2.3 COASTS

Waves

- **Fetch:** the amount of open water over which a wave has passed.
- **Swash:** the movement of water up the beach.
- **Backwash:** the movement of water down the beach.

Types of waves

Constructive	**Destructive**
Lower energy; more gentle	Higher energy
Spilling breakers; roll onto the beach	Plunging breakers; crash onto the beach
Longer wavelength; further distance between crests	Shorter wavelength; less distance between crests
Elliptical orbit	Circular orbit
Lower height & low gradient	Larger height & steep gradient
Less than 8 waves per min; low frequency	13–15 waves per min; higher frequency
Swash > backwash	Backwash > swash (however destructive wave swash > constructive wave swash)
They deposit	They erode
Typically found in sheltered bays and spits where they build sandy beaches.	Usually found in more exposed bays, where they build pebble beaches.

Longshore Drift

The movement of material along a beach by wave action.

- Prevailing winds cause waves to approach the shore at an angle.
- Swash carries loose material up the beach at an angle, in the same direction as prevailing wind.
- Backwash takes material back out at 90 degrees, perpendicular to the beach.
- This creates a zigzag motion that moves material along the beach.

Erosion

Coastal erosion is the wearing or breaking away of the coast by waves.

Occurs when backwash > swash

Processes of Coastal Erosion

Hydraulic action - Air enters cracks - Waves hit the cliff face and compress the air in the cracks - Cliffs are eroded by the power/weight of breaking waves; Undercutting/collapse NOTE: Hydraulic action makes the most impact during storms
Corrasion/abrasion - Waves pick up loose materials - These are thrown against cliffs, wearing away rocks. - This is known as sandpaper action. NOTE: over time, a wave-cut notch forms as cliff material is loosened.
Attrition: Materials reduce in size as they hit each other when being carried or moved around by waves.
Corrosion/solution: - Chemicals or acids in seawater - Dissolve or wear away rocks like limestone

NOTE: Undercutting is the erosion of material at the foot of a cliff. Eventually, the cliff cannot take the weight of the overhanging section and this section collapses.

Erosional processes that shape cliffs:

- Hydraulic action
- Corrasion/abrasion
- Corrosion
- Undercutting & Slumping/collapse

Factors affecting rate of coastal erosion

Coastal erosion is high when:

- Waves have a large fetch.
- Prevailing winds blow for a long time, creating destructive waves.
- The area of coastline has no beach to buffer the waves.
- The cliff material is soft.
- Cliffs made from rock have many joints.
- A headland sticks out into the sea and waves converge on it (wave refraction).

Features of erosion

Headlands & bays

Headland: An area of hard rock that sticks out into the sea.

Bay: A wide, open, curving indentation of the sea

How does a headland develop?

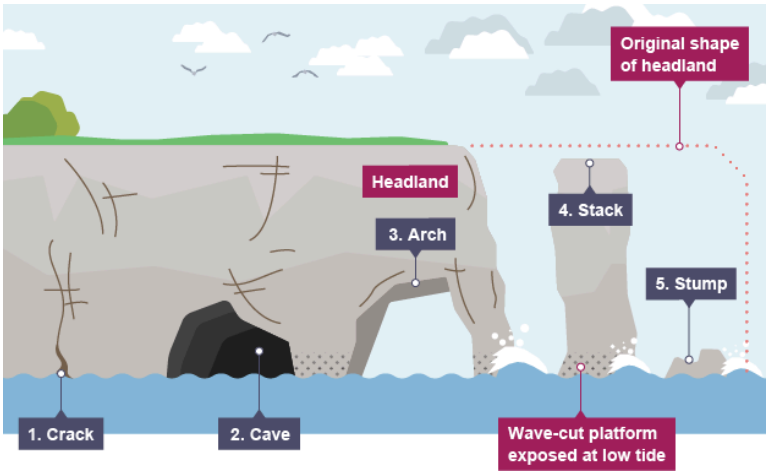
- Formed of resistant rock/hard rock
- Not eroded rapidly, so protrudes into sea,
- Softer rocks on either side are worn back more quickly

Why do bays and headlands form along a coastline?

