

# AQA Geography A-level

## 3.1.3: Coastal Systems and Landscapes Essential Notes



## The Coastal System

The coast is as an **open system** as it receives **inputs** from outside the system and **transfers outputs** away from the coast and into other systems. These systems may be **terrestrial, atmospheric or oceanic** and can include the **rock, water and carbon cycles**.

### Sediment Cells

Coasts can be split into sections called **sediment cells** which are often bordered by **prominent headlands**. Within these sections, the **movement of sediment is almost contained** and the flows of sediment act in **dynamic equilibrium**. The dynamic equilibrium may be upset in the **long term** by **human interventions**, or in the **short term**, they may be interrupted by **natural variations**. Within each sediment cell there are **smaller subcells**.

There are many features to the coastal system and many are listed below - there is more detail on each throughout these notes:

**Inputs:** May refer to **material or energy** inputs. Coastal inputs are not limited to but include three main areas:

- **Marine:** Waves, Tides, Salt Spray
- **Atmosphere:** Sun, Air Pressure, Wind Speed and Direction
- **Humans:** Pollution, Recreation, Settlement, Defences

**Outputs:** May refer to **material or energy** outputs

- Ocean currents
- Rip tides
- Sediment transfer
- Evaporation

**Stores/Sinks:** Refer to stores and sinks of sediment and material. The formation of each of these stores is discussed later in these notes

- Beaches
- Sand Dunes
- Spits
- Bars and Tombolos
- Headlands and Bays
- Nearshore Sediment
- Cliffs
- Wave-cut Notches
- Wave-cut Platforms
- Caves
- Arches
- Stacks

- Stumps
- Salt Marshes
- Tidal Flats
- Offshore Bands and Bars

**Transfers/Flows:** The **processes that link the inputs, outputs and stores** in the coastal system

- Wind-blown sand
- Mass-movement processes
- Longshore drift
- Weathering
- Erosion
  - Hydraulic Action
  - Corrosion
  - Attrition
  - Abrasion
- Transportation
  - Bedload
  - In suspension
  - Traction
  - In solution
- Deposition
  - Gravity Settling
  - Flocculation

**Energy:** The **power and driving force** behind the transfers and flows in the system

- Wind
- Gravitational
- Flowing Water



## Sediment Sources

### Rivers:

- Account for majority of sediment in the coastal zone
- Sediment may be deposited in estuaries which are brackish and important wildlife habitats

### Cliff Erosion:

- Very important in areas with unconsolidated cliffs that are eroded easily. Most erosion occurs during the winter months due to more frequent storms

### Wind:

- The wind is a coastal energy source and can cause sand to be blown along or up a beach
- Sediment transport by winds may occur where there are sand dunes, or in glacial and desert environments which provide sediment inputs

### Glaciers:

- Glaciers can flow directly into the ocean depositing sediment that was stored in the ice when they calve

### Offshore:

- Sediment is transferred to the coastal zone when waves, tides and currents erode offshore sediment sinks such as offshore bars. The sediment is transported onto the beach, helping to build up the beach

### Longshore Drift:

- Sediment is moved along the beach, due to prevailing winds which alter the direction of the waves. This allows sediment to be transported from one section of coastline (as an output) to another stretch of coastline (as an input)

## Sediment Budgets

Sediment budgets use data of inputs, outputs, stores and transfers to assess the gains and losses of sediment within a sediment cell. In principle a system will operate in a state of dynamic equilibrium where input and outputs of sediment are equal. However, human actions and natural variation in the system can disrupt the state of equilibrium.

## The Littoral Zone

The littoral zone is the area of land between the cliff's or dunes on the coast and the offshore area that is beyond the influence of the waves. The littoral zone is constantly changing because of:

- Short-term factors like tides and storm surges
- Long-term factors like changes in sea level and human intervention



## Sources of Energy at the Coast

The **sun is the primary source of energy** for all natural systems. The main energy source at the coast is from **waves which are formed offshore**.

### Wave Formation

The sun has a direct influence on the formation of waves, which occur when **wind moves across the surface of the water**:

- Winds move across the surface of the water, causing **frictional drag** which creates **small ripples and waves**. This leads to a **circular orbital motion of water particles** in the ocean
- As the **seabed becomes shallower** towards the coastline, the **orbit of the water particles becomes more elliptical**, leading to **horizontal movement of the waves**
- The **wave height increases, but the wavelength (distance between two waves) and wave velocity both decrease**
- This causes **water to back up from behind the wave** until the **wave breaks (collapses) and surges up the beach**

### Factors Affecting Wave Energy

**Strength of the Wind:** The larger the **pressure gradient** between two area, the stronger the winds. As waves are caused by the wind, stronger winds also mean stronger waves.

