

OXFORD IB PREPARED



GEOGRAPHY

IB DIPLOMA PROGRAMME

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Answers to questions and exam papers in this book can be found on your free support website. Access the support website here:
www.oxfordsecondary.com/ib-prepared-support



INTRODUCTION

This book provides coverage of the IB diploma syllabus in Geography and offers support to students preparing for their examinations. The book will help you revise the study material, learn the essential terms and concepts, strengthen your essay-writing and improve your approach to IB examinations. The book is packed with exam-style questions throughout to continually test your knowledge, and exam tips that demonstrate best practices and warn against common errors. All topics are illustrated by annotated example student answers to exam-style questions, which explain why marks may be scored or missed.

A complete set of IB-style examination papers at the end of this book provide further opportunities to check your knowledge and skills, boost your confidence and monitor the progress of your studies. Answers to all questions and examination papers are given online at www.oxfordsecondary.com/ib-prepared-support.

DP Geography assessment

All standard level (SL) and higher level (HL) students must complete the internal assessment and take papers 1 and 2 as part of their external assessment. Paper 1 examines the *geographic themes* and paper 2 examines the core *geographic perspectives*. Paper 3 is taken by HL students only, and examines three more geographic perspectives. The internal and external assessment marks are combined, as shown in the table below, to give your overall DP Geography grade, from 1 (lowest) to 7 (highest).

Assessment overview

Assessment	Description	Units or options tested	SL		HL	
			marks	weight	marks	weight
Internal	Fieldwork with a written report	—	25	25%	25	20%
Paper 1	Geographic themes Structured and extended answer questions	Two options (SL)	40	35%	60	35%
		Three options (HL)				
Paper 2	Geographic perspectives—global change Structured, visual and extended answer questions	Units 1–3 (Core)	50	40%	50	25%
Paper 3 (HL only)	Geographic perspectives—global interactions Extended answer questions	Units 4–6	—	—	28	20%

Overview of the book structure

The book is divided into several sections that cover the geographic themes and perspectives, internal assessment, and a complete set of practice examination papers.

The largest section of the book, the **geographic themes and perspectives**, follows the structure of the IB diploma geography syllabus (for first assessment 2019) and covers all *geographic inquiries* and *geographic knowledge and understandings*. At SL, you will study two options from the geographic themes and units 1–3 from the geographic perspectives. At HL, you will study three options and units 1–6.

The **internal assessment** section outlines the nature of the fieldwork that you will have to carry out and explains how to select a suitable topic, collect and process data, draw conclusions and present your report in a suitable format to satisfy the marking criteria and achieve the highest grade.

The final section contains IB-style **practice examination papers 1, 2 and 3**, written exclusively for this book. These papers will give you an opportunity to test yourself before the actual exam and at the same time provide additional practice problems for the material featured in all of the options and units.

The answers and solutions to all text questions and examination papers are given online at www.oxfordsecondary.com/ib-prepared-support.

Key concepts

The “**Geography concepts**” model contains four key concepts—place, process, power, and possibility—and two “organizing” concepts—scale and spatial interaction. Scale has both temporal (short-term, long-term) and spatial (near, far) perspectives.

Places can be identified at a variety of scales, from local (for example, households, farms, villages) to the national or international level (countries, regions). Places can be compared according to their cultural or physical diversity, or disparities in wealth or resource endowment (for example, high income countries, low income countries, core-periphery). The characteristics of a place may be real or perceived (for example, migrants’ views) and spatial interactions between places can be considered (for example, flows of people, goods and ideas).

Processes are human or physical mechanisms of change, such as transport and trade. They operate on varying spatial scales and timescales. Some processes may have negative impacts on people and the environment, whereas some may be more sustainable (such as circular flow processes).

Power is the ability to influence and have impacts at different scales. Unfair trading arrangements are a good example of a power divide. Power is may be concentrated in wealthy individuals, governments

and institutions, and in processes in the natural world (for example, the power in hurricanes). Power has the ability to impact livelihoods, security, and cause unequal development.

Possibilities are the alternative outcomes that may occur. Key possibilities include human impact on climate change, the acidification of the oceans, degradation of farmland, population growth and the increased need for food, water and space.

The *concept link* feature, appearing throughout this book, allows you to connect the material of the geography syllabus to the four key concepts in this model.

Command terms

Command terms are the words in the exam question itself that tell you how to approach the question, and the detail and the depth expected. It is crucial that you interpret these terms correctly. The command terms will not be defined in any part of the exam papers; therefore, it is important to understand their meaning and their importance in advance of the exam.

Before you answer a question you should:

- Underline its command terms.
- Look at the mark weighting of that question.
- Match your answer to the depth required for the command term.

Term	Definition	Sample question	What you should cover
Analyse	Break down in order to bring out the essential elements or structure.	<i>Analyse the challenges associated with transboundary pollution.</i>	Describe and explain the social, economic and environmental issues associated with transboundary pollution.
Annotate	Add brief notes to a diagram or graph.	<i>Annotate the diagram to show short-wave radiation and long-wave radiation.</i>	Identify each of the types of radiation and add a clear label to show each one.
Classify	Arrange or order by class or category.	<i>Classify the following types of migration into forced- and voluntary-migrations.</i>	Decide whether each type of migration is likely to be undertaken voluntarily or whether it is forced.
Compare	Give an account of the similarities between two [or more] items or situations, referring to both [all] of them throughout.	<i>Compare the importance of wind and water in the development of landform features in hot, arid areas.</i>	You need to pick out the similarities—the impacts on erosion, transport and deposition, and the development of landforms.
Compare and contrast	Give an account of similarities and differences between two [or more] items or situations.	<i>Compare and contrast the ecological footprints that occur in HICs and LICs.</i>	For the both groups of countries, you should: <ul style="list-style-type: none"> • describe and explain the similarities [compare] in ecological footprints • describe and explain the differences [contrast]
Define	Give the precise meaning of a word, phrase, concept or physical quantity.	<i>Define the term “tourism”.</i>	State a precise meaning of the term—there may be one or two marks be allocated to this question. Look at the mark weighting to determine the detail required.

Continued on next page

INTRODUCTION

Term	Definition	Sample question	What you should cover
Describe	Give a detailed account.	<i>Describe two predicted trends shown on the graph.</i>	Look at the mark weighting to determine the detail required. You should adapt or manipulate the data provided to achieve full marks.
Determine	Obtain the only possible answer.	<i>Determine the month when the temperature range was greatest.</i>	Calculators are not allowed in the exam, and you may need to work out the value by eye or by using a ruler.
Discuss	Construct a considered and balanced review that includes a range of arguments, factors or hypotheses. Opinions or conclusions should be presented clearly and supported by appropriate evidence.	<i>"Population growth is the greatest threat to the earth's resources". Discuss this statement.</i>	Describe and explain different threats to the world's resources. You may decide that population growth is not a threat but a necessity to discover and develop more resources. Evaluate each view by drawing on case study evidence. Arrive at a conclusion that addresses different viewpoints but favours one more than the other.
Distinguish	Make clear the differences between two or more concepts or items.	<i>Distinguish between population distribution and density.</i>	Your answer should be more than two separate descriptions and it is essential that you emphasize the differences between them.
Draw	Represent by means of a labelled, accurate diagram or graph, using a pencil. A ruler (straight edge) should be used for straight lines.	<i>Draw a labelled diagram to show the impact of urbanization on a flood hydrograph.</i>	You should make sure that your diagrams are very distinct by drawing in black ink or pencil. Labels can be brief.
Estimate	Obtain an approximate value.	<i>Estimate the size of the lake in square 6327.</i>	You will have to use both the scale on the map and your ruler to obtain an approximate value.
Evaluate	Make an appraisal by weighing up the strengths and limitations.	<i>Evaluate the strategies to achieve sustainable urban development.</i>	Your evaluation is not just an opinion, but must provide evidence such as examples, case studies or facts to support it.
Examine	Consider an argument or concept in a way that uncovers the assumptions and interrelationships of the issue.	<i>Examine how inequalities between countries lead to different global flows.</i>	This means explaining thoroughly. It requires you to demonstrate in-depth understanding of both inequalities and global flows.
Explain	Give a detailed account including reasons or causes.	<i>Explain the causes and consequences of famine.</i>	You will need to briefly describe before you explain. You should explain a number of social, economic, political and environmental factors for both causes and consequences.
Identify	Provide an answer from a number of possibilities.	<i>Identify the direction of the most frequent wind.</i>	Only a brief answer (sometimes one word) is required here.
Justify	Give valid reasons or evidence to support an answer or conclusion.	<i>Methods of climate mitigation are shown in figure 1. Select two methods and suggest why they have the greatest potential to reduce carbon emissions. Justify your answer.</i>	You would need to explain the advantages and disadvantages of each methods as well as outlining the disadvantages of the methods not chosen.
Label	Add labels to a diagram.	<i>Label features A, B and C shown in the diagram.</i>	Each label is likely to be just one or two words. Do not describe or explain the feature.
Outline	Give a brief account or summary.	<i>Outline two ways in which a glacier erodes its load.</i>	This command carries few marks, so your answer should consist only of brief statements.
State	Give a specific name, value or other brief answer without explanation or calculation.	<i>State the landform shown in the photo.</i>	Only brief answers (sometimes one word) are required here.
Suggest	Propose a solution, hypothesis or other possible answer.	<i>Suggest reasons for the high level of infectious diseases in LICs.</i>	This term is used when there are several possible answers and you may have to give reasons or a judgement.
To what extent	Consider the merits or otherwise of an argument or concept. Opinions and conclusion should be presented clearly and supported with empirical evidence and sound arguments.	<i>To what extent are physical factors the main cause of water shortages?</i>	Your answer should consider physical factors along with human factors (social, economic and political) and the ways in which they are interrelated.

