River landscapes

1. Drainage basin and the hydrological cycle

2. River valleys – *upper, middle and lower course; long profile*

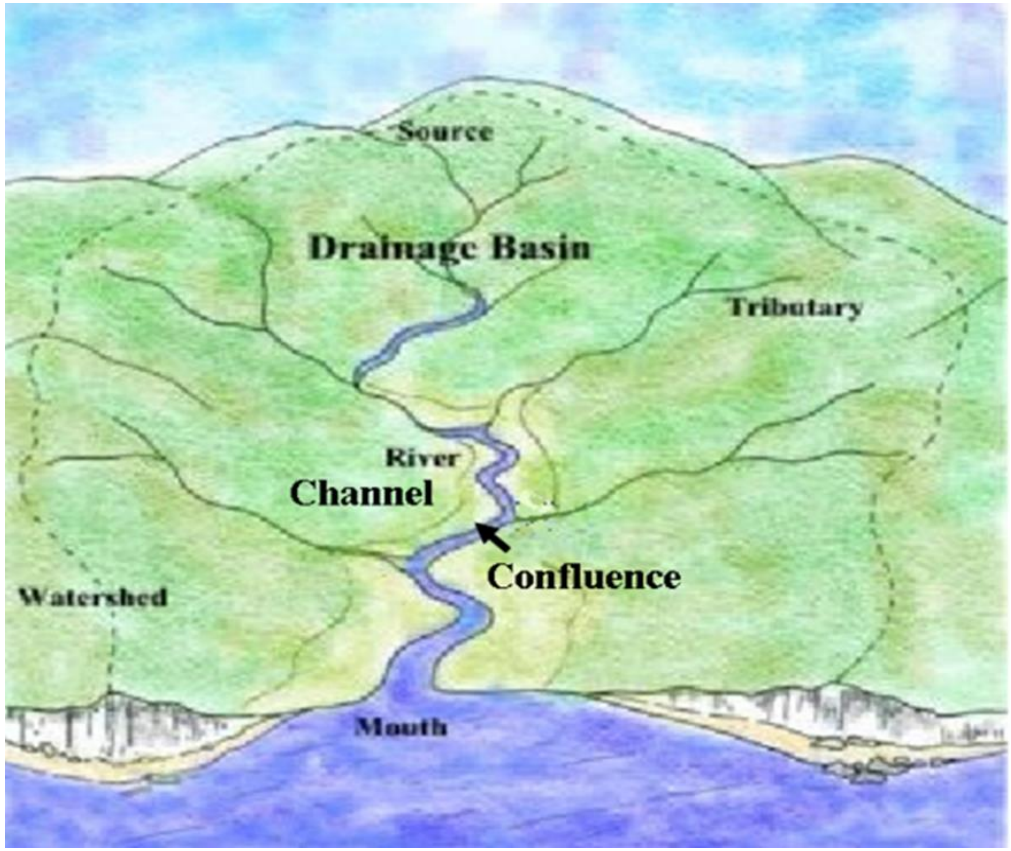
3. River processes – *erosion, transportation and deposition*

4. River landforms
   - *interlocking spurs, waterfalls and gorges*
   - *meanders and ox-bow lakes*
   - *levees, floodplains and estuaries*

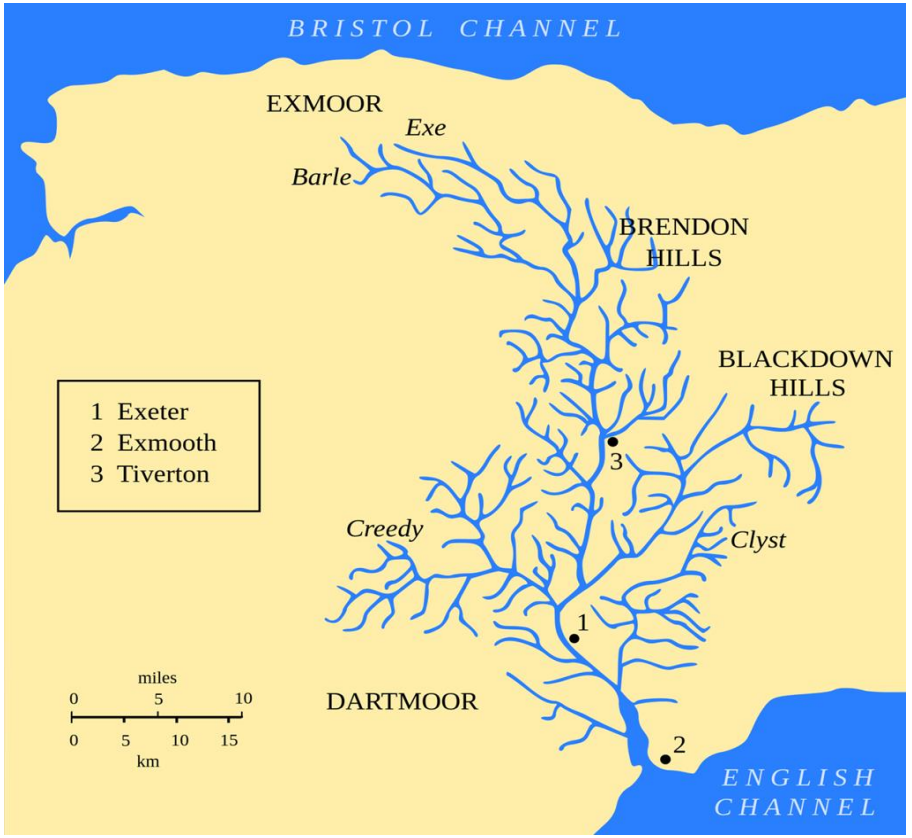
5 River flooding – *causes, effects and management*

A view of the Yangtze River.