**Duration of the Wind:** If the **wind is active for longer periods of time**, then the energy of the waves will build up and increase.

**Size of the Fetch:** The **fetch is the distance over which the wind blows** and the larger it is, the more powerful the waves will be.

### Wave Types

**Constructive waves** act to build up and **create a beach** and increase its size, whereas **destructive waves** act to **remove the beach** and decrease its size.

	Constructive	Destructive
<b>Formation</b>	Formed by weather systems that operate in the open ocean	Localised storm events with stronger winds operating closer to the coast
<b>Wavelength</b>	Long wavelength	Short wavelength
<b>Frequency</b>	6-9 Per Minute	11-16 Per Minute
<b>Wave Characteristics</b>	Low waves, which surge up the beach	High waves, which plunge onto the beach
<b>Swash Characteristics</b>	Strong swash, weak backwash	Weak swash, strong backwash
<b>Affect on Beach</b>	Occurs on gently sloped beaches	Occurs on steeply sloped beaches



The **type of waves** in a coastal environment may vary:

- In summer, constructive waves dominate but destructive waves dominate in winter
- Constructive waves may become destructive waves if a storm begins
- Climate change may increase the storm frequency within the UK
- Coastal management may affect the type of waves that occur

### Negative Feedback: Beaches and Waves

The presence of **constructive waves causes deposition** on the beach, which in turn leads to the **beach profile becoming steeper**. **Steeper beaches favour the formation of destructive waves** which are then more likely to occur. The **destructive waves erode the beach**, reducing the beach profile and **leading to the formation of constructive waves**. As constructive waves occur more **frequently in summer** when there are fewer storms, this means that the **beach profile is more gentle in summer** and **steeper during the winter months** when destructive waves are more common.

### Tides

**Gravity is another key source of energy** in coastal environments. The difference in height between the tides is known as the tidal range and tends to be largest in **channels such as river estuaries**.

The **highest high tide** and the **lowest low tides** occur when the sun and the moon are **in alignment**, so their gravitational forces work **with each other**. This is a **spring tide** and it creates the **largest possible tidal range**.

The **lowest high tide** and the **highest low tides** occur when the sun and the moon are **perpendicular** to each other, so their gravitational forces work **against each other**. This is a **neap tide** and it creates the **smallest possible tidal range**.

### Currents

**Rip currents** are powerful underwater currents occurring in areas close to the shoreline on some beaches when **plunging waves cause a buildup of water** at the top of the beach. The backwash is forced under the surface due to **resistance from breaking waves**, forming an underwater current. Rip currents are an **energy source** in a coastal environment and can lead to **outputs of sediment** from the beach area.

### High-Energy and Low-Energy Coastlines

**High-energy coastlines** are associated with more powerful waves, so occur in areas where there is a **large fetch**. They typically have **rocky headlands and landforms** and fairly frequent **destructive waves**. As a result these coastlines are often eroding as the **rate of erosion exceeds the rate of deposition**.

**Low-energy coastlines** have less powerful waves and occur in **sheltered areas** where **constructive waves** prevail and as a result these are often **fairly sandy areas**. There are **landforms of deposition** as the rates of **deposition exceed the rates of erosion**.



## Wave Refraction

**Wave refraction** is the process by which waves turn and lose energy around a headland on uneven coastlines. The **wave energy is focussed on the headlands**, creating **erosive features** in these areas. The energy is **dissipated in bays** leading to the formation of features associated with **lower energy environments** such as beaches.

## Negative Feedback

Due to the different rock strengths, erosion leads to the formation of **headlands where resistant rock exists** and **bays where unconsolidated rocks and clays are dominant**. This then **increases the forces of erosion on the headlands** and **reduced erosion in the bays** as wave refraction dissipates wave energy and a beach protects the coastline behind. Eventually the **headlands are worn away**, which then again **increases erosion within the bays**.

## Marine Processes

### Erosion

The main processes of erosion are defined below:

**Corrasion** - Sand and pebbles are picked up by the sea from an **offshore sediment sink** or temporal store and **hurled against the cliffs** at high tide.

