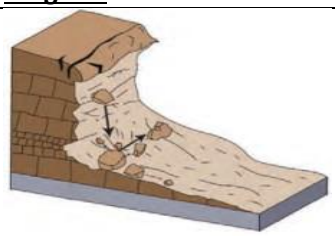
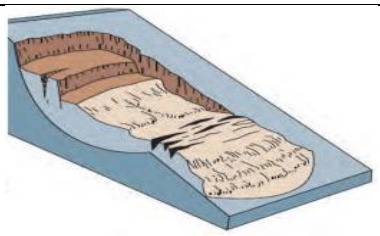
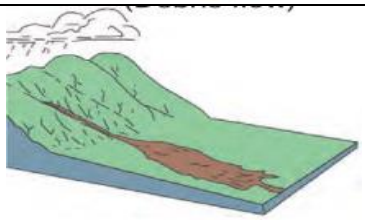
b. Mass movement (blockfall, rotational slumping, landslides) is important on some coasts with weak and/or complex geology.

Mass movement

There are many different types of mass movement and the role of water is very important in many of them. They can be classified in a number of ways including how rapid the movement is and the type of material.

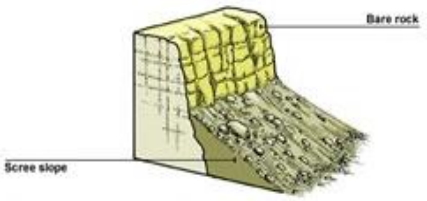
The resultant movement depends on a range of factors including:

- The angle of the slope or cliff
- The rock type and its structure
- The vegetation cover
- How wet the ground is

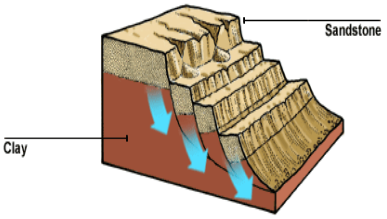
Type	Explanation	Diagram
Falls	Rockfalls, or blockfalls, are a rapid form of mass movement. Blocks of rock can be dislodged by mechanical weathering or hydraulic action. Undercutting of cliffs by the creation of wave-cut notches can lead to large falls. Forms talus scree slopes at their base.	
Topples	This is where rock strata have a steep seaward dip. Undercutting by erosion will quickly lead to instability and blocks of material toppling seaward.	
Rotational slumping	Huge masses of material slowly rotate downslope over periods lasting from days to weeks. They occur when softer material, which overlie impermeable rock, become saturated and therefore slump downwards because they are too heavy. Forms rotational scars and terraced cliff profiles.	
Flow	Flows are common in weak rocks such as clay and unconsolidated sands. These materials can become saturated, lose their cohesion and flow downslope. Heavy rainfall combined with high tides can contribute to saturation.	

c. Mass movement creates distinctive landforms (rotational scars, talus scree slopes, terraced cliff profiles).

Mass movement landforms



- **Talus scree slopes:** where sediment is deposited at the foot of a cliff after a rock fall.
- **Rotational scars:** the exposed land left behind after the downward movement of blocks of rock.
- **Terraced cliff profiles:** a steep-like pattern develops along the cliff face as large chunks of material are slumped downwards.



b. Soft engineering approaches attempt to work with the physical systems and processes to protect coasts and manage changes in sea level.

Soft engineering

Soft engineering is designed to work with natural systems and processes to reduce coastal erosion and flood threat (but not necessarily prevent). This is usually less obvious and less intrusive to the coast, and may be cheaper in the long term.

	Description	Advantages	Disadvantages	Cost
Beach nourishment	The addition of sand or pebbles to an existing beach to make it higher or wider. Sediment is usually dredged from the nearby sea bed.	Looks natural and blends in with existing beach. Increases recreational use. Relatively cheap and easy to maintain.	Needs constant maintenance as it has a short lifespan due to processes like erosion and longshore drift.	£300,000 for 100 metres.
Cliff drainage	Removes water to prevent landslides and slumping.	Hidden structures mean more attractive and natural appearance. Cost-effective.	Drained cliffs can dry out and lead to rock falls. Cliff still opened to wave erosion.	
Dune stabilisation	Marram grass can be planted to stabilise dunes.	Maintains a natural coastal environment. Provides important wildlife habitats. Relatively cheap and sustainable.	Time consuming to plant marram grass. Human recreation and tourism can trample and kill vegetation.	£200-2000 for 100 metres.
Marsh creation	A form of managed retreat by allowing low lying coastal areas to become flooded by the sea. The land then becomes a salt marsh.	Creates a natural defence by providing a buffer to powerful waves. Creates an important wildlife habitat.	Agricultural land is lost. Farmers or land owners need to be compensated.	Variable – depends on size of area flooded.

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.

Sustainable coastal management

Sustainable coastal management is managing the wider coastal zone in terms of people and their economic livelihoods, social and cultural well-being, and safety from coastal hazards, as well as minimising environmental and ecological impacts.

Bangladesh	India	Maldives
Upgrading 600km of embankments using $400 million from the world bank.	They are trying to reverse decades of mangrove destruction. An NGO is helping villagers to plant mangrove swamps along the coastline. These provide a natural defence against flooding.	Created a new inhabitable space above Male (capital city) called Hulhumale. This artificial island is built from coral and sediment dredged from the nearby sea bed and is a full metre higher than Male.
They constrict tidal flows, pushing water further inland, and increasing the tidal range (making the problem worse).	These build up sediment and therefore protects against floods and destructive waves. They are also natural for the environment. However, they take time to come into effect.	This area isn't big enough to relocate population of 340,000.

2B.12 Key idea: Coastlines are now being 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.

ICZM

This is a holistic view of coastal management which brings together all stakeholders in order to protect the coastal environment in a sustainable way.

ICZM works with the concept of sediment/littoral cells. The coastline can be divided up into littoral cells and each managed as an integrated unit. A shoreline management plan is used for each whole unit or sub-unit.

b. Policy decisions are based on complex judgements; cost benefit analysis and environmental impact assessment are used as part of the decision making process.

Policy decisions (the four ICZM options)

- **No active intervention:** no investment in defending against flooding or erosion. The coast is allowed to erode landward and/or flood.
- **Hold the line:** build or maintain coastal defences so that the position of the coast remains the same over time.
- **Managed realignment:** allow the coastline to retreat, but manage the process.
- **Advance the line:** extending the coastline out to sea e.g. using beach nourishment.

What needs to be considered when managing the coast?

Engineering feasibility	Whether the right methods are used and is achievable (as well as being within budget). For example, it may not be possible to hold the line for mobile depositional features such as spits.
Environmental sensitivity	It may be desirable to protect historic sites and areas of unusual biodiversity, despite such locations having questionable economic value. For example, Walton on the Naze has an SSSI area.
Land value	How much the land is worth also affects what management will take place. For example, urban areas have much more economic value than farmland and therefore will be more of priority of coastal management.
Political and social reasons	Pressure from local communities, such as vocal campaigning, can get results. For example, Mappleton was protected at a cost of £2 million despite only being valued at £650,000.

CBA and EIA as part of the decision making process

Cost-benefit analysis (CBA): costs are forecast and then compared with the expected benefits e.g. value of the land saved. Tangible costs (and benefits) are those that are known and can be given monetary value. Intangible costs may be difficult to assess but are still important (such as the visual impact).

Environmental impact assessment (EIA): this decides whether environmental quality will improve or worsen as a result of different options for managing the coast.