Geography AS / A Level | OCR | H081/H481

AS and A Level OCR Revision Booklet

Topic 1.1.1: Option A: Coastal Landscapes

zigzageducation.co.uk **POD 9987a**

Contents

Teacher's Introduction

> **Remember!**
> Always check the exam board website for new information, including changes to the specification and sample assessment material.

The revision booklets in this series are designed to support your students as they study AS OCR Geography (H081) and A Level OCR Geography (H481). These revision summaries match the Edexcel specification perfectly. **This particular set supports Topic 1.1.1 Option A: Coastal Landscapes, examined in Paper 1.**

The concept is that *all* students need a clearly explained, concise yet comprehensive body of notes to revise from, both as they progress through the course and when preparing for the end-of-course examination. For this reason, the booklets are broken into manageable chunks and are provided in both A4 and A5 formats for easy photocopying. A5 booklets allow easy carrying and reference for students, right up to the moment they walk into the exam hall, and allow for effective revision time.

Since revision should be ongoing throughout one's study, it is recommended that after teaching each topic you issue students with the relevant revision booklet as they progress through the course. The booklets can also be issued as a complete revision pack in the run-up to the examinations.

By use of bullet points, text boxes and grids, these revision booklets provide succinct yet comprehensive and relatively detailed coverage of the specification content – probably far more than one would expect from a revision summary.

Each topic follows a clear structure of:

- **Key words:** lots of key words are clearly defined, and by covering up the definitions with a sheet of paper, students can easily self-test their memory of these all-important terms.
- **Key points:** these form the main body of the summaries for each topic. Concise, detailed and easy to follow, they provide a solid bank of notes to support students' knowledge, understanding and evaluation.
- **Core content:** the main content of the specification in bullet points, boxes and diagrams. Boxes with suggested examples allow students to name-drop examples in their exam, or give ideas for further research.
- **If you only remember these three things…:** the three most important takeaways from the topic.
- **Consolidation questions:** several quick questions on the core content – designed to ensure that the key points have been retained.
- **Take it further:** offers suggestions to support the option of extending learning further.
- **Student checks:** useful checklist to help students monitor their own learning.

Each pack also contains a **students' introduction** which introduces the topic and sets out some of the exam structure; introduces command words, AOs and level marking, along with exam tips and a checklist; and explains how to use the booklet. At the end tips are included on time management, and planning and writing answers, along with an introduction to synopticity.

By using this resource, teachers will know that all students have the key points for all the topics of the course in a clear, written format. It saves time in class for teachers and decreases the amount of preparatory work needed outside class.

This resource also helps achieve greater equality among students of differing abilities, as often the weakest students make the least helpful notes from which to study and revise outside class. These easy-to-understand revision summary notes help to overcome this problem and promote greater equality of opportunity.

And remember, these revision booklets are also perfect to refer back to as end-of-year summaries before the examination – especially useful nowadays with linear examinations.

I trust that you and your students will enjoy using these revision summaries as much as I have enjoyed writing them for you.

October 2019

Students' Introduc

What's the topic?

If you're reading this, your teacher has chosen to teach y... he optional modul... more to coasts than just making sandcastles. An... li... g in the coastal zone ... to erode the cliffs, as we fight a battle to ... t ... land from coastal recession

You will be examined ... Paper 1, Section A.

Here's a qu... view of the things you might find in the exam. However, exp... sometimes e... boards can throw in a curve ball – a different type of question ... but don't be too alarmed. Just read the questions carefully and be ready to ada...

You'll be presented with a range of questions – remember that they ramp up in

- Firstly, you might be presented with a short factual recall question.
- Then you might be given a couple of figures – maps, charts and data. You ... before. They're designed to see how you cope with unfamiliar sources – ho... analyse them.
  - You may be asked to use the figure(s) and your knowledge to answer t...
  - These might be medium-length questions.
- Finally, you'll get a longer, essay-based question. You'll probably be asked for your viewpoints or to weigh up two sides of an argument. You may also be able to use a case study to support your answer. Justify your opinion(s), and support it with facts and balanced a... ents if you are reaching for the higher marks. You'll need t... dr... your knowledge and offer a supported opinion. PEE or ... better, PEEL here! And no, we don't recommend yo... t ... satsuma in the exam – link together ev...

If you're st... th... AS, the exam questions are part of Section A in Paper 1.

How to use this guide

You may be given this at the start or at the end of teaching on the topic. Don't w... being stuffed in your pocket (although don't take it into the exam itself!). Reme... you want to. Scribble all over it, or highlight bits you need to look at again.

Here are some brief suggestions:

- Work through it as you go through the course.
- Give it a glance after the lessons.
- Give it a read before an upcoming test.
- Use it when you revise, of course – perhaps even outside the exam hall if y...

Now write down the date of the exam. You can use t... to plan your revision tim...

Date of my exam:

Checklist

It can be a useful idea to make a note of when you've read through something. I
confident that you know a topic, or you last looked at this six months ago, then i
another *look*!

Topic	When did I [illegible] this? *Write the da[illegible] ere [illegible] referably today's*	I kn
Coastal systems		
Coastal processes, in[illegible] and [illegible]m[illegible]		
Land[illegible]pes of erosion		
Landscapes of deposition		
The effects of past, present and future climate change on the coastal system		
Coastal management		
Case studies: 1. Coastal management, 2. Economic development		

Exam tips

Now that you've thoroughly revis[illegible] h[illegible]efully answered a few sample exam
good idea of what to expe[illegible] exam.

Command [illegible]
In each que[illegible] here are 'command words'. These are essentially the instructio
to answer the question, and give you a clue on the type of response the examine

Command words are not a secret, and they're nothing to worry about. You've pr
throughout your year(s) studying the course.

Here's our quick run-down of the different command words and what you need
balanced answer.

- ✓ **DESCRIBE:** Identify the main ideas, processes, or a source. But you don't ne
- ✓ **SUGGEST:** Use a diagram or your knowledge to identify a cause or reason.
- ✓ **IDENTIFY:** Using data or knowledge, pick out issues, e.g. find limitations wi an indicator.
- ✓ **ASSESS:** Show knowledge of a topic and give ev[illegible]e on both sides of an
- ✓ **EXAMINE:** Present facts and explain them. [illegible] evidence and balance.
- ✓ **CALCULATE:** Perform a calculat[illegible] a statistical test.
- ✓ **EXPLAIN:** Set out causes [illegible] the [illegible]ue, event and/or factors influencing its fo understanding [illegible]ss[illegible].
- ✓ **OUTL**[illegible] [illegible] a brief account of relevant information.
- ✓ **DISCU**[illegible] out for and against of an argument, and come to a conclusio between sides.
- ✓ **HOW FAR / TO WHAT / ASSESS THE EXTENT:** Express opinion on merit or examining evidence and/or different sides of an argument.

Assessment objectives

You may come across the words 'assessment objectives', or 'AOs' for short. Thes command words. They are set by the government and vary by subject. As you'd get, and AO3s are the hardest.

Here's a quick summary:

	What you need to d	F
AO1	Show your knowledge and understanding of geographical concepts and issues.	✓ Collecting e together
AO2	Ma[illegible] and draw conclusions from geographical information, both familiar and new.	✓ Use of maps ✓ Statistics ✓ ICT skills: usi ✓ Analysis, pre
AO3	Investigate questions and reach conclusions through many geographical skills and techniques.	✓ Concluding ✓ Use of maps ✓ Statistics ✓ ICT skills: usi ✓ Analysis, pre

In your Paper 1 exam, you'll mostly be assessed on AO1 and AO2. There will be v most of those in the NEA (fieldwork investigation). AO3 marks are usually reserv and when you need to interpret data. Where you perform calculations, you mus

For every question, OCR will have decided which AOs they are targeting. Bear th answer. If it's clear that an answer is looking for some AO2 or AO3 marks, don't s through.

You might find it useful to have a look at a couple of mark schemes for the topic each AO marks are achievable.

Level marking

Now that you've got a handle on how the command words work and what the e you need to be aware of how they will mark your answers.

For anything but the shortest of questions, you will be level marked. Each level h L1 = 1–3 marks, L2 = 4–6 marks. The essay-based questions will have four levels. for, the more marks you'll get.

An example of level-marking criteria can be found below.

Level	Mark	Descriptor
Level 1	(1–4 marks)	AO1: • The student demonstrates simplistic comprehensio • Specific detail is limited and inaccurate. AO2: • The student gives a simplistic presentation of compr • Enquiry is simple and is somewhat inaccurate. • Reasoning and (dis)agreement are unsupported and
Level 2	(5–10 marks)	AO1: • The student demonstrates good comprehension an • There is some specific detail that is generally accurat AO2: • The student demonstrates comprehension and fact • Enquiry is simple and is of some accuracy. • Reasoning and (dis)agreement are generally suppor relating to the different factors and their relative im
Level 3	(11–16 marks)	AO1: • The student demonstrates detailed comprehension • There is good and precise specific detail. AO2: • The student evidences excellent comprehension an • Enquiry is strong and correct. • Reasoning and (dis)agreement are well supported a relating to the different factors and their relative im

Coastal System

Key words

- ✓ **Open system:** A cycle or process where inputs and outputs can add or remo
  or energy.
- ✓ **Input:** Addition to a system.
- ✓ **Store:** Area where material resides for a period of time (residence time).
- ✓ **Flow:** Movement between stores.
- ✓ **Outputs:** Losses from a system.
- ✓ **Dynamic equilibrium:** The steady, balanced state of a system, where inputs
- ✓ **Positive feedback:** A 'runaway' system loop where the system moves further
- ✓ **Negative feedback:** Cycle where the effect weakens, bringing the system ba
  equilibrium.
- ✓ **Sediment cell:** A self-contained section of coastline along which material is in
  without impacting upon neighbouring cells.
- ✓ **Sediment budget:** The difference between the inputs and outputs of materia
  determination of erosion and deposition.
- ✓ **Closed system:** System where energy can transfer across its boundary, but n

Key points

- Coasts are open systems, sediment cells are closed systems.
- Coasts have inputs, outputs, stores and processes.
- These all work together to form distinctive landscapes.
- Coastal processes work towards dynamic equilibrium. Positive and negative f
  change or restore the system to an equilibrium.
- Humans can alter or modify the equilibrium.
- On every coastline, there are different processes that work together in
  each other.
- There are 11 sediment cells, which are essentially closed systems.
- Sediment budgets depend on the inputs and outputs of material on a stretch
  positive or negative.

The natural coastal system

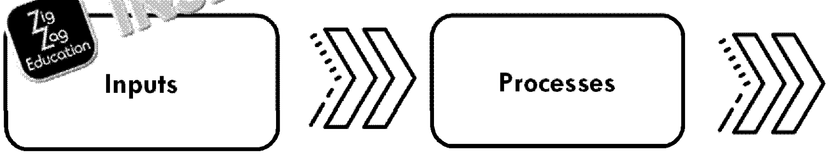
We can break down coasts into systems.