**Abrasion** - Sediment is **moved along the shoreline**, causing it to be **worn down over time**.

**Hydraulic Action** - As a wave crashes onto a rock or cliff face, **air is forced into cracks**, and the high pressure causes the **cracks to force apart**. Bubbles found within the water

may **implode under the high pressure** creating tiny jets of water that over time erode the rock. This erosive process is **cavitation**.

**Corrosion (Solution)** - The **mildly acidic seawater** can cause **alkaline rock** such as limestone to be eroded.

**Wave Quarrying** - This is when breaking waves hit the cliff face to directly pull away rocks from a cliff face or remove smaller weathered fragments.

## Factors Affecting Erosion

There are several factors which affect coastal erosion, which can be **marine or land based**:

- Waves
- Beach Size and Presence
- Activity of Subaerial Processes
- Rock Faults
- Rock Lithology



## Processes of Transportation and Deposition

Coastal transportation is responsible for transferring sediment within a sediment cell and between other sediment cells. The four main processes of **transportation** are:

- **Traction** – Large, heavy **sediment rolls along the sea bed**, pushed by currents
- **Suspension** – Small sediment is carried within the flow of the water
- **Saltation** – Smaller sediment bounces along the sea bed
- **Solution** – **Dissolved material is carried** within the water

### Longshore Drift

- Waves hit the beach at an angle determined by the direction of the **prevailing wind**
- The waves push sediment in this direction and up the beach in the **swash**
- The wave then carries sediment back down the beach in the **backwash**
- This moves sediment along the beach over time

### Deposition

**Deposition** occurs when **sediment becomes too heavy** for the water to carry, or **if the wave loses energy**. **High-energy coastlines** continue to transport smaller sediment, so larger rocks and shingle are deposited in these environments. **Low-energy coastlines** have much smaller sediment, which is only deposited in these areas where there is a much **lower water velocity**. Deposition includes **gravity settling** and **flocculation**

### Weathering

Weathering is the **breakdown of rocks** over time, leading to the **transfer of material into the littoral zone**, where it becomes an **input to sediment cells**.

**Positive Feedback:** If the rate of removal of the weathered rock from the base of the cliff is higher than the rate of weathering, then this will promote further weathering as this will **increase the area of exposed rock**. This will increase the amount of erosion that occurs because this will **increase the supply of rocks** which can become part of the **erosive processes of saltation and abrasion**.

**Negative Feedback:** If the removal of weathered rock from the base of the cliff is slower than the rate of weathering, then this will lead to a **build up of debris at the base of the cliff**, **reducing the exposed cliff area** and therefore **reducing the rates of weathering**. It will also reduce erosion as the cliff foot will be protected from the other forces of erosion.

#### Mechanical (Physical) Weathering:

- **Freeze-thaw (Frost-Shattering):** Water enters cracks in rocks and then the water **freezes** and **expands** in volume causing cracks to develop
- **Salt Crystallisation:** As seawater **evaporates**, salt is left behind. Salt crystals will grow over time, forces the cracks to widen. Salt can also **corrode ferrous rock**
- **Wetting and Drying:** Rocks such as clay **expand when wet** and then contract again when they are drying and these cycles cause the rocks to break up



## Chemical Weathering:

- **Carbonation:** Rainwater absorbs CO<sub>2</sub> from the air to create a weak carbonic acid. Acid rain reacts with limestone to form calcium bicarbonate, which is then easily dissolved allowing erosion
- **Oxidation:** When minerals become exposed to the air it will become oxidised which will increase its volume causing the rock to crack. Most common with iron minerals
- **Solution:** When rock minerals such as rock salt are dissolved

## Biological Weathering:

- **Plant Roots** - Roots of plants growing into the cracks of rocks, which exerts pressure, eventually splitting the rocks
- **Birds** - Some birds such as Puffins dig burrows into cliffs weakening them
- **Rock Boring** - Many species of clams secrete chemicals that dissolve rocks
- **Seaweed Acids** - Kelp contains sulphuric acid, which dissolves rock minerals
- **Decaying Vegetation** - Water flows through decaying plants and becomes acidic

## Mass Movement

Mass movement is the movement of material down a slope under the influence of gravity. Mass movement can be categorised into four main areas: creeps, flows, slides and falls. The different types of mass movement are:

**Soil Creep:** The movement of soil particles downhill. Particles rise and fall due to wetting and freezing and in a similar way to longshore drift. Forms shallow terracettes.

