# Edexcel A Geography GCSE

## Topic 1b - River Landscapes and Processes

### Detailed Notes

# River Processes and Landforms

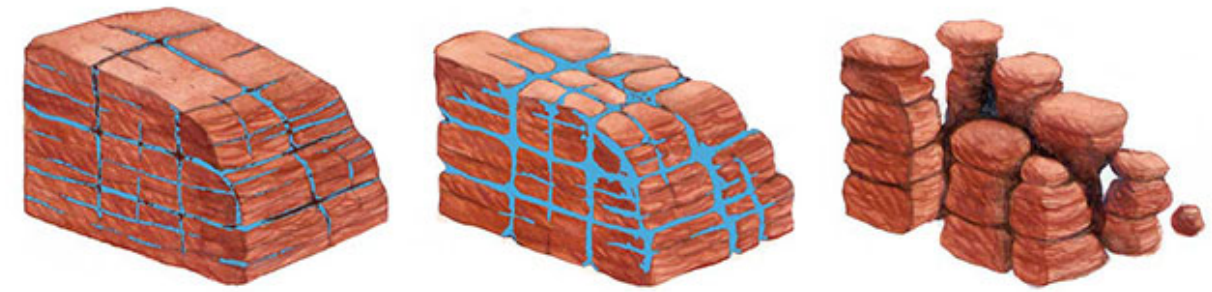
## Weathering

Weathering is a **subaerial** (meaning *below air* - so on the Earth's surface) process that causes the **breakdown of rocks** over time. This process produces materials which are either **deposited** to form **river landforms**, or picked up and carried away through **transportation**. There are three types of weathering that break down the sides of the river valley:

- **Mechanical (Physical) Weathering:** the breakdown of rocks due to exertion of **physical forces** without any chemical changes taking place.

  One example of mechanical weathering is **freeze-thaw**.

  - Water enters cracks in rocks and **freezes** overnight, especially during winter.
  - As it freezes, **water expands by around 10%** in volume which increases the pressure acting on a rock, causing cracks to develop.
  - Over time, repeated freezing and thawing causes these cracks to grow, weakening the valley sides until they break apart. This makes the rock face more vulnerable to other processes of erosion.



(Source: https://www.bgs.ac.uk/discovering-geology/geological-processes/weathering/)

- **Chemical Weathering:** the breakdown of rocks through **chemical reactions**.

  The most common type of chemical weathering is **carbonation**, where **acid rain** reacts with **calcium carbonate** in rocks to form a chemical compound which can then be easily dissolved. Over time, rocks can be slowly dissolved away.

- **Biological Weathering**: the breakdown of rocks due to the actions of plants, bacteria and animals.

  One example of biological weathering is where **roots** grow into rocks and **break them apart**. Also, burrowing animals may also create instabilities in the valley sides.

## Mass Movement

Mass movement is the **downhill** movement of sediments due to gravity. There are several types of **mass movement**, though they are broadly defined as either **slides** or **slumps**.

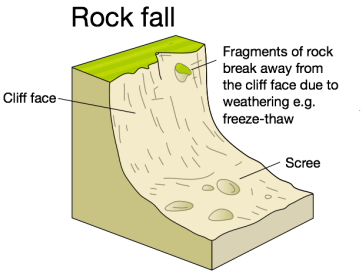
The type of mass movement that occurs depends on:

- the **angle** of the slope/cliff
- the rock type (**lithology**), including its weight and ability to flow downhill
- the **saturation** of the ground from previous rain or flooding

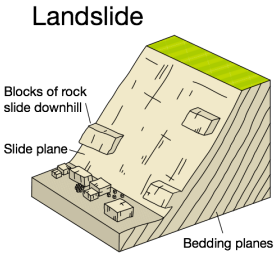
It's possible to predict the type of mass movement based on the shape of the rock face:

### Slides

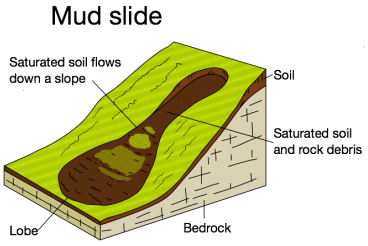
- **Rock falls** - Occur on sloped cliffs (over 40° to the valley floor) when the rock becomes exposed to mechanical weathering (often freeze thaw).




- **Landslides** - Heavy rain causes overlying **rock** to become **saturated** with water, making it **heavier**, resulting in large rocks rapidly **sliding** down the slope.




