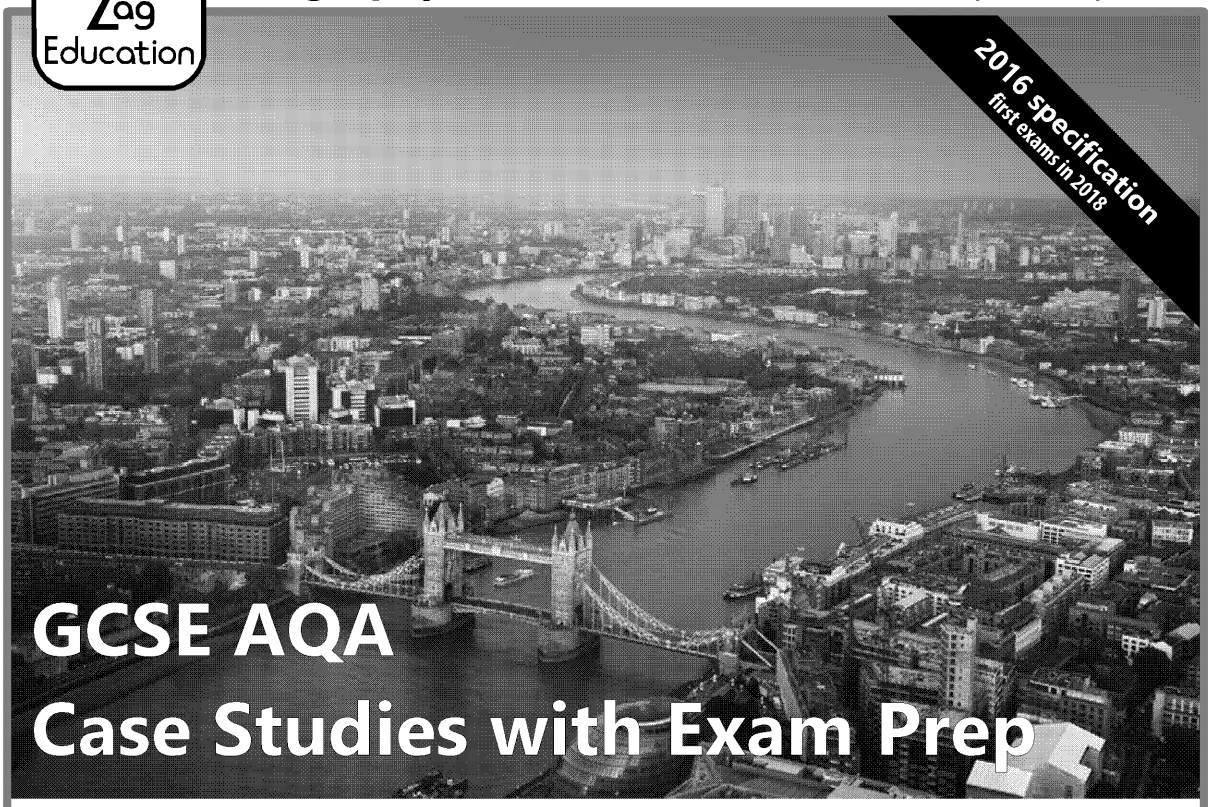
Zig Zag Education

Geography

GCSE (9–1)| AQA | 8035



GCSE AQA Case Studies with Exam Prep

Physical Landscapes in the UK: Rivers

The River Thames

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POD 8799

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Teacher's Introduction

This resource has been developed to provide case studies and exam preparation material to support the GCSE AQA specification (8035) **Section C: Physical Landscapes in the UK**.

This detailed case study is on **The River Thames** representing a **river landscape** within in the UK.

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/8799***

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 AQA 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 (two coastal landscapes, another river landscape, and two glacial landscapes):

- The Jurassic Coast (Coastal)
- The Seven Sisters (Coastal)
- The River Spey (River)
- Snowdonia (Glacial)
- The Lake District (Glacial)

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

Part 1: Case Study

Content

Introduction

The River Thames is probably the most famous river in the UK. It flows for 346 km across southern England from the Cotswolds to the North Sea, passing through eight counties and 18 towns and cities. Most famously it flows through London and then out into the North Sea at the Thames Estuary.

