

**2016 specification**  
first exams in 2018



# **GCSE OCR B**

## **Case Studies with Exam Prep**

### Topic 3: Distinctive Landscapes: Rivers

#### The River Spey

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## Teacher's Introduction

This resource has been developed to provide case studies and exam preparation material to support the GCSE OCR B specification (J384) **Topic 3: Distinctive Landscapes: Coastal and River**.

This detailed case study is on **The River Spey** representing a **UK river landscape**.

The case study includes a main content section which can be used as part of a lesson plan or distributed to students for self-guided research; a selection of ICT interactive links to further students' research around each topic and a set of Springboard Images and discussion questions (also available as a PPT file accessible by digital download) which makes a fantastic starter activity.

*A webpage containing all the links listed in this resource is conveniently provided on ZigZag Education's website at **zzed.uk/8856***

*You may find this helpful for accessing the websites rather than typing in each URL.*

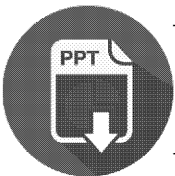


The exam preparation section which follows the case study contains a summary table, bringing together all of the key facts and figures relating to the case study; rapid-fire revision questions (with answers) to help recall and retention of the main points; and an exam-style question and mark scheme, written in the style of the OCR B sample material, so that students can practice answering questions relating to case studies and applying relevant knowledge in their answers.

The resource may be used as a source of reference for the required case studies for individual study, or for group work leading to discussion or debate. Subheadings in the information sections are designed to enable tabulated comparisons of social, economic and environmental impacts.

Other detailed case studies are available for this topic area representing coastal and river landscapes from around the UK:

- The Jurassic Coast
- The Seven Sisters
- The River Thames



**A PowerPoint presentation containing the Springboard Images starter activity to accompany this resource is available as a free digital download. Just register for free updates using the link below to download all available content for your school or purchasing site.**

November 2018

### Free Updates!

Register your email address to receive any future free updates\* made to this resource or other Geography resources your school has purchased, and details of any promotions for your subject.

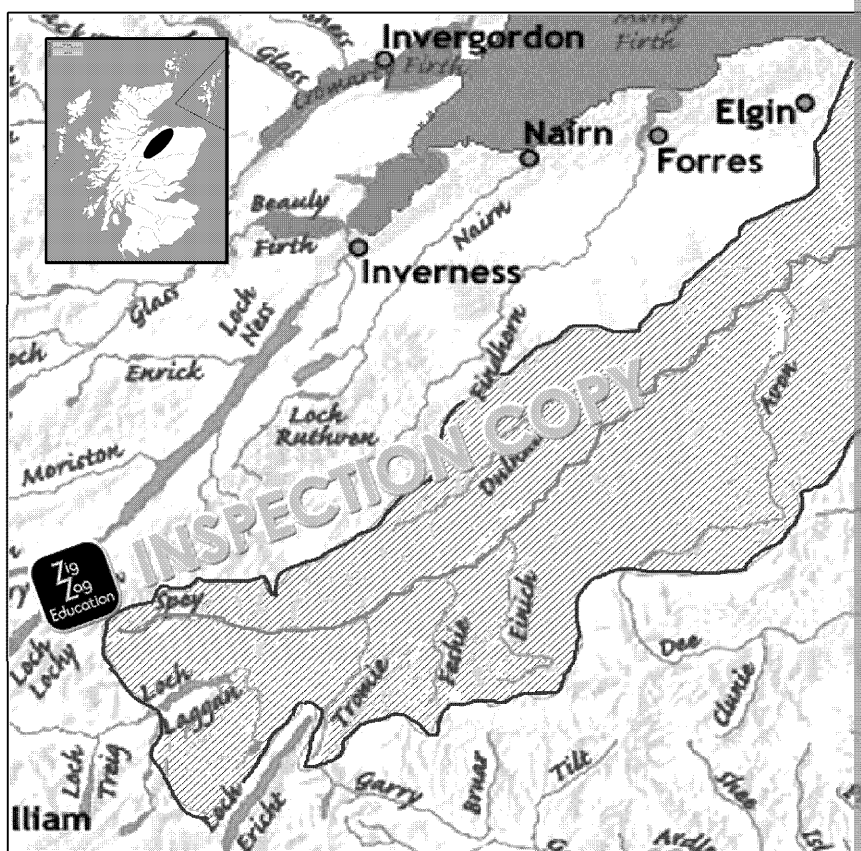
\* resulting from minor specification changes, suggestions from teachers and peer reviews, or occasional errors reported by customers

**Go to [zzed.uk/freeupdates](https://zzed.uk/freeupdates)**

## Part 1: Case Study



The River Spey is located in the east of Scotland between the Monadhliath ranges. The source of the river lies approximately 300 metres above sea level, 107 miles to the west and reaches its mouth at Spey Bay and flows into the Moray Firth. The 3,000 km<sup>2</sup> catchment area contains hundreds of tributaries that flow down the mountainsides. The River Spey is the ninth longest river in the UK and the fastest flowing river in Scotland.



The River Spey is an upland river with fast-flowing and turbulent water. It formed thousands of years ago over the course of four ice ages, which created the landscape that now flows through.

It is famous for its abundance of Atlantic salmon and trout, which makes it a popular fishing spot. The river is considered a Special Area of Conservation (SAC) and a Site of Special Scientific Interest (SSSI) due to the unusual habitats and rare species that can be found there.

The region and the Spey is not very built up, with only around 23,000 population in the area. This makes the area very attractive to tourists for its serene nature and the area is very popular during the Scottish ski season and attracts those who enjoy walking and white-water rafting all year round.

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The **long profile** of the River Spey is shown in the graph below. It shows how the river changes as you go downstream.

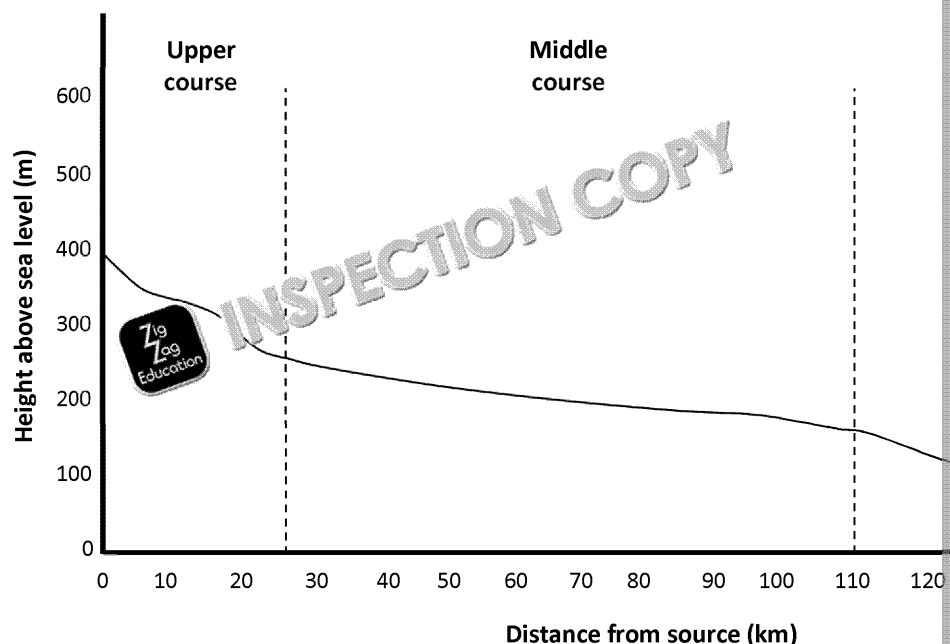


Figure 2 Graph showing the long profile of the River Spey

In most rivers the slope of the river decreases from source to mouth. However, in this graph, the River Spey is a bit unusual because the lower course is actually flatter than the middle course. This has some consequences for the landforms and features in different sections of the river.

