The Geology of the UK

Sedimentary Rock Types

- Sedimentary rocks- these are made from eroded material that has ben compressed to form layers.

Examples:

Sandstone-deposited when the area had a hot desert climate
Chalk-fine deposits from the remains of marine animals
Limestone-deposits of the remains of marine animals and calcium carbonate
Coal remains of tropical swamps and forests
Clay-fine deposits of silt and clay

Upland Areas

- High moors and mountains from approx. 40% of the UK's land area
- Used for farming, forestry and recreational activity
- Nearly 70% of the UK's drinking water is stored in reservoirs in upland areas
- These areas are made up of spectacular scenery and have unique plant and animal life
- They act as a store of billions of tonnes of carbon
- The landscape is heavily influenced by glaciation

Igneous Rock Types

- Formed from molten material or magma resulting from volcanic activity

Examples:

- Basalt-formed on the Earth's surface from flows of lava
- Formed within the Earth and now exposed because of erosion

Metamorphic Rocks

- These are rocks that have been changed by heat or pressure. They are usually found near areas of volcanic activity.

Lowland areas

- Approximately 80% of the UK population live in lowland areas.
- Virtually all major towns and cities are located in lowland areas.

Rivers

- The UK's rivers are a vital source of fresh water for people, farming, industry and wildlife.
- Chalk streams are unique physical features.
- There are only about 200 in the world and most are found in Southern England.
- Many of the UK's busiest ports are based around river estuaries.
- Rivers provide important transport links for people and industrial goods.

Sedimentary Rock Types

Examples:

Upland Areas

The Geology of the UK

Igneous Rock Types

Examples:

Metamorphic Rocks

Lowland areas

Rivers

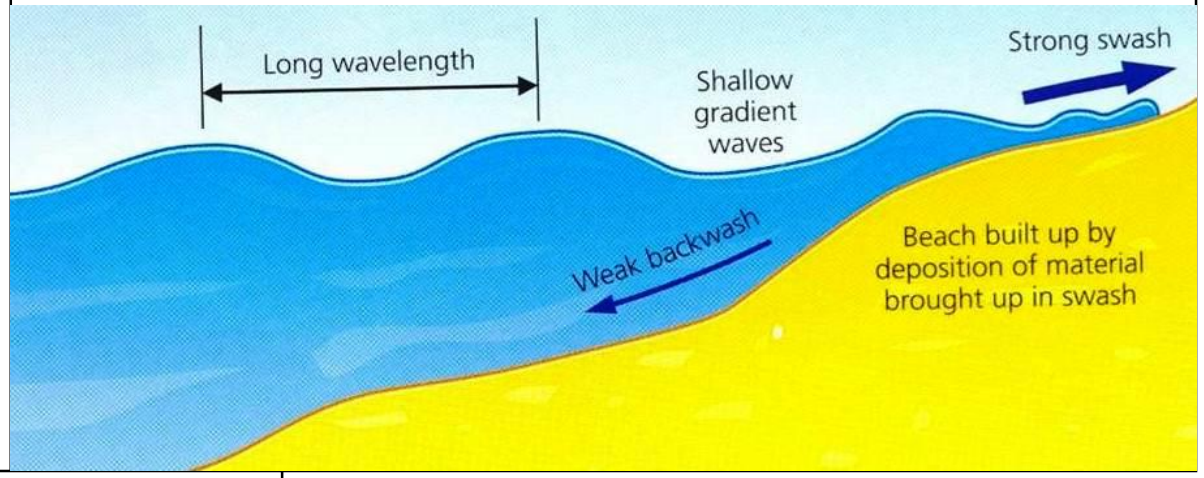
Waves

How are waves formed?

- Wind blows over a sea or ocean.
- Friction occurs.
- The surface of the water is pushed in the same direction as the wind, creating waves
- The stronger the wind, the greater the friction and the bigger the wave.
- The distance over which the wind blows is called the fetch.
- The longer the fetch, the greater the potential wave energy.

Constructive Waves

- Build up beaches by depositing sediment.



Why do waves break?

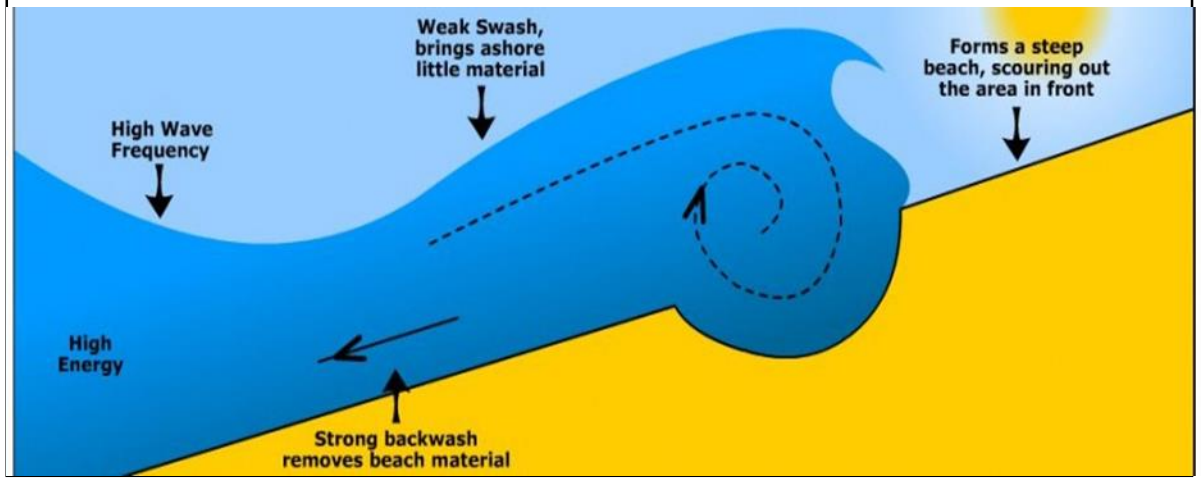
- The energy within a wave moves in a circular motion.
- As a wave moves to shallow, coastal waters, the base of the wave is in frictional contact with the seabed.
- This slows the base of the wave down, reducing the distance between the waves (wavelength) and increasing the wave height.
- The wave breaks because the top of the wave is travelling faster than the base.

Swash-the movement of water and sediment up the beach at an angle, due to the prevailing wind direction.

Backwash-the movement of water and sediment back down the beach by gravity.

Destructive Waves

- Remove sediment from beaches.



Waves

How are waves formed?

Constructive Waves

Why do waves break?

Swash-

Backwash-

Destructive Waves

Coastal Processes

Weathering

1. Mechanical Weathering

Rocks are broken down without any change in their chemical composition.

- Wetting and drying-softer rocks such as clays and shales are affected by water. These rocks expand and contract as they become wet and dry out. As they dry out, cracks develop so rainfall and sea spray can penetrate the rock more easily, making them unstable and leading to landslides.
- Freeze-thaw-moisture in rocks freezes and expands at night and thaws during the day. In cold, coastal areas the constant expansion and contraction weakens the rock surface until it begins to crumble.

Weathering is the breaking up of rocks that occurs *in situ* (the same place) with no major movement taking place.

2. Chemical Weathering

Water reacts with minerals in the rock to change it's structure

- Solution-carbon dioxide in the air dissolves in water, making it slightly acidic.
- This weak acidic solution dissolves some type of rock, especially limestone.

Erosion-the wearing away of material.

1. Abrasion (corrasion)

- Waves pick up sand and pebbles and hurl them at the cliff face
- This is the most powerful type of erosion.

