Geography AS / A Level | Edexcel | 8GE0/9GE0

AS and A Level Edexcel Revision Booklet

Topic 2B: Coastal Landscapes and Change

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Contents

Teacher's Introduction

The revision booklets in this series are designed to support your students as they study AS Edexcel Geography (8GE0) and A Level Edexcel Geography (9GE0). These revision summaries match the Edexcel specification perfectly. **This particular set supports Topic 2B: Coastal Landscapes and Change, 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, th manageable chunks and are provided in both A4 and A5 formats for easy photoco carrying and reference for students, right up to the moment they walk into the ex revision time.

Since revision should be ongoing throughout the study, it is recommended that issue students with the relevant revision booklet as they progress through the co issued as a complete revision pack in the run-up to the examinations.

By use of bullet points, boxes and grids, these revision booklets provide succi relatively d coverage of the specification content – probably far more than revision sum y.

Each topic follows a clear structure of:

- **Key words:** lots of key words are clearly defined, and by covering up the defi 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. Conci they provide a solid bank of notes to support students' knowledge, understa
- **Core content:** the main content of the specification in bullet points, boxes an suggested examples allow students to name-drop examples in their exam, o
- **If you only remember these three things…:** the three most important takea
- **Consolidation questions:** several quick questions on the core content – desi points have been retained.
- **Take it further:** offers suggestions to support the option of extending learni
- **Student checks:** useful checklist to help students monitor their own learning.

Each pack also contains a **students' introduction** which introduces the topic and s structure; introduces command words, AOs and level marking, along with exam t how to use the booklet. At the end tips are included on time management, and p along with an introduction to synopticity.

By using this resource, teachers will know that all students have the key points for al written format. It saves time in class for teachers and decreases the amount of prepa

This resource also helps achieve greater equality among students of differing abi students make the least helpful notes from which to study and revise outside cla revision summary notes help to overcome this problem and promote greater equ

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

I trust that you and your students will enjoy using these revision summaries as m them for yo

Students' Introduc

What's the topic?

This revision booklet is for Topic 2B: Coastal Landscapes and Change. You will b
Paper 1, Section B.

Here's a quick overview of the things you might find in the exam. However, exp
sometimes exam 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 might have heard the term 'AO2'. AO2 marks require yo
  that you understand what it means.
  - You may be asked to use the figure(s) and your knowledge to answer
  - These might be medium-length questions, worth around 6 marks.
- Finally, you'll get a longer, essay-based question – maybe worth 20 marks. 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 arguments if you are reaching for the higher marks. You'll need to draw on your knowledge and offer a supported opinion. PEE or, even better, PEEL here! And no, we don't recommend you get out a satsuma in the exam – link together evidence.

How to use this guide

You may be given this at the start or at the end of teaching on the topic. Don't
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 yo

Now write down the date of the exam. You can use this 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. If y
that you know a topic, or you last looked at this six months ago, then it's probably

Topic	When did I read this? *Write the date in here – preferably today's*	I kn
Coastal Landscapes and Processes		
Erosion Processes and Landforms		
Transport and Deposition – Processes and Landforms		
Subaerial Processes (Weathering, Mass Movement and Associated Landforms)		
Causes of Sea Level Change (Past, Present and Future)		
The Effects of Coastal Recession and Flooding – and Why It's a Problem		
Coastal Management		

Exam tips

Now that you've thoroughly revised and hopefully answered a few sample exam
good idea of what to expect in your exam.

Command words
In each question there are 'command words'. These are essentially the instructio
to answer the question, and give you a clue on the type of response the examin

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

Edexcel has created a list of command words for you to refer to. They have also s
of them will occur and given the number of marks for each. They might not alwa
be concerned if questions are slightly different in your exam. **zzed.uk/9991-co**

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

- ✓ **SUGGEST:** Give a reason or cause, explaining if asked.
- ✓ **COMPLETE, DRAW** [illegible] Use data provided to complete missing value
- ✓ **CALCULATE:** Do mathematical analysis. You will be given marks for showing y
- ✓ **ANALYSE:** Identify the pros and cons or processes of EVERY view or opinio argument or processes in a logical order, showing the relationships betwe
- ✓ **EXPLAIN:** Set out causes of the issue, event and/or factors influencing its fo understanding and discussion of processes, may also require a graphical re
- ✓ **ASSESS:** Set out for and against or a relationship, and come to a conclusio between sides but pick out which is the most significant factor.
- ✓ **EVALUATE:** Consider several options or arguments and come to a conclusi success or worth.

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

Here's a quick summary:

	What you need to do	
AO1	Show your knowledge and understanding of geographical concepts and issues	✓ Collecting together
AO2	Manipulate and draw conclusions from geographical information, both familiar [illegible] new	✓ Use of map ✓ ICT skills: u ✓ Analysis, pr
AO3	Investigate qu[illegible] reach conclusions throug[illegible] geographical skills and [illegible]	✓ Concluding ✓ Use of map ✓ Statistics ✓ ICT skills: u ✓ Analysis, pr

In your Paper 1 exam, you'll mostly be assessed on AO1 and AO2. There will be
most of those in the NEA (fieldwork investigation).

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

You might find it useful to have a look at a couple of mark schemes for the topi
examiner wants you to answer the questions.

Level marking
Now that you've got a handle on how the command words work and what the
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
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 overleaf.
Up to 3 marks can be awarded for AO1. A further 9 marks can be awarded for A
If only AO1 content is provided, allow 1 mark for Level 1 answers, 2 marks for L
Level 3 answers.

Level	Mark	Descriptor
Level 1	1–4 marks	AO1: • The student shows basic comprehension and only limit incorrect and not in line with the context of the questio
		AO2: • The student addresses a narrow range of ideas, and det inferences and links made. • Limited explanation is present. • Ideas are poorly supported, and may be one-sided. Disc follow. • No judgement and/or concluding remarks.
Level 2	5–8 marks	AO1: • The student shows comprehension and some factual re and generally in line with the context of the question.
		AO2: • The student addresses a range of ideas, to a reasonable and links made. • Some explanation is present. • Ideas are supported, but may still be one-sided. Discuss • Some judgement and/or concluding remarks.
Level 3	9–12 marks	AO1: • The student shows good comprehension and factual reca tailored to the context of the question.
		AO2: • The student addresses a wide range of detailed ideas, w and links made. • Good explanation is present. • Ideas are often supported, with both sides supported. D • Good judgement and/or concluding remarks.

Coastal Landscapes and I

Key words

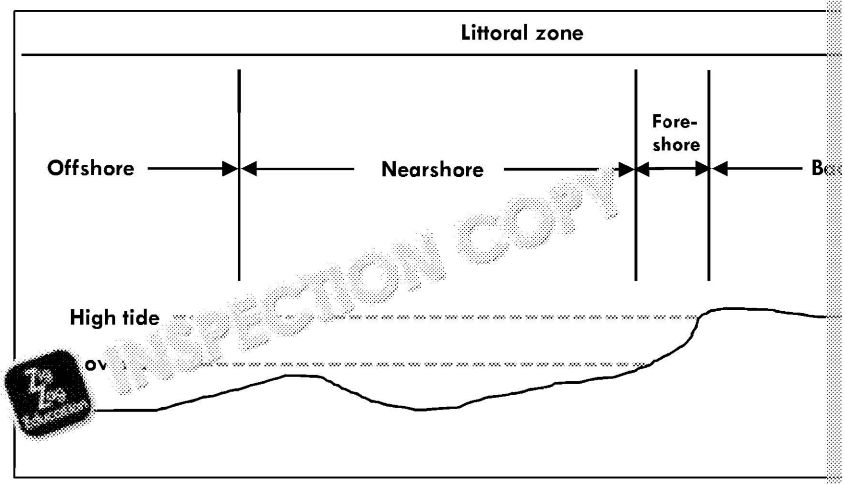
- ✓ **Littoral zone:** Coastal area submerged by tides and the sea near to the coa
- ✓ **Offshore:** The zone furthest from the shore. Waves no longer impact on the u
- ✓ **Inshore:** Submerged area between the shore and offshore area.
- ✓ **Foreshore:** Area of the shore between the high and low tide marks – the are
- ✓ **Backshore:** The zone furthest from the sea, entirely landward of the high-wa conditions. Only affected by waves under storm conditions.
- ✓ **High-energy coastline:** Areas of shore where there is more erosion than dep headlands to form because the waves are large with high erosive power.
- ✓ **Low-energy coastline:** Areas of shore where there is more deposition than e form because the waves are small with less erosive power.
- ✓ **Unconsolidated material:** loose deposits which have not yet been cemented example, boulders, ...
- ✓ **Sedimentary rock:** Layers of stone created by the deposition of material, e.g be fo..., therefore susceptible to erosion.
- ✓ **Metamorphic rock:** Sedimentary rock which has been altered by heat, from intrusions of magma, making the rocks harder than before.
- ✓ **Igneous rock:** Stone created by a volcano, usually very hard and resistant to
- ✓ **Rock joint:** A fracture within stone, allowing erosion to occur at a faster rate
- ✓ **Permeable rock:** Stone with lots of connected pore spaces, allowing the mov
- ✓ **Bedding plane:** Boundary between each layer of sedimentary rock.
- ✓ **Stratum:** A layer of sedimentary rock, different to the layers either side (sep either side).
- ✓ **Folding:** Crumpling of strata due to tectonic processes.
- ✓ **Micro-features:** Small-scale modification to a coastal environment, such as a cave.
- ✓ **Concordant coastline:** A region of the coast where alternating bands of har the coast.
- ✓ **Discordant coastline:** Coast section where alternating bands of hard rock a near right angles.
- ✓ **Dalmatian coast:** Islands remaining above water level from aligned valleys, as sea level rose.
- ✓ **Haff coast:** Concordant coastline formed of parallel spits and lagoons, foun
- ✓ **Sand dune:** A depositional feature in which sand, blown from a beach by on mounds and stabilised by plants (e.g. marram grass).
- ✓ **Psammosere:** Development of a sand-dune ecosystem from bare sand to th
- ✓ **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 and with very little surf
- ✓ **Salt marsh:** Estuarine ecosystem made of salt-tolerant plants which cause m eventually becomes dry land
- ✓ **Halophyte:** A plant which can survive in very salty conditions, such as on a sa for ... of the day, or is subject to salt spray, such as growing on a clif

Key points

- We call the beach, shore and coastal sea the littoral zone. We divide this in the backshore, foreshore, nearshore and offshore.
- We can classify the coast based on many factors such as geology, sea level, and currents.
- High-energy coasts are often rocky, erosive landscapes with powerful, destr sometimes a long fetch. They often have resistant geology.
- Low-energy coasts include sandy beaches and estuaries. They have construc achieve dynamic equilibrium. Material is gained from the land, and from ma
- 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. Some rocks are also more susceptibl permeable rocks may erode faster.
- Rock dip and whether the coast is concordant or discordant also play a k that are seen, and the erosion speed. Special types of concordant coastline a Haff coast.
- Dunes are deposits of windblown sand which form an ecosystem. They devel and new species move in, a process called succession.
- 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 sequence of succession to fo ecosystem develops, the marsh rises and becomes drier. Salt-tolerant plants shrubs and trees eventually form a climatic climax vegetation.

The Littoral Zone

- Another name for the beach and start of the sea is the **littoral zone**. We div on distance from the coast, effects of currents, and how often each area is s
- The four sections are:
  - offshore – out to sea, further out than the nearshore.
  - nearshore (inshore) (affected by currents between low water and beyo
  - foreshore (usual tidal range – also forms the 'shoreline'.
  - backshore (only affected by waves during storms or spring tides, which
- Beyond the beach is the 'coast'.



