimate for Delhi is more than 10,000 deaths per year. The health of hundreds of thousands more is being damaged by living and working in the city.

Past gains from making improvements in emissions from public transport were soon overtaken by more growth. The Delhi authorities know the strategies needed, but finding the funding and time to implement them is the problem. Instead of long-term solutions, they have to resort to temporary measures during bad smog, such as banning vehicles according to registration numbers.

Activity (page 223)

The task is to select the key facts and reduce the content to the amount of information that can be used in a case study-based examination answer. The four headings most likely to appear in examination questions are listed as a guide. There is a suggestion of how a question asking for an evaluation could be answered.



CHAPTER 8

Human population (Pages 224–240)

World population growth over the last 200 years has been remarkable. Figure 8.2 clearly shows its exponential nature—growth speeded up spectacularly from 1950. At last, in recent years, there is some evidence that the rate of growth is slowing down; perhaps the world population will level out at around 9 billion by 2050. The two graphs in the Introduction (Figures 8.2 and 8.3) show what has happened, and give a hint of what might happen in the next thirty years.

There may be a record number of people in the world, but there are still empty places. No one lives permanently in Antarctica, for example. However, this does not mean that Antarctica and other places with few people have been unaffected by the great growth in population numbers. Human influence is everywhere, even though people are very unevenly spread across the Earth's surface. If anything, people are becoming even more concentrated in big urban areas, as rural to urban migration continues in developing world continents.

The simple explanation for big population growth is that the birth rate is higher than the death rate. Critical to the speed of world population growth has been the fact that death rates have fallen faster than birth rates everywhere, even in developing countries, due to improvements in medicine. There is a time lag before birth rates start to fall. In a few countries, birth rates have fallen below death rates, causing a natural decrease of population—a new phenomenon.

The relationship between sizes of the birth rate and death rate affects a country's population structure. Countries dominated by high birth rates and low death rates have youthful population structures, which gives them a triangular shaped population pyramid; whereas countries with low birth rates have ageing populations, shown by a taller and more upright population pyramid (Figure 8.11).

Some governments, notably that of China, have an approach to population growth, which results in the formulation of a national population policy. Others provide family planning and health education, but leave the decisions to individuals. Everywhere in the world there is a strong negative correlation between income and family size (the higher the income, the smaller the family size).

8.1 Human population distribution and density (pages 226–228)

Syllabus coverage

Population distribution shows where people live; population density measures people per square kilometre (i.e. how closely packed together people are). Areas of high and low density are examined along with the physical and human factors responsible. Be aware that a high density of population does not mean that the area is overpopulated. What is important is the availability of resources and how well they can support all the people living there.

Key syllabus terms

population distribution, population density

Activities (page 228)

The purpose of the questions in the two parts of Activity 1 is to make students look more closely at what Figures 8.4 and 8.5 show about the spread of people across the globe. The continents suggested in the question could be replaced by others that may be more appropriate for the student's home part of the world. There is virtually unlimited choice of areas for the student to use in Activity 2 (a). What is always best is to choose areas about which the student can write most. Activity 2 (b) asks for an evaluation of the usefulness of Figure 8.6, only a general world map, for explaining variations in densities in smaller areas. The population distribution map in Figure 8.4 is probably the more useful of the two maps for answering Activity 3 (a). There is no need to worry that the dots merge in areas of high population numbers; this is all part of its visual usefulness. Although there are clear exceptions, in the best answers to 3 (b) students can be expected to conclude that the statement is a reasonable summary of world population distribution.

8.2 Human population growth (pages 228–233)

Migration (pages 231–233)

Syllabus coverage

This section, labelled 'Changes in population size' in the syllabus, is all about population growth. Here is the explanation for the exponential growth shown in graphs in the Introduction. Reasons for high and low birth and death rates are given first. These affect rates of natural increase, and in a few mainly European countries plus Japan, rates of natural decrease.

The other factor which affects population size in an area, whether it is growing or falling, is migration. This leads to a brief study of push and pull factors for migration. Although many different types of migration are named in Figure 8.9, the text is concentrated on reasons for rural to urban migration because worldwide this is the most common type of migration in terms of numbers and extent.