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## The River Profile and Landforms

Like most rivers, the size and shape of the River Spey changes as the river flows. In this way it is influenced by the fluvial processes of erosion, transportation and deposition. The river downstream shows how these fluvial processes work in different ways and the size of the river changes.

### The Upper Course:

The upper course of the River Spey is relatively steep, with a narrow channel. The riverbed consists of large rocks and boulders that are slowly being moved down the river. The upper course has a V-shaped valley with numerous tributaries flowing down the mountain slopes.

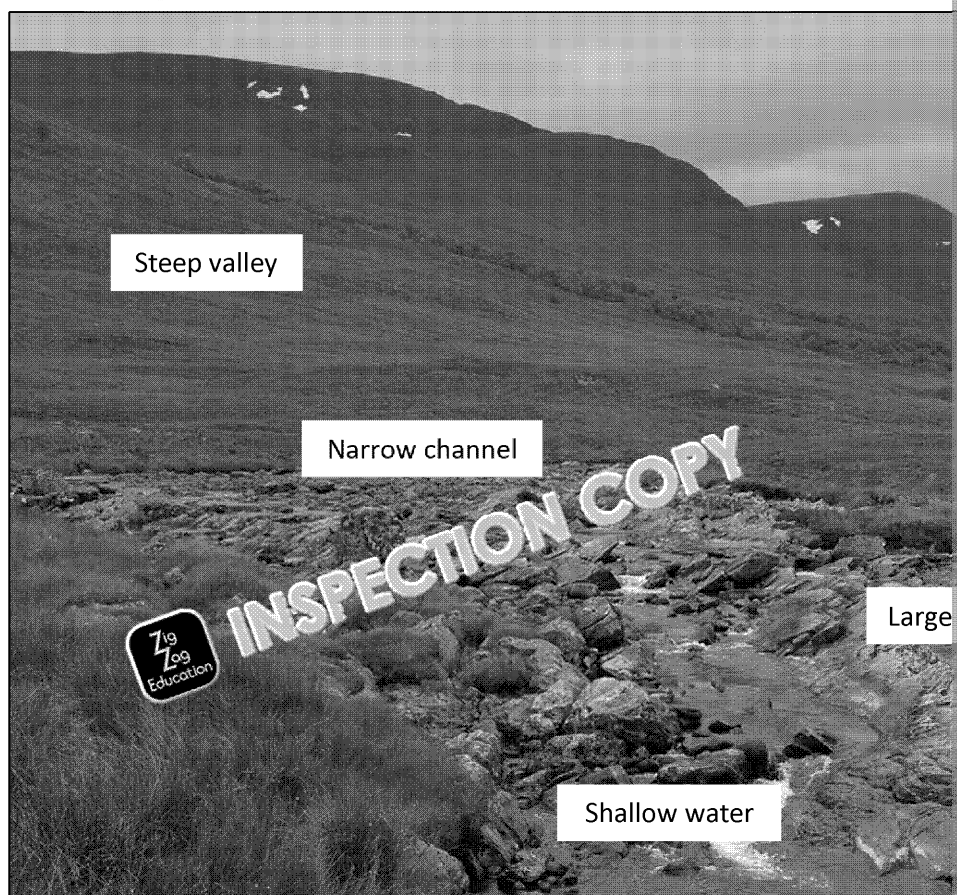


Figure 3 Upper course of the River Spey

#### Upper Course Fact File

Discharge	=	Low but gradually building up as tributaries flow into the river
Velocity	=	Slow due to large rocks and boulders and rough riverbed
Gradient	=	Steep; gradient ratio = 1:225
Channel depth	=	Shallow – 48 cm
Channel width	=	Narrow
Load size	=	Large rocks and boulders
Load quantity	=	Small
Riverbed	=	Rough

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**Landforms** found on the upper course of the River Spey are mainly formed through vertical erosion as the water weakens the bedrock through hydraulic action.

Waterfalls, for example, are formed through the river cutting into the rock vertically. They occur when a layer of hard rock lies next to a layer of soft rock.

The softer rock erodes more easily and undercuts the hard rock. Over time, the undercut gets deeper and the hard rock ends up collapsing into the river, forming a waterfall.

Rapids are another feature that can be found on the upper course of the River Spey. These form when fast-flowing waters flow over alternating sections of hard and soft rock. This makes the water more turbulent and rapids form. These rapids are partly what makes the river so attractive for canoeing and white-water rafting!

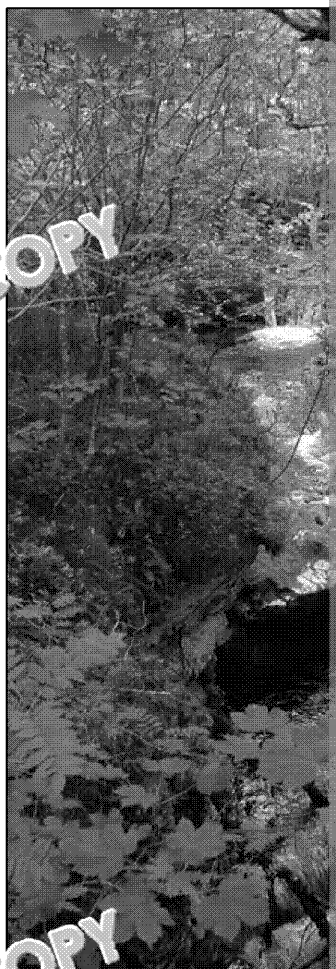


Figure 4 Waterfall on the River

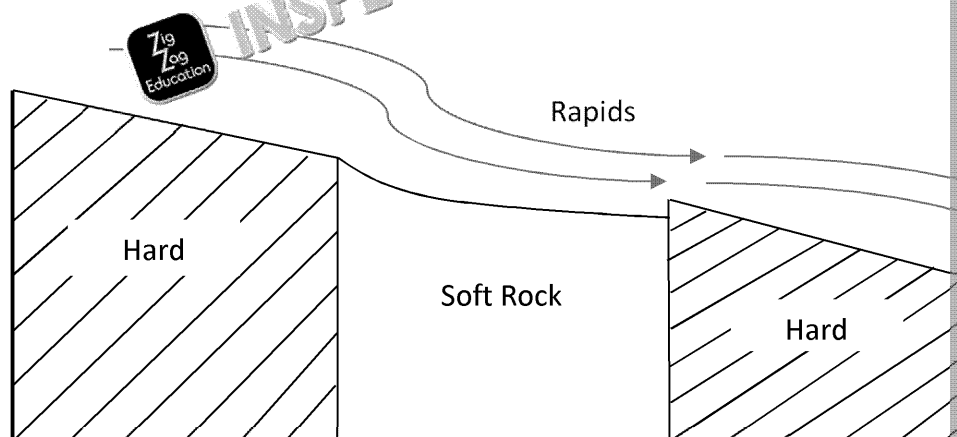


Figure 5 Formation of rapids

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### *The Middle Course:*

The middle course of the River Spey is characterised by a wider and deeper channel than the upper course. By this point the rocks in the river have been smoothed by abrasion and attrition. They are also being transported further downstream in suspension. Due to the shallow gradient of the middle course of the River Spey, the flow is more similar to what you might normally find in the lower section of a river.