Classifying the Coast

We can classify the coast in a number of ways, including…

- geology and features (e.g. cliffs or sand) – influenced by local geology
- changing sea level and land level (eustatic, e.g. submergent coastlines, iso
- inputs from rivers (deposits of sand)
- waves, tides and currents.

Low-energy and High-energy Coasts

A common way to classify coasts based on their 'energy'.

Rocky Coasts = 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
- often resistant geology (sometimes have tall cliffs)

E.g. Cornwall

Sandy Coasts and L

Lots of deposit

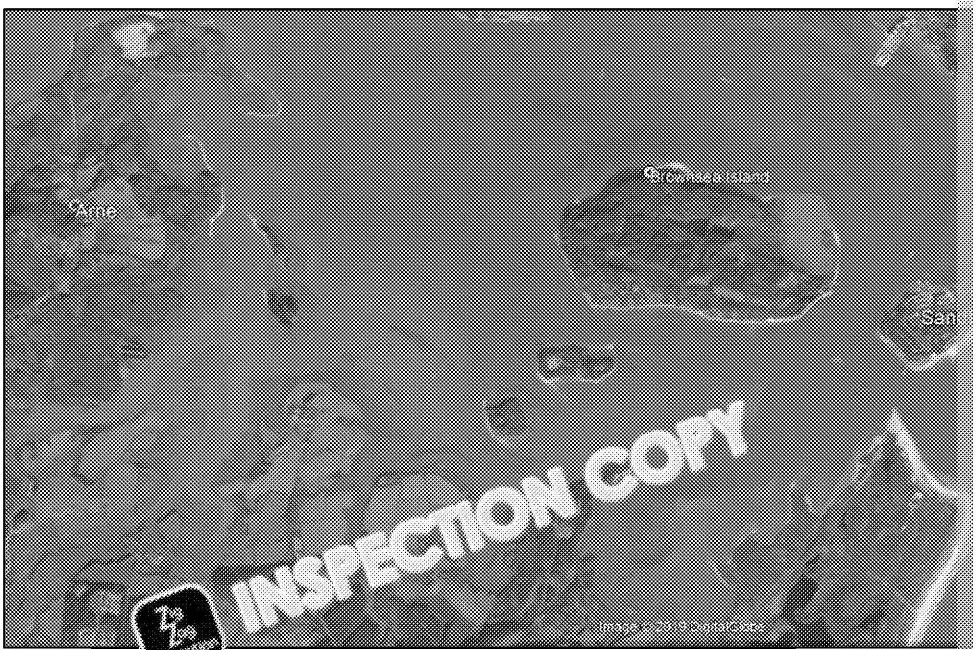
- low, constr
- more depo beaches, m tall cliffs –
- likely to d
- sediment f from the c
- e.g. shelte estuaries

E.g. South c

- Beaches are said to be 'swash-aligned', or 'drift-aligned', depending on wh front-on, or at an angle.

Look at the two aerial photos of the coasts. What can we infer about the coast i

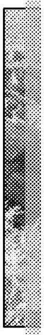
- This is a high-energy coastli… are breaking on the rocks.
- It's also a rocky coa… cliffs.
- There a… – the ones that exist are rocky – the waves break di
- At low … ere may be wave-cut platforms.



- Here is a low-energy coastline.
- To the left is an estuary at the mouth of a river – there is significant deposi marshes visible.
- To the right are sandy beaches, low coastal plain.
- There is evidence of depositional processes including longshore drift, evid

Geology

Geology is very important in influencing coastal features.



Coastlines are often complex – many of the features noted below are shown in a small area. Some of these form **micro-features** such as caves. For example:

- The **rock type** affects the rate of erosion – the softer the rock, the faster it can erode.
    - 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 of volcanic activity.
    - Some rocks such as limestone are susce le chemical weathering
    - Some rocks are **permeable**, m th they can absorb water – the groundwater has pass them and may have high **pore wat**

- **Rock j** - **b planes** and **strata** – weaknesses that can be erode rock fa ta are layers of rock laid down at different times. The layers b planes.
- **Folding** – immense geological pressure over time crumples rocks so that th horizontal. This causes rock dip.
- **Dip** of the rock – whether the strata are horizontal, or dip towards the sea photo above dip towards the sea. Dip affects the way that cliffs collapse.

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

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

Concordant coasts
Bands of rock run parallel to the coast.
Form coves where areas of weakness are exploited and the sea breaks through the hard layer into the softer layer behind.

E.g. Lulworth Cove, Dor

Disc
Bands of rock run
Headlands and bay
resistant rock, whil

E.g. Swanc
and Du

- Two u ypes of concordant coastline also form Dalmatian and Haff co

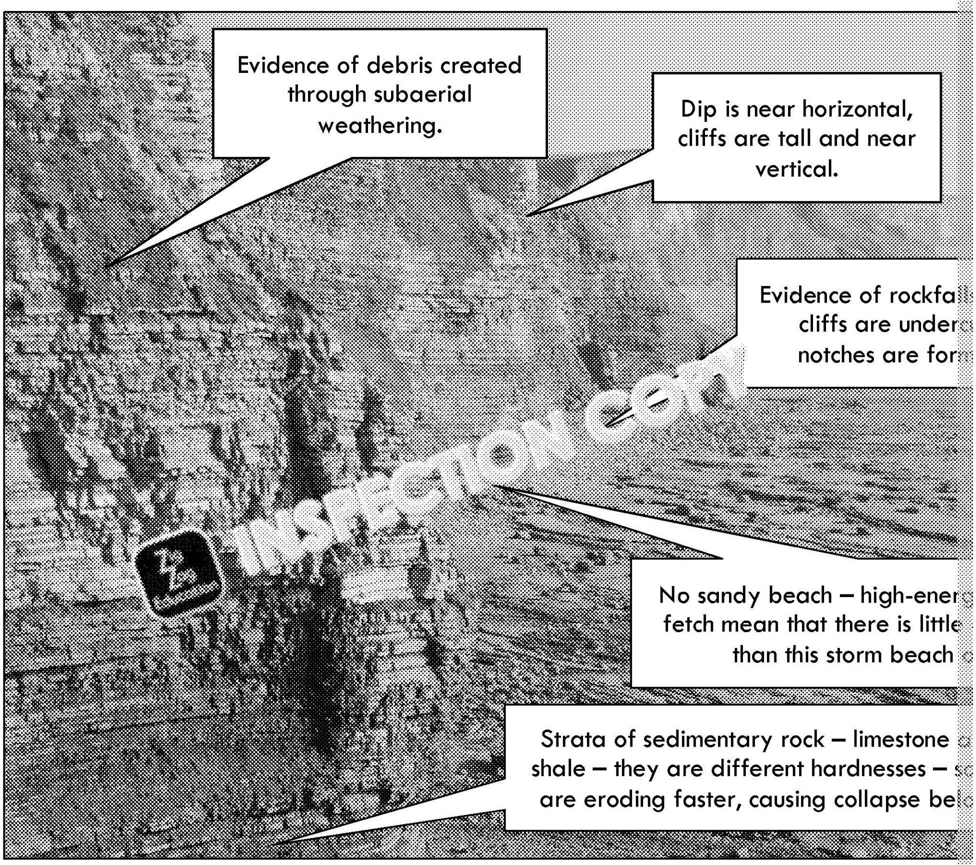
Dalmatian coasts
Rock folding caused valleys to form parallel to the coast. These were deepened by river erosion, but have been flooded by sea-level rise in interglacial periods to form long, wide 'sounds'.

E.g. They are named after the Dalmatian coast in Croatia.

H
Shingle bars of unco
worked by rivers ar
rise and have d
separ

E.g. Sou

How has geology and location affected this landscape?



Complex Cliffs and Landscapes

- Coasts are very complex, often dynamic places. There are many drivers anc can often be seen at once.
- Processes such as erosion and deposition occur at the same time, and the p be deposition without erosion first occurring.

There's a lot going on in this photo:

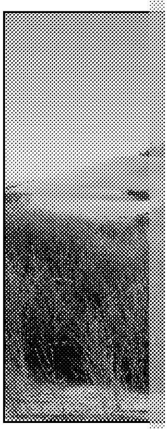
- inputs – waves and wind
- processes – erosion and mass movement – we can see a large crack in the c on the stacks because of the different rock strata
- transport – suspended load
- stores – e.g. the beach in front of the cliff
- outputs – sand and sediment from the cliffs

The Role of Vegetation in Stabilising Depositional F

The roots of plants help to stabilise depositional features such as dunes and ma less susceptible to erosion. Over time, different stages of succession occur, whe another. They occur in sandy coastal plains and estuarine environments.

Here are some common examples

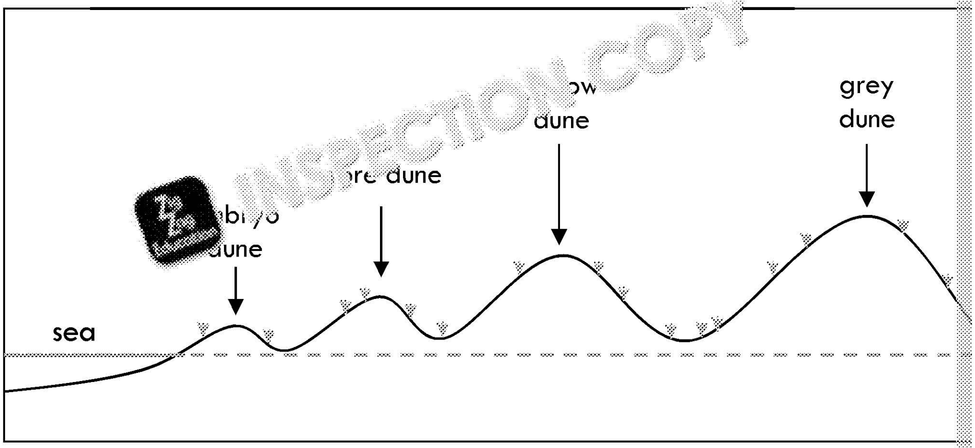
Sand Dunes



- Sand dunes are mounds of sand at the boundary of the land.
- They develop behind sandy beaches where there are prevailing onshore winds – they obviously need a lot of sand available!
- Wide beaches mean that the sand can dry out between high tides – where it is easily entrained by the wind. A large tidal range helps!

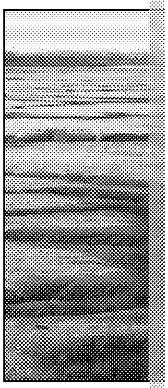
- Sand is deposited when friction increases – for example around obstacles a around marram grass growing on the dune.
- As dunes develop, the accumulated sand increases their height.
- The development of a sand-dune ecosystem is called a **psammosere**. At ea plants – starting with the **pioneer species**, and ending with the **climatic cli** plants and trees.
- Each stage helps the next one develop, by further stabilising the dunes, crea conditions, and adding organic material to the soil.

The stages of dune development are shown on the diagram below. The younge to the sea.



E.g. Sefton Coast (Merseyside), Drigg Dunes (Cumbria), Freshwater We Kenfig (Port Talbot).

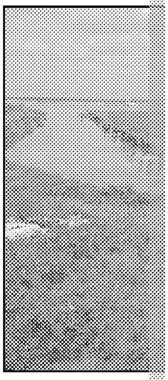
Mudflats



- Mudflats are expanses of bare mud, which are underwater at high tide.
- They are found at the mouths of rivers – estuaries. Rivers carry the very fine sediment, which is deposited when the water meets the incoming tides. The saltwater also causes flocculation – particles clump together so need more energy to keep in suspension.
- There is little to no vegetation growing on mudflats, 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.
- Mudflats can turn into salt marshes.

E.g. Wadd[illegible] Netherlands.