Key syllabus terms

exponential growth, birth rate, death rate, migration

Activities (page 230–231)

One message from Figure 8.7 in Activity 1 is that total population growth has speeded up; the increase in numbers was greater from 1975 to 2000 than it had been from 1950 to 1975. An even stronger message is that most of the growth took place in developing countries. Good students will use values from the graph to support their answers. The difference in population in part 1(b) is 3.7 billion. There is choice of method for showing the data in 2 (a)—a line graph, bar graph, or a pictograph can be used. In column A, the number of years for the population to grow by one billion is expected to increase from 13 to 27 (i.e. almost double); this is the basic evidence needed for answering part (b). In Activity 3, natural increases per 1000 are 18 in Pakistan, 5 in China, and 3 in the UK. A range of different answers to part (b) can be expected. Perhaps the most obvious point for comment is that the developed country (the UK) has the highest death rate. The reason for this is that the death rate is a ratio per 1000 people. Developed countries

like the UK have relatively few young people and high percentages of old people; even though old people are living longer due to improved medical knowledge, many more are reaching the age when they will die. The reverse applies in developing countries; life expectancy may be lower, but a much higher proportion of the population is well below the age of life expectancy.

Activities (page 233)
The main reason for asking the question in Activity 1 is to check that students understand the difference between a push and a pull factor. The most effective answers will be given by students who do more than use simple negatives and positives, such as 'no work' and 'more work'. 'More variety of work', and 'better paid work', or similar, are preferable to 'more work'. In Activity 2, students are asked to draw a push-pull model based on observation from two photographs. The skill requirement here is to apply the specific to the general, which can be quite demanding. Activity 3 is essentially a case study of migration in the student's home country.

Further study
What are the birth, death, and natural increase rates in your country? How do they compare with surrounding countries? If there are big differences, why have they arisen?

8.3 Population structure (pages 234–235)

Syllabus coverage
Population structure is how a country's population is made up in terms of age and sex. Data collected is always shown in a population pyramid. The main theme of this section is the contrast in structure between developed countries (or to give them their full title More Economically Developed Countries or MEDCs) and developing countries (Less Economically Developed Countries or LEDCs). In other words, it is the contrast between countries with ageing and youthful populations, between countries with slow rates of natural increase (or even a natural decrease) and those with high rates of natural increase. The difference in population structure between developed UK and developing Pakistan is shown in the population pyramids in Figure 8.11. The Exam Tip gives step by step guidance to students about how to describe and interpret population pyramids.

Key syllabus terms
population structure, population pyramid

Activities (page 235)
Activity 1 gives students the opportunity to follow the Exam Tip for population pyramids. Their answers will highlight differences in population structure between developed and developing countries, the core theme of this population structure topic. Activity 2 mainly requires students to refer to and use birth rates and death rates, as well as resulting rates of natural increase (and decrease, where relevant to ageing populations).

8.4 Managing human population growth (pages 236–240)

Syllabus coverage

There are many ways to manage population growth by reducing birth rates (Figure 8.12). Most governments in developing countries run family planning, health, and education centres and clinics, although there are considerable variations in availability between countries. Within countries, there are considerable differences between urban and rural provision. National population policies can vary from very strict to very weak (so weak as to be non-existent).

The strictest national policy, and the one most widely reported on, was the 'one child' policy in China. This is why China was chosen as the country for the Population topic case study relating to strategies used to manage population size. Only in 2013 was the policy relaxed. Niger is used as an example from the opposite end of the policy strength scale. The contrasts between the two countries could hardly be greater. Niger has the world's highest birth and natural increase rates, and the most extreme young population structure.

Key syllabus terms

national population policy, family planning, pro-natalist, anti-natalist

Activity (page 238)

Students are guided by five suggested headings to make notes on the case study of national population policy in China.

Activities (page 240)

Activity 1 is about methods for controlling population numbers; brief description in part (a) is followed by more opportunity for students' comments about two of the methods in part (b). Activity 2 is a summary activity about variations in the effectiveness of national population policies. Students can use information from the extreme examples of China and Niger, as well as some of those in between such as Thailand. Activity 3 allows the population policy in the student's home country to be studied and compared with others.

