



## River Landscapes in the UK

### Contents

- \* Changing River Shape
- \* Fluvial Landforms
- \* River Management

# alternativeSpecification links

The notes on this page cover part of 3.1.3.3 River landscapes in the UK on the [AQA GCSE specification](#).

**3.1.3.3** - Key idea: The shape of river valleys changes as rivers flow downstream.

- The long profile and changing cross profile of a river and its valley.
- Fluvial processes:
  - Erosion – hydraulic action, abrasion, attrition, solution, vertical and lateral erosion.
  - Transportation – traction, saltation, suspension and solution.
  - Deposition – why rivers deposit sediment.

## River long profile and cross profiles

### River characteristics

- All rivers have **long** and **cross profiles**
- Each river's long and cross profiles are unique but they do have some characteristics in common
- These profiles show changes in river characteristics from the source to the mouth

### Long profile

- The long profile of a river shows the changes in the river **gradient** from the source to the mouth
- Most long profiles have a **concave shape** with similar characteristics:
  - The source is usually in an **upland area**
  - The upper course of the river includes areas which are steep with uneven surfaces
  - In the middle course the gradient decreases
  - In the lower section the gradient decreases further until it becomes almost flat

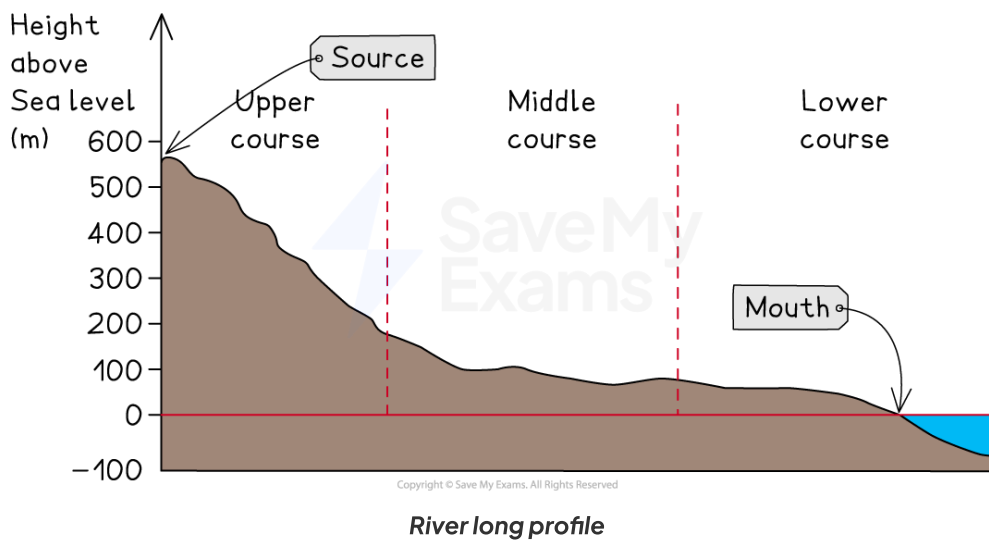
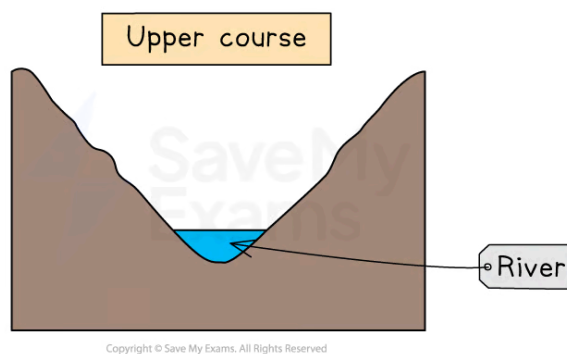


Diagram of a typical long profile

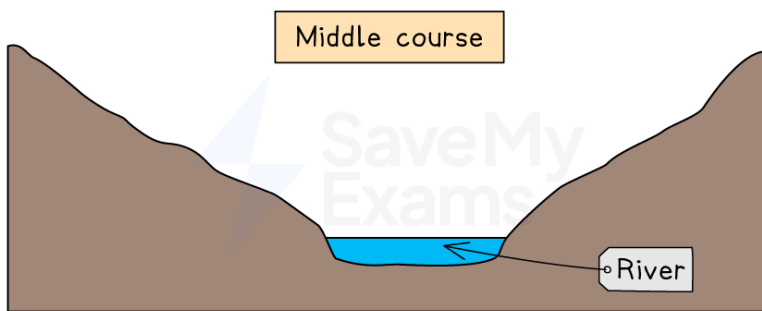
## Cross profiles

- The cross profiles of a river are **cross-sections** from one bank to another
- Cross profiles of the upper, middle and lower courses show the changes in the **river channel** and **valley**
- Upper course characteristics include:
  - **Shallow** channel
  - **Steep valley sides**
  - **Narrow** channel
  - Low **velocity**
  - **Large bedload**
  - Rough channel bed
  - High levels of friction
  - **Vertical erosion**



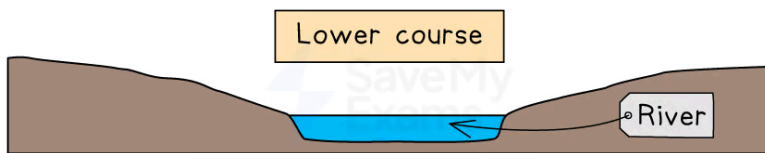
### **Upper course cross-section**

- Middle course characteristics:
  - **Deeper** than upper course channel
  - **Gentle valley sides**
  - **Wider** than upper course channel
  - **Greater velocity** than upper course channel
  - Material in river decreases in size
  - Smoother channel bed
  - **Lower levels of friction** than upper course channel
  - Lateral erosion



**Middle course cross-section**

- Lower course characteristics:
  - **Deeper** than middle course channel
  - **Flat floodplains**
  - **Wider** than middle course channel
  - **Greater velocity** than the middle course channel (apart from as the river enters the mouth)
  - Material carried mainly sediment and alluvium
  - **Smooth channel bed**
  - **Lowest friction**
  - **Deposition** is dominant



Copyright © Save My Exams. All Rights Reserved

**Lower course cross-section**



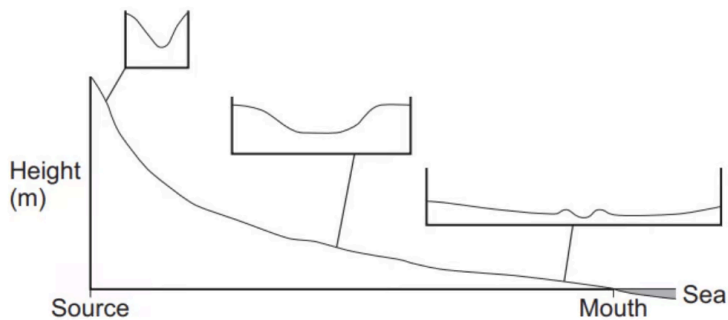
### Examiner Tips and Tricks

Remember, valley shape and river shape are not the same thing. If you are asked to describe a valley shape, you should focus on the gradient and shape of the land on either side of the river channel.



### Worked Example

Study Figure 1, a diagram showing the long and cross profiles of a typical river and its valley.



Describe how the cross profile of the river valley changes downstream.

[2 marks]

Valley slopes decrease in angle. [1 mark]

The valley widens/broadens. [1 mark]

### Marking guidance

- This answer does not need any explanation of why the cross profile changes.
- The question can either be answered as two separate points or as one point which is developed.

