AQA Geography GCSE

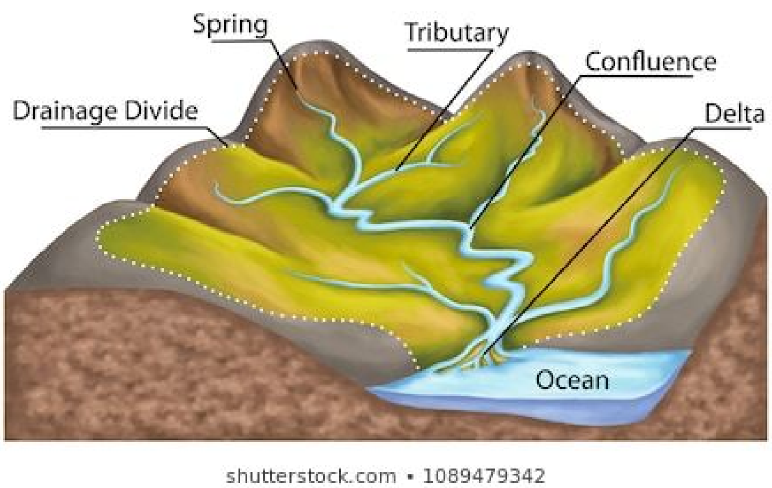
River Landscapes in the UK

Detailed Notes

Rivers

Drainage Basins

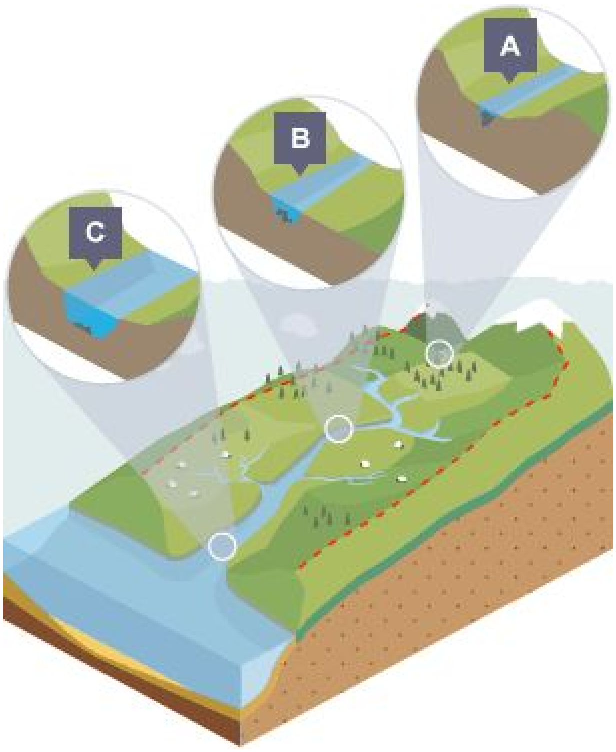
The diagram below shows a drainage basin. It's defined as **an area of land drained by a river and its tributaries** with a boundary (known as the **watershed**), which are usually hills and mountains.



Source: Shutterstock

River Stages

Any river is made up of **three sections**: the upper course, middle course and lower course. The shape of the river changes for each section of the river (these are explained in more detail later on in these notes):



Source: BBC

- **Upper Course** - The river starts as many **tributaries** which are **narrow and v-shaped**. Each tributary is small with a **low volume** of water, but combined they fill up the river channel further downstream. At this stage of the river the sides tend to be like a **valley**, with a large gradient either side which causes the water to run into the tributary.

- **Middle Course** - The tributaries merge together to form a channel which is **rounder** in shape and **deeper** than the upper course. The water here has **more energy** as there's a higher volume of it. This means more erosion takes place, widening the channel. The area around the river channel is **flat and low-lying**, which is the **floodplain** if the river needs to flood.

- **Lower Course** - Now the river is on its last stretch before the sea, carrying the **largest volume of water** in a very wide and very deep channel. There are ridges either side of the river banks called **Levees.** The size of the valley has increased, so it is even wider and flatter than the middle course.

Velocity of water
The **speed** the water travels at is dependent on which course of the river it is travelling through. **Friction** occurs between the water and the riverbed which slows the water down. The more contact the water has with the floor, the more friction occurs which means the water travels slower.

In the upper course, the channel is shallow and so most of the water passes the riverbed, slowing the rate of flow due to friction. As the river channel gets bigger less water is in contact with the riverbed which means the velocity of the water increases.

In the lower course of the river, the water travels a lot **faster** than the upper course as there is **less friction** from the river bed. The river is wider and deeper due to the increased erosion that's occurred from the fast water.

