Edexcel AS and A level Geography

Topic Booklet for Area of Study 1: Dynamic Landscapes, Topic 2: Landscape Systems, Processes and Change, Option 2B: Coastal Landscapes and Change

Practical support to help you deliver this Edexcel specification

Topic 2B: Coastal Landscapes and Change offers students the opportunity to investigate and interpret the coastal areas of the world. For teachers there are areas of cross over between the 2008 legacy specification *Crowded Coasts* and this topic should make planning easier because familiar case studies can to be used. For non-Edexcel teachers this means that there are already plenty of resources on the website, as well as elsewhere, to aid in the teaching of this topic.

Students will study the development of coastal landscapes and how geomorphological factors influence the way they work. The interaction of winds, waves and currents will be studied and the impact of both terrestrial and offshore sediment sources. The sediment budget will help explain the distinctive landforms we see and the influence geology and lithology play. The study of a number of different coastal landscapes will help students appreciate the sheer variety that exists around the world and the reasons why such a variety develops.

Finally students and teachers will investigate why these landscapes are increasingly threatened by physical processes and human activities, and the need for holistic and sustainable management of these areas in all the world's coasts. Study must include examples of landscapes from inside and outside the UK.

Our specifications offer an issues-based approach to studying geography, enabling students to explore and evaluate contemporary geographical questions and issues such as the consequences of globalisation, responses to hazards, water insecurity and climate change. The specification content gives students the opportunity to develop an in-depth understanding of physical and human geography, to understand the complexity of people and environment questions and issues, and to become critical, reflective and independent learners.

The AS and A levels in Geography are linear, and all assessments are at the end of the course. The AS Assessment will be at the end of the first year, and the A level Assessment will be at the end of the second year.

The specification has been designed so that the content is clear and it is manageable for centres to deliver within the guided learning hours over a one-year (AS level) or two-year (A level) period.

The guided learning hours are 180 for an AS level and 360, over two years, for an A level. This document provides a topic guide for teaching Coastal Landscapes and Change and can be adapted by centres to fit their own contexts and teaching styles. It has been produced as an example approach and is not intended to be prescriptive. The topic guides indicate resources that you can use to support your teaching. These are only suggestions and you are encouraged to use a wide range of resources to suit the needs of your own students.

The advised teaching time for this topic is 24 hours with 6 hours of fieldwork; i.e. roughly 6 hours per enquiry question (EQ). This requires some blending together of the detailed content. Detailed information on fieldwork techniques, approaches and integration with the topic content is not provided here. Instead, support for fieldwork can be found in the separate fieldwork guide. In the guidance below, suggestions are made about contextualisation or stretch challenges that may be suitable for more able students, as well as expected lesson outcomes for those less able. Please note that these are suggestions only and not specific syllabus requirements.

Each of the EQs and key areas is broken down into sections, beginning with a quick overview of the breadth of the enquiry question followed by a more detailed explanation of the key concepts and processes, examples of teaching strategies, guidance on integrating geographical skills, and a summary of the key terminology required. The structure is suggestive, not prescriptive.

Synoptic linkages and case study nesting

There are many opportunities to develop knowledge through place and context within this unit as well as areas where past case studies (from *Crowded Coasts*) may be used as well as others. Examples could include (but are not limited to):

- Holderness
- Jurassic Coastline
- Formby Sand Dunes
- Salt marsh development in the Blackwater Estuary
- Towyn.

These are examples which could be developed. However, there are others, both based within the UK and abroad, which have equal merit and should be used as appropriate.

Our synoptic themes help students see 'the bigger picture' by encouraging them to make geographical links between topics and issues. To enable this, and support exam preparations, we have continued to signpost 'Players' (P), 'Attitudes and Actions' (A) and 'Futures and Uncertainties' (F) throughout the specification content. Synoptic links here can include deltas and work on the Nile and California (water security); flooding and poverty in areas such as Bangladesh; climate change and impacts of increased hydro-meteorological hazards (for example, tropical storms) in places such as the Philippines.

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Introduction

Overview
Students and teachers will investigate why these landscapes are increasingly threatened from physical processes and human activities, and the need for holistic and sustainable management of these areas in all the world's coasts. Study must include examples of landscapes from inside and outside the UK. The first area of this topic is built around the ideas associated with the physical processes that create coastlines. For some students the depth of information given can be quite taxing and hard to grasp. However, with differentiated resources and a variety of approaches this can be overcome. Hitting the basics here will bear fruit later in the course. The teaching should cover:

- the littoral zone and dynamic change;
- coastal classification based on geology, changes to sea level and inputs or outputs;
- low- and high-energy coastlines;
- concordant and discordant coasts;
- coastal morphology and geomorphology.