**Common errors**

- Descriptions of the river channel will be awarded no marks because the question refers to the river valley.

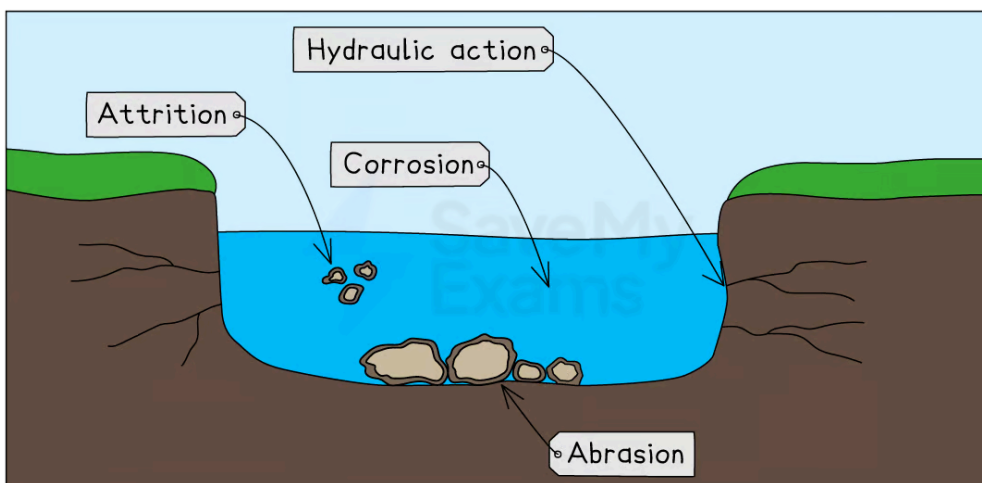
### Alternative content

The answer above is just one example of a response to this question. Other information that could be used in the answer includes:

- Valley sides decrease in height.
- The valley floor becomes wider.
- The valley widens and a narrow floodplain develops, eventually becoming a wide floodplain with levees/embankments.
- Near the source the valley is steep-sided but by the middle stage the valley floor is wider with gentler sides/bluffs.

## River erosional processes

- **Erosion** is the wearing away of surfaces
- There are four erosion processes which change the shape of the river channel:
  - **Hydraulic action**
  - **Abrasion**
  - **Attrition**
  - **Corrosion (solution)**



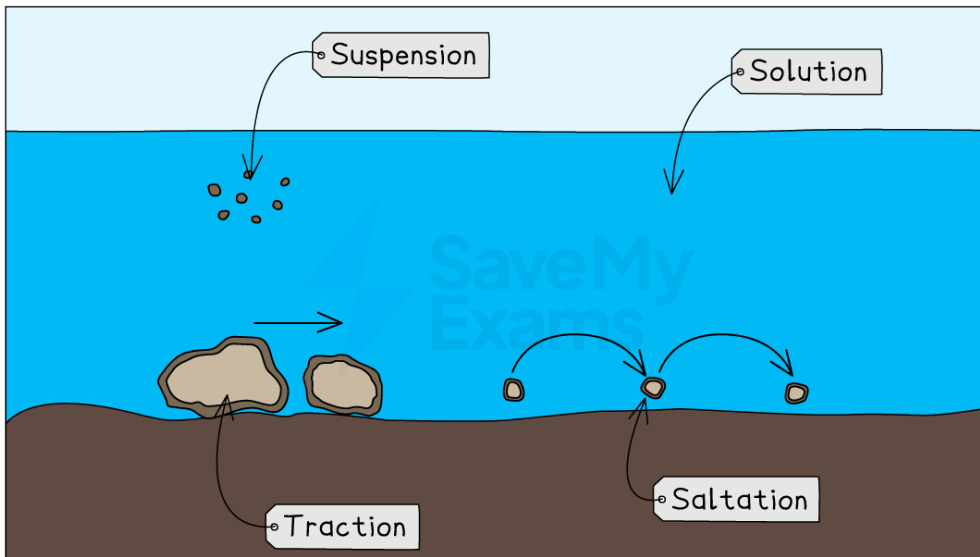
Copyright © Save My Exams. All Rights Reserved

**Processes of erosion**

- Erosion can be mainly vertical or lateral:
  - **Vertical erosion** is dominant in the upper course of rivers
    - It increases the **depth** of the river and valley, as the river **erodes downwards**
  - **Lateral erosion** is dominant in the middle and lower course of rivers
    - It increases the **width** of the river and valley as it **erodes sideways**

# River transportation

- There are four processes of transportation:
  - Traction
  - Saltation
  - Suspension
  - Solution



Copyright © Save My Exams. All Rights Reserved

**Transportation processes**



## Worked Example

Which of these is a process by which a river transports sediment?

[1 mark]

	A. Abrasion
	B. Traction
	C. Deposition
	D, Hydraulic action

**B is the correct answer [1 mark]**

The alternatives answers are incorrect because:

**A:** Abrasion is a form of erosion which occurs when bed load scrapes along the riverbed

**C:** Deposition is when material the river is transporting is dropped

**D:** Hydraulic power is a form of erosion which occurs due to the force of the water

## River deposition

- **Deposition** is when a river does not have enough energy to carry its material and it drops it
- The causes include:
  - Reduced discharge due to a lack of precipitation or **abstraction** upstream
  - Decreased **gradient**
  - Slower flow on the inside of a river bend or where the river is shallower
  - When the river enters a sea/ocean or lake, the gradient is more gentle and the river flow is affected by tides
- The heaviest material is deposited first; this is known as the **bedload**
- Larger rocks are only moved short distances before being deposited
  - This happens at times of high discharge and in the upper section of the river
- The lighter materials, gravel, sand and silt, are known as **alluvium** and they are carried further downstream
- The dissolved materials are carried out to sea

# Specification links

The notes on this page cover part of 3.1.3.3 River landscapes in the UK on the [AQA GCSE specification](#).

**3.1.3.3** - Key idea: Distinctive fluvial landforms result from different physical processes.

- Characteristics and formation of landforms resulting from erosion – interlocking spurs, waterfalls and gorges.
- Characteristics and formation of landforms resulting from erosion and deposition – meanders and oxbow lakes.
- Characteristics and formation of landforms resulting from deposition – levées, flood plains and estuaries.
- An example of a river valley in the UK to identify its major landforms of erosion and deposition.

