Oxford Revise | Edexcel A Level Geography | Answers

Chapter 3

All exemplar answers given are likely to be in the top mark band.

All questions are level-marked.

1 AO1 = 3 / AO2 = 3

Level	Marks	Description
	0	• No rewardable material.
1	1–2	• Demonstrates isolated or generic elements of geographical knowledge and understanding, some of which may be inaccurate or irrelevant. (AO1) • Applies knowledge and understanding to geographical information inconsistently. Connections/relationships between stimulus material and the question may be irrelevant. (AO2)
2	3–4	• Demonstrates geographical knowledge and understanding, which is mostly relevant and may include some inaccuracies. (AO1) • Applies knowledge and understanding to geographical information to find some relevant connections/relationships between stimulus material and the question. (AO2)
3	5–6	• Demonstrates accurate and relevant geographical knowledge and understanding throughout. (AO1) • Applies knowledge and understanding to geographical information logically to find fully relevant connections/relationships between stimulus material and the question. (AO2)

Relevant content may include:

AO1

- Some people argue that hard engineering can negatively affect neighbouring coastlines and limits the ability of the coastline to respond naturally to changes in the coastal system.
- Hard-engineering strategies directly affect the physical coastal processes. They are expensive, but effective at preventing coastal recession and protecting against flooding.
- Groynes are structures built at right angles to the coast that stop longshore drift, trap sediment, and build up a beach, but they can lead to sediment starvation in other areas.
- Rip rap consists of large boulders, commonly granite or concrete, placed along coastlines to absorb wave energy, but the boulders are unsightly.

AO2

- The photograph shows rip rap, a hard-engineering strategy, in use on this coastline.
- The photograph shows groynes being used along the beach.
- The photograph shows a wide beach, which implies that the groynes have been successful in trapping sediment and building up the beach. This will protect the land behind.
- If destructive waves were to reach the back of the beach, the rip rap will absorb the wave energy.

Example answer: *Some people argue that hard engineering can negatively affect neighbouring coastlines and limits the ability of the coastline to respond naturally to changes in the coastal system. On the one hand, hard-engineering strategies will protect against the physical processes of erosion and prevent coastal recession, but on the other hand, they will alter the way that the coastline works as a natural system. Hard-engineering strategies directly affect the physical coastal processes. They are expensive, but effective at preventing coastal recession and protecting against flooding.*

The photograph shows rip rap, a hard-engineering strategy, in use on this coastline. Also, it shows groynes being used along the beach. Groynes are structures built at right-angles to the coast that stop longshore drift, trap sediment, and build up a beach, but they can lead to sediment starvation in other areas. This is because they disrupt the natural transportation of sediment in the coastal system. The photograph shows a wide beach, which implies that the groynes have been successful in trapping sediment and building up the beach. This will protect the land behind. Rip rap consists of large boulders, commonly granite or concrete, placed along coastlines to absorb wave energy, but the boulders are unsightly. If destructive waves were to reach the back of the beach, the rip rap will absorb the wave energy and limit the impact of physical processes, such as erosion.

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Relevant content may include:

AO1

- Soft-engineering strategies involve working with the physical processes and are a more natural form of coastal management.
- Beach nourishment involves adding sediment to a beach to increase its ability to absorb the waves and protect the land behind.
- Cliff regrading and drainage involves reducing the angle of the cliff to lower the risk of mass movement and drain water out.

AO2

- The photograph shows a cliff that appears vulnerable to subaerial processes of weathering and mass movement.
- There is a narrow beach, which means that destructive waves will attack the base of the cliff.
- The geology of the cliff appears unstable.
- Soft-engineering strategies that could be used here include beach nourishment and cliff regrading and drainage. There are no coastal ecosystems, such as salt marshes or sand dunes, to revegetate or stabilise.
- Cliff regrading and drainage removes part of the cliff, and overextraction of water can increase its vulnerability to collapse.
- If beach nourishment is used, sediment is continually transported away, and so needs constant replenishing.
- The narrow beach and weak cliffs may benefit from hard-engineering strategies, such as groynes to create wider beaches, or a sea wall to protect the cliff from destructive waves.
- The type of management used will depend on a cost-benefit analysis (CBA), which compares the economic cost of each policy (e.g. construction, maintenance) with the economic benefit (e.g. improving tourism, saving productive land).