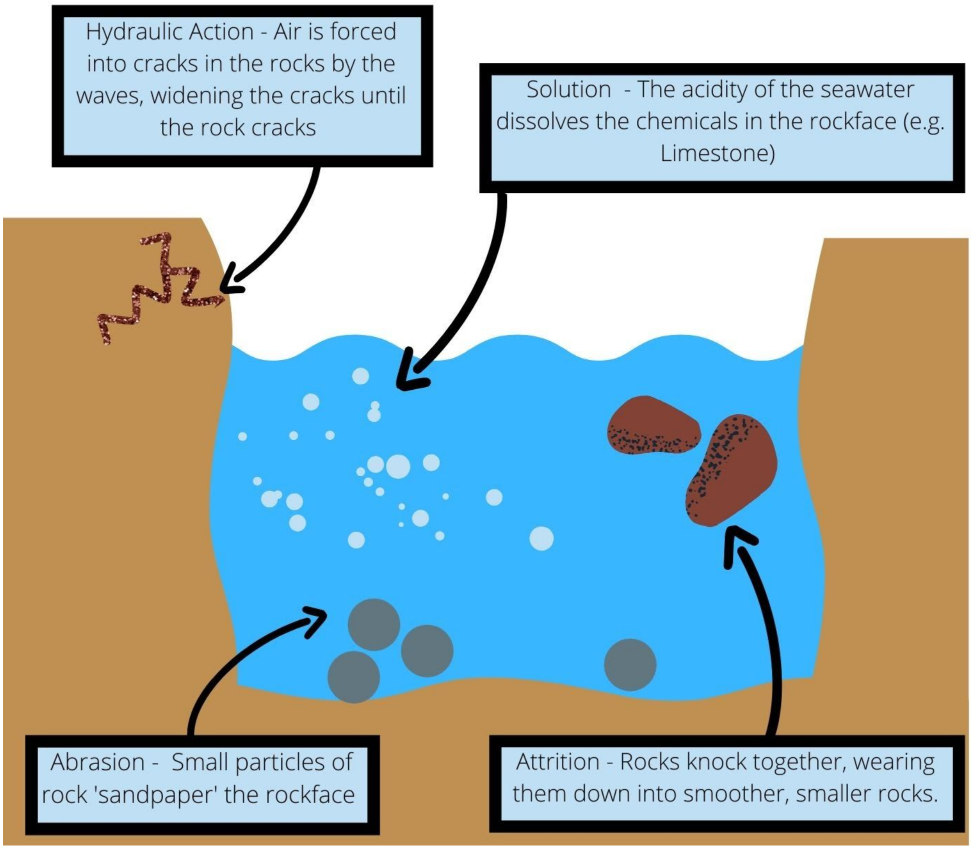
Fluvial (River) Processes & Landforms

Erosional Processes

Erosion occurs along the river, the majority of which occurs in the upper and middle course. Erosion can take place downwards on the river bed (**vertical erosion**) or sideways along the banks of the river (**lateral erosion**). There are four types of river erosion:

- **Abrasion** - This is the process where rocks carried by the water (the load) **scrape and bang** against the sides of the river and so wear away the channel gradually (like **sandpaper** against a piece of wood).
- **Attrition** - **Rocks and pebbles to hit against each other**, wearing each other down and so becoming round and eventually smaller. Attrition reduces the size and shape of the load, but doesn't change the shape of the river channel .
- **Hydraulic Action** - Water under high pressure causes **cracks to force apart and widen** in any rocks along the banks of the river. Over time this causes the rock to fracture and collapse into the river, expanding the river channel.

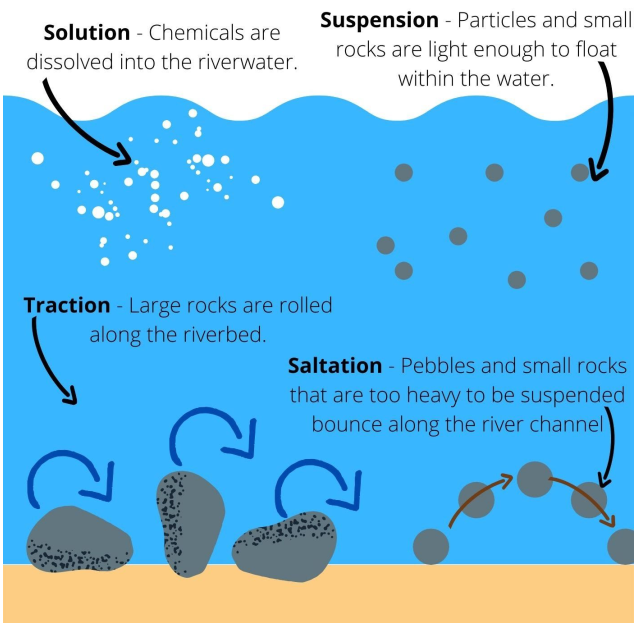
- **Corrosion (Solution)** - The river can gradually dissolve chemical compounds in rocks that it flows over. For example, limestone can dissolve gradually into the river, if the river water is slightly acidic (due to acid rain).