## Erosion Landforms

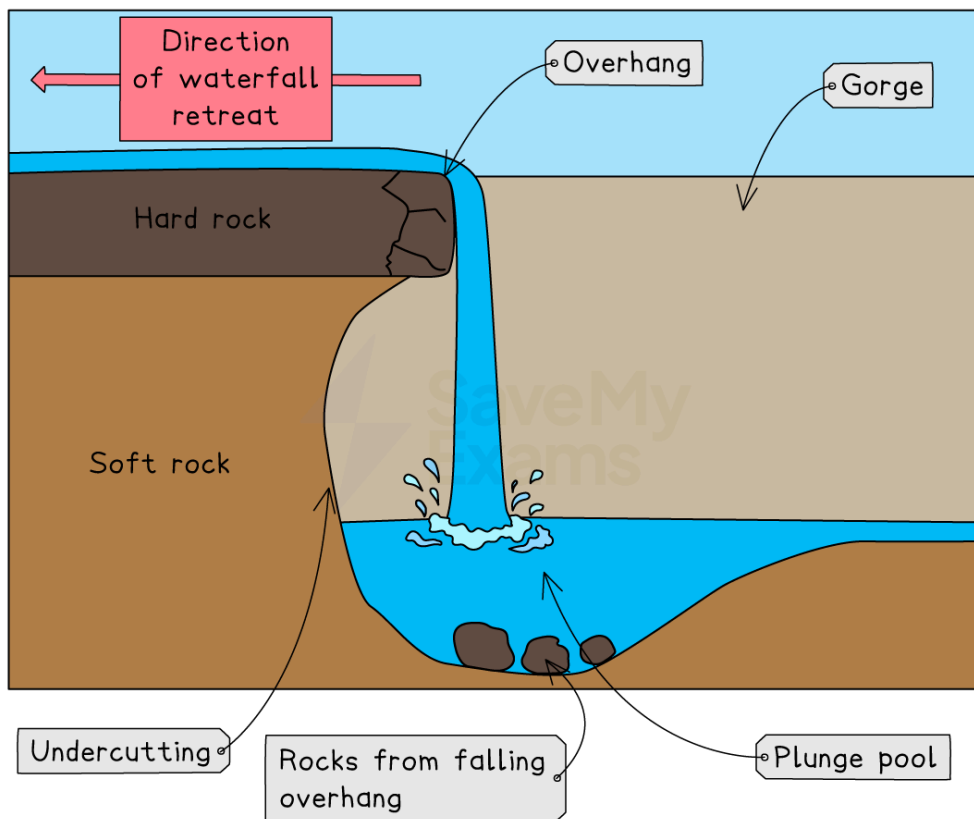
### River landscape characteristics

- The changes in river channel characteristics, lead to changes in the river landscape
- The upland and lowland areas of rivers have distinctive landforms
- Upland:
  - Waterfalls
  - Gorges
  - V-shaped valleys
  - Interlocking spurs
- These are landforms created through [erosion](#)

### Waterfalls and gorges

- Waterfalls form where there is a drop in the riverbed from one level to another
  - This drop is often due to changes in the hardness of the rock, where hard rock overlies soft rock
- [Hydraulic action](#) and **abrasion** are the main erosional processes:
  - The soft rock erodes more quickly, **undercutting** the hard rock and creating a **plunge pool**
  - This leads to the development of an **overhang** of hard rock which eventually, over time, collapses

- The overhang falls into the plunge pool **increasing abrasion** and making the plunge pool deeper
- The process then begins again and the waterfall retreats upstream leaving a **steep-sided gorge**

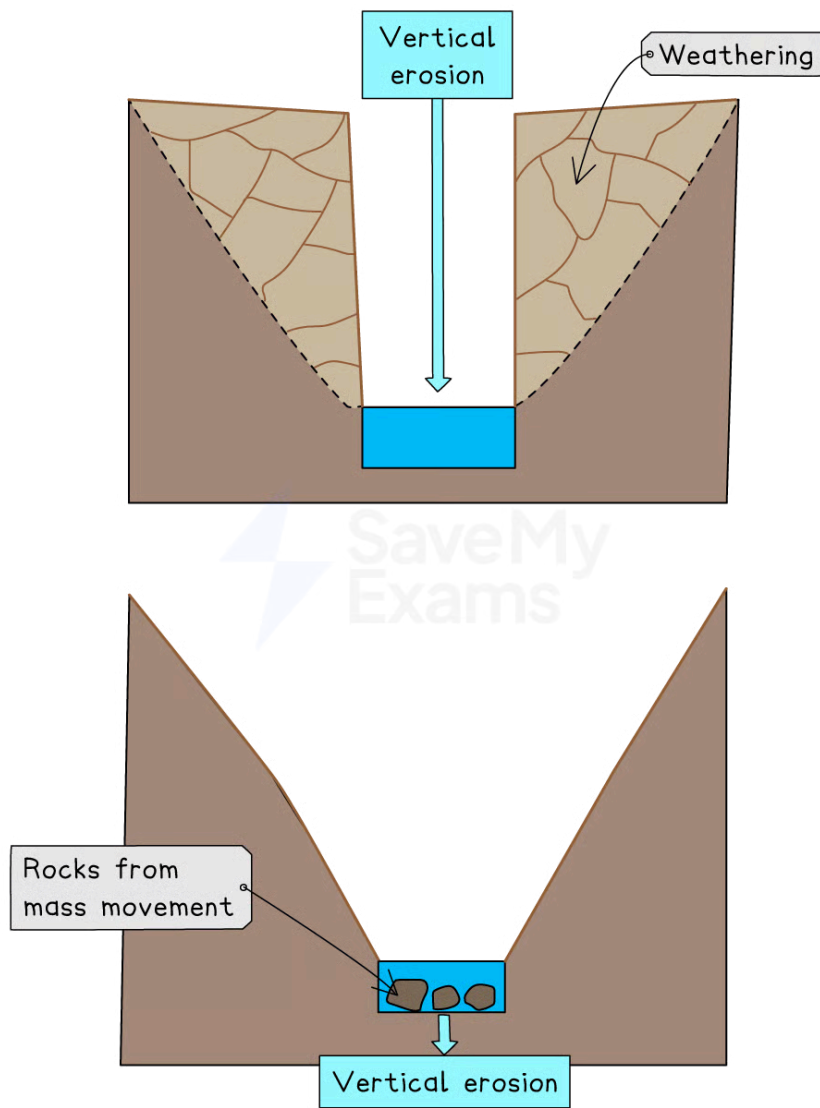


Copyright © Save My Exams. All Rights Reserved

**Waterfall formation**

## V-shaped valleys

- **Vertical erosion** is dominant in the upper course of the river
- This cuts down into the riverbed and deepens the river channel
- **Weathering** and **mass movement** leads to material from the valley sides collapsing into the river, forming a steep v-shaped valley