- **Mudslides** - Saturated (waterlogged) soil flows down the face of a hill like a fluid, bulging at the bottom in a **lobe**

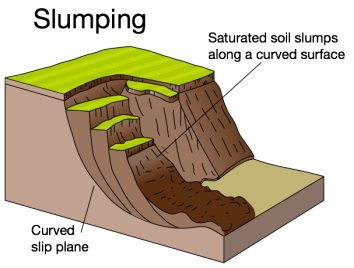



### Slumps

- **Slumping** - Soil and rock fragments become saturated with water.

  However, instead of sprawling down the hill like a mudflow, chunks of rock and soil **slip rotationally**, creating stepped 'heads' down the rock face. This occurs because the **slope is concave** (curved inwards), which is seen on in the diagram.

  Slumping is sometimes called **rotational slip**.




(Diagrams source:www.internetgeography.net)

## Erosional Processes

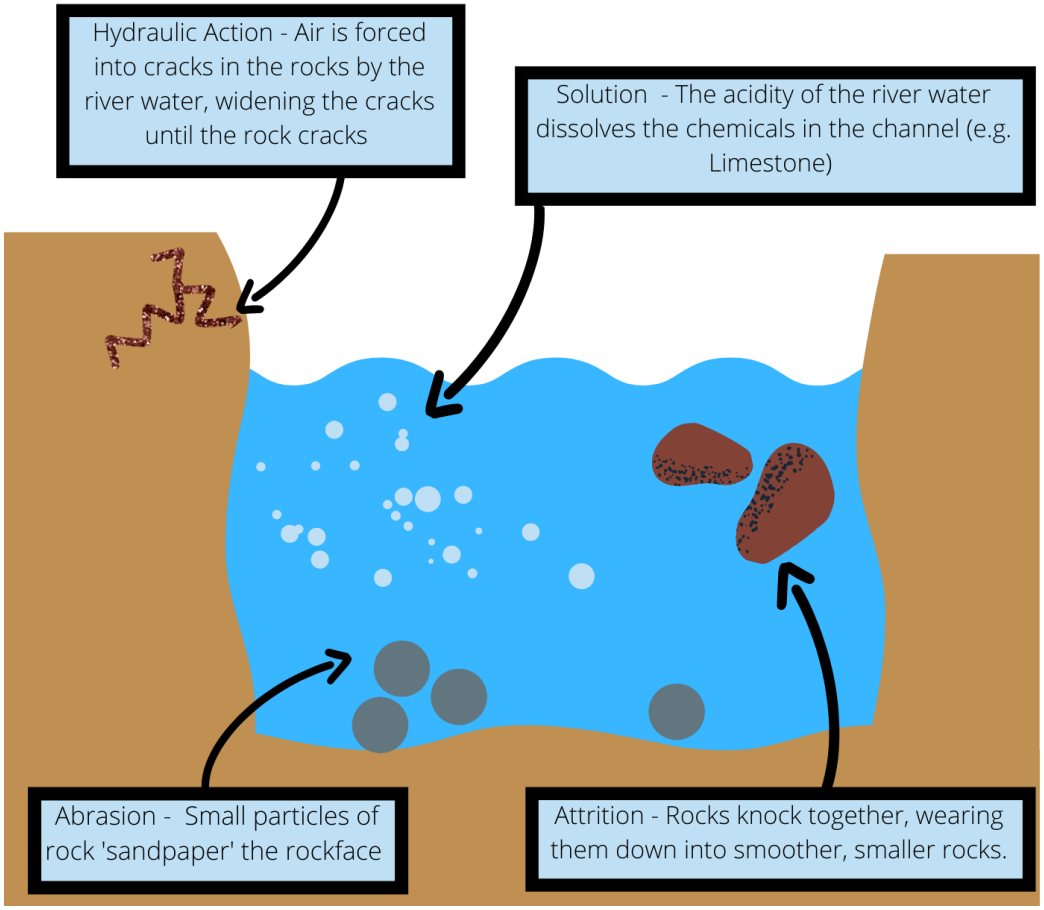
River erosion is the breaking down and removal of rocks and sediment along the river channel by **natural forces**. Erosion can take place downwards on the river bed (**vertical erosion**) or sideways along the banks of the river (**lateral erosion**). There are four types of river erosion, which work together to break down the river channel:

- **Abrasion** - This is the process where rocks and sediment carried by the water (the load) **scrape and bang** against the river channel, wearing it away gradually (like **sandpaper** against a piece of wood).