Transportation Processes

As they flow downstream, rivers transport material as well as water. The material they transport is called the **load**. The load can include **rocks** eroded from the upper course, dead plants which make the lower course more fertile, **chemical compounds** dissolved into the water and many other things.

To move the load, there are four different types of **transportation**. The method of transportation depends on the **size of the load**.



- **Solution** - Chemicals are dissolved in the river water.
- **Suspension** - Particles and small rocks are light enough to float within the water.
- **Saltation** - Pebbles and small rocks which are too heavy to be suspended bounce along the river channel.
- **Traction** - Large rocks are rolled along the river bed.

Exam Tip
It's really important you know the definitions properly for both the **erosional** and **transportational** processes that occur within rivers. They all sound quite similar (there are lots of words beginning with s!) but if an exam asks you to **define** one of them or a question asks you to **explain** processes which occur in a river, you don't want to be caught out. These are easy marks to gain (or lose).

How to revise
- Make cards (in bright colours) and hang them around the house.
- You could learn a word a day (that way you've learnt them in only 8 days!)
- Once you're confident, get anyone you want - parents, friends, brothers, sisters, neighbours, random person on the bus - to spot test you on them.

Deposition

Deposition is the dropping of the river's load when the **water in a river decreases in speed**. If the river travels slower, the water has **less energy** and can carry less material.

The heaviest materials get deposited first: rocks and stones are deposited in the upper course, whereas finer sediment travels as far as the lower course before being deposited. The most deposition occurs in the **lower course** of the river.

You can see large rocks in this picture of the **Aira River** in the **Lake District**. This is in the **upper course** of the river. The water has a low velocity which means it doesn't have the energy to transport such a large load downstream.

Source: Stephanie Green

River Landforms

There are landforms characteristic of each section of the river. This is because different river processes are prominent in each course:

- **Upper Course**: Erosion is the predominant river process.
  Typical Landforms - Waterfalls, Interlocking Spurs, V-Shaped Valley

- **Middle Course**: Mixture of erosional and depositional landforms
  Typical Landforms - Gorges, Meanders

- **Lower Course**: Deposition is the predominant river process
  Typical Landform - Floodplains, Ox-Bow Lake, River Estuary

It's important to be able to **identify** these features, and know **where** they are typically found along the river and **how** they are formed!

Erosional Landforms

Interlocking Spurs

These are found in the **upper course** of the river where the water doesn't have a lot of energy so isn't very powerful. The **low energy** means the water isn't strong enough to erode **resistant rocks** in the spur. Instead, the river re-routes and curls around them. You can see the river doing this in the picture on the right.

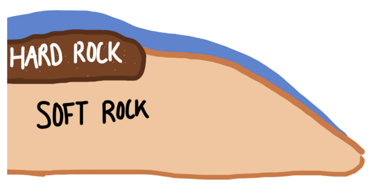
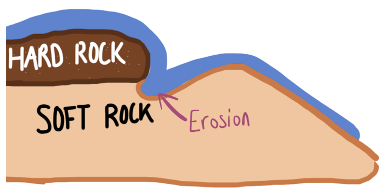
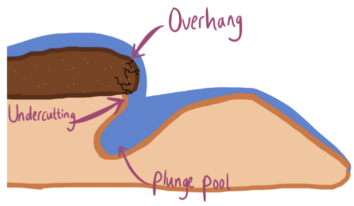
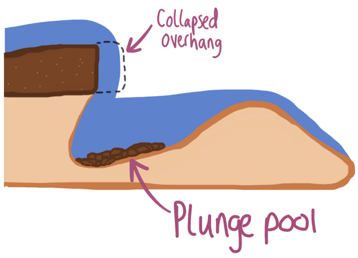
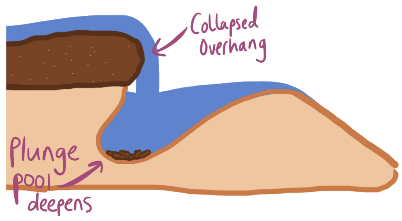
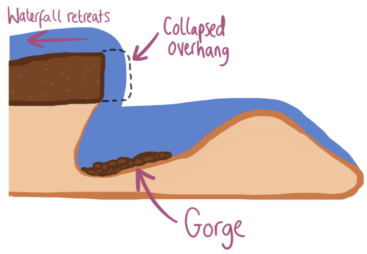
Source: www.internetgeographer.net

Source: Guru Shots

Spurs are the bits of the mountain to the left and right of the river which point down towards it. You can see them more clearly in the picture on the left. This is Hell Gill in the Lake District. As there are spurs on either side of the valley, the tributary looks like a **zigzag** from above.