**Solifluction:** Occurs mainly in periglacial environments when the top layers thaw during summer and the surface layers flow over the frozen layers.

**Mudflows:** An increase in the water content of soil can reduce friction, leading to earth and mud to flow over underlying bedrock, or slippery materials such as clay. Mudflows represent a serious threat to life as they can be very fast flowing.

**Rockfall:** Occurs on sloped cliffs (over 40°) when exposed to mechanical weathering, though mostly occurs on vertical cliff faces. It leads to scree building up at the base of the slope acting as an input to the coastal zone.

**Landslide:** Heavy rainfall can reduce friction in cliffs and lead to a landslide. It occurs when a block of intact rock moves down the cliff face very quickly along a flat slope.

**Landslip or Slump:** Contrary to a landslide, the slope is curved. The land collapses under its own weight, due to increased PWP. This creates a terraced appearance.

**Runoff:** Water may erode the cliff face, or pick up sediment that enters the littoral zone. It may also be responsible for increasing pollution in coastal areas.

## Vulnerability to Sub-Aerial Processes

Temperature and climate can influence the prominence of weathering. In colder climates, mechanical weathering is more common, whereas in warmer climates, chemical weathering is more common.





## Coastal Landforms and Landscapes of Erosion

### Caves, Arches, Stacks & Stumps

This sequence occurs on pinnacle headlands:

- Wave energy is **concentrated at headlands**, leading to erosion
- Joints are eroded first to form a **blowhole/cave**
- Over time, **caves** are eroded through the headland to form an **arch**
- The unsupported rock above the arch collapses to form a **stack**
- Over time, weathering and erosion causes the stack to become a **stump**

### Cliff Profile and Rate of Retreat

**Steep Cliffs:** Most common where the **rock is strong and fairly resistant** to erosion. An absence of a beach, long-fetch and high energy waves also promote steep cliff development. Most commonly found in **high-energy environments**.

**Gentle Cliffs:** Most commonly found in **areas with weaker rocks** which are **less resistant to erosion** and are prone to slumping. A large beach would reduce wave energy and prevent of steep cliffs forming, by reducing erosion. Commonly found in **low-energy environments**.

**Rate of Retreat:** Dependent on the relative importance of **marine** and **terrestrial factors**. The cliff's most likely to retreat are those that are made of **unconsolidated rock** and sands.

**Negative feedback mechanisms** can help to protect and restore a coast. During a storm, part of a cliff may collapse so the material will protect the base of the cliff from erosion, reducing further cliff **recession**. Sand dunes may be eroded during a storm, meaning a loss of a sediment on land. However, the sediment produced may be deposited in **offshore bars**, which protect the coastline from further erosion by **dissipating wave energy**.

### Wave-cut Notch and Platform

This sequence occurs at steep cliffs:

- Erosion is **concentrated around the high-tide line** creating a **wave-cut notch**
- As the notch becomes deeper the cliff face becomes unstable and collapses
- This leaves behind a **platform** of the unaffected cliff base
- Over time a **wave-cut platform** is formed

### Negative Feedback

The length of a **wave-cut platform** is limited as eventually the waves can no longer reach the cliff, reducing the erosion. Therefore the act of **erosion creating the wave-cut platform has acted to directly decrease the rate of erosion in future**



## Coastal Landforms and Landscapes of Deposition

### Beaches

A beach is a **depositional landform** that stretches from roughly the low tide to the high tide line. **Beach accretion** occurs due to constructive waves during the summer. **Beach excavation** occurs due to destructive waves in winter. Beach types:

- **Swash-aligned**: Wave crests approach **perpendicular to coast** so there is **limited longshore drift**. Sediment doesn't travel far along the beach
- **Drift-aligned**: Waves approach at angle, so sediment travels along the beach, which may form a spit. **Larger sediment is found at the start of the beach**

**Larger sediment is found toward the top of the beach** where it has been left from winter storms. Scree near the cliffs means that **angularity of sediment increases towards the cliff**, where hydraulic action acts less frequently to round the sediment.