- Alternate bands of hard and soft rock along coastline
- Hard rocks are resistant to erosion
- Soft rocks are easily eroded
- Hard rock forms headlands
- Soft rocks forms bays
- Differential erosion takes place

Erosion of Headlands

Stage 1: Waves attack a line of weakness in the headland.	
Stage 2: A cave is formed.	
Stage 3: The cave erodes through the headland to form an arch.	
Stage 4: The roof of the arch collapses leaving a column of rock called a stack.	
Stage 5: The base of the stack is then eroded which causes it to collapse leaving a stump.	



- Waves crash against the rocks
- Erosion of line of weakness/joint by hydraulic action (explain)
- Line of weakness enlarges
- Formation of cave
- Back to back caves develop on either side
- Waves break through, and the headland erodes all the way through to form an arch
- Weathering and further erosion takes place; cannot hold weight
- Collapse of arch
- Stack remains isolated from cliff
- Further erosion of stack/formation of stump

Describe an arch (from an image)

- steep slopes/steep
- bare rock/rock/rocky
- area where rock has been worn away/large hole in it/large section
- shape of a bridge
- cracks in rock/joints/faults
- uneven/jagged

How might an arch change in the future as a result of natural processes?

- Further/more erosion will occur
- Hole/arch will become bigger
- roof of arch will get thinner/become unsupported
- Collapse of arch
- Formation of stack
- Further erosion of stack/formation of stump

Features of a stack

- Bare rock/rocky/resistant/hard
- Tall/great height
- Narrow/narrower at base/wider at top/notch at bottom
- Surrounded by sea/separate from main coastline
- Layers of rock/sedimentary

Suggest why a coastline is not straight.

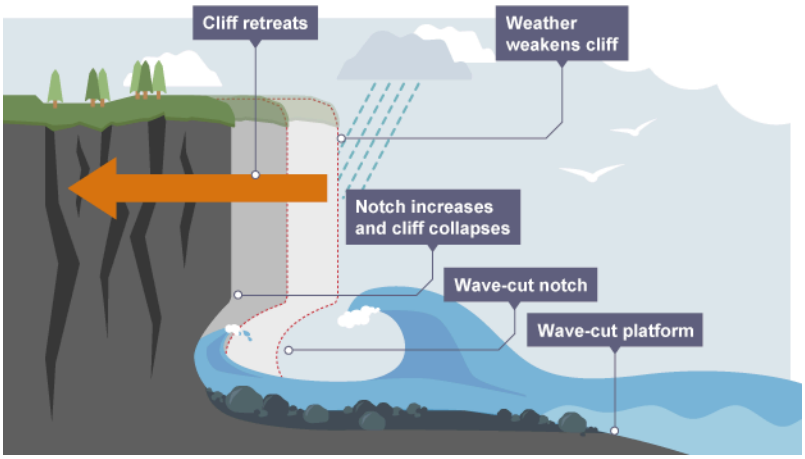
- Different rock types outcrop along the coast/alternating hard and soft/There are areas of soft rock/hard rock;
- Headlands likely to be harder rock/more resistant
- Bays likely to be softer/less resistant/unconsolidated rock
- Hard rock will not have eroded as rapidly, while soft rock erodes very rapidly
- Erosion has taken place at different speeds/differential erosion
- There may be faults/lines of weaknesses etc.

Wave-cut Platform

A gently sloping rock surface found at the base of a coastal cliff. It is covered by water at high tide but is exposed at low tide.

Explain how a wave-cut platform is formed by coastal erosion.