2. Attrition

- Sand grains and pebbles are constantly being moved as waves break on a beach
- This constant movement wears away the beach material making it increasingly smaller and rounded.

3. Hydraulic Power

- The sheer force of waves breaking against a cliff will cause the cliff to break away.
- As waves hit a cliff face air is compressed in cracks in the rocks "blasting" away small fragments of material.
- During storms, hydraulic power can remove enough rock at the base of a cliff to make the cliff face unstable, resulting in rock fall.

Deposition

- The laying down of sediment.

Coastal Processes

Weathering

1.

Erosion-

1.

2.

2.

3.

Deposition

Transportation at the Coast

Mass Movement

- The downhill movement of material caused by gravity.
- Weathering and erosion weakens cliffs and they become increasingly unstable, resulting in mass movement.

Examples of mass movement

- Landslides-where a mass of unconsolidated material moves down a slope, often after a period of rainfall.
- Slumping-where a section of cliff drops down along a line of weakness.
- Rock fall-where material falls from a cliff face and lands at the base of a cliff. This is often seen on chalk cliffs.

Transportation

•Solution - when minerals in rocks like chalk and limestone are dissolved in sea water and then carried in solution. The load is not visible.

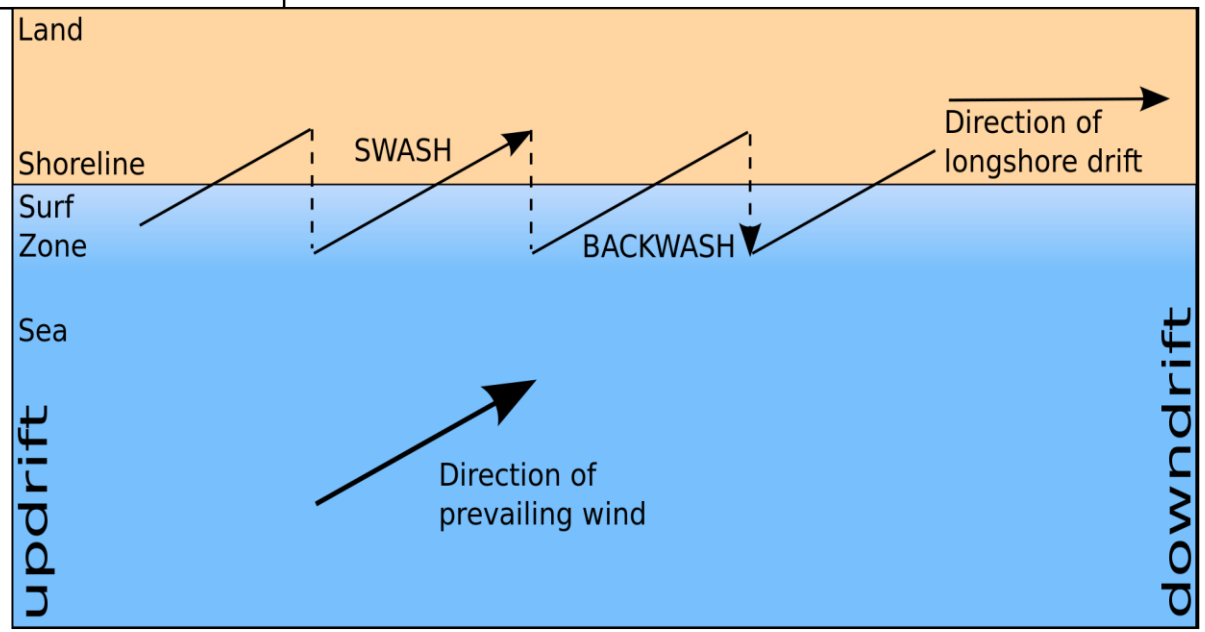
•Suspension - small particles such as silts and clays are suspended in the flow of the water.

•Saltation – where small pieces of shingle or large sand grains are bounced along the sea bed.

•Traction – where pebbles and larger material are rolled along the sea bed.

Longshore Drift-the zig-zag movement of material along a coast in the direction of the prevailing wind.

- Waves approach thee beach at an angle.
- The energy of the swash moves the waves up the beach at an angle, in the same direction as the prevailing wind.
- The backwash moves the sediment back down the beach in a straight line, under the force of gravity.
- Sediment is therefore moved along the beach.
- On some beaches groynes are built to slow this process down.



Mass Movement

Examples of mass movement

Transportation

1.

2.

3.

4.

Transportation at the Coast

Longshore Drift-

Longshore Drift Diagram

Cliffs, Headlands and Bays

- Rocks that have a stronger structure, such as chalk and limestone are more resistant to erosion and of often produce landforms such as cliffs and headlands.
- Weaker rocks, such as sands and clays have less structural strength and are less resistant to erosion. These produce such landforms as bays.

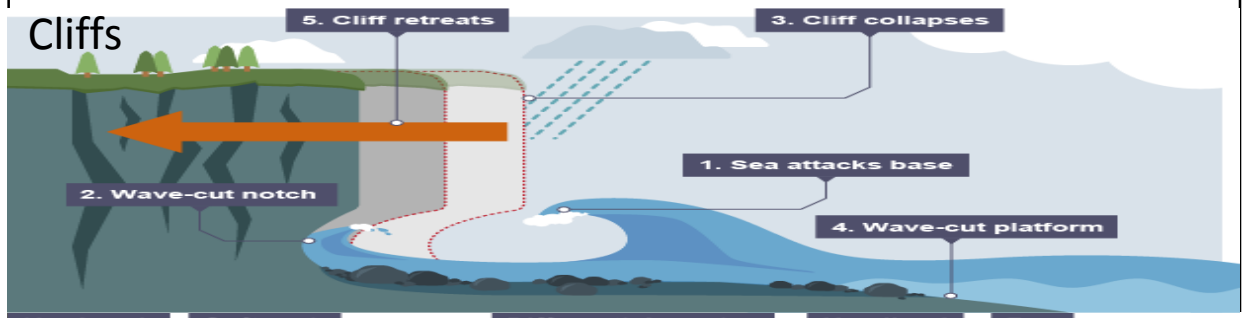
Wave-Cut Platforms

A wave-cut platform is formed when the following occurs:

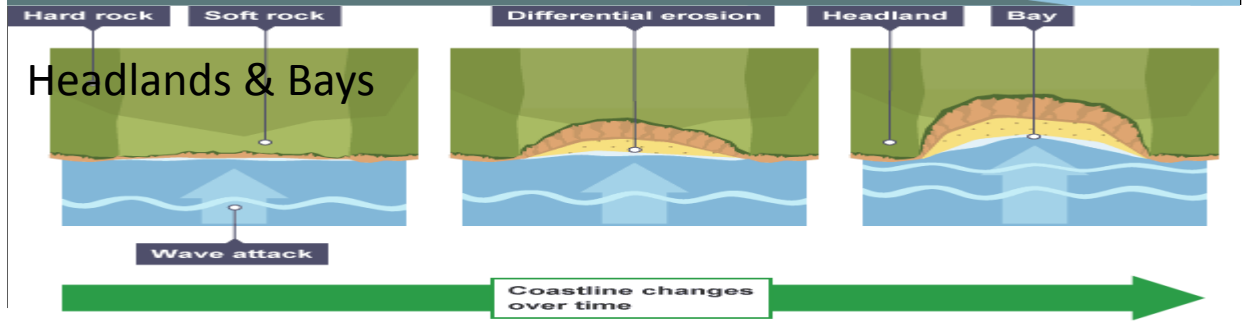
- The sea attacks the base of the cliff between the high and low water mark.
- A *wave-cut notch* is formed by erosional processes such as abrasion and hydraulic action - this is a dent in the cliff usually at the level of high tide.
- As the notch increases in size, the cliff becomes unstable and collapses, leading to the retreat of the cliff face.
- The backwash carries away the eroded material, leaving a wave-cut platform.
- The process repeats. The cliff continues to retreat.