Many exam questions use terms such as describe and explain, but only the extended answer questions (essays) will expect you to discuss, evaluate and present an argument. Extended answer questions will include terms such as describe and explain, but also higher level commands such as examine, discuss, evaluate and to what extent.

These example questions illustrate the way in which a change of command produces a change in response. Each of the following is an extract indicating how you should respond, but not the complete answer.

Describe a population policy.

China introduced the one child policy in 1979. This was an anti-natalist policy which imposed financial penalties on couples having a second child and incentives for those upholding the law. The purpose of this policy was to curb high birth rates in an attempt to improve access to food and other resources, to reduce unemployment and to raise the national standard of living.

The policy reduced the birth rate from 33 per thousand in 1970 to 17 per thousand in 1979. In many rural areas, a preference for boys has led to a gender imbalance of 117:100 boys to girls. Fertility rates in many areas are well below replacement level. 2010 the rate was around 1.4, well below the replacement level of 2.1. As a result of the one child policy, China now has an ageing population. The policy was abolished in 2015.

Explain two impacts of the population policy.

China's one child policy was introduced in 1979 because rapid population growth was beginning to threaten economic progress. The policy was successful in reducing fertility rates and thus improving the livelihoods of families and reducing the economic burden on the state.

Enforcement in urban areas has been most marked and one child families have become typical. Traditionally, there is a preference for sons in Chinese culture, but a one child policy would inevitably lead to gender imbalance in the population because most families wanted a son to carry on traditions. Another consequence of the policy was an ageing population resulting from a fall in the fertility rate and greater life expectancy leading to an ever-increasing elderly population.

Evaluate the success or failure of a named population policy.

There are several adverse consequences of the policy. The preference for boys has created a gender imbalance. In the early days the policy was accused of contravening human rights. This is related to the abortion of female fetuses or female infanticide or abandonment. Both practices were practiced more so in rural than urban areas. The gender balance has created a shortage of child-bearing women now aged 20–40, which is socially undesirable and likely to reduce fertility rates still further. All this has negative economic implications. It will mean a future reduction in the labour force, lower revenue from taxation and the burden of an ageing society.

Exam guidance and strategies

Manage your time effectively: Every year, students lose marks through time mismanagement. The most common tendency is to spend too long on the first question at the expense of the others. Make sure that you are aware of the time allocation for each question and that you stick rigidly to it during the exam. Note that five minutes' reading time is allowed before the start of each exam.

Read the instructions carefully: Your revision should be thorough and no sub-topic should be omitted. For example, in paper 2 you will need to cover all three units of the core, but the questions will not necessarily cover all sub-topics within these core units. Familiarize yourself with the instructions at the top of your exam papers as these give you the instructions about timings and your choice of question.

Do not generalize: Geographers are keen on classification and putting phenomena into boxes. Generalization can sometimes be misleading and statements such as "China is a developing country" fails in several respects. First, China is too large in physical size and population to classify in this way. Second, levels of development vary greatly between rural and urban areas. Third, the rate of economic change is likely to make any classification obsolete within a few years. The solution is to choose a more reliable example such as smaller country at the bottom of the global economic development scale. Simplification can sometimes result in distortion of the truth. "Mumbai is a poor city" disguises the pockets of affluence and the existence of a very rich elite there. Generic expressions such as "e.g. Africa" used in exams reflect badly on the candidate.

Support your answers with evidence: Geography is about the real world, and in longer responses there must be plenty of factual support, examples and statistics.

Use current examples and case studies: There are a few unique and very well documented case studies that are frequently used in exams. One example is the Mississippi floods in 1993. But there are more recent and better documented examples of local floods. Outdated case study events are undesirable because human causes, consequences and responses have changed. Generally, the examples and case studies of geographic events occurring since 2000 are most relevant. Occasionally, older case studies, such as the Chernobyl disaster of 1986, are the best examples to use, in this case for a nuclear power disaster.

Use correct terminology: Good use of geographical terms shows understanding and avoids clumsy description. For example, a situation where "a population keeps on growing due to a lot of young people who are likely to keep the birth rate high for some years into the future", could be described as "population momentum".

Read the question carefully: For example, if you were asked to comment on the relative advantages of tourism as a development strategy in a less developed country and you discussed the issue with respect to a more developed country, you would inevitably lose marks. Ignoring commands is also common and is highly likely to lose marks.

The following table summarizes key information when sitting your exam:

Do	Don't
<ul style="list-style-type: none"> • Read the instructions on the cover of your exam paper to remind you of the exam regulations, such as the time allowed and the number of questions you should answer. • Underline the command terms in the questions and focus on these as you work through each question. • Write a brief plan for essays, to give your answer a logical structure. • Observe the mark weighting of the sub-parts of structured questions. • Give sufficient attention to the parts of the question requiring evaluation, discussion or analysis. • Complete the correct number of questions. • Make sure that all your answers are legible, correctly numbered and in numerical order. 	<ul style="list-style-type: none"> • Pad your answer with irrelevant content just to make it look better. Examiners are impressed by quality, not quantity. • Leave the examiner to draw conclusions if you cannot decide. • Bend the question to fit your rehearsed answer. • Spend too long on your best question at the expense of others. • Invent case studies; these will be checked by examiners. • Use lists or bullet points—these are not suitable for detailed analyses. • Make your own abbreviations; for example, U for Urban and R for Rural. However, you can use accepted ones but make sure you write the term out in full the first time you use it—for example tropical rainforest (TRF) and infant mortality rate (IMR).

Key features of the book

Each chapter typically covers a Geographic theme or perspective, and starts with “You should be able to show” checklists. These outline the *geographic inquiries* and *knowledge and understandings* of the IB diploma Geography syllabus.

Chapters contain the features outlined on this page:

Test yourself

Test yourself boxes contain exam-style questions relating to the main text, where you can test your knowledge and understanding. The number of marks typically awarded to these questions is also given.

Assessment tip

Assessment tips give advice to help you optimize your exam technique, warning against common errors and showing how to approach particular questions and command terms.

Question practice and sample student answer sections occur at the end of each chapter. This section includes typical IB-style questions relating to the chapter material, with advice on how best to approach these questions.

A sample student response to these questions is then given, with the correct points highlighted in green, and incorrect or incomplete answers are highlighted in red. Positive or negative feedback on the student’s response is given in the green and red pull-out boxes.

An example of a question practice section and an accompanying student answer is shown below.

Key definitions are discussed at a level sufficient for answering typical examination questions. Most definitions are given in a grey side box like this one, and explained in the text.

Content link

Content links provide a reference to relevant material within another part of this book that relates to the text in question. Note that there are countless possibilities for linking content in the syllabus.

Concept link

Concept links connect the material of the geography syllabus to the four key concepts in the “geography concepts” model: places, processes, power and possibilities.

B **UNIT 6: OCEANS AND COASTAL MARGINS**

gion reserves are estimated to total around 2,500 cubic kilometres (266 million cubic feet). The countries are competing in their claims to develop these resources and to control sections of the South China Sea.

QUESTION PRACTICE

The following graph shows the distribution of hurricanes.

QUESTION PRACTICE

1) Describe the distribution of hurricanes as shown on the map. [2]

2) Explain two factors needed for the formation of hurricanes. [2+2]

3) Using examples, explain two reasons why oceans may become a source of geopolitical conflict. [2+2]

Essay

Either: Examine the advantages and disadvantages of different types of coastal management schemes. [10]

Or: Using a localised example, examine how conflicting pressures in a coastal area have been managed. [10]

How do I approach these questions?

1) This question asks for a description. You should use the information on the map, for example, lines of latitude, compass bearing, major concentrations and some smaller ones.

2) You are asked to explain two factors. Each explanation is worth two marks, so some detail/development is needed for the award of the second mark.

3) Similarly, here you are asked to explain two reasons. Each explanation is worth two marks, so some detail/development is needed for the award of the second mark.

Essay

For these essays, the command term is examine. This means that you should discuss the underlying assumptions and interrelationships of the issues presented in the question. Good answers will relate these essay questions to the why (factors, processes, power and possibilities) to other geographical concepts. Remember to refer to specific examples, and some critical thinking and evaluation should be present in your answer.

STUDENT'S MODEL ANSWER

1) The distribution of hurricanes is mainly in tropical areas, away from the equator and mostly on the western side of oceans. There are some exceptions such as on the NE side of Australia and off the west coast of Central America.

Marks 2/2

2) Sea temperatures must be over 20°C. (Warm water gives off large quantities of heat when it is condensed - this is the heat which drives the hurricane.)