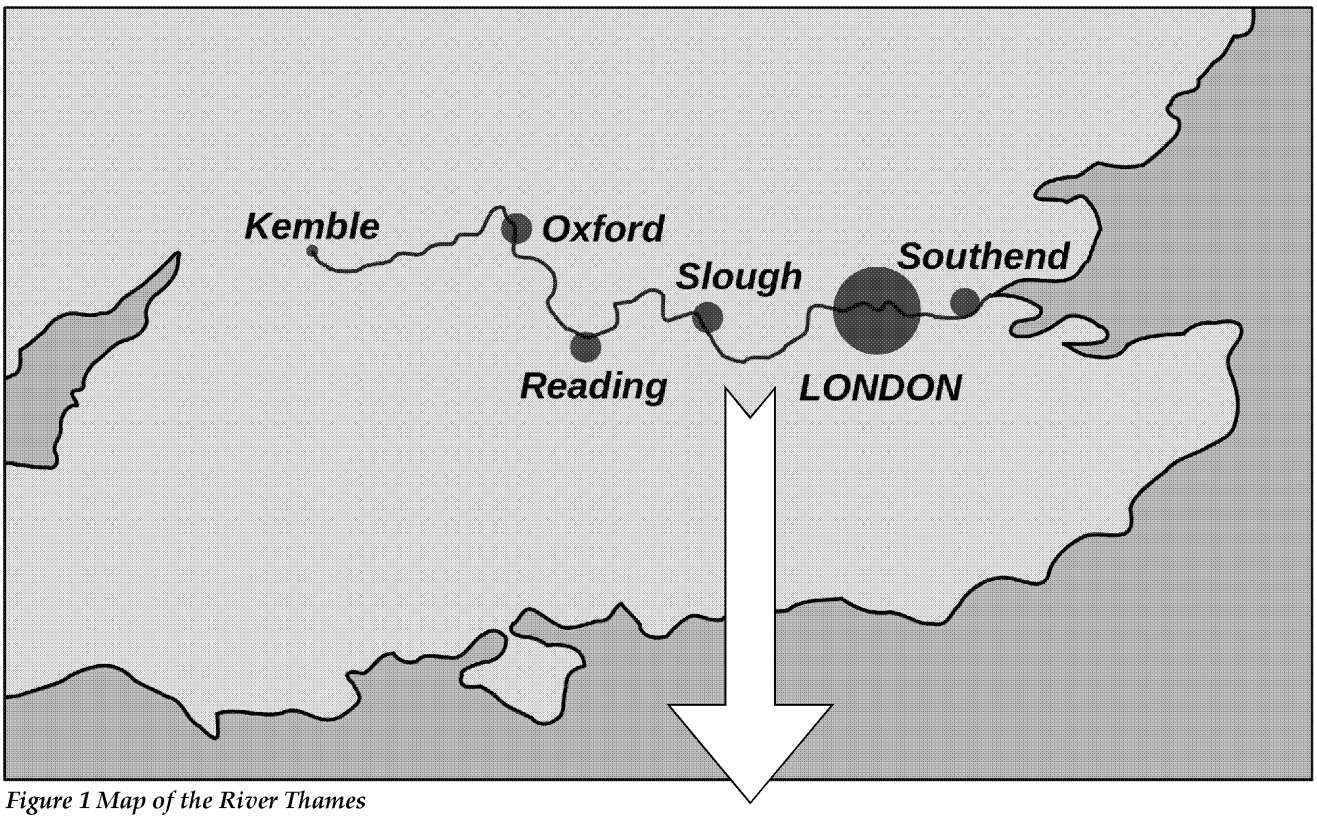


Figure 1 Map of the River Thames

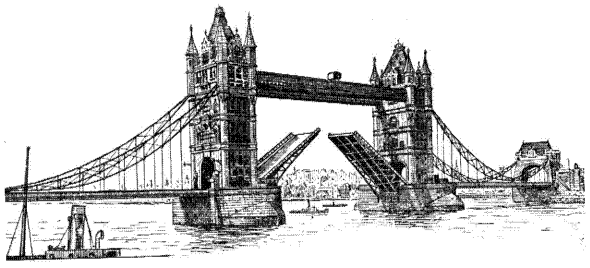
The Thames is the longest river in England and the second longest in the UK. It has 38 main tributaries flowing into it, with a basin size of 12,935 km^2. It is a lowland river with a shallow gradient; its source is only around 108 m above sea level.