EQ1: Why are coastal landscapes different and what processes are causing these differences?

Teaching approach over 6 hours

Lesson 1 (1hr)	The coast, and wider littoral zone, has distinctive features and landscapes.
Lesson 2 (1hr)	Geological structure influences the development of coastal landscapes at a variety of scales, including concordant and discordant coastlines.
Lesson 3 (1hr)	Potential integration of coursework/fieldwork theme in terms of key skills such as field sketches, OS maps and geological maps.
Lesson 4 (1hr)	Geological structure (jointing, dip, faulting, folding) is an important influence on coastal morphology and erosion rates.
Lesson 5 and 6 (2 hrs)	Rates of coastal recession and stability depend on lithology and other factors.

Lesson 1: The littoral zone

Overview
This lesson should introduce the key concepts of the littoral zone, building on what students may have learnt at GCSE. Students need to be able to describe and explain the factors that create the different landscapes around our coastline.
This should then build into ideas of geology through the rock type which is important in determining much of our coasts.

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Images or maps can be used as differentiation tools. These can be annotated to some extent for the less able.

Videos of the changing coastline may help visual learners develop an understanding of the temporal elements involved.

Key concepts and processes

- Why coastal landscapes are different and what processes are causing these differences.
  Students need to:
  - appreciate that the coastline consists of the backshore, nearshore and offshore zones;
  - recognise that the coastline is a dynamic and changing environment that can be altered rapidly;
  - understand that there are inputs and outputs within this system such as rivers and tides and the action of waves.

Guidance on teaching

The first area of this topic is built around the ideas associated with the physical processes that create coastlines.

In terms of teaching, the littoral zone can be explored through both layered diagrammatic exemplification or cause and effect. Less able students might benefit from a more structured element with recourse to personal experience at the beach. Geological themes can be explored through pictorial evidence such as different landscapes being shown with students writing down 'hard' or 'soft' on mini-whiteboards or 'erosional' or 'depositional'. This will improve their ideas and confidence with visualising landscapes.

Lesson 2: Geology

Overview

Students will need to develop an awareness of how geology impacts upon the coastline and its importance in coastal formation.

There will be key terms which students are not familiar with and these will need to be reviewed to help students develop good geographical terminology. The introduction of basic geological maps, many of which can be found online, will be useful; suggestions are given below and throughout.

Apps like iGeology can help students understand the complexities of geology in the UK though only a rudimentary knowledge is needed. More able students may wish to explore this area more through geological maps (bgs.ac.uk – has a UK geology viewer online, which can enhance understanding, as well as other great features to help students.)
Several video websites offer alternative views of geology. However, rock hardness differentiation is key to a student's understanding because, in looking at one rock in

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relation to another, the softer of the two will always erode more quickly. Exemplification of this could be done via annotation/geological maps/OS maps and student investigation.

Less able students may benefit from annotated photographs or slides explaining the rock types. There are some good videos on rock hardness – search by 'Mineral hardness test'. These can used to guide students in identifying rock hardness and in the classroom they can then test common rocks found in coastal locations (chalk, limestone, granite, clay, etc.) By numbering these, students should be able to understand the relationship between rocks and their hardness rating.

Rocks can be collected or bought. Quarries or building companies will usually donate a small amount for educational purposes

Lesson 3: Concordant and discordant coastlines

Overview

Within this lesson students will tackle the lithology of coastlines and how different layers of rocks create potentially different landscapes.

Students will by now be able to begin to differentiate between rock hardness in terms of why certain rocks erode faster than others. Good examples here would be along the Devon coastline or where both concordant and discordant features are visible.

You could begin to introduce different fieldwork skills such as field sketches and geological map reading. A simple understanding of how rocks are laid down over time may be included here through case studies, such as those around the Holderness coast, Devon coast or your chosen case study area. The websites maintained by Hull University are good for Holderness and Southampton University has produced resources on the Devon coast.

Key concepts and processes

- Geology can cause a variety of different coastlines and there are many different reasons, such as wave action and geomorphology, why they vary. Students need to:
    - understand concordant and discordant coasts and the reasons for their creation;
    - appreciate the impacts of erosion on these landforms and the landforms they can create;
    - understand the actions of both marine and terrestrial processes in the creation of these landforms.

Guidance on teaching

There are many areas which teachers need to impress upon students that go beyond the previous (2008) specification. Geological maps – both full and simplified versions – can be used and many are available from sources such as the app 'iGeology'.

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The distinction between concordant and discordant coastlines can be followed up by case-study led investigations, which may or may not be linked to areas students have visited or have yet to visit.

