Coastal Landscapes and Change

EQ1: Why are coastal landscapes different and what processes are causing these differences?

1.Explain the formation of … found in photograph … [6]

2.Explain the factors that influence rates of coastal recession and stability [8]

3.Assess / evaluate the extent to which geological structure affects the development of coastal landforms. [20]

Key Words	Definition
Lithology	The study of the general physical characteristics of rocks.
Morphology	The study of the geological structure, shape or form of a feature.
Submergent coast	Stretch of coastline that is inundated by the sea due to eustatic or isostatic changes (e.g. Dalmatian coast).
Emergent coast	Stretch of coastline that has been exposed by receding sea levels or isotactic uplift/rebound (e.g. Haff coast).
Concordant	Rock structure/ lithology runs parallel to the coast (e.g. creates coves).
Discordant	Rock lithology runs perpendicular to the coast creating bands of alternate rock types (e.g. headlands and bays)

COASTS EQ1: Why are coastal landscapes different and what processes cause these differences?

2B.1 The coast, and wider littoral zone, has distinctive features and landscapes.

2B.1 a. The littoral zone consists of backshore, nearshore and offshore zones, includes a wide variety of coastal types and is a dynamic zone of rapid change.	**b. Coasts can be classified by using longer term criteria such as geology and changes of sea level or shorter term processes such as inputs from rivers, waves and tides.**	**c. Rocky coasts (high and low relief) result from resistant geology (to the erosive forces of sea, rain and wind), often in a high energy environment, whereas coastal plain landscapes (sandy and estuarine coasts) are found near areas of low relief and result from supply of sediment from different terrestrial and offshore sources, often in a low-energy environment.**
Littoral zone	Geology & erosion resistance	Rocky coastlines (use class notes to locate)
	Relative sea level change	
	Formation processes	
Cliffed coast		
Sandy coast	Wave energy	Coastal plains (use class notes to locate)
Estuarine coastline		
	Tidal range	
Dynamic equilibrium		

COASTS EQ1: Why are coastal landscapes different and what processes cause these differences?

2B.2 Geological structure influences the development of coastal landscapes at a variety of scales.

2B.2a. Geological structure is responsible for the formation of concordant and discordant coasts.
b. Geological structure influences coastal morphology: Dalmatian and Haff type concordant coasts and headlands and bays on discordant coasts.

<u>Concordant coasts</u>

Simple sketch of South Dorset coast from your classwork

Dalmation coasts & example

Haff coasts & example

<u>Discordant coasts</u>

Simple sketch of East Dorset coast from your classwork

c. Geological structure (jointing, dip, faulting, folding) is an important influence on coastal morphology and erosion rates, and also on the formation of cliff profiles and the occurrence of micro-features, e.g. caves.

The influence of dip on strata

Faults

Joints

Fissures

Folding

COASTS EQ1: Why are coastal landscapes different and what processes cause these differences?

2B.3 Rates of coastal recession and stability depend on lithology and other factors

a. Bedrock lithology (igneous, sedimentary, metamorphic) and unconsolidated material geology are important in understanding rates of coastal recession.

Rock type	Examples	Erosion rate & explanation
Igneous		
Metamorphic		
Sedimentary		
Unconsolidated sediment		

b. Differential erosion of alternating strata in cliffs (permeable/impermeable, resistant/less resistant) produces complex cliff profiles and influences recession rates

c. Vegetation is important in stabilising sandy coastlines through dune successional development on sandy coastlines and salt marsh successional development in estuarine areas.

How vegetation stabilises sediment

Sand dune succession

Salt marsh succession

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EQ2: How do characteristic coastal landforms contribute to coastal landscapes?