Salt Marshes



- In the same way as sand dunes, 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)

If you only remember these three th

1. The coast and a portion of the sea are called the li beaches based on their energy – high-energy coas and low-energy coasts have many depositional fe beaches as well as estuaries.
2. Geology is key to shaping coastal landscapes, alo energy. Rock type, dip and whether the coasts are affect the features, which are eroded by the full co erosion and subaerial processes.
3. Sand dunes and salt marshes both show the proces Over time, they are colonised by pioneer species. E community further builds the height of the feature b and improving the growing conditions for the future climax vegetation starts to grow.

Activities

Consolidation questions

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

   ....

2. Give **two** characteristics of high-energy coastlines.

   ....

   ....

3. Which type of materia[l] [erode]s fa[s]test?

   ....

   ....

4. Why do jointed rocks increase erosion potential?

   ....

   ....

5. Why does rock 'dip' affect coastal erosion?

   ....

   ....

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

   ....

7. Why does marram grass help to build up the height of a dune?

   ....

   ....

8. How are mudflats related to salt marshes?

   ....

   ....

Take it f[urt]h[er]

Use the g[eolo]gy map to explain the shape of an area of coastline that yo[u ...] with; for example, concordant or discordant, types of rock such as sedime[ntary ...] igneous. You might be able to find photos to help you – for example, sho[w ...] and other features within the cliffs.
zzed.uk/9991-map-geology

Student checks

Topic	What Do I Know?	No Idea ☹	Nearly 😐	Sure ☺	
Coastal Landscapes and Processes	The littoral zone				
	High-energy and low-energy coasts				
	The role of geology in coastal landforms and erosion rates				
	Sand dunes				
	Mudflats and salt marshes				

Erosion Processes and L

Key words

- **Current**: Flow of water around a coastline.
- **Fetch**: Distance over water that the wind blows – the greater the distance, th
  the waves have, and coastal erosion speeds increase.
- **Prevailing wind**: The direction the wind blows from the majority of the time.
- **Constructive wave**: Low and flat wave frequently associated with swells tha
  m), and low frequencies (6–8 per minute), building up beaches.
- **Destructive wave**: Wave frequently associated with st m conditions that ha
  frequencies (12–14 per minute), diminishing bec e.
- **Wave refraction**: Curving of the wave as sh llo water is reached, such as
- **Swash**: Uprush of water on to ac used by incoming waves.
- **Backwash**: Return of w tow ds the sea immediately after the swash.
- **Tidal range**: Th l istance between high and low water experienced
- **Sprir** Ti with the greatest range, occurs when there is a full or ne
- **Neap** he tide with the lowest range, a week after the spring tide whe
  right angles.
- **Storm beach**: Deposit of the coarsest material thrown to the back of the bea
- **Offshore bar**: Ridge of deposited material out at sea. Sometimes exposed a
  high tide in front of the shore. There may be a lagoon, too.
- **Berm**: Ridge on the beach created by waves.
- **Cusp**: Semicircular feature on the beach.
- **Ripples**: Pattern seen on the beach at low tide caused by the action of wav
- **Runnels**: Long hollows in the sand that run parallel to the coast.
- **Intertidal zone**: The foreshore – the area between the limits of high and low
- **Erosion**: The transport away of weathered material, such as by water (wav
- **Hydraulic action**: Water compresses air in gaps in a rock face, creating hig
  expansion that can cause rocks to break apart when repeated.
- **Corrasion (abrasion)**: Pebbles transported in the sea grind against, and are
  erosion.
- **Solution (erosion process)**: Rocks containing calcium carbonate (limestone a
  acids within the sea water.
- **Attrition**: Rocks transported in the sea are slowly worn down into smaller, in
  they are swirled around.
- **Cliffs**: Rock back wall to a beach created by the erosion of the land.
- **Shore (wave-cut) platform**: Rocky ledge caused by the retreat of a cliff fur
- **Headland**: Resistant outcrop of rock, often along a discordant coastline, with
  wave refraction.
- **Bay**: A body of water surrounded by land on three sides (often two headla
  less resistant rock along a coastline.
- **Cove**: Bay with a narrow opening in a concordant c ne where erosion a
  behind.
- **Geo**: A vertical hollow in a rock fac ec the enlargement of a crack
- **Cave**: A natural hollow with rmed by the continual erosion of a cr
- **Arch**: A continuous h a headland, formed by the backward erosi
  the over d er collapse.
- **Stacl** la d column of resistant rock formed by the erosion and collap
- **Stum** eroded remnant (base) of a stack, left behind after the rock deb

Key points

- 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 Sun) – tides v throughout the month.
- Beaches change throughout days, weeks and years – tides and currents regu Winter storms can erode the lower beach and also create storm beaches.
- Beaches contain lots of small erosional and depositional features such as be
- The sea and its waves erode the coast through a number of processes such a The sediment is worn down by attrition. Factors such as wave type and powe erosion potential.
- Cliffs are the boundary between the sea an[illegible] – some are tall and t slump towards the sea.
- Cliffs often collapse due to u[illegible] – the formation of wave-cut notche
- Retreating cliffs fo[illegible] platform.
- On di[illegible]an[illegible], headlands and bays develop.
- Geo[illegible]ves can develop through a headland to create an arch. The ar stack. [illegible] the stack topples, a stump occurs.

Waves and Their Formation

Wind affects coastal environments, mainly because the wind blows across the o 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 fric They therefore 'fall over' – it's called breaking – the waves spill or plunge d onto the shore.

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

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 larger the winds.

H
di

Types of Wave

Waves can be classified as **constructive** and **destruc**[illegible]

Constructive

- Build up beaches a[illegible] [illegible] greater than the bac[illegible]ash
- Wa[illegible] sm[illegible] and spill onto the beach.
- Can c[illegible] a **berm**.
- Can help form beaches on an incoming tide.
- Have a lower frequency*.

D

- Large, powerful that erodes mat
- Waves plunge d
- The strong back
- Can erode the b
- Have a higher fr

* Frequency is the number of waves in a period of time – such as one minute.

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

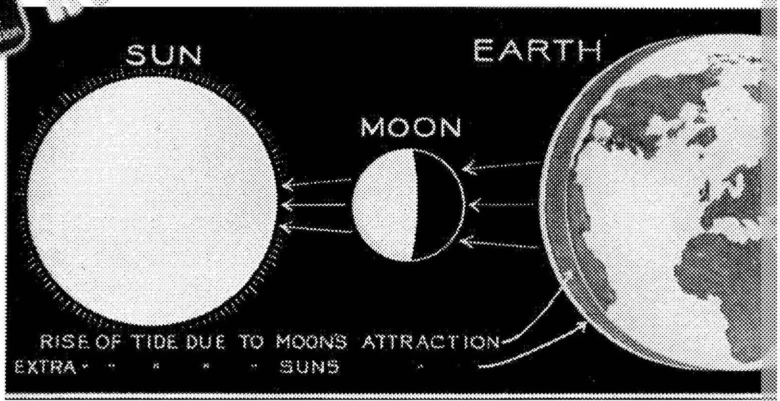
Other Influences on the Coasts

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

Tides

Tides are the rise and fall of water level at the coast, mainly due to the gravitati lesser extent the Sun (because the Sun is further away). The pull creates a bulge the other side, too. This is the *high tide*. At 90°, *low tide* 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 based on the alignment of the Sun and Moon.
    - When the Sun, Earth and Moon align (as in the diagram), there is a larg the gravitational pulls combine.
    - When the moon does not 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, coastli 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.

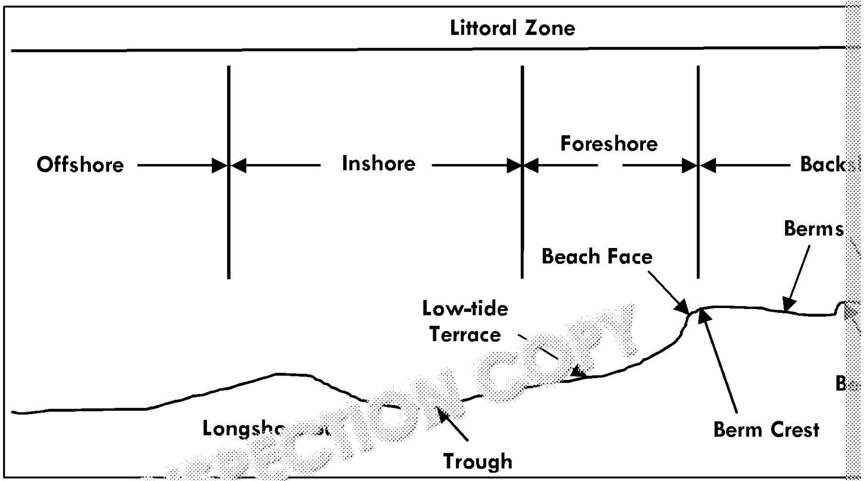
Coastal flooding can be caused by storm surges – onshore winds, and low press can combine at high tide to suck up the water and push it to the land.

Changes to the Coast Throughout the Year

The shape (morphology) of a beach may change throughout the year.

- In the summer, the height of the beach may be built up by constructive waves. Berms may form on the beach.
- During the winter, the beach's steepness will increase as the berms are eroded by destructive waves.
- **Storm beaches** develop during high-energy events where powerful storm waves deposit larger material towards the cliffs in the backshore.
- **Offshore bars** develop when storms erode material from the beach and deposit it offshore.

- While beaches might seem simple, are plenty of smaller features created th depositional processes.



- **Berms** ...ges built up by each lower tide (as range decreases towards t
- **Cusps** ...osional circular depressions.
- Near the low-water mark, **ripples** occur from currents and waves.
- **Runnels** are channels parallel to the shore which channel water, separated

On a shorter timescale, the beach may change with successive tides – e.g. over c tidal range decreases towards a neap tide, a succession of berms may develop o high tide.

On a longer timescale, the beach may change, for example as a result of human engineering, if a river is dammed which prevents sediment transport to the coas sea-level change and climate change.

Erosion

Hydraulic action:
Waves force air and water into pores in the cliffs, increasing the pressure within.

Corrasio
Waves pick up pebbl cliff, or scrape materi wave-cu

Attrition:
Eroded material is reduced in size, and becomes more rounded as the material swirls together, knocking off the edges.

So
Some rocks c

Waves cause erosion of cliffs and beach material by ...ing them away. There a

Each of these is influenced by waves ...heir power, size, destructiveness, tides, a

For examp...
- The mo...werful the waves, the harder the water is forced into cracks, an
- The higher the tide, the more cliff that is exposed to the water.
- The softer the geology or the more cracks, the greater the erosion potentia susceptibility to solution.

Erosional Landforms

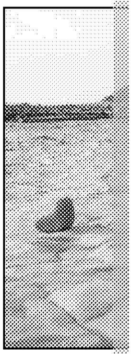
Overleaf are the distinctive landforms created through the erosional processes li

Wave-cut Notches

- The main driver of cliff collapse and retreat.
- The base of the cliff is eroded by hydraulic action and abrasion, causing a groove to develop.
- Over time, this groove cuts deeper into the cliff.
- Eventually, the cliff is so unsupported that the face collapses.
- The collapsed material is worn down by attrition and transported away, allowing a fresh cliff surface for erosion and leading to the development of a wave-cut platform.

E.g. Anywhere there are cliffs being eroded!

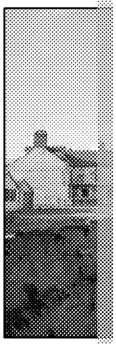
Wave-cut Platform



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

E.g. Lyme 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 geology with a low fetch, mass movement will create a barrier at the foot of the cliffs, helping to protect them.

