AS Geography 1.3 Coastal Environments *Student Notes*

The marine (including refraction) atmospheric and human factors.
factors influencing the rate and location of coastal processes, to include

You need to appreciate the spatial and temporal variations in the influences of a range of factors.

Marine Influences (Waves and Tides).

- **Breaking point of waves.** Maximum erosion is caused if a wave breaks at the base of a cliff, releasing most of its energy. This will happen at high tide, under storm conditions at Hartland Quay. Waves that break further offshore will have their energy dissipated. This will happen on gently sloping beaches such as Saunton Sands or where there are wide wave-cut platforms or reefs. The wave-cut platforms at Warren Bay and Well Beach at Hartland Quay dissipate wave energy, but only at low tide. At high tide waves can cross the platform to the base of the cliffs. In tropical islands like Barbados, coral reefs help to dissipate wave energy.

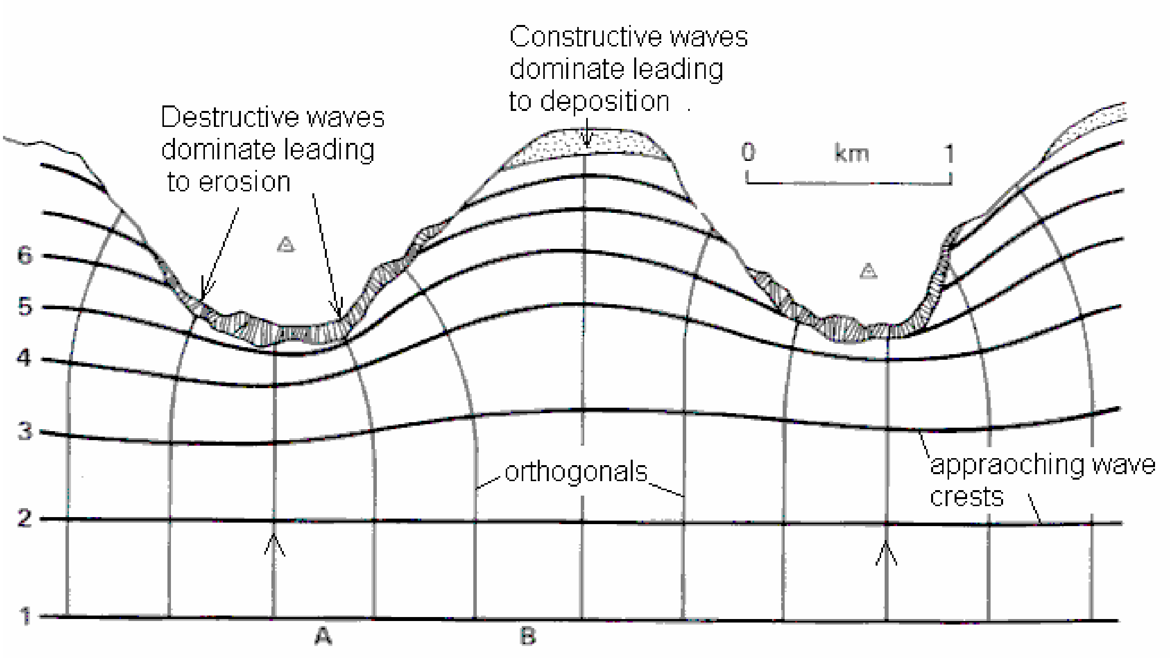
- **Wave steepness.** Locally produced storm waves are often steeply sloping. Large swell waves also become steeper as they approach the shore. Steeper waves are more likely to be **destructive** and less steep, waves are more likely to be **constructive**.

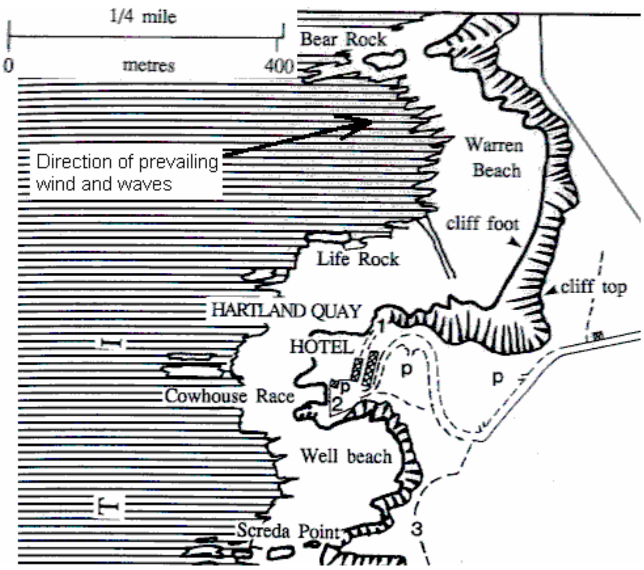
- **Length of Fetch.** Coastlines with a large fetch, such as at Hartland Quay, are more likely to receive high energy waves and therefore erosional processes will be more dominant.