Further study

Activity 3 suggests what might be done in a national survey of population policy.

CHAPTER 9

Natural ecosystems and human activities (pages 241–284)

The Introduction about large scale ecosystems, or biomes, is not part of the specified syllabus content. However, it is background information useful to all the topic sections which follow, and to deforestation and managing forests in particular. Of all the biomes, it is the tropical rainforest which has been referred to most in this chapter. For this reason, its distribution and extent is shown in Figure 9.2, and the climate data for the Equatorial climate, which supports this most biodiverse of ecosystems, is shown in Table 9.1.

Some of the topic sections contain a large amount of content, notably 9.1 and 9.5. For ease of study, sub-section headings have been used to break the content up into manageable sections. For example, under the heading Ecosystems in Topic 9.1, the syllabus content begins with ecosystems and their organization, but also covers biotic interactions and relationships, photosynthesis, energy flows, and the carbon cycle.

In the middle three sections (9.2, 9.3, and 9.4), there is a clear focus on one theme for each of them. The sections also follow on as one leads into the next section. Topic 9.2 is about the types of ecosystems most under threat, including causes and impacts. In Topic 9.3 the focus narrows to the causes and impacts of deforestation. Topic 9.4 is about sustainable management for forests. The sequence of causes, impacts, and management is the one used most throughout the syllabus.

Under the broad heading of 'Measuring and managing biodiversity' in Topic 9.5, there are several different strands of study. These include practical techniques for investigating biodiversity, management strategies for conservation, national parks and wildlife reserves, world biosphere reserves, ecotourism, and strategies for species conservation. As in 9.1, the content has been split up into manageable related sections.

The fact that three case studies are specified for the topic as a whole also indicates how substantial the content is. When selecting a named area for the causes and impacts of deforestation, it made sense to choose an area of tropical rainforest, given all the other references to them in this chapter, and the background information in the Introduction on page 242. Indonesia is used in the case study on page 259; it is an updated version of what was used in the previous book. There is, however, enough information in this chapter about rainforest deforestation in Brazil if an alternative is preferred. The second case study is for the conservation of a named species. The giant panda was chosen for the case study on page 280 because of its high international profile. It is probably the best known of all species' conservation programmes. The other case study is for a named biosphere reserve. The Guadeloupe Archipelago is used again. It has the advantage that three distinct ecosystems are being protected—wet tropical forest, mangroves, and coral reefs.

9.1 ECOSYSTEMS (pages 243–251)

Organization of ecosystems (pages 244–245)
This section begins with the general study of ecosystems comprising both living communities (biotic) and the natural environment (abiotic). All these components are identified in Figure 9.4. In the section about how an ecosystem is organized, specialist terms used in the study of ecosystems, such as population, community, habitat, competition, and niche, are explained.

Key syllabus terms
ecosystem, biotic, abiotic, population, community, habitat, niche

Activities (page 245)
Students need to know and understand the key terms used in the study of ecosystems; this is the main purpose of Activities 1 and 2. Activity 3 tests how well students are able to apply the general to the actual observation of a particular ecosystem. Students might benefit from taking another look at the guidance in Chapter 10 about how to describe from a photograph before starting to answer part (a).

Further study
Students can be asked to investigate a small-scale ecosystem close to where they live. Similar to what is asked for in Activities 3 (a) and (b), students can begin by drawing a field sketch; then they can add labels. The written explanation can be completed later.

Adaptations to physical factors and relationships of living organisms (pages 245–249)
Physical factors vary greatly from place to place, but everywhere on Earth plants and animals have evolved and changed to adapt to the local physical environment. Examples of adaptations to physical factors, such as the amount of sunlight and relative humidity within tropical rainforests, are described and illustrated. The Equatorial climate is so favourable for plant growth that competition between plants is fierce. Interdependence is a key feature of relationships between living organisms. Four different ways are identified in the text—pollination, dispersal of fruits and seeds, vegetation succession, and food supply (predation). The first two of these are described separately.

Key syllabus terms
competition, predation, pollination

Activities (page 249)
Activity 1 focuses on differences in plants between the forest top (canopy) and forest floor in tropical rainforests, which reflect the very different micro-environments found there. Biotic interactions are exemplified in the syllabus by reference to competition, predation, and pollination; to answer Activity 2, students need to select the text information about each one. Activity 3 is about the two-way interdependence between plants and animals.