Lesson 4: Geological structure and the impact on coastal morphology

Overview

Coastlines that can be termed submergent and emergent exist around the world and are the result of changes in eustatic and isostatic sea levels due in main to the processes of long-term climate change such as glacial and interglacial periods.

There are excellent examples of this on the Dalmatian and Haff coastlines of Croatia and the Baltic coast of Germany respectively. Building on the idea of geology and submergent and emergent coasts students will be able to make use of different forms of GIS (Google Earth, Digimaps or similar software) as well as satellite imagery.

Less able students could be given more exemplification of coastlines and ideas while more able students could develop their understanding by looking at progressively less obvious coastline types.

The development of the two case studies of Dalmatian and Haff coastlines with good understanding of their formation will help.

Key concepts and processes

Students should be able to appreciate and understand the concepts of both submergent and emergent coastlines.

Guidance on teaching

As in many of the earlier lessons, testing the more able students should not be too difficult. The less able student can develop an awareness of how geology impacts on coastal morphology via photographic and physical evidence as well as through tests on key terms. Good exemplification should help in their knowledge development. The lesson plans give examples of this.

Historically it is worth pointing out to students that changes in sea level are considerable during glacial periods and they have been both higher and lower than we see today. Annotated photographs of these features may help students identify why some submerge and others emerge. Good case-study analysis is very important to get information across. Examples of emergent coastlines include the west coast of North America, parts of the Swedish and Norwegian coasts as well as, closer to home, the Forth, Clyde and Tay valleys in western Scotland.

Good examples of submergent coasts, and the rias and fjords they can create, include the Chesapeake Bay area of the eastern United States and Southampton Sound (UK). (The British Geographer website is a handy resource for some of this topic - http://thebritishgeographer.weebly.com/coastal-environments.html).

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Lesson 5 and 6: Hard and soft rock

Overview

Building on all the previous lessons, it is important that students get to grips with geological structure (jointing, dip, faulting, folding) and understand why it is an important influence on coastal morphology and erosion rates.

If students failed to fully get to grips with the different concepts or it wasn't covered in depth in lesson 2 now is a key time to bring in the ideas of rock hardness (see 'Overview' lesson 2).

In many cases students can find it hard to differentiate between what is considered to be a hard and a soft rock. In previous specifications it was enough to simply tell the students. Now, the relative hardness of rock is an intrinsic part of understanding the lithologies of the coastline, and the impact that this has on cliff profiles and the micro-features that can form as a result.

Key concepts and processes

- Lithology of rock can alter the recession rates.
  Students need to:
  - understand the context of hard rock in relation to softer rock and how this is a comparative relationship and relative to adjacent rock;
  - understand how different recession rates can have a variety of impacts on the coast;
  - appreciate that different recession rates can impact upon the landforms and features that are visible along the coast, such as headland erosion, stacks, caves and arches.

Guidance on teaching

There are several ways of explaining the concepts here and many websites that offer tests of rock hardness (the simplest being MOH scale of hardness). This should help students understand why some rocks erode quicker than others, even when both could be considered hard. It might be helpful for the teacher to show this via simple tests on sandstone, granite, and limestone (having a mild acid solution may also help show corrosion).

It is important to show that theoretical coastlines, as drawn and revealed on websites and textbooks, are rare in reality. Students should understand that the principles of recession are almost unique in all areas and that formations caused by similar factors can often look different in different places. Less able students may struggle with the amount of different variables involved in causing recession and it might help to give small groups key terms and ask them to use these to build up a picture of a given coastline. For example, provide a picture of Holderness and ask students to add the variables they feel are most relevant (longshore drift, rock type, wave type etc.). Students can then be shown other coastlines and asked to do the same. The teacher could ask for justification by students and they could rank the key terms in order of what they feel is the most relevant to each coastline.

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Key vocabulary for EQ1

There are many key words in this section; here are just some of them.

Key Words	Definition
Lithology	The study of the general physical characteristics of rocks.
Morphology	The study of the geological structure, shape or form of a feature.
Submergent coast	Stretch of coastline that is inundated by the sea due to eustatic or isostatic changes (e.g. Dalmatian coast).
Emergent coast	Stretch of coastline that has been exposed by receding sea levels or isotactic uplift/rebound (e.g. Haff coast).
Concordant	Rock structure/ lithology runs parallel to the coast (e.g. creates coves).
Discordant	Rock lithology runs perpendicular to the coast creating bands of alternate rock types (e.g. headlands and bays)

Resources

fossilhub.org/wp-content/uploads/2013/03/2013_YorksCoast_part1.pdf – great resource on Geology of Yorkshire coastline.
jncc.defra.gov.uk/pdf/gcrdb/GCRsiteaccount1943.pdf – another good source for geological information of Yorkshire coast (Robin Hoods Bay).
http://www.bgs.ac.uk/igeology/home.html - British Geological Survey website for app (Alternatively App stores).
http://mapapps.bgs.ac.uk/geologyofbritain/home.html - geology of Britain viewer excellent interactive resource for students and teacher.
http://thebritishgeographer.weebly.com/ - good resource for students and teachers on all areas of geography.
http://www.hull.ac.uk/php/chsmjh/holdhome.htm - Hull University pages on Holderness.
http://www.southampton.ac.uk/~imw/Torquay.htm - Southampton University pages on Torquay.