Erosional Landforms at the Coast

Cliffs



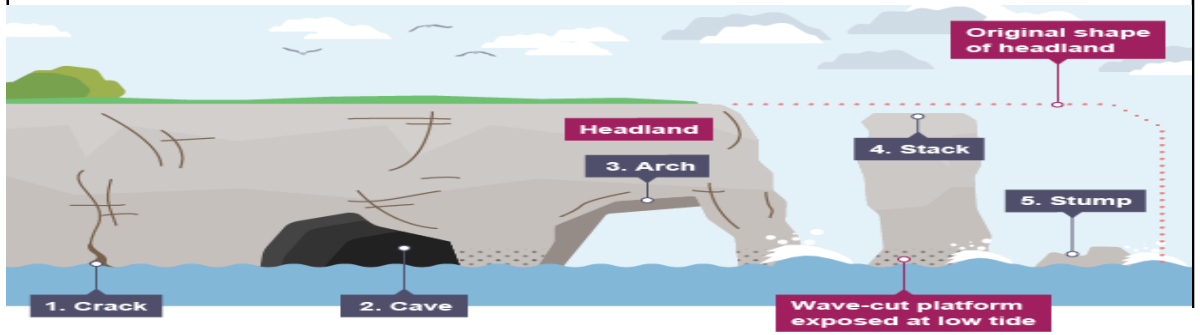
Headlands & Bays



Caves, arches, stacks and stumps

Caves, arches, stacks and stumps are erosional features that are commonly found on a headland.

- Cracks are widened in the headland through the erosional processes of hydraulic action and abrasion.
- As the waves continue to grind away at the crack, it begins to open up to form a cave.
- The cave becomes larger and eventually breaks through the headland to form an arch.
- The base of the arch continually becomes wider through further erosion, until its roof becomes too heavy and collapses into the sea. This leaves a stack (an isolated column of rock).
- The stack is undercut at the base until it collapses to form a stump.



Erosional Landforms at the Coast

Cliffs, Headlands and Bays

Wave-Cut Platforms

Cliffs

Headlands & Bays

Caves, arches, stacks and stumps

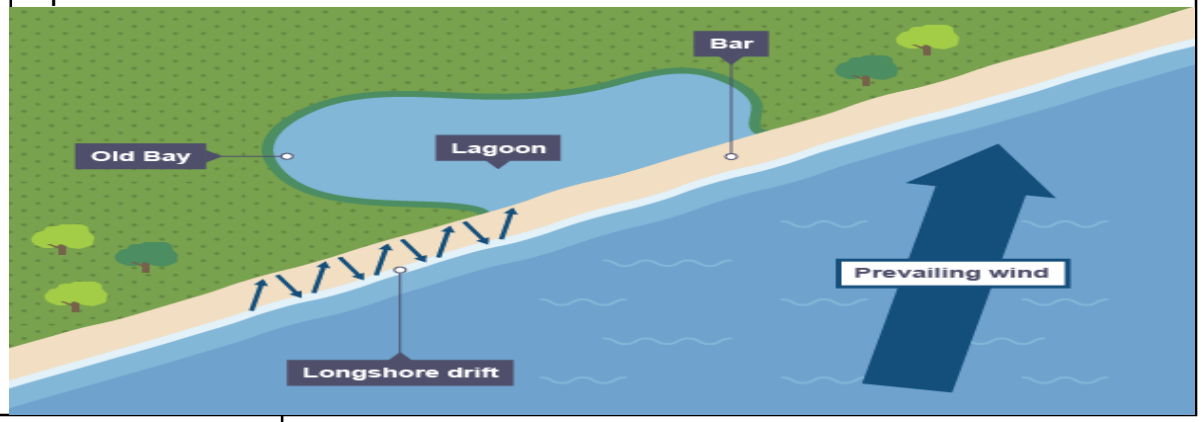
Depositional Landforms at the Coast

Depositional landforms
- When water loses its energy, any sediment it is carrying is deposited.
- The build-up of deposited sediment can form different features along the coast.

Beaches
- Beaches are made up from eroded material that has been transported from elsewhere and then deposited by the sea.
- For this to occur, waves must have limited energy, so beaches often form in sheltered areas like bays. Constructive waves build up beaches as they have a strong swash and a weak backwash.
- Sandy beaches are usually found in bays where the water is shallow and the waves have less energy.
- Pebble beaches often form where cliffs are being eroded, and where there are higher energy waves.
- A cross-profile of a beach is called the beach profile. The beach profile has lots of ridges called **berms**. They show the lines of the high tide and the storm tides.
- A sandy beach typically has a gentle sloping profile, whereas a shingle beach can be much steeper.
- The size of the material is larger at the top of the beach, due to the high-energy storm waves carrying large sediment.
- The smallest material is found nearest the water as the waves break here and break down the rock through attrition.

Bars

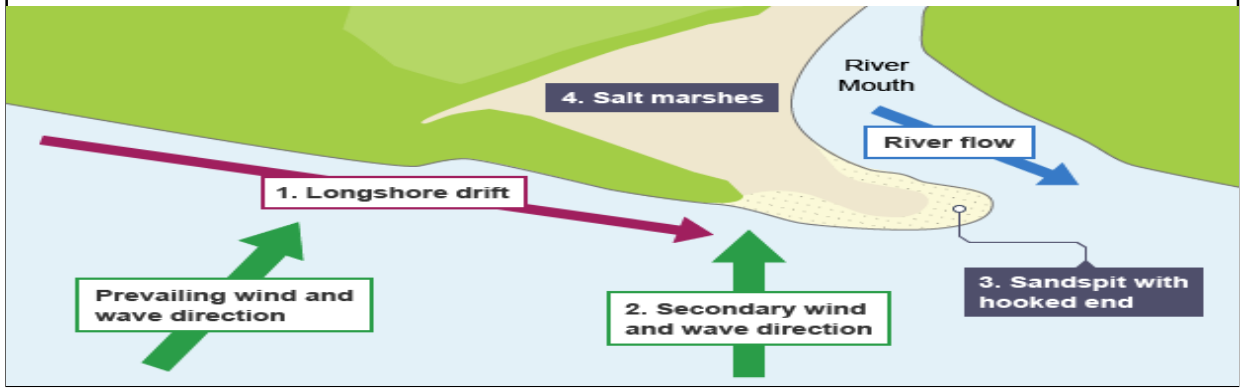
Sometimes a spit can grow across a bay, and joins two headlands together. This landform is known as a bar. They can trap shallow lakes behind the bar, these are known as lagoons. Lagoons do not last forever and may be filled up with sediment.



Spits

A spit is an extended stretch of sand or shingle jutting out into the sea from the land. Spits occur when there is a change in the shape of the landscape or there is a river mouth.

This is how spits are formed:
- Sediment is carried by longshore drift.
- When there is a change in the shape of the coastline, deposition occurs. A long thin ridge of material is deposited. This is the spit.
- A hooked end can form if there is a change in wind direction.
- Waves cannot get past a spit, therefore the water behind a spit is very sheltered. Silts are deposited here to form salt marshes or mud flats.



Sand dunes

- Sand dunes are formed when strong onshore winds blow sand from the beach inland.
- The sand forms into mounds, held together by long rooted grass, such as marram grass.
- Where no vegetation is present the sand will continue to blow inland.
- In some places grasses are planted or fences built in attempt to stabilise the dunes.