Coasts are **open** systems because they have inputs and outputs of matter and e

Most material entering coasts is from outside – rivers.

Coastal systems are driven by energy. They have:

- Inputs
- Stores and components
- Flows
- Processes
- Outputs



Here are some examples:

Stores and components
- Stores – beaches and other depositional landforms
- Components – e.g. landforms – erosion and deposition

Flows and transfers
- Transfer of energy and material, e.g. through longshore drift, aeolian processes

Energy
- Wind and waves, currents and tides

Inputs
- Energy
- Eroded sediment from rivers, cliffs and offshore
- Mass movement from the cliffs

Note that some things can be in more than one box – for example longshore dri out of a system, or features can be stores and landforms – such as a beach.

Dynamic equilibrium

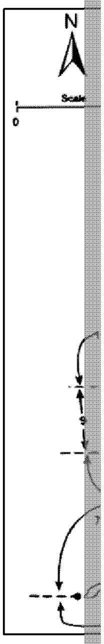
- Coasts are usually in a state of **dynamic equilibrium**. Their inputs and outp
- If this is the case, then there is little change.
- Some coasts are not in equilibrium. They are subject to **positive** and **negati**
- These feedback cycles will result in a new equilibrium.
- Human activity, such as coastal engineering, can change the state of equilib positive and negative.

Positive feedback
A change in a system which continues to contribute to the system, e.g. beach-building as a result of groynes being installed.

Nega
A change in a system storm removing sedim install

What about sediment cells?

We can divide coastlines up into contained closed systems, where material cycles, but can't escape. There are 11 **sediment cells (littoral cells)** in England and Wales. They are separated by headlands, and areas of deep water. Each can be divided into smaller sub-cells.



The map to the right shows the 11 sediment cells, separated by the dotted lines. The circles show the boundaries between the sub-cells.

The **sediment budget** is the difference between the amount of material added and removed from a sector of a coastline. We must know every source and sink of material, so they are often estimates.

The budget is controlled by erosion and transport:
- o Positive budgets occur when erosion adds more material than is transported away, and beaches will build up.
- o A negative budget occurs when there is little erosion or more transport away – beaches become thin and eroded.

They're **closed systems** because headlands and areas of deep water stop the m
cell to another.

> We can apply the concept of a **sediment budget** to an area of coastline, or measuring the inputs and outputs, we can work out whether a beach will grow depth, depending on whether the inputs are larger or smaller tha

Characteristic landscapes

- Coasts are very complex places, ... dynamic places. There are many drive landforms can often ... once.
- Processes ...h as erosion and deposition occur at the same time, and the p be dep..., without erosion first occurring.

There's a lot going on in this photo:

- inputs – waves and wind
- processes – erosion and mass movement – we can see a large crack in the c on the stacks because of the different rock strata
- transport – suspended load
- stores – e.g. the beach in front of the cliff
- outputs – sand and sediment from the cliffs

If you only reme... these three th

1. ...are open systems – energy and material flow in
2. Processes create characteristic landscapes and features
3. Coasts eventually reach dynamic equilibrium. Natural c positive and negative feedback cycles – a new equilib split the coast into independent sediment cells, and can budgets for a coastline.

Activities

Consolidation questions

1. Give a source of material that enters the coastal environment.

2. Give a source of energy in the coastal environment.

3. Give an example of how humans can affect the dynamic equilibrium of a co

4. How could a negative sediment budget influence a beach?

5. Why can coasts be described as 'dynamic'?

Take it further

Take a look at this page on the dynamic landscape at Birling Gap: **zzed.uk/9987-nat-trust-birling**

Here's a recent news article: **zzed.uk/9987-birling-gap-fall**
How does this rockfall relate to the cycle in coastal landscapes?

Student checks

Topic	What do I know?	No idea ☹	Nearly 😐	Sure ☺	
Coastal systems	The costal system and parts of the cycle				
	Dynamic equilibrium, positive and negative feedback				
	Sediment cells and budgets				
	Formation of characteristic landscapes				

Coastal Processes, Influe
Sediment

Key words

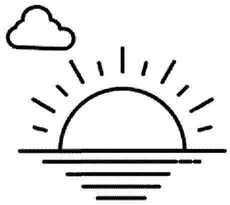
- ✓ **Fetch:** Distance over water that the wind blows – the greater the distance, th the waves have, and coastal … speeds increase.
- ✓ **Prevailing wind:** The … the wind blows from the majority of the time.
- ✓ **Constructive wave:** … and flat wave frequently associated with swells tha (100… low frequencies (6–8 per minute), building up beaches.
- ✓ **Destructive wave:** Wave frequently associated with storm conditions that ha frequencies (12–14 per minute), diminishing beach size.
- ✓ **Wave refraction:** Curving of the wave as shallower water is reached, such as
- ✓ **Swash:** Uprush of water onto a beach caused by incoming waves.
- ✓ **Backwash:** Return of water towards the sea immediately after the swash.
- ✓ **Tidal range:** The vertical distance between high and low water experienced
- ✓ **Spring tide:** The tide with the greatest range, occurring when there is a full o
- ✓ **Neap tide:** The tide with the lowest range, a week after the spring tide when right angles.
- ✓ **Intertidal zone:** The foreshore – the area between the limits of high and low
- ✓ **High-energy coastline:** Area of shore where there is more erosion than depo headlands to form because the waves are large with high erosive power.
- ✓ **Low-energy coastline:** Area of shore where there is more deposition than er because the waves are small with less erosive power.
- ✓ **Unconsolidated material:** Loose deposits which have not yet been cemented example, boulder clay.
- ✓ **Sedimentary rock:** Layers of stone created by the deposition of material, e.g be fairly soft, therefore susceptible to erosion.
- ✓ **Metamorphic rock:** Sedimentary rock which has been altered by heat, from o intrusions of magma, making the rocks harder than before.
- ✓ **Igneous rock:** … created by a volcano, usually very hard and resistant to
- ✓ **Rock …** fracture within stone, allowing erosion to occur at a faster rate.
- ✓ **Bedding plane:** Boundary between each layer of sedimentary rock.
- ✓ **Stratum:** A layer of sedimentary rock, different to the layers either side (sep either side).
- ✓ **Concordant coastline:** A region of the coast where alternating bands of hard the coast.
- ✓ **Discordant coastline:** Coast section where alternating bands of hard rock an near right angles.
- ✓ **Current:** Flow of water around a coastline.
- ✓ **Ocean current:** Flow of water in the deep ocean, for example from the equa at depth.
- ✓ **Physical (mechanical) weathering:** The in-situ breakdown of rocks by the a in moisture and frost, differential temperature, etc.
- ✓ **Chemical weathering:** The in-situ breakdown of rock resulting from the actio within seawater.
- ✓ **Biological weathering:** The in-situ breakdown of rock resulting from the actio plant growth and burrowing creatures.
- ✓ **Mass movement:** The … slope transport of soil, bedrock, rock debris or m the influence of …
- ✓ **Erosion:** … transport away of weathered material – such as by water (wa
- ✓ **Hydraulic action:** Water compresses air in gaps in a rock face, creating high expansion that can cause rocks to break apart when repeated.
- ✓ **Corrasion (abrasion):** Pebbles transported in the sea grind against, and are causing erosion.

- ✓ **Solution (erosion process):** Rocks containing calcium carbonate (limestone a acids within the seawater.
- ✓ **Attrition:** Rocks transported in the sea are slowly worn down into smaller, in they are swirled around.
- ✓ ***Transport:*** Movement of material around a coastline, for example in curren
- ✓ **Traction:** Large particles, such as pebbles, are rolled across the sea floor (o because they are too heavy to be suspended.
- ✓ **Saltation:** Waves and currents bounce larger material across the seabed (o insufficient energy available to constantly suspend the material.
- ✓ **Suspension:** Fine sediment requires very little energy for it to be maintaine air), therefore it will remain in the water for a long time.
- ✓ **Solution (transport process):** Transport of dissolved material within the wat
- ✓ **Aeolian processes:** Processes relating to the wind – such as transport and erosion.
- ✓ **Deposition:** Process where material is dropped from suspension or movemen friction increases.
- ✓ **Longshore drift:** Sediment transport along the coast. Waves approach at a obliquely up the beach. Backwash moves material towards the sea.

Key points

- The energy source is the Sun, which causes wind, which blows across the oce
- Wave strength depends on the fetch, wind speed and the duration/directio
- Waves can be constructive or destructive – building up or eroding beaches.
- Tides occur because of the gravitational pull of the Moon (and the Sun) – ti the month.
- We can classify coasts based on their energy.
- Coasts derive their sediment from the land, the cliffs, from offshore, from oc biological sources.
- Geology and energy combine to create classic coastal landscapes of erosio
- Coasts erode faster when the rock is softer, has lots of cracks or weaknesses made of loose, unconsolidated material.
- Rock dip and whether the coasts are concordant or discordant also play a k that [illegible]
- Weathering affects the cliffs and can be physical, chemical and biological.
- Material slides downwards towards the sea under gravity via a number of p term of mass movement.
- The sea and its waves erode the coast through a number of processes such a The sediment is worn down by attrition.
- Material is then transported away by waves and currents.
- Material is deposited when the energy is lost.
- The process of longshore drift transports material along the coast.

Sources of energy within the coastal zone



Ultimately, the Sun is the primary energy source. Earth's su
air to rise – low pressure. The equator is strongly heated, w
areas, such as the poles, are higher pressure, where cooler
cells on Earth. This creates a pressure gradient – and, there
the surface.

Sun → Wind → Waves

Waves and their formation

Wind affects coastal environments, mainly because the wind blows across the oc
form **waves**.

- Waves form in the open sea where they are circular motions of water.
- When they reach the shore (shallow water), they slow down because of frict
They therefore 'fall over' – it's called breaking – the waves spill or plunge do
onto the shore.

Wind also causes erosion and transport in coastal environments, by entraining m

There are several factors which affect the size of the wave:

Fetch
The amount of ocean that the wind has blown across – the larger the fetch, the larger the wave.

Strength
The greater the pressure gradient, the greater the wind speed and, therefore, the stronger the winds.

H
dir

Types of wave

Waves can be classified as **constructive** and **destructive**.

Constructive

- Build up beaches as the **swash** is greater than the backwash.
- Waves are small and spill onto the beach.
- Can create a **berm**.
- Can help form beaches on an incoming tide.
- Have a lower frequency.