Photosynthesis, energy flows, and the carbon cycle (pages 248–249)
This section begins with detailed studies of the two vital processes of photosynthesis and respiration. Photosynthesis in green plants is the most important process for life on Earth. The store of energy from plants, and their photosynthetic production of organic matter is released when green plants are consumed by organisms higher up the food chain. Great energy loss occurs as energy is transferred up the food chain from one trophic level to the next. This section ends with a description of the carbon cycle. Plants need carbon dioxide from the atmosphere for the process of photosynthesis; carbon is returned to the atmosphere through respiration, decay, and combustion. (The latter, due to the burning of wood and fossil fuels, can be linked back to the study of global warming and the greenhouse effect in Chapter 7.)

Key syllabus terms
photosynthesis, chlorophyll, respiration, food chain, food web, trophic level, ecological pyramid, equation (for photosynthesis and respiration), carbon cycle

Activities (page 250)
Activity 1 is focused upon photosynthesis and its importance to life on Earth. In Activity 2, the theme switches to loss of energy between trophic levels and its effects. Activity 3 encourages local investigation, and requires students to apply what they have learnt to a local example of a food chain.

Activities (page 251)
Activity 1 is to check that students understand the difference between respiration and photosynthesis. Activities 2 and 3 test students' understanding of the carbon cycle. The importance of forests as carbon stores is now more widely appreciated than ever before as widespread deforestation continues (Topics 9.2 and 9.3 below). Activity 4 is to impress on students the size and scale of losses in biomass at each trophic level.

Further study
Students could undertake an individual investigation of a food chain and/or food web in the home region, along the lines suggested in Activity 3, page 250. Alternatively, the full class of students could be asked to name as many living organisms found in the home region as they can, both plant and animal. Individuals or small groups could rearrange these into food chains and a food web.

9.2 Ecosystems under threat (pages 252–255)

Syllabus coverage
All the world's natural ecosystems are under increasing threat due to the persistent rise in world population (Chapter 8), accompanied by technological advances, and economic development. Ecosystems everywhere are feeling these human pressures, leading to habitat losses. Deforestation and loss of wetlands in turn lead to species losses. Included among the details of habitat destruction are lists of reasons why forests and wetlands are worth preserving. Biodiversity is described and an example is used to highlight its importance. In the summary

paragraph for this topic students are reminded of the most important characteristic of all ecosystems—interdependence. Change one component and the balance is upset, with knock-on effects for all other components.

Key syllabus terms
habitat loss, deforestation, wetland, biodiversity, genetic depletion, extinction

Activities (page 255)
A bar graph is the technique most likely to be used to show the data for ecosystem losses in Activity 1 (a). The basis for the answer to part (b) is in the text—cold locations (tundra and coniferous forests) and dry places (hot deserts) do not offer the opportunities for farming and making a living like the hotter and wetter tropical environments (rainforest and savanna) do. A simple definition in 2 (a) is followed by description of the great biodiversity in tropical rainforests in 2 (b). Students are directed back to the start of the chapter in 2 (c) for supporting evidence. As in previous questions similar in nature to the one used in Activity 3, the student's reasons for the choices matter more than the choices themselves. Activity 4 uses an alternative way to make the students think about the importance of preserving natural ecosystems and habitats.

Further study
Students can be asked to choose an endangered habitat (e.g. mangrove forest), or an endangered species of animal (like tigers in India), in their country or region. Then they can describe the attempts being made to prevent loss or extinction. Investigations can be extended to include comment upon the effectiveness of these attempts.

9.3 Deforestation: causes and impacts (pages 255–261)

Syllabus coverage
The text begins with a general historical introduction to forest clearances worldwide, and attempts to explain why the quite large expanses of tropical rainforest that still remain are the ones most at risk from present day and future deforestation. For ease of study, the long list of causes referred to in the syllabus guidance is covered under four headings—commercial farming, logging, minerals, and roads. Many of the examples referred to are in the Amazon Basin in Brazil. Rainforest losses here pre-date 1996, the year from which Table 9.3 data begins.