The low pressure area has to be far enough away from the equator that the Coriolis force (the force caused by the rotation of the Earth) creates rotation in the rising air mass. If it is too close to the equator there is insufficient rotation and a hurricane would not develop.

Marks 4/4

3) Some parts of oceans, such as the South China Sea in the Pacific, may become sources of geopolitical conflict between nations (eg China, Russia, the Philippines, Vietnam and Indonesia) because they contain valuable resources such as oil, gas and fisheries. There can also be conflict over shipping channels, eg the Straits of Malacca between Singapore and Indonesia.

Marks 4/4

Essay

Either: Examine the advantages and disadvantages of different types of coastal management schemes.

There are many types of coastal management schemes. They are generally designed to reduce erosion and prevent flooding. Coastal management schemes vary in terms of their effectiveness and their cost.

Coastal management schemes are often divided into hard engineering and soft engineering schemes. Hard engineering schemes are those that physically alter the landscape, whereas soft engineering schemes try to work with nature. One of the simplest types of hard engineering schemes is a sea wall. This is a large-scale wall designed to reflect wave energy. Modern sea walls are often curved to redirect the waves away from the beach. Traditional sea walls were often straight and vertical and led to the scouring of the bed, and undermining of the walls' foundations. They are relatively expensive and last about thirty years. Chesil Beach in Southern England, has curved sea walls protecting the village of Chiswell.

Another form of hard engineering are gabbions. These are wire boxes which are filled with rocks. The wire boxes prevent the rocks from being washed away or used for attraction, and the rocks reduce the energy of the wave as it passes between different rocks. They are cheaper than sea walls and, from a distance, can look attractive. The gabbions on top of Chesil Beach (gabion mattresses) protect Chiswell from large shingle being flung in storm conditions.

Key definitions:

- Viable second factor
- Development point
- Viable point—exam and competing systems
- Viable point—competing over resources
- A second example
- Development point

Concept links:

- Higher resolution
- Coast—distinction between major types of coastal management
- True example
- Coast point—advantages of sea walls
- Coast point—softness is disadvantage
- Coast point—development disadvantage
- Coast point—local example
- Clear example of sea walls with support
- Second type of management
- Description
- Function
- Advantage
- Local example
- Second method, with supporting example

All of the questions in these sections have been written specifically for this book by the authors to reflect the new IB geography syllabus and examinations.



A FRESHWATER

A systems approach is a characteristic of the Geography course, and the Freshwater unit is no exception. A drainage basin is a system, since it has inputs, processes and outputs that shape landscapes and give rise to flooding. As water becomes scarcer due to human and natural factors, careful management of this precious resource is needed at local, national and international scales. As well as examining depletion, the pollution of freshwater is also studied. You should be able to make connections to other parts of the course as you progress through this unit, and you should ensure that you connect with the key concepts of processes, places, power and possibilities.

You should be able to show:

- ✓ how physical **processes** influence drainage basin systems and landforms;
- ✓ how physical and human factors exacerbate and mitigate flood risk for different **places**;
- ✓ the varying **power** of different factors in relation to water management issues;
- ✓ the future **possibilities** for management intervention in drainage basins.

A.1 DRAINAGE BASIN HYDROLOGY AND GEOMORPHOLOGY

- **Drainage basin** – an area of land that is drained by a river and its tributaries.
- **Watershed** – the border of a drainage basin that separates one drainage basin from another.
- **Open system** – when energy can enter and leave a system, such as a drainage basin.
- **Evapotranspiration** – the total amount of evaporation from land and from vegetation (transpiration).
- **Load** – the material transported by the river. The bed load consists of larger material that is transported via processes such as traction and saltation. The suspended load is transported via processes such as suspension and solution.
- **Cryosphere** – water in solid form (e.g. snow, ice).

You should be able to show how physical processes influence drainage basin systems and landforms:

- ✓ The drainage basin as an open system with inputs (precipitation of varying type and intensity), outputs (evaporation and transpiration), flows (infiltration, throughflow, overland flow and base flow) and stores (including vegetation, soil, aquifers and the cryosphere);
- ✓ River discharge and its relationship to stream flow, channel characteristics and hydraulic radius;
- ✓ River processes of erosion, transportation and deposition, and spatial and temporal factors influencing their operation, including channel characteristics and seasonality;
- ✓ The formation of typical river landforms, including waterfalls, floodplains, meanders, levees and deltas.

Assessment tip

This unit includes a wide range of terminology. Terms such as “eutrophication” and “salinization” are often not spelled correctly or are used out of context. Take time to practise spelling these terms, since appropriate use and spelling of terms will increase your mark for knowledge and understanding in your essay responses.

The drainage basin as an open system with inputs, outputs, flows and stores

A drainage basin is an open system since matter can enter and leave the system to join other systems such as a marine system.

After a period of rainfall, the water is then stored and transferred. Some of the transfers take place on the surface, such as overland flow (also known as surface run-off) which occurs when there is limited infiltration due to impermeable rock, for example. Infiltration occurs when water moves underground from the surface. A permeable rock type will allow water to pass through it, and the movement as it percolates downwards via gravity is classified as throughflow. Lakes, reservoirs, ponds, soil, vegetation and ice are all examples of stores where water is held. Clearly, there are a number of physical processes taking place in a drainage basin that affect the movement of water.

Test yourself

- A.1 Distinguish between an open and a closed system. [2]
- A.2 Analyse how a drainage basin functions. [3]
- A.3 Explain how rock type and vegetation can affect the flow of water in a drainage basin. [2+2]
- A.4 Study the map (figure A.1.1).

▼ Figure A.1.1. River Seine drainage basin



Describe the physical characteristics of the River Seine and its drainage basin. [3]

Concept link



PROCESSES: This section outlines a range of natural processes which create an open system. The dynamic nature of these processes not only shapes landscapes, but it also creates the unique characteristics of places which can be at a range of different scales, from the Nile basin to a basin at a local scale.

Assessment tip

Make sure that you do not include "opposites" or "mirrors" in your answer. This is when you state the opposite compared to the previous part of your answer. You will only get a mark for one side of the "mirror", so do not expect double marks.

Assessment tip

When asked to describe a map, it is important that you utilize your cartographic knowledge by including distances, compass directions, grid references and relief.

River discharge and its relationship to stream flow, channel characteristics and hydraulic radius

The discharge is the volume of water that is flowing at a given point in the river. It is measured in cubic metres per second (cumecs) and theoretically increases downstream. It is calculated by multiplying the velocity by the cross-sectional area at a point in the river. Wider and deeper channels will be able to hold a greater volume of water resulting in a larger hydraulic radius, or in other words, a higher efficiency or ability for water to move downstream.

River processes of erosion, transportation and deposition, and spatial and temporal factors influencing their operation

There are four processes of erosion: hydraulic action, corrasion, corrosion and attrition. Once material has been eroded, it is then transported down the river either as the bed load (material on the riverbed) or as the suspended load (material held in suspension by the flow of the water) or as the dissolved load (soluble material dissolved in the water). Some material may be carried on the surface, such as leaves and branches.

There are four processes for transportation: traction, saltation, suspension and solution.

When material is no longer being transported by a river, it is deposited. For deposition to occur, there must be a reduction in the river's velocity in order that the material can no longer be carried.

The seasonal nature of some rivers can mean an increase or a decrease in processes of erosion, transportation and deposition at different times of the year. For example, ephemeral rivers only contain flow at intermittent periods of the year when there is a rainy season.

Test yourself

A.5 Explain how a river's discharge is related to channel size and shape. [2+2]

A.6 Describe and explain the relationship between a river's discharge and suspended load. [2+2]

A.7 Explain how temporal factors will affect a river's ability to transport material. [2+2]

The formation of typical river landforms

Waterfalls are formed when water flows over two different types of rock. One of the layers is eroded more easily than the other, and due to this the more resistant rock is undercut. Eventually the undercut rock is left without support underneath and it will collapse into the plunge pool below. The process continues, and a gorge is formed. A waterfall is a landform created via erosion.

▼ **Figure A.1.2.** The Goðafoss waterfall in Iceland



Processes of erosion, transportation and deposition are all required for the formation and evolution of meanders. Material is deposited on the inside and lateral erosion occurs on the outside of the meander.

When the sinuosity or “bendiness” of a meander increases, it is possible that the outside bends of two meanders are eroded in order that the meander straightens, creating an oxbow lake. See figure A.1.3 which shows the Juruá River, one of the longest tributaries of the Amazon River. It is a very sinuous river and the image shows a number of oxbow lakes.

▼ **Figure A.1.3.** Oxbow lakes on the Juruá



A floodplain is formed via the deposition of material adjacent to a river. When a river floods on the flat land at the side of the river (normally in the lower course), material is deposited once the water subsides. Layer upon layer of deposited material such as silt or alluvium further develops a floodplain. Levees are created during times of flood when the larger, coarser material is deposited closer to the river channel, as the amount of energy decreases with distance from the channel. Floodplains and levees are depositional landforms although the processes of erosion and transportation are needed to supply the material that is then deposited.

There are different types of deltas: arcuate, bird’s foot and cuspate, and each is created via deposition.

