

Edexcel Geography A-level

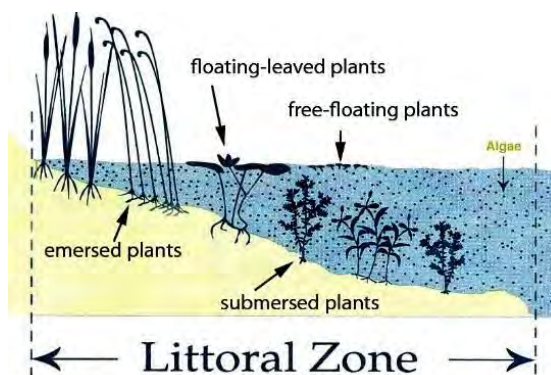
Coastal Landscapes and Change Essential Notes



The Formation & Processes of a Coastal System

Features of Coastal Zones

- Coastal zones develop from interactions between the **winds, waves** and **currents**. These energy flows work with **geological characteristics** of the coast (i.e. sediments) to produce distinctive landscapes, including **rocky, sandy** and **estuarine** (enclosed coastal body of **brackish** water) coastlines.
- Coastal zones are important as the majority of the world's population inhabit these regions. Coastal zones are **rapidly changing** due to the dynamic interaction between oceans and the land.
- The **littoral zone** is the **near shore** area where sunlight penetrates sediments, allowing for aquatic life to flourish, but faces rapid continuous change.
- This zone consists of a **backshore** (inland limit of the beach; waves only reach this area during exceptionally high tides), **nearshore** (region close to the sea) and **offshore** (the sea away from land).
- Coasts can be identified using longer term criteria. For instance, they can be classified using their **geology** (rocky coast, muddy coast, sandy coast etc.) and **changes to sea level**. Shorter term processes can also classify coasts depending on their **inputs** from rivers, waves and tides (e.g. Barrier coasts, Arctic coasts).



→ Rocky coasts are characterised by their **erosional** features. The main erosional processes are: **mechanical wave erosion, abrasion, weathering, bio-erosion and mass movements by rock falls, slides and flows**.

→ These types of coasts are usually in a **high energy** environment where erosion can continuously occur.

→ In comparison, coastal plain landscapes (sandy and estuarine) are found in **low relief** areas. They result from the supply of sediment from offshore sources like rivers.

Structures of Coastal Zones

- Geological structures include **jointing** (fracture dividing rocks), **dip** (indentations), **faulting** (cracks in crust) and **folding** (overlapping of the earth's crust to create ridges).
- These processes are vital in determining **coastal morphology** and **erosion rates**. They also produce **cliff profiles** and **micro features** such as caves and arches.
- Geological structures are responsible for the formation of:
 - **Concordant Coastlines**: where beds, layers and rocks are folded into ridges that run parallel to the coast. Usually, concordant coastlines have the same type of rock along its length. **Dalmatian** and **Haff** morphology occurs on these coastlines.
 - **Discordant Coastlines**: bands of rock and layers run perpendicular to the coastline. Usually the geology alternates between strata of hard rock and soft rocks. **Headlands and Bays** occur at these coastlines as erosion resistance is different between rocks, so they wear away at different speeds.



Coastal Recession and Stability

- Bedrock is made of **indigenous, sedimentary** and **metamorphic** rocks which determines erosion rates. The harder the rock and the more **impermeable** it is, lower the rate of erosion and coastal recession.
- Erosion occurs at the foot of a cliff, creating a notch. Material above the notch collapses and is washed away. Repeated collapsing causes the cliff to retreat further away. Rates depend upon the strata in cliffs.
- **Vegetation** stabilises sandy coastlines, provides habitats and flood defences.



Coastal System Landscapes & Processes

Marine Erosion

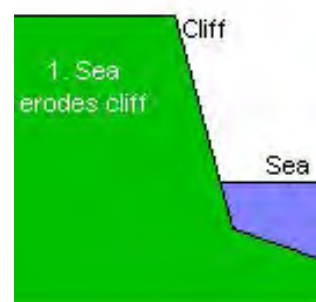
- Waves can be either **constructive** (low waves) or **destructive** (created in storm conditions when wind is powerful and waves are high and dangerous) and influence beach morphology and sediment profiles in the short and long term.
- Erosion processes are influenced by wave type, size and lithology and include:

- **Hydraulic Action:** Waves crash rocks and compress the air in the cracks, adding pressure. Repeated compression widens the cracks and causes the rock to shatter.
- **Corrosion:** Water dissolves minerals from the rocks and washes it away.
- **Abrasion:** Eroded water particles scrape and rub against the rocks, removing small pieces.
- **Attrition:** Eroded particles in water collide with each other and break into smaller fragments. This causes their edges to become rounded off as they rub together.