- **Attrition** - **Rocks and pebbles hit against one another**, wearing each other down and becoming smaller and more rounded. 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 within rocks to force apart and widen** along the river bank. Over time this causes the rock to fracture and collapse into the river, expanding the river channel.

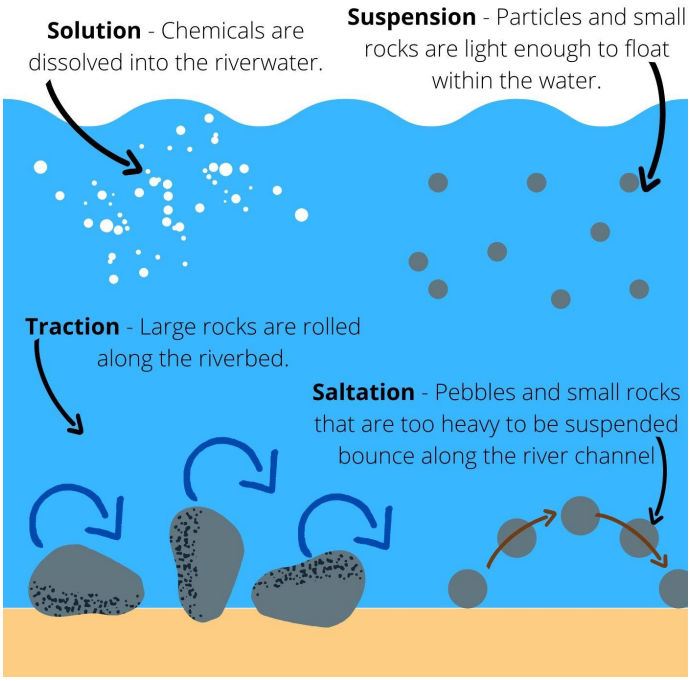
- **Solution (Corrosion)** - The river can gradually **dissolve chemical compounds** in rocks that it flows over. For example, limestone can dissolve gradually into the river, if the river water is slightly acidic (due to acid rain).



## Transportation Processes

Rivers transport material as well as water. The material they transport is called the **load**. The load can include **rocks** eroded at the top of the river (upper course), dead plants, or **chemical compounds** dissolved into the water. 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 and skip along the river channel.
- **Traction** - Large rocks are rolled along the river bed. You could remember this by comparing **tract**ion to the big, round wheels of a **tract**or rolling over a field.




***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 when **sediment is dropped** by a river because it has **lost the energy required to transport the sediment**. Deposition usually occurs when there is a **decrease in speed,** as when the river travels slower, the water has **less energy** and can **carry less material.**

The heaviest materials get deposited first: **rocks and stones are usually deposited in the upper course**, whereas finer sediments can travel all the way down the river before being deposited.

You can see large rocks deposited within and around the river 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.com/2018/03/29/aira-force-aka-waterfalls-and-rainbows)

In comparison, the river to the left - located in Ashes Hollow Valley, Shropshire - has **deposited smaller sediments** like rocks and pebbles along its banks. These sediments have been broken down by erosion and transported downstream.

In the lower course of the River Eden, pictured on the right, there is deposition of even the **finest sediments** along the river banks. This floodplain is made of fine silts, sands and clays.

(Source: Dr Neil Entwistle/University of Salford)

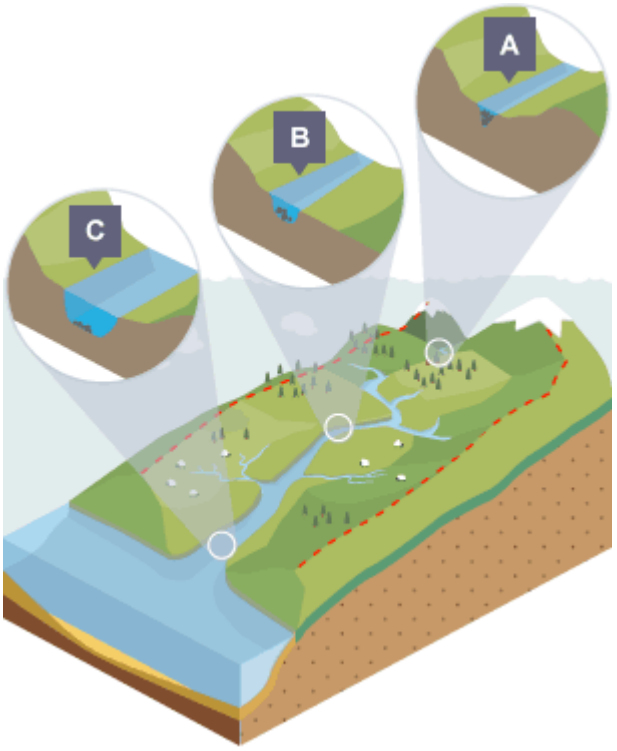
# Rivers

Every 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:

**A: Upper Course** - The river starts as many **tributaries**, which are **narrow and v-shaped**. Each tributary doesn't carry a lot of water (so there is not a lot of energy in the channel), but combined the tributaries all fill up the river channel further down. The tributaries tend to flow through steep sided **valleys**.

**B: Middle Course** - The tributaries merge together to form a channel, which is **rounder** and **deeper** to let more water flow through it. The more water that passes by, the more energy there is to erode and widen the channel. The area around the river channel is **flat and low-lying**, which is the **floodplain** if the river needs to flood.

**C: 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 of sediment 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. The most deposition occurs in the **lower course** of the river.




Source: BBC Bitesize

The **speed** of the water depends on which course of the river it is travelling through. **Friction** occurs between the water and the riverbed which slows the water down.

- 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 channel is **wider and deeper** due to the increased erosion from faster flowing, high energy water.

# How UK Weather and Climate Affects Rivers

The **weather and climate of the UK** have significant impacts on river **processes** that are typical in the UK.

The weather and climate also creates distinct **landforms and landscapes** that can be seen throughout the UK.

**What's the difference between climate and weather?**

When we talk about the **weather** of a place, we are usually referring to the **daily conditions** that a place experiences, such as the **temperature**, how **windy it is**, **how much cloud cover** there is/ how **sunny** it is, and if there's any **precipitation** (rain, snow, hail etc.).

On the other hand, the **climate** is a **long-term trend** in temperature, humidity etc. (usually calculated over a 30 year period or longer).

## Impact of Climate

The quantity of **rainfall** can significantly influence river **processes** and **landscapes**:

- In areas of **high rainfall** in the UK, rivers have **higher discharge** in the channels, leading to higher **rates of erosion**.
- This leads to increased **vertical erosion** in the upper course, forming **V-shaped valleys**.
- This also leads to increased **lateral erosion** in the lower course, forming **flood plains**.
- **Transportation** also increases with increased discharge as the **capacity** of the river to transport material increases.
- Areas with higher quantities of rainfall tend to experience greater **chemical weathering** as the rocks along the river valley become exposed to higher volumes of slightly acidic rain, this could make river valleys **steeper** and prone to **mass movements**.

The **temperature** in certain areas of the UK can influence river processes and landscapes:

- When temperatures fall below 0°C in the winter, there is greater **free-thaw weathering** (mechanical weathering).
- This means lots of sediments that have been eroded fall into the river, influencing **erosion and deposition**.

Snowdonia in winter (Source: www.oddizzi.com).

- As temperatures rise in the summer, **chemical weathering** becomes more prominent as the higher temperatures provide optimum conditions for **chemical reactions** to occur.
- Increased weathering makes mass movements more likely and results in steeper valleys.

## Impact of Short-term Weather Events

### Storms

- Storms bring significant quantities of **rainfall** to UK river landscapes.
- The rainwater **saturates** the sediment of the valley making it vulnerable to **mass movements** through sliding and slumping actions.
- As the ground surrounding the river is saturated, **surface run-off** becomes more rapid, resulting in **increased volume and discharge** of the river.
- This means **erosion** and **transportation** of weathered material increases.
- Increased river flow and therefore erosion can lead to the formation of **ox-bow lakes** as the flow breaks through a meander neck (see next section for details).
- **Levees** can be formed when storms cause flooding in the lower course (see next section for details).

*A house falls into a river by the River Ehen in Cumbria after heavy rain triggered mass movement.*

### Drought

- Droughts can occur when there is a lack of either precipitation, this results in **less runoff** and therefore a reduction in the river's discharge and volume.
- **Erosion and transportation rates decrease** as a result.
- Smaller streams may **dry up**.
- **Mass movement is less likely** in drought conditions as the sediment is not saturated with water. However, heavy rain following a period of **drought** can cause **flash flooding** as the ground can become hard and impermeable.

# River Landforms

Different landforms are found in 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 Valleys*

- **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 Lakes, River Estuaries*

It's important to be able to identify these features, as well as talk about where they are typically found along the river and how they are formed!