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EQ2. How do characteristic coastal landforms contribute to coastal landscapes?

Teaching approach over 4 hours

Lesson 7 (1hr)	Marine erosion creates distinctive coastal landforms and contributes to coastal landscapes: wave types. Types of erosion and refraction.
Lesson 8 (1hr)	Sediment movement and landforms of deposition.
Lesson 9 (1hr)	Weathering and geomorphological processes.

Lesson 7: Wave types; erosion and refraction

Overview

There are two specific types of waves that students must be aware of: constructive and destructive. It is important they are aware of the different impacts these have on our coastline.

Less able students should be able to differentiate between coastlines of deposition and recession via the use of photographs and, to a lesser extent, through beach profiles.

Key concepts and processes

- Destructive and constructive waves.
  Students need to:
  - understand that there are different types of waves and that they have different impacts upon the coastline;
  - appreciate that there are several different factors that create these wave types.
- Recession and deposition.
  Students need to:
  - understand that wave type can create different landforms; why and how these are created and the various processes as well as impacts that they have.

Guidance on teaching

A simple technique to get students thinking of these different coastlines is to show a selection of different types (estuarine, salt marsh, cliff, beach, sand dunes, etc.) They can simply decide whether the coast is receding or growing. The factors that go into this can be explored and, crucially, the idea that waves can create as well as destroy the coast.

More able students can then try to think of the factors for themselves or, in differentiated groups, they can either peer learn or annotate pictures given to the groups with the factors they believe are in operation.

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A case study on sand dune creation may help students in terms of their understanding of depositional coastlines or salt marsh creation. Geo factsheet 119 (September 2001) (http://www.geographylwc.org.uk/A/A2/a2prac/a119%20dunes.pdf) has some excellent information and has questions at the end to test student learning. Groups could work through these in groups to aid understanding at both the higher and lower student level.

Types of erosion and refraction

Overview
There are four types of erosion (hydraulic action, corrosion, abrasion, attrition) that students need to be made aware of and these can be introduced either by PowerPoint or through the use of video. Student interaction could be achieved by having them act out the type of erosion so that every student can understand the processes involved.

It is then important for students to understand the processes that create coastal landforms and these can be approached via a timeline process for less able students or an appreciation of erosion type by more able students.

Key concepts and processes

- The different types of erosion.
  Students need to:
  - appreciate that there are four different types of erosion that often work together and are part of the coastal system.
- The processes that create landforms.
  Students need to:
  - understand that different erosion types have various impacts on landscapes and each can influence the type of landscape that develops depending on many physical factors.
  - recognise the key erosional type within each landform.
  - recognise that key influences such as frictional drag, refraction and shoaling help to dictate how wave action and erosion impact upon the coast.

Guidance on teaching

Types of erosion can be studied and understood by using 'Coastal Kung Fu' which can be found on the internet. This is an interactive way for students to appreciate the mechanisms at work.

This can be built on by the use of good images researched from the internet or photographs which help to exemplify different erosion types at different coastlines. The bending of waves can help students understand how caves begin to form and therefore the way that headlands develop over time. This can be done via annotated diagrams and a recognition of frictional drag.

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Lesson 8: Sediment movement and landforms of deposition

Overview
How the movement of sediment occurs around our coastline, sediment cells and landforms of deposition.

Students will consider the ideas of constructive waves and sediment cells and the variety of processes involved in the creation of the different landforms associated with deposition and transportation.

Key concepts and processes

- Dynamic equilibrium. Students need to:
  - recognise that inputs into a sediment cell must equal the outputs for the cell to remain stable.
- Depositional processes. Students need to:
  - understand that constructive waves and landforms can cause deposition to occur. The action of waves and the ideas from previous lessons should be brought together for students to appreciate the complexity of these processes.
- Sediment cells. Students need to:
  - appreciate that the country can be split up into independent cells and that sediment cells act independently of those around them.