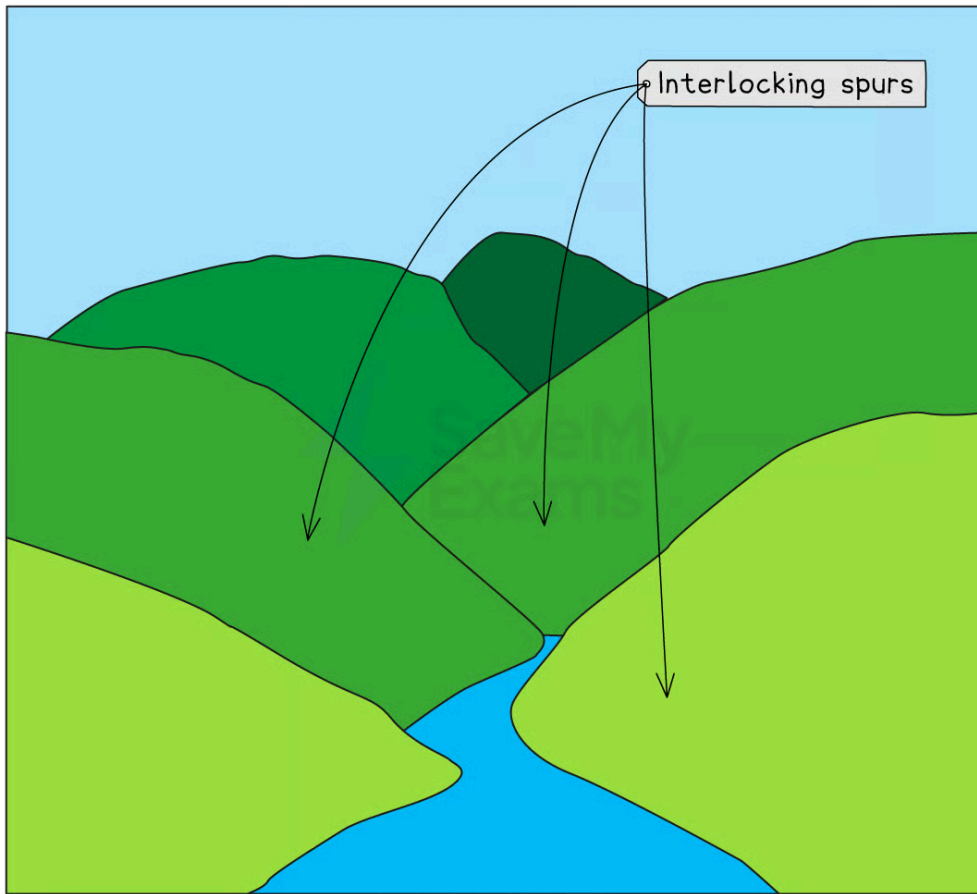


Copyright © Save My Exams. All Rights Reserved

**Formation of a v-shaped valley**

## Interlocking spurs

- In the upper course of the river, the channel starts to meander
- Erosion happens on the outside of the bend
- In the upland areas this forms interlocking spurs



Copyright © Save My Exams. All Rights Reserved

*Interlocking spurs*



### Worked Example

Study Figure 1, a photograph showing some features of a river in the Lake District



Explain how the landforms shown in Figure 1 are created by physical processes

[6 marks]

Answer:

Waterfalls and gorges such as the one shown in Figure 18 are often formed where a river flows over hard rock that lies over an area of softer rock. **[U]** In Figure 18, the soft rock is eroded more rapidly than the hard rock due to the sheer force of the water hitting the rocks through hydraulic action and also by rocks scraping the banks and bed due to abrasion. **[Ap]** This leads to undercutting of the hard rock, which forms an overhang. **[U]** Eventually, because the overhang is unsupported, it breaks up and falls into the plunge pool, which forms at the bottom of the waterfall. **[U]** The material increases the amount of abrasion and deepens the plunge pool. **[U]** This process is repeated again and again, meaning that the waterfall retreats upstream, leaving behind the steep-sided gorge as shown in Figure 18. **[Ap]**

## Marking guidance

- This is a 'Level of response' answer.
  - Each point made in the answer does not equal a mark.

The command is 'explain your answer', which means the answer needs to

### Mark allocation

- 3 marks for understanding **[U]**
- 3 marks for application **[Ap]**

### Common errors

The following errors mean that answers cannot achieve a Level 3 (top marks):

- Identification of only one landform (maximum 4 marks, Level 2). The question asks for an explanation of 'landforms'.
- References to landforms, such as interlocking spurs, not shown in the photograph, receive no credit.

### Alternative content

The answer above is just one example of a response to this question. Other information which could be used in the answer includes:

- Formation of rapids.



### Examiner Tips and Tricks

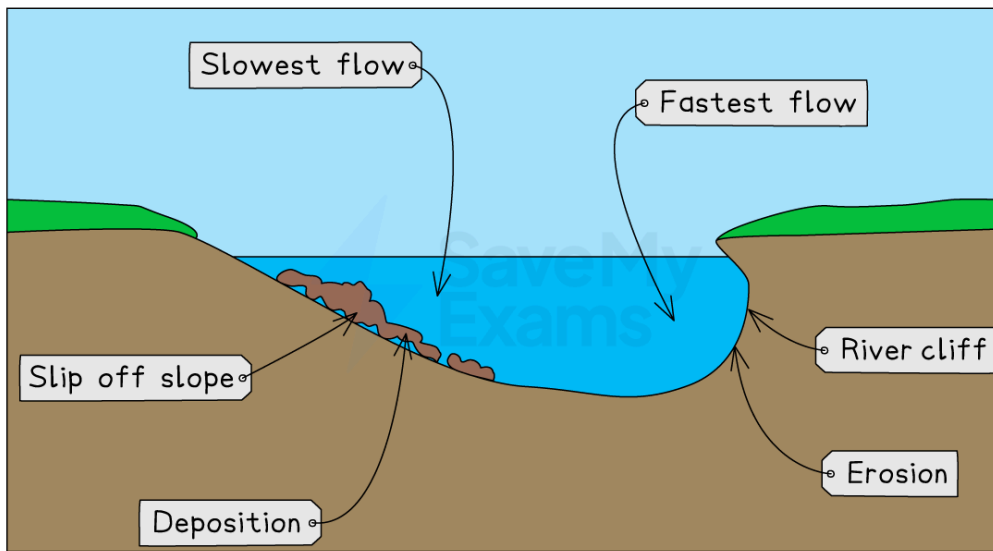
Reading the question carefully is essential. It is very easy to misread it and assume the question only requires an explanation of one landform when it needs you to write about at least two landforms.

## Landforms of erosion and deposition

- Some landforms are created through a combination of erosion and deposition, including:
  - Meanders
  - Ox-bow lakes

### Meanders

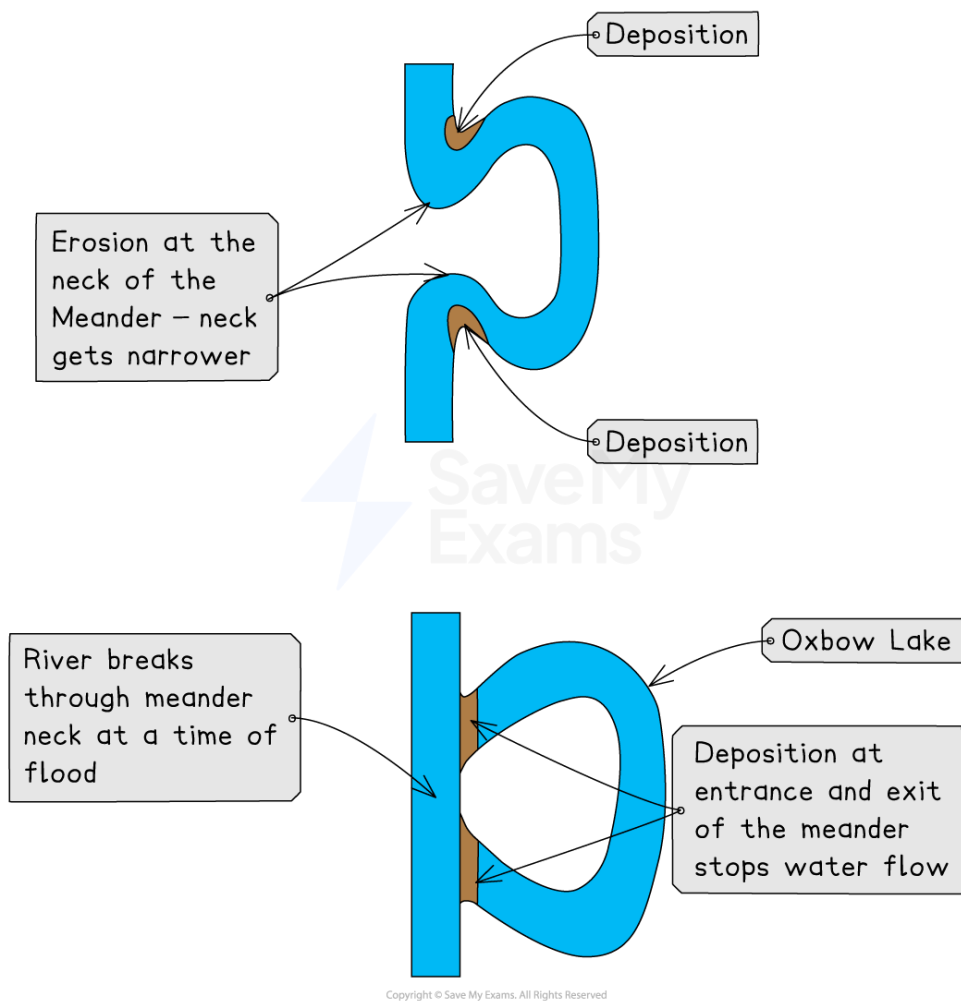
- In lowland areas **lateral erosion** is dominant
- Meanders increase in size
- The fastest water flow (**thalweg**) is on the outside of the river bends, leading to erosion:
  - The erosion undercuts the riverbank forming a **river cliff**
  - The riverbank collapses and the edge of the meander moves further out
- The slowest flow is on the inside of the river bends, leading to **deposition**:
  - The deposits form a **slip-off slope**
- Deposition on one side and erosion on the other leads to the meander **migrating** across the valley