1. Explain how constructive and destructive waves influence beach morphology [6]
2. Explain how the sediment cell model helps us to understand the coastline as a system [8]
3. Evaluate the importance of sub-aerial processes in influencing coastal landforms. [20]

Key Words	Definition
Proxy records	Records or data collected from other sources (e.g. books or paintings).
Geomorphology	The study of origins and evolution of the earth's landforms, and the factors which affect them.
Sedimentary rock	Rock formed over millions of years due to the accumulation of sediment (e.g. sandstone).
Igneous rock	Rock which is formed by the cooling of molten magma (e.g. granite).
Metamorphic rock	Rock formed from other rocks that have been changed due to heat or pressure (E.g. Marble)
Basalt	The most abundant igneous rock found on the planet.
Unconsolidated	Often loosely formed mass of soil, rock and other parts that is weak and easy to break (e.g. glacial till).
Lithology	The general physical characteristics of rocks.
Permeable	Allows liquid to pass through it. (e.g. sandstone).
Impermeable	Will not allow liquid to pass through it (e.g. granite).
Recession rate	The rate at which the land recedes (usually measured in mm to m per year).
Temporal	Relating to time.

Longshore drift	The movement of material along a coast by wave action, which approach at an angle to the shore but recede directly away from it.
Tombolo	A bar of sand or shingle joining an island to the mainland
Cuspate forelands	Formed due to longshore currents by the accretion of sediment, they extend outwards from the shoreline in a triangular shape.

Rotational slump	Where the slope fails and slides down due to undercutting or weathering of unconsolidated material.
Mass movement	The geomorphic process by which soil, sand and rock move downslope typically as a mass, largely under the force of gravity or erosion.
Rotational scars	The scar left behind due to rotational slump.
Talus screes	A mass of small loose stones that form or cover a slope on a mountain due to weathering. They typically have a concave upwards form.
Terraced cliff profiles	Where the cliff profile is stepped due to lithology or fractures in the rock.

Hydraulic action	Mechanical weathering caused by the force of moving water currents rushing into a crack in the rock face and forcing it apart.
Attrition	The wearing away of material as it collides together continually.
Corrosion	Erosion caused by the acidity within the water corroding the rock.
Abrasion	A type of erosion caused by the process of scraping or wearing something away.
Sediment cell	Cells within which the movement of sediment is functionally separated and discrete from the next.
Dynamic equilibrium	The state at which inputs into a system equal outputs.
Succession	The process of change in the species structure of an ecological community over time.

COASTS EQ2: How do characteristic coastal landforms contribute to coastal landscapes?

2B.4 Marine erosion creates distinctive coastal landforms and contributes to coastal landscapes.

a. Different wave types (constructive/destructive) influence beach morphology and beach sediment profiles, which vary at a variety of temporal scales from short term (daily) through to longer periods

Constructive waves

Destructive waves

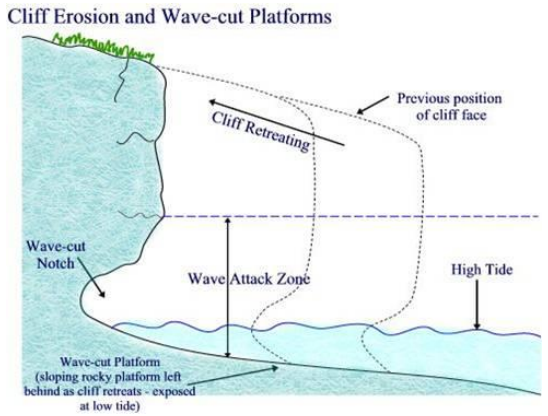
How they vary in the short and long term