- **Tidal currents.** In estuaries, and in narrow straits between the coast and offshore islands, with a macro-tidal range, tidal currents can have a scouring effect leading to erosion. Tidal currents are important in the mouth of Poole Harbour and in the Taw/Torridge estuary for removing sediments. In more sheltered locations, such as the inner part of Poole Harbour or the shores of the Taw/Torridge estuary, tides supply fine sediments for the accumulation of salt marshes. Tides are also important for exposing large areas of sand on Saunton Sands which, when it dries, forms the raw material for sand dune building at Braunton Burrows (see later notes).

- **Wave Refraction.** We have already seen how waves slow down, increase in height and decrease in wavelength as they approach shallow water. The diagram below shows an indented coastline with a uniform sub-marine slope. The approaching wave crests are perpendicular to the general trend of the coastline. As the approaching waves (shown by the position of their crests) move nearer to the shores of the headland, they begin to slow down and increase in height as they meet shallow water. In the bays, the waves continue unimpeded and so move ahead of the fragment of the same wave approaching the headland.

  The end result is that the wave crests attempt to align themselves with the shoreline. Segments A and B have the same width (and therefore equal amounts of energy) in deep water. The *orthoganals*, drawn at right angles to the wave crests show that, by the time they reach the shore, the energy of segment A is concentrated on a length of coast about 1/3rd of the length of segment B, where the energy is more dissipated. This distortion, or **refraction** of waves focuses wave energy onto headlands, islands and dissipates it in bays leading to the construction of a **bay-head beach**.





Wave refraction is important in a range of scales. Waves that refract of south-westerly waves around the Isle of Purbeck into Studland Bay in Dorset result in a southerly wave direction of reduced energy waves.

In, North Devon, refraction of westerly waves around Hartland Point has a similar effect, dissipating wave energy as it enters Bideford Bay. This reduces erosion rates in the Clovelly and Bucks Mills area and assists in the formation of the Pebble Ridge Spit at Westward Ho! by creating a south to north longshore drift. In Warren Bay, the refraction of waves around Life Rock leads to lower wave energy in the southern part of the bay where sandy beaches can accumulate in the summer months (many beaches are temporary features). The Northern part of the bay is swash aligned and receives the brunt of the Atlantic Storm Waves. The Headland, on which the Hartland Quay Hotel stands, is also prone to concentrated wave attack.

Sea Level Change In the long term, sea levels fall leads to increased deposition and rising sea levels lead to increased erosion, as protective beaches, bars and wave-cut platforms become flooded (see later notes)

Atmospheric Factors.

- **Variations in weather.** Variations in **wind speed** and **wind direction** are the most important influences of the weather as these effect the direction and strength of wave energy. Heavy or continuous **rainfall** can also induce landslides and mudflows in coastal environments, accelerating erosional processes. **Frost action** on cliff faces can accelerate weathering rates leading to rockfalls and **chemical weathering** processes which weaken rocks, will usually be more effective in warm, moist locations.

- **Variations in climate.** In the long term, climatic deterioration in the past has lead to glacial erosion on many parts of the coastline of North West Scotland and it is also closely linked to sea level change (see later notes).

Fluvial Influences. Rivers supply much of the coastal sediments in some areas, such as in the Taw/Torridge estuary. Where there are strong river currents, bars can be prevented from forming across bays.

Biological factors. We will examine the role of vegetation later when looking at salt marshes and sand dune systems and the erosive impact of some burrowing molluscs has already been mentioned. In tropical seas, coral reefs and mangrove swamps are both important environments in discouraging coastal erosion and encouraging deposition. Both environments are under threat in many parts of the world, which may lead to an increase in coastal erosion.