Drainage basin and the hydrological cycle



The River Exe drainage basin



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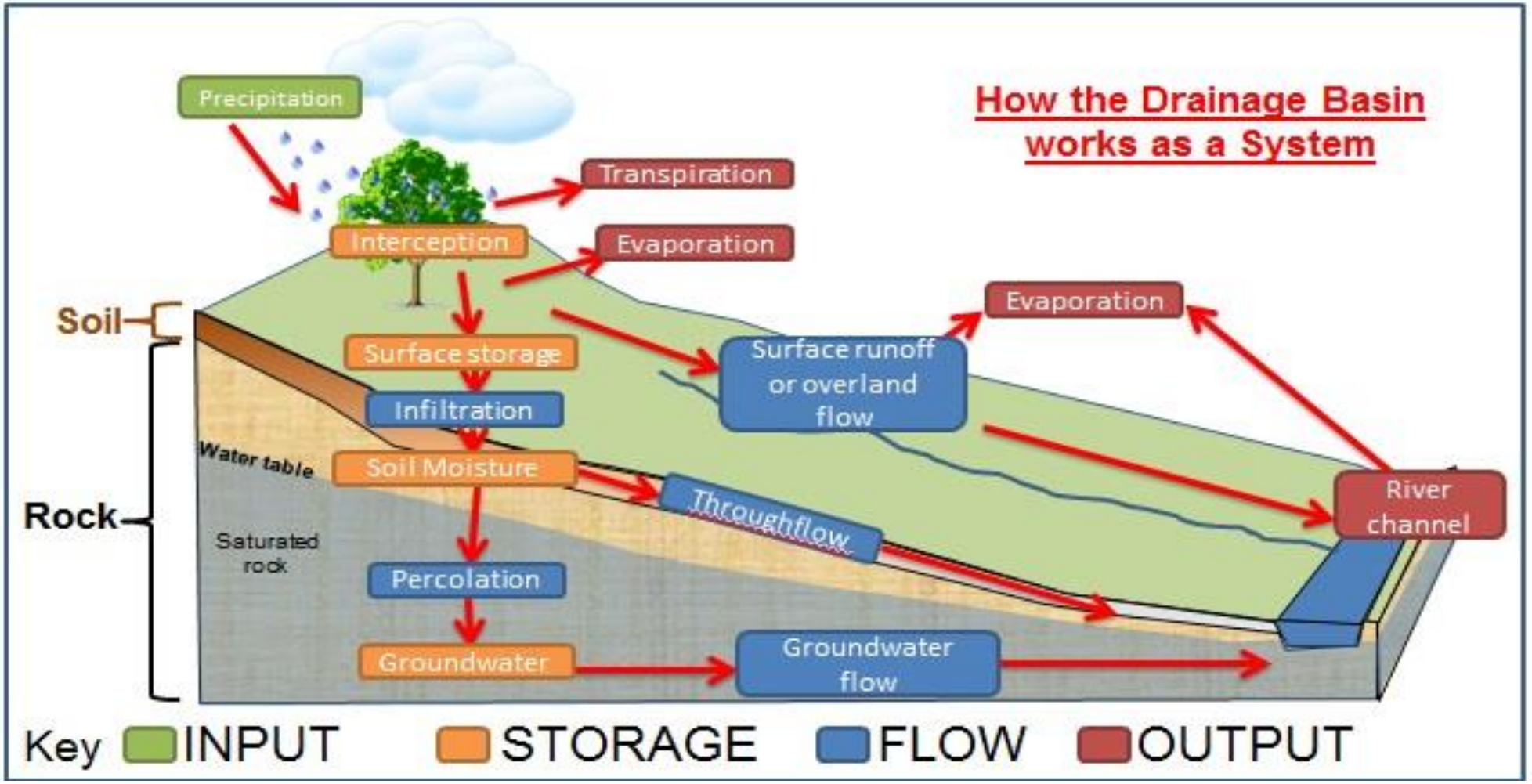
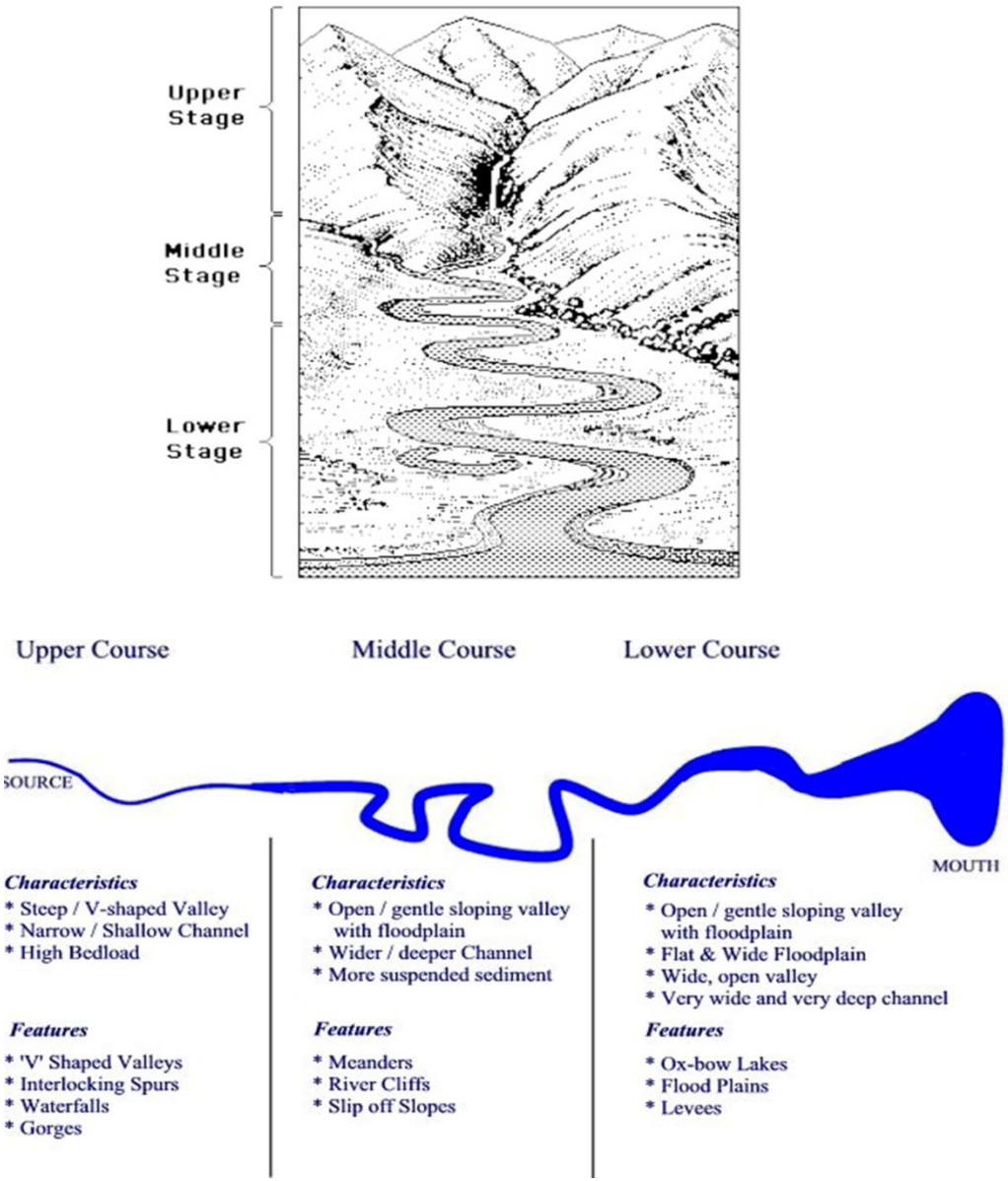
The hydrological cycle and the drainage basin