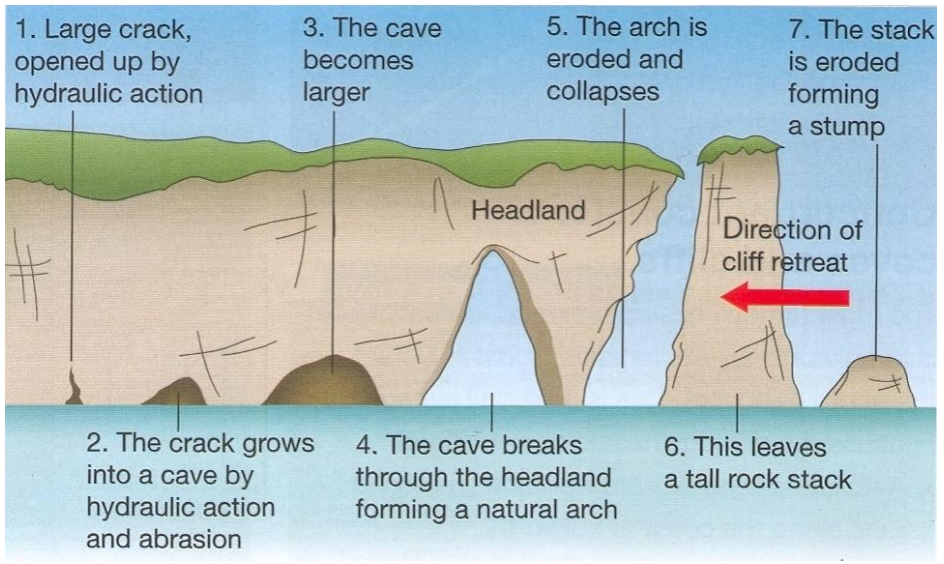
b. The importance of erosion processes (hydraulic action, corrosion, abrasion, attrition) and how they are influenced by wave type, size and lithology.

Process	Explanation	Influence of lithology	Influence of waves
Hydraulic action			
Abrasion			
Attrition			
Corrosion			

c. Erosion creates distinctive coastal landforms (wave cut notches, wave cut platforms, cliffs, the cave-arch-stack-stump sequence).

Named, located examples:





COASTS EQ2: How do characteristic coastal landforms contribute to coastal landscapes?

2B.5 Sediment transport and deposition create distinctive landforms and contribute to coastal landscapes

b. Transportation and deposition processes produce distinctive coastal landforms (beaches, recurved and double spits, offshore bars, barrier beaches and bars, tombolos and cuspate forelands), which can be stabilised by plant succession.

Transportation

- Traction
- Saltation
- Suspension
- Solution

Depositional landforms

Landform	Processes	Example
Spit		
Bayhead beach		
Tombolo		
Barrier beach / bar		
Hooked / recurved spit		
Cuspate foreland		

a. Sediment transportation is influenced by the angle of wave attack, tides and currents and the process of longshore drift.

c. The Sediment Cell concept (sources, transfers and sinks) is important in understanding the coast as a system with both negative and positive feedback, it is an example of dynamic equilibrium.

COASTS EQ2: How do characteristic coastal landforms contribute to coastal landscapes?

2B.6 Subaerial processes of mass movement and weathering influence coastal landforms and contribute to coastal landscapes.

a. Weathering (mechanical, chemical, biological) is important in sediment production and influences rates of recession	**b. Mass movement (blockfall, rotational slumping, landslides) is important on some coasts with weak and/or complex geology.** Mass movement is: Fall Topple Translational slide Rotational slumping	**c. Mass movement creates distinctive landforms (rotational scars, talus scree slopes, terraced cliff profiles).**

Coastal Landscapes and Change

EQ3: How do coastal erosion and sea level change alter the physical characteristics of coastlines and increase risks?

1.Outline the difference in the meaning of the terms 'isostatic' and 'eustatic' [6]

2.Explain why erosion rates vary in time and space on a stretch of coastline [8]

3.Assess the significance of storm surges as a threat to coastal communities [20]

Key Words	Definition
Relict coastline	Coastline formed due to previous sea levels that have now retreated.
Fjord	Long, narrow, deep inlet of the sea between high cliffs formed by the submergence of a glacial valley.
Raised beach	A former beach now lying above water level owing to geological changes since its formation.
Ria	A long, narrow inlet formed by the partial submergence of a river valley.
Isostatic	The movement of land due to weight or release of weight.
Eustatic	A change of sea level due to glacial melt.
Accretion	The gradual growth of sediment accumulated on the coast.
Subaerial processes	Land-based processes which alter the shape of a coastline. A combination of both weathering and mass movement.
Depression	A weather front where low pressure causes air to rise; as it cools it condenses and forms cloud. Associated with precipitation.
Tropical cyclone	Very intense low-pressure wind system, forming over tropical oceans and with winds of hurricane force.