It is also the most densely populated river basin in the UK, with around 13 million people living in it.

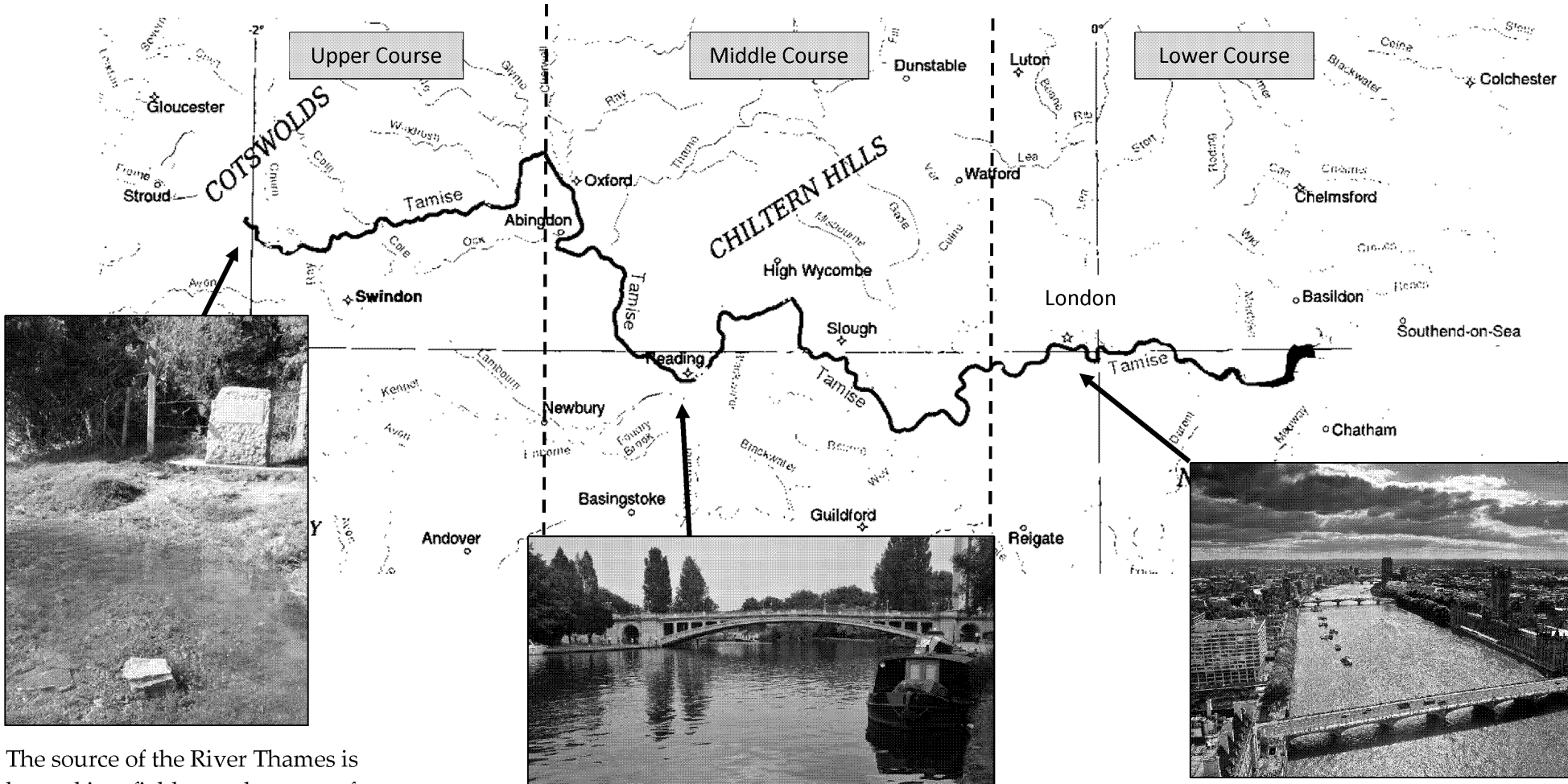
Throughout history, humans have used the Thames as a key trade and transport site. Today, it is mostly used for recreational travel, sport and tourism.