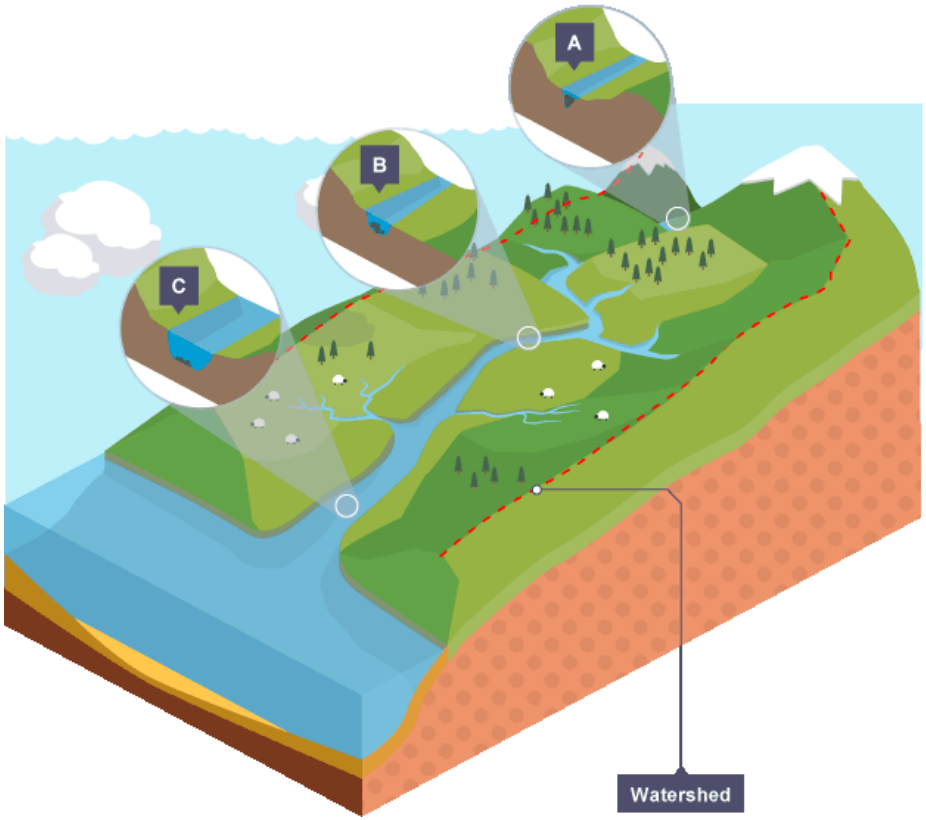


The River Valley



- ✓ The path of a river as it flows downhill is called its course
- ✓ Rivers have an **upper course** (*closest to the source of the river*); a **middle course** and a **lower course** (*close to the river mouth*)
- ✓ Rivers form valleys and channels as they flow downhill
- ✓ Rivers **erode** the landscape (*wear it down*), then **transport** the eroded material somewhere else where it is **deposited**
- ✓ The shape of the river valley or channel changes depending on whether erosion or deposition is the dominant process

The Cross Profile



A cross profile shows a cross-section of a river's channel and valley at a certain point along the river's course.

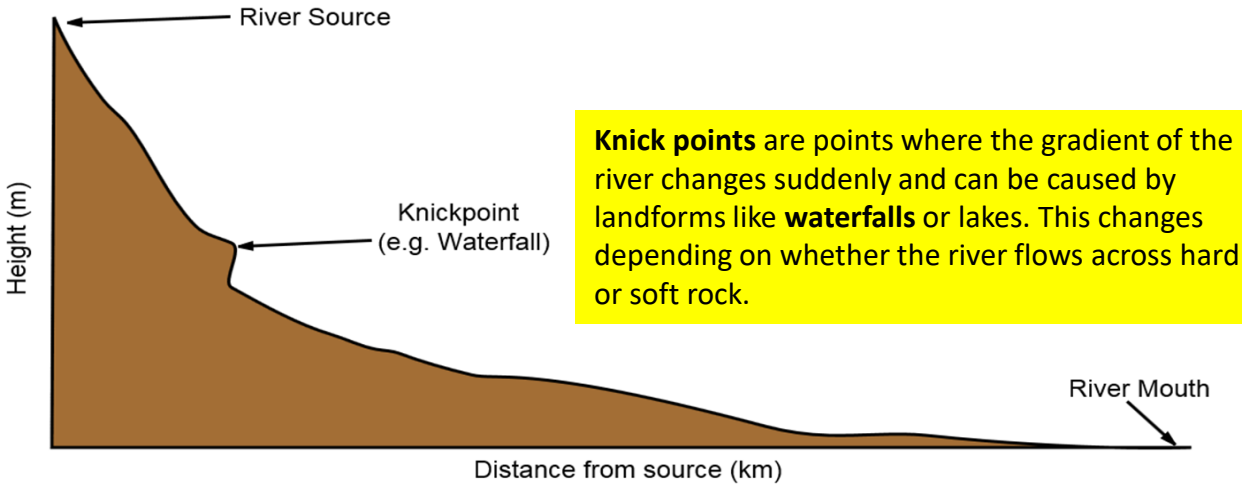
A - as the river flows downhill there is an increase in vertical erosion. The channel is shallow and narrow because there is not a lot of water in the channel.

B – as the river flows into the middle course, there is some vertical erosion but more lateral erosion. The channel is wider and deeper as a result.

C - in the lower course there is a lot less erosion, with only some lateral erosion. The channel is at its widest and deepest.

The Long Profile

The long profile shows how a river's gradient changes as it flows from its source to its mouth.



Knick points are points where the gradient of the river changes suddenly and can be caused by landforms like **waterfalls** or lakes. This changes depending on whether the river flows across hard or soft rock.

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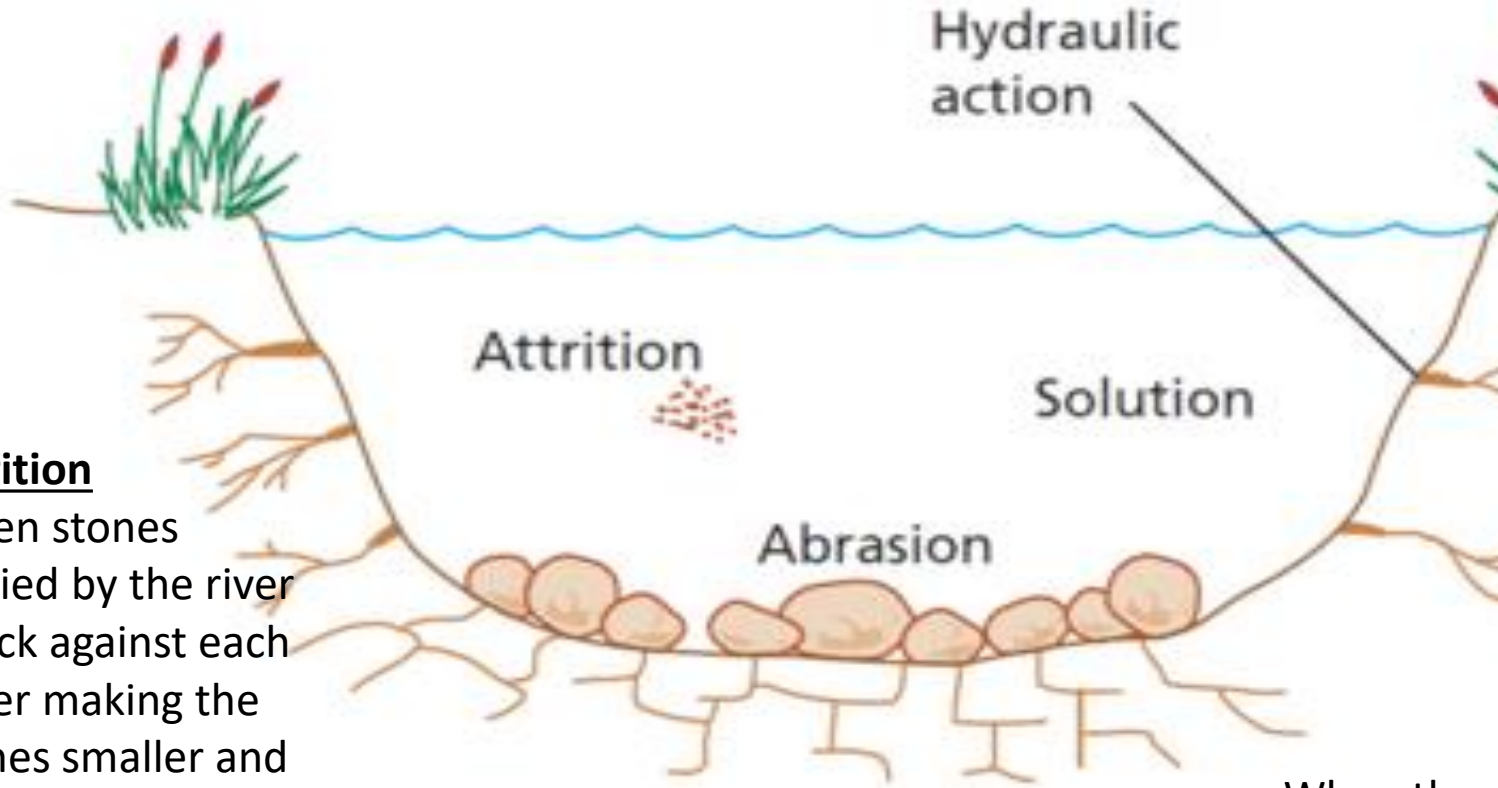
River (fluvial) processes