COASTS EQ3: How do coastal erosion and sea level change alter the physical characteristics of coastlines and increase risks?

2B.7 Sea level change influences coasts on different timescales.

a. Longer-term sea level changes result from a complex interplay of factors both eustatic (ice formation/melting, thermal changes) and isostatic (post glacial adjustment, subsidence, accretion) and tectonics.

Isostatic change:

Eustatic change:

Marine regression Former seabed is exposed as the sea level drops, producing an **emergent** coast.	**Marine transgression** Areas of land flood, so the coastline is 'drowned', producing a **submergent** coast.
Eustatic fall in sea level	Eustatic rise in sea level
Isostatic fall in sea level	Isostatic rise in sea level

b. Sea level change has produced emergent coastlines (raised beaches with fossil cliffs) and submergent coastlines (rias, fjords and Dalmatian).

Emergent Coastlines features

Submergent coastlines features

c. Contemporary sea level change from global warming or tectonic activity is a risk to some coastlines.

Global warming

Tectonic activity

COASTS EQ3: How do coastal erosion and sea level change alter the physical characteristics of coastlines and increase risks?

2B.8 Rapid coastal retreat causes threats to people at the coast.

a. Rapid coastal recession is caused by physical factors (geological and marine) but can be influenced by human actions (dredging or coastal management the Nile Delta, Guinea and Californian coastlines).	b. Subaerial processes (weather and mass movement) work together to influence rates of coastal recession.	c. Rates of recession are not constant and are influenced by different factors both short- and longer term (wind direction/fetch, tides, seasons, weather systems and occurrence of storms)
Physical causes of erosion on the Holderness coast Human influence on erosion – Nike Delta	Weathering and mass movement on the Holderness coast	Variations in recession along Holderness coast

COASTS EQ3: How do coastal erosion and sea level change alter the physical characteristics of coastlines and increase risks?

2B.9 Coastal flooding is a significant and increasing risk for some coastlines.

a. Local factors increase flood risk on some low-lying and estuarine coasts (height, degree of subsidence, vegetation removal); global sea level rise further increases risk (? Bangladesh, the Maldives).

Areas at risk from coastal flooding

Spider diagram of factors that increase risks from sea level rises in Asia's mega deltas

Islands at risk from sea level rise: The Maldives

b. Storm surge events can cause severe coastal flooding with dramatic short-term impacts (depressions, tropical cyclones) can cause severe coastal flooding (? the Philippines, Bangladesh).

What is a storm surge

2013 North Sea storm surge

Storm surges in Bangladesh

c. Climate change may increase coastal flood risk (frequency and magnitude of storms, sea level rise) but the pace and magnitude of this threat is uncertain.

Summary of IPCC AR5 report in 2014

Flood risk factor	Projection / evidence	Confidence / certainty?
Sea level		
Delta flooding		
Wind and waves		
Coastal erosion		
Tropical cyclones		
Storm surges		

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EQ4: How can coastlines be managed to meet the needs of all players?

'Using examples you have studied, explain why management relies on a spectrum of approaches and then assess the reasons for this.' (12)

'Assess the value of Inter-Coastal Zone Management in the protection of coastline you have studied.' (12)

'Examine the role of different players in the protection of the UK coastline.' (12)