Test yourself

A.8 (a) State two landforms found in a drainage basin that are formed solely via processes of erosion. [2]

(b) Explain how the landforms you identified in part (a) are formed. [2+2]

Assessment tip

A clear annotated diagram is an appropriate approach to answering this question.

A.2 FLOODING AND FLOOD MITIGATION

- **Hydrograph** – a graph that shows how a river or stream's discharge changes over time and its relationship with the amount of precipitation that falls during a rainfall event.
- **Antecedent moisture** – the amount of moisture stored underground after a previous period of precipitation.
- **Peak discharge** – the greatest amount of discharge flowing in a river after a rainfall event.
- **Peak rainfall** – the time at which there is the highest amount of rainfall into a drainage basin for a given storm.
- **Afforestation** – the process of planting trees in an area where there were previously none.
- **Reforestation** – replanting trees in an area that was previously deforested.

Concept link



PLACES: The relationship between the human and natural worlds is never more present than when a place experiences a natural disaster such as a flood, which can devastate places. The power of a place, based on experience and/or the economic ability to put in place defences to mitigate the effects of flooding, is able to ensure that the relationship does not bring negative consequences.

You should be able to show how physical and human factors exacerbate and mitigate flood risk for different places:

- ✓ Hydrograph characteristics (lag time, peak discharge, base flow) and natural influences on hydrographs, including geology and seasonality;
- ✓ How urbanization, deforestation and channel modifications affect flood risk within a drainage basin, including its distribution, frequency and magnitude;
- ✓ Attempts at flood prediction, including changes in weather forecasting and uncertainty in climate modelling;
- ✓ Flood mitigation, including structural measures (dams, afforestation, channel modification and levee strengthening) and planning (personal insurance and flood preparation, and flood warning technology);
- ✓ Two contrasting detailed examples of flood mitigation of drainage basins.

Hydrograph characteristics and natural influences on hydrographs

A hydrograph shows data for two variables on the same chart, e.g. a river's discharge and the amount of rainfall that a drainage basin receives. The amount of rainfall influences the amount of discharge, and this is via overland flow, throughflow and groundwater flow. The lag time—the time between peak rainfall to a river's peak discharge—is an important period. A short lag time means that a river may reach its bank full discharge, which is the maximum amount of discharge a channel can hold, and flood an area quickly. Increasing the lag time and reducing the discharge can reduce the risk of flooding. The monitoring of hydrographs can enable predictions to be made regarding flooding as well as measuring the effectiveness of flood mitigation strategies.

Test yourself

A.9 Discuss how physical factors can influence a hydrograph. [3+3]

Assessment tip

If you are asked to discuss the factors that influence a hydrograph in an extended response, it is important that you evaluate the impact, since this is normally necessary to reach the highest mark bands. For example, human activities can decrease the discharge and increase the lag time via afforestation, whilst urbanization and building on a floodplain will increase discharge and reduce the lag time.



A.10 Suggest how hydrographs can be used to forecast and manage flooding. [2+2]

Assessment tip

When discussing hydrographs in your answer, it is appropriate to include an annotated hydrograph showing the different responses from a river when there are natural differences between two drainage basins or there is change annually in a particular basin.

How urbanization, deforestation and channel modifications affect flood risk within a drainage basin, including its distribution, frequency and magnitude

Human factors such as urbanization will mean that there are more impermeable surfaces, thus increasing overland flow and the time taken to reach a nearby stream or river.

Deforestation reduces interception and exposes soil to erosion whilst increasing the amount of overland flow due to soil capacity being reached.

Increasing the cross-sectional area of a channel reduces the risk of flooding since the channel can hold more volume.

The frequency and magnitude of a flood will depend on the natural and human factors that influence the movement of water. Infrequent flood events tend to have a large magnitude and vice versa. In summary, the characteristics of places via a range of human and physical factors will influence the risk of flooding.

▼ **Figure A.2.1.** Urbanization means an increase in impermeable surfaces and a reduction in infiltration



Attempts at flood prediction

Weather forecasting can predict the timing and the amount of rainfall during a period of low pressure and this data will forewarn authorities and residents in a drainage basin about the impending risk of flooding. Extreme weather events such as cyclones will increase the amount of rainfall and debris reaching a river. Meteorologists are able to detect and track these events days, possibly a week, before they arrive in an area.

Flood mitigation

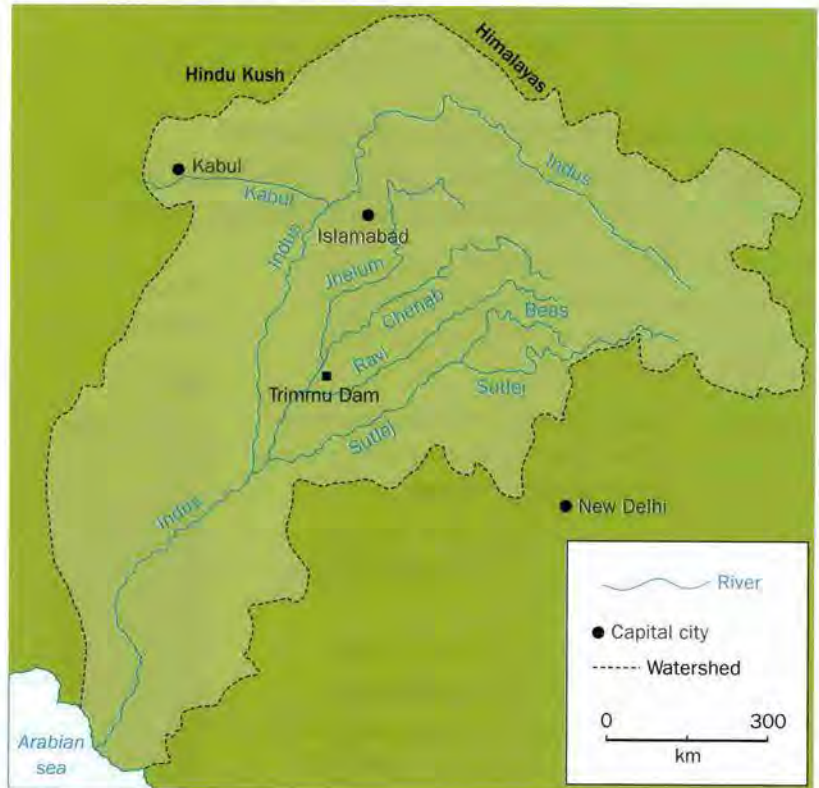
There are a variety of flood mitigation strategies, and they can be classified as “hard” or “soft” engineering. Hard engineering is when the structural measure uses artificial materials with which to alter the landscape. This may involve building a concrete dam in order to control the flow of a river, or construct levees to form channels that will hold more water and protect nearby infrastructure. Soft engineering works with nature, so no concrete or artificial structures are created. Afforestation and reforestation would be examples of this type of flood mitigation strategy. Other strategies such as widening, deepening, lining and straightening a channel (channelization) will also enable a river to hold more discharge and increase its hydraulic radius, thus becoming more efficient.

Two contrasting detailed examples of flood mitigation of drainage basins

The following case studies (Pakistan and Queensland) show that although both places had flood management strategies in place, there was still significant economic damage and the loss of life.

Case study: Flood mitigation in Pakistan

▼ **Figure A.2.2.** The Indus river system



Pakistan has regular floods due to heavy monsoon rainfall, snowmelt from the Himalayas and deforestation.

In September 2014, the rivers Jhelum, Chenab, Ravi and Sutlej started rising above their banks due to monsoon rainfall, and they flooded. Around 2.5 million people were reported to have been affected; 367 people were killed and over 125,000 homes were destroyed. Warnings about the flooding came too late for many people.

Additional dams had been built on rivers further upstream in neighbouring India and some suggested that the release of floodwaters from these dams increased the discharge and amount of flooding further downstream. The Pakistani government denied this. After spending millions on barrages and embankments, the authorities had to allow controlled breaches of the embankments such as on the west bank of the Chenab upstream from a major dam at Trimmu, in order to protect urban areas. This meant that 200 villages were flooded.

Case study: Flood mitigation in Queensland, Australia

In January 2011 there was a major flood in Queensland, Australia due to higher than normal rainfall in a La Niña year and also from Tropical Cyclone Tasha. Rivers such as the Burnett topped their banks and flooded large portions of the state. The economic cost of the disaster was approximately A\$10 billion and 35 people died.

Flood management was in place, such as the Wivenhoe Dam which was built to stop Brisbane being flooded (and also to secure water

supplies). Residents argue that insufficient water was released from behind the dam in spite of forecasts of heavy rainfall. When water was eventually released, the Brisbane River already had a high discharge due to rainfall amounts, so the level rose by 10 metres causing widespread damage.

Test yourself

A.11 Using evidence from figure A.2.2, **outline** the potential difficulties for the Pakistani government in relation to mitigating flooding. [3]

A.12 Evaluate the success of flood mitigation strategies in Pakistan from 2010 onwards. [4]



Content link

Flood mitigation in cities is explored in option G.4.