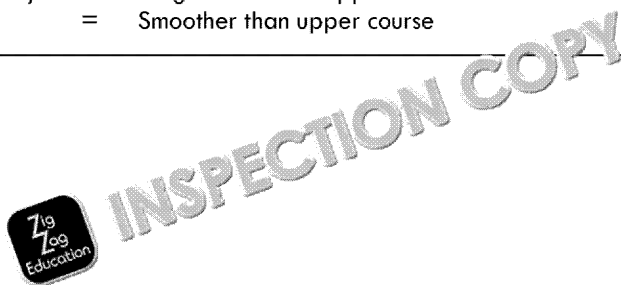
Figure 6 Middle course of the River Spey

#### **Middle Course Fact file:**

Discharge	=	Higher than the upper course as more tributaries join the main river
Velocity	=	Faster than the upper course as discharge has increased
Gradient	=	At its flattest; gradient ratio = 1:1 200
Channel depth	=	Deeper than upper course – 68 cm
Channel width	=	Wider than upper course
Load size	=	Mixture of smaller, smoother pebbles and large rocks
Load quantity	=	Larger load than upper course
Riverbed	=	Smoother than upper course

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**Landforms** found in the middle course are different to that of the upper course. The river is deeper and at its shallowest gradient, it means both lateral erosion and deposition causes the river to meander and form floodplains.

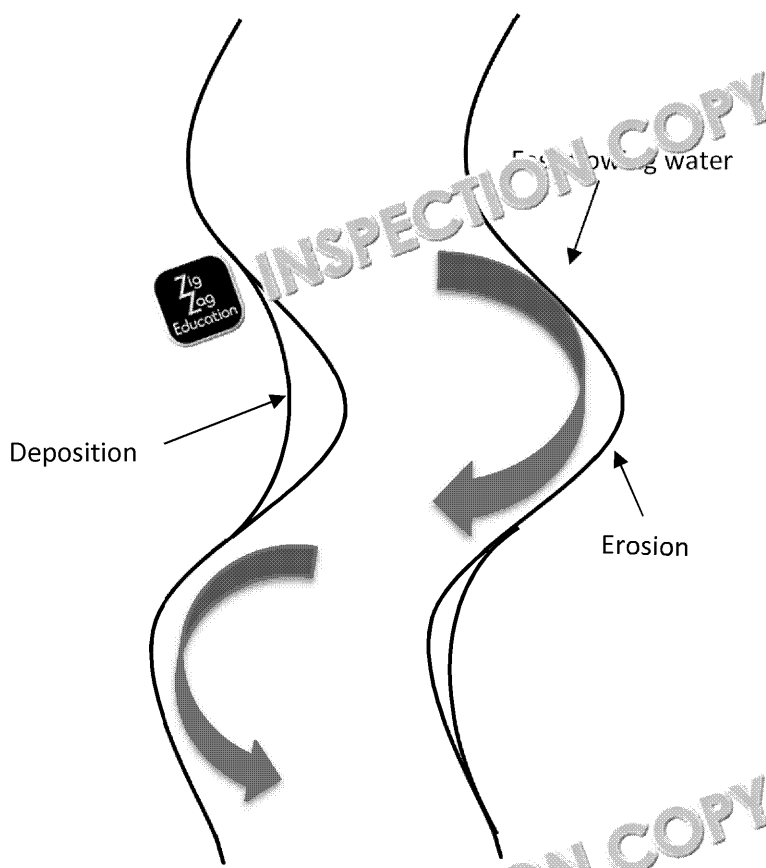


Figure 7 Formation of a meandering river

Meanders form in the middle course of a river where the flow is faster in the shallower area. The river will flow from one side to the other. As it flows, it erodes the outer bank and deposits material on the inner side, changing its course.

The middle course features a large area of floodplain, which is normally just a few metres above the level of the river. Over time, the river deposits silt and clay in the floodplain area. Over time, the floodplain becomes a flat area of land.



Figure 8 River Spey meander and floodplain

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### *The Lower Course:*

The lower course of the River Spey is the widest and deepest section of the river. It has its largest load of sediment that is being carried downstream by suspension. The steeper slope and faster velocity of this section of the river also means that it is able to carry larger pebbles all the way to the shore.



*Figure 9 Lower course of the River Spey*

#### **Lower Course Fact file:**

Discharge	=	At its highest as all the tributaries have joined the river
Velocity	=	At its fastest due to the high discharge and steep angle
Gradient	=	Steeper than the middle course; gradient ratio = 1:380
Channel depth	=	At its deepest – 89 cm
Channel width	=	At its widest
Load size	=	Mixture of fine particles and larger pebbles
Load quantity	=	Largest load
Riverbed	=	Smooth

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The **landforms** of the lower course are formed through lateral erosion and the lower course of the River Spey is steeper than the middle course, more erosion has occurred in the lower course of the river. The erosion, combined with deposition and the fact that the river has wide channels that fluctuate and change shape frequently and the amount of sediment being brought down from upstream and deposited in the river.



Figure 10 Braided channels and estuary of the River Spey

The unusual combination of steep slope and large sediment load also leads to the formation of a braided river. This is when the river breaks up and rejoins as it flows towards the sea and inlets of sediment.

Another feature of the lower course of the River Spey is its estuary as the river is characterised by a wide plain and the mixing of fresh water and salty seawater.

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## Flooding on the River Spey

Flooding is a natural and frequent occurrence on the River Spey. The river is often flooded downstream and across the floodplains.



Figure 11 River Spey in spate



A spate is the sudden flooding of a river

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Figure 12 Flooded Garmouth golf course

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## Physical Influences on the River Spey

The River Spey is heavily influenced and shaped by fluvial processes from the lower course. However, what other physical factors affect the river? Why does the river flood? This section will concentrate on how geology and climate have affected the flow of the river.

### Geology

The geology of a river system can affect its discharge, velocity and the land use. The catchment area of the River Spey is mostly formed of very hard crystalline rocks which are very resistant to erosion. That's what keeps the river steep, with large boulders in the upper course.

There is very little soil and vegetation in the upper catchment area of the river. This, combined with the hard geology, means that rainfall is not absorbed by the soil and instead creates high amounts of run-off. The tributaries of the River Spey have little capacity to hold much water so the run-off tends to flow straight into the River Spey. This is what makes the river the most fast-flowing river in Scotland but is also one of the reasons the river floods so easily.

The variety of more resistant and less resistant rock is also what causes some of the features of the upper course, such as rapids and waterfalls.

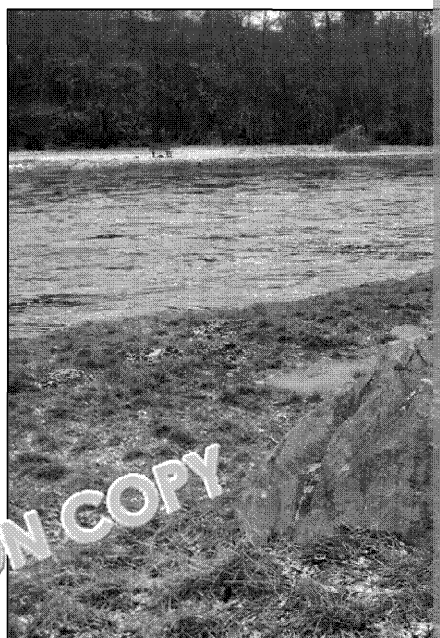


Figure 13 Rock on the River Spey

### Climate

Climate is another factor that can affect the flow in a river system.

North-east Scotland has a wet and mild climate and is prone to snow during the winter months. In the winter and spring, this high amount of rainfall and the snowmelts tend to cause spates in the river. During the summer, however, the spates are often caused by summer storms which bring heavy rain.

