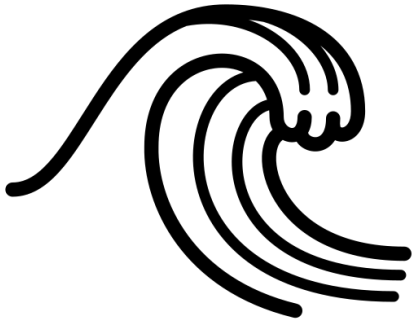
1.1

Year 12

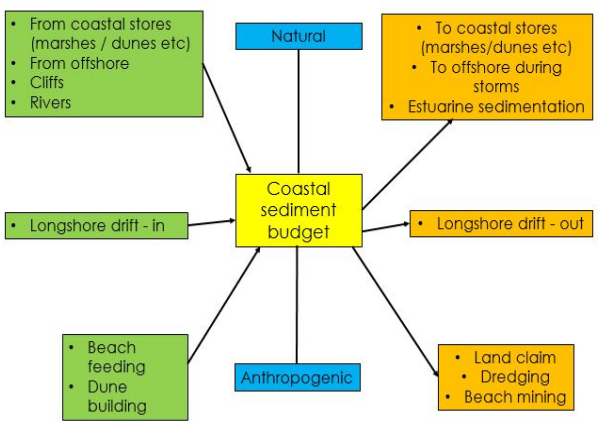
Module 1P

Coastal Landscapes

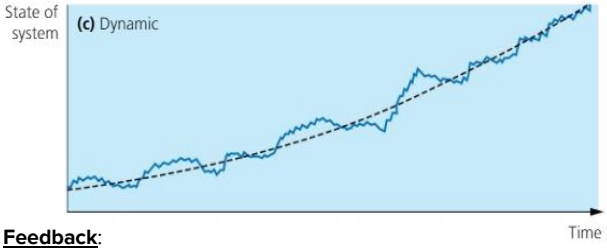


Geography Knowledge Organiser

1.1.1 - The coast as a system



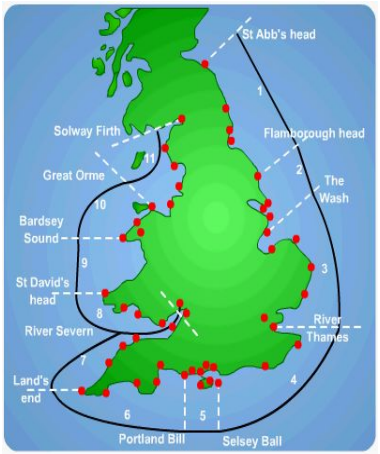
Balanced budget:
Volume of sediment in = volume of sediment stored + volume of sediment out.



Feedback:
A positive feedback is a process in which an initial change will bring about an additional change in the same direction.

Negative feedback is when the process seeks to counter the change and maintain equilibrium.

Sediment cells:
11 major cells, divided into sub-cells. This is an example of how the coast is an open system - inputs are received and outputs are transferred, across the boundary of the system.



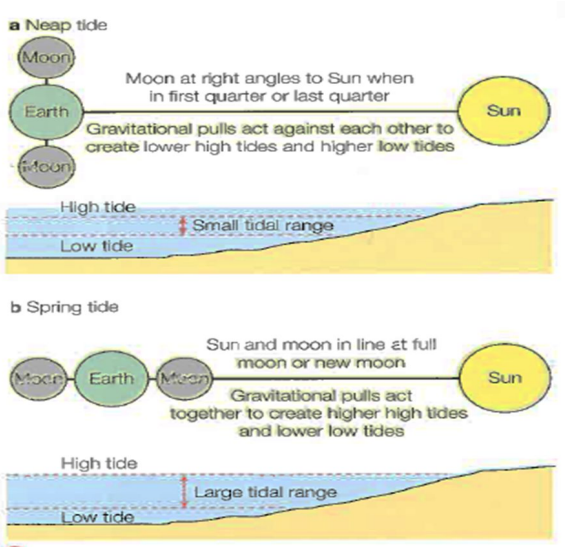
1.1.2 - Temporal variations

Onshore and offshore currents:

- Tidal currents: water floods the intertidal zone at high tide, depositing sediment. As the tide falls (ebb tide), sediment moves in the opposite direction.
- Shore normal currents: waves align parallel to the coast pushing water straight up the beach.
- Rip currents can form when the water returns.
- Longshore currents: waves approach at an oblique angle, but return straight down the beach.
- Threshold: critical water velocity that mud, silt will be entrained or deposited. Fine material is very cohesive and needs a higher threshold.