- Erosion creates distinctive coastal landforms such as:

- **Wave Cut Notches:** Erosion occurs at the foot of a cliff, creating a gap within the structure.
- **Wave Cut Platforms:** Narrow base left behind as the cliff retreats
- The **Cave-Arch-Stack-Stump** Sequence: Caves, arches and stacks form from eroded headlands (narrow piece of land that projects from a coastline). As waves crash into headlands, hydraulic action and abrasion causes enlargement of cracks in rocks. Continued erosion deepens cracks into caves which can eventually turn into arches.

When these arches collapse, due to erosion, they form a stack of isolated rock. Over time, the base of the stack will in turn become eroded, and the stack will collapse into a stump.



Sediment Transport and Deposition

- **Sediment transformation** is influenced by the angle of wave attack (depending on wind direction), tides, currents and longshore drift (current flowing along the coast, taking material with it).
- Depositional landforms include:
- **Beaches**: Found on coasts between the high water mark (highest point on the land which the sea level can reach) and the low water mark. They form due to constructive waves depositing sand and shingle.
 - **Spits**: Beaches which stick out into the sea. They form at sharp bends on coastlines where **longshore drift** transports sand and shingle past the bend and deposits it in the sea. Strong winds can curve the spit (called a recurved spit) and plants can grow bashing the spit where waves cannot reach.
 - **Bars**: Forms when a spit joins two headlands together, cutting off the sea from the water trapped between the bar and the coastline. This forms a lagoon. Also known as a **Barrier Beach**.
 - **Tombolo**: A spit connected to the mainland, an example being Chesil Beach.
 - **Cuspate Forelands**: Created by longshore drift where sand and shingle deposition extends outward from the shoreline in a triangular shape.

Mass Movement and Weathering

- **Weathering** can be either **mechanical, chemical or biological** and can influence the rate of recession. The greater the weathering process, the greater the rate of recession.
- Mass movement can be in the form of: **blockfall, rotational slumping** (slump blocks slide over a slip surface with rotation) and **landslides**. Mass movement creates the following landscapes:
- **Rotational Scars**: Material deposited from rotational slumping.
 - **Talus Scree Slopes**: The loose debris accumulated at the foot of a cliff.
 - **Terraced Cliff Profiles**: Eroded rocks create ridges within the cliff.



Sea Level Change

The Influence of Sea Level Change

- Long term sea level changes can be either **eustatic** or **isostatic**.
- Eustatic sea change occurs when ice on land melts and returns to the ocean, increasing the volume of water present in the sea. Usually this is accompanied by thermal changes which primarily melts land ice.
- Isostatic sea change occurs from the downward movement of land, causing localised sea level rise. Land can be stressed downward from **post-glacial adjustments, subsidence** (sinking of land) and **accretion** (accumulation of layers pushing down on the earth).
- Sea level change has produced **emergent coastlines** (raised beaches with fossil cliffs) and **submergent coastlines** (rias, fjords and Dalmatian).
- **Global warming** is causing eustatic sea level change as ocean temperatures become warmer and particles expand, taking up more space in the ocean basin. This causes sea levels to rise. Additionally, a warmer climate causes the melting of ice on land which adds water to the ocean.
- Remember that melting ice on water does **NOT** add to sea level change. For example if you melted an ice cube and placed it into a full glass of water, the volume of the water would increase. But if you put an ice cube into water and let it melt, the volume of the water would not change because the ice cube displaced the same volume of water it filled when it melted. (Try it!!)
- Tectonic activity can cause **sea floor spreading**, creating a larger platform for water to sit on. Tectonic activity also contributes to the shape of ocean basins. If the ocean basins get smaller, the volume of the oceans decrease and sea level consequently rises.
- Isostatic sea level change can also be caused by **tectonic uplift** on plate boundaries, forcing the oceans to be at a higher platform than the land.