Depositional landforms

Beaches

Bars

Depositional Landforms at the Coast

Spits

This is how spits are formed:

Sand dunes

Coastal Management

Hard engineering

Erosion is a natural process which shapes cliffs. Over time, erosion can cause cliff collapse - therefore the coastline needs to be managed. Hard engineering involves building artificial structures which try to control natural processes. Each engineering strategy has its advantages and disadvantages.

Sea walls

Concrete walls that are placed at the foot of a cliff to prevent erosion. They are curved to reflect the energy back into the sea.

Advantages

•Effective at protecting the base of the cliff.

•Sea walls usually have promenades so people can walk along them.

Disadvantages

•Waves are still powerful and can break down and erode the sea wall.

•Expensive - approximately £2,000 per metre.

Rock armour

Large boulders placed at the foot of a cliff. They break the waves and absorb their energy.

Advantages

•Cheaper than a sea wall and easy to maintain.

•Can be used for fishing.

Disadvantages

•They look different to the local geology, as the rock has been imported from other areas.

•The rocks are expensive to transport.

Soft engineering

Soft engineering does not involve building artificial structures, but takes a more sustainable and natural approach to managing the coast. Each strategy has its advantages and disadvantages for use.

Beach nourishment

Sand is pumped onto an existing beach to build it up.

Advantages

•Blends in with the existing beach.

•Larger beaches appeal to tourists.

Disadvantages

•Needs to be constantly replaced.

•The sand has to be brought in from elsewhere.

Gabions

Rocks are held in mesh cages and placed in areas affected by erosion.

Advantages

•Cheap - approximately £100 per metre.

•Absorbs wave energy.

Disadvantages

•Not very strong.

•Looks unnatural.

Groynes

Wooden or rock structures built out at right angles into the sea.

Advantages

Builds a beach - which encourages tourism.

They trap sediment being carried by longshore drift.

Disadvantages

By trapping sediment it starves beaches further down the coastline, increasing rates of erosion elsewhere.

They look unattractive.

Reprofiling

The sediment is redistributed from the lower part of the beach to the upper part of the beach.

Advantages

•Cheap and simple.

•Reduces the energy of the waves.

Disadvantages

•Only works when wave energy is low.

•Needs to be repeated continuously.

Dune nourishment

Marram grass planted on sand dunes stabilises the dunes and helps to trap sand to build them up.

Advantages

•Relatively cheap.

•Maintains a natural-looking coastline.

Disadvantages

•Can be damaged by storm waves.

•Areas have to be zoned off from the public, which is unpopular.

Coastal Management

Hard engineering

Sea walls

Advantages

Disadvantages

Rock armour

Advantages

Disadvantages

Soft engineering

Beach nourishment

Advantages

Disadvantages

Gabions

Advantages

Disadvantages

Groynes

Advantages

Disadvantages

Reprofiling

Advantages

Disadvantages

Dune nourishment

Advantages

Disadvantages

Managed retreat

Managed retreat is the controlled flooding of low-lying coastal areas. If an area is at high risk of erosion, managed retreat could be an option. It usually occurs where the land is of low value, for example farm land.

Advantages

- This is a cheap option compared to paying for sea defences.
- Creates a salt marsh which can provide habitats for wildlife and a natural defence against erosion and flooding.
- Salt marshes are diverse ecosystems supporting many species.

Disadvantages

- Land is lost as it is reclaimed by the sea.
- Landowners need to be compensated - this can cost between £5,000 - £10,000 per hectare.

Conflicts

- There has been an increase in erosion at Great Cowden because of the groynes used in Mappleton.
- This has led to farms being destroyed by the erosion and the loss of 100 chalets at the Golden Sands Holiday Park.
- Some people disagree with where the sea defences are located, especially if it means the land in their community is not protected.
- Some sea defences negatively impact tourism and reduce the amount of money coming in to the area.

Managed Retreat and Coastal Management Case Studies

Coastal management case study: Holderness coastline

The Holderness coastline is located on the east coast of England. It is the fastest eroding coastline in Europe.

Reasons for management

The coastline is rapidly eroding at an average of 1.8 metres a year. There are several reasons why the coast at Holderness is eroding so quickly:

•**Rock type** - the cliffs are made from less-resistant boulder clay (made from sands and clays) which slumps when wet.

•**Naturally narrow beaches** - these beaches give less protection to the coast as it doesn't reduce the power of the waves.

•**Man-made structures** - groynes have been installed to stop long-shore drift. This narrows unprotected beaches elsewhere even more.

•**Powerful waves** - waves at Holderness travel long distances over the North Sea (so have a long fetch) which means they will increase in energy.

Management strategies

- Bridlington is protected by a 4.7 km long sea wall.
- Hornsea is protected by a sea wall, groynes and rock armour.
- Coastal management at Withersea has tried to make the beach wider by using groynes, and also uses a seawall to protect the coast.
- Mappleton is protected by rock groynes.
- Spurn Head is protected with groynes and rock armour.

Managed Retreat: Case Study

The Essex Marshes

Abbotts Hall in Essex is the site of a pioneering managed realignment scheme developed in 2002, and shows how farming and nature conservation can work side by side at the coast.

- Abbotts Hall is an area of farmland in Essex, south of Colchester. Located at the centre of a 25km section of coastline between the Blackwater Estuary and the Colne Estuary, it is the site of a pioneering managed realignment scheme developed in 2002.
- Owned by the Essex Wildlife Trust, the land at Abbotts Hall is an area of international wildlife importance. The scheme has shown how farming and nature conservation can work side by side at the coast – as well as delivering the important additional benefit of protection from flooding.

Managed retreat

Advantages

Disadvantages

Conflicts

Managed Retreat and Coastal Management Case Studies

Coastal management case study: Holderness coastline

The Holderness coastline is located

Reasons for management

.

Management strategies

Managed Retreat: Case Study

Coastal Landscapes Case Studies

Landforms of Erosion

Case study: Dorset coastline

Dorset is located in the south of England. Its coastline has examples of many erosional and depositional landforms. For example:

- Swanage is an example of a headland and bay
- Old Harry Rocks is an example of caves, stacks and stumps

Swanage Bay

- The area around Swanage is made up of bands of hard and soft rock.
- The soft rock is made of clay and sands, and the hard rock is chalk and limestone.
- As erosion processes take place, the clay erodes away quicker than the limestone and chalk. This forms headlands and bays, creating Swanage Bay and two headlands - Ballard Point and Durlston Head.

Landforms of Erosion

The Holderness Coast, Yorkshire

The Holderness Coast at Yorkshire has a mixture of hard and soft rocks, resulting in a range of spectacular coastal landforms.

Cliffs, Headlands and Bays

- At Flamborough Head there is a chalk headland, consisting of many chalk cliffs.
- There are soft clays, south of Bridlington, forming Bridlington Bay.

Old Harry Rocks

Old Harry Rocks are located on the headland between Swanage and Studland Bay.

- The headland is made out of chalk, a hard rock.
- The headland juts out into the sea, so it is more vulnerable to high-energy waves.
- This caused the formation of Old Harry, a stack.
- Over time Old Harry will collapse to form a stump

Landform of Deposition-Chesil Beach

- At Chesil Beach, there is a bar.
- Chesil Beach is an example of a bar.
- Sediment has been deposited over time to form a spit.
- The spit has continued to join to the Isle of Portland. Behind the spit there is The Fleet, a lagoon.
- Chesil beach is a bar, with The Fleet, a lagoon, behind it.