D

- Large, powerful
that erodes mate
- Waves plunge do
- The strong backw
- Can erode the be
- Have a higher fre

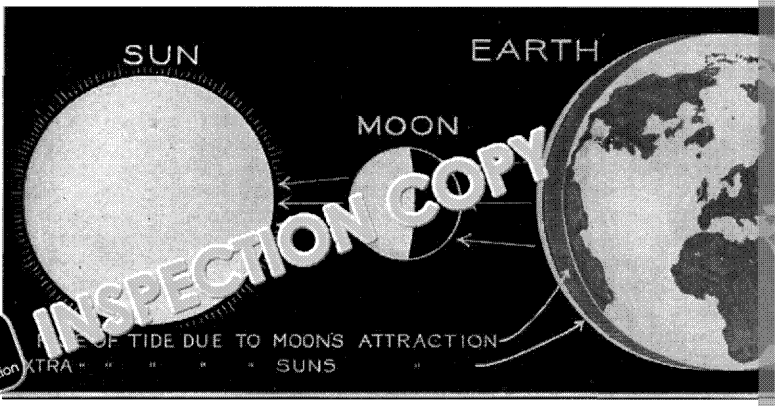
Wave refraction causes differential erosion from the way that waves bend aroun

Tides

Tides are the rise and fall of water level at the coast, mainly due to the gravitatio
lesser extent the Sun (because the Sun is further away). The pull creates a bulge
water, and there's a bulge on the other side too. This is the *high tide*. At 90°, *low*
occurs.

- There are usually two high and two low tides each day.
- The **tidal range** (difference between heights of the high and low tides) cha
throughout the month based on the alignment of the Sun and Moon.
  - When the Sun, Earth and Moon align (as in the diagram), there is a larg
tidal range (a spring tide) as the gravitational pulls combine.

- When the Moon doesn't align (at right angles), the pulls of the Moon a
  the tidal range is reduced. This is called a *neap tide*.



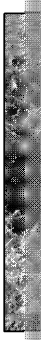
While there is variation in tidal ranges because of spring and neap tides, coastlin
their typical tidal ranges.

Microtidal	Mesotidal
<2 m	2–4 m

The tidal range can influence erosion – whether a large width of shoreline is exp
zone), or whether just a small area is constantly exposed.

Coastal flooding can be caused by storm surges – onshore winds, and low pressu
can combine at high tide to suck up the water and push it onto the land.

Geology



Geology is very important in influencing coastal features. For example:

- The **rock type** affects the rate of erosion – the softer the rock, the faster it erodes.
  - The softest 'rocks' are **unconsolidated material** such as sand and boulder clay.
  - **Sedimentary** rocks are made of compressed deposits. They form in layers as they were laid down at different times.
  - The hardest rocks are **igneous** rocks – they are volcanic.
  - **Metamorphic** rocks are in between – they were formed by increased heat and pressure, or as a result of volcanic activity.
- **Rock joints** – **bedding planes** and **strata** – weaknesses that can be eroded
  rock falls.
- **Dip** of the rock – whether the strata are horizontal, or dip towards the sea o
  photo above dip towards the sea. Dip affects the way that cliffs collapse.

> **Geology is complicated – just look at any geological map. The UK is made up**
> **it's why coastlines are also complicated, causing <u>differential erosion</u>. Rock**
> **angles, and form very different sequences.**

- The types of features are also partially dependent on whether the coastline

Concordant coasts

Bands of rock run parallel to the coast.
Form coves where areas of weaknesses are exploited.

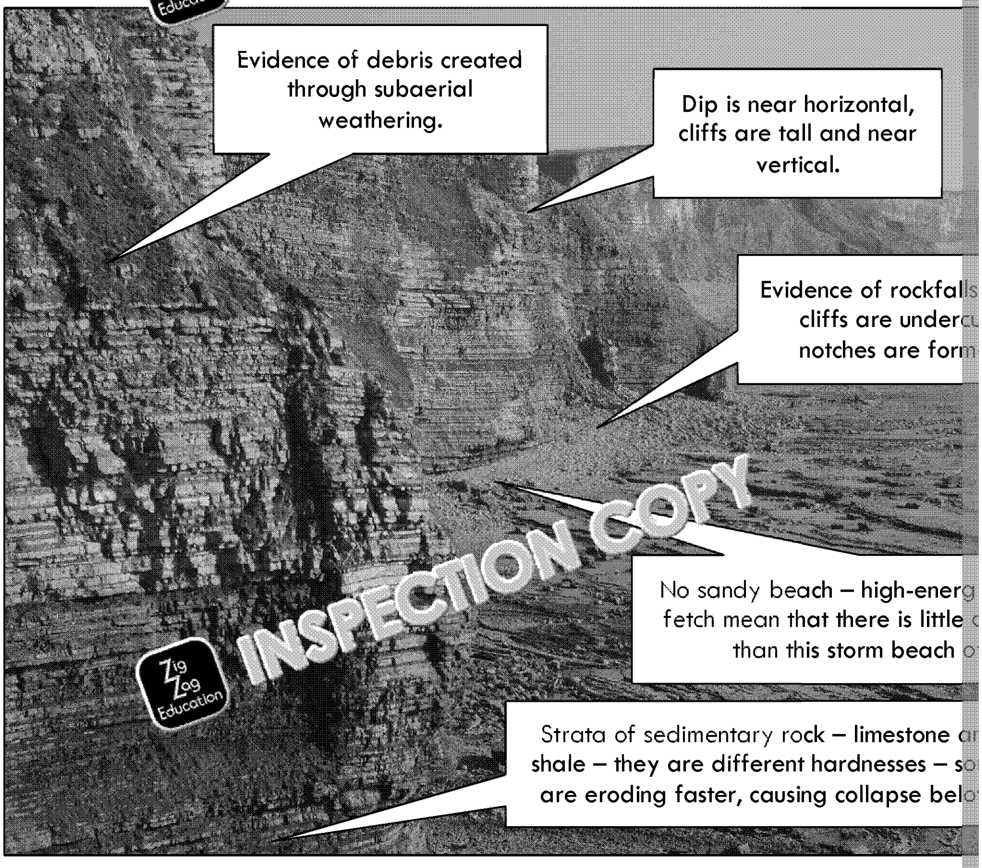
E.g. Lulworth Cove, Dorset

Disc

Bands of rock run
Headlands and bays
resistant rock, while

E.g. Swanage Ba
and

How has geology and erosion affected this landscape?



Low-energy and high-energy coasts

We classify coasts based on their 'energy'.

High energy
Lots of erosional features and material transport caused by:

- Powerful, destructive waves.
- Onshore wind (prevailing) and waves
- May have a long fetch.
- Dynamic coasts.

E.g. ...rnwall

L...
Lots of depositi...

- Low, constr...
- More depo... beaches, m...
- Achieve dy...
- e.g. shelte... estuaries.

E.g. South c...

Other influences on the coasts

Currents are the movement of water and they can transport suspended materia... **longshore drift** – moving sediment along a coastline. Offshore currents are call... water and material out to sea.

Ocean currents are larger-scale currents of warm surface water from the equato... return. They indirectly affect coasts by changing the air temperature, which can ... conditions can increase mass movement and speed up chemical weathering.

Sediment sources

Coasts receive sediment from a number of sources includi... ...m the land (terrestri...

Rivers:
Fine sediment from eroded roc... ...major so...

Clif...
Mass movement, rockfa... cliffs onto t...

...ore and the seabed:
During storms, powerful waves stir up the seabed.

Ocean c...
Upwelling of material f...

Biological sources:
Form sands of broken-up shells and coral.

Human s...
Beach nourishment – ad... the beach, often dre...

Geomorphological processes

Weathering is the *in-situ* break-up of rock structure. It's often called *sub-aeri...* occurs on cliffs and land not affected by waves, but can be influenced from the s... the Sun, wind, and rain.

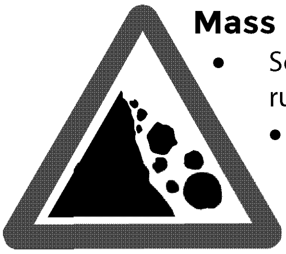
There are three types of weathering:

Physical
Changes to the ...k ...re ...s:

- ...-thaw
- ...etting and drying
- Heating and cooling / exfoliation
- Salt crystallisation

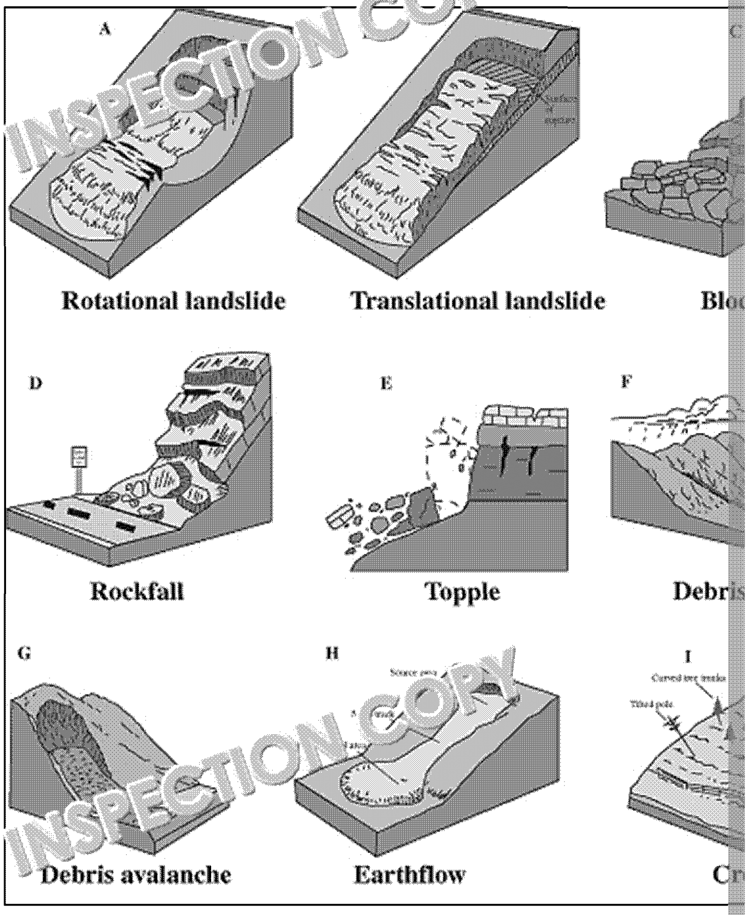
Chemical
Chemical attack on the rock, such as:

- Oxidation ('rusting')
- Carbonation (acid attack)
- Solution (dissolving soluble minerals)



Mass movement is the downslope movement of soil and

- Soil loses its mechanical strength when lubricated with run-off, and mass movement is influenced by rock type.
  - There are several different types – some are very sl seconds.
    - Mass movement adds material from the land a



A – also called a **slump**. They occur in loose soils, with impermeable rock below. formed by the curved rupture surface.