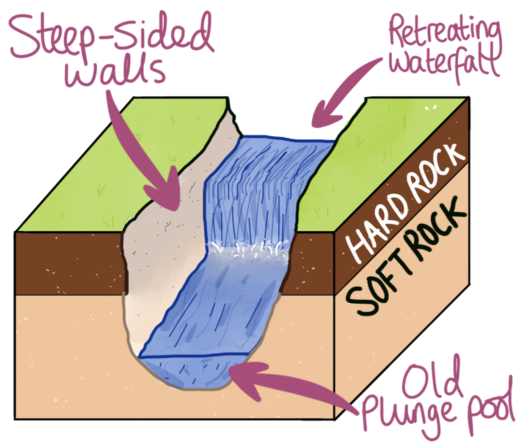
Waterfalls

Waterfalls occur when a river flows over rocks with **different resistances** to erosion. Rock which is resistant to erosion is called **hard rock**, and rock which is easily eroded is called **soft rock**.

Step 1	**Step 2**	**Step 3**
 	 	
In an area where **a river flows over an area of hard rock and soft rock**, the soft rock erodes more **quickly**.	The soft rock erodes away around the hard rock over time, creating a **step**.	The soft rock continues to erode, **undercutting the hard rock**. The hard rock is left suspended in the air as an **overhang**. The **rotational movement of the water** quickens erosion, creating a **deep plunge pool**.
Step 4	**Step 5**	**Step 6**
 	 	
Due to the force of gravity, the **unsupported overhang** collapses. The broken up rocks fall into the **plunge pool**, which act as **tools for erosion** and further **deepens** the plunge pool.	Erosion continues to **undercut underneath the hard rock**, creating an overhang again further upstream.	The continual process of the **overhang collapsing** causes the waterfall to **retreat upstream** over time. The **plunge pool continues to deepen**, and the **hard rock continues to be undercut** to create an overhang.

Gorges

Gorges form from **waterfalls**. As the waterfall **retreats** upstream it leaves behind a **steep valley** carved into the rock with the river running along the base.



Below is an aerial view of **Victoria falls** which is located on the **border of Zambia and Zimbabwe**. In the left half of the picture you can see a **gorge** with the river flowing at the bottom of it.

On the right side of the picture you can see the white spray from the **waterfall** itself. Over time the waterfall will retreat further upstream.

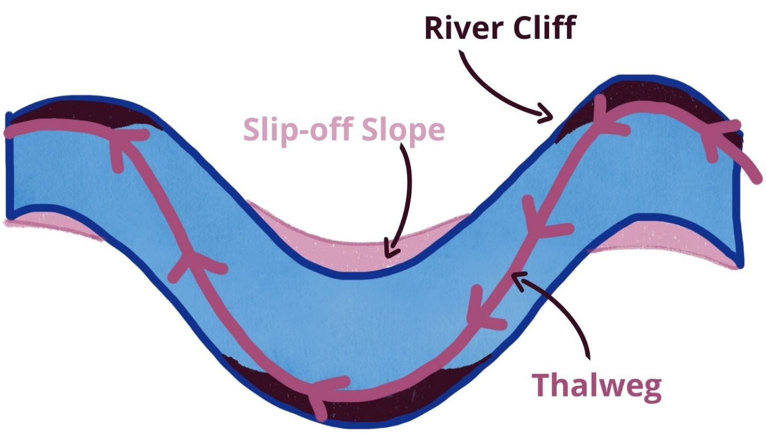
Source: www.zambiatourism.com/destinations/waterfalls/victoria-falls/the-formation-of-victoria-falls/

Landforms Due to Erosion and Deposition Combined

River landforms can be created by a **combination** of erosion and deposition. Often, these landforms change the shape of the river and are easily identifiable from above.

Meanders

These are **bends** in the shape of the river, often found in the **middle course**. The creation of meanders is a gradual process which depends on the **velocity** of the water.



- ➔ Water travels faster on the outside of the bend which means **lateral erosion** takes place here. This leaves a river cliff, as material falls into the river and gets transported downstream.
- ➔ On the opposite side the water travels slowly and changes direction sharply and so the water loses energy and deposits sediment.

- Hence, erosion wears away a cliff on the outer edge of a bend and deposition creates a slip-off slope on the inside of the bend.

The **thalweg** is the path of the **fastest water**, which can be used to show the locations of erosion and locations of deposition. If asked to draw a meander it's important to draw the thalweg on your diagram, with arrows to show the flow of water.