Landforms of Deposition

The Holderness Coast, Yorkshire

Beaches

- The beaches at Scarborough, Filey and Bridlington are very popular with tourists.

Spits

- Spurn Point is a curved spit, created by deposited sediment transported south along the Holderness Coast. It is approximately 6km in length, but only 50m wide in places. It is made of sand and shingle. Mudflats and saltmarshes have developed behind the spit, creating an ideal habitat for wildlife.

Landforms of Erosion

Case study: Dorset coastline

Dorset is located in

Swanage Bay

Landforms of Erosion

The Holderness Coast, Yorkshire

Cliffs, Headlands and Bays

Coastal Landscapes Case Studies

Old Harry Rocks

Old Harry Rocks are located

Landform of Deposition-Chesil Beach

Landforms of Deposition

The Holderness Coast, Yorkshire

Beaches

Spits

River Landscapes and Processes in the UK

The Long Profile of a River

The long profile of a river shows the gradient of a river from its source to its mouth. It is not always a smooth line and can have:

- Steep slopes in upland areas.
- Shallow areas where lakes may form.
- Breaks in the slope where waterfalls can be seen.

The Cross Profile of a River

The cross profile of a river shows the shape of the valley from one side to the other. As a river flows downstream, its cross profile changes:

Upper Course
- Shallow, narrow river channel
- Steep valley sides
- Narrow valley floor
- Mainly vertical erosion

Middle Course
- Wider, deeper river channel
- Shallow valley sides
- Wider valley floor
- Increasing amount of lateral erosion

Lower Course
- Widest, deepest river channel
- Wider, open valley floor
- Erosion less evident
- Increasing deposition.

What factors affect the rate of erosion in a river?

The more energy a river has, the greater the rate of erosion.

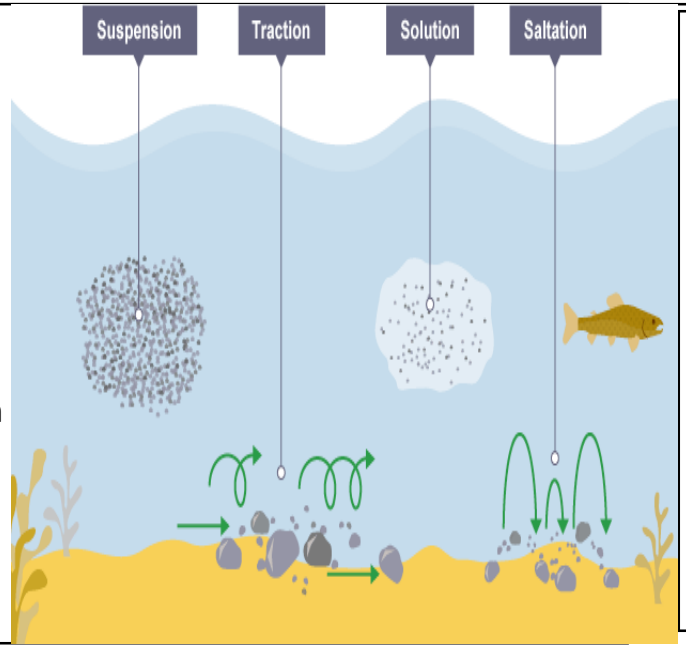
Rainfall-the higher the amount of rainfall, the greater the rivers' discharge and the higher the rate of erosion.

Gradient-the steeper the gradient, the more energy the river has and therefore the greater the amount of erosion.

Amount of Bedload-the greater the amount of rocks, pebbles and sediment in the river, the rate of abrasion will increase.

Human Factors-removing vegetation will decrease the amount of time it takes for rainfall to reach the river and therefore increase its energy and therefore rate of erosion.

Building Concrete Riverbanks-will reduce lateral erosion.



Transportation

The river picks up sediment and carries it downstream in different ways.

There are four types of transportation:

- **Traction** - large, heavy pebbles are rolled along the river bed. This is most common near the source of a river, as here the load is larger.
- **Saltation** - pebbles are bounced along the river bed, most commonly near the source.
- **Suspension** - lighter sediment is suspended (carried) within the water, most commonly near the mouth of the river.
- **Solution** - the transport of dissolved chemicals. This varies along the river depending on the presence of soluble rocks.

The Long Profile of a River

The Cross Profile of a River

What factors affect the rate of erosion in a river?

River Landscapes and Processes in the UK

Upper Course

Middle Course

Lower Course

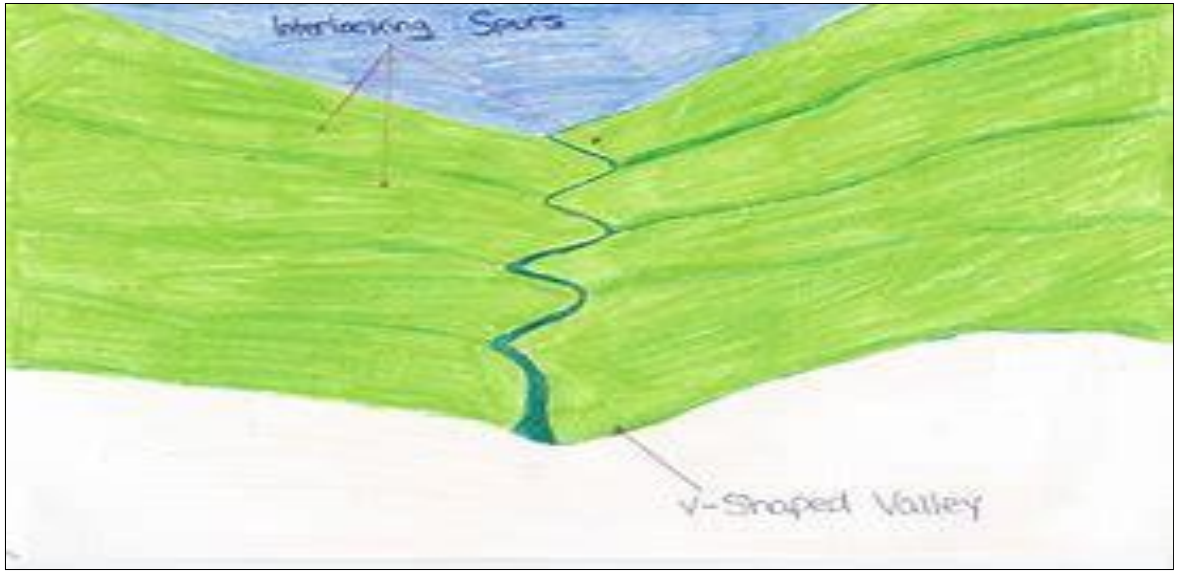
Transportation

There are four types of transportation:

The Upper Course of a River

Interlocking Spurs

- In the upper course there is more vertical erosion.
- The river cuts down into the valley.
- If there are areas of hard rock which are harder to erode, the river will bend around it.
- This creates interlocking spurs of land which link together like the teeth of a zip.