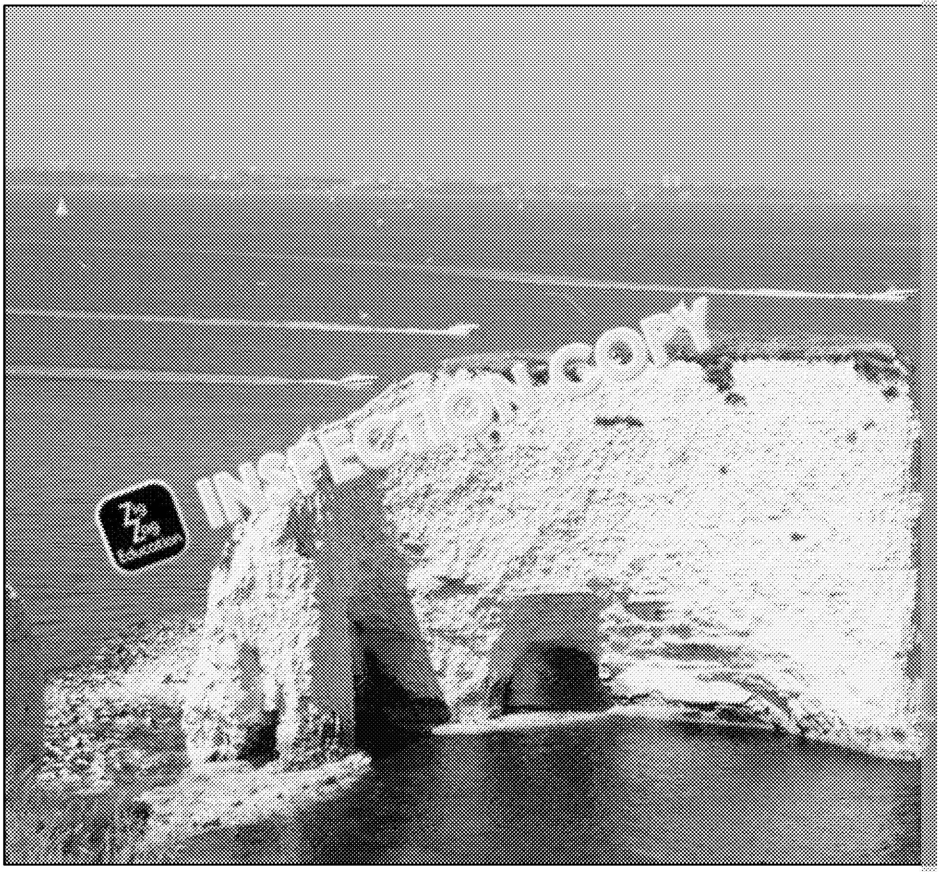
E.g. Rapidly eroding coastlines: Norfolk – Happisburgh is shown in th
Tall, hard cliffs: Conachair, St Kilda – up to 426 metres!

Headlands and Ba

- Headlands are promon
extend outwards into t
- They often form on dis
softer rock either side a
bays.
- Material is deposited in
- Wave refraction is a fac
wave power and helpin

Headland → Geo → Cave → Arch → Stack → Stump

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

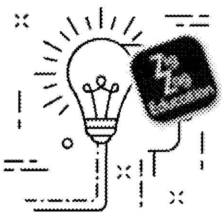


So, how did they form, and how will they evolve?

1. This sequence started with a chalk headland.
2. Hydraulic action, for example, exploited a weakness in the rock to form a c
3. Further erosion opened up the geo into a larger **cave**.
4. If a cave on the other side opens up, or the single cave extends all the way t is formed.
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 subaerial weathering, which reduces its height

If you only remember these three th



❶ The waves are affected by the wind and fetch, a by the Moon (mainly); the tidal range influences h eroded.

❷ The waves and currents cause different forms of e eroded material away.

❸ The coast is lined by cliffs, which can either be ta slump towards the sea. When cliffs retreat, wave Headlands can start the sequence of developmen stacks and stumps.

Activities

Consolidation questions

1. What causes waves to 'break'?

2. What is 'fetch'?

3. If winds are **offshore**, do you think that the coastline will be high-energy o

4. Give one difference between a constructive wave and a destructive wave.

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

6. Give an example of a short-term change to a beach structure.

7. Which type of erosion: a. forces air and water into cracks; b. dissolves rocks; material?

8. Give a cause of cliff collapse.

9. Why do headlands and bays form on discordant coastlines?

10. 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 a
affect the shape of the coastline:
zzed.uk/9991-geology-map-uk

Student checks

Topic	What Do I Know?	No Idea ☹	Nearly 😐	Sure ☺	
Erosion Processes and Landforms	**Wave formation**				
	Types of wave				
	Tides				
	Beach structure and changes				
	Erosion processes				
	Wave-cut notches				
	Wave-cut platforms				
	Cliffs				
	Headlands and bays				
	Sequence from a headland to a stump				

Transport and Deposi Processes and Landf

Key words

- **Transport**: Movement of material around a coastline, for example in current and wind.
- **Traction**: Large particles, such as pebbles, are rolled across the sea floor (o in the wind) because they are too heavy to be suspended.
- **Saltation**: Waves and currents bounce larger material across the sea bed (o insufficient energy available to constantly suspend the material.
- **Suspension**: Fine sediment requires very little energy for it to be maintained air), therefore it will remain there a long time.
- **Solution (transport)**: transport of dissolved material within the wate
- **Aeolian**: occurring relating to the wind, such as transport and erosion.
- **Longshore drift**: Sediment transport along the coast. Waves approach at a oblique up the beach. Backwash moves material towards the sea.
- **Deposition**: Process where material is dropped from suspension or movemen friction increases.
- **Gravity settling**: When the energy within the water or air decreases, mater water because of gravity.
- **Flocculation**: When fresh river water meets saline water in estuaries, suspen meaning that they become larger and need more energy for transport. If th deposition occurs.
- **Beach**: A band of material such as sand, pebbles and crushed shells deposit sea and land, mostly under water at high tide.
- **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.
- **Offshore bar**: Ridge of deposited material out at sea. Sometimes exposed 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.
- **Cuspate foreland**: Triangular protrusion formed from two merging spits. The material is exposed to longshore drift in two opposing directions.
- **Open system**: A cycle or process where inputs and outputs can add or remo
- **Inputs**: Additions 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 reverses, bringing the system b equilibrium.
- **Sediment cell**: A self-contained section of coastline along which material is i without impacting on neighbouring cells.
- **Sediment budget**: The difference between the inputs and outputs of materi determination of erosion and deposition.
- **Closed system**: System where energy can transfer across its boundary, but

Key points

- Coasts derive their sediment from the land, the cliffs, from offshore, from oc biological sources.
- Material is then transported away by waves and currents and also by the w include traction, saltation, suspension and solution.
- The process of longshore drift transports material along the coast.
- Material is deposited when the energy is lost, or when it clumps together.
- 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 can form across a bay.
- Offshore bars are ridges of material across a bay (that might be submerge like spits, or are glacial deposits pushed towards the shore.
- Barrier beaches are like bars, but are certainly above the water level, and holes are made in the beaches, then they appear to be a series of islands.
- Tombolos are ridges of deposits that link an island to the mainland.
- Cuspate forelands are triangular wedges of material which occur when longsho directions along the coast.
- Coasts are open systems, sediment cells are closed systems.
- Coasts have inputs, outputs, stores and processes.
- Coastal processes work towards dynamic equilibrium. Positive and negative or restore the system to an equilibrium.
- Humans can alter or modify the equilibrium.
- On every coastline, there are many different processes that work together i each other.
- There are 11 sediment cells in England and Wales, which are essentially clo
- Sediment budgets depend on the inputs and outputs of material on a stretch positive or negative.

Transportation

Coasts gain material from the land (e.g. rivers), from cliffs, from offshore and when transported from other areas of the coast (e.g. transported via longshore drift).

- Beaches are said to be 'swash-aligned', or 'drift-aligned', depending on whether the waves strike the beach front-on, or at an angle.
  - Drift-aligned beaches have waves at an angle, meaning that longshor
  - Swash-aligned beaches don't have waves at an angle, so longshore dr

Once eroded material reaches, or is eroded within, the coastal zone, there are f and waves **transport** the material along the coast. The larger the particle, the m move it!

Wind and currents can also entrain and transport material.

From **largest** to smallest material…

Traction:
Largest particles (rocks) are rolled along during storms. They're too large to ever be suspended.

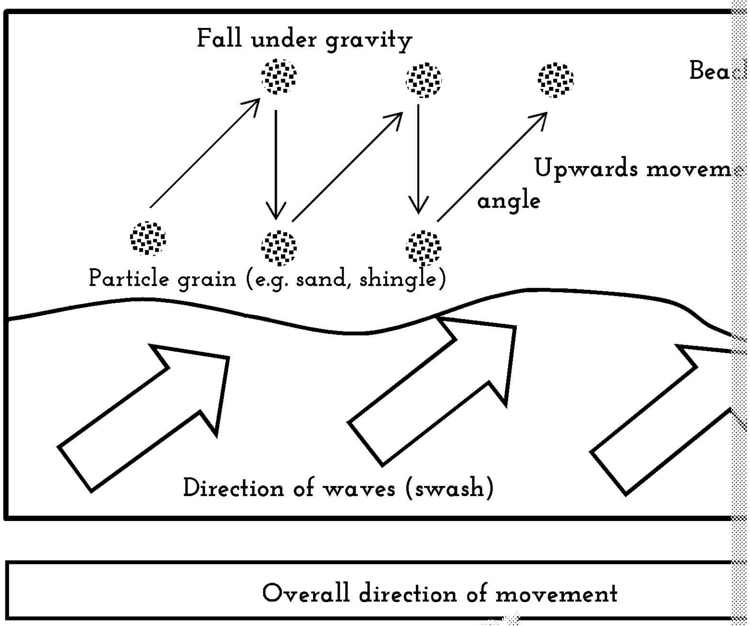
Saltation:
Smaller pebbles or shingle 'bounce' along in stages – require powerful waves.

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

Solution:
Dissolved load (minerals) – essentially invisible.

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, gr sediment.



Deposition

Deposition occurs when:

- The energy is reduced – e.g. wind speed drops.
- Friction slows down the water or wind – such as rough ground surface.
- Flow becomes more turbulent.
- Load increases.

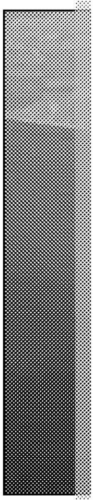
The largest particles are deposited first, as they require the most energy. This is fall out of suspension due to gravity.
Very small particles are deposited due to **flocculation** – particles combine, maki This process occurs in estuaries where fresh and saline (salty) water meet.

Transport and deposition combine to form the following landforms.

Beaches

- Beaches are large gently-sloping deposits of material in sheltered locations, ample supply of material, and by constructive waves.
- 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 calle
- Beaches are stratified – the smallest material is exposed at low tide.
- The profile changes during the year, too – they are often steeper in summe constructive waves.

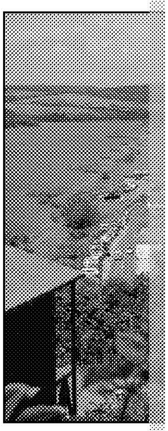
Spits



- **Spits** are protrusions of mat... deposited when the coastline changes d... as at the mouth of an estuary.
- The mat... is ...ed downstream via longshore drift, and contin... into the deeper water, before deposition occurs due to ...ased 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 several types of spit – including simple and recurved, and double spits.

Simple spits	D
Straight or with one hook. E.g. Spurn Head, Sandbanks in Poole	Two dominant winds pro E.g. Christchurch

Offshore Bars



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

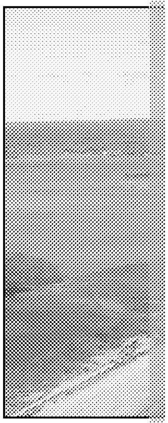
They are thought to be made in two ways:

1. Resulting from longshore drift – like a spit.
2. Accumulated glacial till transported toward... ...e from the oceans (rising sea level after the ... ...).