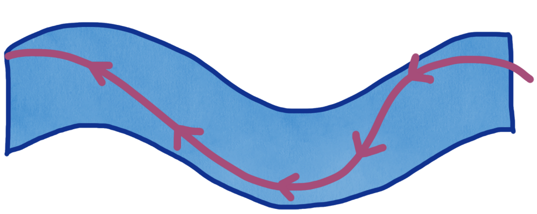
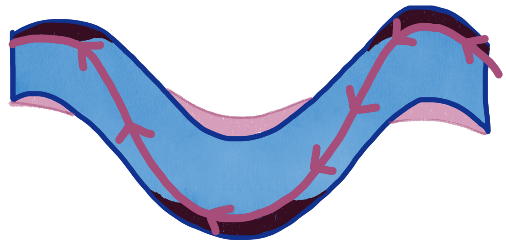
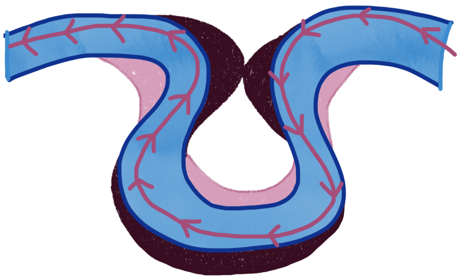
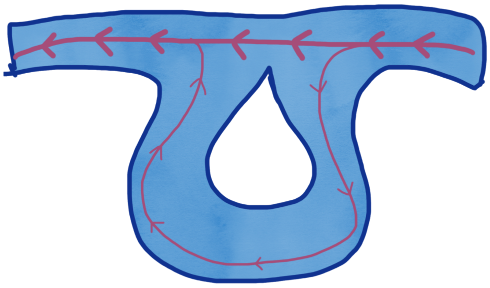
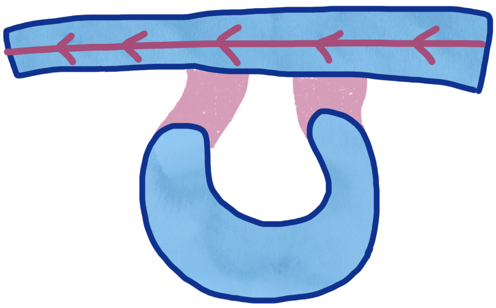
Tip: If you're struggling to work out where the thalweg should be, imagine the river as a giant waterslide and draw where you would go if you were going down it. You would be flung to the outside of corners wouldn't you?

In the picture below we can see many **meanders**. On the insides of the bends there are small **beaches** which have been formed by the **deposition of sediment** due to the water losing its energy. On the outside of the bends we can see where **erosion** is taking place and the water is cutting into the bank, creating small cliffs.

Can you draw where the thalweg is likely to be on this river using the diagram on the previous page to help you?

Source: http://nwrm.eu/measure/re-meandering

Ox-Bow Lake - Similar to a meander, an **ox-bow lake** is formed due to a combination of **erosion and deposition**. You can watch a video of an ox-bow lake forming in the **Ucayali River, Peru**, here.

	
In the beginning, the river has meanders that form depending on the **speed** of the water.	**Erosion** happens when the **fastest water** hits the sides of the meander, whereas **deposition** occurs on the inside of the bend, where the **water is slowest**.
	
Gradually, erosion bends the river so that the **meanders** travel towards each other.	The neck of the meander will eventually break (normally due to a flood), creating a straight river and a bend where water is slow if not stationary.
	
The old meander becomes separated from the main river as material gets deposited at the top, creating the separate **ox-bow lake**.	

How many ox-bow lakes can you identify in the picture of the Kinabatangan River, Malaysia?

Source: https://mdgradationaltour.wordpress.com/2016/04/11/oxbow-lake/

Depositional Landforms

There are two landforms which are common in the lower course of the river - floodplains and levees - both of these occur due to deposition.

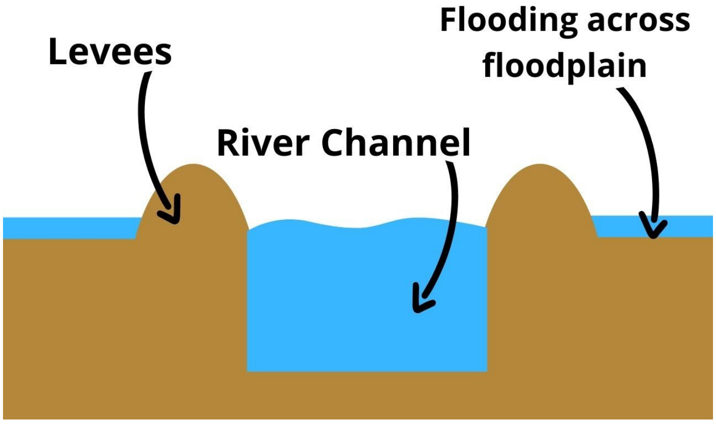
Deposition determines the lower course's shape, making it distinctive to view from aerial photographs.

