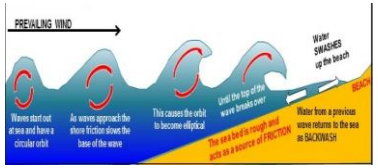
PHYSICAL LANDSCAPES: COASTS (part 1)

Coastline	The outline of the land. Where the land meets the sea
Waves	Ripples on the sea formed by the wind
Wave length	The horizontal distance between two wave crests
Wave height	The vertical distance from the trough to the crest.
Prevailing wind	The usual direction the wind blows (causes wave direction)
Wave trough	The base of a wave
Wave fetch	The distance a wave travels before it breaks on the shore
Swash	The forward movement of breaking waves up the beach.
Backwash	The backward movement of a broken wave out to sea
Erosion	The wearing away and removal of rock by the sea
Weathering	The breakdown of rocks where they are located. Usually due to the weather
Transportation	The movement of sediment along the beach by waves
Deposition	The dropping of sediment by low energy waves
Longshore Drift	The transportation of material in a zig zag along a beach due to wave direction
Infiltration	Water enters the ground
Saturation	Ground that is full of liquid
Resistant rock	Rocks that is hard to erode
Less resistant rock	Rocks that is easier to erode

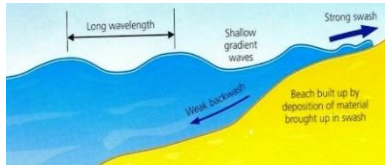
How are waves formed and how do they break?

- Winds cause friction at the surface of the sea, causing the surface of the water to be pushed in the direction of the wind.
- The water moves in a circular motion creating waves on the surface.
- The waves move into shallow water.
- The rough sea bed causes friction and the base of the circular wave slows down
- The top of the wave moves faster than the base.
- Eventually the top of the wave breaks



Constructive Waves:

- Long wavelength and low wave height – 6-8 waves per minute
- Strong swash and gentle backwash = deposition to and create big beaches
- Very gentle, created in calm conditions and a short fetch.



Destructive Waves

- Short wavelength and high wave height. 13-15 waves per minute
- Weak swash and strong backwash = remove material and erode beaches
- Very powerful, created in storms and with a long fetch.

Erosion is the wearing away or removal of rocks. Erosion attacks the base of the cliff.

- **Hydraulic Action:** The force of the waves hitting the cliffs removes material. Air bubbles in the water are pushed into cracks in the cliff and is compressed. The pressure causes fragment of rock to break off.
- **Abrasion**: Material carried by waves hits against the cliffs and removes rocks and soil. *It acts like sandpaper.*
- **Corrosion:** Chemicals in the water dissolve the cliff. E.g. limestone and chalk rocks
- **Attrition:** Rocks and Pebbles in the sea and on beaches crash into each other and break into smaller pieces. Continued attrition creates smaller, smoother pebbles and sand particles.

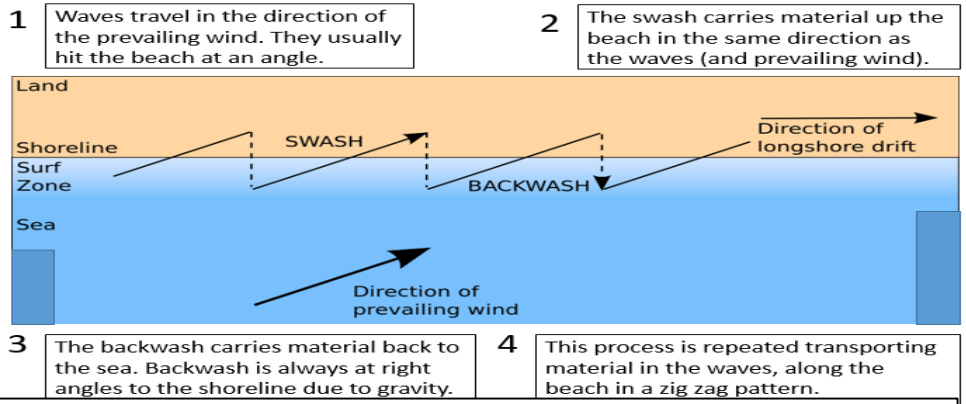
Weathering is the breakdown of rocks, mostly caused by the day-to-day changes in the atmosphere. Weathering attacks the face and top of the cliff weakening the rocks. Mass movement may cause pieces of rock or mud to fall off, or eventually the cliff to collapse completely