A.3 WATER SCARCITY AND WATER QUALITY

You should be able to show the varying power of different factors in relation to water management issues:

- ✓ Physical and economic water scarcity, and the factors that control these including the causes and impacts of droughts; the distinction between water quantity and water quality;
- ✓ Environmental consequences of agricultural activities on water quality, to include pollution (eutrophication) and irrigation (salinization);
 - ✓ Detailed examples to illustrate the role of different stakeholders;
- ✓ Growing human pressures on lakes and aquifers, including economic growth and population migration;
- ✓ Internationally shared water resources as a source of conflict;
 - ✓ Case study of one internationally shared water resource and the role of different stakeholders in attempting to find a resolution.

Physical and economic water scarcity—water quality and quantity

Water stress is when annual water supplies drop to less than 1,700 m³ per person per year, whereas water scarcity is when a person has access to less than 1,000 m³ annually. The causes of water scarcity can be natural and human, for example a lack of rainfall in an area for a significant period and the unsustainable consumption of water by agriculture.

A decrease in water quality can be caused by a number of different factors. For example, the disposal of plastic in the world's oceans and rivers has led to fibres being present in the food chain and in drinking water. Chemicals from commercial agricultural are another significant source of contamination (see following page), while inadequate sewage and sanitation systems may pollute clean water. Waterborne diseases have caused the deaths of millions, and more than 3 million deaths a year are due to diseases such as cholera, malaria and diarrhoea.

- **Physical water scarcity** – where water resource development is approaching or has exceeded unsustainable levels; it relates water availability to water demand and implies that arid areas are not necessarily water scarce.
- **Economic water scarcity** – where water is available locally but not accessible due to human, institutional or financial capital reasons.
- **Drought** – a prolonged period of abnormally low rainfall. Drought is a broad category and can be subdivided into hydrological, meteorological and agricultural drought.
- **Eutrophication** – a process that affects freshwater whereby dense algal and plant growth occurs due to increased concentration of chemical nutrients.
- **Salinization** – a process in which the salt content of surface and/or groundwater increases as overland flow or throughflow transfers crystallized salts left behind after irrigated water has evaporated.



Content link

Water security is examined further in unit 3.2.

Content link

The environmental impact of global agribusiness is explored further in unit 6.2.

Concept link



POWER: As water becomes more scarce due to the effects of global climate change, population growth and increased consumerism, the opportunity to access water can be decided by the power of a place. The places upstream in a drainage basin have the upper hand in controlling the amount of water to reach places further along the course of a river. In addition, the quality of the water can decrease due to agricultural and industrial processes, which can also negatively affect places.

Environmental consequences of agricultural activities on water quality

Agriculture can have a negative impact on freshwater. The use of irrigation and the application of chemicals in the form of fertilizer and pesticides can pollute freshwater on the surface and underground. Algae grow on the surface of rivers due to eutrophication which reduces the amount of oxygen available for vegetation and creatures under the water.

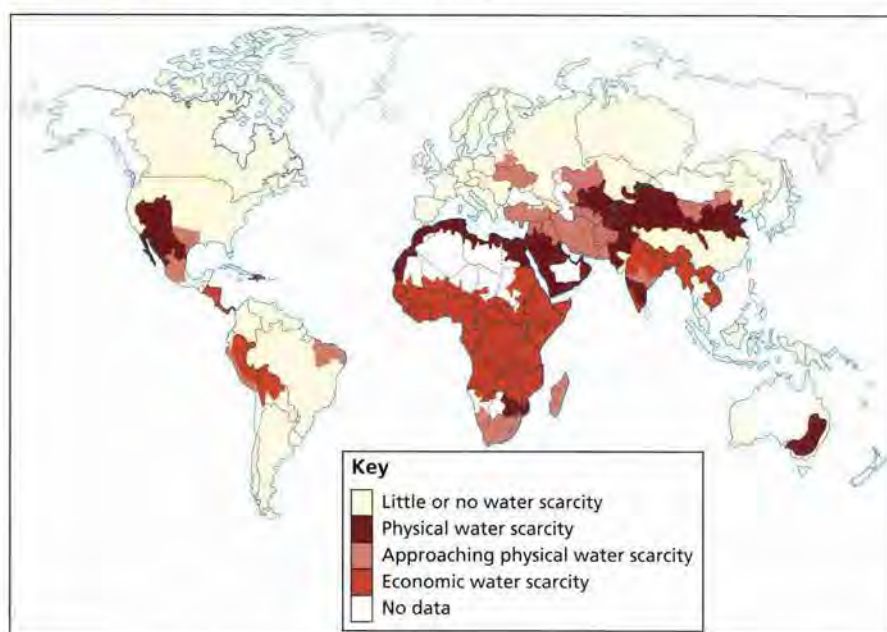
A reduction in oxygen results in a reduction of life in a lake or river. A number of different groups and organizations are trying to resolve this problem, including farmers (subsistence or commercial), environmental groups, residents and government departments such as the Environment Agency in the UK.

Case study: The role of different stakeholders in North Carolina, USA

Jordan Lake suffers from eutrophication due to nutrient rich run-off into tributaries that feed into the lake. A number of different stakeholders are involved in this issue, such as the state government which has the power to provide funding for the clean-up of the lake and the national government which is able to put in place rules for industry and agriculture. Here are some of the stakeholders:

- 300,000 people who rely on the lake for drinking water
- The Environmental Protection Agency (EPA), which enforces legislation from the Clean Water Act
- The state government of North Carolina, which provides funding for cleaning the lake
- The Army Corp of engineers who maintain the lake and dam
- Clean Jordan Lake is an environmental organization that organizes volunteers to help clean the lake
- 30 animal-feeding operations
- 12 wastewater treatment facilities.

▼ **Figure A.3.1.** Distribution of water scarcity



Test yourself

- A.13 Distinguish** between physical and economic water scarcity. [2]
- A.14** Study figure A.3.1, which shows the distribution for different types of water scarcity.
- Describe** the pattern of economic water scarcity. [3]
- A.15 Examine** how agriculture can have a negative impact on freshwater. [2+2+2]

Growing human pressures on lakes and aquifers, including economic growth and population migration

Aquifers (rocks that contain significant quantities of water) are not subject to evaporation, but they are at risk of significant depletion due to population increase via migration and also from economic growth. Economic growth can create pressure as consumption increases due to industrial processes requiring greater amounts of water as an input. In addition, economic growth may result in an increase in disposable incomes and the growth of a country's middle-class. A person's diet may change, with increased consumption of food, which leads to increased agricultural production and increased stress on water sources.

Groundwater is an important source of freshwater around the world. Aquifers can be either unconfined (they can be recharged via percolation) or confined (the water is enclosed between layers of impermeable rock). For confined aquifers, the recharge has to take place artificially since percolation is not possible.

Internationally shared water resources as a source of conflict

The political borders of countries and the watersheds of drainage basins are never a perfect fit. Many drainage basins straddle two or more countries. The residents of those countries may rely on the same freshwater source, on the surface and/or underground, to fulfill their needs. Agreements are often needed in order that water is shared equitably and consumption by the different stakeholders is environmentally sustainable. This becomes increasingly important as economic development takes place and populations increase.

Case study: Internationally shared water resource

Over recent decades there has been tension between the 11 countries that share the waters of the River Nile. Uganda, Egypt, the Republic of the Sudan, South Sudan, Rwanda, Burundi, Ethiopia, Kenya, Tanzania, Eritrea and the DRC all have a vested interest in the Nile since the drainage basin falls within each country's borders (it covers 10% of Africa's landmass). Egypt has a long-established historic agreement signed in 1929 and amended in 1959, which gives it (and the Republic of the Sudan) full access to water from the Nile, its only source of water, and an ability to veto any plans to restrict water upstream, such as the building of a dam.

Assessment tip

For short-response questions, try to avoid writing a long list of country names when you are asked to describe data shown on a map. As a geographer, you should be skilled at identifying general patterns and anomalies. You will only receive 1 mark at most for a 3-mark question if you provide a list. A 3-mark question will require three distinct patterns when describing a map. A useful strategy would be to comment on the pattern, the extremes and any anomalies.

Assessment tip

Be aware that the syllabus specifically requires you to connect a *human reason* (such as irrigation) with salinization.

In order to generate hydroelectric power for the country and to export it to other countries, Ethiopia decided to build the Grand Ethiopian Renaissance Dam (GERD) on the Blue Nile (the White and Blue Nile join to form the River Nile) and construction began in 2011. Egypt was immediately concerned since it expected a 25% reduction in the water that it would normally receive. At one point, a former Egyptian president proposed military action against Ethiopia.

Despite this past friction, in March 2015, Egypt, the Republic of the Sudan and Ethiopia signed a Declaration of Principles agreement. Part of the agreement was that an independent assessment would take place to evaluate the impact of the dam and ensure that each country would not be affected detrimentally. This independent assessment has never been published due to issues around getting access to accurate information from each country. Therefore, tension remains between the three countries, especially when other issues are considered, such as reduced rainfall and a growing population in Nile basin countries.

Test yourself

A.16 Suggest possible challenges for countries that have to share a source of freshwater. [2+2]

A.4 WATER MANAGEMENT FUTURES

- **Integrated drainage basin management (IDBM)** – a comprehensive approach to the planning and management of a drainage basin involving a variety of different stakeholders in order that there is a balance between economic development and environmental impact.

- **Wetlands** – areas of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt.