*Cross-section of a meander*

## Oxbow lakes

- With distance downstream the size of the meanders increase
- The erosion on outside bends can eventually lead to the formation of a meander neck
- At a time of the flood, the river may cut through the neck of the meander, forming a straighter course for the water
- The flow of water at entry and exit from the meander will be slower, leading to **deposition**
- The meander becomes cut off from the main river channel, forming an **oxbow lake**



**Oxbow lake formation**



### Examiner Tips and Tricks

Remember, when describing the formation of oxbow lakes, it is important to state that the river will break through the neck of the meander during a flood. At other times the river does not have enough power to break through.



### Worked Example

Explain the formation of an oxbow lake.

[4 marks]

Answer:

A meander is a winding curve [K] in a river where water flows fastest on the outer bend of the river [K] where there is less friction, leading to erosion forming a river cliff [U]. The flow on the inside of the bend is slower, leading to deposition forming a slip-off slope. [U] The neck of the meander narrows and then during flood conditions, the river breaks through, with the river taking the shortest route. [K] Deposition then occurs at the edges of the new straight section and cuts off the old meander, forming an oxbow lake. [U]

## Marking guidance

- This is a 'level of response' answer.
  - Each point made in the answer does not equal a mark.
- The command word is 'explain', which means the answer needs to outline how and why physical and human factors increase the risk of flooding.

### Mark allocation

- 3 marks for knowledge [K]
- 3 marks for understanding [U]

### Common errors

The following errors mean that answers cannot achieve a Level 2 (top marks):

- Not correctly outlining the sequence.
- No reference to the processes.



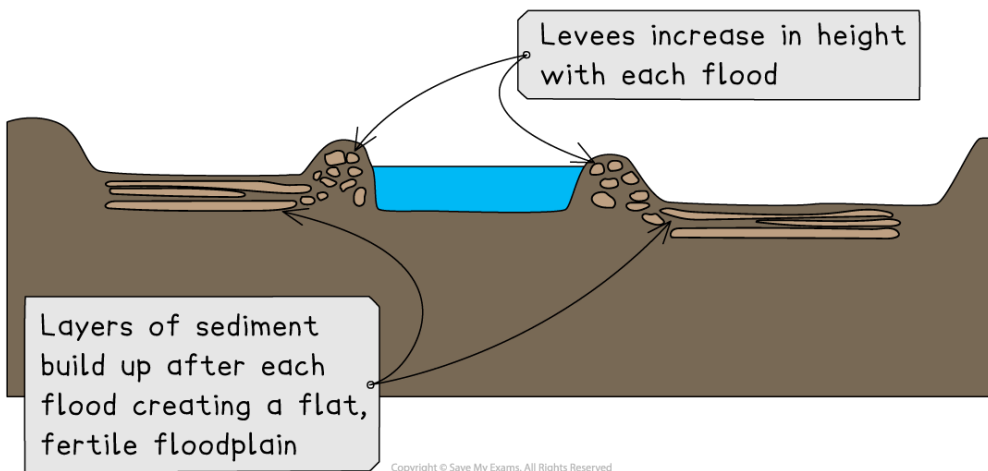
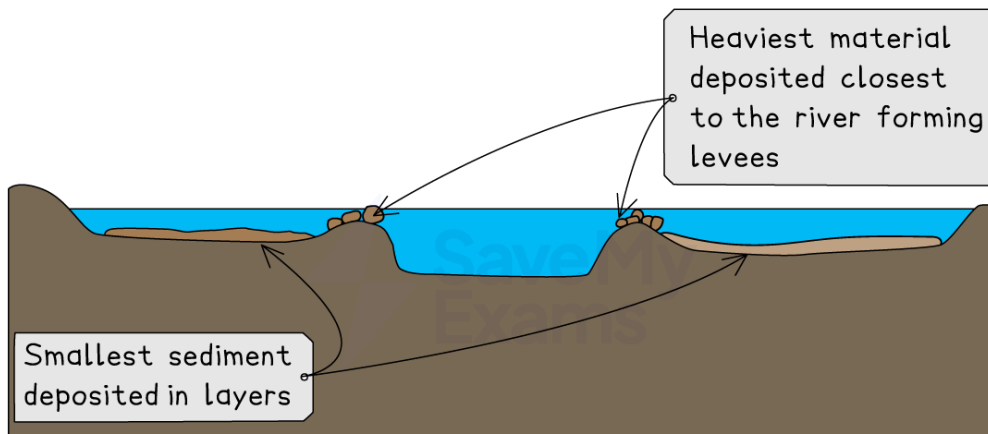
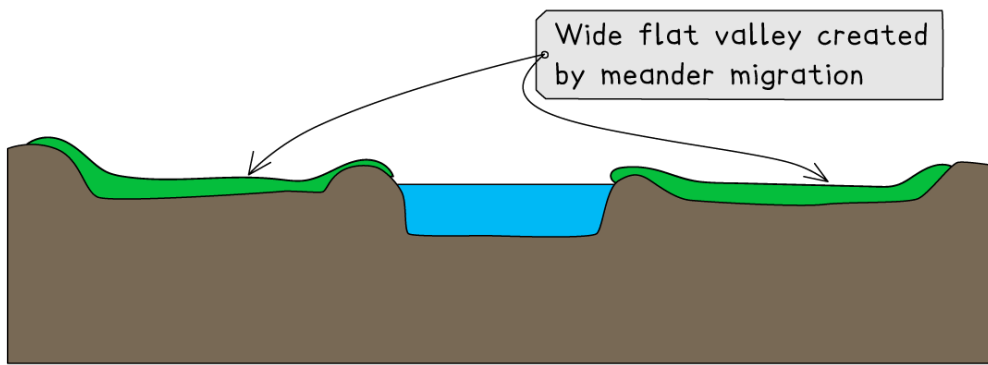
### Examiner Tips and Tricks

It is important when describing the formation of landforms that you correctly outline the sequence. To revise this, try writing it out as a flowchart or numbered steps. Putting the information into a different format will help you remember it.