Floodplains - The river in the lower course has many large meanders, which grow outwards over time. When a river floods the water spills out onto the surrounding land. The water loses velocity and deposits its load. Deposition of finer sediment called alluvium occurs (the larger materials have been deposited upstream first, leaving finer sediments and silts to be deposited in the lower course).

Therefore, floodplains are made from silts which make the land fertile. This is why lots of farming takes place in the lower course of the river. The picture above shows a farm in West Yeo near Moorland in Somerset. You can see that the fields and farm are built on a floodplain.

Image: https://ro.pinterest.com/pin/541065342704114389/

Levee - The banks of the river in the lower course are called levees. They are higher than the height of the water but aren't very wide, since it takes thousands of years for the sediment to build up. If the river floods over the levees, the floodwater can reach out far across the flat floodplain, as shown in the diagram below.



Every time the river floods, sediment is deposited on the top of the banks and so the levees grow in height. You can watch a video of how they form here.

Estuaries - At the mouth of the river (where the river joins the sea), the river water is affected by the tides as well as the flow of water behind it from the river. Since the river flow becomes disrupted and slowed greatly by the tides, there is a large amount of deposition. This can create mudflats and saltmarshes that over time can build into permanent habitats on the river/coastline.

The picture below shows Cardiff Bay in the early 90s. During low tide the sea would retreat leaving mudflats behind as seen below. In 1994 construction started on a large scheme which built a barrage across the bay to retain water. This meant the bay would always be filled with water. You can read more about this redevelopment project here.

Source: https://en.wikipedia.org/wiki/Cardiff_Bay_Barrage

Flooding

Flooding occurs when an **excess** amount of water fills the river in a **short period** of time. If the river channel isn't large enough to contain this excess water the river overspills into the surrounding land.

Often, the worst flooding occurs across the **floodplains** where the land is flattest and so the flood water travels the furthest. However, this is often the location of farming, towns and businesses who all lose from flooding.

There are several factors - **human** and **physical** - that increase a location's **flood risk**.

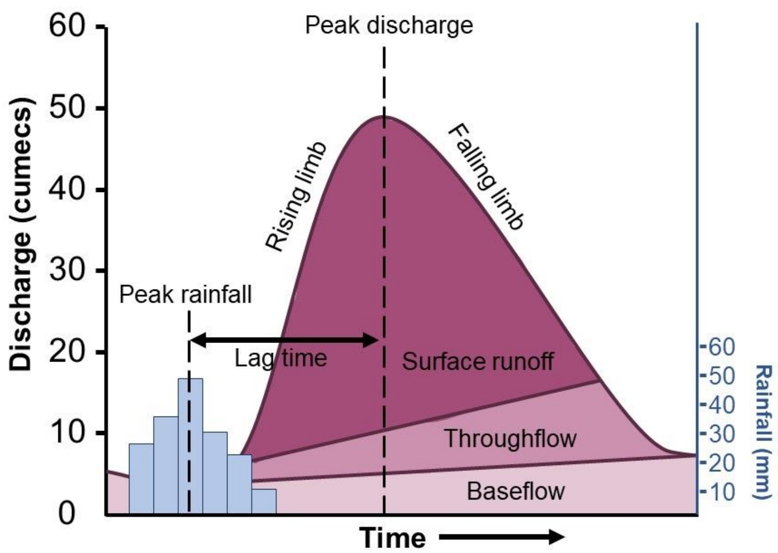
Human Factors that increase the flood risk	Physical Factors that increase the flood risk
Urbanisation - Increasing the amount of **impermeable surfaces** (concrete & tarmac, for example) decreases the time taken for water to flow into the river, and so increases the risk of **flash flooding**.	The **rate and volume of rain** (**precipitation**) falling - if there is a **storm**, and a large amount of rain falls in a short amount of time, the amount of water running into the river is increased. This increases the risk of **flash flooding** downstream.
Deforestation - Trees **intercept** the rain and so it takes longer for the rain to travel through the leaves into the river. Therefore, cutting down trees will **speed up** the time taken for rainwater to flow into the river, increasing the risk of **flash flooding**.	**Geology** - If the area has many **impermeable rocks**, the rainwater can't run into the soil and into **underground storage**. Instead, the rainwater runs straight into the river, increasing the risk of **flash flooding** on bad weather days.
The **Capacity** of the River - If the river becomes filled with **rubbish and debris**, the **channel's size** will decrease. This means the river can carry less water and so is more likely to flood.	**Topography** - The **shape of the land** will determine how quickly rainwater flows into the river. **Steep hills** with **high gradients** are more likely to have flash floods than gradual gradients.