You should be able to show examples of future possibilities for management intervention in drainage basins:

- ✓ The importance of strengthening participation of local communities to improve water management in different economic development contexts, including sustainable water use and efficiency, and ensuring access to clean, safe and affordable water;
- ✓ Increased dam building for multipurpose water schemes, and their costs and benefits;
 - ✓ Case study of contemporary dam building expansion in one major drainage basin;
- ✓ The growing importance of integrated drainage basin management (IDBM) plans, and the costs and benefits they bring;
- ✓ Growing pressures on major wetlands and efforts to protect them, such as the Ramsar Convention;
 - ✓ Case study of the future possibilities for one wetland area.

Concept link



POSSIBILITIES: Possibilities from managing freshwater within a drainage basin can bring benefits and problems at a variety of scales. The implementation of IDBM aims to bring benefits to all stakeholders in a basin, whether they live in different countries or have different priorities.

Strengthening participation of local communities to improve sustainable water use

The sustainable use of water at a national and international level has already been discussed in this chapter. Local communities can also improve the management of their water supplies by recycling water for residential gardens or using more efficient irrigation methods, such as drip irrigation pioneered in Israeli communities, to ensure that no water is wasted when growing crops. Empowering local people is another benefit of community involvement in safeguarding water supplies. The Self-Employed Women's Association (SEWA) in India is just one example of how women are trained to repair hand pumps in order that rural areas can secure clean water without having to walk several miles to an alternative source.

Increased dam building for multipurpose water schemes

Multipurpose dam schemes can provide protection against flooding and an area for recreation and fishing. They can also generate significant amounts of energy in a manner that has fewer emissions than the continual burning of fossil fuels. However, they can be detrimental to the natural environment. The difference in temperature between the water downstream and the water released from the reservoir causes problems for fish, while evaporation and siltation can reduce the amount of water in the reservoir and the potential for generating energy. The construction of dams releases large amounts of carbon dioxide due to the amount of concrete required. The money used to build a dam could also be used instead to significantly improve many aspects of a country, such as health and education.

Case study: Contemporary dam building expansion—the Lesotho Highlands Water Project (LHWP)

The Lesotho Highlands Water Project (LHWP) is a complex network of pipelines, tunnels and dams which divert water from Lesotho to the Gauteng region in South Africa (cities such as Johannesburg, Pretoria and Vereeniging) and the dams generate hydroelectric power for Lesotho. Lesotho has a surplus of water and the whole country is enclosed within the Orange river drainage basin. Once fully completed, the LHWP will have five dams with 2,000 million cubic metres of water transferred through 200 km of tunnels from Lesotho to South Africa every year. This is a significant engineering project with three phases of construction. The first was completed in 2004 and the second is to be finished in 2025, with no date given for the third phase. For Phase 1, approximately 4,857 hectares of arable land were flooded and 3,400 households were relocated to create the reservoirs necessary behind the Mahole and Katse dams. The Katse Dam was opened in 1998 and then the Mahole Dam in 2004. The Polihali Dam will be completed by 2025 as part of Phase 2.

The benefits for Lesotho were 16,000 jobs created during Phase 1, with 3,000 more jobs in Phase 2, over US\$500 million in water sales and US\$71 million from the sale of electricity by 2016. South Africa received much cleaner water which did not require treatment. The costs were that 20,000 people were displaced during Phase 1, and 17 more villages will be relocated during Phase 2. Inadequate compensation was provided to the people, and bribery was uncovered involving 12 construction companies during Phase 1 with allegations of malpractice during Phase 2.

The growing importance of integrated drainage basin management (IDBM) plans, and the costs and benefits they bring

As you have already seen a number of times in this chapter, growing populations, economic development and global climate change bring challenges when trying to please different stakeholders economically and socially, while also aiming to achieve environmental sustainability. IDBM tries to achieve all of these with the mutual cooperation of different stakeholders and different countries.

▼ Figure A.4.1. The Katse Dam in Lesotho



Test yourself

- A.17 Suggest** reasons why the benefits gained from the construction of large dams may outweigh any costs. [3+3]
- A.18 Briefly outline** what is meant by the term IDBM. [2]
- A.19 Describe** an IDBM using an example that you have studied. [3]
- A.20 Suggest** how an IDBM can bring both costs and benefits to different stakeholders. [3+3]

▼ **Figure A.4.2.** Wetlands in a periglacial environment



Growing pressures on major wetlands and efforts to protect them, such as the Ramsar Convention

The Ramsar Convention—the Convention on Wetlands—was signed in Ramsar in Iran in 1971. It is a treaty that was signed by a number of governments in order to protect the unique ecology of wetlands. The UN Environment Programme (UNEP) estimates that about 6% of the world's land surface can be classified as wetlands.

Case study: The future possibilities for one wetland area—the Iraqi Marshes

The Iraqi Marshes are an area of wetlands in the south-east of Iraq. The area is home to the Marsh Arabs, who live on the water in a way that is unique to this part of the Middle East. In recent decades, their life has been made difficult due to Saddam Hussein draining the marshes to punish the Arabs for being disloyal during the Iran–Iraq war in the 1980s and the invasion of nearby Kuwait in 1990. By draining water from the marshes via a series of dams upstream, Hussein forced the Marsh Arabs out of the area, displacing over 200,000 people. By 2003, the wetlands had shrunk by 90%. Livestock perished, revenue decreased, and the unique culture of the Marsh Arabs was devastated.

The UN began a programme to restore the marshes in 2003 and by 2006, 50% of the marshes had been rejuvenated.

In 2016, the area was designated as a UNESCO World Heritage site, and by 2017 some families had returned to the area thanks to further initiatives from the Iraqi government.

Several thousand families now make a living from fishing and buffalo herding, while native birds are present once more. Domestic tourism has been increasing, with groups touring the wetlands and watching the migratory birds such as eagles and pelicans. However, the situation with sectarian conflict in Iraq and the rise of ISIS has meant that few tourists from outside Iraq have visited.

There are positive possibilities, but there are some negative issues too. Turkey is planning to build a series of dams that will starve the rivers Euphrates and Tigris of potentially 40–50% of their normal waters and thus once again decimate the Iraqi wetlands.

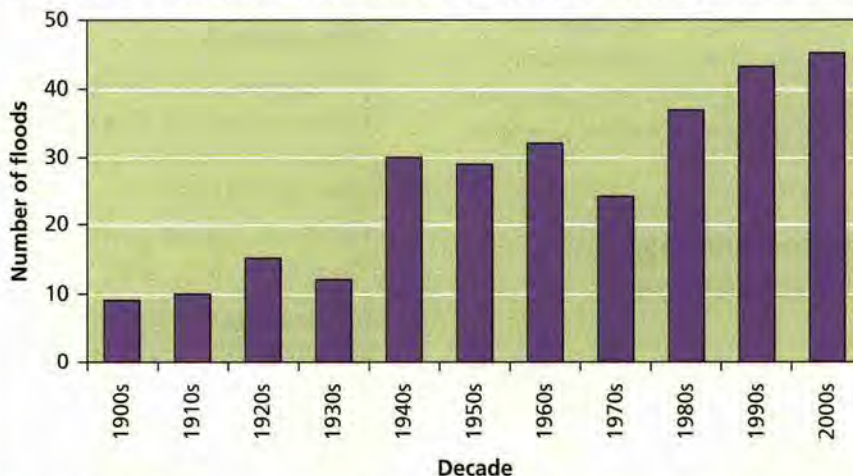
Test yourself

A.21 Define the term “wetlands”.

A.22 Outline the value of wetlands.

QUESTION PRACTICE

The graph below shows the number of floods per decade for a river.



Source of data: International Baccalaureate Organization (2016)

- a) **Describe** the changes in flood frequency shown on the graph. [2]
- b) **Outline** one flood prediction strategy. [2]
- c) **Suggest** one physical reason and one human reason why the risk of a river flooding can change over time. [3 + 3]

Essays

- Either: Examine** the role of river deposition in the formation of floodplain landforms. [10]
- Or: Evaluate** the costs and benefits of river flooding. [10]

How do I approach these questions?

- a) This 2-mark question will require two distinct points and the inclusion of data. Try to categorize changes that have taken place over time and write one sentence for each time period. Consider the general trend, periods of significant increase or decrease and any anomaly that is not part of the general trend. Do not forget to include data in your answer.
- b) A brief account or summary is required for this question; it is worth 2 marks so two or three sentences will be sufficient.
- c) For each factor (one natural and one artificial) it will be necessary to clearly state the factor, and then explain in detail how it links to increased or reduced flooding. It would also be appropriate to try and include an example for each of the factors.

First essay choice:

The command term is “examine”, and because of this you will need to ensure that the relationships between the river processes and the formation of landforms on a floodplain are discussed. Consider how some landforms are a product of deposition and other landforms require other fluvial processes. Try to ensure that your paragraphs have a focus, and be prepared to draw an annotated sketch that explains how **processes** help to form different landforms on the floodplain.

Second essay choice:

“Evaluate” is the command term for the alternative essay response, and therefore you will need to ensure that you offer a measured response, with both costs and benefits detailed in your answer. In order to provide context and to substantiate the positive and negative effects, you will need to include relevant case studies with detail. Conceptual connections are possible: you can outline how flooding can be beneficial to a **place** in terms of how the land around a river is used.