Rapid Coastal Retreat

- **Coastal recession** is caused by a mixture of physical and human factors, such as **dredging** or **coastal management**.
- The Holderness coastline erodes by 1.8m of land per year. This is due to the easily erodible rock types and naturally narrow beaches alongside the building of coastal defences which makes the beaches narrower and more easily erodible. Locals have faced declining property prices, poor accessibility and the loss of farmland, impacting their livelihoods.
- There is often a **conflict between players**: conservationists wish to preserve coastal landscapes whilst businesses may alter natural systems for vested interests. Often the needs of locals are left out of decisions.
- **Subaerial processes**, such as weathering and mass movement erosion influence the rates of coastal recession. The larger the number of processes occurring, the greater the rate of recession.
- Rate of recession also depends on: wind direction, tides, seasonality, weather systems and storm occurrence. These factors all suggests that recession rates are not constant and can be both short and long term.



Risk of Coastal Flooding

- Local factors such as height, degree of subsidence and vegetation of coasts can increase flood risks on low-lying and estuarine coasts. For instance, Kiribati is made of 33 atolls, all at risk of **inundation** as sea levels rise.
- **Storm surges, tropical cyclones and depressions** can cause severe coastal flooding. This has social, economic and environmental implications.
- **Coastal flooding** in The Maldives causes a loss of tourism, beaches, soil and freshwater whilst disrupting the fishing industry and damaging homes.
- **Climate Change** is likely to cause an increase in extreme weather, the frequency and magnitude of storms whilst contributing to sea level rise. However, the future is clouded by uncertainties as the strength of this context hazard is unknown.

Consequences of Coastal Recession and Flooding

- Losses of coastal recession and flooding can be **economic** (housing, businesses, agricultural land, infrastructure) and social (relocation, livelihood loss, amenity value loss). This is a particular problem for **densely populated coastal developments**, such as Holderness in North Norfolk, where declining property values have impacted everyone.
- Coastal flooding and storm surge events can have serious economic and social consequence for communities in both the developed and developing world.
- For example, storm damage on Chesil Cove (UK) in February 2014 caused severe erosion, leaving the Kimmeridge clay bedrock exposed. The last time this happened was in 1989. The storm also forced the closure of the main A354 road, impacting businesses and locals. Following the, the sea wall was strengthened to avoid future losses.
- Flooding in Bangladesh in 2007 made 9 million people homeless and 1000 people died from drowning and water borne diseases. Bangladesh suffers from coastal flooding due to the occurrences of cyclones and heavy monsoon rains. Additionally the low lying land and deforestation increase flood risks. It is predicted that, due to climate change, Bangladesh may become completely inundated by water in the future. This however remains uncertain.
- Climate change may cause a **rise in environmental refugees** from coastal areas, such as those living in Bangladesh and Tuvalu (arguably the most likely countries to face severe flooding).



Management of Coastlines

- **Hard engineering** is very costly and directly alters physical processes and systems. Approaches involve:
- **Groynes**: low wall/barrier built out into the sea. This prevents the movement of beach material along the coast by longshore drifts but can be seen as unattractive and costly.
 - **Sea Walls**: Built on the edge of coastlines. These protect cliffs, land and buildings from erosion but are expensive and waves can become powerful as curved sea walls reflect the energy of the waves back in to sea. Over time, the walls can start to erode and need high maintenance.
 - **Rip Rap**: Loose stones create a foundation for a breakwater. This system reduces the energy of waves.
 - **Revetments**: Concrete structures built along the base of a cliff to absorb wave energy, preventing erosion. They are effective and do not require much maintenance albeit start-up costs being high
 - **Offshore Breakwaters**: Offshore concrete walls that break incoming waves so erosive power is reduced. These can be easily destroyed using storms and they are unattractive (visual pollution).
- **Soft engineering** techniques work with physical systems and processes to protect coasts and manage sea level changes. These approaches include:
- **Beach Nourishment**: Sand and shingle are added to a beach to make it wider, increasing the distance a wave travels before reaching the cliffs. This reduces its energy and erosive power.
 - **Cliff Regrading and Drainage**: Inserting pipes within a cliff to remove excess water. Cliff is still open to wave erosion but technique prevents mass movement and clay build-up.
 - **Beach/Dune Stabilisation**: Widen the beach/dunes to dissipate wave energy.
- **Sustainable management** aims to meet the needs of today without destroying the needs of the future. Sustainable management is designed to cope with future threats but implementation can cause conflict.

Holistic Integrated Coastal Zone Management (ICZM)

- Globally, strategies are being developed so they are sustainable and use **ICZM** techniques.
- ICZM regards all aspects of the coastal zone (geographical and political boundaries) in an attempt to achieve sustainability. This creates **winners and losers** as some can achieve effective management whilst others cannot.
- Political judgements require **Cost-Benefit Analysis** and **Environmental Impact Assessment** which can spark conflict as multiple procedures and players (homeowners, authorities etc.) are involved.