Offshore bars may be (... ...merged, and protect the coast from t... ...

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

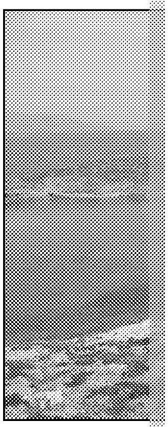
Barrier Beaches and Islands



Barrier beaches are ridges of material above the water level that protect the coast from erosion. Sometimes erosion erodes holes in the barrier, essentially creating a chain of islands.

E.g. Extensive barrier beaches are found on the eastern coast of the United States. Have a look on satellite images to find them!

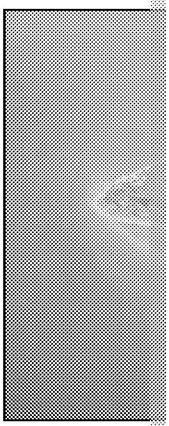
Tombolos



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!

Cuspate Forelands



Longshore drift occurs in opposite directions to create a wedge of land. The example in Dungeness is thought to have been created from glacial material transported via longshore drift, while powerful storms deposited material in protective ridges.

E.g. Dungeness, Kent.

Note that, as we saw in the last chapter (dunes and marshes), vegetation c features. Over time, plant succession occurs.

The Natural Coastal System

We can break down coasts into systems.

Coasts are open systems because they have inputs and outputs of matter and energy.

Most material entering coasts is from outside – rivers.

Coastal systems are driven by energy. They have:

- Inputs
- Stores and components
- Flows
- Processes

o Outputs

Inputs >>> **Processes** >>>

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 or other processes

Energy
- Winds, 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.

You may hear the terms 'sources' and 'sinks'.
- Sources are areas where material is generated from, e.g. inputs and stores.
- Sinks are the stores – e.g. depositional features.
- As noted above, they can sometimes be the same features.

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 **nega**
- These feedback cycles will result in a new equilibrium.
- Human activity, such as coastal engineering, can change the state of equili 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.

Neg
A change in a system storm removing sedim install

Sediment Sources, Cells and Budgets
Sediment cells are **closed systems** because headlands and areas of deep water from one cell to another.

We can apply the concept of a **sediment budget** to an area of coastline, o 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

Coasts receive sediment from a number of sources:

Rivers:
Fine sediment from eroded rock inland – a major source.

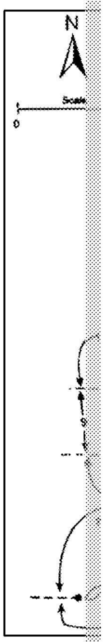
Cl
Mass movement, rockf
cliffs on to

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

Ocean
Upwelling of material

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

We can divide coastlines up into co[illegible] closed systems, where material cycles, but can't e[illegible]. There are 11 **sediment cells (littoral cells)** in En[illegible] Wales. They are separated by headlands, [illegible] 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 stretch of coastline. We must know every source and sink of material, so they are often estimates.

The budget is controlled by erosion and transport:

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

If you only remember these five th

1. Material is transported by waves, currents and w the energy drops. Longshore drift is a process th the coast.
2. Beaches are probably the [illegible] well-known dep require upstream e[illegible] and the deposition of l shingle or [illegible] during the summer. There are bea[illegible] berms and cusps.
3. The formation of spits, tombolos and bars have s narrow ridges of material out to sea, between t and across a bay, respectively. Cuspate forelan deposited material where longshore drift occurs
4. Coasts are open systems – energy and material eventually reach dynamic equilibrium. Natural a positive and negative feedback cycles – a new e achieved.
5. We split the coast into independent sediment ce sediment budgets for a coastline.

Activities

Consolidation questions

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

2. Why does friction cause deposition?

3. Why is material deposited in bays?

4. Some beaches are 'drift-aligned', what is the other type of beach?

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

6. What does a tombolo connect to the mainland?

7. Which depositional feature can protect the coast?

8. Which type of feature is found at Dungeness?

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

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

11. How can a negative sediment budget influence a beach?

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

Take it further

Check out some of the videos here: **zzed.uk/9991-coasts-videos**

Take a look at the documents here: **zzed.uk/9991-coastal-explorer** which f
of coastline where Spurn Head is located. How might the spit be affected b

Take a look at this page on the dynamic landscape at Birling Gap:
zzed.uk/9991-nat-trust-birling

Student checks

Topic	What Do I [illegible]	No idea ☹	Nearly 😐	Sure ☺	
Processes – Transportation and Deposition	Transportation				
	Longshore drift				
	Deposition				
Landscapes of Deposition	Beaches				
	Spits				
	Tombolos				
	Offshore bars				
	Barrier beaches and islands				
Coastal Cycles	The costal system and parts of the cycle				
	Dynamic equilibrium, positive and negative feedback				
	Sediment cells and budgets				

Subaerial Processes (We
Mass Movement and As
Landforms)

Key words

- ✓ **Physical (mechanical) weathering**: The in-situ breakdown of rocks by the c by changes in moisture and, frost, differential temp e, etc.
- ✓ **Chemical weathering**: The in-situ breakdow of ro resulting from the actio contained within seawater.
- ✓ **Biological weathering**: The kdown of rock resulting from the acti plant growth and b atures.
- ✓ **Mass m n downslope transport of soil, bedrock, rock debris or m the i o waves.
- ✓ **Block** pple of rocks from a cliff, rapidly under gravity.
- ✓ **Rotational slump**: As material slides downslope, there is a curved, upwards
- ✓ **Landslides**: Changing run-off and ground disturbance can cause unconsolida flow downhill under gravity.
- ✓ **Talus (scree) slope**: Accumulation of fallen rock debris at the base of a cliff, weathering.
- ✓ **Terraced cliff profile**: Sequence of beaches and cliffs stepping back at diffe caused by ice ages, isostatic and tectonic activity.

Key points

- Weathering affects the cliffs and can be physical, chemical and biological.
- Factors such as climate (temperature and rainfall) affect the rate of weathe types of weathering occur in different locations.
- Some rocks (especially sedimentary and unconsolidated material) are more
- Weathering is not the same as erosion – but they are closely related proces
- Material slides downwards towards the sea under gravity via a number of p term of mass movement. Mass movement is influenced by the type of materi
- Some mass-movement events occur very quickly, while others occur over yea
- Debris piles at the base of cliffs temporarily halt erosion.
- Landforms resulting from mass movement include scars (and debris piles), ta

Geomorphological Processes

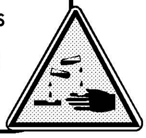
Coasts are not just influenced by the action of th astal recession is also i including weathering and mass movem as ies in different climates retr the effect of climate on weath g a ass movement.

Weather t break-up of rock structure. It's often called *subaeri* occurs on c land not affected by waves, but can be influenced from the the Sun, wind, and rain.

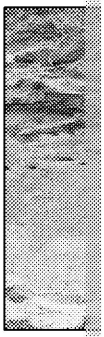
There are three types of weathering:

Physical
Changes to the rock structure, such as:
- freeze–thaw (water expands as it freezes)
- wetting and drying
- heating and cooling / exfoliation
- salt crystallisation (crystal growth exerts pressure)

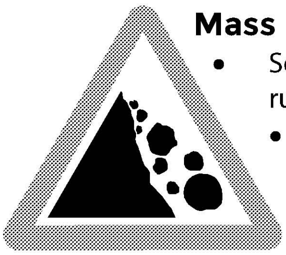
Chemical
Chemical attack on the rock, such as:
- oxidation ('rusting' – adding oxygen)
- carbonation (acid attack)
- hydrolysis – formation of clay from [illegible] rocks
- [illegible] (dissolving soluble minerals)



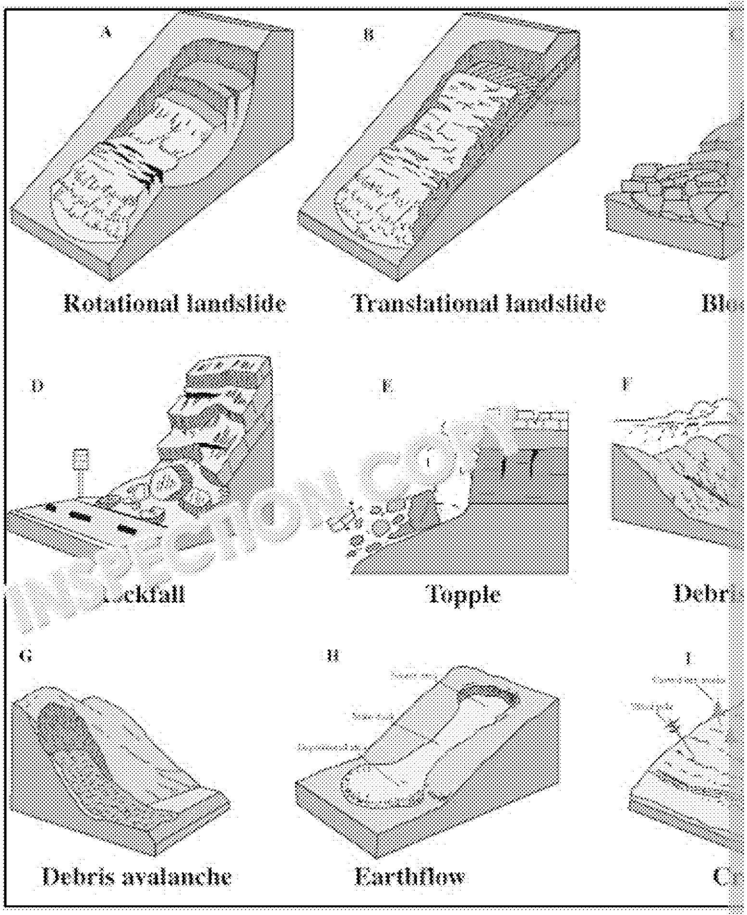
There are f[illegible] wh[illegible] alter the speed of weathering, such as:



- Climat[illegible]
  - Precipitation and temperature – chemical weathering is faster in warm and wet conditions.
  - Diurnal temperature change and the aspect (direction) of cliffs influence the number of freeze–thaw cycles (e.g. north-facing cliffs will stay frozen in the day and have less cycles than south-facing cliffs).
  - Cliffs facing away from the prevailing winds and rain will remain drier.
- Lithology (geology) – softer and unconsolidated geology and well-jointed rocks are more susceptible to erosion. Granite, for example, erodes very slowly, and some rocks are not susceptible to chemic
- Habitats – whether the cliff has plants growing on it, or has burrowing anin in this sandy cliff are made by nesting birds called sand martins. There is als cliff, and a debris pile is seen at its base. The material is unconsolidated, so



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 slo seconds.
    - Mass movement adds material from the land a
    - The mass movement temporarily halts coastal material protects th[illegible] and takes time and re away.



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

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

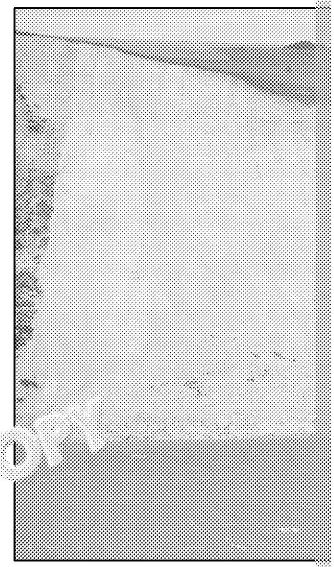
D and E – **rockfalls (blockfalls)** and **topples** occur quickly, blocks fall from the
occur when cliffs are undercut, or from freeze–thaw.