The many and varied impacts of deforestation are listed in Figure 9.24. This acts as a summary since most of these impacts have already been covered in this and earlier chapters. Cross references are given.

Indonesia is used as the case study for the causes and impacts of deforestation in a named area (page 259). Continuing population pressure and weak government controls mean that illegal forest clearances are still a big issue. Air pollution and poor air quality, plus haze and poor visibility, remain major international issues with Indonesia's regional neighbours during the dry season forest fires.

Key syllabus terms

None are new; all have already been referred to in this or in previous chapters.

Activities (page 257)

The tropical rainforest is the focus of all four activities. The purpose of Activity 1 is to get students to think about why rainforests are the subject of so much attention from the media and conservation groups. Activity 2 requires both photographic observation and evaluation. The best answers will come from students who attempt to give balanced answers. The natural forest (seen in the background of the photograph) would have kept runoff low and meant that little risk of soil erosion existed in the area now being used for cattle rearing. However, a good surface covering of grass can be seen; provided that the area is not overgrazed (not evident so far), serious soil erosion should be avoided. In Activities 3 and 4 the focus narrows to just Brazil. Superimposing a line on the student's bar graph in Activity 3 (a) and (b) will highlight year to year variations. For part (c), all annual losses are below those of 1996; a new low was reached in 2006; the other low in 1997 was followed by several years in which the total crept up again and it stayed high between 2002 and 2004. In Activity 4 (a), the road pattern shown in Figure 9.23 is both north-south and east-west, thereby providing a framework from which most parts of the Amazon Basin are now accessible. Access is the key to the answer to 4 (b), both allowing new companies and settlers to enter, and products of commercial value to leave. The two basic economic reasons in 4 (c) are minerals and agricultural products; it could be argued that logging for valuable hardwoods, although much of it is illegal is a third reason.

Activity (page 258)

Activity 1 (a) concentrates on checking students' understanding to ensure that they are ready for examination questions that include any of the six terms listed here for impacts of deforestation. Most of these impacts have more than one cause. Activity 1 (b) makes students focus on deforestation alone.

Activities (page 261)

Several techniques are appropriate in Activity 1, but the bar graph is as good as any; this is the one that the majority of students are likely to use. Air pollution from the Indonesian forest fires in 1997 spread to neighbouring countries; this is the basis for the answer to Activity 2. Before sensible judgements can be made, all options need to be examined. This is why in part (a) of Activity 3 students are asked to explain the part played by each one before choosing the one they consider to be the most to blame in part (b). The quality of the justification is more important than the choice.

Further study

Case study of deforestation in your home country: follow a similar approach to the one used in this case study.

A Research data for amount of deforestation and population numbers

B What is the attitude of the government to deforestation? Does it have a policy?

C In what ways can deforestation aid economic development?

D How great are the pressures from a growing population?

9.4 Managing forests (pages 262–265)

Syllabus coverage

The value of forests to both people and the environment is summarized in Figure 9.26. It is this which justifies management. Each of the areas of study identified in the guidance notes in the syllabus is covered in the text. The amount of detail for each one varies. Some such as the water cycle and soil erosion have been covered in earlier chapters; coverage here is limited to the role of forests—how forests nourish the water cycle and limit soil erosion. Preservation of biodiversity as a genetic resource is covered in greater detail. Seeds of wild plants were the genetic resource from which today's farm-grown food crops have been selectively bred over many centuries. There are fears that the natural pool of genetic materials, useful as a source for new crops and medicines, will diminish due to continual reductions in biodiversity, caused by humans. Resources and ecotourism have sections of their own within Topic 9.5.

Key syllabus terms

carbon sink, carbon store, genetic resource, ecotourism

Activities (page 265)

Activity 1 requires students to show that they understand the differences between three pairs of syllabus terms. Activity 2 makes the student use two diagrams in order to compare a healthy nutrient cycle under a cover of rainforest with what happens when the nutrient cycle is destroyed by forest clearances. These changes are a consequence of changes to water cycle processes and their importance. Activity 3 is about biodiversity as a genetic resource. Should you wish, the scope of this question could be widened to include GM crops. Activity 4 suggests, a student investigation into biodiversity on a continent different from South America, the one used as the book example.