- It is formed by erosion of cliffs
- Hydraulic action / abrasion (or descriptions)
- Undercutting/erosion at base
- Wave cut notch is formed
- Cliff becomes unstable/ overhang collapses/ cannot support weight.
- Cliff retreats and wave cut platform remains/base of previous cliff
- Smoothing by waves



Characteristics of wave cut platforms

- Low/at sea level/likely to be covered by high tide
- Solid rock / hard rock / rocky
- Flat/gently sloping
- But not perfectly smooth / contains rock pools / joints
- Some loose rock material on it
- Located at base of cliff / under the cliff / front of cliff
- White/cream/grey

Why would a cliff be eroding rapidly?

- Soft/unconsolidated rock/clay
- Saturated rock/soil/clay/heavy rainfall weakens cliff/slumping
- There are no protective measures for the cliffs/no groynes/lack of beach
- Large/strong/destructive waves/storms
- Long fetch
- Lack of vegetation

Explain why coastal erosion is more rapid on some coasts than others

- rock type
- consolidated or unconsolidated rock
- hard/strong or soft/weak rock
- presence of lines of weakness/joints/bedding planes
- whether rocks will be eroded by corrosion or not
- wave power/wave type/amount of swash and backwash
- presence or absence of coastal defences
- distance of fetch
- stabilised by vegetation
- width of/presence of beach or whether shallow or deep water
- shelter
- wind strength
- wave refraction
- impact of other processes e.g. sub–aerial processes etc.

Problems caused by coastal erosion for the people in that area.

- Loss of farmland/farmers lose jobs / reduction in food production
- Collapse/damage to housing
- Loss of gardens/yards/backyards/fences
- Roads/paths/parking areas destroyed; access disrupted
- Danger to people/children from collapsing cliffs
- Damage to underground drainage/water supply pipes/gas pipes/electricity cables

- People forced to move away from their homes/evacuation
- Property values go down; people are unable to get insurance/cannot sell their home
- Cliff top businesses damaged/closed down
- Negative impact on tourism
- Cost of protection measures

Deposition

A process involving the load/materials being dropped/dumped/left behind by the waves/the build-up of materials on a beach or by the sea.
Occurs when swash > backwash

Where do coastal erosion and coastal deposition occur?

- Coastal erosion occurs where the area is exposed to prevailing winds. Here the waves will be large, and the fetch will be long.
- Coastal deposition occurs where the area is sheltered or protected by land.

Beaches

Landform formed due to deposition by the sea.

Why do beaches form in bays?

- Bays are sheltered
- Refraction of waves may occur
- Shallow water
- Constructive waves/low energy waves
- Deposition occurs/sediment builds up

Variation of beach material along the beach transect (from sea to cliff):

- Sand/smaller material is near the sea; no sand near the cliff
- More shingle in the middle section - mixture of smaller and larger
- Pebbles/large materials higher up beach
- The wave cut platform is generally rocky

Reasons for variation in beach materials:

- Some materials are from the cliffs
- Some are deposited by waves
- Materials are sorted by sea
- Longshore drift can add to the beach
- Strong swash and weak backwash: material is moved up the beach by swash, but is too heavy to be removed by backwash; only finer materials moved by backwash.
- Constructive/destructive waves

- Boulders/large rocks are deposited during storms

Why do beaches vary from place to place?
- rock type along coast
- effects of swash/backwash
- impact of longshore drift
- wave type/destructive or constructive waves
- size of waves
- prevailing winds/direction/speed
- impact of sea defences
- whether used by people
- large rocks near cliff because fallen from cliff
- smaller material near sea as affected by attrition from waves

Bars & Spits

Located where material is abundant, where coastline is irregular, in estuaries/rivers.
Spit: a beach of sand or shingle linked at one end to land.

Describe the features of a sand spit and explain how it has been formed, including a labelled diagram or a series of diagrams. (7 marks)
Features: Shape, Location, Height, Other features e.g. dunes, salt marsh behind it.
Formation: Constructive waves, Swash, Backwash, Zig zag movement of materials, Change in direction of coastline, Longshore drift, Deposition, prevailing wind.