# Depositional landforms

## Floodplains and levees

- **Floodplains** are flat expanses of land on either side of the river
- The migration of meanders leads to the formation of the floodplain
- High discharge may cause the river to overflow the banks
- More of the water is in contact with the land surface as the water spreads across the floodplain
- Increased friction reduces velocity and material is deposited across the floodplain gradually increasing the floodplain height
- The heaviest material is deposited first nearest to the river channel, forming natural embankments called **levees**



**Levee and floodplain formation**

## Estuaries

- An estuary is where the **river meets the sea**
- Large deposits of sediment form **mudflats** and **salt marshes**
- These are the result of the interaction between the river and tides
  - **Incoming tides** bring in sediment which mixes with the sediment being carried by the river

- When the incoming tide of saltwater meets the freshwater of the river, the **river velocity decreases** and **deposition** occurs
- The deposited sediment builds up in layers to form mudflats which rise above the water surface, particularly at low tide
- Eventually the vegetation starts to grow on the mudflats and form salt marshes



### Worked Example

Explain how river levées are formed.

[4 marks]

Answer:

Levées are found in the lower course of the river and are long, raised embankments adjacent to the river. **[K]** When the river floods, friction reduces the velocity and leads to deposition. **[U]** The largest material is deposited first and the finer material further away. **[K]** After many floods, the larger sediment builds up to form embankments which are higher than the surrounding floodplain. **[U]**

### Marking guidance

- This is a 'Level of response' answer.
  - Each point made in the answer does not equal a mark.

The command word is 'explain', which means the answer needs to outline how and why levées form.

#### Mark allocation

- 2 marks for knowledge **[K]**
- 2 marks for understanding **[U]**

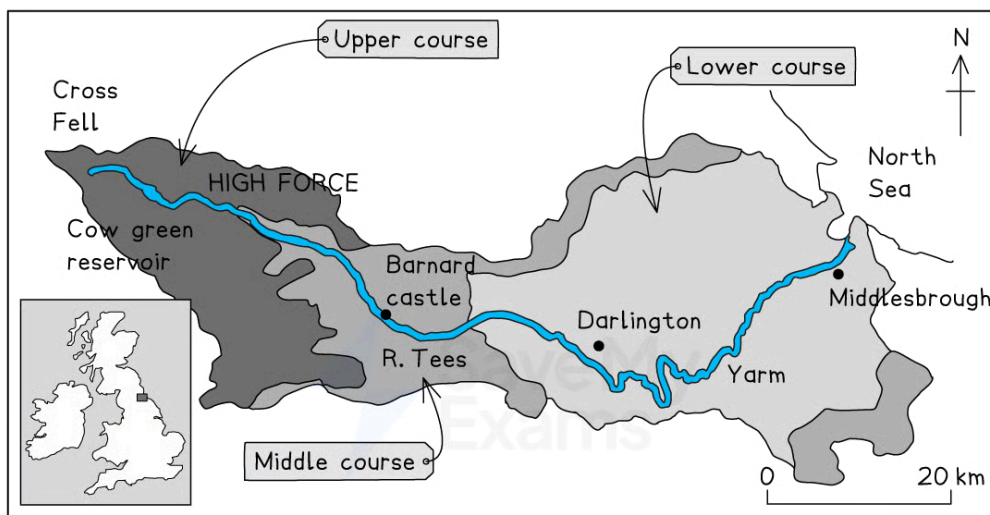


### Examiner Tips and Tricks

In revision, many students focus on the formation of waterfalls and meanders/oxbow lakes. It is important to revise landforms from all sections of the river course, including levées and floodplains.

## Case study: River Tees

- The River Tees is located in north-east England
- It is 85 miles from source to mouth
- It flows eastwards from the source in the Pennines to the mouth, where it flows into the North Sea



**Key:**  
Height (metres)

■	301+
■	61-300
■	0-60

Copyright © Save My Exams. All Rights Reserved

**Map of the River Tees drainage basin**

## Landforms of erosion

- High Force waterfall is the highest waterfall in England
- High Force formed where **dolerite**, a **hard igneous** rock (known locally as '**whinstone**'), lies over a **softer sedimentary** rock, **limestone**
  - The water erodes the limestone more quickly, **undercutting** the hard dolerite
  - Eventually the dolerite falls because it is **unsupported** and the process starts again
- The retreat of the waterfall upstream as a result of this process has left behind a **steep-sided gorge**

## Landforms of erosion and deposition

- In the middle and lower sections of the River Tees the river flows over flat, low-lying land
- **Meanders** form, such as in the area to the south-east of Darlington

## Landforms of deposition

- In the middle and lower sections **floodplains** and **levées** also form as a result of repeated flooding of the areas

# Specification links

The notes on this page cover part of 3.1.3.3 River landscapes in the UK on the [AQA GCSE specification](#).

**3.1.3.3** - Key idea: Different management strategies can be used to protect river landscapes from the effect of flooding.

- How physical and human factors affect the flood risk – precipitation, geology, relief and land use.
- The use of hydrographs to show the relationship between precipitation and discharge.
- The costs and benefits of the following management strategies:
  - Hard engineering – dams and reservoirs, straightening, embankments, flood relief channels
  - Soft engineering – flood warnings and preparation, flood plain zoning, planting trees and river restoration.
- An example of a flood management scheme in the UK to show:
  - Why the scheme was required.
  - The management strategy.
  - The social, economic and environmental issues.

## Factors affecting flood risk

- Flooding occurs when the **capacity** of the river channel is exceeded
  - The water flows over the banks and onto the surrounding area
- Flooding is usually the result of **heavy** or **prolonged rainfall**
- The key factor is the time taken for the precipitation to reach the river from where it falls: the **lag time**
- The shorter the lag time, the higher the risk of flooding because the **discharge** of the river rises more quickly
- The lag time depends on some human and physical factors
- These lead to increased overland flow which shortens the lag time

## Human factors which increase flood risk

- **Deforestation**
  - Lack of trees reduces interception and infiltration, increasing overland flow
- **Urbanisation**

- Impermeable concrete and tarmac increase overland flow

Water flows into the drains reaching the river rapidly

- **Agriculture**

- Bare soil and ploughing increase overland flow, especially where ploughing is downslope

- **Climate change**

- Rising global temperatures may increase storm frequency and intensity

## Physical factors which increase flood risk

- **Relief**

- Steep slopes reduce infiltration and increase overland flow

- **Rock type**

- Impermeable rocks reduce percolation and increase overland flow

- **Soil**

- Frozen, saturated or compacted soil reduces infiltration and increases overland flow
- Some soil types, such as clay reduce infiltration and increase overland flow

- **Weather**

- Heavy or **prolonged rainfall** means that the rate at which water reaches the surface exceeds the infiltration rate, leading to **increased overland flow**
- After a period of snow rising temperatures can cause rapid melting which increases overland flow

- **Seasonal variations**

- Flooding in Northern Europe tend to occur in the **autumn** and **winter** when rainfall is more frequent
- In areas affected by **monsoon** much of the annual rainfall occurs in a few weeks **saturating the ground** and increasing overland flow
- Higher temperatures in spring leads to **snowmelt** in mountainous areas, increasing overland flow

- **Drainage density**

- Where drainage density is high there are many **tributaries** taking water to the main channel causing a rapid increase in discharge

- **Vegetation**

- Where there is little natural vegetation, there is reduced interception leading to increased overland flow