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Relevant content may include:

AO1

- Deposition occurs when waves lose their energy and drop the sediment that they are carrying.
- Deposition processes produce spits, which can be stabilised by plant succession.
- Longshore drift transports sediment along the coastline, in the direction of the prevailing wind. When the coastline changes direction (due to a bay, estuary, or indent), longshore drift continues to carry material out into the open sea. Sediment is deposited, and this process continues until the sediment is visible

above the water line. The area behind a spit is sheltered, and pioneer species may establish there, creating a salt marsh.

- Spits are more common in areas with low tidal ranges.

AO2

- The photograph shows a spit that has been colonised by thick vegetation.
- The spit has been created by deposition, after the transportation process of longshore drift.
- Constructive waves will be present due to the evidence of deposition.
- The vegetation in the photograph has encouraged further deposition of sediment.
- This spit may have formed across an estuary, as it has been cut off when the river current is too strong, allowing deposition to continue.
- A secondary wind, or a change in wave direction, can create the recurved end.

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Relevant content may include:

AO1

- Both lithology and rock type affect coastal morphology and landscapes.
- On a discordant coastline, different rock types run perpendicular to the sea. They feature headlands and bays, created when softer rock strata are eroded to create bays and harder rock strata resist erosion to form headlands either side (differential erosion).
- Geological structure (jointing, dip, faulting, folding) is an important influence on coastal morphology and the formation of cliff profiles.
- The dip of a rock describes the angle between the horizontal and the rock strata. Rocks dipped towards the sea are vulnerable to landslides and create gently sloping cliffs. Rocks dipped towards the land produce vertical or steep cliffs, which are more stable.

AO2

- The photograph shows a bay, with a headland in the foreground and in the background, a discordant coastline.
- The photograph shows some steep cliffs where mass movement may have occurred.
- The cliffs appear to be stabilised by vegetation growth.
- The angle of dip may have affected the steepness of the cliff profiles. Steeper cliffs in the background may have rocks dipped towards the land.
- The type of bedrock can influence the rate of coastal recession occurring in this landscape.

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Relevant content may include:

AO1

- Beaches are an accumulation of deposited sediment.
- Different wave types influence beach morphology and beach sediment profiles, which vary at a variety of temporal scales from short-term (daily) through to longer periods.
- Destructive waves remove material from the beach and decrease the gradient of the beach profile.
- Constructive waves build up a beach and increase the gradient of the beach profile.
- The energy of waves varies seasonally.
- Transportation processes (longshore drift) and plant succession also play a role in beach morphology, although there is no evidence of this in the photograph.

AO2

- The photograph shows a beach, at the back of which are cliffs.

- The beach is shingle, which influences its steeper gradient. Shingle beaches have a steeper gradient than sand beaches as percolation is more rapid, leaving less backwash.
- There is evidence of strand lines on the beach. Features such as these on beach profiles reflect the daily changes in swash and backwash. Berms are ridges of sediment that run parallel along the beach and mark the furthest extent of each high tide.
- The beach appears to have a gentle gradient. Therefore, the photograph could be taken in the winter when high-energy waves are more common, reducing the gradient of the beach profile. Low-energy waves are more common in the summer, building up the beach and increasing the beach gradient.

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Relevant content may include:

AO1

- Longer-term sea level changes result from a complex interplay of factors, including both eustatic (ice formation/melting, thermal changes) and isostatic (post-glacial adjustment, subsidence, accretion, and tectonics).
- Eustatic sea level change is a global change in the volume of water in the ocean.
- It is responsible for historic and contemporary sea level change.