Guidance on teaching

If students can understand the concepts of sediment cells and dynamic equilibrium, along with the ideas of wave refraction covered earlier, then this area should be straight forward. (Several themes can be carried over from Specification 2008). Blank maps, such as the one shown, allow students to practice their understanding of how deposition occurs. These can become progressively more complex to help both less able and more able students develop their understanding.

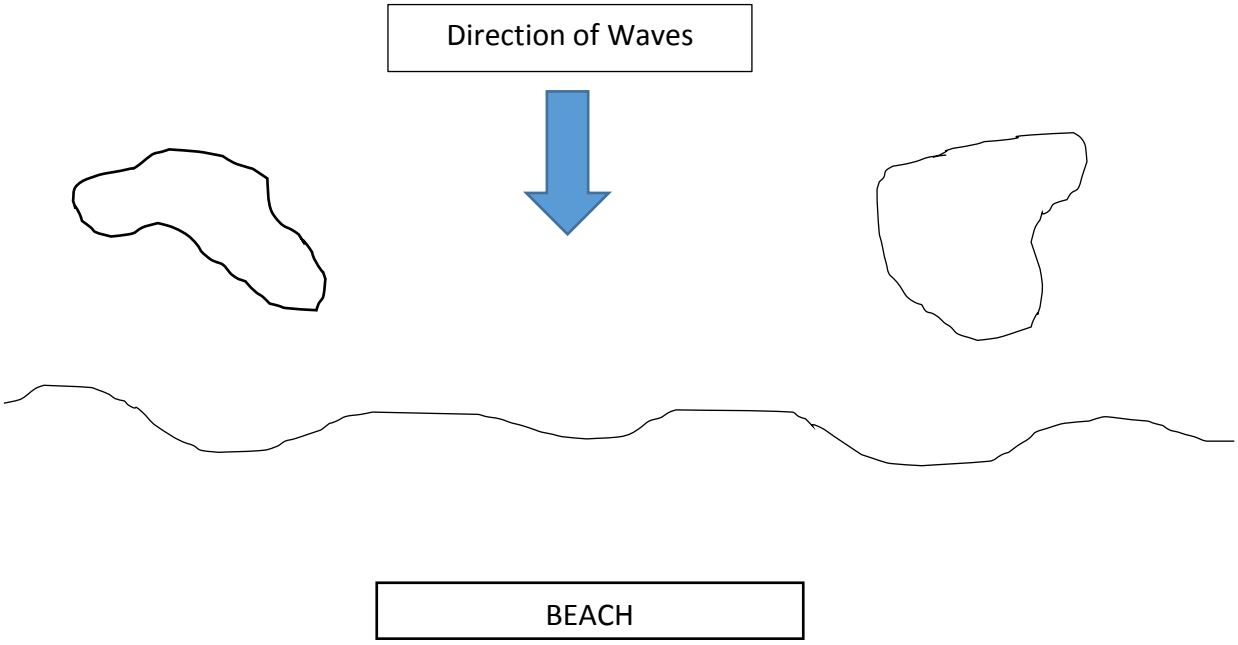

Figure 1

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Lesson 9: Weathering and geomorphological processes

Overview
Students should look at the variety of subaerial processes that help to erode coastlines. There are several ways this can be developed using photographic examples ranging from plants growing on coastal rocks to rotational slump in places such as Happisburgh or Holderness.

Key concepts and processes

- The processes of geomorphology and weathering. Students need to:
  - realise that there are several types of geological processes that can occur; recognise these and be able to apply them to different coastal environments.
- Rock type. Students need to:
  - understand that rock type can have a large influence on recession rates and the impact of weathering.
- Forms of coastal erosion. Students need to:
  - appreciate that subaerial process and cliff-foot processes work together to influence recession rates.

Guidance on teaching

The British Geological Survey website the article on Holbeck Hall has an excellent slideshow which could be used for students to consider what caused the landslide. For less able students a list could be given and they could use this to help exchange ideas. The different types of slumping could be considered through pictorial evidence and students asked to consider all aspects to see if they can appreciate how each has occurred.

Further extension work could be considered to include an understanding of how vegetation can bind a slope and prevent landslides as well as how both subaerial erosion and cliff-foot processes are in operation together.

Key vocabulary for EQ2

Key Words	Definition
Proxy records	Records or data collected from other sources (e.g. books or paintings).
Geomorphology	The study of origins and evolution of the earth's landforms, and the factors which affect them.
Sedimentary rock	Rock formed over millions of years due to the accumulation of sediment (e.g. sandstone).