Further study

Activity 4 provides an example of one area for further investigation.

9.5 MEASURING AND MANAGING BIODIVERSITY (pages 266–284)

Investigating and measuring biodiversity (pages 266–267)

Four of the most commonly used fieldwork techniques for estimating biodiversity are described—pooter, pitfall trap, quadrat, and transect. The amount of study involved has to be brought down to manageable levels for students. This is the reason why some form of sampling is used in most local investigations, often systematic sampling.

Key syllabus terms

pitfall traps, pooters, quadrats, transects, sampling techniques

Activities (page 267)

Activity 1 is about the fieldwork techniques; the two chosen are the ones most widely used by school students in investigations. Activity 2 is about sampling to check student understanding of their choices of sampling techniques.

Further study
A trial investigation using a variety of these techniques could be undertaken in the school grounds or close to the school—to introduce students to the biological investigation of diversity. Should different students use different techniques, results could be compared and the more successful of the techniques identified.

Management strategies for conservation in tropical rainforests (pages 268–269)
Management of tropical rainforests is more recent and not as widespread for many temperate forests, particularly coniferous forests. Conservation groups have shown that preservation of the forests can bring long-term benefits greater than the more obvious short-term economic benefits from clearance (Figure 9.34). Sustainable management usually involves local communities, but even overtly commercial activities like logging can be practised in a way that does not require complete forest destruction.

Key syllabus terms
sustainable forestry, agro-forestry

Activities (page 269)
In Activity 1, a study of Figure 9.34 reveals long-term (sustainable) benefits over short-term (but finite) economic gain. To achieve the long-term benefits, research, education, training, and management are needed. Activity 2 allows some of the options for forest preservation to be described in more detail. Increasing public awareness is important; designing a poster in Activity 3 is intended to make students think about a message that will persuade people to value their rainforests more. Activity 4 encourages local investigation.

Further study
Activity 4 can be extended to include management methods that could be used should the country become more conservation-minded.

Sustainable harvesting of wild plants and animal species (pages 269–271)
Forests are great providers of food and raw materials for humans. Like everything else, due to population pressure, many forest resources have been over-exploited. Increasing threats to plant and animal species have forced governments to act and encouraged international action aimed at preserving biodiversity. As part of the international strategy for species preservation, IUCN and CITES were set up. Large companies and governments are coming under increasing pressure from charities and environmental groups to exploit forest products in less exploitative and damaging ways. Extractive reserves have been set up in Brazil's Amazon Basin; these allow local communities to own and control the harvesting of natural forest products. Despite the best efforts of some organizations and people, species losses are continuing, though at a lower level than is likely to have been the case without them.

Key syllabus terms
sustainable harvesting, extractive reserves

Activities (page 271)
Activity 1 examines the 'evaluate international strategies' part of the syllabus. Activity 2 is about explaining the need for conservation strategies for activities which have been practised since the beginning of human history. The two main reasons for answering part (c) that are given in the text are population growth (increasing local and national demand) and export growth (reflecting commercial demand in other countries). Extractive reserves are the focus of Activity 3. Questions in parts (a) and (b) allow students to show that they know what these reserves are, while they have to evaluate their success in part (c).

National parks, wildlife reserves, and corridors (pages 272–274)
This is about creating areas in which wildlife can be protected. Such areas can be small and fragmented; this is why wildlife corridors are necessary to allow wildlife to move between protected areas and reduce contacts with humans. Most of the information given is of a general nature, although examples are named in passing and slightly more detail is given about the Galapagos Islands and their unique species. Many schools might prefer to use examples from their home country or world region, since national parks and wildlife reserves are conservation strategies widely used, irrespective of whether a country is developed or developing.

Key syllabus terms
national parks, wildlife reserves, wildlife corridor

Activities (page 274)
Activity 1 covers the basic, general content for examination needs. Activity 2 continues the plea to use local examples and case studies in examination answers whenever such examples exist. What is more familiar to a student is likely to be better remembered and more effectively used in future examination answers.

Further study
The local investigation in Activity 2 can be taken a stage further to include comment about the adequacy and effectiveness of the country's national park / wildlife reserve programmes.