AO2

- Future sea level change is expected to vary globally but many areas will experience regional mean sea level rise.
- It is likely that eustatic changes are causing the global sea level rise, due to climate change and global warming leading to ice melting and thermal changes.

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- Temperatures increase, the ice stored in ice sheets and ice caps melts, and sea level rises.
- Warmer temperatures also lead to thermal expansion, where the water volume increases, and sea level rises.

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Relevant content may include:

AO1

- Erosional processes (hydraulic action, corrosion, abrasion, attrition) create distinctive coastal landforms (the cave-arch-stack-stump sequence).
- Geological structure (jointing, dip, faulting, folding) is an important influence on coastal morphology and erosion rates.
- Differential erosion of alternating strata in cliffs (permeable/impermeable, resistant/less resistant) produces complex cliff profiles.

AO2

- The photograph shows a stack surrounded by cliffs and headlands.
- Geological weaknesses are visible. They will begin the process of the stack formation sequence and influence the rate of erosion.
- There are four main erosional processes that will contribute to the creation of the landform in the photograph: hydraulic action, corrosion, abrasion, and attrition.
- The impact of erosional processes is influenced by waves (destructive waves have more erosional power) and lithology (weaker rocks are more susceptible to erosion).
- Waves attack geological weaknesses in a headland such as joints and cracks. Geological weaknesses are eroded easily, and widen and deepen to form a cave. Back-to-back caves eventually join and break through the headland to form an arch. Continued erosion at the base of the arch and subaerial processes

on the roof cause the arch to collapse. A tall, isolated pillar of rock stands separate from the headland, which has retreated. Erosion at the base of the stack can create a notch which is unable to support the weight above, so the stack collapses to form a stump, which may only be visible at low tide.

- Subaerial processes, weathering and mass movement, have also played a role in the creation of the stack (arch collapse).
- There is some evidence of erosional processes on the surrounding cliffs and headlands.

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Relevant content may include:

AO1

- Vegetation is important in stabilising sandy coastlines through dune successional development and salt marsh successional development in estuarine areas.
- 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.
- Deposition occurs when waves lose their energy and drop the sediment that they are carrying.

AO2

- The photograph shows a salt marsh with channels or creeks of brackish water.
- The vegetation appears to be a species of grass, such as cord grass, eel grass, or sea lavender.
- The photograph may be taken behind a spit where the area is sheltered and pioneer species may establish there, creating a salt marsh.
- The roots of vegetation in salt marshes trap sediments and stabilise their structures.
- Salt marshes are formed in sheltered areas of coastline such as estuaries and bays. The first plants to grow in salt marshes are small pioneer plants and algae. Both help to bind the mud and clays together and trap

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sediment. Halophytes (salt-tolerant) plants establish themselves next and decompose to add organic matter to the soil. Over time, a wider variety of plants will be able to survive in the salt marsh.

- Salt marsh succession has played a key role in the establishment of this landscape, as well as deposition.

9 AO1 = 8

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Relevant content may include:

- 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.
- Geology:
    - Coasts can be classified based on their rock type and structure.
    - Concordant coastlines are those where different rock types are parallel to the shoreline.
    - Discordant coastlines are those where different rock types are perpendicular to the shoreline.
    - Rocky coasts are formed by more resistant rocks as they can withstand physical processes.
- Changes of sea level:
    - Long-term changes in sea level can create distinctive coastlines.
    - Rises in sea level can create submergent coastlines with landforms such as rias (submerged river valleys) and fjords (submerged glacial valleys).
    - A fall in sea level can create emergent coastlines where features such as relict cliffs and raised beaches can be found.
- Waves:
    - The power of the waves can influence the processes and landforms that occur.
    - A high-energy environment is characterised by powerful, destructive waves and high rates of erosion.
    - A low-energy environment has a higher rate of deposition due to less powerful, constructive waves for most of the year, and is more likely to be a sandy and estuarine coast.
- Tidal range:
    - The tidal range influences the area that is affected by wave action.
    - Some coastlines have small tidal ranges (more enclosed coasts, such as those in the Baltic Sea) and some have much larger tidal ranges (such as those in the UK).