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Igneous rock	Rock which is formed by the cooling of molten magma (e.g. granite).
Metamorphic rock	Rock formed from other rocks that have been changed due to heat or pressure (E.g. Marble)
Basalt	The most abundant igneous rock found on the planet.
Unconsolidated	Often loosely formed mass of soil, rock and other parts that is weak and easy to break (e.g. glacial till).
Lithology	The general physical characteristics of rocks.
Permeable	Allows liquid to pass through it. (e.g. sandstone).
Impermeable	Will not allow liquid to pass through it (e.g. granite).
Recession rate	The rate at which the land recedes (usually measured in mm to m per year).
Temporal	Relating to time.
Hydraulic action	Mechanical weathering caused by the force of moving water currents rushing into a crack in the rock face and forcing it apart.
Attrition	The wearing away of material as it collides together continually.
Corrosion	Erosion caused by the acidity within the water corroding the rock.
Abrasion	A type of erosion caused by the process of scraping or wearing something away.
Sediment cell	Cells within which the movement of sediment is functionally separated and discrete from the next.
Dynamic equilibrium	The state at which inputs into a system equal outputs.
Succession	The process of change in the species structure of an ecological community over time.
Longshore drift	The movement of material along a coast by wave action, which approach at an angle to the shore but recede directly away from it.
Tombolo	A bar of sand or shingle joining an island to the mainland
Cuspate forelands	Formed due to longshore currents by the accretion of sediment, they extend outwards from the shoreline in a triangular shape.

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Rotational slump	Where the slope fails and slides down due to undercutting or weathering of unconsolidated material.
Mass movement	The geomorphic process by which soil, sand and rock move downslope typically as a mass, largely under the force of gravity or erosion.
Rotational scars	The scar left behind due to rotational slump.
Talus screes	A mass of small loose stones that form or cover a slope on a mountain due to weathering. They typically have a concave upwards form.
Terraced cliff profiles	Where the cliff profile is stepped due to lithology or fractures in the rock.

EQ3. How do coastal erosion and sea-level change alter the physical characteristics of coastlines and increase risks?

Teaching approach over 5 hours

Lessons 10 and 11 (2 hr)	Sea-level change influences coasts on different timescales.
Lesson 12 (1hr)	Rapid coastal retreat causes threats to people at the coast.
Lesson 13 (1hr)	Coastal flooding is a significant and increasing risk for some coastlines.
Lesson 14 (1hr)	Different protection methods and increasing risks

Lessons 10 and 11: Sea-level change and increasing risks

Overview
Much of EQ 3 is aimed at allowing students to learn about the problems many areas of the world face due to both erosion and rising sea levels. Using case study information and key processes learnt earlier in the course, they should be able to begin to piece together not only what the issues are but an understanding of the solutions.

Key concepts and processes

- Eustatic and isostatic sea-level changes.
  Students need to:
  - appreciate that eustatic and isostatic change can impact upon coastal recession rates.

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- Impacts of sea-level changes on a micro and macro scale.
  Students need to:
  - have a clear understanding of these impacts on a small and large scale.

Guidance on teaching

Many students may well be aware of the problems and the causes of sea-level rise due to climate change. It is important that students appreciate these causes and that teachers build on this by introducing the ideas of long-term changes brought about by global cooling (ice ages) and warming (interglacial) periods.

Less able students should appreciate that there is only so much water on the planet and that it is a closed system. Snow and ice can lock up much of the water in stores to be released when climate warms – this means that sea levels act as a barometer for the amount of water locked up in the system.

Diagrammatical ideas, videos and images or maps of past sea levels should help to reinforce these ideas.

More able students might begin to consider the implications of sea-level rise on a much larger scale. Maps could be used to plot new coastlines if sea levels were to rise 10m – 150m, showing the potential losses that could be caused due to land being inundated by the sea.

Cities likely to disappear with sea-level rise	
London	UK
Liverpool	UK
Boston	USA
Miami	USA
Calcutta	India
Mumbai	India

Figure 2

Cities at risk: http://www.rrojasdatabank.info/statewc08093.3.pdf

Lessons 12, 13 and 14: Coastal recession and human impacts

Overview
In these lessons students should aim to concentrate on the specific issues caused by physical factors and how they impact upon humans at different levels. This may be approached via a case study or indeed via specific impacts. Teachers will be able to draw on a whole bank of information available to them from textbooks relating to previous specification (Increasing Risks part of *Crowded Coasts*) as well as clearly defined case studies from various parts of the country (for example: Happisburgh, Holderness, St. Bees) and, on a global level, (Bangladesh, the Nile Delta, California).