#### Average Rainfall

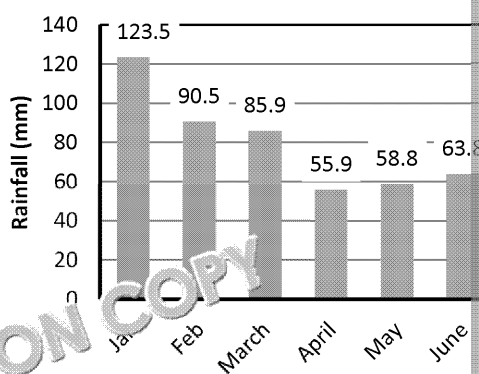


Figure 14 Rainfall in Aviemore

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Average number of days per year of sleet/snow falling and snow lying (1981-2010) at Aviemore (228 metres amsl)

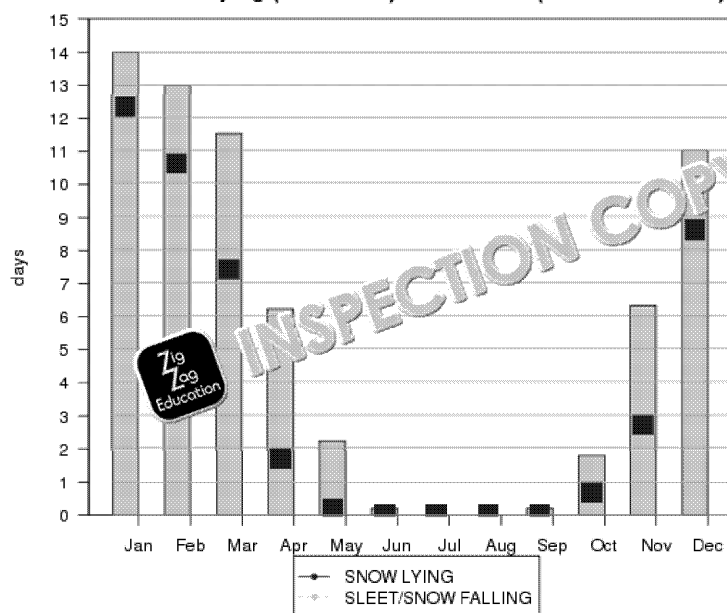


Figure 15 Average Snow levels in Aviemore



Figure 16 Snow on the River Spey

### How climate change might affect the River Spey

- Increased rainfall in winter months will increase the flow of the rivers and cause flooding.
- More frequent storms will also bring unpredictable water levels and flooding.
- Warm winters with less rainfall so there may be fewer spates during the winter months.
- Rising sea levels may impact flooding around the mouth of the river.

The upper course of the River Spey is located in the Scottish Highlands. The upper course of the river is in a high mountain area. The upper course of the river is in a high mountain area. The upper course of the river is in a high mountain area.

The middle course of the River Spey is located in the Scottish Highlands. The middle course of the river is in a high mountain area. The middle course of the river is in a high mountain area. The middle course of the river is in a high mountain area.

The lower course of the River Spey is located in the Scottish Highlands. The lower course of the river is in a high mountain area. The lower course of the river is in a high mountain area. The lower course of the river is in a high mountain area.

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## Human Influences on the River Spey

Human activities can influence the flow and flooding of a river system. In main ways human activity affect the river system are:

- **Farming** in the catchment area has stripped areas of land of natural vegetation. This means less rainwater is soaked up by the land, potentially making the impact of flooding worse.
- **Hydroelectric dams.** Water from the upper course is diverted to make hydropower for neighbouring regions of Scotland. A dam has formed a small reservoir which allows water to be diverted. This affects the amount of water that is in the river system.
- **Built-up area.** Around 23,000 people live in the catchment area of the River Spey. Although this is relatively few people, any settlement can cause a river to flood due to there being more impermeable surfaces, such as concrete.

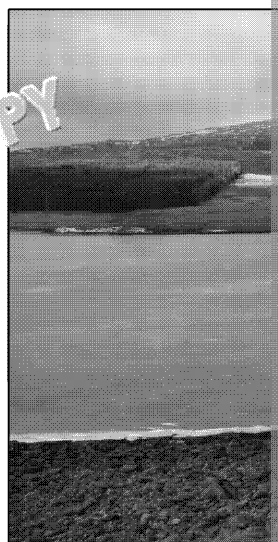


Figure 17 The small reservoir

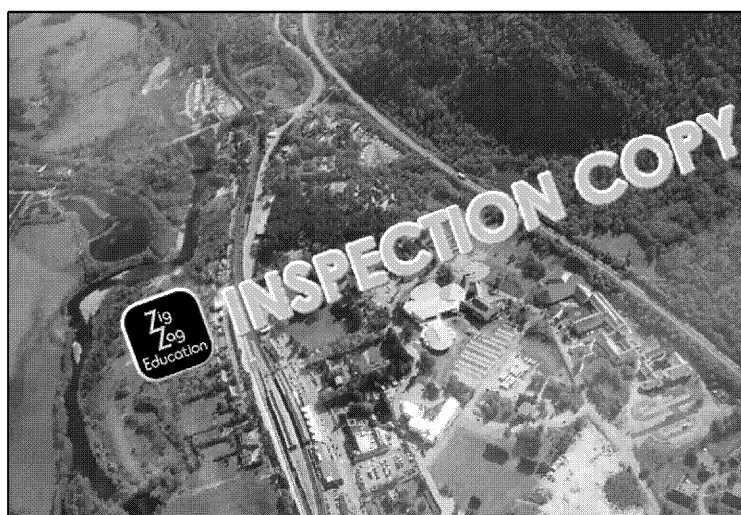


Figure 18 Town of Aviemore on the bank of the River Spey

On the whole, the River Spey system. The River Spey seems to have more activities than that reason, and influence the River management.

## Flood Management on the River Spey

### Why is flood management needed?

Across the catchment area, there are around 130 residential properties and 40 non-residential properties at risk of flooding. This leads to around £300,000 average damages per year.

### The flood defence plan:

The overall plan for the flood defence in the region is mainly strategies of soft management. The river is a site of special conservation and, therefore, any planning permission would be difficult to get and could ruin the unique ecology of the area. Soft engineering is considered the most sustainable, with the broad aim of adaptation rather than defence. Although there are vulnerable areas on the river there are only a few towns threatened by the river. For these reasons, soft management was deemed the most appropriate for the River Spey.

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Flood Defence Scheme	How it works
<i>Flood warnings</i>	Stations that are located up and down the river measure water levels. If the water is too high and there is a risk of flooding the police and the organisation Floodline are alerted, who then warn the public.
<i>Flood forecasting to improve the warnings</i>	The Scottish Environment Protection Agency (SEPA) provides regular updates on the river's water levels to help improve the warnings.
<i>Engage with community groups</i>	Talking to the communities affected by the flooding helps to build understanding of the issues. It also means that the communities can take part of the action against flooding.
<i>Self-help</i>	Encouraging individuals to manage their own flood risk by creating individual flood plans and emergency kits, as well as making sure they have the right insurance on their property.
<i>Maintain the waterways</i>	Clear the waterways of debris, such as fallen trees or silt. There is sometimes conflict over this due to the expense. Some people think clearing the waterways is obtrusive to the natural habitats which are necessary for flood protection.
<i>Development restrictions</i>	The zoning of some areas so no development can take place on the floodplains.
<i>Roadworks</i>	The only bit of hard engineering planned is to be completed by 2020 for Scotland around any roads at risk of flooding. These works will be completed for another 10–15 years.



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## The Impacts

### *Social:*

- Flood warnings and individual flood plans help people feel more prepared for a flood.
- Community involvement means the local people feel they are playing a part in their own town.
- There has been some conflict between the local people and the council over flood defence. Some local people feel not enough money is being put into the areas they live in and that more hard engineering should be built.
- Some residents also feel that the flood warning systems are not quick enough to give a flood warning and so warning systems need to be able to give sufficient warning.