## Erosional Landforms

### Interlocking Spurs

Interlocking spurs look like lots of hills **overlapping** each other in a valley.

They are found in the **upper course** of the river where the water doesn't have a lot of energy, so the water cannot erode **resistant, hard rocks** that make up the valley sides. 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)

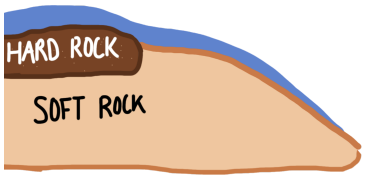
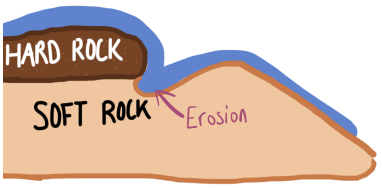
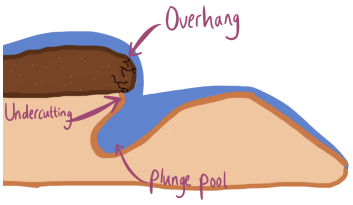
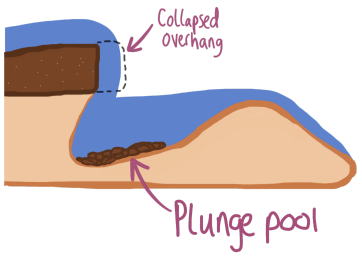
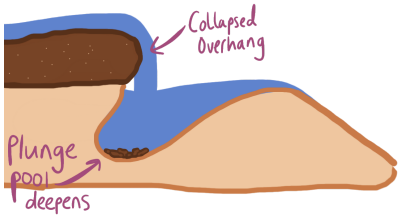
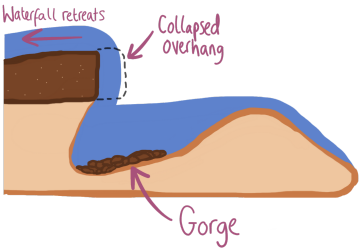
(Source:https://api.gurushots.com/photo/8b88b73bd1389d83f76e79f945115c04)

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.

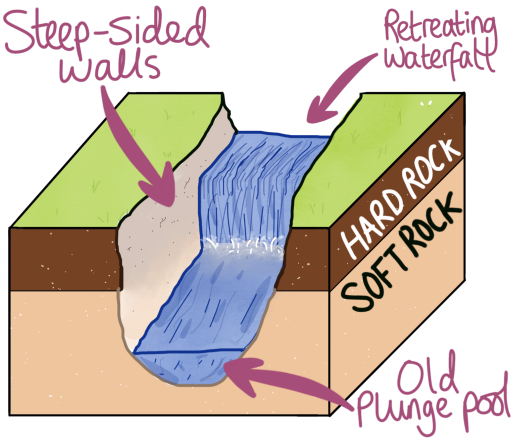
## Waterfalls

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.




(Source: www.zambiatourism.com)

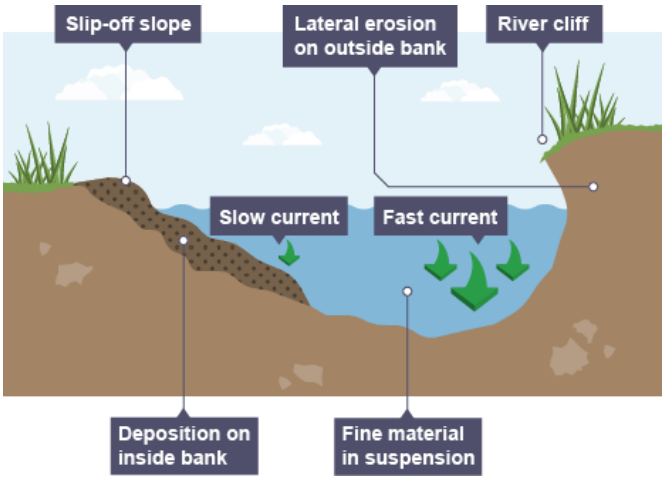
To the left is an aerial view of **Victoria Falls** which is located on the **border of Zambia and Zimbabwe**.

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.

## River Cliffs

**River cliffs** form when rivers flow around a bend and the water is pushed to the **outside** of the bend. This causes the flow to increase in speed leading to increased **lateral erosion**. This results in the **undercutting** of the river bank, forming a river cliff.