- **Freeze-thaw:** Water collects in cracks. At night this water freezes and expands. The cracks get larger. In the day the temperature rises and the ice melts (thaws). This weakens the rock and it breaks apart.
- **Roots & Burrowing Animals:** Plant roots grow in cracks in the rocks and break them apart. Animals burrow into weak rocks and weaken the structure causing it to collapse.
- **Carbonation:** Carbon dioxide and sulphur dioxide mix with rainwater to produce weak acid rain. This reacts with rocks such as chalk and limestone and slowly dissolves them

Mass movement is the downward movement or sliding of material because of the force of gravity

- **Rock fall** occurs when chunks of rock fall from a cliff., often due to freeze thaw weathering.
- **Landslide**s occur when blocks of rock and rubble slide downhill.
- **Mudflows** occur when saturated soil and weak rock flow down a slope.
- **Rotational** slip is when saturated soil and weak rock slip down a slope along a curved surface (plane)

Material is transported along the beach by the process of Longshore Drift. It is transported in the direction of the prevailing wind and therefore the breaking waves.



Deposition is the dropping of material carried by the waves to form features like beaches, spits and bars.

It takes place in areas where the flow of water slows down. Constructive waves lose energy when they break and can no longer carry sediment. It is therefore dropped (deposited) and builds up.

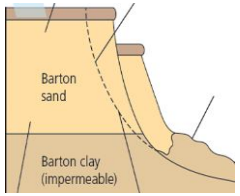
- Material is deposited in sheltered bays when the wave's energy decreases.
- Material is deposited in areas where there are constructive waves (strong swash/weak backwash)
- Material is deposited where there are groynes. These are wooden walls that are built out to sea, along the beach. They trap sediment being transported by longshore drift.

PHYSICAL LANDSCAPES: COASTS (part 2)

Mass movement is the downhill movement of material caused by gravity. Weathering and erosion weaken the cliff making it unstable leading to mass movement.

Rotational Slump – where saturated material moves down a slope, along a curved line of weakness.

- A layer of **soft permeable rock** lies on top of a layer of **impermeable rock**.
- Rain **infiltrates** the permeable rock. It becomes **saturated**, weak and heavy.
- Water becomes trapped in a layer **(slip plane)** between the permeable rock and impermeable rock and the rocks become very slippery
- The rocks **slump** down the line of weakness (slip plane) due to gravity.



Rock Fall – where rocks fall vertically down a cliff face due to gravity.

- **Weathering** weakens the rocks at the top of the cliff.
- These weakened rocks fall due to **gravity** to the base of the cliff.
- The material that collects at the bottom of the cliff is called a **scree slope**.

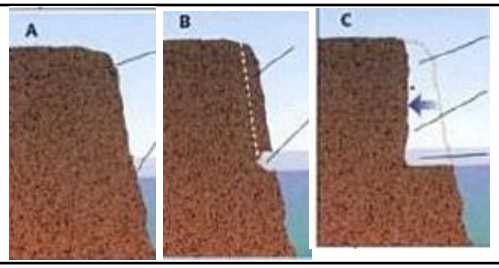
Landslide – rock, soil and mud move down a slope due to heavy rainfall and gravity.

- Heavy rain **infiltrates** soil and rock which become saturated, heavier and weaker
- Lines of weakness form in the slope.
- The heavy rain soaked material falls down the slope, along a line of weakness.

Erosional Landforms

WAVE CUT PLATFORM

- Waves erode (hydraulic action and abrasion) the base of the cliff between the high and low tide levels.
- Continued erosion forms a ***wave cut notch*** and ***overhanging cliff***. The notch gets larger and the overhanging cliff becomes unstable.
- Eventually it collapses leaving a flat area of rock (***wave cut platform***) as the cliff retreats backwards.