Erosion – *hydraulic action; abrasion; attrition & solution*

Transportation - *traction; saltation; suspension & solution*

Deposition – what causes the river to lose its energy?

River Erosion



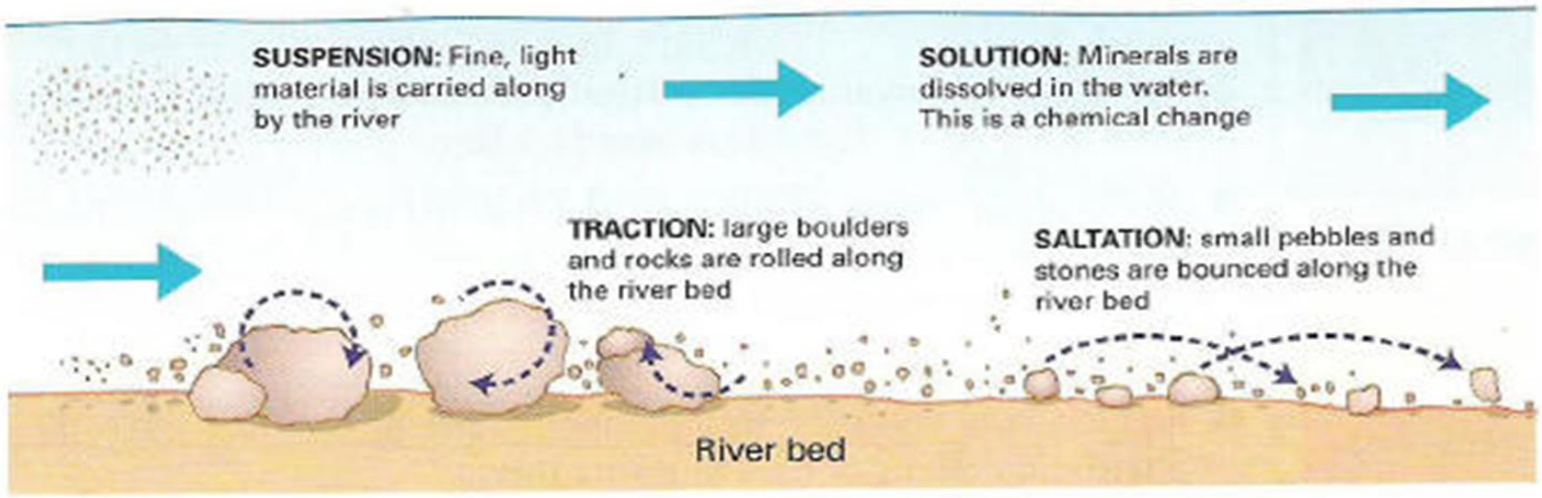
Hydraulic action
The force of the water hitting the river bed and banks. This is most common when the water is fast moving

Attrition
When stones carried by the river knock against each other making the stones smaller and more rounded

Abrasion
When the river load repeatedly hits the bed and banks dislodging particles into the flow of the river

Solution
When the river flows over limestone and chalk and the rock is slowly dissolved. This rock is soluble in mildly acidic water

River transportation



Deposition occurs when the river **speed slows** down or it no longer has **enough energy** to transport the sediment it is carrying and it deposits its load.

Larger rocks tend to be deposited in the **upper course**
Finer sediment is carried **downstream** and is deposited when the river is slowed by **friction** against the river banks or bed
A large amount of deposition occurs at the **river mouth** when the river and sea collide and the flat gradient slows the rivers velocity

Key term	Definition	Key term	Definition
Source	The starting point of a river	Condensation	The process whereby gas changes back to liquid form, visible as clouds
Tributaries	A river that flows into a smaller one	Surface run off	Rainwater that flows over the surface en route to the river or stream
Confluence	Where two rivers join	Infiltration	Soaking into the soil layer
River/ Drainage basin	The land from which water drains into a river	Groundwater storage	Rainwater that has soaked down through the soil and accumulated in the rocks below
Estuary	The wide part of the river mouth which flows into the sea	Throughflow	Water passing through the soil layer en route to the river
Watershed	The dividing line between one river basin and the next – usually a ridge of land.	Impermeable	Does not let water pass through
Floodplain	Flat land around a river that gets flooded when the river overflows – usually in the lower course.	Permeable	Let's water soak through
Precipitation	Water falling from the sky as rain, snow, sleet or hail	Groundwater flow	Water that flows through the rocks en route to the river
Evaporation	The change from liquid to gas	Transpiration	The change from liquid to a gas as water transfers from vegetation back into the atmosphere
Water vapour	Water in gas form	Percolation	Water soaking into the bedrock

River landforms created by erosion

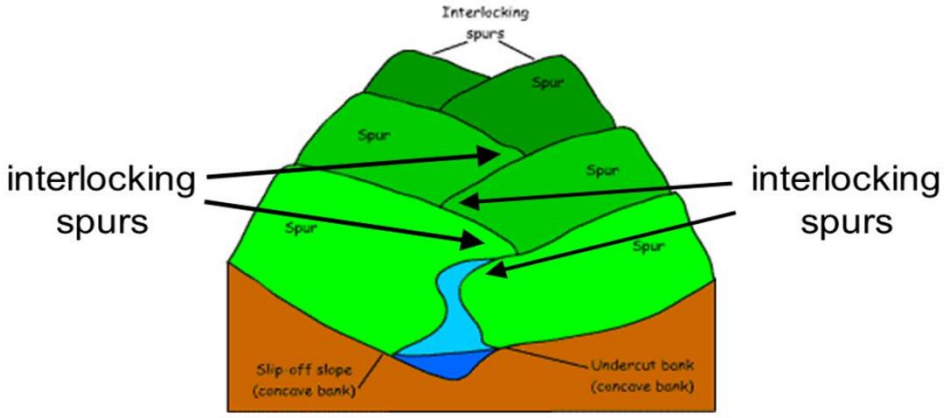
1. Interlocking spurs
2. Waterfalls
3. Gorges

V-Shaped valleys and interlocking spurs

Interlocking spurs

In the upper course the river does not have a huge amount of energy to erode as it does not have a high discharge and it has to transport large pieces of sediment.