River Thames Fact File:

Length: 346 km
Basin size: 12,935 km^2
Tributaries: 38
Number of islands: 80
Number of bridges: over 200
Number of locks: 45



Source to Mouth of the River Thames:



The source of the River Thames is located in a field near the town of Kemble in the Cotswolds. It is marked by a headstone and a large puddle of water. However, during the dry summer months there is little sign of any water at all, making it hard to believe it's the source of a great river!

The middle section of the river flows through various large towns and cities. This image is of the River Thames flowing through Reading.

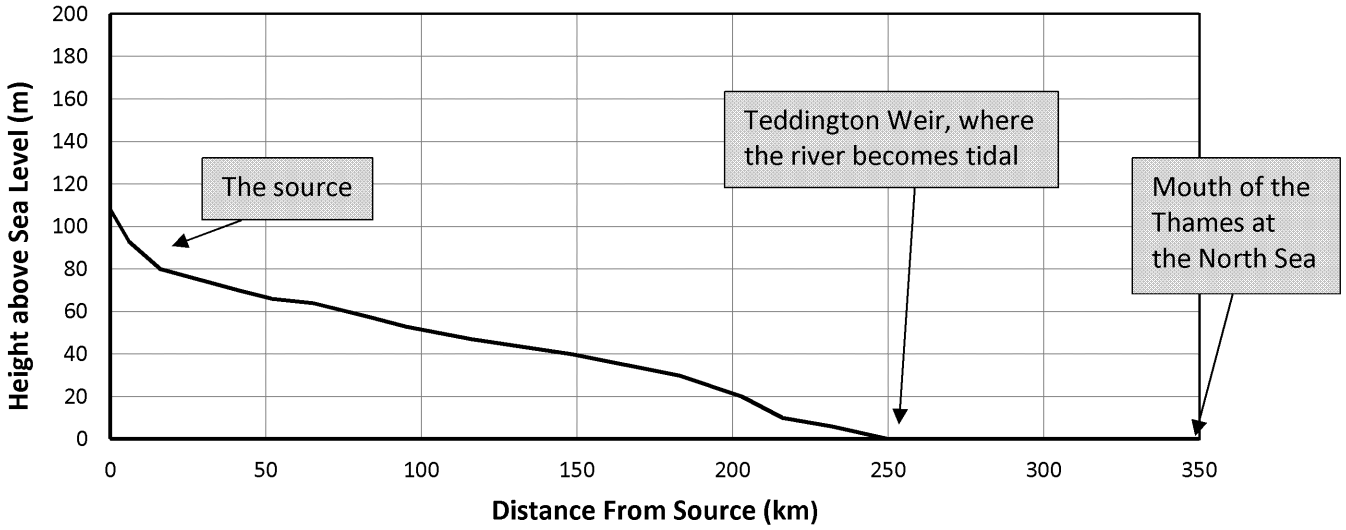
Once the Thames passes through a lock in a town called Teddington it becomes a tidal river. This means that it moves around seven metres up and down with the tide every day. The river then flows through London before it reaches its mouth at the Thames Estuary, where it flows into the North Sea.

River Profile and Landforms

Like most rivers, the size and shape of the River Thames changes as the river flows downstream. This is due to various factors, such as the gradient of the river and the fluvial processes (erosion, transportation and deposition) acting on the river. By examining the different sections of the river from source to mouth you can see how the shape and landforms of the river change.