(Source:www.bbc.co.uk/bitesize/guides/zpxc7hv/revision/2)

# 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** is the dominant process in the lower course. These distinct landscapes shaped by depositional landforms can be seen 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 pictures below show a farm in West Yeo near Moorland in Somerset. You can see that the fields and farm are built on a floodplain.

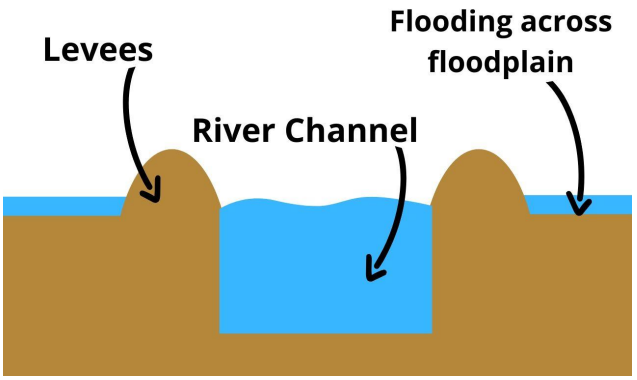
*An aerial view of the farm. You can see the flat, fertile land which is distinctive of a floodplain.*

*The same farm after a period of flooding. Floodplains will typically flood when river levels are high, which deposits more material onto the plain and builds it up.*

(Source: 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 River Nith estuary*.
(Source: britishseafishing.co.uk/fishing-tactics/estuary-fishing/)

## Point Bar

A point bar is a mound of deposited material found in a river bend.

Alluvium is deposited on the **inside bend of a river below the slip-off slope** and accumulates over time to form a point bar. They are commonly found on the inside of a bend in a meandering river or stream.

(Source:geography-revision.co.uk)

# Landforms Due to Erosion and Deposition Combined

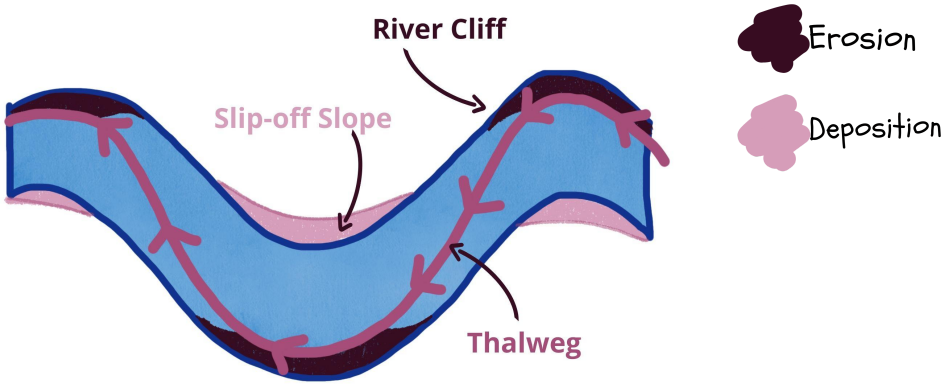
River landforms can be created by a **combination** of erosion and deposition. These landforms change the shape of the river and are easily identifiable from above.

## 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 outside 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.




In the picture to the right 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 cliffs.

**Can you draw where the thalweg will be using the diagram to help you?**

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

## Ox-Bow Lake

Like 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.