World biosphere reserves (pages 274–277)
Recognized and supported by UNESCO, world biosphere reserves are a worldwide strategy of protection, having been set up in more than one hundred countries. The reasons for setting them up are explained and their distinctive zones are described. The specified syllabus case study of a named biosphere reserve is an example from the Caribbean island of Guadeloupe. The majority of students are likely to be less familiar with these than they are with other areas of protection like national parks. At the end is a summary of who benefits from establishing these reserves.

Key syllabus term
world biosphere reserves

Activities
Activity 1 covers all the general information that students are likely to need to know about biosphere reserves for answering examination questions. Activity 2 enables students to use a real example so that they can become more familiar with the essential characteristics of a biosphere reserve. Activity 3 encourages individual investigation of another biosphere reserve, with which they will possibly be more familiar. Visiting the UNESCO web site at www.unesco.org/mab will help.

Further study
Develop further the study initiated in Activity 3. mab in the UNESCO address above refers to the 'Man and Biosphere' programme.

Conservation of species: seed banks, zoos, and captive breeding (pages 278–281)
These are the less natural ways of species conservation. Given the scale of losses in the wild due to continuing population pressure, and the increasing risk of some species disappearing for ever, these strategies are regarded by many as the last line of defence. Seed banks are less controversial than are zoos and captive breeding programmes. The giant panda is used for the syllabus-specified case study of a named species. As a result of captive breeding programmes, there has been a significant increase in the total number of giant pandas. The captive programme is separate from the wildlife reserves needed for the protection of pandas still living in the wild in China.

Key syllabus terms
seed banks, zoos, captive breeding

Activities (page 281)
The purpose of the two questions in Activity 1 is to make students understand why these less natural ways of species conservation are needed. In Activity 2 the focus is on seed banks (what they are, why they are needed) with an opportunity for further investigation in part (c). Activity 3 requires students to state advantages and disadvantages of zoos and captive breeding programmes first in part (a), so that they are in a stronger position to evaluate, in a meaningful way, whether or not advantages outweigh disadvantages in part (b). The theme of Activity 4 is broader—what kinds of protection for species are there? Which one is best? Is it ever going to be possible to rely upon protection in the wild alone? To answer students are required to look back at information earlier in the chapter. Activity 5 reduces the scale and encourages awareness of species endangered in the student's home country or region.

Further study
Activity 2 (c) encourages investigation of the global seed bank in Svalbard. There were reports in 2017 of problems with melting permafrost—is it still an issue?

Activity 5 suggests what might be investigated closer to home, which could be useful to students as examples in examination answers.

Ecotourism (pages 282–284)

What is usually meant when the label 'ecotourism' is used is summarized in the Information Box at the start of this section. The text illustrates some of the key features of ecotourism by referring to examples, mainly Mauritius and Kenya. Tourism in Kenya is covered in the most detail. It has many National Parks and Reserves and a long history of wildlife protection. Also tourism is big business. It is useful for illustrating some of the problems, conflicts, and pressures that conservation measures bring within the country, especially in a country where the population is growing rapidly. Encouraging the growth of ecotourism is seen as a way forward for the future, because of its potential to deliver social and economic benefits to the local tribes-people at the same time as it increases protection of wildlife.

Key syllabus terms

sustainable tourism, ecotourism

Activities (page 284)

Activity 1 is a check on students' understanding of what is meant by ecotourism. For answering Activity 2, there is more information that is relevant about Kenya than any other example. However, students are free to use any example in the book or from elsewhere.

Further study

Are there any examples of ecotourism in the students' home country or world region?
If yes, gather information which will allow answers to questions like those in Activity 2.
If no, why not?

CHAPTER 10

Techniques for investigation and examination

(pages 285–295)

The first part of this chapter covers skills of a more practical nature, notably enquiry, presentation, and analysis. When and where it is possible, students should be encouraged to undertake first-hand local investigation, using basic techniques to observe, record, and classify primary data. This is similar to what specialist students in biology, geography, or earth science are expected to do. Secondary sources, such as Internet web sites, newspapers, and booklets are also useful providers of information and data.