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Key concepts and processes

- The causes and impacts of storm surges. Students need to:
  - understand the physical causes of storm surges;
  - recognise that some areas of the world are more susceptible to the impacts of storm surges.
- The causes and consequences of coastal flooding. Students need to:
  - appreciate that different tides can cause sea levels to rise over the short term;
  - understand the impacts of coastal flooding.
- The impacts that climate change will have for coastal regions. Students need to:
  - appreciate that some areas of the world are more vulnerable to sea-level rise than others and the reasons for this.
- The terms mitigation and adaptation. Students need to:
  - understand that these techniques are available to people; what the different techniques are and the costs associated with them.

Guidance on teaching

Teachers will need to be able to demonstrate to the students that specific problems exist with rising sea levels and the causes of these rises can be both eustatic and isostatic. These could be investigated by using student-led research on example areas such as the Nile Delta, Bangladesh, Holderness or the North Norfolk coastline. Posters or annotated pictures drawn by students may aid less able students to see the problems. For differentiation, students could give presentations on their own case-study research. Examples could include the Maldives, Bangladesh, the Philippines, and the south-west coast of the UK. More able students should be able to show the impacts and also explore the relative costs of these impacts in terms of level of development and strategies to modify the loss.

For less able students, cost-benefit analysis or SWOT analysis may help with the learning of specific problems faced in different areas and enable comparisons between places within different regions to draw these out. On YouTube there are several chances to see films based on the experiences of people living through these problems (an internet search for the BBC's Look North's programme on *Coastal erosion, Holderness* or *Cliffhanger* based on Happisburgh offer excellent examples). Students could carry out role plays based on the roles of individual types or stakeholders within the case study. Allowing them to take on these roles may aid in the appreciation of the issues they face from different perspectives.

Key vocabulary for EQ3

Key Words	Definition
Relict coastline	Coastline formed due to previous sea levels that have now retreated.
Fjord	Long, narrow, deep inlet of the sea between high cliffs formed by the submergence of a glacial valley.

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Raised beach	A former beach now lying above water level owing to geological changes since its formation.
Ria	A long, narrow inlet formed by the partial submergence of a river valley.
Isostatic	The movement of land due to weight or release of weight.
Eustatic	A change of sea level due to glacial melt.
Accretion	The gradual growth of sediment accumulated on the coast.
Subaerial processes	Land-based processes which alter the shape of a coastline. A combination of both weathering and mass movement.
Depression	A weather front where low pressure causes air to rise; as it cools it condenses and forms cloud. Associated with precipitation.
Tropical cyclone	Very intense low-pressure wind system, forming over tropical oceans and with winds of hurricane force.

EQ4. How can coastlines be managed to meet the needs of all players?

Teaching approach over 5 hours

Lesson 15 (1hr)	Coastal recession and coastal flooding have serious consequences for affected communities.
Lesson 16 & 17 (1hr)	The different approaches to managing the risks.
Lesson 18 (1hr)	Sustainable management of our coasts and Integrated Coastal Zone Management (ICZM).
Lesson 19 (1hr)	Approaches to coastal management From ICZMs to SMPs.

Lesson 15: Coastal recession and coastal flooding have serious consequences for affected communities

Overview
Building on case studies, students will need to appreciate that there are communities at risk and the implications for governments and different players in mitigating or adapting to the threats that they face.

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The main thrust of this is that students can understand the relationship between the impacts of storm surges and sea-level rise on countries at different levels of development. How people put themselves at risk and how risk can be managed.

Key concepts and processes

- The rise in the number of environmental refugees is set to rise.
  Students need to:
  - understand that here are many reasons why coastal refugees will increase; be aware of these and be able to look at the causes and the impacts.
- The impacts of sea levels will vary.
  Students need to:
  - appreciate that sea-level rise is not universal and that some areas will suffer from the impacts while others will not.
  - appreciate that areas at different levels of development will cope differently.

Guidance on teaching

Case-study analysis of areas from different levels of development and the impacts they face can be done via news articles of different events. Events such as coastal flooding on Tuvalu, the Ganges Delta, UK storm surges (e.g. Storm Desmond) and mangrove removal in Thailand can be investigated in terms of students researching the variety of causes and impacts and then using these for comparative purposes. The impacts can be assessed in different ways such as social, economic and environmental impacts and evaluated in terms of level of development or Human Development Index indicators.

Less able students should benefit from the hands-on approach and through personal/ group investigations. This could be teacher-led via statements which students have to decide are either true of false, and also what the implications are. This style of directed learning should help students identify key reasons and build their knowledge in steps.

Alternatively students could be given a case-study sheet that has areas which they need to find (this can make a good homework exercise).

Lessons 16, 17, 18 and 19: Coastal management

Overview
In these lessons students will research the variety of ways that we are able to protect our coastlines and how the decisions are made for each area. They will learn to undertake both a cost-benefit analysis and environmental impact assessment. These can be done using virtual fieldwork techniques by undertaking guided researching into the chosen area. More able students should be able to see the problems and the technique that is potentially correct for that area, while less able students may not be able to understand the value of protection other than building sea walls. This can be overcome by exercises such as role playing games.