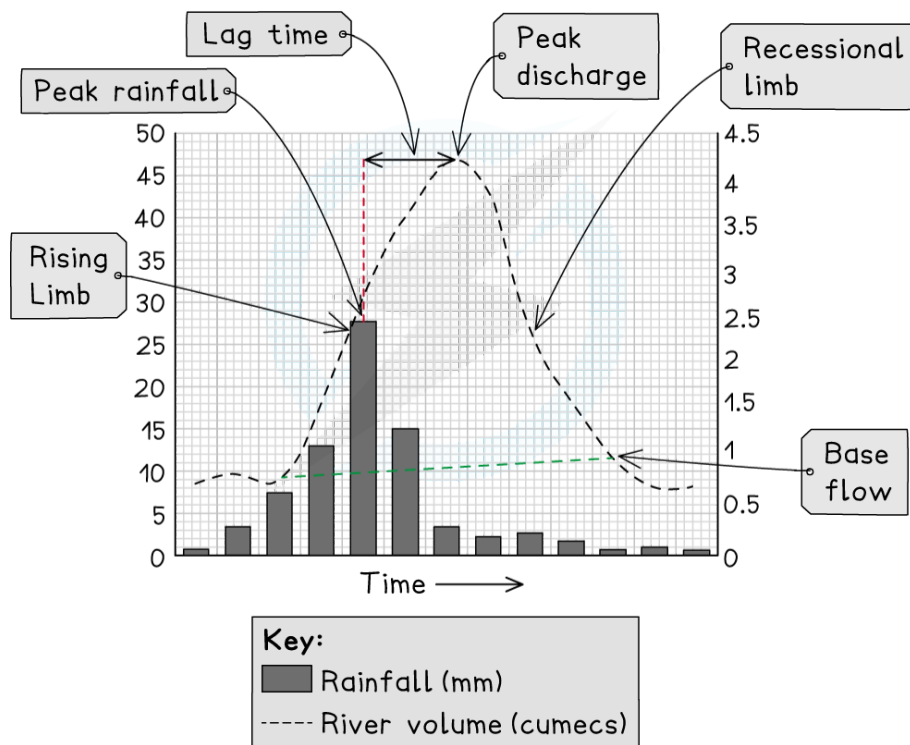
### Examiner Tips and Tricks

In the exam, you may be asked to explain the causes of flooding. Remember this means that you need to make connections between factors such as deforestation and the increased flood risk. Rather than simply stating that deforestation increases flood risk, you need to explain the reasons: Decreased interception and infiltration, leading to increased overland flow and shorter lag time.

## Hydrographs

### Flood prediction

- Prediction of flooding means that steps can be taken to manage flooding
- Hydrographs can be used to understand the risk of flooding because they show the changes in discharge which result from a rainfall event
- A flood **hydrograph** shows the changes in river discharge after a storm event
- The graph shows a short period of time, usually 24 hours
- The flood hydrograph has a number of features:
  - **Base flow**
  - **Peak rainfall**
  - **Rising limb**
  - **Peak discharge**
  - **Lag time**
  - **Recessional limb** or falling limb



*Flood hydrograph in an urban area*

## Increased flood risk

- Factors which **increase surface runoff** or overland flow lead to:
  - Short lag time
  - Steep rising limb
  - High discharge
- These factors include:
  - Steep slopes
  - Impermeable rocks
  - Deforestation
  - Urbanisation
  - Saturated or frozen soil
  - Heavy or prolonged rainfall
- As a result the river may not have the capacity to contain the water and so flood risk is higher

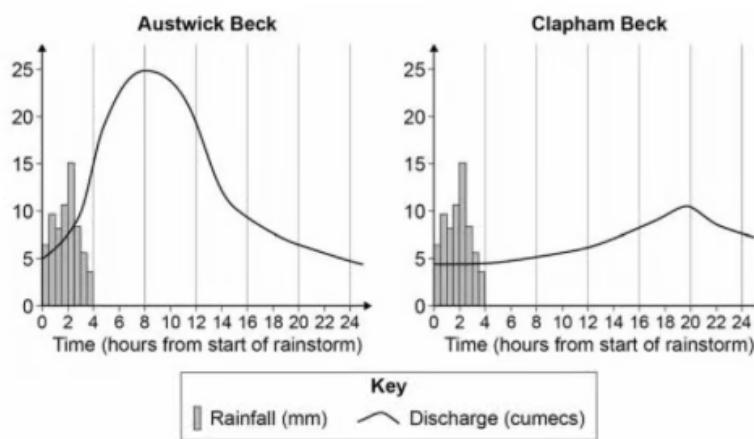
## Low flood risk

- Factors which cause **lower surface runoff** or overland lead to;
  - Longer lag time
  - Gentle rising limb
  - Lower discharge
- These factors include:
  - Gentle slopes
  - Permeable rocks
  - Lots of vegetation or afforestation
  - Rural areas
  - Deep, dry soils
  - Light rainfall
- As a result the river is more able to cope with the water entering the channel and the flood risk is lower



### Worked Example

Study Figure 1, flood hydrographs for two different streams after the same storm.



'Differences in the shape of flood hydrographs are caused by both human and physical factors.'

Do you agree?

Use Figure 1 and your own understanding to explain your answer

[6 marks]

Answer:

Yes, the shape of flood hydrographs is caused by both human and physical factors.

**[U]** In Figure 14, the two drainage basins experience the same levels of precipitation over a 4-hour period **[U]** but the shape of the hydrographs is very different. Stream A is a flashy river where there is a short lag time, steep rising limb, and high peak flow (from 5 to 25 cumecs). This could be due to the physical features of the drainage basin, such as steep slopes, or the result of impermeable rocks **[Ap]**, both of which would result in low/no infiltration and increased surface runoff. This means more water will reach the river, and it will do so more rapidly. **[Ap]** Equally, the shape could be the result of human activity such as urbanisation. **[U]** The covering of surfaces with tarmac and concrete, as well as the installation of artificial drainage, will lead the water to reach the river very quickly, reducing lag times and increasing discharge. **[Ap]** The amount of precipitation is the primary factor in the response of a river, but it is clear from streams A and B that other factors can make a significant difference and may be either human or physical. **[Ap]**

## Marking guidance

- This is a 'Level of response' answer.
  - Each point made in the answer does not equal a mark.

The command is 'explain your answer', which means the answer needs to support whether your decision was 'yes' or 'no' by explaining the causes.

The question refers to both physical and human factors. You can focus on one side of the argument, 'the shape is affected more by physical factors,' or you can take a more balanced approach, looking at the impact of both on the shape.

### Mark allocation

- 3 marks for understanding **[U]**
- 3 marks for application **[Ap]**

### Common errors

The following errors mean that answers cannot achieve a Level 3 (top marks):

- A lack of evaluation regarding what causes the differences in the hydrograph shapes.

### Alternative content

The answer above is just one example of a response to this question. Other information which could be used in the answer includes:

Human causes:

- Deforestation.
- Agriculture.

Physical causes:

- Precipitation.
- Vegetation.