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- Rivers:
  - They are a main source of sediment input for the coastline.
  - Rivers with large loads can create different types of deltas.
  - Periodic increases in sediment discharge, such as during storms, can create depositional features, such as bars.

Example answer: *Coasts can be classified by using longer term criteria such as geology and changes of sea level. Coasts can be classified based on their rock type and structure. Concordant coastlines are those where different rock types are parallel to the shoreline. Discordant coastlines are those where different rock types are perpendicular to the shoreline. Rocky coasts are formed by more resistant rocks as they can withstand physical processes such as marine erosion. Long term changes in sea level can create distinctive coastlines. A rise in sea level can create submergent coastlines with landforms such as rias (submerged river valleys) and fjords (submerged glacial valleys). A fall in sea level can create emergent coastlines where features such as relict cliffs and raised beaches can be found. Coasts can also be classified by using shorter term processes such as inputs from rivers, waves and tides. The power of the waves can influence the processes and landforms that take place. A high-energy environment is characterised by powerful, destructive waves and high rates of erosion. A low-energy environment has a higher rate of deposition due to less powerful, constructive waves for most of the year and are more likely to be sandy and estuarine coasts. The tidal range influences the area which is affected by wave action. Some coastlines have small tidal ranges (more enclosed coasts like in the Baltic Sea), some have much larger tidal ranges (such as those in the UK). Rivers are a main source of sediment input for the coastline. Rivers with large loads can create different types of deltas. Periodic increases in sediment discharge, such as during storms, can create depositional features, such as bars.*

10 AO1 = 8

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Relevant content may include:

- 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.

- ICZM involves all stakeholders and takes their views and needs into account. It ensures that approaches in one area of the littoral cell do not have negative impacts elsewhere, and that management is long-term, sustainable, and allows for changes in economic development as the threats to coastal areas develop.
- With any policy decisions, there will be conflict between different players as their attitudes towards coastal management vary. Therefore, it is important that an ICZM takes all these views into account to avoid conflict.
- Shoreline management policy decisions (no active intervention, strategic realignment, 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.
- An ICZM undertakes important assessments to understand the impact of the management.
- An EIA assesses the likely consequences of the management on the environment (e.g. biodiversity, soil, water, climate, people's health).
- A CBA compares the economic cost of each policy (e.g. construction, maintenance) with the economic benefit (e.g. improving tourism, saving productive land).

Example answer: *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. ICZM involves all stakeholders and takes their views and needs into account. It ensures that approaches in one area of the littoral cell do not have negative impacts elsewhere, and that management is long-term, sustainable, and allows for changes in economic development as the threats to coastal areas develop. With any policy decisions, there will be conflict between different players as their attitudes towards coastal management vary. Therefore, it is important that an ICZM takes all these views into account to avoid conflict.*

Shoreline management policy decisions (no active intervention, strategic realignment, 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. An ICZM undertakes important assessments to understand the impact of the management. An EIA assesses the likely consequences of the management on the environment (e.g. biodiversity, soil, water, climate, people's health). A CBA compares the economic cost of each policy (e.g. construction, maintenance) with the economic benefit (e.g. improving tourism, saving productive land).