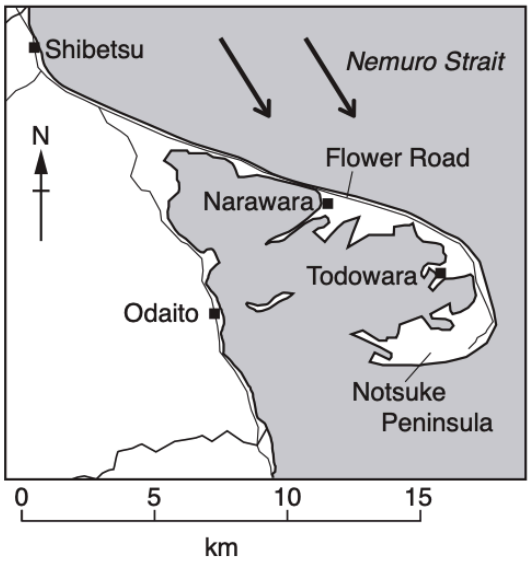
<u>Features</u>
Shape:
- Long and thin/elongated
- Curved/hooked end
- Attached to land at one end only

Location: Stretches partly across estuary/bay/river mouth, where wave energy is low.
Height: Low in height/just above sea level

Other features:
- made of sand shingle/may be covered by sand dunes/deposited material
- marsh develops behind spit

<u>Formation</u>
- Prevailing winds cause waves to approach the shore at an angle.
- Swash carries loose material up the beach at an angle, in the same direction as prevailing wind.

- Backwash takes material back out at 90 degrees, perpendicular to the beach.
- This creates a zigzag motion that moves material along the beach.
- This process is called longshore drift.
- Spit develops where there is change in direction of coastline; in estuary/river mouth.
- They become recurved/hooked by strong waves from other directions / when waves undergo refraction.



Sand dunes

Conditions required for formation of sand dunes:

- Flat land/around an estuary/on a sand spit
- Onshore winds
- Supply of sand
- Obstruction for sand to build up around
- Vegetation, for plants to colonise/marram grass to anchor the sand

Formation of sand dunes:

- Winds blow from the sea/onshore wind
- Winds pick up/blow sand
- Winds drop the sand around an obstacle/plant/litter/rock at top end of beach
- Sand is trapped by the obstacle
- Dunes increase in size due to build up of sand/deposition over time
- Dune succession/colonisation by vegetation/plants grow on them/vegetation anchors sand / growth of marram grass.

Features of a coastal sand dune (from an image)

Example:

- Various heights
- Mainly bare sand
- Steep slope (in foreground)
- Vegetation on higher parts
- Gentle slopes/steep near beach/windward side;
- Low level;
- Marram (grass) growing on it;
- Some bare sand/patches, etc.

Coral Reefs

Areas of heavy biodiversity found in shallow water where sunlight can penetrate; $CaCO_3$ structures.

Conditions required for the development of coral reefs.

- Warm water/water/sea temperatures between 18– 27 °C (accept figure within range)
- Shallow water/not more than 50–60 metres deep (or any figure within this range)
- Water free from sediment/clear/clean/not polluted
- Plentiful supply of oxygen in water
- Plentiful supply of plankton/nutrients
- Gentle waves/currents/slow moving/calm water
- Neutral/high pH/alkaline water
- Salty water

Describe the distribution of coral reefs (from a map)

- On/at/near coast OR Close to/along/near/just off coasts/around the coast
- Clustered OR All around the island
- More/particularly on south coast (or any other part)
- Many are in/near/around bays
- Around the smaller island
- More concentration on south west (or any other part)

Mangroves

Salt tolerant forests of trees and shrubs that grow in tidal estuaries and coastal zones of tropical areas.