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

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

Features of Mass Movement

Mass movement leads to several features of the cliff.

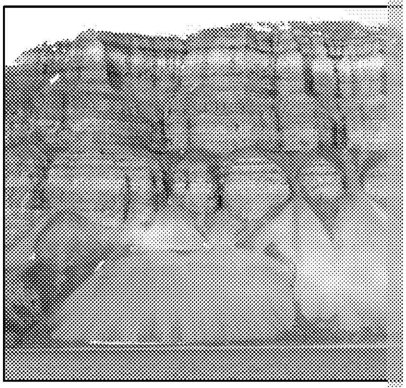


In this photo we can see the scar left behind from a rapid rockfall. We know this happened quickly because the chalk is uniformly white – weathering and plant colonisation have not occurred. The debris pile at the foot of the cliff protects the cliff from the sea while the debris is worn down and transported away.

Chalk is a sedimentary rock that is susceptible to chemical weathering. It is a porous rock that can hold a lot of water, and is well-jointed.

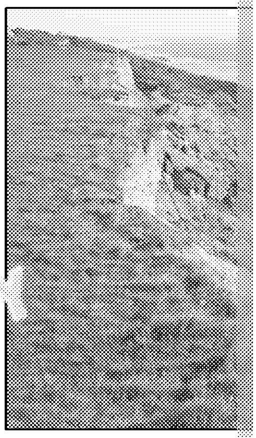
Sometimes you see the scar left behind from the flow of unconsolidated soil and s

E.g. The cliffs of Dover (chalk)



In contrast, this image shows talus slopes in Svalbard. Freeze–thaw weathering has dislodged the material because of the freeze–thaw cycles in the cold environment. The talus (scree) deposits have probably taken many years to build to this size.

E.g. Cold environments



This photo shows a series of cliff terraces caused by several rotational slump events. The material is clearly unconsolidated soil. Vegetation is starting to colonise the lower terraces, which will help to stabilise the surface layers – but further movement to the sea can and probably will occur.

E.g. Norfolk

If you only remember these three th

1. Weathering occurs on the land and cliffs. Materia coastal zone, mainly from rivers.
2. Mass movement causes material to slide or fall fro the beach.
3. Mass-movement events cause characteristic features and terraces. The debris can temporarily halt localis

Activities

Consolidation questions

1. What is the difference between weathering and erosion?

2. Which form of mass movement can be very fast?

3. How does climate affect weathering rates?

4. Which type of material is the slowest to weather?

5. Which type of feature is most likely to occur after freeze–thaw?

6. What is required for cliff terraces to develop?

Take it further

Here's a recent news article: **zzed.uk/9991-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 ☺	
Subaerial Processes	Weathering				
	Mass movement				
	Landforms				

Causes of Sea Level Char Present and Futu

Key words

- ✓ **Ice age**: Sustained period of reduced global temperatures during which ice r and advance into lower altitudes.
- ✓ **Sea level rise**: Addition of water to the oceans, resulting in the water's heigh inundating land and increasing flood risk to low-lying areas.
- ✓ **Isostatic change**: A local change in the level of the ... relative to a fixed s
- ✓ **Eustatic change**: A type of change in sea level ... affects the whole plane volume of water stored in the oceans.
- ✓ **Isostatic readjustment** (... rebound): The surface height of a land level following ice ... therefore pressure release.
- ✓ **Accre**... De... of sediment on the land surface. The weight causes the
- ✓ **Subs**... Lowering of the land's surface locally.
- ✓ **Relic** ...**es / coastlines**: Landforms that were formed in the past – such a longer affected by their original processes, but rather by subaerial process
- ✓ **Raised beach (marine terrace)**: A deposit of sand which formed when the se lower, but is now above the current sea level.
- ✓ **Fossil cliffs**: Cliffs that are located above current sea level. They are no lon 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 trou ages, when sea levels were lower.
- ✓ **Dalmatian coast**: Islands remaining above water level from aligned valleys as sea level rose.
- ✓ **Thermal expansion**: If the atmosphere warms, heat energy is transferred to expands, increasing in volume. This causes sea level to rise.

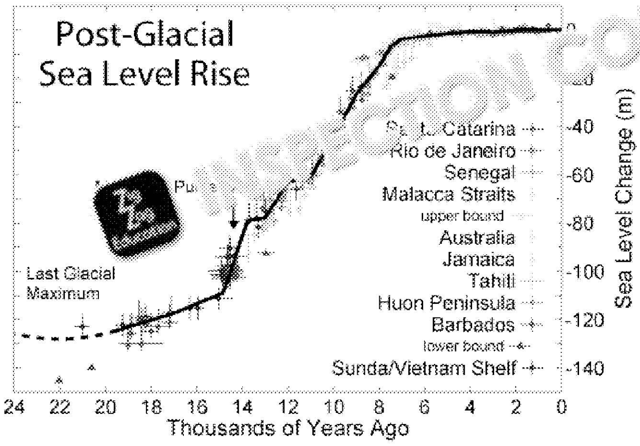
Key points

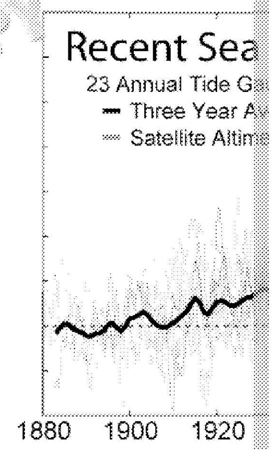
- Sea level is related to climate based on the amount of ice on the land – dur level falls and it rises again once the ice melts.
- Eustatic changes are rises or falls in sea level.
- Isostatic changes are local-scale changes of the land level relative to the oc release of ice weight during an ice age. The UK is currently experiencing re the south is sinking! Accretion and subsidence, and local tectonic activity, are
- If the sea level falls, or the land level rises, then current beaches and featur the sea. They form raised beaches and relic features.
- If sea level rises, then features are flooded – ... flooded glacial trou valleys.
- Sea level is rising due to hu... – rising global temperature is melti accumulates in the oc... water warms, it expands – taking up m
- The eff... of ... level will be devastating to our coastal communities cities ... also other effects, such as water quality issues and loss of f
- Huma... efore need to limit CO_2 emissions to stop the greatest rises in se 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 sn 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 rap down – as shown on the graph overleaf.
- The second graph shows the smaller changes in sea level since 1880. Note centimetres rather than metres.





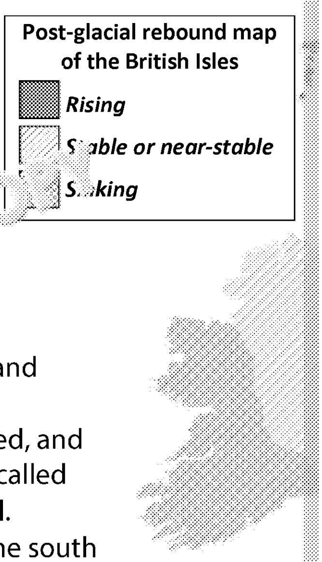
What are Eustatic, Isostatic and Tectonic Change?

Eustatic change
When the global sea level changes.

Iso
When the local la
gl

Eustatic:

- Ice ages cause sea level to rise and fall, depending on the amount of ice on the land.
- Humans are warming the planet through greenhouse gas emissions. This means that sea level is currently 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.



Isostatic:

- During the last ice age, the weight of ice on the land pushed the crust downwards into the mantle.
- Now that the ice has melted, the weight is released, and the land rises once again – quickly at first. This is called **isostatic readjustment** or **post-glacial rebound**.
- In the UK, Scotland had a thicker ice sheet than the south of England. Therefore, this created a pivot effect – Scotland is now rising, while the south is sinking, as shown on the map.

- This can lead to coastal features being stranded away from the sea, while ot
- Isostatic rebound is a very slow process compared to eustatic change.
- **Accretion** is where sediment is deposited on the land. Like ice, the weight

Tectonic:

- Very slow changes – over millions of years. The development of mid-ocean rises upwards. This reduces the volume of the ocean, causing mean sea lev of sea-floor spreading can increase the ocean's volume.
- If tectonic plates collide there is more space for water in the ocean, and a f
- On volcanic islands, lava eruptions can increase or decrease the height of t through the addition of new land, or as erupted lava is spilled into the sea.
- Tectonic uplift or displacement can also raise or lov cal areas of land re

Emergent Features (raise ches (marine platform

- When the land rises faste an level, or if sea levels fall, the current bea longer affected by ey are called '**relic features**'.
- Instea a ected by subaerial processes such as weathering.
- Examp ude raised beaches and wave-cut platforms, fossil cliffs show and other landforms such as stacks.
- Sometimes a series of terraces develops if the sea level drops several times

What are the relic features shown in the photos below?

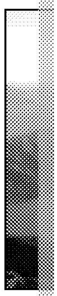
E.g. Isles of Jura and Arran, but also in Cornwall and New Zealand.

Submergent Features (rias and fjords)

- When sea level rises, features that were created on below current sea
- In areas where there were glaciers, these ar n acial troughs.
- In areas without glaciers, these can r valleys.
- Of course, features are als the land sinks (isostatic change).

Rias

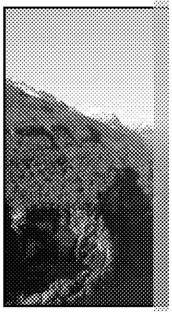
Flooded riv ys and their tributaries mean that unlike the straight fjords, rias b and are much shallower (deepest at the mouth).



E.g. Devon and Cornwall, Sydney – Australia, Chesapeake Bay – United States.

Fjords

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



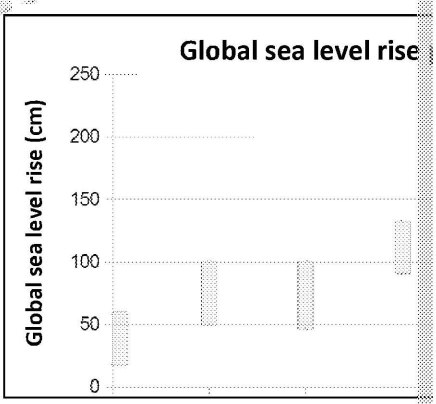
E.g. Norway, Canada and Alaska, New Zealand, Greenland and Chile.

Dalmatian coast

Rias that run parallel to the land, forming ridges of islands.

E.g. Croatia – where the feature is named after.

Predicted Sea Level Rise



Sea level rises in two ways:

- Melted 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 level rise between 2000 and 21… be two metres. This would have catastrophic results to those living in coastal ar…

The speed at which sea level has changed is increasing each year – it's currently…

Furthermore, some coastlines in tectonically active regions are at risk of local is… out of the sea, and causing subsidence in others.

The Future Effects of Sea Level Rise

- One of the largest threats from sea level rise is to the people living in coast… cities developed due to ports – think of London and New York, for example… from the rising sea level will be significant (**adaptation**).
- There are many countries and small islands which are very close to sea level… countries will be flooded.
  - Population will need to migrate further inland, putting pressure on ex… more land.
- Agricultural land will be lost.
  - Increased pressure and intensity inland.
- Aquifers will be contaminated by saltwater, saltwater further up rivers.
- Greater threat of storm surges.
- Increased area exposed to coastal erosion – increased coastal retreat.
- Habitats will also be lost.

If you only remember these three th

1. During ice ages, sea level falls because the water i
   The water returns to the sea during the interglacia
   land pushes the plate downwards into the mantle.
2. If sea level changes, it's called eustatic change. If th
   to the sea, it's an isostatic change. If the land rises /
   emergent features such as raised beaches. If the se
   we get submergent features such as rias (river valle
   troughs).
3. Sea level is rising due to climate change – land ice
   volume is increasing through thermal expansion. The
   catastrophic for those living in coastal areas – includ
   Therefore, we need to reduce CO_2 emissions and li
   that will take place.