### *Economic:*

- The flood defence costs less than hard engineering.
- Saves money from all the damages in the long run.
- Not actually as effective as hard engineering techniques.
- Conflict with the need to build more houses so building restrictions can be lifted.

### *Environmental:*

- It's the most sustainable form of management.
- It allows the river to flow naturally and flood when it needs to flood.
- However, the flooding can cause damage to the environment round the river and its habitats.
- With the uncertain nature of climate change, the scope of the flooding could increase and engineering plans may not be enough.



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## Fact table

<b>Location:</b>	North-east Scotland
<b>Source:</b>	Near Loch Spey in the Cairngorms National Park
<b>Mouth:</b>	Spey Bay into the Moray Firth
<b>Length:</b>	107 miles
<b>River basin size:</b>	3,000 km <sup>2</sup>
<b>Rankings:</b>	Ninth longest river in the UK Fastest-flowing river in the UK
<b>Status:</b>	Special Area of Conservation Site of Special Scientific Interest
<b>Human population in catchment:</b>	23,000 (approx.)
<b>Gradient ratios:</b>	Upper course: 1:225 Middle course: 1:1200 Lower course: 1:380
<b>River depth (averages):</b>	Upper: 48 cm Middle: 68 cm Lower: 89 cm
<b>Upper course features:</b>	Waterfalls Rapids
<b>Middle course features:</b>	Meanders Floodplains
<b>Lower course features:</b>	Braided channel Estuary
<b>Number of homes evacuated in the 2009 floods:</b>	400
<b>River Spey geology:</b>	Crystalline rock and glacial deposits
<b>Average rainfall in Aviemore:</b>	977.1 mm
<b>Residential properties at risk from flooding:</b>	130
<b>Non-residential properties at risk from flooding:</b>	40
<b>Average yearly damages from floods:</b>	£300,000
<b>Flood defence type:</b>	Soft engineering

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## ICT interactive page

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### Videos:


River Spey – Source to mouth

 <https://www.youtube.com/watch?v=P46O1-g12Y>

### News Stories:

BBC – 2009 floods


 <http://www.bbc.co.uk/1/hi/scotland/8239074.stm>

 <http://news.bbc.co.uk/1/hi/scotland/8239567.stm>

Residents' response to the frequent flooding on the River Spey

 <http://www.northern-scot.co.uk/Home/Flooding-nightmare-5751043.1>

Residents' response to flood plans in Garmouth and Kingston

 <https://stv.tv/news/north/186543-flood-plan-for-kingston-and-garmouth-time/>

Criticism of Floodline by local residents

 <http://www.strathspey-herald.co.uk/News/Flood-of-SEPA-complaint-10122015.htm>



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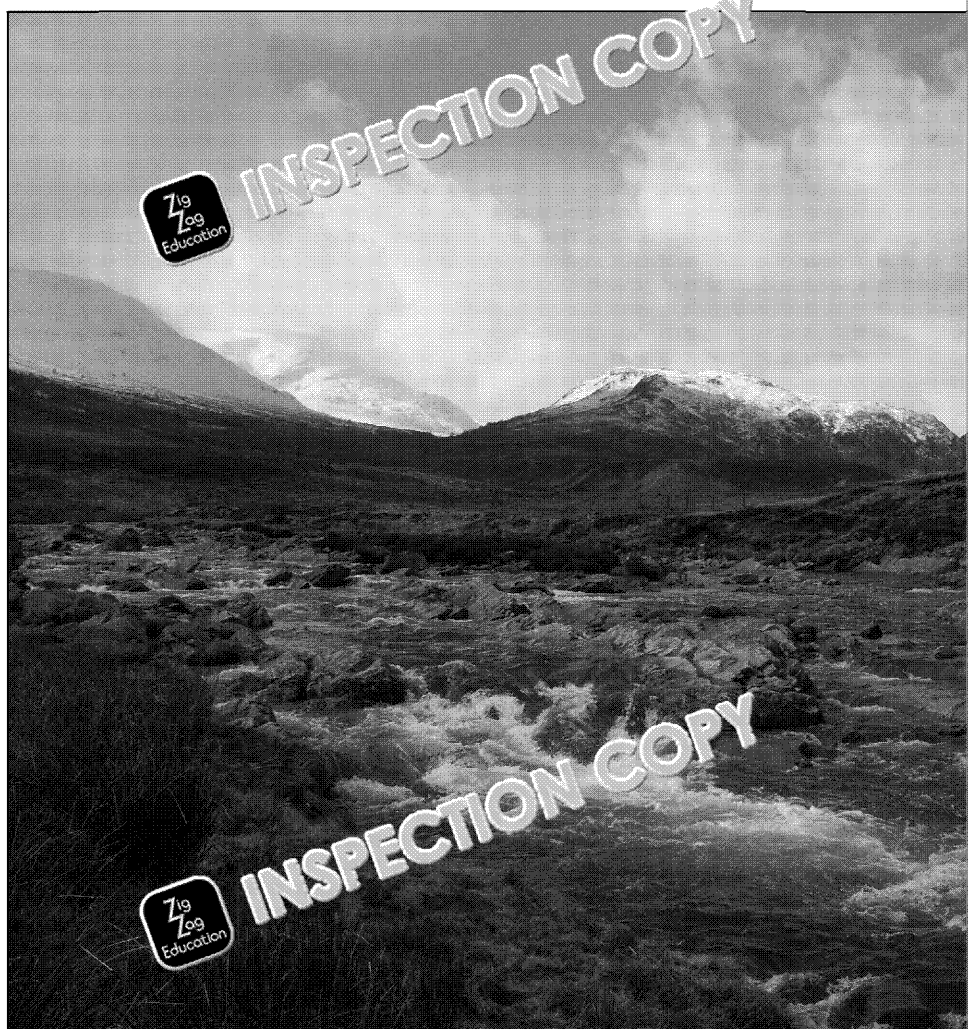
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Springboard 1



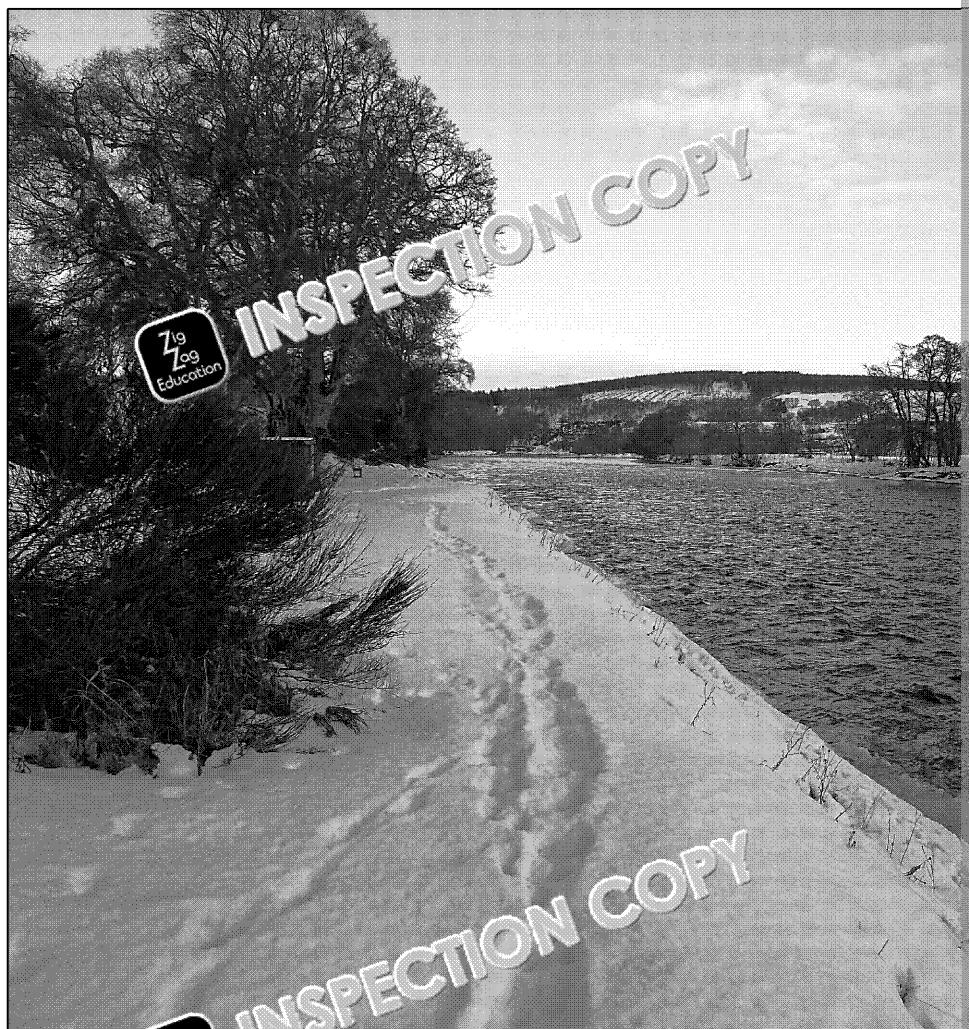
1. Which section of the river do you think this is? Why?
2. Suggest which fluvial processes are at play in this part of the river.
3. Suggest how the geology of the River Spey might affect these fluvial processes?