Tides, waves and currents
Key inputs of energy into the coastal system – can erode, transport and deposit.

Tides result from the gravitational attraction on water from the moon and the sun, with the moon having twice the impact of the sun.

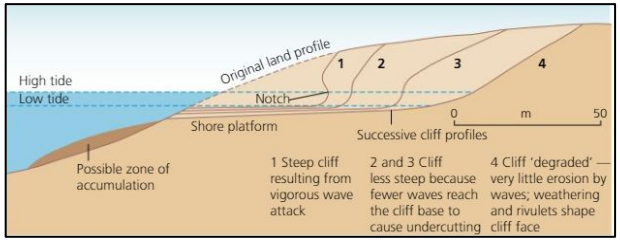


Constructive waves - a low height, but with a long wavelength and low frequency of around 6-8pm. Their swash tends to be more powerful than their backwash and as a consequence beach material is built up.

Destructive waves - a high wave height and with a steep form and height frequency (10-14pm). Their swash is generally stronger than their backwash, so more sediment is removed than is added.

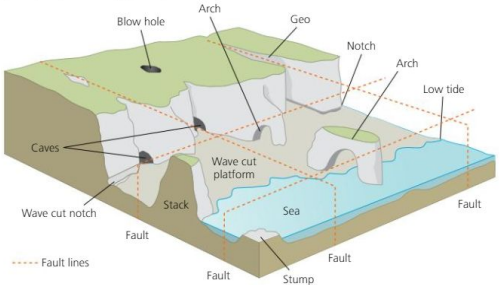
1.1.3 - Coastal Landforms

Cliff retreat and the formation of shore platforms



- Wave cut notch – formed by quarrying and corrosion, undermines the cliff, leading to mass movement (slumping / vertical collapse)
- Cliff retreat leads to a sloping surface of 1-5o
- This is a wave-cut platform / intertidal shore platform
- Marine processes fail to affect the cliff except in storm conditions

The formation of micro-features

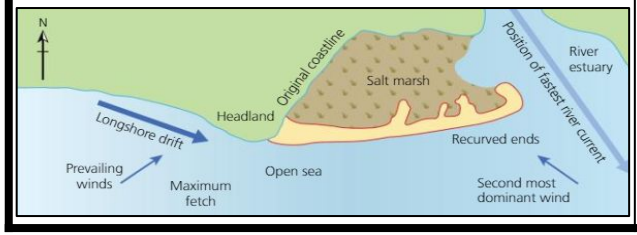


Blow hole: Air and water forced into caves by wave action can lead to vertical shafts and tunnels upwards to the ground to form a **blow hole** e.g. Spouting Horn in Kauai, Hawaii.

Geo: Air and water are forced through the blowhole by breaking waves, at certain tides and particular wind directions, with an **explosive force**. This causes large pressure changes in the cave and further erosion. The blow hole roof may collapse to form a **geo or inlet**. Alternatively, **differential erosion** may exploit the weakness of the fault or shatter zone to form a narrow gully, or geo, for in Orkney.

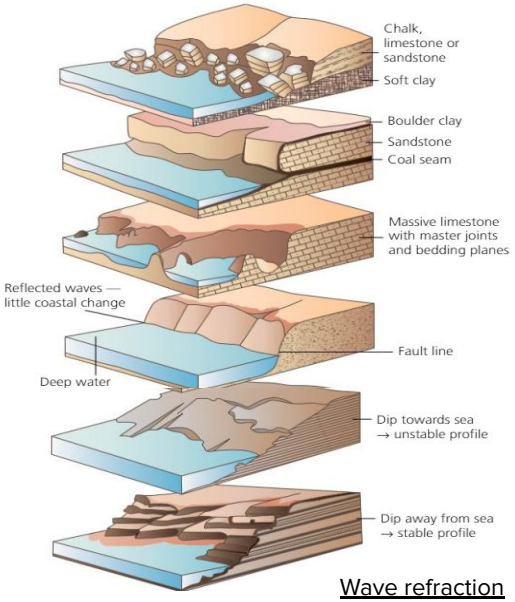
Spit formation

Longshore drift moves the sand and shingle along the shore. Where the coastline suddenly changes direction, longshore drift may continue to deposit sediments into the sea, building up the spit. Short term changes in wind direction or currents can cause the distal end to curve.