Human factors

Human activity can have both positive and negative effects on the coastal processes and the coastal environment. Some of these will be explored in greater detail in the synoptic link so a brief summary is included here:

- **The Constructions of Dams on Rivers.** The large scale construction of dams, such as the Akasombo Dam on the Volta River in Ghana, or the dams on the Colorado River in the USA have reduced the amount of river sediment reaching the sea. This has reduced natural beach replenishment and has lead to coastal erosion in the Gulf of Guinea and The Gulf of California.

- **Damage to coastal ecosystems.** Pollution of seawater from sources such as untreated sewage and oil spills can lead to deterioration and damage to coral. Coral reefs that protect tropical island, such as the Maldives, from erosion can be destroyed and leave the island more vulnerable.

  In places such as Cairns in Australia, hotel development has destroyed mangrove swamps leading to increased sedimentation in the seawater. This also has a damaging effect on coral reefs leaving the coast more vulnerable to marine erosion.

  Heavy trampling of plants in sand dune systems can lead to **blow-outs** and the lowering of protective sand dunes, which might otherwise protect land from coastal flooding during storms.

- **Climatic Change** Global warming could accelerate coastal erosion and lead to the inundation of coastal lowlands such as Northam Burrows (in the lee of the Pebble Ridge Spit) in North Devon or parts of Christchurch Harbour in Dorset.

- **Unintentional Barriers to Longshore Drift.** In both Dorset and North Devon are examples of unintentional barriers to longshore drift.

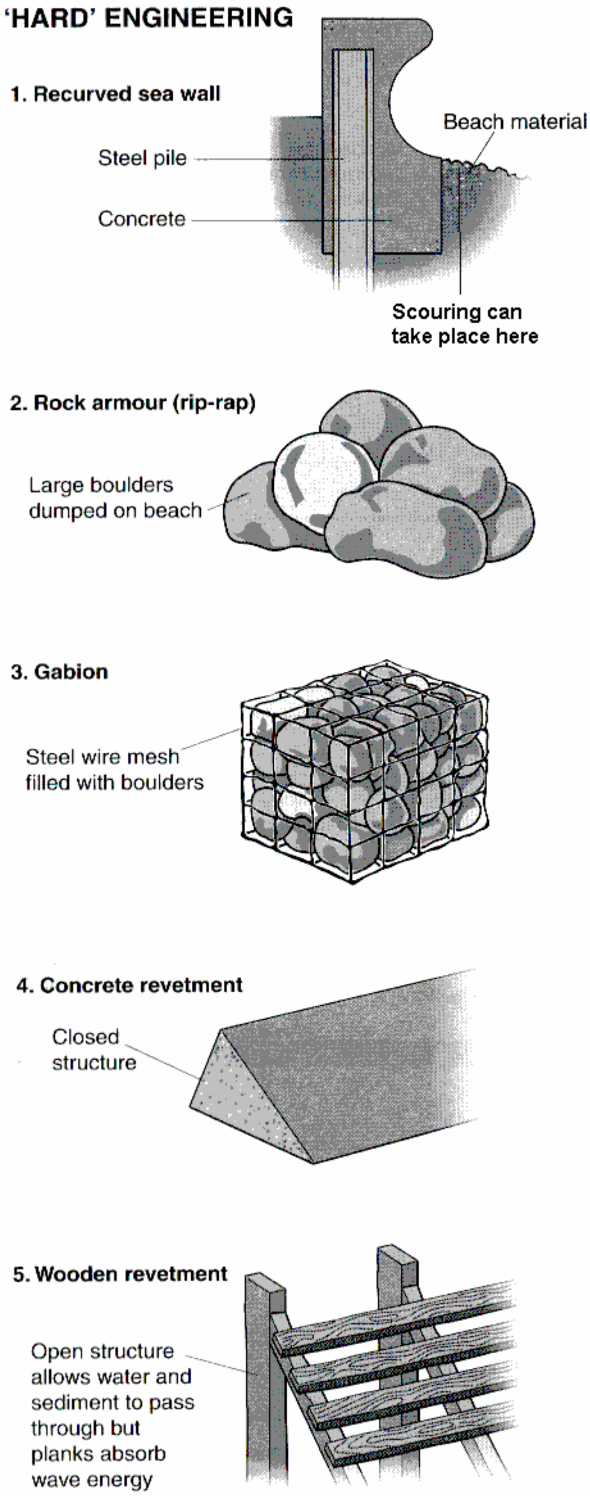
  At West Bay in west Dorset, two piers have been built extending into the sea either side of the mouth of the River Brit to maintain safe access to the harbour for fishing and pleasure boats. The sandstone cliffs to the east of the piers are prone to some erosion and supplies sand, which was originally carried westward by longshore drift. This sand used to accumulate at the base of the cliffs to the west of the river mouth in the form of a wide beach that helped to protect the west cliff from the direct impact of marine erosion. The clays and limestones of the west cliff are weak, heavily faulted and unstable. The piers have created a barrier to longshore drift so that sand accumulates to the east of the east pier, but little is transported to the base of the west cliff. Meanwhile, the same process has removed much of the protective beach from the base of the west cliff, which is now prone to erosion. Part of the village on the west cliff is now under threat.