B – **landslides** keeps the material more intact – can be fast, and occur when the slope towards the sea.

D and E – **rockfalls** and **topples** occur quickly, blocks fall from the cliffs onto be are undercut, or from freeze-thaw.

H – **mudflows** occur when soil is lubricated with rainwater and material quickly

I – **creep** is a very slow process, and forms terraces a the soil conditions change

Transportation

Once eroded material reaches, or is eroded within, the coastal zone, there are four main ways that the oceans and waves **transport** the material along the coast. The larger the particle, the more energy that is required to move it!

Wind and currents can also entrain and transport material.

From largest to smallest material…

Traction:
Largest particles [illegible] are rolled along during storms. They are too large to ever be suspended.

Saltation:
Smaller pebbles or shingle 'bounce' along in stages – require powerful waves.

Suspension:
Small particles such as sand and silt are suspended within the water, making it look cloudy.

Solution:
Dissolved load (minerals) – essentially invisible.

Hy
Waves force ai
cliffs, increa

Wa
Process where

Corr
Waves pick up pe
cliff, or scrape mo
wav

Process where vo
hy

Some roc

Eroded material is
more rounded as
knocki

Marine processes

Erosion

Waves cause erosion of cliffs and beach material by wearing it away. There are several erosion processes.

The wind can also transport material. This is called **aeolian**

The wind can entrain dry sand, where it can be suspended, or move by traction
speed. When the wind speed drops, or friction increases, **dunes** are formed. San
and sometimes suspension if the grains are small enou

Deposition

Erosion is affected by factors such as:

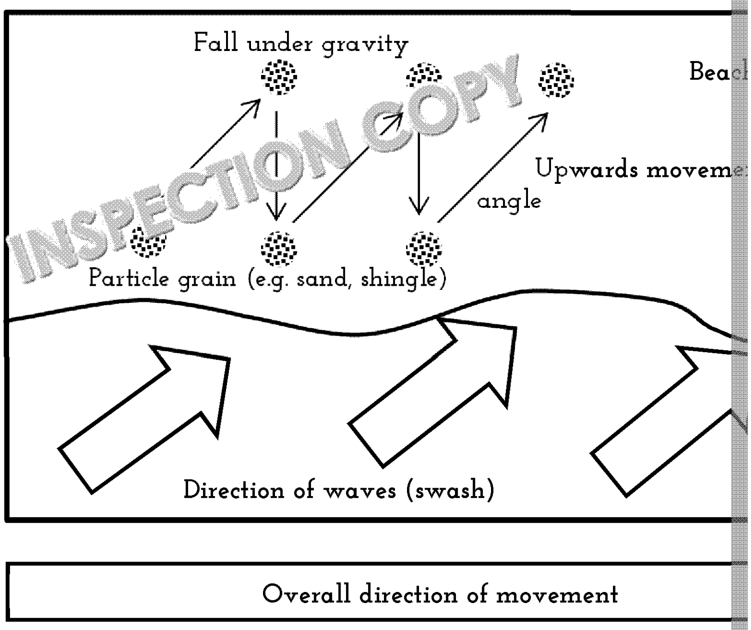
- Geology – the hardness (resistance of the rock) – or unconsolidated material such as sand and boulder clay – will erode quickly!
- The cliffs – the *dip* of the rock – whether the layers slope to, or away from, the sea.
- Run off – rivers create valleys down towards the sea, and mass movement helps to erode the [illegible] sides.

Deposition
↓ The en
speed
↓ Frictio
– such
↓ Flow b
↓ Load i

The largest
as they req

Longshore drift

One marine process is **longshore drift**. Waves meet the shore at an angle, pushi
material then falls back downwards towards the sea. To stop longshore drift, gro
sediment.



If you only remember these three th

1. We classify coast[illegible] their energy.
2. We sp[illegible] into independent sediment cells, and [illegible] a coastline.
3. Weathering and erosion break down material. Materia currents (remember longshore drift).

Activities

Consolidation questions

1. What causes waves to 'break'?

2. What is 'fetch'?

3. Which type of current draws water away from the coast (out to sea)?

4. Which tide occurs when the Sun, Moon and Earth are **NOT** aligned?

5. If winds are **offshore**, do you think that the coastline will be high or low en

6. What is the difference between weathering and erosion?

7. Which type of mass movement can be very slow?

8. Which type of transport makes the sea appear cloudy?

9. Which word is both a type of erosion, and a transport mechanism?

10. Why does friction cause deposition?

Take it further

Check out some of the videos here: **zzed.uk/9987-coasts-videos**

Student checks

Topic	What do I know?	No idea ☹	Nearly 😐	Sure ☺	
Coastal processes	Sources of energy				
	Waves				
	Tides				
	Geology				
	High- and low-energy coasts				
	Currents				
	Weathering				
	Mass movement				
	Transportation				
	Erosion				
	Deposition				
	Longshore drift				

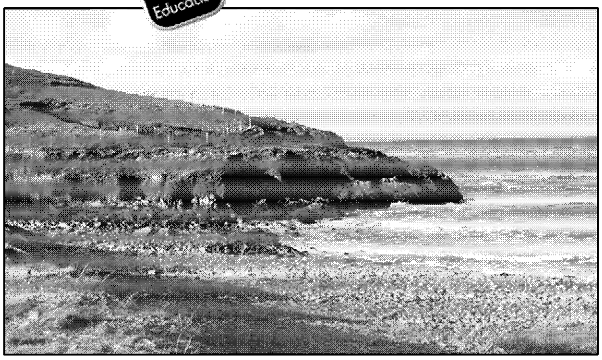
Landscapes of Eros

Key words

- ✓ **Headland:** Resistant outcrop of rock, often along a discordant coastline, with influenced by wave refraction.
- ✓ **Bay:** A body of water surrounded by land on three sides (often two headlan erosion of less resistant rock along ... line.
- ✓ **Shore (wave-cut) platform** ... ge caused by the retreat of a cliff fur
- ✓ **Cliff:** Rock back w... created by the erosion of the land.
- ✓ **Cove:** ... w... ow opening in a concordant coastline where erosion a behi...
- ✓ **Geo:** ...cal hollow in a rock face, caused by the enlargement of a crack
- ✓ **Cave:** A natural hollow within a cliff formed by the continual erosion of a cr
- ✓ **Blowhole:** Upward erosion in a cave roof along a weakness in the rock, or w collapses, extending the cave up to the surface.
- ✓ **Arch:** A continuous hole through a headland, formed by the backward erosio side); the overburden may later collapse.
- ✓ **Stack:** An isolated column of resistant rock formed by the erosion and collaps
- ✓ **Stump:** The eroded remnant (base) of a stack, left behind after the rock deb

Key points

- On discordant coastlines, headlands and bays develop.
- Retreating cliffs form a wave-cut platform.
- Cliffs are the boundary between the sea and the land; some are tall and t are low and slump towards the sea.
- Geos and caves can develop through ... to create an arch. The arc stack. When the stack topple... develops.
- All of the forms of co... and weathering combine to form distincti a partic...



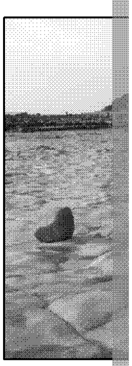
Headlands and ba

- Headlands are promont extend outwards into th
- They often form on disco rock either side are erode
- Material is deposited in
- Wave refraction is a fact wave power and helpin

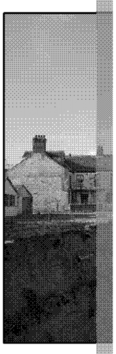
Shore (wave-cut) platform

- As cliffs retreat, and the resulting material is ... away, a shallow-sloping sheet of rock deve...
- They slope towards the sea.
- Some are smooth, ... are worn down by abrasion.
- Others ... are filled with rock pools.

E.g. ...yme Regis, Glamorgan Heritage Coast (South Wales).



Cliffs



Cliffs often form the boundary between the land and the sea. They are influenced by geology and the energy of the coastline.

- Resistant rock types often form steep cliffs.
- Soft and unconsolidated material may gently slope towards the sea.
- Unconsolidated rocks will erode fastest, even in a relatively low-energy coastline.
- Hydraulic action and corrasion can form a notch at the base of the cliff – the overhang later collapses.
- On some softer coasts with a low fetch, mass movement will create a bar helping protect them.

E.g.

Rapidly eroding coastlines: Norfolk – Happisburgh is shown in th
Tall, hard cliffs: Conachair, St Kilda – up to 426 metres!

Headland → Geo → Cave → Arch → Stack → Stump

Here's the Old Harry Rocks. This probably isn't the first time you've seen them!

So, how did they form, and how will they evolve?

1. This sequence started with a chalk headland. Wave refraction focuses energ
2. Hydraulic action, for example, exploited a weakness in the rock to form a cr
3. Further erosion opened up the geo into a larger **cave**. A blowhole might de vertical erosion continues upwards to the surface.
4. If a cave on the other side opens up, or the single cave extends all the way t is form
5. Eventually the arch collapses to form a pillar of rock called a **stack**.
6. The stack is eroded through corrasion and hydraulic action at its base. Even
7. Abrasion will erode down the remaining rock to form a **stump**.
8. Eventually the remains will become part of a **wave-cut platform**.

The rock is also being affected by sub-aerial weathering, which reduces its height

An example of a high-energy coastline

The Olympic Peninsula is located in northern Washington, with Canada lying just across the Strait of Juan de Fuca.

The coastline is rocky – high-energy because of its long fetch across the Pacific Ocean. Winter storms with high waves are frequent, and contribute greatly to the erosive action of the waves – hydraulic action, corrasion and attrition all occur.

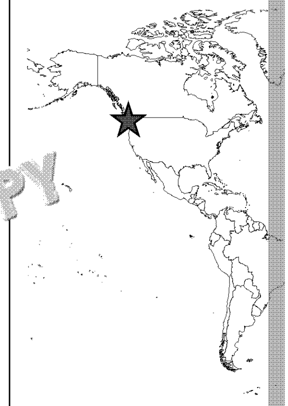
Ruby Beach is relatively famous for its erosional features. Tall cliffs tower over the beaches, and stacks, islands and caves are found here.

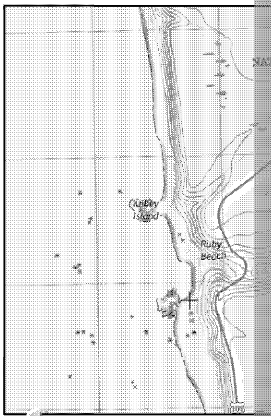
Around Ruby Beach, the geology is concordant – erosion has worn away the softer sandstone, while harder igneous rock lies to the north – shown by changes on the geology map. North of Ruby Beach, between La Push and Oil City, the geology is concordant (not shown on the map). Wide coves are located where the sea has eroded through the harder band of rock.