Activities

Consolidation questions

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

 ....

2. How has sea level changed over the past 3,000 years?

 ....

 ....

3. Why are parts of Scotland rising out of the sea?

 ....

 ....

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 the areas flooded due to climate chang to determine the temperature, and you can pan the map to show differen world. **zzed.uk/9583-sea-rise-map**

Student checks

Topic	What Do I Know?	No Idea ☹	Nearly 😐	Sure ☺	
Past, Present and Future Climate Change	Past climate change				
	Isostatic, eustatic and tectonic changes				
	Emergent features				
	Submergent features				
	Predicted sea level rise				

The Effects of Coastal Rec
Flooding – and Why It's a

Key words

- ✓ **Dam-building:** Building dams inland cuts off much of the sediment reaching t to increased erosion.
- ✓ **Dredging:** The removal of sand and gravel from the coast, thought by some t of coastal erosion.
- ✓ **Coastal management:** Technique of controlling th[illegible] [illegible]f coastal erosion c
- ✓ **Coastal flooding:** The sudden inundation of [illegible] which occurs when se normal high-tide water levels.
- ✓ **Depression:** Low-pressure [illegible]tem associated with strong winds and coastal flooding du[illegible] onshore winds and low pressure (storm surge).
- ✓ **Tropic[illegible]** [illegible]olving storm found near to the equator, fuelled by w seve[illegible] r[illegible]ult, a cause of coastal flooding.
- ✓ **Storm[illegible]:** An offshore rise in sea level – low-pressure weather systems a flooding, e.g. from tropical cyclones, depressions and funnelling from the sho
- ✓ **Mangroves:** Tropical forests which grow in intertidal zones. They are import from flooding.
- ✓ **Climate change:** Alteration to long-term weather patterns, e.g. increased te which can influence sea level and storm occurrence and severity.
- ✓ **Adaptation:** Coping with the effects of sea level rise.
- ✓ **Mitigation:** Reducing the severity of climate change.
- ✓ **Climate refugee:** A person who has been forced to move from their home b changing climate, such as sea level rise, or droughts.

Key points

- Coastlines retreat because of the erosion, weathering and mass-movement p geology that have been covered in the previous chapters. Erosion rates are throughout the year – winter storms can cause sudden retreat.
- Coastal communities are under threat of coastal flooding because of climate increased severity of storms.
- Coastal areas are also under threat from increased coastal erosion because dredging, and coastal management – all three can reduce the availability o
- Coastal flooding also occurs because of storm surges from both depressions cyclones.
- To reduce the threat of coastal erosion and sea level rise, we need to reduc (mitigation) and adapt to cope with the remainin[illegible].
- The effects of coastal recession and floodin[illegible] [illegible]lassified as social and include homeowners, businesses [illegible]ru[illegible]re – in countries of all levels
- Rising sea level will cre[illegible] climate refugees – forced from their h Bangladesh and [illegible] As many as 2 billion people could be displac

Natural Causes of Coastal Recession (retreat)

These causes have already been covered in the previous chapters on coastal er mass movement. If you need a quick refresher, read the points below:

- Coastal erosion processes undercut cliffs to create notches (hydraulic actio cliffs collapse.
- Erosion rates change with the seasons. Much of the erosion in coasts occur (powerful, destructive waves), and immense hydraulic action. There is less beach profiles are built up with constructive waves. A single storm can sig causing large cliffs or features to collapse.

- On long-term scales, we classify coasts as high-energy or low-energy – high shores and more erosional features compared to the sandy beaches and de energy coasts.
- Long-term wind direction affects longshore drift, and the development of spits and bars. While deposited material builds up beaches, it is quickly mo the erosion rates.
- Fetch is the distance that wind has blown over water. The longer the fetch, imparted to the waves.
- Tidal range affects erosion – the higher up cliffs the water reaches, the grea
- Geology – the weaker and more jointed the rock (especially unconsolidated susceptible it is to erosion and mass movement. Igneous rocks erode very s
- Weathering and mass movement work together to erode cliffs that are not waves and currents. The speed of mass movement is influenced by geology

Human Causes of Coastal Recession

When coasts are starved of sediment, the effectiveness of natural barriers includ bars is reduced and coastal recession increases. The impacts can be generated by a dredging companies (who may have government permits), to national governm

- Dams – building large dams reduces the flow of sediment from rivers. App the coastal zone is derived from rivers – the impact can be severe. The Nile construction of the Aswan Dam in 1964, causing rapid recession and subsid
- Dredging – sand is a non-renewable resource and rapid urbanisation is inc concrete. Material is dredged from offshore, removing natural barriers and beaches. Material is also dredged for beach nourishment.
- Management – more on coastal management in the next chapter – but off nourishment and building groynes trap sediment. The sediment trapped b transported down the coast by longshore drift.

Coastal Flooding

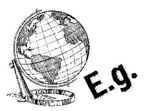
Coastal areas are at risk from flooding. The risk is increased through local chang surges, and sea level and climate change. Some coasts, especially low-lying coas risk of flooding, especially those in areas where tropical cyclones also occur. Flo than the risk of coastal erosion.

- In local areas, people are increasing the risk of flooding, removing the natu mangrove forests. Mangrove forests reduce the height of incoming waves
- Climate change is melting land-ice, adding water volume to the ocean. Thi expansion. Low-lying islands are most at risk – two thirds of Bangladesh is l sea level. Islands such as the Maldives are under threat as the highest point above sea level. Small rises in sea level will flood large parts of these countr resulting in thousands of people being evacuated from their homes.
- Storm surges are caused in two ways:
  - Winter storms (depressions) – occur at high tide (including spring tides low air pressure release pressure on the ocean, helping to pull up the h can also increase flood risk, such as a funnelling effect of the coast – e and 2013.
  - Tropical cyclones (e.g. hurricanes) – the same factors occur as the hurri effects are often extreme, e.g. Hurricane Sandy.
- Climate change will increase the threat of storm surges by combining high frequency of winter storms, and the increased severity of storms and hurric water, the more energy given to hurricanes.
- There are always uncertainties over the effects of climate change, which in
  - Using models to predict future changes.
  - Complex climate systems may not be fully understood and there are m land use change.
  - We're not certain how much greenhouse gases humans will produce – mitigation, development, etc. That's why we develop different emissio

- There are two ways of coping with climate change:
  - **Mitigation** is reducing the scale of change (e.g. reducing CO_2 emissio
  - **Adaptation** is coping with the effects of climate change after the war
- **To cope with climate change, we need both adaptation and mitigation.**
- In the UK, we've built many coastal defences including following the East C Thames Barrier to protect London.

Effects of Coastal Recession and Coastal Flooding

- Houses and property are lost slowly as part of coastal recession, while coas areas very quickly.
- The effects can be:
  - economic – value of the lost and damaged property (housing and bui pipelines and cables), agricultural land and business premises and cos residents may receive some compensation for their loss of property
  - social – relocation and health effects (including stress and mental hea property, housing and the need to move
- Property ... st throughout the world – tropical cyclones affect both develo The res... be catastrophic – for example the loss of economically impo

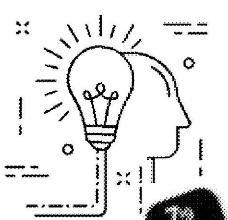


- Hurricane Katrina (United States, 2005) – a catastrophic caused a 7.5–8.5 metre storm surge
- Hurricane Irma (Caribbean, 2017)
- UK winter storms of 2013–2014

Climate Refugees

- **Climate refugees** are people who are forced to relocate to more hospitab This could either be due to climate (e.g. droughts and water insecurity), or levels. Climate refugees can either result from a single event, or the move worsen.
- Greater pressure is placed on the land in the areas which refugees migrate for jobs, housing and personal stress for the individuals involved.
- A scientific paper published in 2017 suggested that by 2100 there could be caused by sea level rise. The total human population could be 11 billion by
- Those affected will live in coastal areas and low-lying islands.

If you only remember these three th



1. Natural coastal processes, geology and human act coastal recession and flooding by raising sea level storm surges.
2. Climate change is a major threat to millions of peo ... the threat, we need to reduce the level o learn to cope with the effects of change (adaptatio
3. Sea level rise will displace millions of people from climate refugees. One paper in 2017 suggests tha refugees resulting from climate change by 2100.

Activities

Consolidation questions

1. When does the most erosion occur?

2. Why can dam-building increase the coastal recession rate?

3. What are the two causes of storm surges?

4. Which feature protects London from storm surges?

5. What is a consequence of climate refugees?

Take it further

Read the following article on the key moments of the 2013–2014 winter st
zzed.uk/9991-winter-storms

Read about Hurricane Sandy's storm surge at:
zzed.uk/9991-sandy-storm

While the actual paper is inaccessible, here's an article outlining the 2 bill
refugee figure.
zzed.uk/9991-rising-seas

Student checks

Topic	What Do I Know?	No Idea ☹	Nearly 😐	Sure ☺	
The Effects of Coastal Recession and Flooding	Natural causes of coastal recession				
	Human causes of coastal recession				
	Causes of coastal flooding				
	Effects of coastal flooding and recession				
	Climate refugees				

Coastal Managem

Key words

- **Coastal management:** Technique of controlling the rate of coastal erosion o protection.
- **Hard engineering:** The construction of large-scale construction schemes to di processes, in order to defend an area against flooding or coastal erosion.
- **Soft engineering:** The use of the natural environments and materials that wo provide defence against flooding or coastal erosion.
- **Sustainable management:** Policies which promote long-lasting, beneficial a
- **Strategic realignment:** Management which allows coastal erosion including n of depositional features such as marshes.
- **Hold the line:** Maintaining the existing coastline by retaining current flood d structures in locations where they have not previously existed.
- **No active intervention:** Letting nature take its course by not interfering with
- **Shoreline Management Plans (SMPs):** Long-term plans in England and Wa coast, considering the effects of management on people and the environ
- **Integrated Coastal Zone Management (ICZM):** Sustainable development w *encompassing the system as a whole, and accounting for different land uses*
- **Cost–Benefit Analysis (CBA):** The process of choosing whether a scheme is financial, social and environmental advantages and disadvantages.
- **Environmental Impact Assessment (EIA):** A study commissioned to find out engineering strategy upon the natural world.
- **Winners:** People who benefit from coastal management – e.g. those who ow by a hold-the-line policy.
- **Losers:** People who lose out from coastal management – e.g. those who own are not planned for their section of the coast, meaning that their property w
- **Conflicts:** Tensions between the different users in a coastal environment – e outcome.

Key points

- We use coastal engineering to protect areas of the coast from erosion, and flooding.
- In the past, areas of the coast were protected by hard engineering projects effective, but having the ability to damage the environment, including down
- Nowadays, sustainable management and soft engineering are preferred. T ensure that coasts are protected for future generations.
- In England and Wales, we manage coasts through Shoreline Management P / sub-cell level. We can use all of the different hard and soft options, and protected or allowed to erode, based on the value or use of the land.
- A larger-scale sustainable management scheme is Integrated Coastal Zone covers both land and sea, and all of these land uses.
- We can use a tool called Cost–Benefit Analysis (CBA) to decide whether the outweigh the benefits.
- Each scheme must have an Environmental Impact Assessment to appraise the e the construction process and later operation of the scheme.
- Coastlines are complicated areas with many different uses. Some will be these winners. But others will inevitably lose out – we call them losers. Mana conflicts between planners and losers.

Why Do We Manage the Coast?

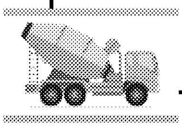
Coastlines are very important to us – many of us live near the coast, and we use for shipping, agricultural land and tourism.