### Spits

- Occur when the coast suddenly **changes direction**
- Longshore drift continues to deposit material in line with the coast but at sea
- Changes in **wind direction/wave refraction** lead to a curved end (**recurved spit**)
- Multiple curved ends form a **compound spit**
- Area behind the spit is sheltered and often **develops into mudflats and saltmarshes**
- **Cannot extend across estuaries** but can extend across bays to form a **barrier beach**

### Barrier Beach/Bars

- Occurs when a **beach or spit extends across a bay to join to headlands**
- Traps water forming a **brackish lagoon** which is separated from the sea
- Can form from contemporary processes or due to **rising sea levels after the last glacial period**, when glaciers deposited sediment in the coastal zone
- If a **barrier beach is separated from the mainland, it becomes a barrier island**
- Common in areas with **low tidal ranges**

### Tombolo

- Bar or beach that **connects the mainland to an offshore island**
- Formed due to **wave refraction off the coastal island reducing wave velocity**

### Offshore Bars

- An **offshore region where sand is deposited**, as the waves don't have enough energy to carry the sediment to shore. They absorb wave energy
- Waves may pick up sediment from an offshore bar, which then provides an **important sediment input into the coastal zone**
- Also formed when **backwash removes sediment from a beach**



## Coastal Vegetation

Vegetation is essential in **stabilising** coastal landforms such as dunes:

- **Roots** of plants bind soil together which helps to reduce erosion
- When completely submerged, plants provide a **protective layer** for the ground
- Plants reduce the **wind speed** at the surface and so less wind erosion occurs

## Sand Dunes

- Wind blows sand landwards from beach or **offshore bar**
- **Large tidal range** allows the sand to dry, so that it is light enough to be picked up and carried by the wind to the back of the beach
- Dunes develop as a process of a **vegetation succession**:
  - Pioneer species such as **sea rocket** are resistant and able to survive in the salty sand, with its roots helping to bind the dunes together
  - **Decaying organic matter adds nutrients and humus** to the soil allowing marram grass to grow
  - **Climatic climax** occurs when trees are able to colonise the area

Marram grass is a good example of a **pioneer plant**:

- It is tough and flexible, so can cope with sandy conditions
- It has **adapted to reduce water loss through transpiration**
- Their roots grow up to **3 metres deep** and can tolerate temperatures of up to 60°C

## Estuarine Mudflats and Saltmarshes

Deposition occurs in river estuaries as water velocity is low so the water can no longer carry its sediment in suspension. Mudflats/marshes may also occur in sheltered areas such as **behind a spit**. **Deposition occurs as a result of flocculation**, leading to mud above the high tide level. Pioneer plants colonise the transition zone, leading to more sediment becoming trapped. A **meadow** is formed as sections of the salt marsh rise above the high tide level, leading to the **climatic climax of the vegetation succession** when trees begin to colonise the area.

## Sea Level Change

### Isostatic Change

Isostatic change occurs when the **land rises or falls relative to the sea** and is a **localised change**. Isostatic sea level change is often a result of **isostatic subsidence**. When the glaciers melted, this led to **isostatic recovery** and the coastline to **rebound and rise again** in the areas that were covered by ice. **Tectonic activity** may cause land subsidence, therefore causing isostatic sea level change. This was seen in the 2004 Indian Ocean earthquake, which caused the city of **Bandeh Aceh to sink permanently by 0.5m**.

### Eustatic Change

**Eustatic** change affects sea level across the whole planet. **Eustatic** change may be due to **thermal expansion/contraction** or changes in glacial processes. Thermal expansion is the process of water expanding when it gets warmer, and so the volume of water increases leading to rising sea levels. In the last ice age, **sea levels were over 100m lower than they are currently**



due as the water was stored in large ice caps as the majority of precipitation fell as snow. When the ice caps melted, this led to rising sea levels.

### Emergent Coastal Landforms

Where the land has been raised in relation to the coastline. **Raised beaches** are common before cliffs which are also raised (**relic cliffs**), with **wave-cut notches** and similar features proof of historical marine erosion.

### Submergent Coastal Landforms

**Landforms of submergence** occur when the **sea level rises or the coastline sinks** in relation to the sea: **Rias** are formed when rising sea levels **flood narrow winding inlets and river valleys**. They are **deeper at the mouth of the inlet**, with the **water depth decreasing further inland**. **Fjords** are formed when rising sea levels **flood deep glacial valleys to create natural inlets and harbours**. They are **deeper in the middle than they are at the mouth**, with the shallower section showing where the glacier left the valley. **Dalmatian Coasts** occur when **valleys running parallel to the coast become flooded** as a result of sea level change. This leaves a **series of narrow, long and rugged islands**.