Storm Hydrographs

Storm hydrographs represent the variation in the river's **discharge** (the **volume of water** passing through the river channel at a specific point) within a short period.

They are useful in showing how **precipitation** affects a **drainage basin**.

Features of storm hydrographs include:

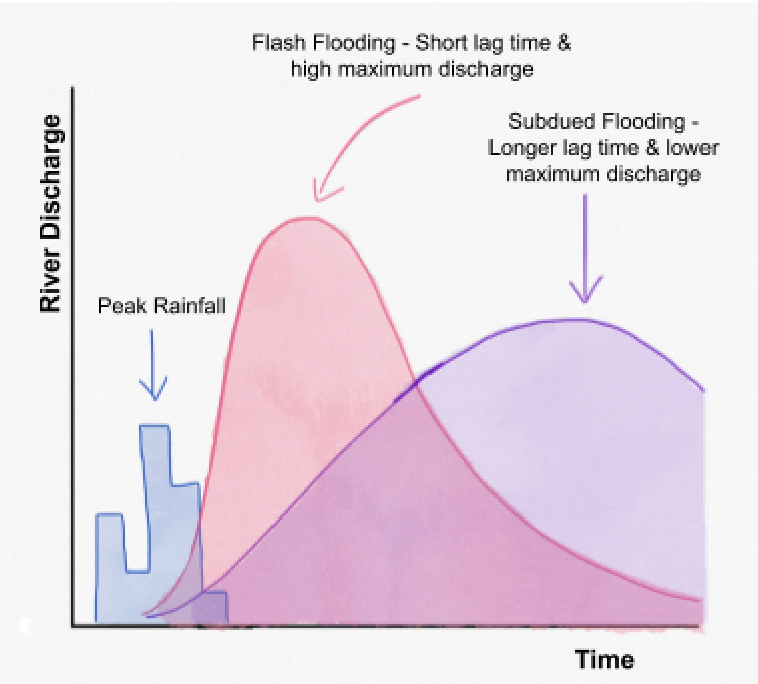


- **Peak Precipitation** - The maximum rainfall that occurs, shown as bar charts at the start of the graph.
- **Rising limb** – The increase of river discharge, not necessarily straight after precipitation.
- **Peak flow -** The maximum discharge, delayed after maximum precipitation has occurred.
- **Lag time** – The time delay between peak rainfall and peak river discharge
- **Falling limb** – As the storm precipitation levels decrease, river discharge will in turn decrease over time.
- **Base flow** – Eventually, the discharge returns to its normal level

Types of flooding

A flood can be described as either **flashy** or **subdued**. The description tends to depend on how quickly the water flows into the river. For example, a **flash flood** tends to be a flood with little warning, where a very large volume of water suddenly overwhelms the river. This can happen if a **large amount of rain occurs in a short period of time**.

On the other hand, a **subdued flood** could take up to a week of consistent rain. There isn't a large quantity of water falling per day, but because the ground is saturated any rain runs straight into the river. This would cause longer term flooding, but wouldn't sweep people or buildings away.



On the storm hydrograph above can you label the rising limb, falling limb, peak flow and lag time? (Hint: there's 2 of each!)

Can you explain why the two are different shapes? (If you're stuck there's a table on the next page which will help)
Factors that affect the shape of the hydrograph:

Below are some key **characteristics** of each type of flooding, as well as some of the **causes**:

	Flashy Storm Hydrograph	Subdued Storm Hydrograph
Description of hydrograph	Short lag time High peak Steep rising limb	Long lag time Low peak Gently sloping rising limb
Weather/Climate	Intense storm or rapid snow melt	Steady rainfall or slow snow melt
Rock type	Impermeable rocks like granite	Permeable rocks like limestone
Relief	High and steep slopes → More runoff	Low and gentle slopes → Less runoff
Basin size	Usually a small drainage basin	Usually a large drainage basin
Vegetation	Few plants or lawn space, deforestation has reduced the number of trees	High density of vegetation, which can intercept and absorb some rainwater

Can you draw the shape of the different storm hydrographs which you think would be created from the descriptions in the table above? *Tip: make sure you label your axis!*

Management of Drainage Basins

Why do we want to manage a drainage basin?

Drainage basins are really important to the **people** and **wildlife** that live in a drainage basin, for many different reasons - people live here, fish live in the river and many wildlife live on the banks, farmland tends to be found on the lower course.

However, if drainage basins aren't **managed**, there is a risk that the river might **flood**. Flooding can:

- ➔ Damage properties and families can lose their belongings, which can be upsetting
- ➔ Farmers might lose their crops or cattle might **drown** in extreme flooding
- ➔ If industry and factories become flooded, workers could lose their jobs so **unemployment** will rise

So flooding can cause significant **economic** or **social losses**, which will impact the **community** that live within the drainage basin.