Characteristics of mangroves

- Grow in water (between high and low water mark)
- Grow in shallow/muddy water

- Salt tolerant/live in brackish water/salty water/live in sea water/are halophytes;
- Evergreen trees
- Aerial roots
- Prop roots
- Salt filtering roots; salt water converted to freshwater
- Salt excreting leaves & shiny
- Packed tightly / grow closely together

Conditions required for the development of mangrove swamps
- High salinity
- Between high and low water mark / large tidal range
- Water higher than 20 °C in coldest month
- Seasonal temperature range lower than 5 °C / small temperature range
- Gentle wave action / sheltered coastline / delta/estuary/bay
- Low shore gradient

Importance of mangroves
- Provides large quantities of food and fuel.
- Protect coastlines by absorbing the force of hurricanes and storms.
- Protect coral reefs from sedimentation from land.
- Provide spawning and nursery areas for animal species that spend their adult lives on reefs.
- Act as natural filters - absorb nutrients from farming and sewage disposal.

Coastal hazards

Why is living on or close to a coast hazardous?
- Coastal erosion: which causes collapse/damage of property, loss of gardens/farmland, damage to roads & parking areas
- coastal flooding / rising sea levels
- Tropical storms/hurricanes/cyclones/typhoons which damage port installations / boats
- tsunami
- rock falls / cliff collapse

Describe problems faced by people as a result of coastal erosion and tropical storms.
- Kill/injure/endanger people
- Homes/gardens/property/lost/damaged/flooded
- Transport/roads/paths damaged/flooded
- Boats/ships/ports/harbour damaged/fishing industry disrupted
- Loss of farmland/crops/grazing land/kills livestock
- Businesses/example flooded/lost

- Loss of electricity/water supply/contaminates water
- Waterborne diseases
- Less tourists

Why do many people live on or close to the coast although it may be hazardous? (Opportunities provided by coasts)

- Employment in tourism
- Leisure activities like surfing
- Ports/trade
- Fishing
- Fresh/clean air
- Scenic beauty/good view
- Sentimental attachment/lived there all their life
- Can't afford to move
- Friends and family
- Prepared to take the risk
- Confidence in precautions
- Temperate climate/cooler/equable (if developed appropriately)

Coastal Management

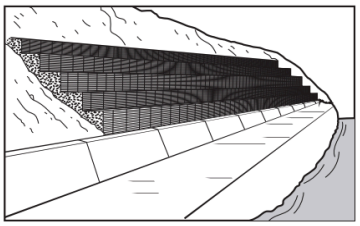
Hard engineering methods: involves building artificial structures which try to control natural processes.

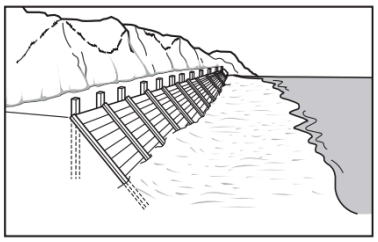
Soft engineering methods: does not involve building artificial structures but takes a more sustainable and natural approach to managing the coast.

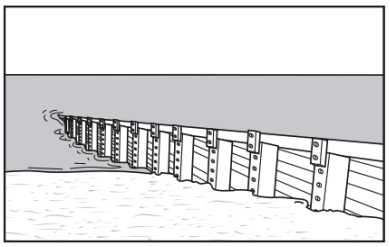
Hard Engineering Methods

- Sea walls: Large concrete curved walls built to cover a cliff/ in front of the coast/town.
- Revetments: Wood/steel/ concrete panels constructed at an angle at base of cliff
- Groynes: Wooden/concrete extension from beach, downwards into sea. It is constructed at right angles to the beach.
- Gabions: Wire-mesh cages filled with pebbles or rocks.
- Rip raps/ rock armour: Large rocks at base of cliff
- Offshore breakwaters: Large concrete blocks and boulders located offshore


Sea wall


Gabions


Revetment


Groynes

Disadvantages of hard engineering methods:

- Generally expensive
- Last only a short amount of time
- Visually unattractive
- Unsustainable
- Often increase erosion in other places further down the coast.

Soft Engineering Methods

- Beach nourishment/replenishment: Sand/shingle is artificially added at intervals, to an area affected by longshore drift.
- Managed retreat: Areas of coast are allowed to erode
- Dune Regeneration
- Beach Reprofiling