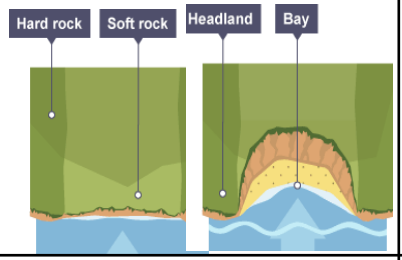


HEADLAND AND BAY

*A **headland** is a piece of land that sticks out into the sea.* **e.g. The Foreland**

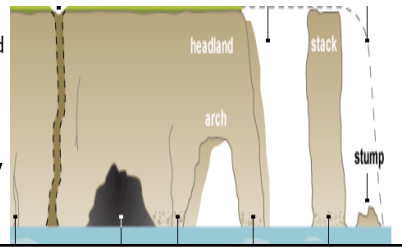
*A **bay** is an indentation in the coastline between headlands* **e.g. Swanage Bay**

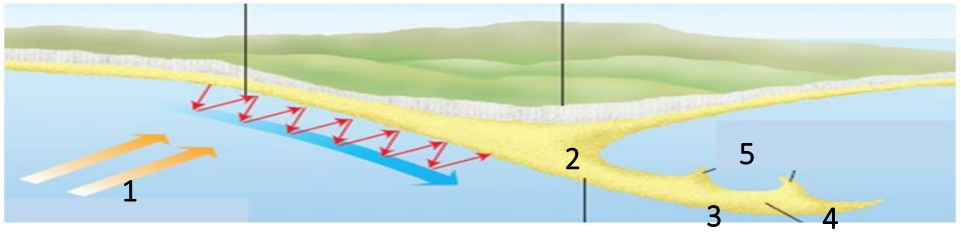
- **Discordant coastlines** have rock types of different resistance that will erode at different rates making an uneven coastline.
- The more resistant ***hard rock*** will erode slowly forming a ***headland.***
- The less resistant ***soft rock*** will erode more quickly forming a ***bay***.
- Bays are sheltered so deposition occurs and beaches are formed.



CAVE, ARCH, STACK

- Erosion (hydraulic action, abrasion) attacks a line of weakness in a headland forming a cave.
- The waves erode right through the headland to form an arch.
- Weathering weakens the top of the arch which weakens and becomes unstable. It eventually collapses leaving a free standing stack. **e.g. Old Harry**
- The stack is eroded at the base by the sea and weakened at the top by weathering, so collapses to form a stump.

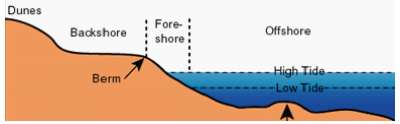




Depositional Landforms

BEACHES – deposits of sand and shingle (pebbles) at the coast. e.g. Swanage beach

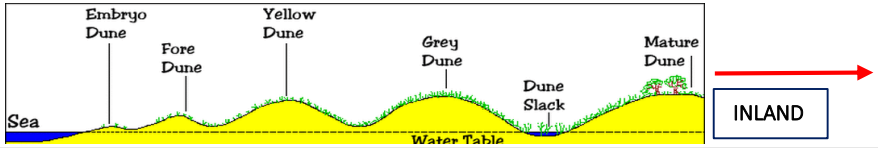
- **Beaches** are formed when **constructive waves** in sheltered bays deposit large amounts of sand that becomes trapped between two headlands. Constructive waves have a bigger swash than backwash so wash sand to shore.



Beaches are made up of the **offshore** (*out to sea*), **foreshore** (*between high and low tide lines*) and **backshore** (*high up the beach, near the sand dunes).*

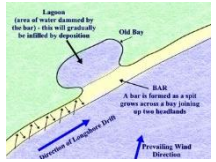
SAND DUNES – mounds of sand at the back of the beach, where material has been blown inland and deposited near obstacles (e.g. driftwood or fences) and collected.

As you travel inland from the sea, the sand dunes get: taller, larger, more vegetated and more permanent. **e.g. Studland**

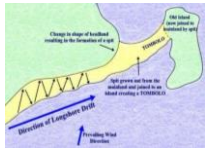


BARS AND TOMBOLAS

A **Bar** is formed when continued longshore drift causes a **spit** to grow right across the bay. A **freshwater lake** becomes trapped behind it.
e.g. Chesil breach



A **Tombola** forms when continued longshore drift joins a spit to an **island**. **e.g. Portland Bill**



SPITS

1. Waves hit the beach at an angle so **Longshore drift** transports material along the beach
2. There is a sudden change in the angle of the coastline e.g. a **river mouth or bay**
3. Longshore drift continues to transport sediment in the direction it had been travelling. This gets **deposited** across the bay. More and more sediment builds up and a beach extends across the bay *(a spit).*
4. Strong winds and occasional storm waves curve the end of the spit. Called a **recurved end.**
5. The area behind the spit is sheltered from waves so deposition occurs . Saltmarshes and mud flats form here.