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1. What does this image suggest about the climate around the River Spey?
2. Suggest how this amount of snow might affect the River Spey and its surroundings.
3. Suggest how climate change might affect the River Spey in the future.

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1. What section of the River Spey do you think this picture shows? Why?
2. Suggest which natural processes are at play in this section of the river.
3. How might the frequently changing course of the river affect the local community?

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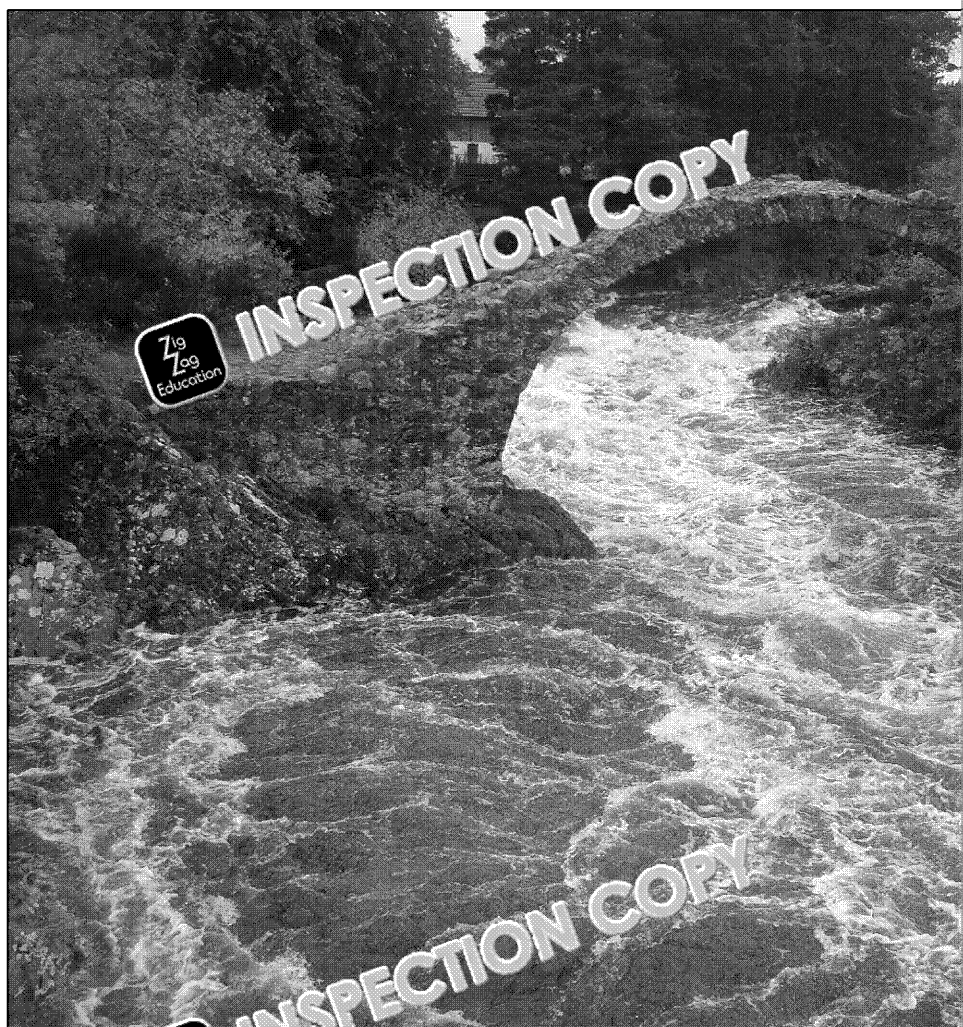
1. What does this map tell you about the area where the River Spey is located?
2. What does the map tell you about the human population in the region?
3. What does the map suggest about human activities in the region around the River Spey?

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1. What might have caused the spate in this tributary of the River Spey?
2. How might the spate affect the people living on the River Spey?
3. Discuss the different ways flooding from spates could be prevented.

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## Springboard Suggested Answers

### Springboard 1

1	<p>The upper section</p> <ul style="list-style-type: none"> <li>Mountainous area</li> <li>Steep gradient</li> <li>Large rocks and boulders</li> <li>Slow flow</li> <li>Other valid point(s)</li> </ul>
2	Vertical erosion is the main fluvial process working on this section of the river. Weathering from the rain, ice and snow.
3	The geology of the river might affect these processes because some rocks are harder than others.

### Springboard 2

1	The image suggests that the climate around the River Spey can get very cold and have a lot of precipitation.
2	<ul style="list-style-type: none"> <li>When the snow melts the water could flow into the river and cause it to flood.</li> <li>This could flood the surrounding land, causing damage to any vegetation.</li> <li>It could flood buildings and roads around the river.</li> <li>The high water levels and the flooding could also be dangerous to the people living nearby.</li> </ul>
3	<ul style="list-style-type: none"> <li>There will be wetter winters which could cause the river to flood more often.</li> <li>Storms could be a more frequent occurrence which may also cause the river to flood.</li> <li>Although there may be drier summers so there may be fewer summer floods.</li> </ul>

### Springboard 3

1	<p>The lower course</p> <ul style="list-style-type: none"> <li>Wider channel</li> <li>Lots of deposition</li> <li>Estuary – where the river meets the sea</li> </ul>
2	Deposition with some lateral erosion due to the wide plain and high amount of sediment seen around the river.
3	<ul style="list-style-type: none"> <li>It could cause more flooding</li> <li>It also makes the river unpredictable, which can make the flooding worse</li> <li>It creates a larger floodplain</li> </ul>

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#### Springboard 4

1	<ul style="list-style-type: none"><li>• Flows through the Cairngorms National Park, which has very natural</li><li>• This also implies it is an upland river</li><li>• There are only a few towns in the region</li><li>• There are quite a lot of other rivers around the region</li><li>• Any other valid point(s)</li></ul>
2	There are a few small towns but the area is a whole is not very densely populated
3	<ul style="list-style-type: none"><li>• The towns suggest that there are a number of people living in the area</li><li>• The variety of roads and smaller roads also suggests the movement of people</li><li>• The river is located partly in the Cairngorm mountains also suggests people would like to enjoy the landscape, go hiking or even go skiing in the winter</li><li>• Any other valid point(s)</li></ul>