### Contemporary Sea Level Change

Since records began around 20,000 years ago, sea levels have always been rising from 120m below the levels which they are now at today. Sea level increase **slowed around 8,000 years ago**, and **levelled at the current height around 3000 years ago**. Since 1880 **sea levels have increased by around 235mm**. The **International Panel on Climate Change (IPCC)** predicts that sea levels may rise between **0.3 - 1.0m by 2100**. This could **cause aquifers to be polluted in low-lying atoll islands**. It may also **inundate many coastal cities** and increase the risks from tropical storms and Tsunamis. Turning the coastal area into recreational land as **adaptation** to climate change will become more popular.

### Risks to Coastal Environments

#### Storm Surges

A **storm surge is a result of the low pressure** created by large weather events such as tropical storms. The risk from a storm surge may be exacerbated by:

- **Removing Natural Vegetation:** Mangrove forests **provide protection against extreme weather events such as cyclones** which are very common in the Bay of Bengal. Due to pressure for land space, **many mangrove forests are destroyed** to make space for tourism, local industry, or housing. Mangroves can **keep up with global sea level rises of up to eight times the current rate**
- **Global Warming:** As the surface of oceans get warmer, it is **predicted that the frequency and intensity of storms and storm surges will increase**

#### Consequences for Communities

Some areas of the coast may have significantly **reduced house and land prices** leading to **economic loss for homeowners and local coastal economies**. Storm surges also damage the environment by **destroying plant successions** and **damaging many coastal landforms**. If depositional features are destroyed then erosion may occur more quickly, which can increase the risk of cliff collapse and threats to land owners.



Globally, **more than 1 billion people live on coasts that are at risk from coastal flooding** and **50% of the world's population currently live within 60km of the coast** (and this figure is increasing daily). Around **75% of all of the world's large cities are coastal**. As storm surges and erosion along some coastlines are predicted to increase, so too is the volume of environmental refugees displaced internally or internationally.

## Coastal Management

Strategies used can mostly be classified into two types - **hard and soft engineering** which **both relate to traditional approaches to coastal management** and are a **direct solution** to the problem that is occurring.

### Hard Engineering

Hard engineering involves **man made structures that aim to prevent erosion**. They are often very effective at preventing erosion in the desired area, but by reducing erosion in one area of the coastline, they may act to exacerbate erosion elsewhere.

**Offshore breakwaters** are rock barriers which force waves to break. **Effective at reducing wave energy, but are visually unappealing, a navigation hazard and interfere with LSD**

#### Groynes



Source: Tripadvisor

Description: Timber or rock protrusions that trap sediment from LSD

- 👍 Builds up beach, protecting cliff and increasing tourist potential
- 👍 Cost effective
- 👎 Visually unappealing
- 👎 Deprives areas downwind of sediment increasing erosion elsewhere

#### Sea Walls



Source: Southampton University

Description: Concrete structures that absorb and reflect wave energy, with curved surface

- 👍 Effective erosion prevention
- 👍 Promenade has tourism benefits
- 👎 Visually unappealing
- 👎 Expensive to construct and maintain
- 👎 Wave energy reflected elsewhere, with impacts on erosion rates



### Rip Rap (Rock Armour)

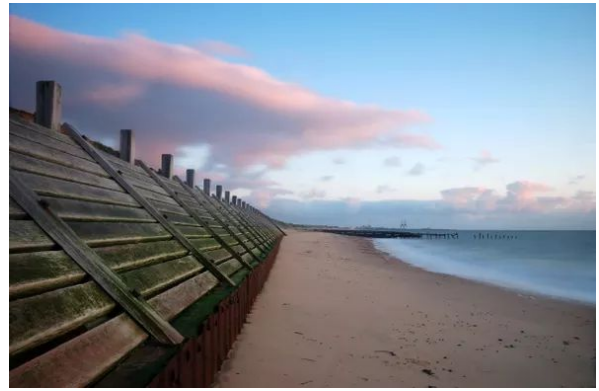


Source: Stacey.Peak-Media

Description: Large rocks that reduce wave energy, but allow water to flow through

- 👍 Cost effective
- 👎 Rocks are sourced from elsewhere, so do not fit with local geology
- 👎 Pose a hazard if climbed upon

### Revetments



Source: Geographical.co.uk

Description: Wooden or concrete ramps that help absorb wave energy

- 👍 Cost effective
- 👎 Visually unappealing
- 👎 Can need constant maintenance, which creates an additional cost

## Soft Engineering

Soft engineering **aims to work with and complement the physical environment** by using natural methods of coastal defence. They are useful for protecting against sea-level change as well as coastal erosion.