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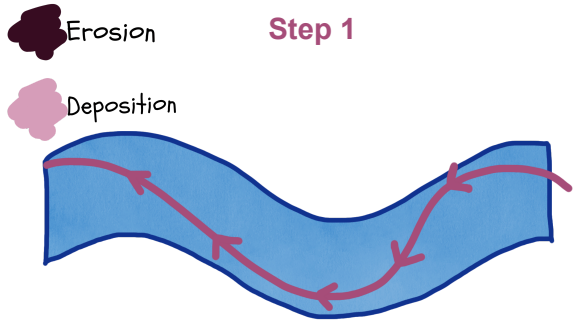
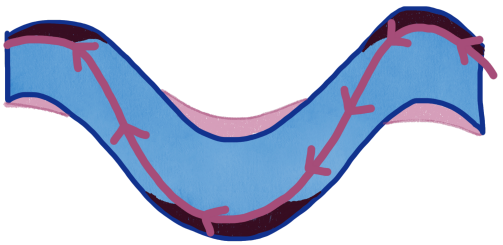
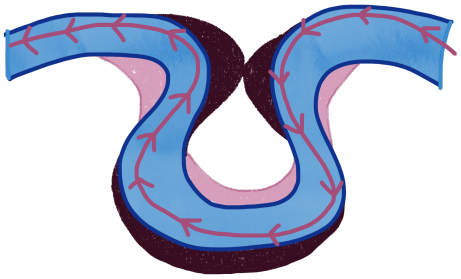
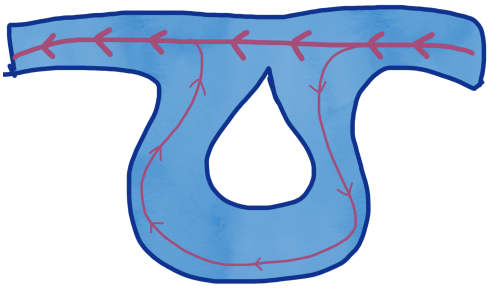
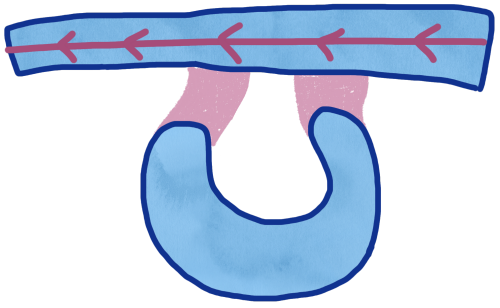
<tr><td> 

Step 1</td><td>Step 2<br>  </td></tr>
<tr><td>In the beginning, the river has meanders that form depending on the speed of the water.</td><td>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.</td></tr>
<tr><td>  </td><td>  </td></tr>
<tr><td>Gradually, erosion bends the river so that the meanders travel towards each other.</td><td>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.</td></tr>
<tr><td colspan="2">  </td></tr>
<tr><td colspan="2">The old meander becomes separated from the main river as material gets deposited at the top, creating the separate ox-bow lake.</td></tr>
</table>

# Impacts of Human Activity on River Processes and Landscapes

## Urbanisation

- Urbanisation in river landscapes (including flood plains) mean that **surfaces surrounding the river are now impermeable** as they are composed of concrete and tarmac.
- This **increases surface runoff**, resulting in **increased river discharge**.
- The increased river discharge also results in **increased erosion, transportation and even flood risk** due to the increased volume of the river.

*Boscastle, a town located on a river*

(Source: https://www.nationaltrust.org.uk/boscastle)

## Agriculture

- Water extracted from rivers for **irrigation** reduces river discharge, decreasing erosion and transportation. Deposition is more likely, resulting in landforms such as levees or point bars.
- **Deforestation** reduces interception and increases runoff, thus **increasing river discharge**.
- The lack of vegetation to hold together the soil makes **soil erosion** more likely as a result of rainfall. This could increase deposition if sediment is washed into the river.

(Source: environmentagency.blog.gov.uk)

## Industry

- Industrial development in river landscapes involves an increase in **impermeable surfaces**, resulting in increased surface **runoff**.
- Industrial development may also involve **dredging** in order for ships to access factories, this increases the river flow and therefore the erosion rate.


*Dredging in Somerset.*

(Source:environmentagency.blog.gov.uk)

# Flooding

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

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 the flood risk to a location:

| Human factors that increase the flood risk | Physical factors that increase the flood risk |
|---|---|
| **Urbanisation**<br><br>Increasing the amount of **impermeable surfaces** (concrete and 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)<br><br>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**<br><br>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**<br><br>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<br><br>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**<br><br>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. |

## Types of flooding

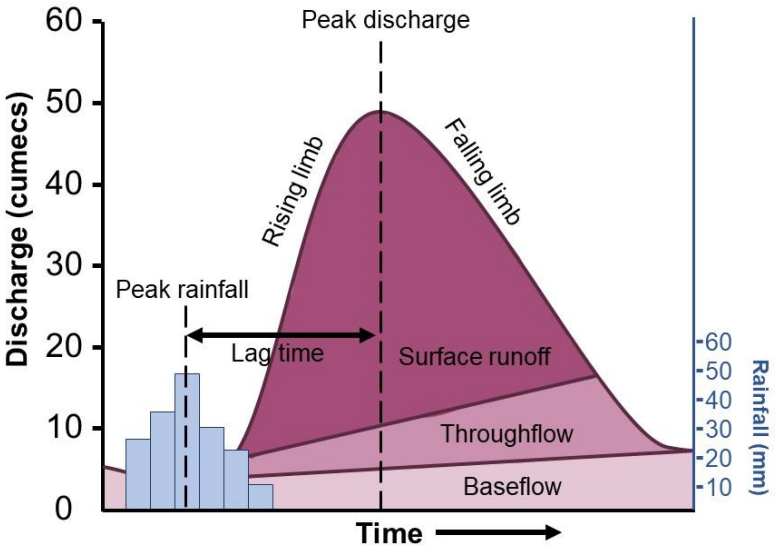
A flood can be described as either **flashy** or **subdued**. The description tends to depend on how quickly the water flows into the river. For example, a **flash flood** tends to be a flood with little warning, where a very large volume of water suddenly overwhelms the river. This can happen if a **large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