The second part of the chapter covers examination techniques. In many examination questions, source materials accompany the questions. These sources include:

- diagrams, maps, and photographs,
- tables of data,
- graphs (e.g. bar, line, pie, and pictographs),
- written information such as newspaper reports.

The first stage in answering these resource-based questions is usually describing what is there. Students are required to identify and extract relevant information, or to recognize trends and patterns. It is expected that relevant values will be quoted and used to support good answers. Later, students can be asked to deduce relationships between the data, and to draw reasoned conclusions. Many of these source materials will contain information about parts of the world unfamiliar to students; they are expected to use their skills and understanding, gained from general study of the topic, or familiarity with similar local examples, rather than having knowledge of that part of the world.

Investigation skills (pages 285–290)

Students are first taken through the four stages of enquiry—choosing a topic, collecting data, processing and presenting data, and writing it up. Four methods used in local investigations of plant and animal species were described in Chapter 9, as were methods of sampling. In most fieldwork investigations, some type of systematic sampling will be needed.

Instead of repeating these, the focus of the text is on another, widely used method for data collection—questionnaires. Good questionnaire composition is vital, both for the questions asked and the layout. This is why two questionnaires for the same investigation are shown in Figure 10.2. Hopefully, students will readily appreciate the superiority in the usefulness of Questionnaire A over Questionnaire B.

At the end of the section, students are invited to list reasons why Questionnaire A is better. Some of these are listed below.

- An introduction about the purpose: short and to the point; the aim of the investigation is clear.
- Questions 1 and 2 establish how far from the quarry the person lives; Question 1 is included as a check on the answers given to Question 2.

- Questions 3 and 4 contain lists of likely answers so that it is easy for people answering to think of bad and good things about the quarry. There might be others that the students did not think about, so spaces have been left for the person to enter alternatives.
- Question 5 is about how bad things are now. Questions 6 and 7 are about possible future effects from a larger quarry than felt now. Again, people are guided as to how to fill in the questionnaire.
- Question 8 allows those people who want to say more to do so, instead of just ticking the boxes.
- Using boxes and giving people choices for answers not only makes it easier for them to fill in the questionnaire, but also makes it easier for the student to process the answers and present them.
- One question follows on from another to make an effective sequence following the aim of the investigation.

In contrast, Questionnaire B includes some questions which are not needed for the survey, such as Questions 1 and 9. Not much information that is useful will be obtained from yes/no and good/bad answers. What can the student do with the answers? It is very limiting. Despite there being three more questions than in A, less useful information will be obtained overall. Also, you can have too many questions. Will the answers yield any information that can be plotted in a graph? As well as this, the layout is less user-friendly.

Examination technique (pages 290–295)
Background atlas knowledge of the location and names of continents and oceans, as well as of major world regions and countries, is invaluable. It will give the students confidence to make sense of world maps even when they show unfamiliar content.

When you analyze exam questions, you find that all must comprise of at least two parts. One is the command word(s) telling the student what to do; the other is the topic theme telling the student what the question is all about. There may be other elements to the question confining the scope, perhaps to just one water-related disease, or to one part of the world such as developing countries or the tropics.

Some students find it useful to underline the command word(s) and themes on the question paper before they begin to answer. This is good practice and is recommended. It has the advantage of making the student look even more closely at the question—and by just delaying the start of writing by a few seconds, it increases the chance that the student will answer the question set (and only the question set).

The other underused piece of information in exam questions is the number of marks for the question. While the number of lines left for answers is proportional to the number of marks, the definitive information for the amount needed is the stated number of marks. It determines how much detail, and how many valid points, are needed for full marks. Students' writing varies greatly in size; so also does the precision with which they express themselves. Some students fill four lines and only make one point. Be aware that many students think that they have given

a full answer once all the lines given for answering have been filled. Looking at the number of marks, and focusing on the amount expected, is so important that it is mentioned more than once in the chapter when looking at possible answers to questions.

The section about answers based on source materials lists the many types of source materials used in Environmental Management exams. It is not exhaustive, but covers those used the most. There is specific guidance for interpreting line graphs, climate graphs and data, and population pyramids. Describing and interpreting from other types of graph and tables of data should be approached in similar ways. Additionally, there is guidance about answering photograph-based questions in the section on command words.