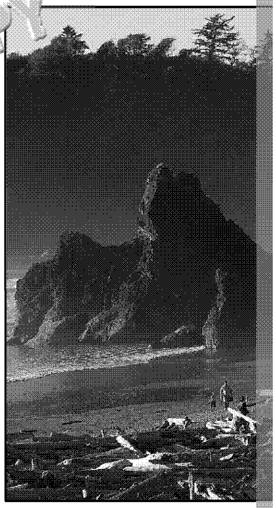
There is little evidence of depositional features such as spits. Aerial photos show the waves breaking at a slightly oblique angle to the coast, suggesting that longshore drift can occur. Inland, glacial landscapes provide a source of sediment.

In the future, continuing erosion and rising sea levels will cause stacks to topple, and cliff retreat as notches are cut at their bases. The more material that is eroded, the greater the transport of material and potential for processes such as longshore drift.

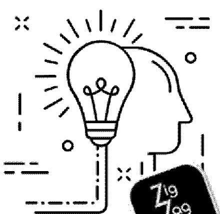
While the overall landscape will change very slowly, mass movements such as rockfalls and the topple of the stacks are instantaneous.







If you only remember these three th



1. Headlands and bays form on discordant coastlines whe eroded slowly, headlands stick out into the sea. The b deposition takes place.
2. The coast is lined by cliffs, which can either be tall and towards the sea. When cliffs retreat, wave-cut platfor
3. Headlands can start the sequence of development of g stumps.

Activities

Consolidation questions

1. Which type of material erodes fastest?

   ....

2. Which type of coast is **less** likely to develop headlands?

   ....

3. Give a [illegible] of cliff collapse.

   ....

   ....

4. Why is material deposited in bays?

   ....

   ....

5. Which is missing in this sequence?
   Cave, ______, stack, stump

   ....

Take it further

Take a look at this interactive geology map and see how the rock types and sequ
shape of the coastline:
zzed.uk/9987-geology-map-uk

Student checks

Topic	What do I know?	No idea ☹	Nearly 😐	Sure ☺	
Landscapes of erosion	Headlands and bays				
	Shore (wave-cut) platforms				
	[illegible]				
	Sequence from a headland to a stump				

Landscapes of Depo

Key words

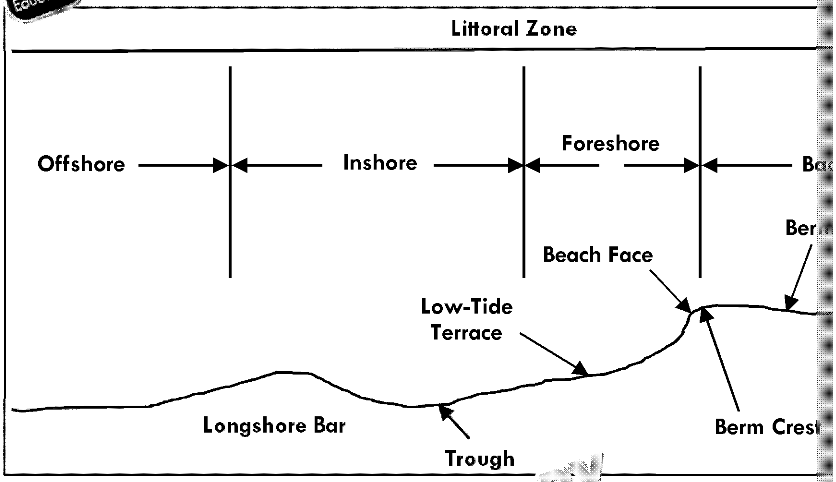
- ✓ **Littoral zone:** Coastal area submerged by tides and the sea near to the coa
- ✓ **Offshore:** The zone furthest from the shore. Waves ... ger impact on the u
- ✓ **Inshore:** Submerged area between the shor ... shore area.
- ✓ **Foreshore:** Area of the shore betw ... high- and low-tide marks – the ar
- ✓ **Backshore:** The zone furthe ... sea, entirely landward of the high-wa conditions. Only ... aves under storm conditions.
- ✓ **Berm:** ... each created by waves.
- ✓ **Cusp** ... ircular feature on the beach.
- ✓ **Ripple** ... ttern seen on the beach at low tide caused by the action of wave
- ✓ **Storm beach:** Deposit of the coarsest material thrown to the back of the bea
- ✓ **Spit:** Strip of deposited material connected to the land and out to sea, cause direction or enters an estuary, but transport continues in the same direction.
- ✓ **Tombolo:** A spit that joins the mainland to a previously offshore island.
- ✓ **Onshore bar:** Ridge of deposited material out at sea. Sometimes exposed a high tide in front of the shore. There may be a lagoon, too.
- ✓ **Barrier beach:** Usually permanently exposed sand ridge out at sea, protecti that connected with land again.
- ✓ **Pioneer species:** The first life to colonise a bare surface, such as algae on a
- ✓ **Succession:** The process where different species take over an area of land pioneer species, and ending with the climatic climax vegetation.
- ✓ ***Climatic climax vegetation:*** The final stage of succession, e.g. broadleaved marsh develops into dry land.
- ✓ **Mudflat:** Area of fine silt, often exposed at low tide ... with very little surf
- ✓ **Salt marsh:** Estuarine ecosystem formed of s... ...nt plants which cause m eventually become dry land.
- ✓ **Halophyte:** A plant which can ... e ... very salty conditions, such as on a sa for a portion of the d... is ... ject to salt spray, such as growing on a cliff

Key p...s

- Beaches are large deposits of sand, shingle or pebbles. They form in low-en and are built up by constructive waves in the summer. Waves sort the materi largest at the back – sometimes a ridge of pebbles called a storm beach.
- Spits are ridges of deposits out to sea and occur where the coastline change of an estuary, but the flow of sediment continues downstream. Spits can be s spits have several hooks.
- Onshore bars are ridges of material across a bay (that might be submerge like spits, or are glacial deposits pushed towards the shore.
- Tombolos are ridges of deposits that link an island to the mainland.
- Mudflats are large expanses of river sediment at the river's mouth, exposed their load when reaching the sea. They have very little vegetation growth.
- Mudflats can eventually support plants, another se... of succession to fo ecosystem develops, the marsh rises and be... ...er. Salt-tolerant plants shrubs and trees eventually form a ... c...ax vegetation.

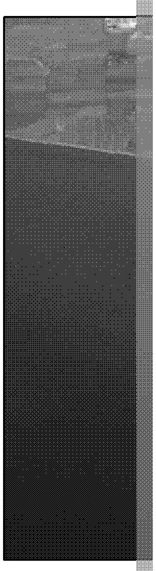
Beaches

- Beaches are large gently-sloping deposits of material (sand, shingle and cob formed where there is an ample supply of material, and by constructive wav
- Beaches can rapidly change – a storm can erode and change the shape.
- They're made of sand, shingle and pebbles, often a combination.
- At the landward **backshore**, storms hurl the largest rocks into a ridge called
- Beaches are stratified – the smallest material is e... at low tide.
- The profile changes during the year, too – they ... often steeper in summer constructive waves.
- Beaches are said to be '...-aligned', or 'drift-aligned', depending on whe front-on, or at ...
- While ...ig... seem simple, there's plenty of smaller features.



- **Berms** are ridges built up by each low... ...de ... range decreases towards th
- **Cusps** are erosional circular de... ...ic...
- Near the low-water m... ...les occur from currents and waves.

Spits



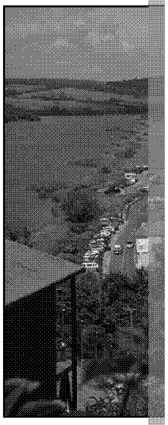
- **Spits** are protrusions of material that are deposited when the coastline changes direction, such as at the mouth of an estuary.
- The material is transported downstream via longshore drift, and continues out into the deeper water, before deposition occurs due to increased turbulence.
- In an estuary, river flow stops the spit from growing across the whole channel.
- Spits can have a curved end, when the wind changes direction out to sea, or due to wave refraction.
- Behind the spit, where water is sheltered, deposition occurs and marshes can develop.
- There are two types of spit – simple an... ...ompound.

Simple spi...
Str...ht ... hook.
E.g. ...n Head, Sandbanks in Poole

Compound spits
Have several hooks – where the spit continued to grow after developing its hook.
E.g. Miho no Matsubara, Japan

Onshore bars

Bars are ridges of material that extend across a bay (not an estuary), creating a la



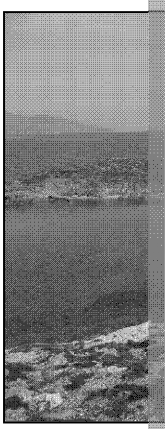
They are thought to be made in two ways:

1. Resulting from longshore drift – like a spit.
2. Accumulated glacial till transported towards the shore from the oceans (rising sea level after the last ice age).

Offshore bars may be (partially) submerged, and protect the coast from the waves.

E.g. Slapton Ley, Devon (in the photo) – the lagoon is on the left.

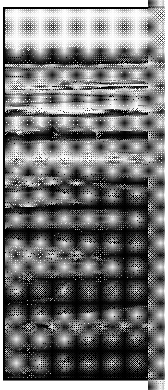
Tombolos



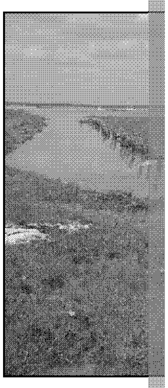
A ridge of deposited strip of material that connects an island with the mainland. The waves have less energy due to the shelter of the island, and being closer to the shore. This allows material to be deposited.

E.g. St Ninian's Isle, Scotland, Howth Head, Ireland, Crummock Water – an inland lake!

Mudflats to salt marshes



- Mudflats are expanses of fine mud, which are underwater at high tide. They are found at the mouths of rivers – estuaries.
- There is little to no vegetation growing on mud flats, but many birds rely on the abundant source of shellfish and worms that live within the mud.
- In the summer, algae can grow on the mud.

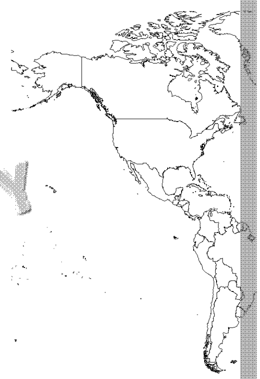


- A series of succession can develop a mudflat into a salt marsh.
- Salt marshes are also found in the lee of spits.
- Plants that live on salt marshes have to cope with the salt. They're called '**halophytes**'.
- The pioneer species might be eelgrass; later, spartina and glasswort colonise the marsh.
- These species trap more sediment, and the marsh rises.
- This means that they are submerged for shorter periods each day.
- A meadow of plants can then take hold.
- The climatic climax may be woody shrubs and eventually trees.