PHYSICAL LANDSCAPES: COASTS (part 3)

Our coastline is at risk of erosion due to destructive waves, soft rock and longshore drift. We must protect our coastline because we are an island surrounded by the sea and many people live near the coast. However we cannot protect all of it.

For a section of coastline to be protected, the cost of the management scheme must be less than the value of the land, property and infrastructure (e.g. roads) to be protected, and the scheme must have no negative 'knock-on' environmental effects, for example making erosion worse somewhere else.

The British Government creates **shoreline management plans (SMPs)** that outline how our coastline will be protected. There are four strategies.

- **Advance the line:** build new coastal defence structures in front of existing defence structures. It is expensive and used to protect very high value land.
- **Hold the line**: maintain or improve existing coastal defences to continue protecting the coastline from erosion. It is expensive and used to protect high value land.
- **Management retreat**: allow the sea to naturally move inland until it comes to a natural barrier of higher land, or a natural defence forms such as a salt marsh. Leads to loss of land and infrastructure and so used in areas where there is low land value.
- **Do nothing**: no change, no investment, no existing or new defences. Natural processes are allowed to shape the coastline. Used in areas where there is very low land value.

Hard engineering – using manmade, artificial structures to prevent erosion and flooding..
More effective, long lasting and need less maintaining than soft engineering, however much more expensive and less natural or environmentally friendly.

Key: **Sustainable** / **Not sustainable**

Sea Wall	A strong concrete wall built in front of the cliff/settlement that absorbs and deflects the wave's energy. • Effective, long lifespan, tourists like to walk along it. • Expensive to build and maintain, looks unnatural and reduces access to the beach
Rock Amour	Large rocks placed in front of the cliff or settlement, that absorb (dissipate) the wave's energy. • Effective, long lifespan, more natural than sea wall and easier to build/maintain. • Expensive, access to the beach can be difficult, can become slippery and dangerous.
Gabions	A wire cage filled with rocks that are placed in front of the cliff or seaside settlement, that absorb (dissipate) the wave's energy. • Cheaper than rock armour/sea walls, and if covered in vegetation can look natural. • Wire cages have short lifespan (5-10 years). Sea water corrodes metal cages. Broken gabions can be dangerous to tourists. More expensive than soft engineering.
Groynes	Wood or rock fences built out into the sea. They trap sediment transported by longshore drift and make the beach larger. Wider beach makes it harder for waves to reach the coast. Sand also dissipates waves. • Groynes - Beach becomes wider so waves lose energy as they rush up the beach so less erosion. Big beaches boosts tourism. Looks natural. • They prevent sediment reaching beaches further along the coastline which become narrower and les effective at preventing erosion. The problem is shifted down the coast and not solved.
Off-shore Break-water	Rock barriers built out in the ocean parallel to the coastline. • They reduce the energy of the waves and shelter the beach so deposition occurs (e.g. Sea Palling), • However they can also be very expensive and get in the way of boats.

Example: - Swanage Bay – Dorset South coast of England. Swanage has suffered with rapid erosion of the soft clay cliffs of the bay, threatening property and coastal roads. Long Shore Drift also removed material from the beach making in narrower and less effective as a barrier to the waves Original groynes were old and damaged and the sea wall was being undercut by the sea

Swanage coastal management strategies

19 new wooden groynes - Trap sand transported by Long Shore Drift and build up the beach as a barrier to the sea

Beach replenishment and **re-profiling** - 160 000 tonnes of sand added to make the beach wider and higher and protect the sea wall from undercutting and erosion

Repair the sea walls – An extra line of defence prevention erosion and flooding of the town and sea front road in storms

Soft engineering – using natural, environmentally friendly methods to prevent erosion and flooding. Often cheaper than hard engineering however need more maintaining and has a shorter lifespan. More environmentally friendly