SAMPLE STUDENT ANSWER

a) The general trend of flood frequency from the 1900s to the 2000s is increasing. Between the 1900s and 1920s is quite a large jump from about 9 floods to approximately 15 floods. There is a decrease between 1920s and 1930s from approx. 15 floods to about 11 floods in the 1930s. Between 1930s and 1940s is the largest increase from 11 floods to 30 floods in 1940s. Relatively staying the same between 1940s to 1960s but a small decrease in 1950s.

▲ General increase a valid point

▲ Significant increase a valid point

This is a comprehensive answer that includes plenty of data and achieves full marks. Given the time constraints in an exam, it would be more appropriate to include less content since two sentences would have been sufficient.

Increasing number of floods = 1 mark

Flood-rich period 1940s–1960s = 1 mark

Marks 2/2

b) Weather forecasting and tracking weather systems is one way that authorities are able to predict floods.

This answer includes a valid strategy, but it requires development in order to link the strategy to flood prediction. For example, the monitoring of any future increases in precipitation can aid authorities in making predictions for potential flooding when also considering river levels and soil moisture. The answer only states or identifies a strategy rather than providing an outline.

Mark 1/2

▲ Increased precipitation

▼ Lacking development/
explanation/examples

▲ Channelization

c) The amount of precipitation received in an area can affect the discharge of a river as additional water will fall in the channel. The human interferences such as flood management, for example channelization, can create negative effects. This is because places further downstream that have not implemented channelization will see an increase in discharge resulting in flood as the size of the channel cannot cope with the excess water.

Increased precipitation, but quite simplistic development = 1 mark

Channelization = 1 mark

Explanation is present via a reduction in capacity for places downstream to cope with an increase in discharge = 1 mark

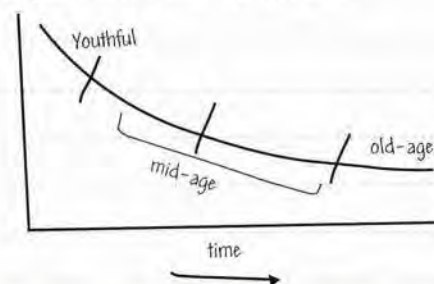
This answer requires more depth. For the physical reason, precipitation could be further developed by explaining that additional volume will be added to the river via overland flow and throughflow. In addition, antecedent moisture could be present from a previous rainfall event, which would further increase overland flow and the risk of flooding. An example would ensure that 3 marks for the physical factor would be credited. The human part of the answer is better since there is more explanation, and an example of where channelization has caused flooding would provide the third mark for this part of the answer.

Marks 3/6

Essay

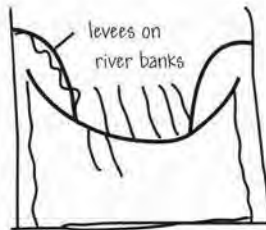
Either: Examine the role of river deposition in the formation of floodplain landforms.

Floodplain landforms are caused by different river processes the further down or upstream a landform is.

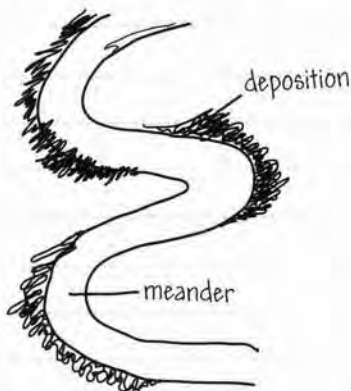


Due to discharge, and velocity upstream and gradient also playing a major role, the landforms may be different due to erosion taking place such as hydraulic action, abrasion and attrition.

Eroding the large rocks and turning to matter that can be transported downstream and the formation of larger levees begin to form as the velocity of the rivers gets slower the centre of the river will be the fastest as it will be the largest wetted perimeter leaving less friction hence deposition on the sides of the river as less velocity and matter cannot be transported as it's too heavy therefore it is deposited.



Just like the formation of oxbow lakes the velocity is higher on the inner side of the river making it deposit on the outer.



Rivers have different stages such as the upper, the middle and the lower courses and these sections will have different landforms present as the influence of erosion and deposition will differ.

Some sentences are very long, and the essay would benefit from being more structured with clear, focused paragraphs. Some appropriate terminology has been included although more could have been included such as 'slip-off slopes' for the inside of a 'meander'. The drawings do not add much value to the response since they lack annotations and a limited amount of content is provided in the response. Floodplains and deltas could have been discussed, as well as providing a clearer explanation of the formation of a meander.

Marks 4/10

▲ Processes

▲ Landform

▼ This is a very long sentence and it should be broken down in order to achieve greater clarity

▲ Deposition—link to the question

▲ Processes

▲ Landform

▼ This is incorrect; the velocity is higher on the outer side of the meander, and will deposit on the inner side.

Or: Evaluate the costs and benefits of river flooding.

▲ Appropriate terminology

River flooding tends to occur on an annual basis in most basins due to climatic conditions such as snowmelt in spring, monsoonal rains, and more. The effects of this flooding can be detrimental. However, the relative consistency of these means that communities living within floodplains can adequately prepare in order to avoid detrimental effects and even benefit from flooding. An example of this is Bangladesh, where 30% of the country floods annually due to a combination of its three main rivers – the Brahmaputra, Ganges and Meghna – flooding due to Himalayan snowmelt in the spring paired with heavy monsoonal rains. These floods lead to improved soil fertility (as sediment/alluvium is deposited over the floodplain), which benefits agricultural productivity. This also causes the country's aquifers to be restored, increasing the groundwater supply. This is highly important in a highly densely populated country like Bangladesh, which may be at risk of water scarcity without these floods. Due to the inexistence of sewage treatment plants due to the country's poverty, water cannot always be extracted from the river, and therefore the natural filtration system of aquifers is even more important.

▲ Relevant example with detail

▲ Appropriate terminology

▲ Benefit

▲ Benefit

▲ Application to example

▲ Application to example

▲ Benefit

Floods also help to flush away these pollutants, increasing the overall well-being of local ecosystems as well as the aforementioned benefit of eradicating the country's high pollution in its rivers.

As can be seen, the effects of these annual floods can be

highly beneficial, especially for a nation like Bangladesh that doesn't have very developed urban settlements and relies primarily on agriculture. However, the volatility of global climate on an increasing scale due to climate change means that these floods are not entirely predictable, and can have devastating negative consequences.

Normal floods can destroy settlements, kill livestock and destroy infrastructure, however their unpredictability means their consequences can be mitigated. Intense floods, such as the Bangladesh flood of 2017, can be devastating due to their unexpected nature. This particular case was caused by synchronized discharges of the three rivers due to abnormally intense monsoon rains at the same time as high snowmelt. The effects were consolidated by Himalayan foothill deforestation as well as a high water table due to consistent antecedent rainfall. This led to the largest flood in modern history and devastated the low-lying delta nation. It killed over 100 people and 6 million people were affected. Its effects were consolidated by Bangladesh's poverty, however the flood's negative consequences were immense. Here it can be seen that despite consistent flooding being beneficial, the potential for a large-scale unexpected flood can arise and be highly damaging.

In conclusion, I disagree with the statement that the negative consequences always outweigh benefits, given that it is often the benefits of flooding that maintain the survival of these river/delta communities. However, climatic volatility can lead to large floods which communities aren't prepared for, which can often be devastating enough to make the benefits of flooding appear meagre in comparison.

Detailed explanation of the problems and benefits with an evaluation.

Marks 10/10

▲ Case study knowledge

▼ This final sentence is not aligned with the rest of the paragraph, which discusses the benefits of flooding

▲ Structure

▲ Negative consequences

▲ Relevant example

▲ Appropriate terminology

▲ Appropriate terminology

▲ Negative impacts, case study detail

▲ Effective summary with no new information included, aligned with the rest of the essay

B OCEANS AND COASTAL MARGINS

Covering more than 70% of the Earth's surface, oceans are of great importance to humans in a number of ways. This optional theme provides an introduction to the physical characteristics and processes of the oceans with particular reference to the atmosphere–ocean linkage, concentrating on the important role that oceans play in influencing climatic conditions.

You should be able to show:

- ✓ how physical **processes** link the Earth's atmospheric and ocean systems;
- ✓ how coastal **places** are shaped by their interactions with oceans;
- ✓ the varying **power** of different stakeholders in relation to coastal margin management;
- ✓ future **possibilities** for managing the oceans as a global commons.

B.1 OCEAN–ATMOSPHERE INTERACTIONS

- **ENSO (El Niño Southern Oscillation)** – a reversal of the normal atmospheric circulation in the southern Pacific Ocean.
- **La Niña** – an intensification of normal atmospheric processes in the southern Pacific Ocean.

You should be able to show how physical processes link the Earth's atmospheric and ocean systems:

- ✓ The operation of ocean currents, including their distribution, nutrient and energy transfers, and the importance of oceanic conveyor belts;
- ✓ Atmosphere–oceanic interactions associated with El Niño Southern Oscillation (ENSO) and La Niña cycles and their climatic, environmental and economic effects;
 - ✓ Detailed examples of the geographic impacts of El Niño and La Niña;
- ✓ The formation, distribution and physical impacts of hurricanes on coastal margins, including storm surges;
 - ✓ Case study of one hurricane and its impacts on coastal places and people;
- ✓ The changing role of oceans as a store and source of carbon dioxide (CO₂) and the impacts of ocean acidification on coral reefs.