E.g. Newtown, Isle of Wight (pictured), Crymlyn Burrows (South Wales)

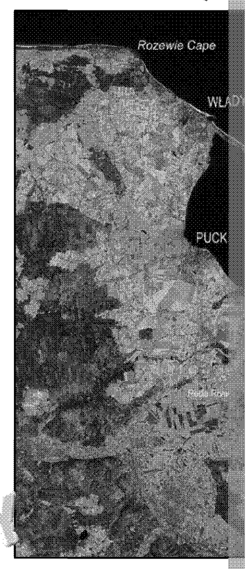
An example of a low-energy coastline

The Hel Peninsula is a 36 km spit which lies in the Baltic Sea – a relatively sheltered body of water. The peninsula is part of Poland. The Baltic Sea is famous for its long depositional features.



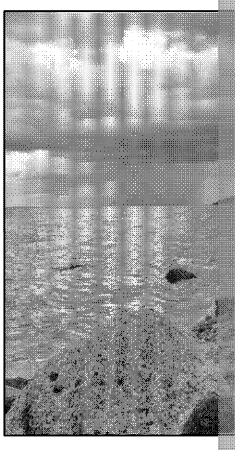
The spit is made of sand and gravel, formed from material eroded from the upstream coast. Material is moved by longshore drift as expected, moving along to the tip of the spit. Tidal range in the area is very low – just a few centimetres.

On the side of the spit which meets the Baltic Sea, sand dunes have formed. Behind the spit is the Bay of Puck – it's a very shallow lagoon (the water is only two metres deep). The lagoon may have been formed by glacial erosion, and some of the sediment is of glacial origin, but sedimentation is likely to have occurred because of the shelter of the spit. The shallowest parts can be seen on the aerial image. Narrow marshes occur where the sea meets the land.



However, the area still has a fair amount of energy. Strong winds in the autumn and winter are exerted from the north, causing the erosion of material to form the spit and cause the waves for longshore drift. The storms and associated storm surges can also damage the spit.

Most of the spit lies within metres of the sea. To help resist erosion, the height of the spit has been artificially built up, and coastal defences such as groynes and gabions have been employed.



Without intervention, rising sea level and strong winter storms could quickly alter the shape of the spit as erosion occurs. Over time, the spit could become a series of islands as parts are eroded, and the hook on the end become more pronounced.

If you only remember these three th

❶ Beaches are probably the most well-known depositio
upstream erosion and the deposition of large quantiti
during the summer. There are many smaller features o
and cusps

❷ The formation of spits, tombolos and bars is similar – t
material out to sea, between the mainland and an isl
respectively.

❸ Salt marshes show the process of vegetation successio
colonised by pioneer species. Each successive plant co
height of the feature by trapping more material, and
conditions for the future species, until the climatic clim

Activities

Consolidation questions

1. Which is missing from this sequence?
   Offshore, _______, foreshore, backshore

   ……………………………………………………………………………………

2. Some beaches are 'drift-aligned'. What is the other type of beach?

   ……………………………………………………………………………………

3. Give **two** features necessary for a spit to develop.

   ……………………………………………………………………………………

   ……………………………………………………………………………………

4. What does a tombolo connect to the mainland?

   ……………………………………………………………………………………

5. What ecosystem can a mudflat develop into?

   ……………………………………………………………………………………

Take it further

Take a look at the documents here: **zzed.uk/…37-coastal-explorer** which follows the coastline where Spurn Head is located. How might the spit be affected by erosion?

Student checks

Topic	What do I know?	No idea ☹	Nearly 😐	Sure ☺	
Landscapes of deposition	Beaches				
	Spits				
	Onshore bars				
	Tombolos				
	Mudflats and salt marshes				

The Effects of Past, Pre Future Climate Change Coastal System

Key words

- ✓ **Ice age:** Sustained period of reduced global temperatures during which ice m and [illegible] lower altitudes.
- ✓ **Sea-level rise:** Addition of water to the oceans, causing the water's height to inundating land and increasing flood risk to low-lying areas.
- ✓ **Eustatic change:** A type of change in sea level that affects the whole planet, volume of water stored in the oceans.
- ✓ **Raised beach (marine terrace):** A deposit of sand which formed when the se lower, but is now above the current sea level.
- ✓ **Relic features:** Landforms that were formed in the past – such as cliffs and be affected by their original processes, but rather subaerial processes.
- ✓ **Abandoned cliffs:** Cliffs that are located above current sea level. They are but subaerial processes instead.
- ✓ **Ria:** A river valley, or a system of river valleys, that is flooded during sea-le
- ✓ **Fjord:** A glacial valley that has been flooded by sea-level rise. Glacial troug ages, when sea levels were lower.
- ✓ **Shingle beach:** Ridges of gravel which were either deposited on the land by waves pushing material onto the shore as sea level rose after an ice age.
- ✓ **Thermal expansion:** If the atmosphere warms, heat energy is transferred to expands, increasing in volume. This causes sea level to rise.

Key points

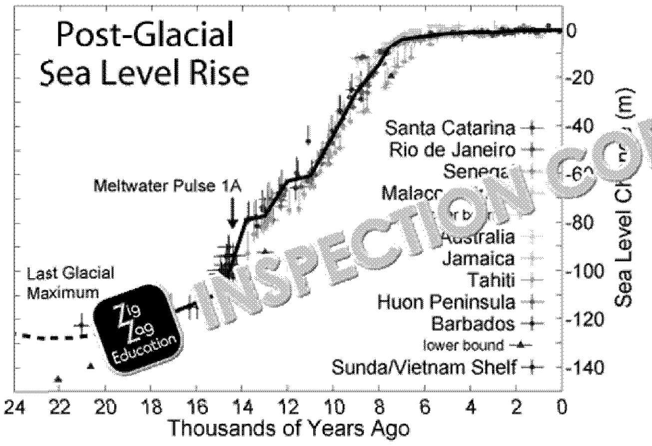
- Sea [illegible] related to climate based on the amount of ice on the land – durin level [illegible] and it rises again once the ice melts.
- Eustatic changes are rises or falls in sea level.
- If the sea level falls, or the land level rises, then current beaches and feature the sea. They form raised beaches and relic features.
- If sea level rises, then features are flooded – fjords are flooded glacial troug valleys.
- Sea level is rising due to human activity – rising global temperature is meltin accumulates in the oceans. As ocean water warms, it expands – taking up mo
- The effects of rising sea level will be devastating to our coastal communities, cities. There are also other effects, such as water quality issues and loss of fa
- *Humans therefore* need to limit CO_2 emissions to stop the greatest rises in sea that sea level may rise by two metres or more!

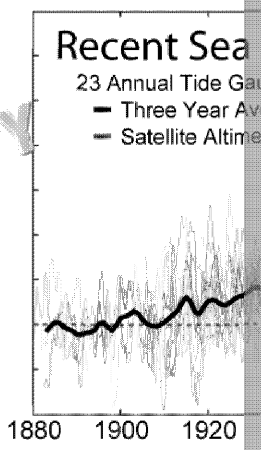
How has sea level changed in the past?

Sea level changes with the climate.

- During ice ages, water is stored on the land as ice – it falls on the land as sno thousands of years.
- Therefore run-off into the oceans decreases.
- Global sea level falls – during the last ice age, sea level might have been as than today.
- Once the ice age ends, sea level rises again as the ice melts. This occurs rapi down – as shown on the graph overleaf.

- The second graph shows the smaller changes in sea level since 1880. Note t centimetres rather than metres.





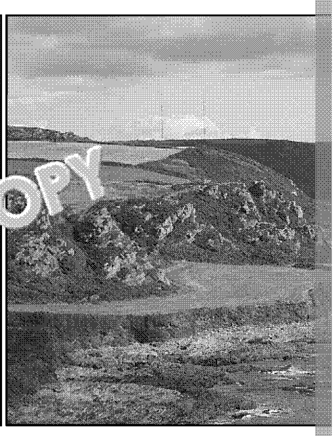
We call this eustatic change

- Ice ages cause sea level to rise and fall, depending on the amount of ice on
- Cooling also causes the water in the sea to shrink – the opposite effect to th
- In the past, changes were due to coinciding natural factors such as orbital a Solar activity is likely to have influenced ice ages.
- Humans are warming the planet through greenhouse gas emissions. This m rising, as more land ice melts.
- Sea level has been higher in the distant past than today.
- When sea level rises, valleys and glacial troughs (that were formed when sea level was lower) are flooded.

Emergent features (raised beaches (marine platform

- When the land rises relative to sea level, or if sea levels fall, the current bea longer affected by the sea. They are called '**relic features**'.
- Instead they are affected by sub-aerial processes such as weathering.
- Examples include raised beaches and marine terraces (wave-cut platforms), evidence of wave action, and other landforms such as stacks.
- Sometimes a series of terraces develops if the sea level drops several times.
- The features may become overgrown by vegetation.
- If sea level rises again, then the features will once again be impacted by the

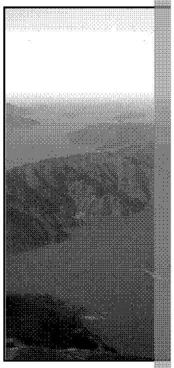
What are the relic features shown in the photos below?



E.g. Isles of Jura and Arran, but also in Cornwall and New Zealand

Submergent features (rias and fjords)

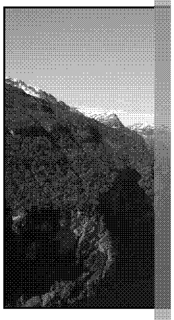
- When sea level rises, features that were created on land below current sea l
  after ice ages – as seen on the graphs overleaf.
- In areas where there were glaciers, these are often glacial troughs.
- In areas without glaciers, these can be river valleys.



Rias

Flooded river valleys and their tributarie... th... unlike the straight fjords, rias branch and ar... ...allower (deepest at the mouth).

E.g. ...on and Cornwall, Sydney – Australia, ...esapeake Bay – United States.



Fjords

Fjords are flooded U-shaped glacial troughs. They are narrow, very deep (deepest inland), and have steep walls.

E.g. Norway, Canada, Alaska, New Zealand, Greenland and Chile.

Shingle beaches

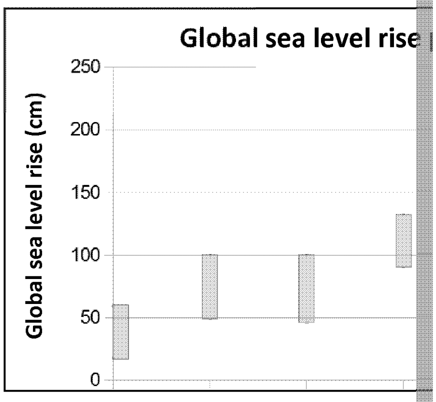
Shingle beaches are ridges of gravel which were either deposited on the land, s... deposited by waves pushing material onto the shore as ... ...evel increased afte...