Beach Replenishment	Adds sand to the beach from other places to make it wider and higher. It acts as a barrier from the waves and absorbs wave energy so reducing erosion and flooding. • Cheap and easy to maintain, natural looking, bigger beaches boost tourism industry • Winter storms can destroy the beach so needs to be done regularly.
Beach Reprofiling	Material removed by longshore drift or destructive waves is returned to the beach so prevents the beach getting smaller. The beach acts like a barrier to the waves • Cheap and easy to maintain, natural appearance, bigger beach attracts more tourists • Winter storms can destroy the beach so needs to be done regularly.
Dune Regeneration	Sand dunes are repaired and made larger using fences or marram grass forming a barrier to the waves. • Cheap, very natural, popular with wildlife (creates habitats). • While being repaired, dunes are closed affecting tourists, constant maintenance as dunes are constantly changing.
Dune Fencing	Fences are built on sandy beaches to collect sand and create new sand dunes which act as a barrier from the waves • Cheap, natural, help make dunes larger, minimal impact on wildlife. • Can be dangerous if the fences break, need regular maintenance after storms

Managed retreat – a deliberate decision to allow the sea to flood an area of low-value land.

People are evacuated, buildings demolished and any existing sea defences removed. The sea floods the land and salt marshes develop which absorb the energy of future waves. New flood defences can be built to protect high-value land behind the salt marshes.

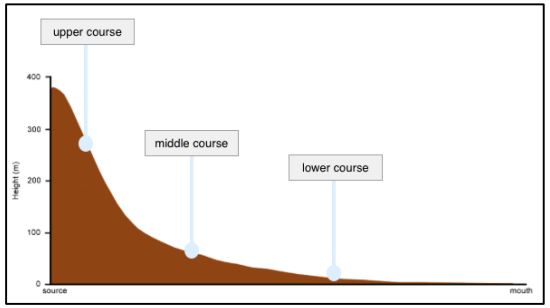
Medmerry Managed Retreat, Chichester, South England: *largest managed retreat project in Europe*

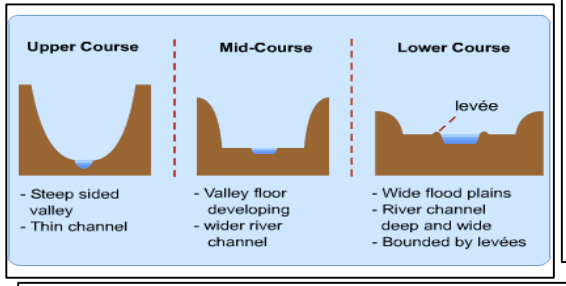
The flat, low-lying land had a low value (used for farming and caravan parks). The sea wall that protected the area needed repairing, but the decision was to not repair it and allow the land to flood as it was cheaper than repairing the sea wall. The managed retreat took place in November 2013.

SUSTAINABLE	NOT SUSTAINALBE
Created a large saltmarsh to absorb the energy of the sea during storms and high tides Inland embankments protect farmland and caravan parks Created wildlife habitats, encouraging tourism	People and businesses were flooded by the scheme and had to be relocated. It cost the government £28 million. A large area of agricultural land was lost.

Evaporation	The sun heats up water. The water turns into a gas which rises up into the atmosphere (air).
Transpiration	Trees absorb water through their roots and it evaporates from their leaves as water vapour which rises up into the atmosphere (air).
Condensation	As the water in the atmosphere rises, it cools and condenses to form clouds.
Precipitation	Water in the cloud falls to the earth's surface as rain, hail, sleet and snow.
Surface run-off	When the water runs downhill over the surface of the ground, eventually entering a river or stream.
Throughflow	Water flows downhill through the soil, eventually entering a stream or river
Infiltration	When surface water seeps into the soil layer
Drainage Basin	The area of land from in which water drains into a specific river.
Watershed	The boundary of a drainage basin. It separates one drainage basin from another. It is usually high land.
Source	The point where the river begins.
Tributary	A stream or small river that joins a larger stream or big river.
Confluence	A point where two streams or rivers meet.
Mouth	The point where the river meets the sea or ocean.
Long Profile	Shows the gradient of a river from its source to mouth.
Cross Profile	Shows the shape of the river channel and valley. It is an imaginary 'slice' across a river channel/valley at a specific point.
Erosion	The wearing away and removal of rock by the river
Weathering	The breakdown of rocks or soil, particularly the sides of river valleys because of the day-to-day action of the weather.
Transportation	The movement of sediment along the river due to the force of water
Deposition	The dropping of sediment when a river slows down and looses energy
River channel	The channel that the river actually flows in
River valley	The land surrounding the river. It can be narrow or wide.
Contour Line	Brown lines on an OS map that join up points of equal height. They allow us to determine slope gradient.
Flash Flood	Rapidly rising river levels leading to a fast flood due to heavy rainfall
Storm Hydrograph	Shows how river discharge changes after a storm and is used to predict floods
Lag time	The time (in hours) between the peak rainfall and peak discharge
Discharge	The volume of water in a river channel (measured in cumecs)