When the river meets areas of harder rock that are difficult to erode it winds around them. A series of hills form on either side of the river called **spurs**. As the river flows around these hills they become interlocked. So, a series of **interlocking spurs** are often found in the upper course of a river valley.



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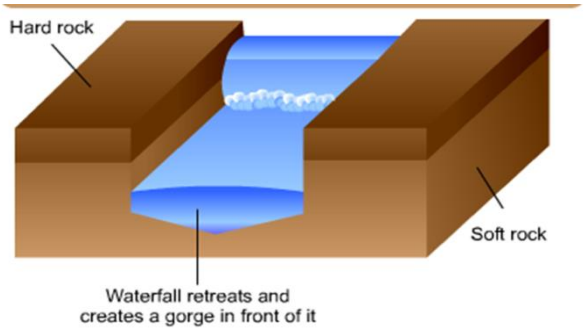
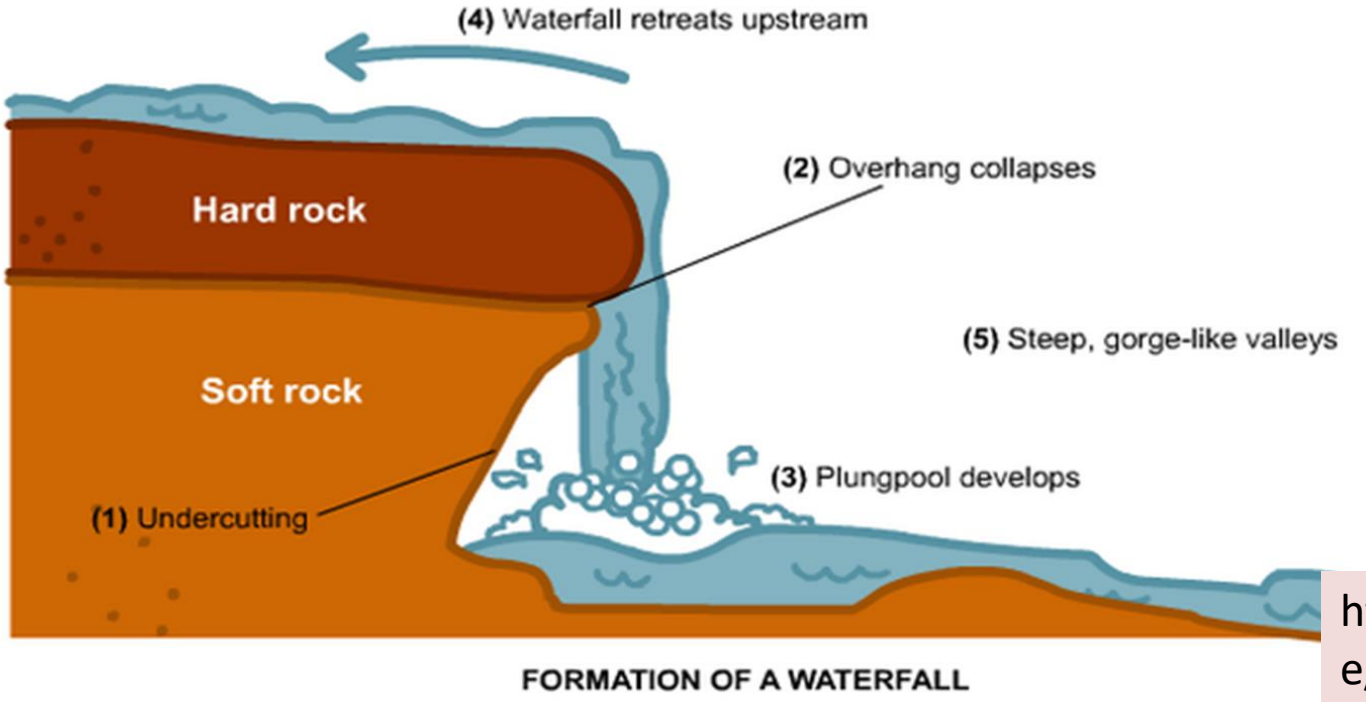
Formation of a waterfall & a gorge





FORMATION OF A WATERFALL

Gorges are deep, narrow and steep sided river valleys

They are mostly formed by continuous erosion of a retreating waterfall moving upstream and leaving steep sides behind

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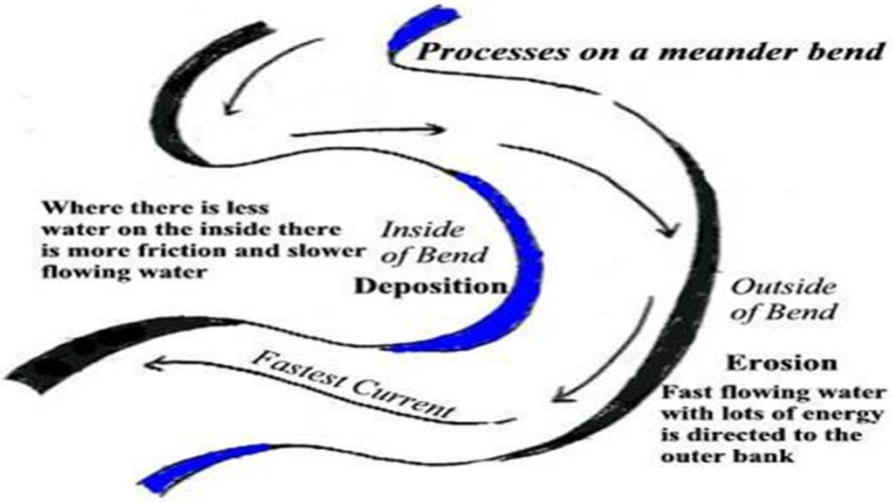
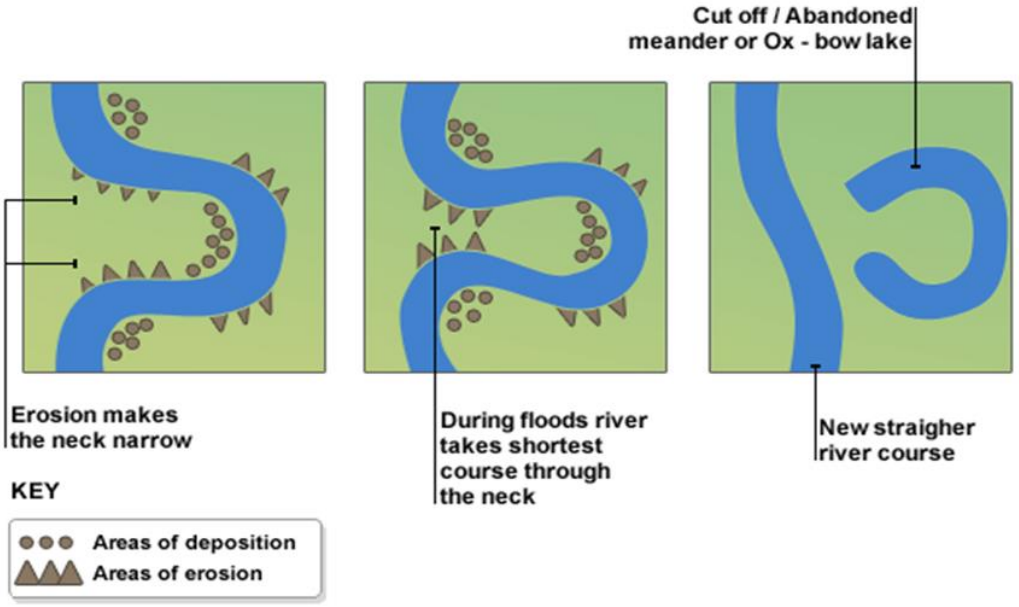
River landforms created by erosion and deposition