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Relevant content may include:

- Geology has two aspects: lithology (the geological structure of a rock) and rock type.
- Geological structure is responsible for the formation of concordant and discordant coasts.
- At concordant coastlines, different rock types run parallel to the sea.
- The Dalmatian type of concordant coastline has long islands and coastal inlets which lie parallel to the coastline. They are commonly high-energy, submergent coastlines. The Haff type has lagoons which are created by spits that form parallel to the coast.
- At discordant coastlines, different rock types run perpendicular to the sea. They feature headlands and bays, created when softer rock strata are eroded to create bays and harder rock strata resists erosion to form headlands either side (differential erosion).
- Layers within rock can become folded due to tectonic movement. In anticlines, the folds move upwards, so the oldest rocks are in the centre. In synclines, the rocks fold downwards so the youngest rocks are in the centre.
- Joints and faults are fractures in rocks which create points of weakness that are vulnerable to weathering and erosional processes. They can be exploited to form wave-cut notches and caves in the cliff.
- The dip of a rock describes the angle between the horizontal and the rock strata. Rocks dipped towards the sea are vulnerable to landslides and create gently sloping cliffs. Rocks dipped towards the land produce vertical or steep cliffs that are more stable.
- Layers of less resistant strata within the rock erode more easily into wave-cut notches. Permeable rocks are less resistant to weathering processes. A permeable layer of rock above an impermeable layer will become saturated with water and more susceptible to mass movement.

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Relevant content may include:

- Bedrock lithology (igneous, sedimentary, metamorphic) and unconsolidated material (boulder clay) geology are important in understanding rates of coastal recession.
- Igneous bedrock (e.g. basalt and granite) is formed by molten rock which has cooled and solidified either on Earth's surface (extrusive) or underground (intrusive) and is impermeable with few faults. Igneous rocks are highly resistant to marine erosion and weathering, leading to slow rates of coastal recession.
- Sedimentary bedrock (e.g. limestone and sandstone) is formed from sediments which have become compacted to form rocks with a layered structure and is permeable with many bedding planes. Sedimentary rocks are susceptible to chemical weathering such as carbonation and less resistant to marine erosion, leading to fast rates of coastal recession.
- Metamorphic bedrock (e.g. slate and gneiss) is formed when rocks are subject to heat and pressure, altering them into different rocks with crystalline structures, and is impermeable. Metamorphic rocks more resistant to marine erosion and weathering, leading to slow rates of coastal recession.
- Unconsolidated bedrock (e.g. boulder clay) is a mixture of rock material formed by the deposition of sediment carried by glaciers (till). It is very easily eroded and weathered, so leads to fast rates of coastal recession.
- There are other influences, such as cliff strata, vegetation, human activity, wind direction/fetch, tides, seasons, weather systems, and the occurrence of storms.

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Relevant content may include:

- The impact of erosional processes is influenced by waves (destructive waves have more erosional power) and lithology (weaker rocks are more susceptible to erosion).
- Erosional processes include:
  - hydraulic action – waves force air into the cracks in cliffs; the repeated increase in pressure will force cracks to widen and break pieces off the cliff.
  - corrosion – a chemical process where limestone is dissolved by carbonic acid in seawater; it is the only erosional process that is not more effective under storm conditions.
  - abrasion – sediment that is carried by the waves is thrown at the cliffs and wears the cliff face away.
  - attrition – sediment that is carried in the waves knocks against each other, breaking parts of the rock down and creating smoother, smaller, and rounder particles.
- Erosion can create distinctive landforms: cliffs, headlands and bays, wave-cut notches and platforms, and stacks.
- Stack formation: waves attack geological weaknesses in a headland, such as joints and cracks. Geological weaknesses are eroded easily and widen and deepen to form a cave. Back-to-back caves eventually join and break through the headland to form an arch. Continued erosion at the base of the arch and subaerial processes on the roof cause the arch to collapse. A tall, isolated pillar of rock stands separate from the headland, which has retreated. Erosion at the base of the stack can create a notch which is unable to support the weight above, so the stack collapses to form a stump which may only be visible at low tide.
- Wave-cut platform formation: waves attack cliffs between the high and low tide marks, forming a wave-cut notch. Continued undercutting creates an overhang. The unsupported overhang will eventually collapse, and the cliff has retreated. Fallen debris is removed from the base of the cliff by wave action. A wide, gently sloping platform is left behind at the base of the cliff, which is covered at high tide.