PHYSICAL LANDSCAPES: RIVERS (part 1)





The ***long profile*** shows the gradient of a river from its source to its mouth. A typical river profile is concave in shape, steep in the upper course and flattening out as you move downstream towards the mouth
The ***cross profile*** shows the shape of the river channel and valley. It is an imaginary slice across a river at a specific point. The valley widens as you move downstream

Rivers are split into three courses:

- ***Upper course***: steep gradient; vertical erosion so steep V shaped valleys, waterfalls and gorges; narrow and steep river channel, turbulent shallow water with rapids, Fairly low river discharge
- ***Middle course***: gentle gradient, lateral erosion so wider and deeper river valley and channel, less turbulent faster flow, tributaries join so more discharge added to river. Landforms are meanders, ox-bow lakes and floodplains
- ***Lower course***: very gentle gradient, lateral erosion so very wide open valley floor, widest and deepest river channel, lots of deposition caused by flooding. Landforms are estuaries, floodplain, levees, meanders, ox bow lakes

Erosion is the wearing away and removal of rocks. By the force of the water

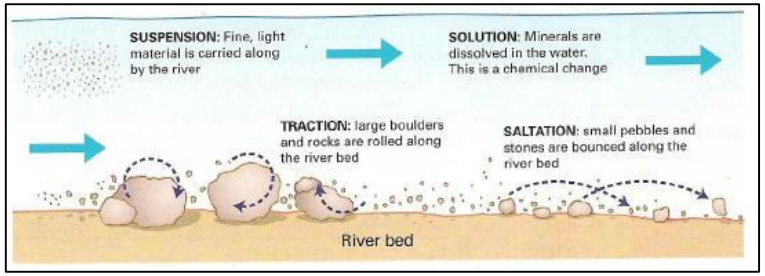
- **Hydraulic Action:** The force of the waves hitting the river bed and banks removes material. It is most effective when there is lots of very fast moving water.
- **Abrasion**: Sediment carried by the river hits the river bed and banks. It acts like sandpaper removing material.
- **Solution:** Chemicals in the water dissolve rocks (e.g. limestone)
- **Attrition:** Stones carried by the river hit into each other, gradually making the rocks smaller and smoother.

Weathering is the breakdown of rocks caused by the day-to-day changes in the atmosphere. Also the roots of plants

- **Freeze-thaw weathering:** Water collects in cracks. At night this water freezes and expands. The cracks get larger. In the day the temperature rises and the ice melts (thaws). The repeated freezing and thawing weakens the rock and breaks apart. **Biological weathering**: Plants roots break up rocks as they grow and expand in cracks in the rock.

Mass movement is when weathered rocks or soil fall down slopes or when cliffs collapse due to the force of gravity

Transportation: eroded material is carried downstream by the river because of the energy of flowing water. When in flood a river has lots of energy transports large amounts of material. This is why the water goes brown in colour

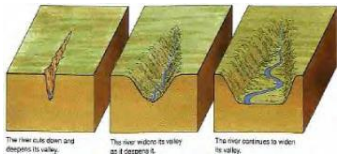


Deposition takes place where a river does not have enough energy to carry sediment (its load). As a result it is dropped.

- Larger rocks are deposited first in the upper course as they require more energy to transport them.
- Finer sediment requires less energy to move it. As a result it is deposited further downstream in the middle and lower course.