1. Meanders
2. Ox-bow lakes



Formation of a meander



Formation of a Ox bow lake

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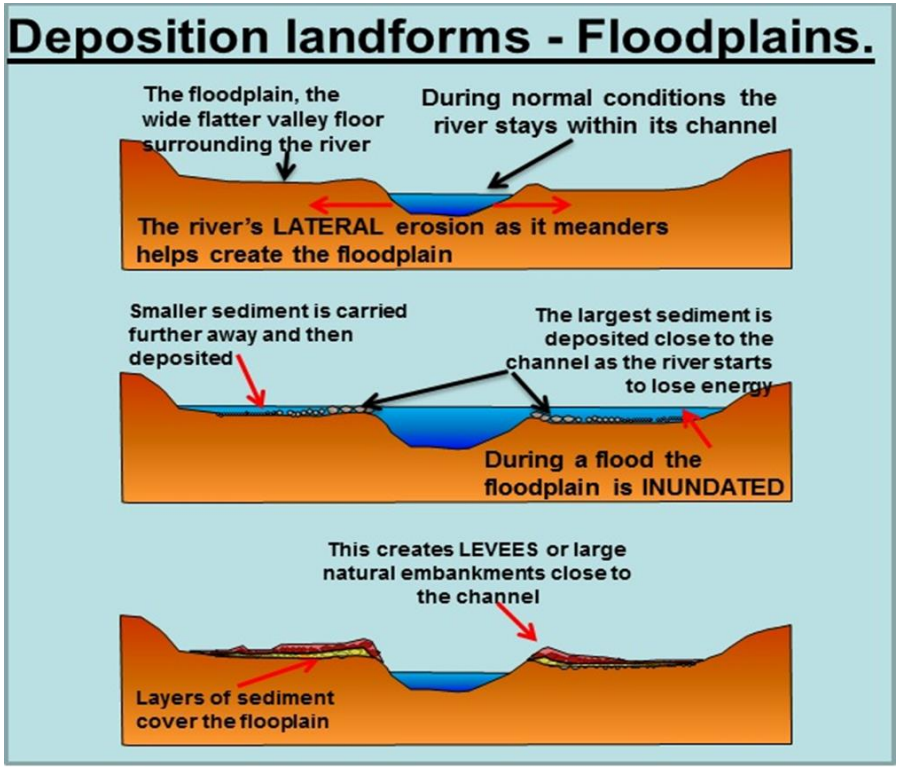
River landforms created by deposition

1. Floodplains & Levees
2. Estuaries

Estuary

An estuary is a **partially enclosed body** of water along the coast where **freshwater** from the river **mixes** with **salt water** from the sea

They are influenced by the tides but are protected from the full force of the ocean by barriers such as spits e.g. (*Exe Estuary and Dawlish Warren*)



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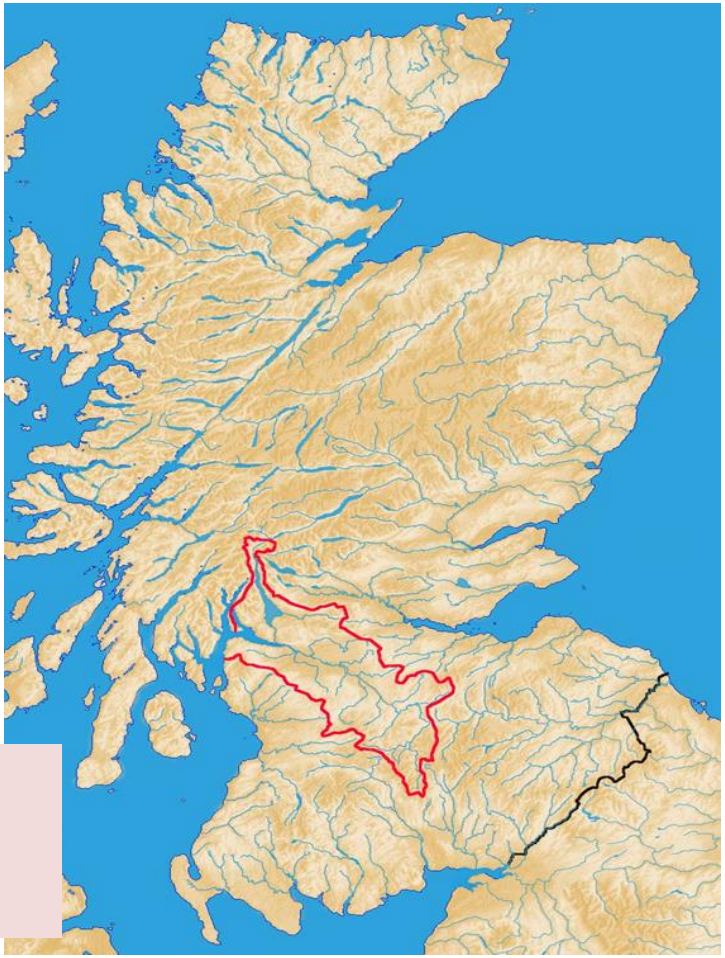
CASE STUDY:

An example of a river valley in the UK to identify its major landforms of erosion and deposition.

Learn your case study that you completed in class to show the different landforms found along the River Clyde in Scotland.

Be able to:

- ✓ Identify the variety of landforms
- ✓ Locate the landforms along the River Clyde
- ✓ Describe them
- ✓ Explain how they were formed



Alternative case study if you are/were absent from class:
River Tees
https://www.bbc.co.uk/bitesize/guides/ztpkqty/revision/4

What causes a river to flood?

A river flood occurs when a river channel can no longer hold the amount of water flowing into it.