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Key concepts and processes

- Mitigation and Adaptation.
  Students need to:
  - understand that countries at different levels of development might use different techniques to deal with the impacts and those will include mitigation and adaptation.
- Cost Benefit Analysis (CBA) and Environmental Impact Assessment (EIA).
  Students need to:
  - appreciate that often the technique used is decided upon using a CBA and an EIA.
  - know how to carry out both of these influential fieldwork techniques.
- Stakeholders in coastal impacts on communities.
  Students need to:
  - appreciate that each of the different people involved in making decisions, as well as those on whom the decisions will have an impact, should have a say in the development of any management strategy.

Guidance on teaching

Often mitigation and adaptation are not completely understood by students and clarification of this early on is essential.

For less able students it may be pertinent to refer back to these points time and again to make sure they understand the difference and which technique or policy falls under which banner.

This could be done via persistent questioning or questions on techniques. Preventing the causes of sea-level rise are often complex and slow while adapting to the impacts is often cheaper and faster. In developed nations they can use both techniques while developing countries often rely on the simpler adaptation strategies which involve moving or using the environment to protect them. Often this is made more complex by those nations who exploit the resources found in coastal environments such as mangroves which, in turn, makes countries more vulnerable to the impacts. Students should understand the relationship between wealth and vulnerability as well as how this can impact on their capacity to cope.

The relationship between ICZM and Shoreline Management Plan (SMP) is often misunderstood. Exploration and research on different case studies and ideas may well overcome this. However, students may take time to appreciate these relationships.

There are many ways to deliver CBAs and EIAs many of which can be done via slides or visits within the school grounds. Understanding why these are important techniques will help later in their fieldwork.

An understanding of the different players involved is often best approached via delivered debate in which students take on the roles of specific groups and argue researched causes. These can then be assessed through essay-based homework.

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An ICZM has been defined by the UK Government as:

'A process that brings together all those involved in the development, management and use of the coast within a framework that facilitates the integration of their interests and responsibilities. The objective is to establish sustainable levels of economic and social activity in our coastal areas while protecting the coastal environment. ICZM is essential to the ecosystem-based approach.'

SMPs on the other hand are different. These are designed by the Environment Agency and local councils to consider the best ways to manage their coastlines. They identify the most sustainable approach to managing the flood and coastal erosion risks to the coastline in the short, medium and long term.

Students should appreciate that management is broken down into cells so as to maintain dynamic equilibrium between areas. By using a players-based approach it is possible to integrate geographical skills and the ability to think geographically on a larger and wider scale.

Key vocabulary for EQ4

Key Words	Definition
Environmental refugee	A person who has been displaced due to an environmental hazard, such as flood, drought or tropical storm.
Beach nourishment	Where sand and sediment are put onto a beach, generally to replace the sediment which has been removed by longshore currents.
Cliff regrading	Changing the angle of a cliff to try and prevent rotational slump occurring.
Dune stabilisation	A sand dune protection exercise that can involve several methods including planting vegetation or fences to reduce the impact of wind and water, and help retain sand and other material needed for a healthy sand dune ecosystem.
Revetments	Retaining wall which helps dissipate the energy of storm waves and prevent further recession of the backshore if well designed and maintained. Can come in various types from rock, to wood or concrete.
Terminal groyne effect	Beyond the last groyne the beach is starved of sediment so is more vulnerable to erosion.
Inter-coastal zone management	Where all aspects of the coastal zone are considered, and actions decided on the best management of the area.

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Shoreline Management Plan	The management plan put in place to help protect the coastline over the short, medium and long term.
Piecemeal	Unrelated decisions made over a period of time.
Strategic realignment	Allowing the coast to realign to another position to help stabilise erosion and retreat.
Holistic approach	An approach that take economic, social and environmental factors into consideration before a decision is made.

Resources

Websites of interest in this area:

http://coastal.udel.edu/ngs/waves.html - Short article on shoaling, refraction and diffraction.
http://www.rgs.org/OurWork/Schools/Fieldwork+and+local+learning/Fieldwork+techniques/Coasts.htm - Fieldwork techniques by the Royal Geographical Society.
https://www.bgs.ac.uk/landslides/holbeckHall.html - Article on Holbeck Hall landslide, Scarborough.
http://apps.environment-agency.gov.uk/wiyby/134834.aspx - Environment Agency SMPs.

https://www.gov.uk/government/publications/shoreline-management-plans-smps/shoreline-management-plans-smps - SMP example list.

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