#### Springboard 5

1	<ul style="list-style-type: none"><li>• Heavy rainfall</li><li>• Snowmelts</li><li>• Storms</li></ul>
2	<ul style="list-style-type: none"><li>• Could flood the villages and towns around the river very quickly</li><li>• Flood the roads around their village, making them more isolated</li><li>• People may have to be evacuated from their homes</li><li>• The water could affect the power and water supplies</li></ul>
3	<ul style="list-style-type: none"><li>• Could use hard engineering or soft engineering techniques.</li><li>• Soft engineering would focus more on adaptation and preparation, such as flood warnings and emergency flood plans.</li><li>• Hard engineering techniques could change the course of the River Spey and flood the built-up areas. Dams and flood barriers could also be built to stop the river from flooding.</li></ul>

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## The River Spey

### Introduction

- The River Spey is an unbridged river located in north-east Scotland covering an area of 1,500 km<sup>2</sup>.
- The source of the river is located in the Highlands approximately 300 m above sea level.
- The river then flows for 107 miles to the river mouth at Spey Bay.
- It is ranked as the ninth longest river in the UK and the fastest-flowing river in the UK.
- Its unique ecology and rare species make it a Special Area of Conservation and a Site of Special Scientific Interest.
- The river is a popular site for fishing for salmon and trout as well as activities such as canoeing, water rafting or gorge walking.
- The long profile of the River Spey is unusual in that the lower course of the river is steeper than the middle course.

### River profile and landforms

- The size and shape of the river change from source to mouth.
- The fluvial processes of erosion, transportation and deposition act at different rates in different ways.
- The upper course is steep. It has a narrow channel and shallow waters with many rocks and boulders.
- Waterfalls and rapids can be found in this section of the river.
- The middle course is more gradual and deeper than the upper course. The rocks are smaller and more rounded.
- The river is at its lowest gradient at this point and its features consist of meanders and oxbow lakes.
- The lower course of the river is the widest and deepest section with a high sediment load of silt, clay particles and pebbles.
- It features a braided river and an estuary.

### Flooding on the River Spey

- Flooding is a frequent occurrence on the River Spey.
- It is often subject to spates, which can flood the towns and land around the river.
- The most recent major flood was in 2009 when 400 homes were evacuated and the town of Garmouth was completely flooded and a small road bridge was swept away.

### Physical influences on the River Spey

- The geology of the River Spey affects how it flows and the landforms that it creates.
- The catchment area is mostly formed of hard crystalline rock and granite, which means there are high amounts of rainfall that can cause spates.
- The climate of the area also affects the river system.
- North-east Scotland experiences high amounts of rainfall and snow in the winter, and the high amount of rain can also cause spates.
- Climate change could also increase the amount of flooding due to it being predicted that there will be more amounts of rainfall and storms.

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### Human influences on the River Spey

- Humans also influence the River Spey through their activities, such as hydroelectric dams.
- They also try to influence the river through flood management.
- The strategy for flood management on the River Spey mainly consists of techniques, such as flood warning systems and development restrictions.
- The schemes have helped people feel more secure and safe but some people think they are not doing enough to protect them.
- The schemes are, however, often seen as less sustainable than hard engineering.



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## The River Spey

### Quick-fire Questions

1	Where is the River Spey located?	
2	Approximately where is the source of the river?	
3	How long is the River Spey?	
4	How big is the river basin?	
5	How many people live in the area around the River Spey?	
6	Name one specially protected species found in the river.	
7	What is unusual about the long profile of the River Spey?	
8	What is the gradient ratio of the upper course of the River Spey?	
9	Name two features found on the upper course of the River Spey.	
10	How deep is the middle course of the River Spey?	
11	Name two features found on the middle course of the River Spey.	
12	What is the sediment load like in the lower course of the River Spey?	
13	Name two features found on the lower course of the River Spey.	
14	What is the flood risk in the lower course of the River Spey?	
15	How many homes had to be evacuated in the 2009 floods of the River Spey?	

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16	What type of geology does the River Spey have?	
17	What can the geology affect on a river?	
18	What is the annual average rainfall in Aviemore?	
19	Name one way climate change may affect the River Spey.	
20	Name one way other than flood risk management that humans influence the River Spey.	
21	How many residential properties are vulnerable to flooding?	
22	Name two flood defence schemes in place for the River Spey.	
23	Name one social impact of the flood defence plan on the River Spey.	
24	Name one economic impact of the flood defence plan on the River Spey.	
25	Name one environmental impact of the flood defence plan on the River Spey.	

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## Quick-fire Answers

1	Where is the River Spey?	North-east Scotland
2	Approximately where is the source of the river?	In the Scottish Highlands
3	How long is the River Spey?	107 miles
4	How big is the river basin?	3,000 km <sup>2</sup>
5	How many people live in the area around the River Spey?	Approximately 100,000
6	Name one specially protected species found in the river.	Atlantic Salmon Otters Pearl mussel Sea lamprey
7	What is unusual about the long profile of the River Spey?	The lower course is very steep
8	What is the gradient ratio of the upper course of the River Spey?	1:225
9	Name two features found in the upper course of the River Spey.	Waterfalls Rapids
10	How steep is the middle course of the River Spey?	68cm (a mile)
11	Name two features found on the middle course of the River Spey.	Meanders Floodplains
12	What is the sediment load like in the lower course of the River Spey?	It holds a lot of sediment A mixture of silt and clay
13	Name two features found on the lower course of the River Spey.	Braided channels An estuary
14	What is a spate?	A sudden rise in the river level
15	How many homes had to be evacuated in the 2009 floods of the River Spey?	400
16	What type of geology does the River Spey have?	Hard crystalline rocks

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17	What can the geology affect on a river?	<i>The discharge, velocity</i>
18	What is the annual average rainfall in Aviemore?	<i>977.1 mm</i>
19	Name one way climate change may affect the River Spey.	<i>Increased rainfall</i>
20	Name one way other than flood management that humans influence the River Spey.	<i>Farming Hydroelectric dam Residential/built-up</i>
21	How many residential properties are vulnerable to flooding?	<i>130</i>
22	Name two flood defence schemes in place for the River Spey.	<ul style="list-style-type: none"> <li>• Flood warning</li> <li>• Flood forecast</li> <li>• Engaging the community</li> <li>• Self-help plans</li> <li>• Maintaining the defences</li> <li>• Development of new defences</li> <li>• Work on the river</li> </ul>
23	Name one social impact of the flood defence plan on the River Spey.	<ul style="list-style-type: none"> <li>• Residents feel safer</li> <li>• Community feeling</li> <li>• Some local people</li> <li>• Some have concerns</li> <li>• Not enough</li> </ul>
24	Name one economic impact of the flood defence plan on the River Spey.	<ul style="list-style-type: none"> <li>• The flood defence</li> <li>• Saves money</li> <li>• Not actually a</li> <li>• Conflicts with</li> <li>• can be seen as</li> </ul>
25	Name one environmental impact of the flood defence plan on the River Spey.	<ul style="list-style-type: none"> <li>• It's the most</li> <li>• It allows the</li> <li>• However, the</li> <li>• the river, such</li> <li>• With the unce</li> <li>• could get wor</li> </ul>

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## Extension Questions

1. Describe the path of the River Spey from source to mouth.
2. Explain why the long profile of the River Spey is unusual.
3. Describe how the fluvial processes change as you go downstream.
4. Compare the upper course to the lower course of the River Spey.
5. Suggest how geology and climate influence the River Spey.
6. Suggest how human activities can influence the River Spey.
7. Evaluate how climate change may affect the River Spey catchment area.
8. Examine why soft management flood defence was chosen for the River Spey.
9. Evaluate what might be different about the River Spey if hard engineering was used.
10. Using your knowledge of flood management, discuss whether soft or hard engineering would actually be better for the River Spey.