River floods usually occur after a **long period of rain**. Soil and rock layers become **saturated** and there is nowhere for the water to go, this often occurs in the ***winter months***

Sudden floods can occur following **torrential storms**, these are known as flash floods and are more associated with the ***summer***

There are both **physical (natural) causes** of flooding and **human (man-made) causes**

Physical causes

Precipitation

- Heavy rain
- Continuous rain

Geology (*rock type*)

- Impermeable rock

Gradient of the slope (*steep slopes*)

- Rapid transfer of water

Human causes (land use)

Urbanisation

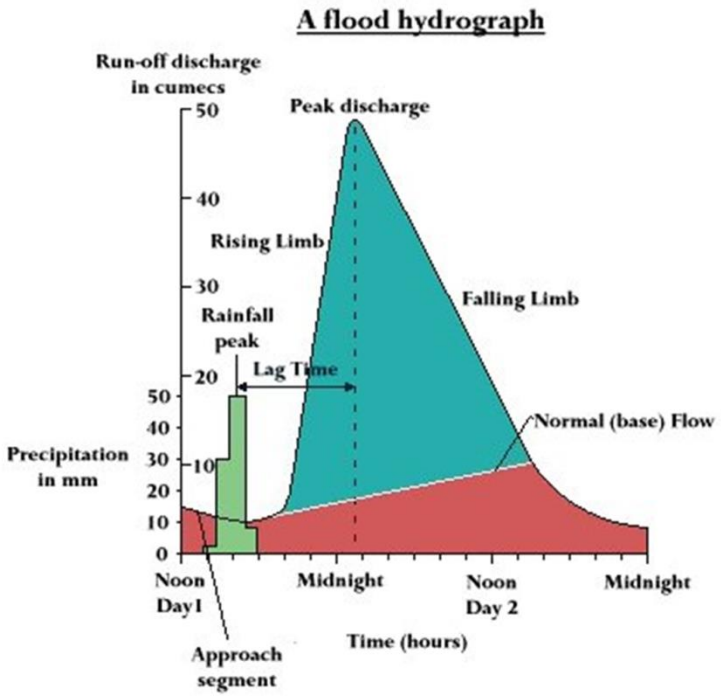
- Building on a floodplain creates impermeable layers

Deforestation

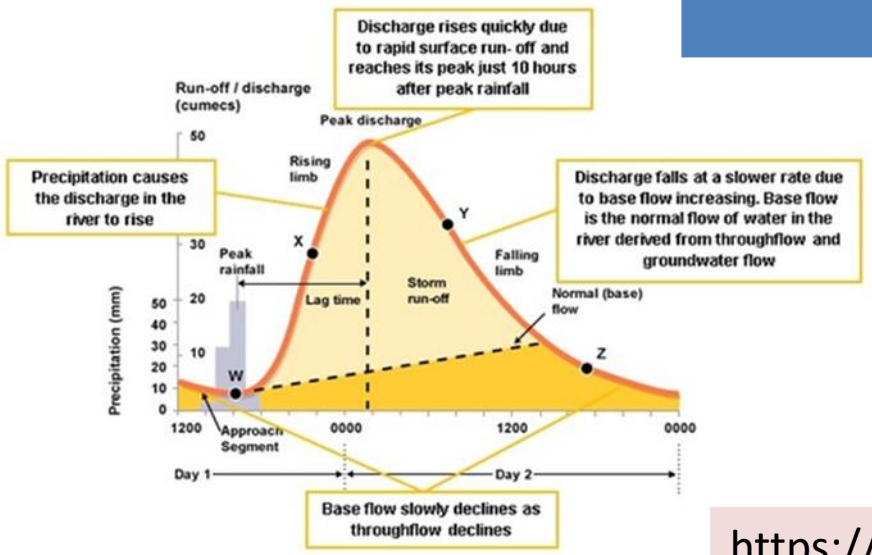
- Roots no longer absorb water; lack of interception speeds up journey to river; top soil washed into river

Agriculture

- Increases the flow of water into the river via furrows of ploughed land



Peak Rainfall	**This shows the reduced discharge once the main effect of run- off has passed. Its shown by the last part of the line graph as it is going down**
Falling limb	The highest amount of rainfall. It is shown by the bar graph
Peak Discharge	The time difference between peak rainfall and peak discharge. It is measured in hours.
Lag time	The highest recorded discharge following a rainfall event. It is shown by the top of the line graph
Base flow	This shows how quickly the discharge rises after the rain storm. This is shown by the rising line graph
Rising Limb	This is the normal flow of the river when its water is being sustained by groundwater and throughflow. This is shown by a separate line to the discharge
Discharge	The quantity of water that passes a given point in a river at a given time. Measured in cumecs



Understanding and interpreting a flood hydrograph

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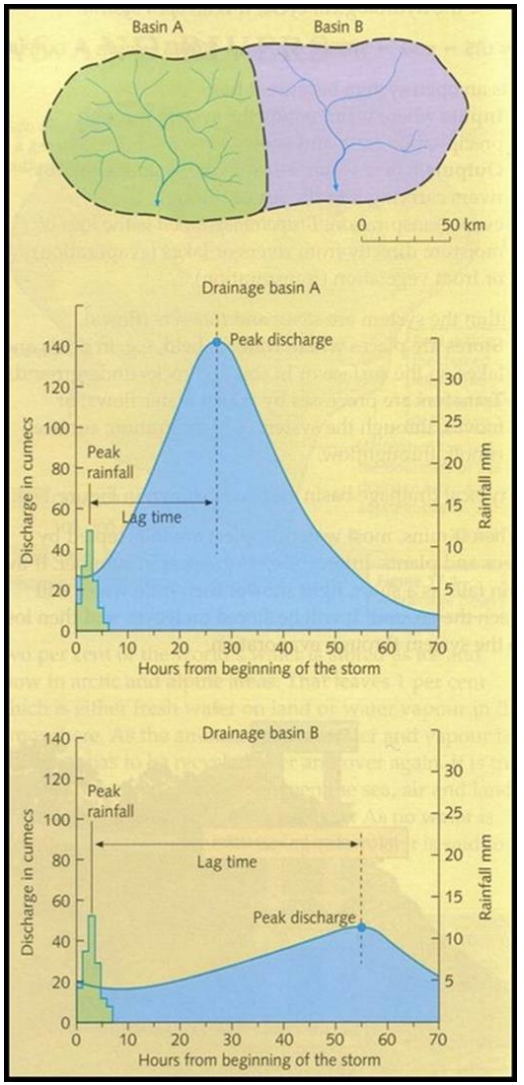
Comparing flood hydrographs

Characteristics	'flashy' hydrograph -short lag time & high peak	Low, flat hydrograph with a low peak
Basin size	Small basins lead to water entering the river fast - less distance to travel	Large basins can delay water entering the river
Drainage density	High density leads to more water flowing in the basin	Low density leads to less water flowing in the basin
Rock type	Impermeable rocks cause increase surface run off because water can't pass through	Permeable rocks allow water to pass through which slows down the speed of the water entering the river via groundwater flow
Land use	Urbanisation creates lots of impermeable layers through tarmac and concrete	Trees and grass slow down water going into the river due to interception and absorption by the roots
Relief	Steep slopes lead to water entering river quickly	Gentle slopes slow down water entering the river
Soil moisture	Saturated soil results in increased surface runoff	Dry soil will soak up water slowing down the transfer to the river through throughflow
Rainfall intensity	Heavy rain may lead to rapid surface runoff	Light rain will transfer slowly; most with soak into the soil