The operation of ocean currents

Surface ocean currents are caused by the influence of prevailing winds blowing steadily across the sea.

The effect of ocean currents on temperatures depends on whether the current is cold or warm. Warm currents from equatorial regions raise the temperatures of polar areas (with help from prevailing westerly winds).

Ocean currents are important as they transfer heat, oxygen and nutrients around the world.

Nutrient and energy transfers

Many eastern oceans experience upwelling currents, where the ocean currents move cold water, rich in nutrients, from the ocean floor to the surface. Such upwelling currents are found off the coast of Peru, California and south-west Africa.

Test yourself

B.1 Identify (a) one warm ocean current and **(b)** one cold current in the North Atlantic Ocean. [2]

B.2 Outline the impact of ocean currents on the climate of places at coastal margins. [4]

The importance of oceanic conveyor belts

In addition to the transfer of energy by wind and ocean currents, there is also a transfer of energy by deep sea currents. Oceanic convection occurs from polar regions where cold salty water sinks into the depths and makes its way towards the equator. The densest water is found in the Antarctic area. This cold dense water sweeps round Antarctica at a depth of about 4 km. It then spreads into the deep basins of the Atlantic, the Pacific and the Indian Ocean. Surface currents bring warm water to the North Atlantic from the Indian and Pacific Oceans. These waters give up their heat to cold winds which blow from Canada across the North Atlantic. This water then sinks and starts the reverse convection of the deep ocean current.

Temperature, salinity and pressure affect the density of seawater. Large water masses of different densities are important in the layering of the ocean water (denser water sinks). A cold, highly saline, deep mass of water is very dense, whereas a warm, less saline, surface water mass is less dense. When large water masses with different densities meet, the denser water mass slips under the less dense mass.

Atmosphere–oceanic interactions associated with ENSO and La Niña cycles

El Niño conditions in the Pacific Ocean

El Niño—the “Christ Child”—is a warming of the eastern Pacific that occurs at intervals between two and ten years, and lasts for up to two years.

During El Niño Southern Oscillation (ENSO) episodes, water temperatures in the eastern Pacific rise as warm water from the western Pacific flows into the east Pacific. The sea surface temperatures (SSTs) of over 28°C extend much further across the Pacific. Low pressure develops over the eastern Pacific; high pressure over the west.

The 2015–16 El Niño event led to 100 million people being short of water and food. Some 40 million people in rural areas and nearly 10 million people in urban areas in southern Africa were affected. The area experienced its driest year for 35 years. Up to one million children in East Africa and southern Africa needed treatment for malnutrition. The heavy rains in South America enabled the Zika virus to spread easily (there was more stagnant water for mosquitoes to breed).

La Niña

La Niña is an intermittent cold current that flows from the east across the equatorial Pacific Ocean. It is an intensification of normal conditions whereby strong easterly winds push cold upwelling water off the coast of South America into the western Pacific. Its impact extends beyond the Pacific and has been linked with unusual rainfall patterns in the Sahel and in India, and with unusual temperature patterns in Canada. Generally, there are wetter-than-normal conditions over northern Australia, Indonesia and the Philippines. Wetter conditions are also experienced in northern Brazil and south-eastern Africa. The summer monsoon tends to be stronger over north-west India. Drier conditions are experienced along the west coast of South America.

Concept link

PROCESSES: The processes that exist within the hydrosphere and atmosphere, and between both systems, enable the distribution of energy. These natural processes are important at a variety of scales, such as the economic impact on a country's agricultural industry in the South Pacific during a La Niña year, for example. Human input can alter some of these processes, such as the increased frequency of cyclones due to the warming of the atmosphere and oceans.

Test yourself

B.3 Compare the climate conditions in the southern Pacific region associated with El Niño events with those of La Niña. [2+2]

The formation, distribution and physical impacts of hurricanes on coastal margins

Hurricanes are intense hazards that bring heavy rainfall, strong winds and high waves; they cause other hazards such as flooding and mudslides. High-intensity rainfall, as well as large totals (up to 500 mm in 24 hours), invariably causes flooding.

Hurricanes move excess heat from low latitudes to higher latitudes.

For hurricanes to form, a number of conditions are needed:

- Sea temperatures must be over 27°C. (Warm water gives off large quantities of heat when it is condensed—this heat drives the hurricane.)
- The low pressure area has to be far enough away from the equator so that the Coriolis force (the force caused by the rotation of the Earth) creates rotation in the rising air mass. If it is too close to the equator, there is insufficient rotation and a hurricane will not develop.
- There must be low wind shear (the gradient of wind velocity with altitude) to allow the hurricane to maintain its structure.

Case study: Hurricane Sandy, 2012

In Haiti, over 100 deaths were attributed to Sandy. Tents across the refugee camps were flooded and crops washed away.

In the USA, Sandy affected 24 states, including the entire eastern seaboard from Florida to Maine and west across to Michigan and Wisconsin. Damage was particularly severe in New Jersey and New York. At least 131 people in eight states were killed. The New York Stock Exchange was closed for two days, the first weather closure since 1985 and the first two-day weather closure since 1888. Seven subway tunnels under the East river were flooded. Battery Park in Manhattan had a storm surge of 14 feet. Over 100,000 homes on Long Island were damaged or destroyed.

The changing role of oceans as a store and source of carbon dioxide (CO₂), and the impacts of ocean acidification on coral reefs

The oceans are the largest reservoir of carbon in the carbon cycle—they contain approximately 38,000 trillion kg of carbon. The oceans are also a major *source* of carbon. For example, photosynthesis by plankton creates organic compounds from CO₂. Some of this passes through the food chain and sinks to the seabed where it is decomposed into sediments.

Acidification of oceans

Atmospheric carbon dioxide is taken in by the ocean and becomes dissolved. It reacts with sea water to produce carbonic acid, lowering the water's pH level and making it more acidic. This affects coral reefs and organisms with shells.

Test yourself

B.4 Briefly **explain** the main hazards associated with hurricanes. [4]

B.5 **Suggest** why Haiti experienced a relatively high number of deaths despite not being in the direct path of Hurricane Sandy. [2]

Test yourself

B.6 **Analyse** the importance of the ocean as a source and a store of carbon. [2+2]

B.7 (a) **Describe** how the ocean is becoming more acidic. [2]

(b) **Explain** how more acidic oceans are damaging to marine life. [3]

B.2 INTERACTIONS BETWEEN OCEANS AND COASTAL PLACES

You should be able to show how coastal places are shaped by their interactions with oceans:

- ✓ Physical influences on coastal landscapes, including waves, tides, sediment supply, lithology, vegetation, subaerial processes and wave processes (littoral drift, hydraulic action and abrasion);
- ✓ The characteristics and formation of coastal landforms of erosion and deposition, including wave-cut platforms, cliffs, stacks, spits and beaches;
- ✓ Advancing and retreating coastlines, including the role of isostatic and eustatic processes, and the associated landforms (relict cliff, raised beach, fjord);
- ✓ The role of coastal processes, wind and vegetation in sand dune development.

Physical influences on coastal landscapes

Waves

Constructive waves tend to occur when wave frequency is low (6–8/minute). Swash is stronger than backwash, so sediment is moved up the beach.

Destructive waves are the result of locally generated winds, which create waves of high frequency (12–14/minute). As the backwash is stronger than the swash, material is eroded from the beach.

Tides

Tides are regular movements in the sea's surface, caused by the gravitational pull of the Moon and Sun on the oceans. In general:

- tides are greatest in bays and along funnel-shaped coastlines
- during low pressure systems, water levels are raised 10 cm for every decrease of 10 mb.

Sediment supply

Sediment transport is generally categorized into two modes:

- **Bedload**—grains transported by bedload are moved with continuous contact (traction or dragging) or by discontinuous contact (saltation) with the seafloor.
- **Suspended load**—grains are carried by turbulent flow and generally are held up by the water.

Subaerial and wave processes

Subaerial, or cliff-face, processes include salt weathering, freeze-thaw weathering, solution weathering, slaking and biological weathering.

Mass movements are also important in coastal areas, especially slumping and rock falls.

- **Eustatic changes** – worldwide changes in sea level caused by the growth and decay of ice caps, thereby locking up and later releasing water from ice.
- **Isostatic changes** – localized changes in the relative level of the land and sea, caused by the depression of the Earth's crust, such as due to the weight of an ice sheet. Following deglaciation, the crust beneath the weight begins to rise again, and relative sea level therefore falls.
- **Advancing coasts** – coastlines that are growing/getting larger either due to deposition or a fall in sea level.
- **Subaerial** – processes that occur on the Earth's surface.

Assessment tip

Oceans and their coastal margins are open systems as they receive energy and matter from external sources. However, for convenience, geographers use the concept of a sediment cell (or littoral cell) in which inputs and outputs are balanced within a single bay or region, and each sediment cell is self-contained.

Content link

Some of these mass movements are discussed in more detail in option D.1.