Key Words	Definition
Environmental refugee	A person who has been displaced due to an environmental hazard, such as flood, drought or tropical storm.
Beach nourishment	Where sand and sediment are put onto a beach, generally to replace the sediment which has been removed by longshore currents.
Cliff regrading	Changing the angle of a cliff to try and prevent rotational slump occurring.
Dune stabilisation	A sand dune protection exercise that can involve several methods including planting vegetation or fences to reduce the impact of wind and water, and help retain sand and other material needed for a healthy sand dune ecosystem.
Revetments	Retaining wall which helps dissipate the energy of storm waves and prevent further recession of the backshore if well designed and maintained. Can come in various types from rock, to wood or concrete.
Terminal groyne effect	Beyond the last groyne the beach is starved of sediment so is more vulnerable to erosion.
Inter-coastal zone management	Where all aspects of the coastal zone are considered, and actions decided on the best management of the area.
Shoreline Management Plan	The management plan put in place to help protect the coastline over the short, medium and long term.
Piecemeal	Unrelated decisions made over a period of time.
Strategic realignment	Allowing the coast to realign to another position to help stabilise erosion and retreat.
Holistic approach	An approach that take economic, social and environmental factors into consideration before a decision is made.

COASTS EQ4: How can coastlines be managed to meet the needs of all players?

2B.10 Increasing risks of coastal recession and coastal flooding have serious consequences for affected communities

a. Economic losses (housing, businesses, agricultural land, infrastructure) and social losses (relocation, loss of livelihood, amenity value) from coastal recession can be significant, especially in areas of dense coastal developments (Holderness, north Norfolk).

Economic losses faced by the Holderness coast

Social losses faced by the Holderness coast

How does compensation work?

b. Coastal flooding and storm surge events can have serious economic and social consequences for coastal communities in both developing and developed countries (the Philippines, Bangladesh and the Netherlands).

The Philippines – economic and social costs

Bangladesh (previous section of book)

The Netherlands – economic and social costs

The Deltawerken megaproject

c. Climate change may create environmental refugees in coastal areas (Tuvalu Islands).

Define environmental refugee

Risk factors for most at risk islands

COASTS EQ4: How can coastlines be managed to meet the needs of all players?

2B.11 There are different approaches to managing the risks associated with coastal recession and flooding.

a. Hard engineering approaches (groynes, sea walls, rip rap, revetments, and offshore breakwaters) are economically costly and directly alter physical processes and systems.

Hard engineering

Overall advantages / disadvantages

Type & cost per metre	Construction & materials	Purpose	Impact on physical processes
Rip-rap (rock armour)			
Rock breakwater			
Sea wall			
Revetments			
Groynes			

b. Soft engineering approaches (beach nourishment, cliff regrading and drainage, dune stabilisation) attempt to work with physical systems and processes to protect coasts and manage changes in sea level.

Beach nourishment

Cliff stabilisation

Dune stabilisation

c. Sustainable management is designed to cope with future threats (increased storm events, rising sea levels) but its implementation can lead to local conflicts in many countries (Maldives, Namibia).

Sustainable coastal management

Conflict in the Maldives

COASTS EQ4: How can coastlines be managed to meet the needs of all players?

2B.12 Coastlines are now increasingly managed by holistic integrated coastal zone management (ICZM).

a. Coastal management increasingly uses the concept of littoral cells to manage extended areas of coastline. Throughout the world, countries are developing schemes that are sustainable and use holistic ICZM strategies.

Littoral cells

ICZM

Shoreline Management Plans

b. Policy decisions (No Active Intervention, Strategic Realignment and Hold The Line Advance The Line) are based on complex judgements (engineering feasibility, environmental sensitivity, land value, political and social reasons); Cost Benefit Analysis (CBA) and Environmental Impact Assessment (EIA) are used as part of the decision- making process.

No active intervention (and Holderness example)

Strategic realignment (and Holderness example)

Hold the line (and Holderness example)

Advance the line

Cost Benefit Analysis (CBA)

Environmental Impact Assessment (EIA)

Complexity of decisions depending on different factors: ….

c. Policy decisions can lead to conflicts between different players (homeowners, local authorities, environmental pressure groups) with perceived winners and losers in countries at different levels of development (developed and developing or emerging countries) (Hapisburgh and Chittagong).

Winner and losers

Blackwater Estuary conflict

Bangladesh conflict