The Long Profile:

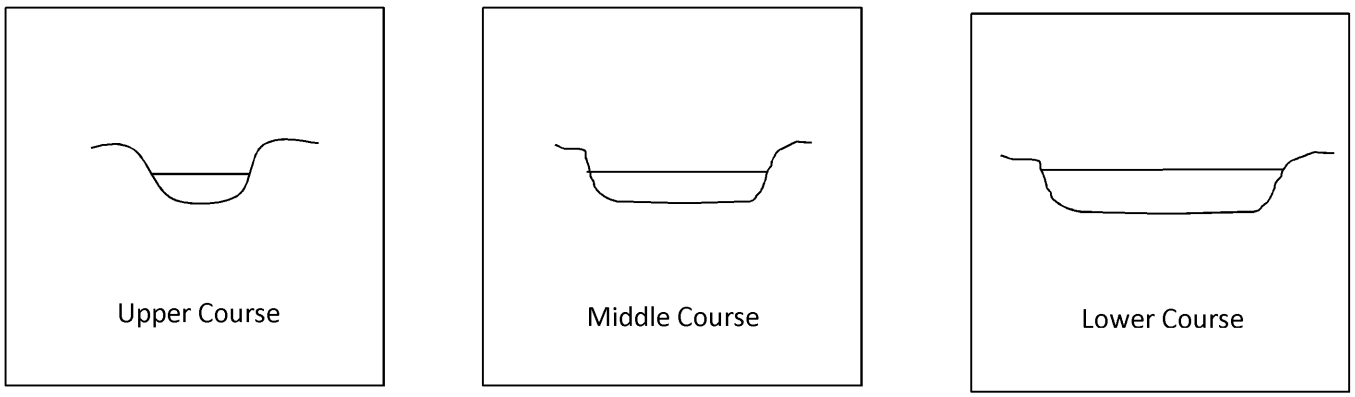
The long profile shows the height of the river above sea level compared to its distance from the source.



The graph above shows the long profile of the River Thames. The long profile of an average river shows the gradient gradually decreasing downstream, in a concave fashion. As you can see from the graph, the gradient of the Thames does decrease as it flows downstream but there are a few bumpy areas. These bumps are most likely formed from changes in where the riverbed is due to the sea level fluctuating over thousands of years. This has then had an impact on the gradient of the river in some areas downstream.

Another thing to note about the long profile of the Thames is that the height of the source above sea level is only around 108 m. Comparing this to other rivers around the UK, such as the River Severn where the source lies 610 metres above sea level, the Thames does not have a high altitude. As the last 100 km of the Thames is tidal, it means the river is at sea level from this point.

Cross Profiles:



The Upper Course:

The upper course of the River Thames is not a typical upper course due to its gentle gradient. Although the channel is narrow and shallow it is not very steep. Instead the stream gently flows downhill through beautiful countryside and a few villages. At this point the river has a low discharge of around 17.6 m^3/s. It also carries a small load of larger rocks that are being transported downstream through traction.

Figure 2 The gentle upper course of the River Thames

Even though the river only flows gently downhill, it still cuts into the riverbed through vertical erosion. However, the erosion is not very powerful so there are no usual distinctive features of an upper course, such as waterfalls, gorges or rapids.

The Middle Course:

The middle course of the Thames is characterised by a wider and deeper channel than the upper course. More tributaries join the main river in this section, causing the discharge to increase to 39.7 m^3/s. The greater energy and shallower gradient cause the river to erode laterally.

Figure 3 The meandering River Thames

The bedload at this point is also larger as the tributaries have deposited more rocks into the main river. The load consists of smaller rocks than the upper course, which are being transported through suspension and traction.

Just from looking at a map of the Thames you can see how significantly the river **meanders** along its course. This meandering is caused by lateral erosion and deposition. As the gradient of the river has decreased by the middle course, its energy moves from side to side and erodes the riverbank laterally. Where the water is deeper and moves faster, it erodes the bank. The river then deposits this material on the other side of the bank where the water moves more slowly, creating the meander. Over time this meandering changes the course of the river.