E.g. Possibly Chesil Beach, Wa... ...n and Oregon in the United Stat...

Predict... ...e... ...vel rise

Sea level ris... ...wo ways:

- Melted land ice adds volume of water to the oceans.
- **Thermal expansion** as water warms increases the volume.



We're not certain how much sea level will rise by – partially how ice sheets will respond to climate change, and it's also down to us – how much CO_2 that we will emit. The more we emit, the more warming that might occur.

The graph shows some projected ranges of sea l... ...ris... ...etween 2000 and 21... be two metres. This would have catastr... ...su... to those living in coastal ar...

The speed at which sea l... ...anged is increasing each year – it's currently

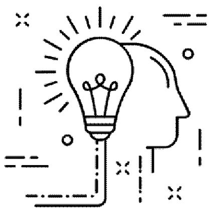
The future effects of sea-level rise

- As sea level rises, the water level in rias and fjords will increase. A greater area is
  processes rather than subaerial weathering and mass movement. Other featur
  have greater influence and erosion by the sea, especially as climate change is p

Other implications of coastal erosion and flooding include:

- Greater threat of storm surges.
- Increased area exposed to coastal erosion – increased coastal retreat.
- Habitats will also be lost.
- The need for coastal defence spending to protect cities, populations and im

If you only remember these three th



❶ During ice ages, sea level falls because the water is loc
returns to the sea during the interglacial period. This is c

❷ If sea level drops, we get emergent features such as r
level rises, we get submergent features such as rias (ri
troughs) and shingle beaches.

❸ Sea level is rising due to climate change – land ice is r
is increasing through thermal expansion. Landforms wil
level increases.

Activities

Consolidation questions

1. How much did sea level fall during the last ice age?

   ....

2. How has sea level changed over th[illegible],000 years?

   ....

3. Give tw[illegible]ures resulting in a rise in sea level.

   ....

4. How are relic features eroded?

   ....

5. Why is there uncertainty over how much sea level will rise in the future?

   ....

   ....

   ....

Take it further

Here's an interactive map showing [illegible] flooded due to climate change. Use [illegible] determine the temperature [illegible] you can pan the map to show different parts of t[illegible]
zzed.uk/9987-sea-[illegible]

Student checks

Topic	What do I know?	No idea ☹	Nearly 😐	Sure ☺	
Past, present and future climate change	Past climate change				
	Eustatic changes				
	Emergent features				
	Submergent feat[illegible]				
	[illegible]dicted sea-level rise				
	The effects of sea-level rise				

Coastal Managem

Key words

- ✓ **Coastal management:** Technique of controlling the rate of coastal erosion a protection.
- ✓ **Hard engineering:** The construction of large scale construction schemes to dis processes, in order to defend an area against flooding or coastal erosion.
- ✓ **Soft engineering:** The use of the natural environment and materials that work provide defence against flooding or coastal erosion.
- ✓ **Sustainable management:** Policies which promote long-lasting, beneficial ad

Key points

- We use coastal engineering to protect areas of the coast from erosion, and t flooding.
- In the past, areas of the coast were protected by hard engineering projects s effective, but having the ability to damage the environment, including downst
- Nowadays, sustainable management and soft engineering are preferred. Th ensure that coasts are protected for future generations.

Why do we manage the coast?

Coastlines are very important to us – many of us live near the coast, and we use t for shipping, agricultural land and tourism.

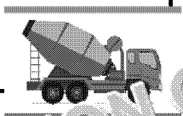
Coasts are under threat from human activity, both directly and indirectly – such sea level resulting from anthropogenic climate change.

We therefore manage the coast for two reasons:

Reduce erosion	**Reduce**
Some coastlines are very valuable – especially around large towns and cities. In these cases, we want to stop coastal retreat.	Sometimes we want surges, made worse b build up the coastline

We can build structures to help protect the coast, or manage the physical enviro ways:

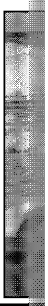
Hard engineering
Often older schemes, but still make up 'hold-the-line' aspects of coastal engineering.



Soft
(includi
Often

Hard engineering

- Hard engineering involves pouring concrete, or using rocks and timber – they're expensive projects, can damage the environment and can be visually obtrusive.
- It is said to work **against** nature.



Here's a rundown of some common types.

Name of scheme	How it works	Advantages
Sea wall	Hard concrete barrier to: • stop erosion • raise the height • deflect the energy back out to sea – they are sometimes curved for this reason	If they are well maintained, they can last a long time, and are effective at protecting large settlements and important installations.
Gabions	Cages filled with rocks – form a barrier to the land and absorb wave impact.	Cheaper and quicker to install than sea walls.
Riprap (rock armour)	Piles of boulders to absorb wave impact.	Large, hard rocks last a very long time, with low maintenance costs.
Revetment	Wooden or rock structures to decrease wave action.	Fairly cheap and quick to build.
Groynes	Wooden structures run across the beach, designed to trap sand and shingle transported by longshore drift.	Allow for the development of beaches for tourist use.

There are other forms of hard engineering, such as offshore reefs and barrages.

Soft engineering

- Soft engineering involves enhancing natural processes and ecosystems in order to protect the coastline. It can create new and important ecosystems such as dunes and marshes.
- It is said to work **with** nature.

Here's a rundown of some common types.

Name of scheme	How it works	Advantages
Dune regeneration	New dunes are created, or existing dunes are fixed. Sometimes they are fenced off, or even old Christmas trees can be used to trap the sand.	Create or enhance a valuable habitat. Cheap to implement – nature does most of the work for us!
Beach nourishment and reprofiling	The level of the beach is built up with imported sand to absorb wave energy. With reprofiling, the slope of the beach is altered.	Creates a valuable and pleasant tourist attraction.
Creation of marshes or mudflats	Natural marsh habitats are created to build up the surface and absorb the impact of the waves.	Highly beneficial ecosystems are created – habitat for birds.

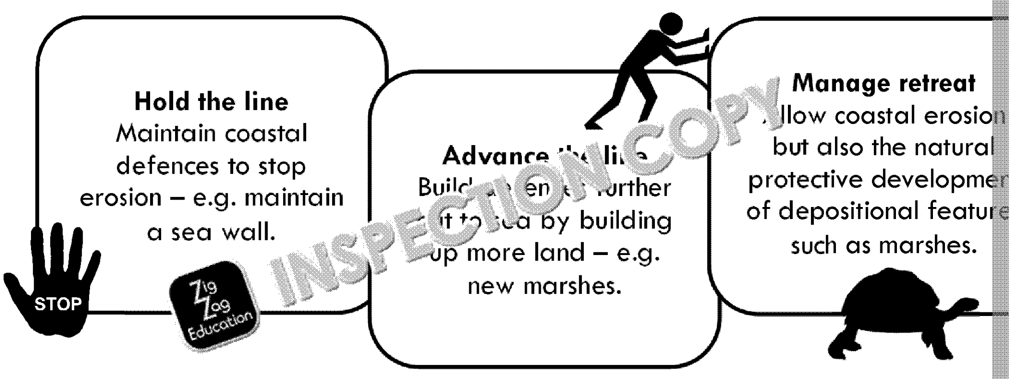
Sustainable management

Recently, there has been an increase in various forms of management that is sustainable. Sustainable management decreases our impact on the coast, so it's there for future generations to use and enjoy.

For example, we decide which parts of the coast are worth protecting, and which parts we allow to be eroded to provide a source of sediment for downstream processes.

The land in this photo has been flooded by the sea – the increased salt content of the soil may have caused this tree to die.

There are several ways that we can manage a particular stretch of coastline:



If you only remember these three th

❶ We manage our coasts to reduce erosion and coasta careful – stopping erosion in one place can have big the coastline.

❷ We used to use hard engineering – building lots of s example. Of course we still use hard engineering wh important places – but we now try to use sustainable engineering.

❸ With pressures on the coast increasing with populatio sea-level rise, sustainable management is key to pres generations.

Activities

Consolidation questions

1. One of the main reasons for coastal management is to reduce coastal erosi… main reason?

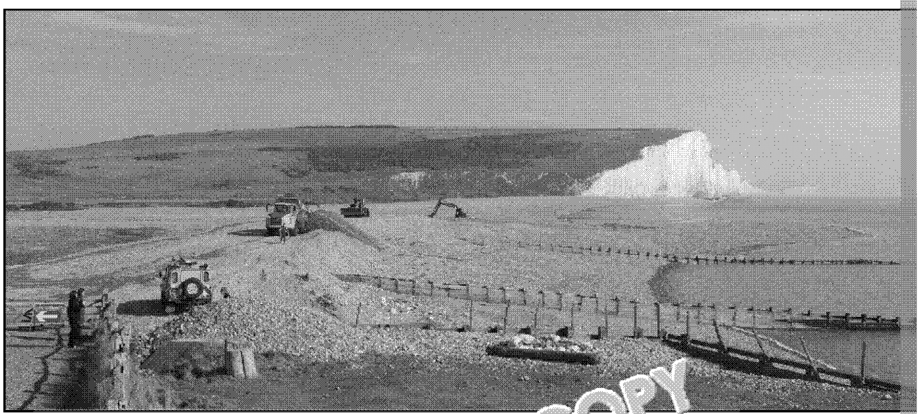
   ……………………………………………………………………………………………

2. Why do hard forms of management 'work against nature'?

   ……………………………………………………………………………………………

   ……………………………………………………………………………………………

3. What type of coastal management is taking place in the photo?



   ……………………………………………………………………………………………

4. Which coastal management allows land to be lost to the sea?

   ……………………………………………………………………………………………

Take it further

See whether your nearest stretch of coast is being managed (mainly England): **zz… coastal-erosion-map**

You can view the types of management – e.g. hold the line and no active interven… use affects the style of management.