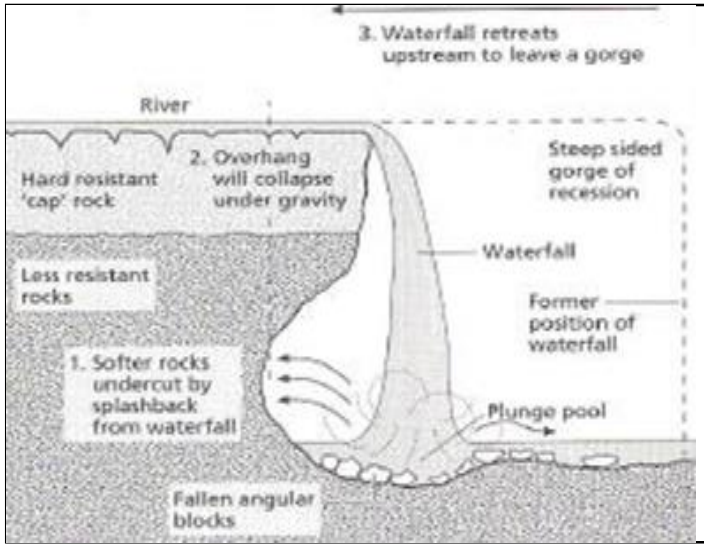


Erosional Landforms

Waterfalls and gorges

A waterfall is a sudden drop along the river course. It forms when there are horizontal bands of resistant rock (hard rock) positioned over exposed, less resistant rock (soft rock).

- The soft rock is eroded quicker than the hard rock and this creates a step.
- As erosion continues, the hard rock is undercut forming an overhang.
- Abrasion and hydraulic action erode to create a plunge pool.
- Over time this gets bigger, increasing the size of the overhang until the hard rock is no longer supported and it collapses.
- This process continues and the waterfall retreats upstream.
- A steep-sided valley is left where the waterfall once was. This is called a gorge.



Case Study = High Force on the River Tees, UK.
In Upper Teesdale an outcrop of hard igneous rock, Whinstone is the cap rock, lying above softer sandstone and limestone. At 22m, this is one of the tallest waterfalls in England. The gradual retreat of the waterfall has created a steep sided gorge.

The Upper Course of a River

Interlocking Spurs

Interlocking Spurs Diagram

Erosional Landforms

Waterfalls and gorges

A waterfall is a

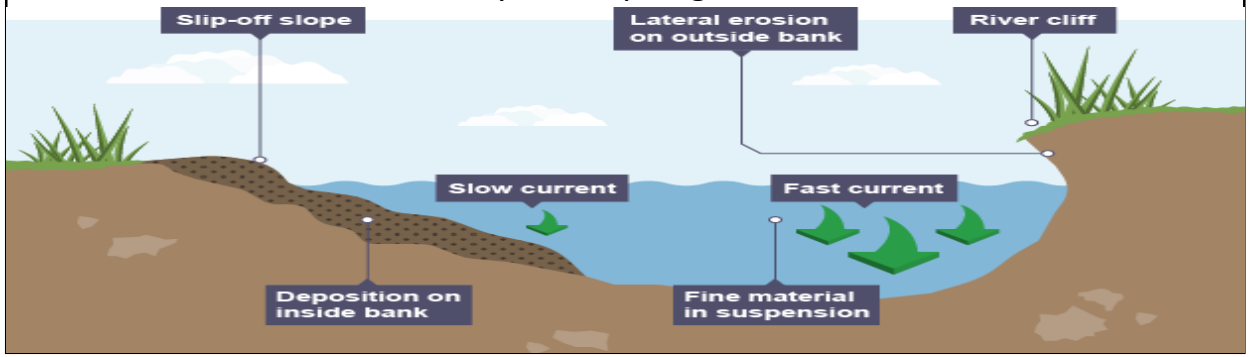
Waterfall Diagram

Case Study =

Landforms of Erosion and Deposition

Meanders (case study = Yarm, River Tees)

As the river makes its way to the middle course, it gains more water and therefore more energy. Lateral erosion starts to widen the river. When the river flows over flatter land they develop large bends called meanders.

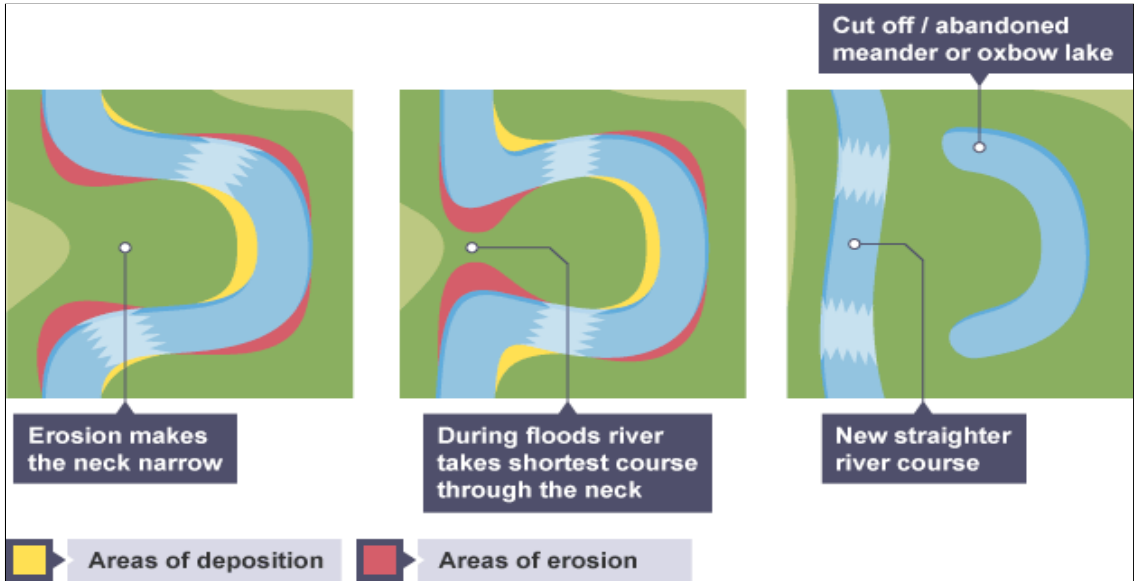


Oxbow lakes (case study = Yarm, River Tees)

- Due to erosion on the outside of a bend and deposition on the inside, the shape of a meander will change over a period of time.
- Erosion narrows the neck of the land within the meander and as the process continues, the meanders move closer together.
- When there is a very high discharge (usually during a flood), the river cuts across the neck, taking a new, straighter and shorter route.
- Deposition will occur to cut off the original meander, leaving a horseshoe-shaped oxbow lake.

Erosional and Depositional Landforms

- **As a river goes around a bend, most of the water is pushed towards the outside.**
- **This causes increased speed and therefore increased erosion (through hydraulic action and abrasion).**
- **The lateral erosion on the outside bend causes undercutting of the bank to form a river cliff.**
- **Water on the inner bend is slower, causing the water to slow down and deposit the eroded material, creating a gentle slope of sand and shingle.**
- **The build-up of deposited sediment is known as a slip-off slope (or sometimes river beach).**



Landforms of Erosion and Deposition

Meanders

Oxbow lakes

Erosional and Depositional Landforms

Levées

- Levees occur in the lower course of a river when there is an increase in the volume of water flowing downstream and flooding occurs.
- Sediment that has been eroded further upstream is transported downstream.
- When the river floods, the sediment spreads out across the floodplain.
- When a flood occurs, the river loses energy.
- The largest material is deposited first on the sides of the river banks and smaller material further away.
- After many floods, the sediment builds up to increase the height of the river banks, meaning that the channel can carry more water (a greater discharge) and flooding is less likely to occur in the future.