## Storm Hydrographs

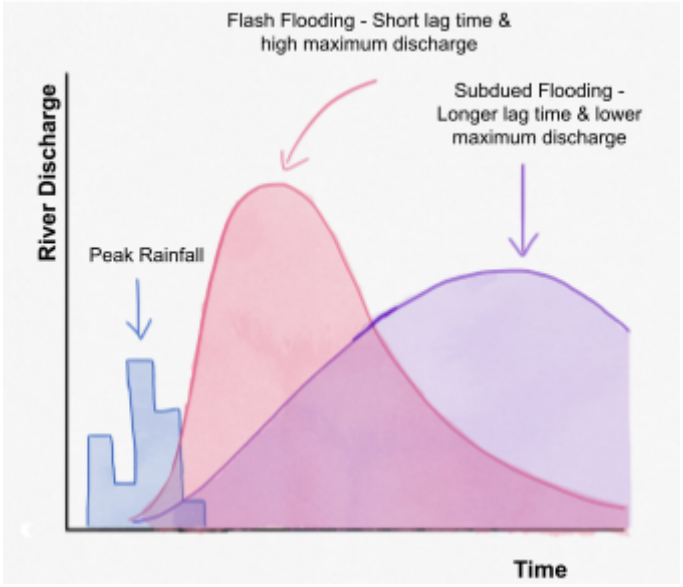
**Storm hydrographs** represent the variation in the river's **discharge** (the **volume of water** passing through the river channel at a specific point) within a short period.

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




*Flashy vs subdued flood hydrographs.*

# Management of Drainage Basins

**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 cause **threat to life**
- ➔ Destroy **crops**, or **livestock** 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 **communities** that live within the drainage basin.

## Choosing a Management Strategy

Flooding risk can be managed using **flood defences**. There are **hard engineering** and **soft engineering** strategies. each with their own benefits and costs. There are many factors to consider when choosing the most appropriate **management strategy**:

The **economic** value of the land:

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

The **cultural or social** value:

- o Is the river historic or a location of cultural/religious importance?
- o Do events or festivals happen here, and on what scale do they affect lives (locally, national, international events)?
- o Are the river's floodplains home to a village or town? Will these people need to migrate and live elsewhere if flooding continues?
- o Is there a risk to life during flooding?

The **environmental** value:

- o Are there any rare or endangered species living along the river banks or in the river?
- o Would nature reserves become at risk if flooding continues?
- o Are there any farms at risk? What would happen to the animals?

# 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.

## River Channel Restoration

Source: Sustainable City Network

Description: Concrete structures are replaced with natural sediment, meanders are rebuilt to slow down the water, banks are lowered so floodplains can flood naturally.

- 👍 More natural resources and concrete discouraged, which is heavily polluting to produce
- 👍 The natural environment benefits, as the ecology recovers
- 👎 Land will still flood, but often this is parks and football fields

## 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

## Flood Plain Zoning

Involves policies allowing only certain land uses on flood plain in order to minimise the risk of flooding to people and property

### Advantages

- Most expensive buildings are located further away from the river and are therefore at reduced risk from flooding
- Less claimed in insurance from flooding

### Disadvantages

- May be difficult to change existing land uses if there is already significant amounts of development or settlement

# 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 unappealing
- 👎 Villages can be flooded to create the reservoir and so people must move out of their homes

## Embankments and Flood Walls

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


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

## Channel Straightening and Flood Relief Channel

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

## Reservoirs

https://fwrinformationcentre.co.uk/html/lakes-and-reservoirs---overview.html

Description: An artificial lake formed behind a dam.

- 👍 Store water in periods of heavy rainfall which reduces flood risk
- 👍 Stored water can be used for drinking and to generate HEP
- 👎 Very expensive to build
- 👎 May flood existing farmland or habitats