## Hard engineering along rivers

- The main cause of the flooding is the amount and duration of precipitation: **This cannot be altered**
- There are a number of methods of managing floods and reducing the severity and/or impact
- The two main categories of flood management are **hard** and **soft engineering**:
  - Hard engineering involves building structures or changing the river channel
  - Soft engineering works with natural processes of the river and surrounding environment

## Hard engineering strategies

### Dams and reservoirs

- Controls the river flow by blocking the river and letting water in a controlled way
- This creates a reservoir behind the dam

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Multi-purpose can be used for energy production (HEP) and water storage as well as flood control</li> <li>▪ Provides opportunities for recreation: Water sports, fishing</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ Expensive</li> <li>▪ Loss of farmland and homes due to reservoir creation</li> <li>▪ Displacement of people</li> <li>▪ Affects on ecosystems: can affect fish breeding</li> <li>▪ Reservoirs silt up over time</li> </ul>

### Embankments and levées

- Embankments and levées artificially raise the banks of the river, increasing channel capacity

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Increased river capacity means it is less likely to flood</li> <li>▪ New river bank habitats may be created</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ unattractive,</li> </ul>

### Straightening channels

- Straightening the river channel by removing meanders

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Speeds up the movement of water over a short distance</li> <li>▪ Allows easy navigation for boats</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ May increase flood risk downstream as the discharge reaches those areas more quickly</li> <li>▪ Expensive</li> <li>▪ Affects river ecosystems due to changes in velocity</li> </ul>

## Flood relief channels

- Channels built to allow excess water to flow around high-value areas

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Effective in reducing the flood risk in high-value areas</li> <li>▪ New habitats may be created</li> <li>▪ Insurance costs may be reduced for people living nearby</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ Expensive</li> <li>▪ Regular maintenance is needed</li> <li>▪ Disruption to existing habitats</li> <li>▪ Can be visually unattractive</li> </ul>

## Soft engineering

### River restoration

- Restores the river to its natural state with meanders and wetland areas

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Increases the number of habitats</li> <li>▪ Restores wetland areas</li> <li>▪ Slows down water flow reducing flooding downstream</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ Expensive to construct the new channels</li> <li>▪ Some areas will flood</li> </ul>

### Floodplain zoning

- Restricts land use in areas that are at high risk of flooding and ensures high-value buildings are not in flood-prone areas

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Low cost</li> <li>▪ Conserves habitats on floodplains and wetlands</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ Restricts areas where houses can be built and may impact on economic development</li> <li>▪ Can only happen in places where development has not already happened</li> </ul>

## Afforestation

- Afforestation is the planting of trees to increase **interception** and **infiltration**
- Trees also use up large quantities of water

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Inexpensive</li> <li>▪ Absorbs and stores CO<sub>2</sub></li> <li>▪ Slows down water transfer, increasing lag time</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ Can increase acidity in the soil</li> <li>▪ Loss of farmland</li> </ul>

## Flood warnings

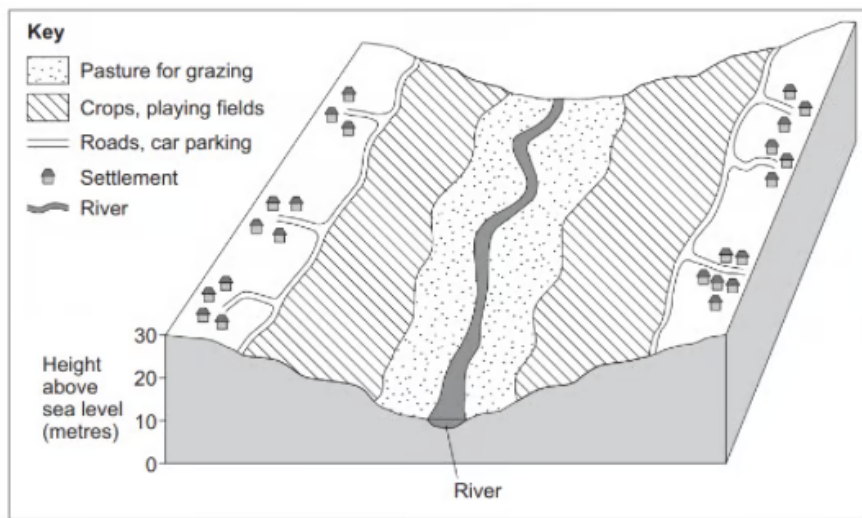
- Monitoring of rivers to provide people with warnings when flooding may occur

<b>Advantages</b>	<ul style="list-style-type: none"> <li>▪ Helps people to prepare and evacuate if needed</li> <li>▪ Less expensive than hard engineering</li> </ul>
<b>Disadvantages</b>	<ul style="list-style-type: none"> <li>▪ Expensive to set up monitoring equipment</li> <li>▪ People may not take warnings seriously</li> </ul>



### Worked Example

Study Figure 1, a diagram showing floodplain zoning.



Explain how soft engineering strategies can help reduce the impact of river flooding. Use Figure 1 and your own understanding.

[4 marks]

Answer:

Soft engineering strategies work with the natural processes along the river to reduce flooding risk, such as floodplain zoning shown in figure 17. **[U]** In the area closest to the river, the land is used for animal grazing, and houses and industry are built on the land furthest away from the river. **[Ap]** This is a low-cost strategy and does not impact river processes. **[U]** It reduces the chances of houses and industry being flooded and therefore the amount of damage. **[Ap]**

## Marking guidance

- This is a 'Level of response' answer.
  - Each point made in the answer does not equal a mark.

The command word is 'explain', which means the answer needs to outline how and why soft engineering reduces the impact of flooding.

### Mark allocation

- 2 marks for understanding **[U]**
- 2 marks for application **[Ap]**

### Common errors

The following errors mean that answers cannot achieve a Level 2 (top marks):

- Explaining hard engineering strategies rather than soft engineering strategies.
- No reference to Figure 17 (maximum 2 marks, level 1).

### Alternative content

The answer above is just one example of a response to this question. Other information that could be used in the answer includes:

- Planting trees.
- Reduction in discharge and flooding risk.
- New habitats.
- River restoration.
- Flood warnings.

## Case study: York

- York is a city located in the north of England
  - The city's population is just over 200,000
- It is located at the **confluence** of the **River Ouse** and the **River Foss**

## The need for flood management

- York regularly floods:
  - Serious flooding has occurred in 1947, 1978, 1991, 1995, 2000 and 2015
- The floods in 2000 were the worst on record
  - The Ouse rose **5.5 meters** above its normal level
  - Over **540 properties were flooded** and **320 were at serious risk**
  - Approximately, **18,700 hectares of farmland** were affected
  - The overall cost of the floods was estimated to be over £12 million, including lost income from tourism

## Flood management

- Flood management has been in place since 1978. Over time, the strategies have been increased, including:
  - **The Foss Barrier:**
    - This was built to prevent water from the River Ouse backing up the River Foss
    - This barrier failed in 2015 and led to the flooding of many areas which had not been flooded since 1978
    - It has since been upgraded at a cost of £38 million
  - **Embankments at Leeman Road:**
    - These increase the capacity of the river channel
  - **Floodplain zoning:**
    - **Clifton Ings** has been left as an open, undeveloped floodplain
    - It can store 2.3 million m<sup>3</sup> of water
  - **Flood relief channels** around **Acomb** to divert water directly into the Ouse downstream of York

- **Floodgates** such as those on **Marygate**:
  - These can be removed when there is no flood risk; floodgates are also on individual properties

## Social issues

- The flood management strategies have reduced the risk of flooding for many properties in York
- Transport disruption during times of flood has been reduced
- The Sustrans cycleway over **Clifton Ings** made wider and resurfaced

## Environmental issues

- Some habitat destruction in the creation of the embankments and flood relief channels
- Two ponds created connected to the River Foss which have created **new wetland habitats**

## Economic issues

- **Foss Barrier upgrade** cost **£38 million** rather than the estimated £17 million
- Total cost of flood management strategies estimated at £83 million
- Increased the protection for over 2000 homes and businesses
- Possibly lower insurance premiums