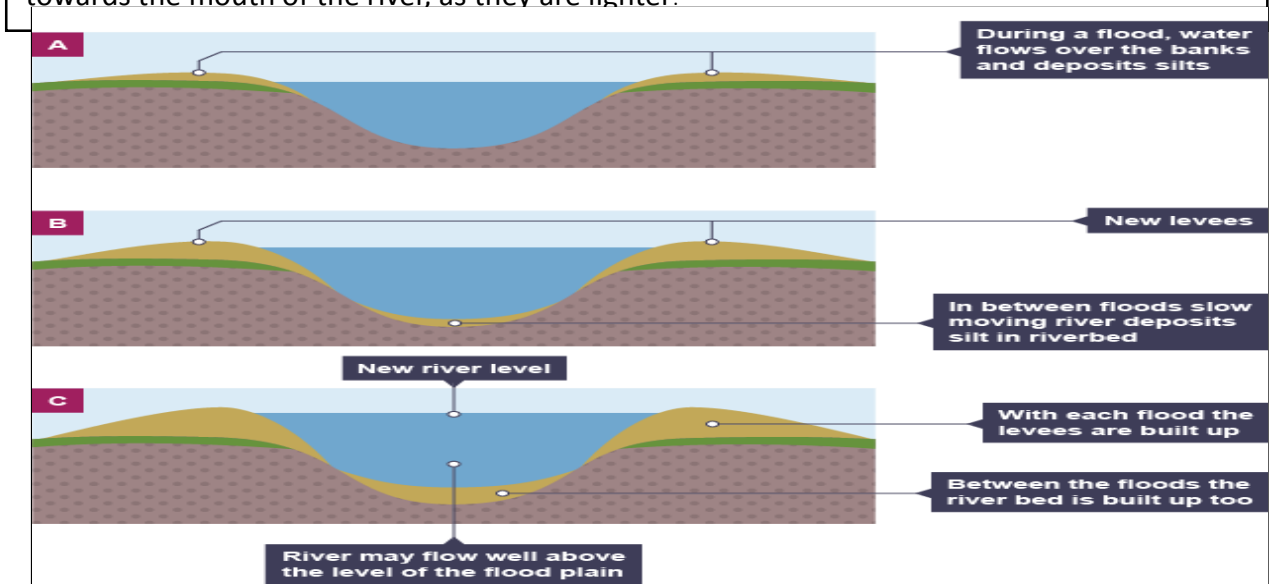
Floodplains

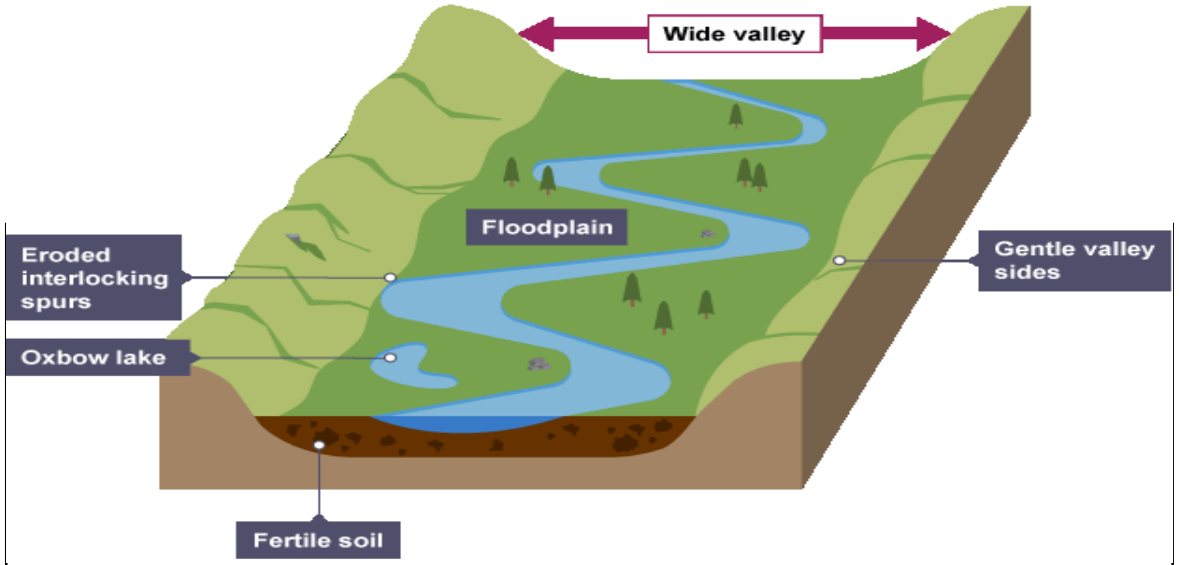
A floodplain is an area of land which is covered in water when a river bursts its banks.

- Floodplains form due to both erosion and deposition.
- Erosion removes any interlocking spurs, creating a wide, flat area on either side of the river.
- During a flood, material being carried by the river is deposited (as the river loses its speed and energy to transport material).
- Over time, the height of the floodplain increases as material is deposited on either side of the river.
- Floodplains are often agricultural land, as the area is very fertile because it's made up of alluvium (deposited silt from a river flood).
- The floodplain is often a wide, flat area caused by meanders shifting along the valley.

Depositional Landforms

Deposition occurs when a river does not have enough energy to carry its load. Large boulders are deposited first because they are heavier. Finer materials can be transported further towards the mouth of the river, as they are lighter.





Estuaries (case study = Stockton-on-Tees/Seal Sands), River Tees

An estuary is where the river meets the sea. The river here is tidal and when the sea retreats the volume of the water in the estuary is less reduced. When there is less water, the river deposits silt to form mudflats which are an important habitat for wildlife.

Levées

Floodplains

Depositional Landforms

Deposition occurs where

Estuaries

Flooding

Causes of flooding

- Prolonged rainfall - if it rains for a long time, the land around a river can become saturated (it's holding as much water or moisture as can be absorbed). If there is more rainfall it cannot be soaked up, so it runs along the surface - this is known as surface run-off.
- **Heavy rainfall - if there is heavy rainfall there is less chance of it being soaked up by the soil (infiltration) so it runs off into the river. The faster the water reaches the river, the more likely it will flood.**
- **Relief - a steep valley is more likely to flood than a flatter valley because the rainfall will run off into the river more quickly.**
- **Geology - permeable rocks allow water to pass through pores and cracks, whereas impermeable rocks do not. If a valley is made up of impermeable rocks, there is a higher chance of flooding as there is an increase in surface run-off.**
- **Vegetation - trees and plants absorb water, this is known as interception. Lots of vegetation reduces flood risk. Sometimes people cut down trees (deforestation). This will increase the flood risk, as the water will not be intercepted and flow into the river.**
- Urban land use - when an area surrounding a river is built on, there is an increase in the amount of tarmac and concrete, which are impermeable surfaces. Drains and sewers take water directly to the river which increases flood risk.

- Peak discharge - maximum amount of water held in the channel.
- Peak rainfall – maximum amount of rainfall (millimetres).
- Lag time - the time taken between peak rainfall and peak discharge.
- Rising limb - shows the increase in discharge on a hydrograph.
- Falling limb - shows the return of discharge to normal/base flow on a hydrograph.
- Base flow - the normal discharge of the river.