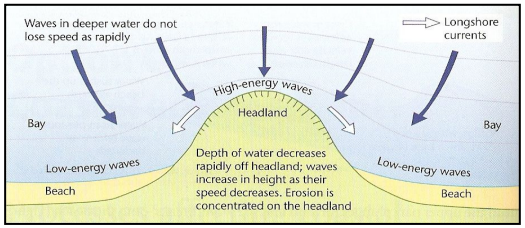


1.1.4 - Factors affecting coastal processes and landforms

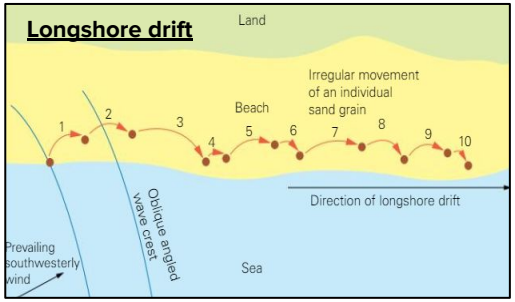
Structural geology: Cliff profiles can be affected by different factors: Rock type, joints, depth of water, dip`



Wave refraction



Most waves usually arrive at an angle to the shoreline. This angled approach of a wave toward the shore can change the direction of wave travel.



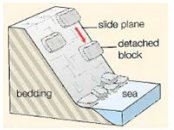
1.1.5 - Coastal Processes

Erosion process	Explanation
Hydraulic action	Breaking waves create hydraulic pressure in joints. Air in the cracks can be compressed by the waves and then rushes out when the wave retreats, weakening the rock.
Quarrying	High energy, tall waves hit the cliff face and have the power (tonnes per m2) to enlarge joints and remove large chunks of loose unconsolidated rock in one go through vibration.
Abrasion / Corrasion	Abrasion – rock particles scrape over bare rock, wearing it away and smoothening it. Corrasion – waves hurl debris against the cliff, breaking fragments off and wearing it away.
Attrition	Eroded rocks are worn smaller and rounder by constant rubbing against each other with the movement of the sea.
Corrosion / Solution	Weak acidic sea water chemically attacks certain rocks, dissolving minerals.

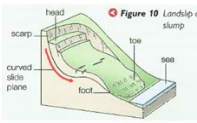
Mass movement

Rockfall: A rockfall involves the sudden collapse or breaking away of individual rock fragment (or a block of rock) at a cliff face. They are most commonly associated with steep or vertical cliffs in heavily jointed and quite resistant rock. A rockfall is often triggered by mechanical weathering (often freeze-thaw) or an earthquake. Once broken away from the source, rocks falls or bounce down the slope to form scree at the foot of the slope. Scree often forms a temporary store within the coastal system, with material gradually being removed and transported elsewhere by the sea. When this occurs, the scree forms an input into the sediment cell.

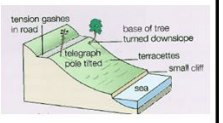
Rock slides: A landslide involves a block of rock moving very rapidly downhill along a planar surface (a slide plane) – this is often a bedding plane that runs roughly parallel to the surface. Unlike a mudflow, where the moving material becomes mixed, the moving block of material in a landslide remains largely intact. Landslides are frequently triggered by earthquakes or very heavy rainfall. In this case, the slip surface becomes lubricated and friction is substantially reduced. Landslides tend to be very rapid and pose a considerable threat to people and property.



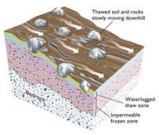
Rotational slides or Slumps: This differs from a landslide in that its slide surface is curved rather than flat. Landslips commonly occur in weak and unconsolidated clays and sands – often when permeable rock overlies impermeable rock, which causes a build up of pore water pressure. Landslips or slumps are characterised by a sharp break of slope and the formation of a scare. Multiple landslips can result in a terraced appearance on the cliff face.



Soil creep: Is an extremely slow form of movement of individual soil particles downhill. Soil creep cannot be seen in operation, but its action can be implied by the formation of shallow terracettes, the build-up of soil on the upslope side of walls and the bending of tree trunks.