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Relevant content may include:

- Coasts can be viewed as open systems with inputs, processes, and outputs.
- Inputs include energy from wind and waves, and sources of sediment (eroded sediment, sediment from weathering and mass movement, river sediment).
- Processes include flows; transfer of sediment by longshore drift, swash and backwash; stores of sediment, such as depositional landforms (e.g. beaches).
- Outputs are the removal of sediment to the ocean by currents, and evaporation.
- Coastal sediment cells can be viewed as closed systems. The coastline of England and Wales is divided into 11 stretches of coastline called sediment cells. For example, sediment cell five runs between Portland Bill to Selsey Bill on the south coast of England and has seven sub-cells.
- Sediment cells have sources of sediment, transfers of sediment, and sediment sinks (depositional landforms).
- Sediment theoretically stays within each cell, with no transfer between one cell and its neighbour.
- The system can be in dynamic equilibrium, meaning that the inputs and outputs are equal, but the system is still in a state of change. In other words, sediment accumulation happens at the same rate as it is removed.
- Positive feedback is when a change in the coastal system leads to a further change. For example, an increase in wave energy will lead to an increase in erosion.
- Negative feedback is when a change in the coastal system leads to a change that returns the system to equilibrium. For example, an increase in deposition will steepen the beach profile, encouraging the formation of destructive waves which will flatten the beach.

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15 AO1 = 8

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Relevant content may include:

- Physical factors cause coastal recession.
- Geological factors: softer, weaker rock is more easily eroded. Rocks with more geological weaknesses, such as joints, are more easily exploited by erosional processes. Rocks dipped towards the sea are less stable, so more vulnerable to mass movement.
- Subaerial factors: material at the coastline that is loosened by weathering is more vulnerable to mass movement. For example, blockfalls of material loosened by freeze-thaw can occur, leading to cliff retreat. Heavy rainfall can also trigger landslides.
- Marine factors: destructive waves that break at the foot of a cliff have more energy to erode. High-energy waves, created in high winds and with long fetches, have more erosive power. A narrow beach will be unable to dissipate wave energy as well as a wide, flat beach. Wave refraction will cause wave energy to be concentrated around headlands and dissipated in bays.
- Rates of recession are not constant and are subject to short- and long-term influences (wind direction/fetch, tides, seasons, weather systems, and the occurrence of storms).

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Relevant content may include:

- Hard-engineering approaches directly affect the physical coastal processes. They are expensive, but effective at preventing coastal recession and protecting against flooding.
- Groynes stop longshore drift, trap sediment, and build up a beach, but can lead to sediment starvation in other areas.
- Sea walls can be recurved and repel wave energy to protect the coastline from destructive waves, but are large and unsightly.
- Rip rap comprises large boulders, commonly granite or concrete, placed along coastlines to absorb wave energy, but the boulders are unsightly.
- Revetments are often wooden frames placed at the back of a beach to absorb wave energy, but they need frequent maintenance.
- An offshore breakwater is a structure in the sea that is parallel to the shore. It reduces the power of incoming waves, but can reduce the amount of sediment reaching the beach.
- Some people argue that hard engineering can negatively affect neighbouring coastlines and limits the ability of the coastline to respond naturally to changes in the coastal system. No one approach suits all coastlines and there is conflict over which approach is best.
- Hard engineering may be part of a shoreline management plan (SMP) or holistic integrated coastal zone management (ICZM), which manage extended areas of coastline.

17 AO1 = 8

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Relevant content may include:

- 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.
- ICZM involves all stakeholders and take their views and needs into account. It ensures that approaches in one area of the littoral cell do not have negative impacts elsewhere, and that management is long-term, sustainable, and allows for changes in economic development as the threats to coastal areas develop.
- With any policy decisions, there will be conflict between different players as their attitudes towards coastal management vary. Therefore, it is important that an ICZM takes all these views into account to avoid conflict.
- Shoreline management policy decisions (no active intervention, strategic realignment, 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.
- An ICZM undertakes important assessments to understand the impact of the management.
- An EIA assesses the likely consequences of the management on the environment (e.g. biodiversity, soil, water, climate, people’s health).
- A CBA compares the economic cost of each policy (e.g. construction, maintenance) with the economic benefit (e.g. improving tourism, saving productive land).