### Beach Nourishment



Source: Eastern Solent Coastal Partnerships

Description: Sediment is taken from offshore sources to build up the existing beach

- 👍 Builds up beach, protecting cliff and increasing tourist potential
- 👍 Cost effective and looks natural
- 👎 Needs constant maintenance
- 👎 Dredging may have consequences on local coastal habitats

### Cliff Regrading and Drainage



Source: Stacey.Peak-Media

Description: Reduces the angle of the cliff to help stabilise it. A steeper cliff would be more likely to collapse

- 👍 Cost effective
- 👎 Cliff may collapse suddenly as the cliff is drier leading to rock falls which pose a hazard
- 👎 May look unnatural



### Dune Stabilisation



Source: Wikipedia

Description: Marram grass planted. The roots help bind the dunes, protecting land behind

- 👍 Cost effective and creates an important wildlife habitat
- 👎 Planting is time consuming

### Marsh Creation



Source: DurDoor

Description: Type of managed retreat allowing low-lying areas to flood

- 👍 Creates an important wildlife habitat
- 👎 Farmers lose land and may need compensation as a result

## Cost-Benefit Analysis (CBA)

An analysis **carried out before any form of coastal management takes place**. The **expected cost** of a coastal management plan is compared to the **expected benefits** of a scheme. Cost and benefits may be **tangible** or **intangible**. **DEFRA's** 1:1 analysis suggests, the **expected benefits have to out way the costs** for a project to go ahead.

## Sustainable Coastal Management

**Sustainable integrated approaches** are becoming more widely used. They are **holistic strategies** and smaller sections are not considered separately, unlike with traditional methods. Aspects of managing coast in a sustainable way include:

- **Managing natural resources** to ensure **long term productivity**
- Creating **new jobs** for people who face unemployment due to management schemes
- **Educating communities** about the need to adapt and how to protect the coastline
- **Monitoring coastal changes** and responding appropriately
- Ensure that **everybody is considered** when changes are proposed

## Integrated Coastal Zone Management (ICZM)

Large sections of coastline are managed with **one integrated strategy**. Management occurs **between different political boundaries**. ICZM overview:

- The ICZM recognises that coastal management must be **sustainable** whereby **environmental protection is prioritised over economic development**
- The ICZM **must involve all stakeholders** and plan for the long term
- It recognises a decision to protect one coastal community may not outweigh the disadvantages of exposing another community to increased erosion
- In 2013 the EU adopted a new initiative which promotes the use of ICZM's



## Shoreline Management Plans (SMPs)

There is an SMP for each UK sediment cell. Each SMP **identifies all of the activities, both natural and human** which occur within the coastline area of each sediment cell. SMP's are **recommended for all sections of English and Welsh coastlines by DEFRA**. Four options are considered for each stretch of the coastline:

- **Hold the Line**
- **No Active Intervention**
- **Managed Retreat/Realignment**
- **Advance the Line**

Different factors are considered when choosing a management options: The **economic value of assets** that could be protected, the technical feasibility of **engineering solutions** and the **ecological and cultural value** of land

## Conflict Over Policy Decisions

When considering coastal management they may be **winners and losers**. Winners can be classified as those who benefit **economically, environmentally and socially**. **Losers** can be classified as those who lose their property, lose a job, or have to relocate elsewhere. Communities and homeowners have a **strong attachment to a place** so losing their properties and their social networks is a great loss.

## The Impact of Coastal Management on Sediment Cells

Coastal management has a variety of impacts on sediment cells. **Installing a sea wall would reflect wave energy downdrift** increasing wave energy and erosion elsewhere on the coastline. **Less erosion occurs in these areas with the sea wall**, so there is also **less sediment in the areas with increased wave energy**. **Less sediment reduces the beach size**, so the **cliff is more exposed to erosion** from the higher energy waves. Building groynes has the same effect on downdrift areas as **longshore drift** can no longer transport sediment away from one stretch of coastline.