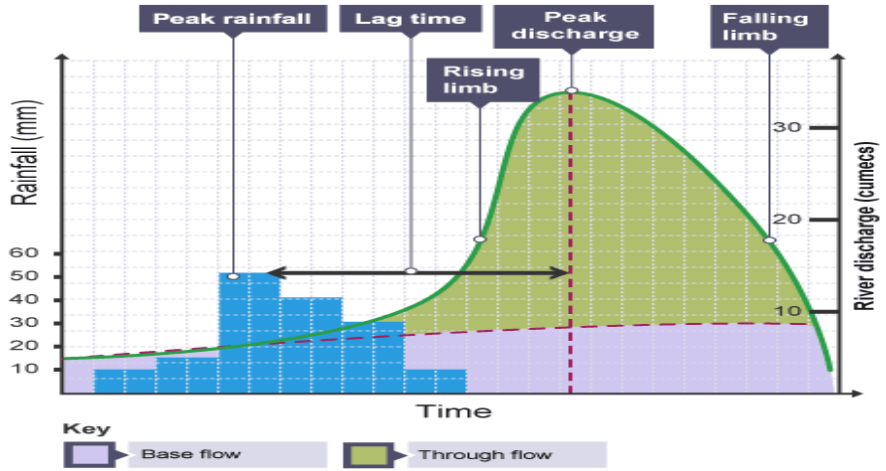
- Factors influencing lag time include:
- Size of drainage basin
- Vegetation
- Valley side steepness
- Soil type

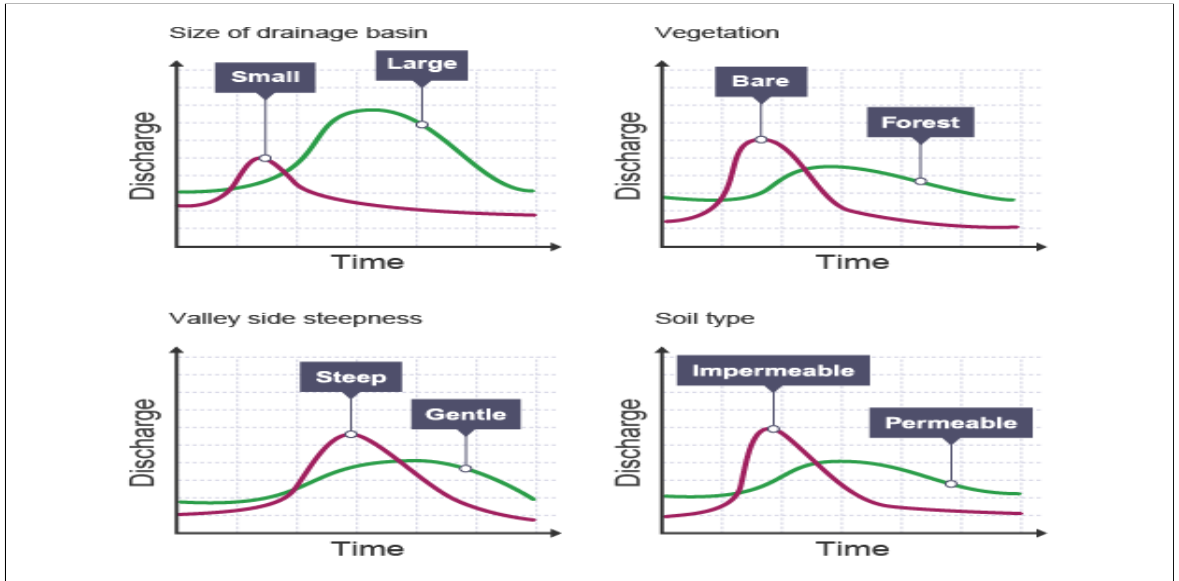
When it rains, water will either:

- Be lost through evaporation.
- Be held in storage, for example, lakes.
- Or make its way into rivers, either on the surface or by soaking through the ground.

Flood Hydrographs

A hydrograph shows how a river responds to a period of rainfall.





Causes of flooding

- Peak discharge -
- Peak rainfall -
- Lag time -
- Rising limb -
- Falling limb -
- Base flow -

- Factors influencing lag time include:

When it rains, water will either:

Flooding

Flood Hydrographs

A hydrograph shows

Hard engineering

Involves building artificial structures which try to control rivers. They tend to be more expensive. Each hard engineering strategy has its advantages and disadvantages.

Dams and reservoirs

- The dam traps water, which builds up behind it, forming a reservoir. Water can be released in a controlled way.

Advantages

- Can be used to produce electricity by passing the water through a turbine within the dam.
- Reservoirs can attract tourists.

Disadvantages

- Very expensive.
- Dams trap sediment which means the reservoir can hold less water.
- Habitats are flooded often leading to rotting vegetation. This releases methane which is a greenhouse gas.
- Settlements are lost leading to the displacement of people. In developing countries locals are not always consulted and have little say in where they are relocated.

Embankments

Raising the banks of a river means that it can hold more water.

Advantages

- Cheap with a one-off cost
- Allows for flood water to be contained within the river.

Disadvantages

- Looks unnatural.
- Water speeds up and can increase flood risk downstream.

Flood Relief Channels

The floodwater flows into the relief channel and is taken either to an area where it can be absorbed, or re-enters the river further down its course.

Advantages

- Removes excess water from the river channel to reduce flooding.

Disadvantages

- Expensive to build.
- If water levels continue to rise, the relief channel may also flood.

Flooding can cause damage to homes, businesses, infrastructure and communications.

Flood Management – Hard Engineering

River Straightening and Dredging

Straightening the river speeds up the water so high volumes of water can pass through an area quickly. Dredging makes the river deeper so it can hold more water.

Advantages

More water can be held in the channel.

It can be used to reduce flood risk in built-up areas.

Disadvantages

Dredging needs to be done frequently.

Speeding up the river increases flood risk downstream.

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Flood Management

River Straightening and Dredging

Advantages

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Embankments

Advantages

Disadvantages

Soft Engineering

Soft engineering does not involve building artificial structures, but takes a more sustainable and natural approach to managing the potential for river flooding. Each approach has its advantages and disadvantages.

Flood warnings and preparation

The environmental agency monitors rivers and issues warnings via newspapers, TV, radio and the internet when they are likely to flood so people can prepare

Advantages

- People have time to protect their properties, e.g. with sandbags.
- Many possessions can be saved, resulting in fewer insurance claims.

Disadvantages

- Some people may not be able to access the warnings.
- Flash floods may happen too quickly for a warning to be effective.
- They do not stop land from flooding - they just warn people that a flood is likely.

Flood management case study: Boscastle, Cornwall

In August 2004, the village of Boscastle saw a month's worth of rain fall in two hours. The drainage basin of Boscastle is steep and impermeable rock. Boscastle is also located on a confluence of three rivers. These factors led to a flash flood which caused over one thousand homes, cars and businesses to be swept away and damaged.

Effects of the Flood

- 3-metere wall of water flooded the village at over 60kph
- The water containing huge boulders and tree s battered buildings in the village.
- Cars swept away.
- Buildings destroyed.
- 20 business properties were destroyed.
- 4 bridges washed away
- A number of people were injured.

Flood Management – Soft Engineering

Floodplain zoning

Allowing only certain land uses on the floodplain reduces the risk of flooding to houses and important buildings.

Advantages

- More expensive buildings and land uses are further away from the river, so have a reduced flood risk.
- Less damage is caused, leading to fewer insurance claims.

Disadvantages

- Not always possible to change existing land uses.
- Planners have to decide what type of flood to plan for.

The flood defence scheme

To prevent this type of flood happening again, the environmental agency invested £10 million into several flood defences, such as:

- Widening and deepening the river channel - this allowed the river to carry more water.
- Removing low bridges and replacing them with wider bridges - this meant large amounts of water could flow freely underneath the bridge and the bridge wouldn't act like a dam (in the 2004 flood, vegetation and debris became blocked, creating the effect of a dam).
- Raising the car park and using a permeable surface - this allowed cars to be much higher and so they were less likely to be swept away.
- Tree management - dead trees were removed to prevent them being swept away, causing blockages under bridges. Land owners were encouraged to maintain vegetation and plant new trees.

Soft Engineering

Flood warnings and preparation

Advantages

Disadvantages

Flood management case study: Boscastle, Cornwall

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Flood Management – Soft Engineering

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