In the **upper course** the **relief is steep** and the river is small. The river **erodes vertically** into the landscape. There are many features of erosion

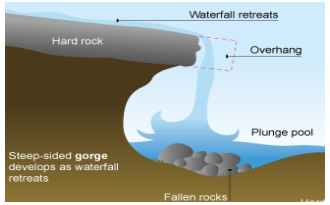
V shaped valley
River erodes **vertically** in the steep relief forming a deep narrow channel
Sides are **weathered** and weaken in the cold wet climate.
Valley sides collapse into the river by **mass movement**
River uses the **load** to erode a deeper channel by **abrasion**
A V shaped valley is created



Interlocking spurs
Areas of **more resistant** rock stick in to the river channel
The river doesn't have enough **energy** to erode them so flows around them.
The small river **zig zags** through the landscape

Narrow channel
The river is near its **source** so has not collected much **discharge**. The river can only erode a **small channel**.

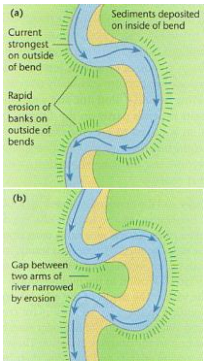
Waterfall
The river flows over a band of **more resistant (hard)** rock on top of **less resistant (soft)** rock.
The river erodes a **rock step** and a deep **plunge pool** in to the softer rock.
The river **undercuts** the harder rock which forms an **overhang**



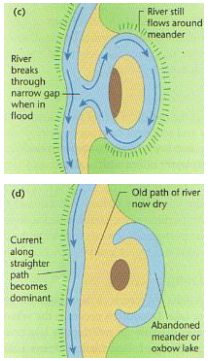
Gorge
The **overhang** on the waterfall **collapses** over time and the waterfall **retreats**.
After this is repeated a steep sided **gorge** is left in front of the waterfall

In the middle course the relief is flatter and the river is larger. Both erosion and deposition take place to form river features

Meanders
As a river flows over **flatter relief** it finds the easiest route across the land which makes it wander around
Small bends begin to form
Water on the outside of the bend flows **faster** so has **more energy**. It erodes a **deeper channel** and a **river cliff**
Water on the inside of the bend flows **slower** so has **less energy** and therefore **deposits** a river beach (point bar)
Over time the meander grows



Ox bow lake
In time of flood a river has more **energy** and may erode a **new channel** through the **neck** of a meander.
The old meander becomes cut off due to **deposition** in the slower flow out of the main channel
The old bend is eventually totally blocked off and becomes an **ox-bow** lake



Flood Plain
As a river meanders on flatter land the constantly changing position of the bends carves out a **wide flat valley**. The river also regularly floods this area and **deposits mud** on it. This is the rivers **floodplain**

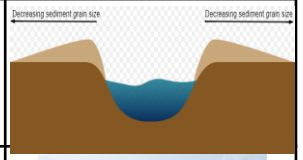
Wider channel
The river is now carrying **more discharge** that it has drained from many **tributaries**. It uses this water to carve a wider channel for itself

In the lower course the relief is very flat and the river is very large. It deposits large amounts of load eroded and transported from upstream

Estuaries
Near its **mouth** a the fresh water of the river mixes with salt water from the sea. This area is **tidal**. The river may rise or fall many meters and flow upstream when the tide comes in

Mud flats
Large areas of deep mud deposited when the river stops flowing when **incoming tide** and **river flow** cancel each other out

Levees
Raised banks along the river edge formed as rivers repeatedly flood and **deposit** larger mud and sand particles first



Very wide and deep channel
The river is carrying a large amount of **discharge** drained from the whole of its **drainage basin** so carves a very wide and deep channel for itself

NO FLOOD	• Trees in drainage basin – intercept rainfall = longer lag time. • Gentle rain = more water infiltrated = takes longer to reach river channel • Permeable rock = more water infiltrated = takes longer to reach river. • Dry soils = more water infiltrated = takes longer to reach river channel • Large drainage basins = water has to travel further to reach river = slower
FLOOD	• Deforestation – no trees to intercept rainfall = shorter lag time • Intense rain = too fast to infiltrate = more surface runoff = quicker to river • Impermeable rock = rain not infiltrated = more surface runoff = quicker to river. Impermeable surfaces created when areas are urbanised (concrete). • Steep slopes = quick transfer of water to river channel = short lag time

Lag time – the time between the peak (highest) rainfall and peak discharge. The lag time shows how quickly the water reaches the river channel.
- Short lag time = greater risk of flooding
- Long lag time = reduced risk of flooding