Sustainable Management

Attempting to manage a drainage basin **sustainably** can be challenging. There are **hard engineering** and **soft engineering** strategies, each with their own benefits and costs.

Sustainable means that a strategy will stop **flooding** in the future, whilst **protecting** the people that live there now. There are many things to consider to decide if a management strategy is sustainable:

- ★ Are the resources/materials renewable and safe for the environment?
- ★ Will machinery produce carbon dioxide emissions which contribute to Global Warming?
- ★ Are long term jobs created to keep the river maintained? Jobs keep the economy going, as well as making sure any management strategy doesn't crumble away
- ★ Is there an impact to the environment and wildlife that live in the river?

Choosing a Management Strategy

There are many factors to consider when choosing the most appropriate **management strategy**:

- The **economic** value of the land:
    - How many jobs depend on the river?
    - Are there business parks or industries built in the floodplains at risk from flooding?
    - What will the insurance cost be for a flood?
    - How much does it cost the government to respond to a serious flood (emergency services, army etc)?

- The **cultural or social** value:
    - Is the river historic or a location of cultural/religious importance?
    - Do events or festivals happen here, and on what scale do they affect lives (locally, national, international events)?

- Are the river's floodplains home to a village or town? Will these people need to migrate and live elsewhere if flooding continues?
- Is there a risk to life during flooding?

- The **environmental** value:
  - Are there any rare or endangered species living along the river banks or in the river?
  - Would nature reserves become at risk if flooding continues?
  - Are there any farms at risk? What would happen to the cattle?

Soft Engineering Strategies

Soft engineering uses more natural materials to restore the river's natural state or reduce the damage caused by flooding, in a more environmentally friendly way. Unlike hard engineering, soft engineering aims to **complement the physical environment** by using natural materials.

Floodplain Zoning

Source: BBC

Description: Constructing houses and buildings furthest from the river reduces their risk of flooding.
- 👍 Reduces the damage to houses in the future, without altering the river
- 👍 Creates recreational land (football pitches, parks) near to the river
- 👎 Can only be done for new developments, you cannot reconstruct an existing village or town.

Wetlands

Source: Norfolk Wildlife Trust

Description: Vegetation is planted and legal protection stops building on wetlands.
- 👍 Wetlands store river water and can flood when needed, with no damage to houses
- 👍 Creates valuable habitats for river wildlife
- 👎 It takes a long time for wetlands to establish and grow

Hard Engineering Strategies

Hard engineering uses **man-made**, **artificial structures** to change the shape of the river or control the flow of water. They are often very effective but are **high-cost** and have a **significant environmental impact due to the use of concrete** and other man-made materials.

Dams

Source: Elan Valley

Description: Concrete blockade that stores water in the upper course and can regulate river flow.

- 👍 Valves can control and release the right amount of water to avoid flooding
- 👍 Can generate electricity (HEP)
- 👎 Visually unappealling
- 👎 Villages can be flooded to create the reservoir and so people must move out of their homes

Embankments

Source: Walking Britain

Description: The banks of the river are built up in brick and concrete, to increase the channel capacity

- 👍 Reduces lateral erosion, so the river doesn't grow wider
- 👍 Protects valuable property on the riverfront.
- 👎 Looks unnatural and destroys habitats along the river bank

Dredging	Channel Straightening & Flood Relief Channel
	
Source: Channel 4 Description: Rubbish and sediment are dug up from the bottom of the river 👍 Widens the river channel and removes pollution from the water 👍 Doesn't alter the look of the river 👍 Cheap hard engineering strategy 👎 Takes time to complete, and the river must be dredged regularly	Source: Seven Sisters Description: The river is straightened and relief channels constructed to bypass the meanders increase the speed of river flow. 👍 Reduces flooding risk since water flows faster downstream 👍 Protects urban villages by directing flood water away. 👎 Expensive and disruptive of natural habitats

Flood Management

Even if a river is managed, **extreme weather** may occur causing the river to flood. In these instances there's not a lot which can be done.

The **local council** can try to prepare for the flood to protect its community and businesses. Flood damage can be **minimised** by:

- Putting **sandbags** in the doorways to reduce flood water leaking into homes through the bottom of the door.
- **Temporary flood barriers** can be put up, which act like temporary banks and increase the river's capacity.
- Valuable possessions are moved upstairs and locals are told to stay inside and upstairs.
- **Roads are closed** that cross the river or come close to the river banks, to reduce the risk of someone being swept away.

In the UK, the **Environmental Agency** monitors and distributes warnings when floods are likely, to give locals time to prepare and evacuate.