18 AO1 = 5 / AO2 = 15

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Relevant content may include:

AO1

- 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 (e.g. Bangladesh or the Maldives).
- Storm surge events can lead to severe coastal flooding with dramatic short-term impacts (depressions, tropical cyclones).
- Longer-term sea level changes result from a complex interplay of factors, including both eustatic (ice formation/melting, thermal changes) and isostatic (post glacial adjustment, subsidence, accretion, and tectonics).

AO2

- There are many local factors which are very influential in increasing the flood risk on coastlines.
- Places that are higher above sea level have a lower risk of coastal flooding and can be subject to much local variation (e.g. land topography).
- Human activity, such as the extraction of groundwater, can lead to land subsidence, increasing its vulnerability to flooding (e.g. Jakarta in Indonesia).
- Removing vegetation and its roots from coastlines can destabilise landforms such as sand dunes, and destroy ecosystems such as mangrove forests, which provide natural protection from flooding.
- Storm surges are short-term increases in sea level which can be caused by depressions (areas of low pressure) and tropical cyclones (a rapidly rotating storm system with very low air pressure). The low air pressure 'pulls' the sea level up, and strong winds create large waves and push the water towards the coast. When Hurricane Katrina hit the USA in 2005, the storm surge was over 8 metres and overtopped existing coastal protection, flooding 80% of the city of New Orleans.
- There are also global factors affecting coastal flood risk.
- Future predicted sea level rise will exacerbate the risk, particularly for low-lying areas, such as the Maldives, where much of the land is already less than 5 metres above sea level and is at risk of becoming uninhabitable in the future.
- Sea level rise is a global phenomenon, caused by a global change in the volume of water in the ocean (eustatic changes), rather than local (isostatic).
- Temperatures increase, the ice stored in ice sheets and ice caps melts, and sea level rises. Warmer temperatures also lead to thermal expansion, where the water volume increases, and sea level rises.
- Both local and global factors affect the flood risk on coastlines. The extent to which the coastal flood risk is due to local factors will depend on the specific coastline being discussed, as well as considering the short-term or the long-term. Many global factors depend on the future, which is uncertain, and can change due to human action against climate change. The extent to which these factors will affect flood risk will also depend on human action to prevent and manage coastal flooding.

Example answer: *There are many local factors which are very influential in increasing the flood risk on coastlines. Land topography can influence flooding as places that are higher above sea level have a lower risk of coastal flooding. Human activity, such as the extraction of groundwater, can lead to land subsidence, increasing its vulnerability to flooding. For example, in Jakarta in Indonesia, less than half the city's population has access to piped water, and so the Illegal extraction of groundwater to fulfil water requirements has caused subsidence, resulting in some parts of northern Jakarta sinking four metres in the last twenty years. Other human activities such as removing vegetation and its roots from coastlines can destabilise landforms such as sand dunes, and destroy ecosystems such as mangrove forests, which provide natural protection from flooding.*

Other local factors include storm surges, which are short-term increases in sea level which can be caused by depressions (areas of low pressure) and tropical cyclones (a rapidly rotating storm system with very low air pressure). The low air pressure 'pulls' the sea level up, and strong winds create large waves and push the water towards the coast. For example, when Hurricane Katrina hit the USA in 2005, the storm surge was over 8 metres and overtopped existing coastal protection, flooding 80% of the city of New Orleans.