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## Extension Answers

1. The River Spey begins in the Scottish Highlands about 300 m above sea level.

It then flows through the mountain valleys in the Cairngorms, with tributaries from the Cairngorm and Monadhliath mountains.

It passes by a few small towns and enters into the middle course where the lateral erosion creates floodplains on both sides of the river.

It then continues to flow on the plateaus to the north-east of the Cairngorms until it reaches the Moray Firth.

2. The long profile of the River Spey is unusual because the lower course is actually steeper than the upper course. In most rivers, the lower course is at its shallowest gradient. The reason for this is because the slope of the land gets steeper nearer the sea.

3. The upper course – main fluvial processes are vertical erosion, weathering and mass wasting. This can be seen in the type of landforms found in the upper course, such as waterfalls and corrie lakes.

The middle course – both lateral erosion and deposition are at play in this section. The discharge and velocity of the river and the larger bedload. The bedload is moved by both traction and suspension. The lateral erosion and deposition cause the river to create floodplains.

The lower course – the main fluvial process that is happening on the lower course of the River Spey also experiences a fair amount of lateral erosion. The bedload is being carried out to shore by suspension and solution. The combination of erosion and deposition has created the braided river at the mouth of the Spey.

4. The upper course of the River Spey is in a mountainous region, with a steep valley and fairly fast flowing shallow waters. The rocks are large and are moved by traction. The landforms are mainly created by vertical erosion.

The lower course of the River Spey, however, is very wide and deep. At this point, the bedload is mainly just fine particles with some pebbles. The landforms formed are due to deposition and lateral erosion.

5. Geology

- The hard rock and lack of soil means that the river basin experiences high flows. The tributaries also have little capacity to hold all this water so it ends up in the main river, causing spates.
- The alterations between hard and soft rocks also cause the features such as waterfalls.

### Climate

- The wet and cold climate of north-west Scotland means that there are often high levels of rainfall flowing into the River Spey, causing it to flood.

6. Farming – can strip the land near the river from vegetation making the land more susceptible to flooding.

Hydroelectric dam – There is a small dam on the upper course which has created a reservoir for hydroelectric power. The dam plays a role in influencing how much water flows downstream.

Built-up areas – any towns or villages that are on the banks of the River Spey are at risk of flooding easily due to the increase of impermeable materials, such as concrete.

Flood management – forms of flood management can change how the river flows and how much water is in the river.

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7. Climate change could have a significant impact on the River Spey in the future
  - The increased amount of rainfall during the winter months could cause the river to flood more often.
  - The more frequent number of storms that may occur could have the same effect.
  - If there are more frequent floods it may not give towns and villages enough time to prepare. If this is the case, other flood management techniques may be needed.
  - There should be drier summers, however, so there may be fewer floods during the summer months.
8. Soft management could have been chosen for the River Spey for the following reasons
  - The area is both a Special Area of Conservation and a Site of Special Scientific Interest, so any hard management could have brought damage to the area.
  - Soft management is more sustainable and, therefore, will be better for future generations.
  - It is cheaper than hard management.
  - There is a high population in the catchment area so the area may be more at risk of flooding.
  - Any other valid point(s).
9. Differences to the River Spey if hard engineering was used:
  - The river could have changed course.
  - There could have been worse damage up or downstream from the managed area.
  - More houses could have been built in the area if it was not deemed to be at risk of flooding.
  - Wildlife and habitats could have been lost.
  - Any other valid point(s).
10. Soft engineering impacts:
  - Cheaper for the area
  - Sustainable
  - Isn't as effective as hard engineering
  - The area still floods and causes damage
  - May not be effective against the future impact of climate change

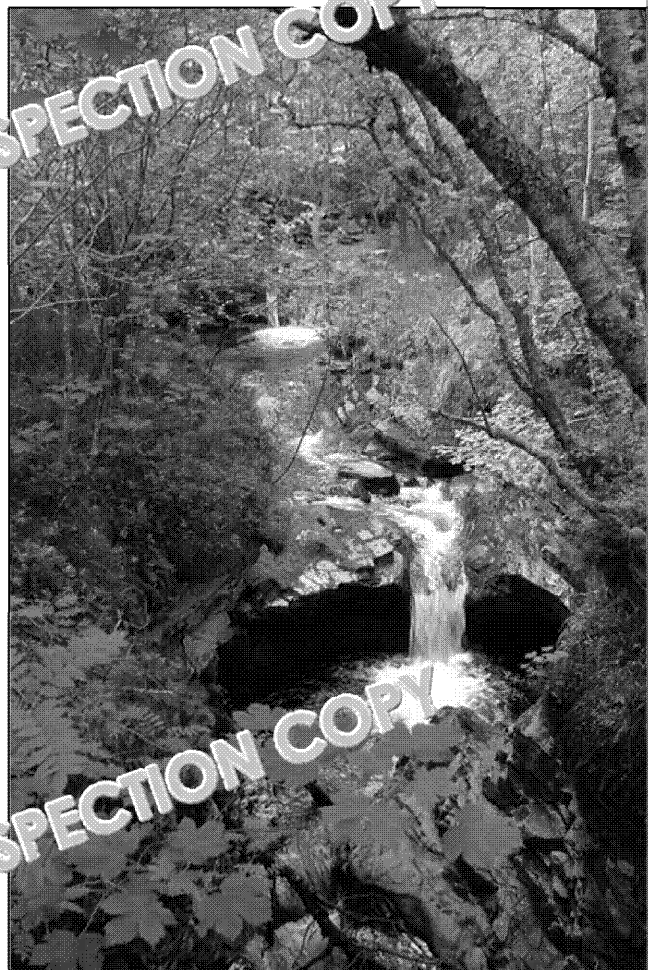
Hard engineering (potential) impacts:

- More effective than soft engineering
- Could help to protect the residents who are living there now
- May allow for more development in the area
- It's expensive
- It isn't sustainable and upkeep is expensive
- Hard to know if it would work without knowing the full impact of climate change

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## Exam Style Question



*Figure 1: Waterfall on the River Spey.*

Using examples and Figure 1 to help you, explain how geology helps to shape landforms that are found along a river.

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## Level Marking

Level	Mark	Description
1	1–2	<ul style="list-style-type: none"> <li>The student evidences basic knowledge of</li> <li>The student evidences limited understanding of how landforms exist between places, environments and processes</li> <li>The ideas expressed by the student are limited</li> </ul>
2	3–4	<ul style="list-style-type: none"> <li>The student evidences some knowledge of</li> <li>The student evidences good understanding of how landforms exist between places, environments and processes</li> <li>The ideas expressed by the student are clear</li> </ul>
3	5–6	<ul style="list-style-type: none"> <li>The student evidences thorough knowledge of (AO1)</li> <li>The student evidences a firm understanding of how landforms exist between places, environments and processes</li> <li>Ideas expressed by the student are in-depth</li> </ul>

## Indicative Content

- Students should offer an explanation of how geology can help to shape a river.
- They must use examples of river landforms.
- The student should also clearly demonstrate how geology, the structure of landforms are found along a river.

## Suggested Content

Using the example of the River Spey:

- The geology of a river basin can help determine which landforms form
- The River Spey, for example, is mainly formed from very hard crystalline rock which is less resistant to erosion, keeping the river steep.
- There are, however, bands of softer rock which create waterfalls and rapids
- Waterfalls are formed because the softer rock is eroded more easily and the harder rock remains
- Rapids form where fast flowing water flows over alternating hard and soft rock

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