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 (coastal recession) Some coastlines are very valuable – especially around large towns and cities. In these cases, we want to stop coastal retreat.	**Reduce** Sometimes we want ...rges, made worse ... 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 <u>expensive</u> projects, can damage the environment and can be visually obtrusive.
- They are said to work **against** nature. Their use may have unforeseen consequences.

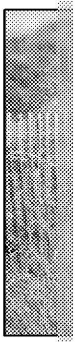
Here's a rundown of some common types.

Name of scheme	How it works	Advantages
Groynes	Wooden structures run across the beach, designed to trap sand and shingle being moved by longshore drift.	Allow for the development of beaches for tourist use.
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.

Name of scheme	How it works	Advantages
Rip rap (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.
Offshore breakwater	Waves break out to sea, reducing the erosion at the coast.	Can create habitats – artificial reefs.

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

Soft Engineering



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

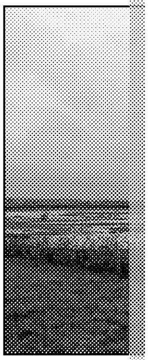
Here's a rundown of some common types.

Name of scheme	How it works	Advantages
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.
Cliff regrading and drainage	Reduces the potential for mass movement (e.g. by reducing the angle of cliffs and the water content of cliffs).	Protects infrastructure and maintains tourist amenities.
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 it for us!

Another 'soft' form of management is climate change mitigation – reducing
and therefore sea level.

Sustainable Management

Recently, there has been an increase in various forms of management. Sustainable management decreases our impact on the coast, so that 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.

Sustainable management takes in many different aspects such as the enviro habitat value), land use and cultural heritage (and therefore value), settleme social and political components, in addition to the feasibility of the coastal e many users of the coast, and each user has different demands. Therefore co each person differently, and some may be opposed if they perceive the effe that coastal engineering is a complex process!

Sustainable coastal engineering includes management, monitoring and adap include relocation of residents and finding alternative livelihoods.

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

Hold the line
Maintain coastal defences to stop erosion – e.g. maintain a sea wall.

Advance the line
Build defences further out to sea by building up more land – e.g. new marshes.

Managed retreat (strategic realignmen
Allow coastal erosio but also the natural protective developme of depositional featur such as marshes.

STOP

Shoreline Management Plans (SMPs) – England and

A combination of the four methods above can be used within **shoreline manag plans**. There are 22 plans in England and Wales, which cover all 11 sediment ce some of their sub-cells. The plans assume that sediment cells are closed system

The management plans are based on three time scales – up to a hundred years i future – to plan how the shape of the coast will change. Different policies are cr order to protect important areas, in some cases letting other areas erode to prov sediment source for places further along the coast in the direction of longshore sustainable approach.

The plans contain maps showing the predicted position of the coast over a rang the forms of management used. They also ensure that all international policies a

The plans are designed to link together the different authorities which are resp that actions in one place don't adversely affect other places.

Integrated Coastal Zone Management (ICZM)

An overarching, large-scale form of sustainable management is Integrated Coas developed after the 1992 Rio Earth Summit. Sustainable management protects All different users of the landscape, on a local scale, are considered within the p coast and ensure that some uses don't cause problems elsewhere.

ICZM takes into account long-term changes and uses, and monitors these over 'holistic' to describe ICZM – it means overarching – that all users, uses, social, en resources are included, and the wider landscape is considered. Coastlines are u development from many sources.

E.g. EU, Maritime Spatial Planning (MSP).

Cost-Benefit Analysis (CBA)

To help work out whether the costs or benefits of coastal protection are greater, analysis' can be used. The costs and benefits can be environmental, social and e tool can be ...e.

For example, we can weigh up:

- cost of the engineering vs value of the land and housing
- cost of erosion in the area vs downstream sediment availability and protec SMP/ICZM)
- cost of the social stress of moving vs benefits of a scheme

Some of the costs and benefits are difficult to measure. How easily can you put the social upheaval of moving?

Environmental Impact Assessment (EIA)

All coastal engineering projects have an assessment of the damage that they co The impacts can include changes to erosion and deposition rates and their effe sediment budgets and water quality, and the impacts while the engineering wo

The assessment is a report that looks at both the construction and long-term in is completed.

Winners and Losers

Because of the complex coastal environment with many users and landowners, will always cause someone problems. SMPs look at large stretches of coastline s consider – on the land surrounding the coast, on the beaches, and offshore uses Engineering is expensive – so cost benefit analysis m... the value of the la cost of engineering works.

Some people are seen as 'winners' (who benefit from the scheme) and others as disadvantaged). There will always be some people who will be seen to lose out, property fo... greater need of a downstream sediment supply. However, the s throughout the world. In less developed countries the rural poor have the most and flooding – including property, land and livelihoods.

The issue of winners and losers creates **conflicts** – for example, landowners wh authorities who cannot afford protection, environmental pressure groups who s environmentally damaging, and planners responsible for overseeing ICZM.

In the following scenario, a person living in a village where no active interventio
loser. However, someone living down the coast and who is, therefore, protecte
are winners if the coastal recession leads to marsh development (great habitat f

If you only remember these three th

❶ We manage our coasts to reduce erosion and c
to be careful – stopping erosion in one place ca
places along the coastline.

❷ We used to use hard engineering – building lo
for example. Of course we still use hard engine
protect important places – but we now try to us
or soft engineering.

❸ With pressures on the coast increasing with pop
development and sea level rise, sustainable ma
the coasts for future generations. ICZM, SMPs, C
checking and implementing sustainable manage
or management within one part of the coast do
places. However, there will always be winners a

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?

....

5. How many Shoreline Management Plans are there in England and Wales?

....

6. Which sustainable management structure was implemented following the

....

7. Which tool can be used to appraise whether the advantages of coastal pro
disadvantages?

....

8. What report must be completed before any coastal management scheme

....

9. Why does coastal management inevitably lead to conflicts?

....

....

Take it further

See whether your nearest stretch of coast is being managed (mainly Engla
zzed.uk/9583-coastal-erosion-map

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

You can also see how coastal flooding affects culture – here's an example
which is experiencing rapid flooding in the coastal ecosystem: **zzed.uk/95**

Student checks

Topic	Wh[illegible]ow?	No Idea ☹	Nearly 😐	Sure ☺	
Coastal Management	Reasons for managing the coast				
	Hard engineering				
	Soft engineering				
	Sustainable management				
	Shoreline Management Plans				
	Integrated Coastal Zone Management				
	Cost–benef[illegible]				
	Environmental Impact Assessments				
	Winners, losers and conflicts				

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 everyth

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 examiners order the questions for a reason, and earlier questions might help you answer later ones.

Reading th

- Too often stud and lose marks
- It might be use and command w what the questi

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 be put off by h around you.
- Any mistakes y don't use corre
- If you get stuck go on to anoth back to it at th
- Adopt a forma and concisely.
- Your introducti issue at hand, g information.
- The body of yo evidence for yo the points you For long-answ demonstrate y recommendati need to presen 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 have used, and put them in the correct order in your answer book, using a treasury tag to attach them if needed.
- Put a line through any pages you don't want marking, 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 wher 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 unsu include them only when they are relevant and useful.

Getting the tone right

As well as using key geograph[illegible] te[illegible] in your answers, your writing should st This helps your answe[illegible] considered and professional.

Do ✓	Do
• 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 • 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 language • Use rhetorical qu

It might help to think of yourself talking to your examiner, or a geography teac don't know you, so you need to make sure you are clear, but they do know abo to explain every key term you use if 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 senten getting too long, which aids with clarity and readability.

While examiners are used to reading all sorts of handwrit[illegible] it is good to try to answers as legible as possible. One way to do thi[illegible] o[illegible] w down while writin letters are an appropriate size. The final r[illegible] h[illegible] gh of your answers before f any words which are especially tr[illegible]

Qu[illegible] o[illegible] [illegible]tity: writing skills are only important in that they h n[illegible] clear and communicate your geographical knowledge and u ha[illegible] focused and clear answer than a waffled answer stuffed with c question.

In the event of emergencies!

- All your planning and preparation means this isn't going to happen... But i
  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 con

'Thinking like a geographer' and 'synopticity'

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

As you are well aware, the world is a complicated place of cause and effect, and a
pull information together, join up the dots, and work out why things happen in
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 tha
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

- Think across the social/natural divide, using your knowledge of b
  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 cu
  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, l
  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 in

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 Landscapes and Processes

1. Nearshore.
2. Rocky shores, often with high cliffs, powerful, destructive waves with strong b
3. Unconsolidated material – e.g. sands, gravels and boulder clay.
4. The cracks in the rocks are weaknesses which can be exploited by erosional
5. Rocks that are tilted towards the sea are more likely to erode quicker than r away from the sea.
6. Concordant coasts.
7. Roots stabilise the dune, meaning that erosion is less likely. The stems also by slowing down the wind speed and therefore the ability to transport ma
8. Mudflats don't have vegetation – however they later become colonised by devel

Erosion Processes and Landforms

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. Low-energy.
4. Any suitable difference, e.g. build up the beach or erode the beach, spilling outgoing tides, frequency.
5. Neap tide.
6. Ridges created by successive high tides.
7. a. hydraulic action (wave quarrying); b. solution; c. attrition.
8. Undercutting creates a notch – eventually the overburden collapses.
9. The hard rock is eroded slower, causing the headlands. Softer rock in betw the bays.
10. Arch.

Transport and Deposition – Processes and Landforms

1. Suspension.
2. The wind or water has less velocity, meaning that it can't support as much
3. Bays are more sheltered, reducing the amount of energy for suspension, et
4. Swash-aligned.
5. Supply of sediment being transported down the coast, and a change in co mouth of an estuary.
6. An island.
7. Barrier beach.
8. Cuspate foreland.
9. Allow any suitable suggestion, including from the land (rivers, subaerial pr from out at sea, and from marine creatures.
10. Allow any suitable explanation, such as wind, waves, currents.
11. Smaller, lower, eroded beach.
12. Chang equilibrium, many processes occurring at the same time, feedb

Subaerial Processes (Weathering, Mass Movement and

1. Weathering is in-situ break-up of rock, erosion transports the rock away.
2. Blockfall.
3. Moisture and warmth speed up chemical weathering, affect physical weat
4. Igneous rocks.
5. Talus (scree) slope.
6. Rotational movement of material, occurring over several periods. Allow an material over impermeable rock.

Causes of Sea Level Change (Past, Present and Future)

1. Around 120 metres.
2. Very little change until the last 140 or so years.
3. Isostatic rebound – the greater weight of ice pushed Scotland further dow of the UK.
4. Subaerial weathering and mass movement.
5. It's unknown how much CO_2 we will produce and therefore the amount of models and emissions scenarios. We also don't know for certain how some warming – they could melt faster than predicted.

The Effects of Coastal Recession and Flooding – and W

1. During the winter months, especially caused by wir[illegible] torms.
2. Most of the input of material into the coasta[illegible] from rivers. Dams trap beaches have less ability to protect [illegible]
3. Depressions (winter storms[illegible] [illegible]canes, especially those that coincide tides.
4. The Th[illegible] Ba[illegible]
5. Great [illegible]l stress through the migration process, loss of homes and pr increase[illegible] environmental pressure and pressure on the job market in the a

Coastal Management

1. To reduce the threat of coastal flooding.
2. They disrupt natural processes – e.g. cause sediment starvation downstrea physically disrupt the environment.
3. Either beach nourishment or reprofiling.
4. Do nothing (no active intervention).
5. 22.
6. ICZM.
7. Cost–benefit analysis.
8. Environmental Impact Assessment.
9. Within any scheme covering lots of different stakeholders, there will alway to complain about a scheme.