There are also global factors affecting coastal flood risk. Future predicted sea level rise will exacerbate flood risk, particularly for low-lying areas (such as the Maldives) where much of the land is already less than 5 metres above sea level and is at risk of becoming uninhabitable in the future. Sea level rise is a global phenomenon, caused by eustatic changes (a global change in the volume of water in the ocean), rather than isostatic changes (local changes to seal level). As temperatures increase, the ice stored in ice sheets and ice caps melts, and sea level rises. Warmer temperatures also lead to thermal expansion, where the water volume increases, and sea level rises.

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Relevant content may include:

AO1

- Increasing risks of coastal recession and coastal flooding have serious consequences for affected communities.
- 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.
- Coastal flooding and storm surge events can have serious economic and social consequences for coastal communities in both developing and developed countries.
- Climate change may create environmental refugees in coastal areas.

AO2

- The consequences of coastal recession and flooding can be significant, especially in areas of high coastal populations.
- Properties and businesses can be completely destroyed by cliff collapse or flooding. Homeowners whose homes are at risk may struggle to insure properties. Homeowners may find themselves in negative equity as properties at increasing risk will lose their value.
- Agricultural land can be lost to flooding, or allowed to flood to manage the retreat of the coastline.
- Transport infrastructure is at risk. In 2014, storm winds and high sea levels washed away 80 metres of train track along the coastal path in Dawlish, UK.
- In the UK, 35 power stations, 22 water facilities, and 91 sewage works are at risk from coastal flooding.
- There are also social consequences.
- Recreational uses of the coastline will be affected if beaches and facilities disappear.
- Social and political tensions could arise over how to manage or cope with the risks.
- The wellbeing of a community could be affected as people are forced to relocate.
- Businesses or agricultural land that is destroyed will affect people's livelihoods. Areas could become less attractive to locals and tourists if infrastructure is at risk or destroyed.
- Environmental refugees will be forced to flee their homes as the effects of climate change put more coastal communities are risk from flooding and storm surges. For example, sea level rise could create over 20 million refugees as Bangladesh will lose 17% of its land by 2050.
- The consequences of costal recession are both social and economic. There may be other impacts too, such as political and environmental consequences.
- The degree to which the losses are mainly economic varies by level of development of the area, which is affected, the rate of recession, the management type and effectiveness in place, the size of population affected, and the land use in the affected area.

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Relevant content may include:

AO1

- 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.
- Hard-engineering approaches (groynes, sea walls, rip rap, revetments, offshore breakwaters) are economically costly and directly alter physical processes and systems.
- Soft-engineering approaches (beach nourishment, cliff regrading and drainage, dune stabilisation) attempt to work with physical systems and processes to protect coasts and manage risks caused by changes in sea level.

AO2

- Sustainable coastal management involves protecting the coastline from erosion, inundation from floodwater, conserving coastal ecosystems and ensuring the livelihoods of those who live near the coast.
- It is predicted that future global warming will put more coastal communities at risk from the threat of rising sea level and more intense tropical storms.
- Some people argue that hard engineering can negatively affect neighbouring coastlines and limits the ability of the coastline to respond naturally to changes in the coastal system.
- Some people argue that soft engineering is only a temporary response to sea level rise and protection may be outpaced by future sea level rise.
- Hard-engineering approaches (sea walls, groynes, revetments, rip rap) directly affect the physical coastal processes. They are expensive, but effective at preventing coastal recession and protecting against flooding.
- Soft-engineering approaches (beach nourishment, dune stabilisation, cliff regrading and drainage) involve working with the physical processes and are a more natural form of coastal management.
- There are benefits and drawbacks of each strategy and people will have different views over the weight of each positive and negative aspect of the approach. For example, sea walls can be recurved and repel wave energy to protect the coastline from destructive waves, but are large and unsightly.
- No one approach to suit all coastlines and there is conflict over which approach is best.
- With any policy decisions, there will be conflict between different players as their attitudes towards coastal management vary. There are perceived winners who are protected or gain from the decision and losers who may disagree with the decision or lose economically or socially.
- Conflicts can occur between locals, environmental groups, tourists, farmers, policy makers, and any other users of the coastal environment.