Solifluction: Is similar to soil creep, but specific to cold environments where temperatures fluctuate around freezing. In the summer, the surface layer of the soils thaws out and becomes extremely saturated as it sits on top of impermeable permafrost. Known as the active layer, this sodden soil with its blanket of vegetation slowly moved downhill by a combination of heave and flow. This results in unique landforms known as solifluction lobes.

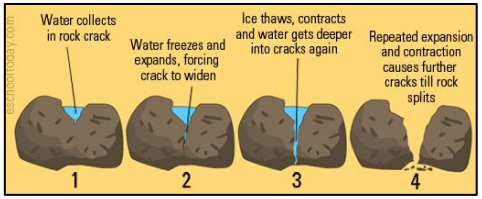


1.1.6 - Coastal processes

Weathering is the breakdown or disintegration of rock in situ (its original place) at or close to the ground surface.

Sub-aerial weathering is land based processes shaping the coastline.

Freeze-thaw weathering



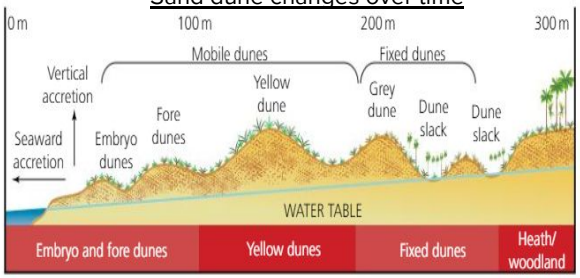
Physical / Mechanical Weathering Process	Effect
Salt water crystal growth	Crystals grow when seawater that collects in cracks in the cliff face evaporate. As the grow, the crystals exert pressure
Freeze-thaw	Repeated freezing and thawing of water causes a type of crystal growth that is most effective on high latitude coasts
Wetting and drying (water-layer weathering)	Expansion and contraction of minerals is most effective on clay and in macro-tidal environments
Chemical Weathering Process	
Solution	Solubility of minerals depends on temperature and acidity of water. Limestone is affected by carbonation
Hydration	Minerals absorb water, weakening their crystal structure. Rock is then more susceptible to weathering
Hydrolysis	Reaction between mineral and water related to hydrogen ion concentration in water – affects feldspar minerals
Oxidation/reduction	Adding or removing oxygen. Oxidation results form oxygen dissolved in water and affects rocks with a high iron content
Chelation	Active on vegetated upper slopes of cliffs and opens up the cliff face to other destructive processes
Biotic Weathering Process	
Plant roots	Organic acids, produced by plant roots and decaying organic matter, bind to metal ions causing weathering
Animals	Burrowing animals can cause weathering of soft rocks such as clay and can disturb coastal sand dunes

How can weathering cause positive and/or negative feedback?

- If the rate of debris removal exceeds the rate of weathering and mass movement then a ***positive feedback*** can operate, as the rate of weathering and mass movement could increase.
- If debris removal is slow and ineffective, this will lead to a build-up of an apron of debris (scree) that reduced the exposure of the cliff face. Weathering and mass movement rates will decrease – ***negative feedback***.

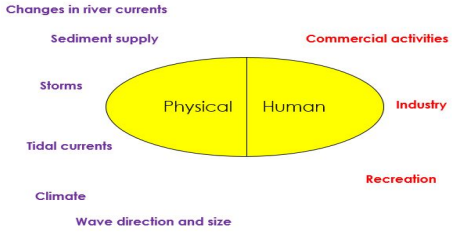
1.1.7 - Aeolian, fluvial and biotic processes

Sand dune changes over time

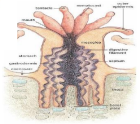


Sand dune features	Description
Ridges	Lines of dunes parallel to the coast
Slacks	Hollows found between the dune ridges
Grey dunes	Older dunes where decomposing organic matter creates a humus layer on the surface, making the dunes appear this colour
Yellow dunes	Younger dunes with no humus layer
Embryo dunes	Youngest dunes in the early stages of formation
Fore dunes	Dune ridges closest to the sea
Fixed dunes	Older dunes, stabilised with vegetation, which are unlikely to change
Blow-out	Area of a dune that has been eroded by the wind, often due to it's protective cover of vegetation being removed by animal or human activity

Factors affecting salt marsh formation:



Coral Reef formation:



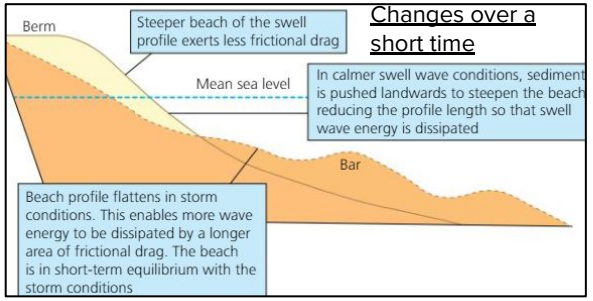
-Starts with a polyp (small animal with tiny tentacles)
-It secretes a calcareous skeleton when it dies
-Coral polyps have symbiotic relationship with tiny algae (zooxanthellae)
-Growth rates are 1-100 cm per year and can reach 100s of m thick

What natural and human processes affect coral reefs?

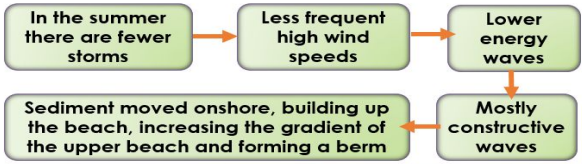
- Dead coral can be eroded by wave activity
-Tidal currents transport the limestone rubble
- Swept into a pile to create coral islands (cays)
- Or creating rubble mounds for new coral

1.1.8 - Variation of landforms overtime

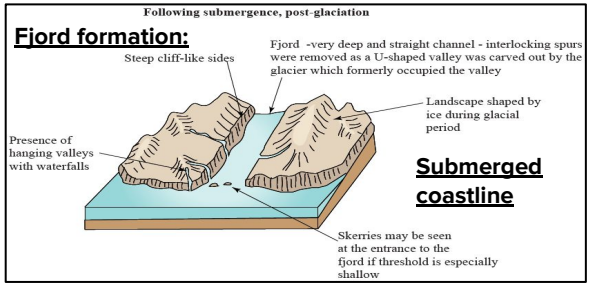
Absolute timescale	Human timescale	Coastal process
Seconds Minutes Hours Days Weeks Months Years	Dumping of litter, sewage Emergency defences against erosion and floods Impacts of tourists, visitors and local population Coastal management decisions Coastal development	Sediment movement by wind or water Cliff falls from mass movements Tidal cycles, shore normal sediment movement. Storms Storm surges, breaks of defences Beach scour Shore profile adjustment Tidal cycles Shore profile adjustment (seasonal) Coast accretion erosion Coastal process response to defences Longshore drift
Decades	Coastal defences	Erosion and accretion cycles Coastal process response to defences Formation and loss of habitat
Centuries	Shifts in settlement	Historic coastal development, loss of towns and villages to the sea
Millennia		Sea level changes in response to glaciation, tectonics etc.



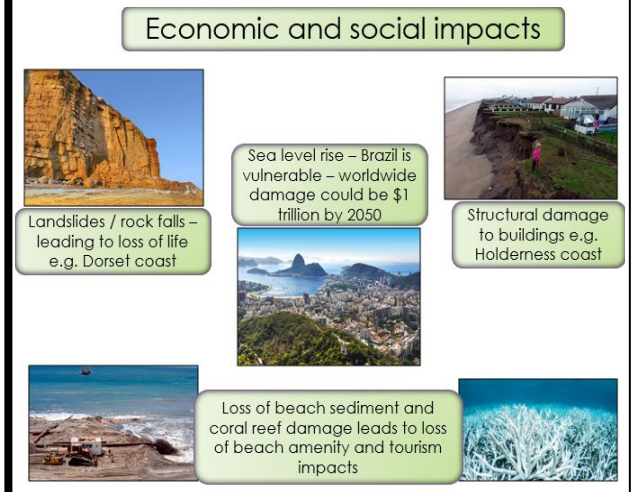
Changes at a seasonal temporal scale



Eustatic and isostatic changes in sea level: Eustatic change is when the sea level changes worldwide because of the volume of water in the oceans, for example, because of climate change. Isostatic sea level changes result from an increase or decrease in the height of the land, as a result of ice ages or sediment deposition or tectonic activity and occur locally.



1.1.9 - Impact of coastal processes on Human activity



The development of tourism in Benidorm has social/cultural, economic and environmental effects.