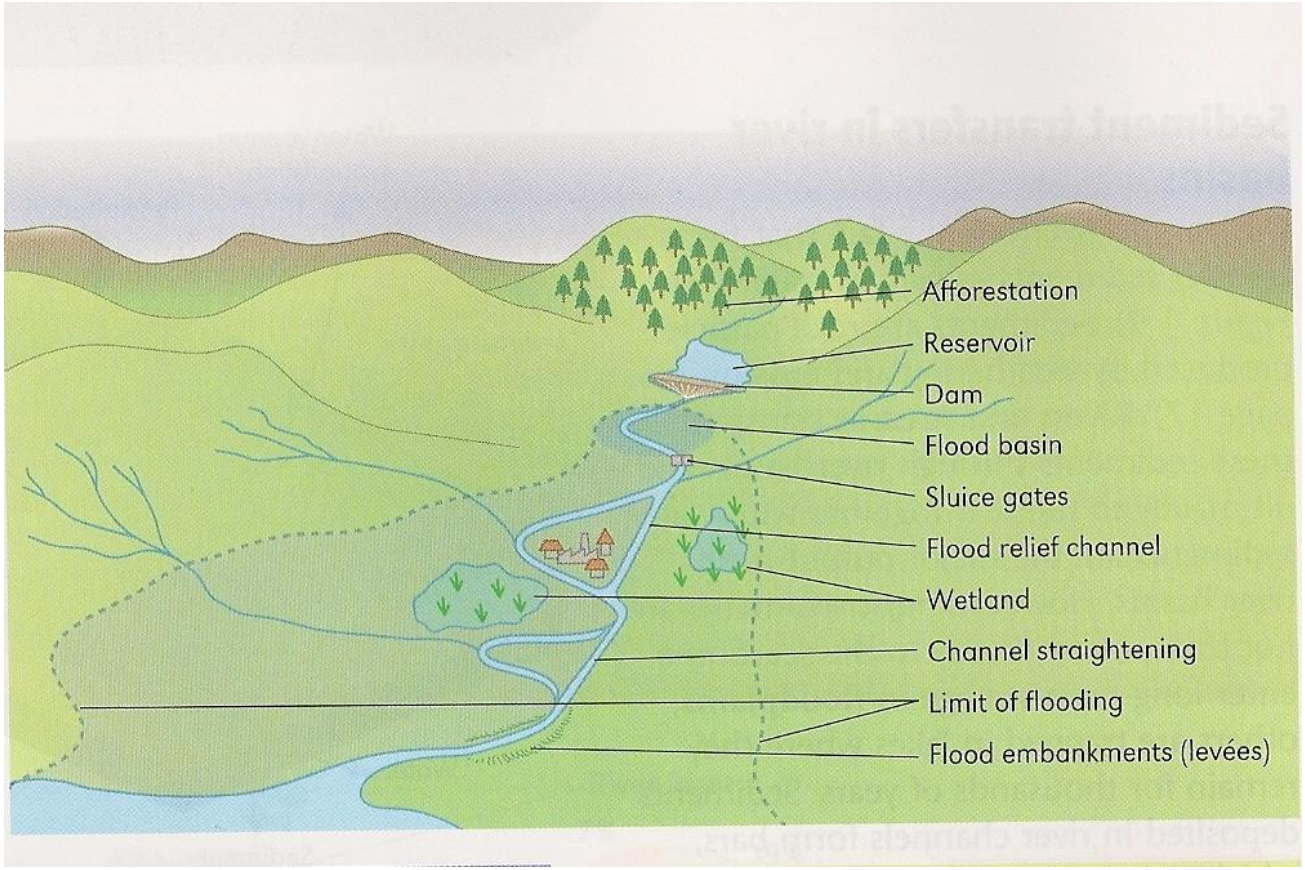
Different management strategies can be used to protect river landscapes from the effects of flooding

Hard engineering

- ❑ Dams & reservoirs
- ❑ Channel straightening
- ❑ Flood relief channels

Soft engineering

- ❑ Flood warnings & preparation
- ❑ Floodplain zoning
- ❑ Planting trees
- ❑ River restoration



Dams & reservoirs

Dams are built across rivers , usually in the upper course. A reservoir (artificial lake) forms behind the dam. Above is Hoover Dam and Lake Mead in the USA

Channel straightening

The rivers course is straightened . Meanders are cut out by building artificially straight channels . This allows water to move through an area 'at risk' more quickly

Embankments

Raised walls built along river banks to hold in more water

Hard engineering

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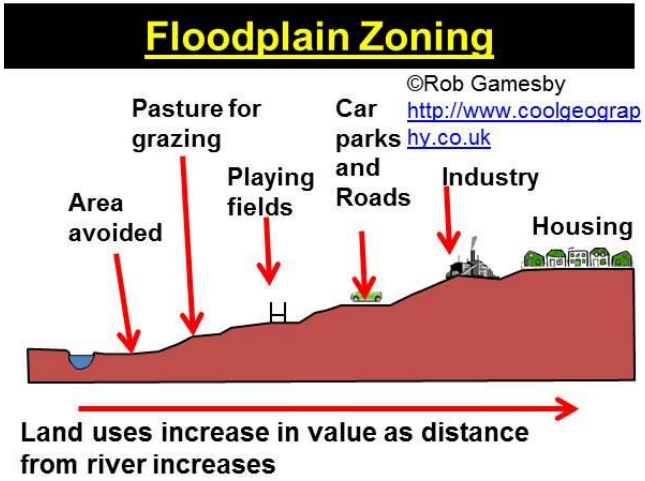
Channels are built that divert the water around important areas like a city centre if river levels get to high. There is one in Exeter and this is the one in Los Angeles used in the film Grease!

Soft engineering strategies

Floodplain zoning



Restrictions prevent building on parts of a flood plain that are likely to be affected by a flood

Planting trees

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Trees can delay runoff by:

- ✓ Roots absorbing some of the water
- ✓ Interception of precipitation reduces the amount of water in the river basin through transpiration or causes it to enter the river more slowly through stem flow.
- ✓ Binding topsoil together to prevent soil washing into the river and causing water level to rise.

Flood warnings & preparation

The Environment Agency warns people of potential flooding via TV, radio and internet

Costs and benefits of hard engineering

Advantages Hard Engineering	Disadvantages Hard Engineering
As well as controlling floods **dams** can also store water in the reservoir behind for drinking and also generate electricity through Hydro Electric Power (HEP)	**Dams** are very expensive and require settlements and large areas to be flooded. Farmland downstream can become infertile as silt is trapped behind the dam
If the river can hold more water through higher **embankments** it will be less likely to flood	Flooding can happen downstream instead if the river **channel is straightened** as water moves quickly to another area
Flood relief channels help to reduce river discharge which reduces the flood risk	If the **embankments** break there can be severe flooding
Advantages Soft Engineering	**Disadvantages Soft Engineering**
Measures like afforestation and river restoration involve a more natural approach which is better for habitats	Less land is available for urban development and farming due to zoning and afforestation
Need little maintenance and tend to be cheaper	Warnings don't actually prevent the flood!
The impacts of the floods are reduced if people are given adequate warning	Local flood risk can increase if nothing is done to prevent major flooding

CASE STUDY: Banbury OR Jubilee flood relief channel (River Thames)

An example of a flood management scheme in the UK

Learn your case study that you completed in class to show knowledge and understanding of the flood management scheme

Be able to show:

- ✓ Why was the scheme required?
- ✓ **Characteristics** of the scheme
- ✓ What have been the **social**, **economic** and **environmental** costs and benefits

Alternative case study if you are/were absent from class: Boscastle , Cornwall

https://www.bbc.co.uk/bitesize/guides/zg4tfrd/revision/5

What have been the **social**, **economic** and **environmental** costs and benefits of the Boscastle scheme?