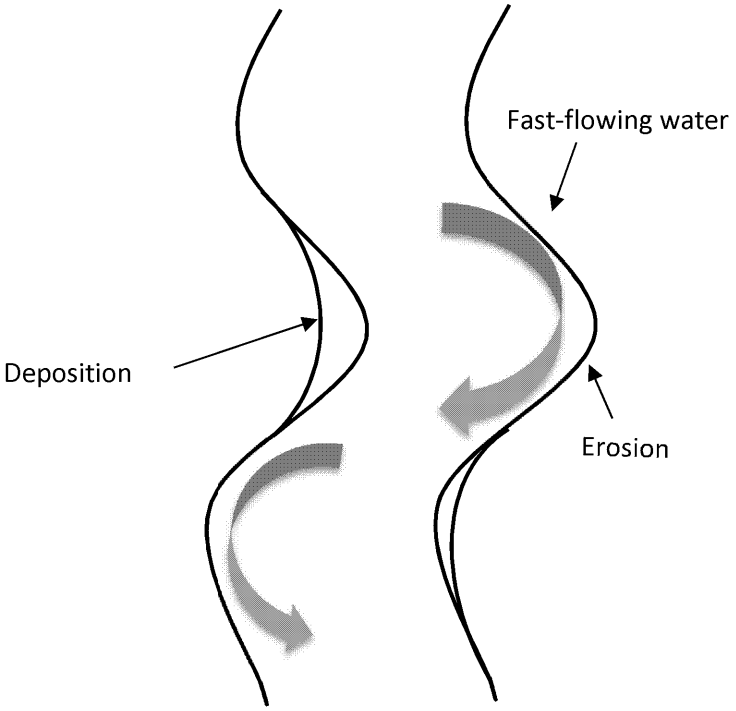


Figure 4 Diagram of a meander

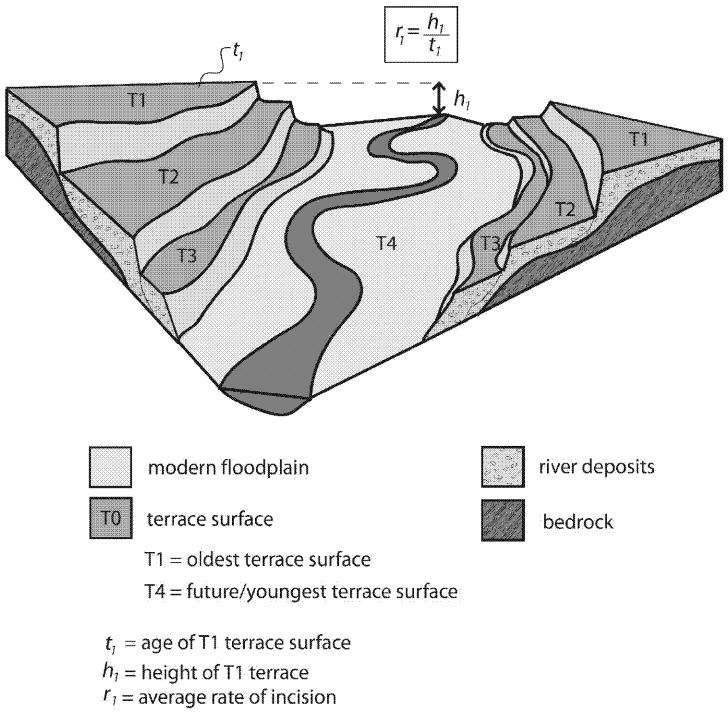


Figure 5 Diagram of river terraces

River terraces are another feature that start to occur in the middle course of the Thames. They formed thousands of years ago due to fluctuations in sea level throughout the ice ages. When sea level changes it can give rivers more energy and, therefore, more vertical erosion can take place. This then causes the river to cut down into the riverbed and form a new one. The old riverbeds are called terraces.

Terraces don't just feature on the middle section of the river, parts of London lie on these river terraces.