  To protect the village, sea-walls have been constructed below the west cliff and **rock bastions** (a type of rock armour groyne) have been built to trap beach sediments below the west cliff.

  A similar problem has occurred at Westward Ho! The resort was suffering some coastal erosion, so a sea wall, including a projecting promenade, was constructed to protect the town and to proved additional sea front space. The promenade reduces the amount of sediment that is transferred along the coast to the Pebble Ridge Spit. The spit suffered sediment depletion and began to become lower and to retreat landwards, leaving Northam Burrows, the area behind the spit, prone to flooding from the sea. A series of engineering projects have been tried to resolve the problem but most have been thwarted by the unusually large cobbles in the spit. Thus wooden baffles, wooden groynes and steel-caged gabion groynes have all failed to stop the deterioration of the spit.

- **Cliff Protection.** Where coastal erosion threatens buildings or land considered to be of value, coastal defences are used which can in themselves lead to further problems, particularly if sediment supply and movement is disturbed.

  Groynes. Wooden groynes are probably the most familiar way in which people try to manage coastal processes. These reduce longshore drift and help to accumulate beach sediments. This can protect cliffs from erosion. At West Bay, larger groynes called bastions are used. These are more robust, but serve much the same purpose. In Christchurch Bay in Hampshire, they are called **strong-points**. More conventional wooden groynes are used at Milford-on-Sea.



  Sea walls are quite effective but expensive. Curved sea walls reduce wave reflection and wave energy is deflected. The walls are impermeable so, at the base of sea walls, scouring by wave activity can undermine the wall, increasing maintenance costs.

  Rock armour (rip-rap) consists of large boulders of hard rock. Their irregular surfaces dissipate wave energy effectively. Their disadvantage is that they create a barrier for users of the beach and they can be unsightly. In heavy storms, boulders can be displaced. These are used at Westward Ho! to protect the base of the sea wall from scour.

  Gabions are wire cages with pebbles or rocks can be used to protect the base of a cliff (used near Overstrand in North Norfolk) or they can be built into groynes to reduce longshore drift. These were ineffective at Westward Ho! as the Pebble Ridge spit retreated leaving them stranded. They also became an eyesore and a safety hazard as the steel cages rusted.

  Concrete revetments are aprons of concrete laid on a graded slope to dissipate wave energy. Cheaper than sea walls but can be displaced by waves. A stepped variety is used at the base of the sea wall at West Bay in Dorset.

  Wooden revetments are open structures designed to absorb wave energy while allowing the sediment to pass through, thus allowing the accumulation of a protective beach. Not used in North Devon or Dorset but widely used on the North Norfolk coast. They have a short life and require regular maintenance.

  A widely used alternative to hard engineering is to use **beach replenishment.** The beach is fed artificially with material from another locality or dredged from the seabed, or from down drift where sediments are accumulating. This has been used at Westward Ho! but engineers have found that the down-drift supplies are running out, as quantities of the replenished beach material are lost to the offshore zone.

- **Dredging.** Dredging is used, either to maintain deep water channels for shipping or to obtain aggregate for the construction industry. Dredging can upset the balance of sediment within a littoral cell. This was demonstrated in 1917 when the South Devon village of Hallsands was largely destroyed by a storm. Contractors building the Devonport Naval Dockyard removed the shingle beach that had previously protected the village. The beach was lowered by 65m when 660,000 tonnes of gravel were removed. The beach was probably a relict feature deposited as sea levels rose about 6000 years ago. Up to 6m of cliff erosion took place at Hallsands between 1907 and 1957.