You can also see how coastal flooding affects culture – here's an example from L… experiencing rapid flooding in the coastal ecosystem: **zzed.uk/9987-cajun-cultu…**

Student checks

Topic	What do I know?	No idea ☹	Nearly 😐	Sure ☺	
Coastal management	Reasons for managing the coast				
	Hard engineering				
	Soft engineering				
	Sustainable management				

Case Studies

Part 1: Coastal management

Location:	*e.g. Jurassic Coast – Devon a*
Why is coastal management important to the area (e.g. land use, rate of erosion, threat of coastal flooding)?	The following answers will relate to the town of Ly The town has a population of almost 3,700, and is therefore coastal protection surrounding the town and the local economy. Waves in the region are powerful, causing erosion
Has human activity in the region caused issues (e.g. dredging or groynes elsewhere – sediment starvation)?	Shingle has been locally dredged, sand imported fr from Norway and groynes installed. These are issu not an issue before the development and therefor engineering works. However, there could be negat locations dredged.
What type(s) of management is implemented in the area?	A £56 million, four-phase scheme was implemente 1995 and 2015. The scheme balanced hard and so included sea walls, rock armour, extending existin Soft engineering strategies included beach nouris 'do nothing' approach in other areas.
How is the management sustainable? Is it sustainable?	Within the scheme, there are a lot of hard enginee – however, the schemes also include soft engineer nourishment, and areas where a 'do nothing' appr supply of material for downstream protection. Students may also discuss economic sustainability opportunities. Students may, however, question the sustainabilit France, and rocks from Norway.
What are the consequences of the management on the landscape and landforms?	There are relatively few landforms on the immedia nearby area comprises cliffs showing evidence of s Further east are headlands and bays, and even fur beach of Chesil beach. The hard engineering schemes at Lyme Regis hav rocks – trapping sediment, stopping erosion, and t and increasing erosion elsewhere. Students may argue that the area protected by ha fairly small, and will therefore have relatively little i either side of the town would be more than capab supply to allow longshore drift to continue.

Part 2: Economic development

Location:	*e.g. Great Barrier Reef, Au*
What is the economic development taking place (e.g. ports and trade, tourism)?	Tourism is a big business at $5.4 billion annually, and employed in tourism. Two million visitors a year, mai areas, come for a variety of reasons such as boating, Many developments and coastal resorts have been b hotels. Many visitors arrive by air in addition to the cr
How is the economic activity damaging to the area?	Coral reefs are complex and fragile ecosystems, mea damaged. As the popularity increases, more tourists reef through visiting sites and the amenities they re including: • damage from ships, e.g. from anchor drops d the illegal dumping of oil and rubbish • discharge of sewage into the sea • dredging increases sediment on the coral • sun cream released into the water by swimm • accidental damage from divers In addition to the issues caused by tourism, parts of t because of climate change – ocean acidification and bleaching (and eventual coral death). A severe bleac heatwave of 2016.
What are the unintentional problems caused by the damage you identified above (e.g. material flows, sediment cells and balance)?	Coral reefs are important in protecting coasts becau energy and mitigate storm surges, reducing erosion that worldwide, coral reefs provide an equivalent of protection, protecting around 200 million people! The death of coral would lead to changes in the sedi [illegible] and currents could affect transport of materia waves and currents, there is more transport potentia material.
Changes to landforms	The area of coast protected by the reef shows many features. Many rivers flow into the sea – deposits of clearly be seen on aerial photographs. Without prote that the beaches will become eroded.
Changes to the landscape (e.g. coastal retreat)	As noted above, it is possible to link coral death with been few studies on the issue.
Any management to reduce the disruption?	Tourism is carefully managed to reduce the impact – the reef are protected. Management plans are in forc promote sustainability, permits are necessary for vari

Case Studies

Part 1: Coastal management

Location:	e.g. Jurassic Coast – Devon a
Why is coastal management important to the area (e.g. land use, rate of erosion, threat of coastal flooding)?	
Has human activity in the region caused issues (e.g. dredging or groynes elsewhere – sediment starvation)?	
What type(s) of management is implemented in the area?	
How is the manag… sustainab… sustainabl…	
What are the consequences of the management on the landscape and landforms?	

Part 2: Economic development

Location:	*e.g. Great Barrier Reef, Aus*
What is the economic development taking place (e.g. ports and trade, tourism)?	
How is the economic activity damaging to the area?	
What are the unintentional problems caused by the damage you identified above (e.g. material flows, sediment cells and balance)?	
Changes to landforms	
Changes to the landscape (e.g. coastal retreat)	
Any management to reduce the disruption?	

Exam Advice

Time management

If you open the paper and see a question you didn't expect: don't panic! Take a
follow the steps below. Whatever you do, don't just start writing down everythi

Before you rush headlong into the exam, take a moment to look at the question

Reading the whole paper

- Remember to take your time at the beginning, reading through all of the questions.
- **You don't have to answer them in any particular order, but be aware that sometimes AQA order the questions for a reason, and earlier questions might help you answer later ones.**

Reading th

- **Too often stude**
  and lose marks
- **It might be usef**
  and command w
  what the questio

Planning

- **After reading through the question, make sure you plan your answer.**
- This stage is key to getting higher marks, so make sure you don't skip it. Planning can help you:
  - structure your answer
  - answer the question properly
  - save time
- You may do any rough work and planning in your exam paper, but make sure to ~~put a line through~~ it to indicate it is not to be marked.

- **Remember to p**
  spelling, gramm
  as content.
- **You can use as**
  need, but try to
  quantity when i
  be put off by ho
  around you.
- **Any mistakes yo**
  don't use correc
- **If you get stuck**
  go onto anothe
  back to it at the
- **Adopt a formal**
  and concisely.
- **Your introducti**
  issue at hand, g
  information.
- **The body of you**
  evidence for yo
  the points you r
  For long-answe
  demonstrate yo
  recommendatio
  need to present
  viewpoints.

Checking

- **Leave some time after to go through your answers, correcting spelling, grammar and terminology errors and making sure you haven't left anything out.**
- **Finally, double-check that your candidate** details are on any extra sheets you may have, and put them in the correct order with your answer book, using a treasury tag to attach them if you need to.
- Put a cross through any pages you don't want marked, e.g. planning pages.

Writing

Geographical terms

One of the points you are being assessed on is the correct and appropriate use c
geographical terms. You should have assembled a list of key terms that might b
useful for this exam, so make sure you learn them and think about how you mig
include them in your answers. If you are scared of forgetting these words when
start writing your answers, you could try writing them all down as soon as you a
permitted to start writing – remember to cross them out at the end though!

However, don't use geographical terms if they are unnecessary or you are unsur
include them only when they are relevant and useful.

Getting the tone right

As well as using key geographical terms in your answers, your writing should st
This helps your answers appear considered and professional.

Do ✓	D
• Write out abbreviations in full the first time you use them. • Be clear when a statement is a personal opinion as opposed to fact. • Use linking words: thus, therefore, etc. • Try to include the source of a fact if you can, e.g. according to the WHO, the death toll from the tsunami was 1,200.	• Write in the first p • Use contractions: • Use slang terms a • Use rhetorical que

It might help to think of yourself talking to your examiner, or a geography teach
don't know you, so you need to make sure you are clear, but they do know abou
to explain every key term when it's not necessary.

Ask your teacher if you are unsure about your current 'tone', but don't worry ab
are more focused on how you answer the question.

Spelling, punctuation, grammar and legibility

It can often be hard to think about these in the exam hall, but proper spelling, p
and grammar really help keep your meaning clear. They also keep your sentenc
getting too long, which aids with clarity and readability.

While examiners are used to reading all sorts of handwriting, it is good to try to k
answers as legible as possible. One way to do this is to slow down while writing
letters are an appropriate size. The final read-through of your answers before fi
any words which are especially tricky to read.

Quality over quantity: writing skills are only important in that they h
and communicate your geographical knowledge and understanding.
and clear answer than an answer stuffed with complex words th

In the event of emergencies!

- All your planning and preparation means this isn't going to happen... But if the first rule is always to try to relax!
- Take a minute for some deep breaths, close your eyes and imagine a lush, g woodland... Clear your mind.
- Now read over the question, think over what you haven't said yet, and conti

'Thinking like a geographer' and 'synopticity'

Learning to 'think like a geographer' is crucial for exam success and important fo

As you are well aware, the world is a complicated place – cause and effect, and a pull information together, join up the dots, and work out why things happen in t include space, place, environment and scale.

Don't be afraid to draw on your own knowledge and other modules to help illus creative, original and innovative, but use this skill wisely. Make sure you use that question rather than going off on a tangent or writing down *everything* you kno called '*synopticity*'.

Here are a few tips on thinking like a geographer:

Consider the many aspects of the issue from many v

- Think across the social/natural divide, using your knowledge of bo geography.
- Involve many aspects of the issue: historical context, cultural pers
- SPEED can be a useful tool for thinking synoptically: social, politic environmental, and demographic. But don't forget to consider cul material factors when appropriate.
- Try to see the issue from many viewpoints: work on your empathy
- Don't be afraid to think outside the box!

Spatial concepts

- Geographical perspectives often focus on the importance of space, lo issues at hand.
- Think about movements and flows of people, goods, ideas, etc.
- Think about the effects of 'scale': local, regional, global.

Be creative

As long as your approach is logical and well justified, you can think inn

Exam preparation

My take-home tips:

- ✓ Before the exam (Eat a good BREAKFAST)
- ✓ During the exam (Read the question CAREFULLY)
- ✓ Planning (HIGHLIGHT key words and concepts)
- ✓ After the exam (Take some time to RELAX!!!)

Answers to Consoli
Questions

Coastal systems

1. Allow any suitable suggestion, including fro‑ t' e ‑d rivers, subaerial pr out at sea, and from marine creatures.
2. Allow any suitable suggestion ‑ a ‑ind, waves, currents.
3. Coastal engineering c‑ ‑s to sediment availability from changes inland sediment) and ‑ffs‑ (e.g. dredging).
4. Smalle ‑w‑, eroded beach.
5. Chang‑ ‑quilibrium, many processes occurring at the same time, feedb

Coastal processes, influences and sediment

1. Near to the shore, the water is shallower, meaning that the base of the rota
2. The distance over the sea that the wind has blown.
3. Rip currents.
4. Neap tide.
5. Low energy.
6. Weathering is in-situ break-up of rock, erosion transports the rock away.
7. Creep.
8. Suspension.
9. Solution.
10. The wind or water has less velocity, meaning that it can't support as much

Landscapes of erosion

1. Unconsolidated material – e.g. sands, grave' ‑a‑ ‑ ‑ulder clay.
2. Concordant coasts.
3. Undercutting creates a notc‑ ‑ ‑ually the overburden collapses.
4. Bays are more shel‑ ‑ ‑ing the amount of energy for suspension, et
5. Arch.

Landsca‑ of deposition

1. Inshore.
2. Swash-aligned.
3. Supply of sediment being transported down the coast, and a change in co mouth of an estuary.
4. An island.
5. A salt marsh.

The effects of past, present and future climate change

1. Around 120 metres.
2. Very little change until the last 140 or so years.
3. Two from: rias, fjords, shingle beaches.
4. Subaerial weathering and mass movement.
5. It's unknown how much CO_2 we will produc‑ ‑ ‑refore the amount of models and emissions scenarios. W‑ ‑on't know for certain how some warming – they could melt f‑ ‑ predicted.

Coastal ‑a‑ent

1. To red‑ threat of coastal flooding.
2. They di‑ ‑pt natural processes – e.g. cause sediment starvation downstrea physically disrupt the environment.
3. Either beach nourishment or reprofiling.
4. Do nothing (no active intervention).