-Loss of community feeling as outsiders arrive.
-influx of newcomers stimulates activities and brings new ideas.
-Threshold numbers needed for the economic survival of services such as shops, post offices and pubs are met.
-More jobs available. The economy becomes more resilient as there's a range of job types.
-Benidorm has more than 30,000 swimming pools across the resort. It has a dry climate almost all year round and depends on extracting water stored underground.
-Water is being removed from aquifers 2 or 3 times faster than it can be replenished.

Cliff strategies to manage erosion

Pinning – inserting bolts through shear planes (where rocks are under most stress). Done at White Cliffs of Dover. The cliffs there are a World Heritage Site.
Grading – decreasing the height and slope angle of the cliffs to stabilise the cliff. At Llantwit Major, South Wales, rock falls from horizontally bedded limestones underlain by weak shales were causing danger to recreational users. The upper cliff was blasted in 1969 to reduce it's slope angle, and the blast material used as armouring to protect the cliff toe. However, the blasting weakened the rock and allowed increased weathering and the cliff remained geologically unstable, so the scheme was considered unsuccessful.
Cliff drainage – used with high clay content. Pore water pressures can be reduced by drainage lines in the cliff face, field drains, gravel trenches and by intercepting overland flow. However, this can result in subsidence of cliff-top land as the cliff dries out, and it can also have an ecological impact.

1.1.10 - Impact of human activity

Managing the coral reef -The Great Barrier Reef Marine Park Authority

The Great Barrier Reef is the largest coral reef in the world. It is made of over 2900 individual reefs and 900 islands stretching for over 3000 kilometres. It is in the Coral Sea, which lies off the coast of Queensland in North-East Australia. The Great Barrier Reef is so large that it can be seen from outer space. It was selected as a UNESCO World Heritage Site in 1981.

The Great Barrier Reef Marine Park is a multiple-use area. It covers 344,000 square kilometres. Zoning helps to manage and protect the Marine Park so that all users can enjoy it, now and in the future. Zoning therefore helps to make sure that the Park is managed in a sustainable way.

Zoning

The Great Barrier Reef Marine Park is a ***multiple-use area***. The Great Barrier Reef Marine Park Zoning Plan 2003 provides for a range of ecologically sustainable recreational, commercial and research opportunities and for the continuation of traditional activities.

Zoning helps to manage and protect the values of the Marine Park that people enjoy. Each zone has different rules for the activities that are allowed, the activities that are prohibited, and the activities that require a permit. Zones may also place restrictions on how some activities are conducted.

Erosion of sand dunes: Dynamic systems, constantly in flux –wind patterns and sediment supply / uncompacted sediment, poorly bound by vegetation / Exploitation, activities leaves them vulnerable

Human activity affecting sand dunes

Conversion	Removal	Use	External
Urbanisation	Mining	Tourism	Reduced sediment supply
Golf courses	Development	Trampling	Sea defences
Agriculture		Horse riding	Dune migration prevention
Forestry		Sand yachting	
		Off-road vehicles	
		Water extraction	
		Conservation	
		Military training	

Managing sand dunes

Management strategies can be developed to stabilise and reconstruct the coastal dunes as well as to control usage, although the heavier the usage the more difficult management becomes. There are three approaches.

1 Heavily degraded areas need **complete reconstruction**.
2 On less severely degraded dunes **restoration and repair** of the seaward face by replanting and fencing can be carried out.
3 The cause of the problem can be tackled with holistic solutions.

At Kenfig, South Wales, the sediment supply was reduced by the building of a jetty at Port Talbot. This, combined with sand extraction from the dunes and dredging near shore, reduced the sediment supply to the dunes, leading to a negative sediment budget. A **holistic management** plan (walkways, access permits and keeping out grazing livestock) was the answer.

Home study questions

DEVELOPING

Discuss the terms structure and lithology **[4 marks]**

Explain how erosion can change the profile of a cliff **[4 marks]**

SECURING

Draw an annotated sketch of a fjord coastline describing the main features and explaining the role of changing sea level **[6 marks]**

Outline one positive impact of coastal processes on human activity **[6 marks]**

MASTERING

Examine the relative importance of geology in the development of one or more landforms of coastal erosion **[15 marks]**

Evaluate the extent to which human actions have had a negative effect on coastal processes and landforms **[15 marks]**

CHALLENGE

Discuss how the morphology (shape) of a coral reef can change over time (1.1.9)

Assess how the strength of the multiplier effect and the magnitude of it's impact vary? (1.1.9)