Lower Course:

The lower course of the Thames is the widest and deepest section of the river. The discharge here is around 65.9 m^3/s and the river widens from 100 m as it flows through London to over 7 km as it reaches its mouth. The Thames is at sea level at this point due to its tidal nature; it therefore moves up and down with the tide.

The lower Thames also carries the largest bedload of around 300,000 tonnes, in the form of fine particles and silt which are transported through suspension and solution.

Deposition and lateral erosion are the main fluvial processes taking place in the lower Thames. One feature of these processes is **floodplains**, where the river has repeatedly flooded over time, depositing silt onto the land. This creates flat and fertile land either side of the riverbank. Today, much of the Thames floodplains have been built on. London is one example of a floodplain settlement.

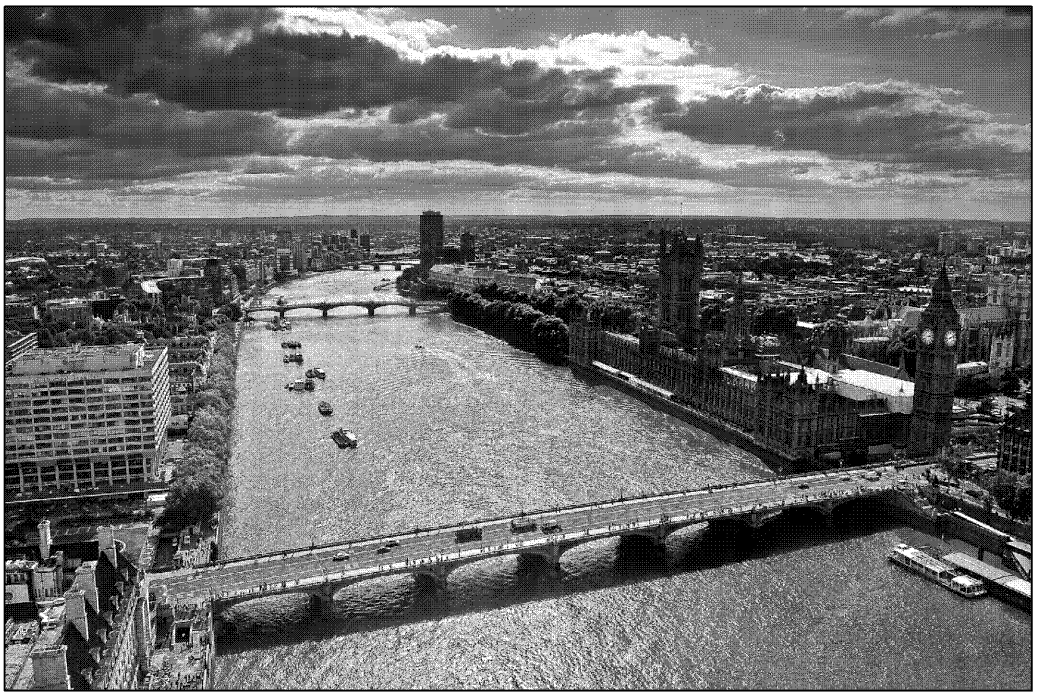


Figure 6 Thames flowing through London

As the Thames reaches its mouth it forms an **estuary** where the fresh water and salty seawater mix together. As deposition is the main fluvial process in this section of the river, the Thames estuary is characterised by its mud and silt deposits. This forms a flat and muddy coastline with few coastal features.

Figure 7 Thames Estuary

Flooding

The River Thames is prone to flooding, which can have serious consequences on the 13 million people living in its basin. In the last century there have been around 10 major floods on the river, five of which occurred in the last 20 years. The flooding of the Thames is either caused by the river or the tide.

Notable floods of the twentieth century:

1928 – On 7th January the Thames flooded and rose over the embankments in central London. Thousands lost their homes and 14 people died.

1947 – Heavy snow over the winter caused major floods when it melted in March. It cost around £12 million to repair the damage to the Thames Valley. That's equivalent to around £400 million today!

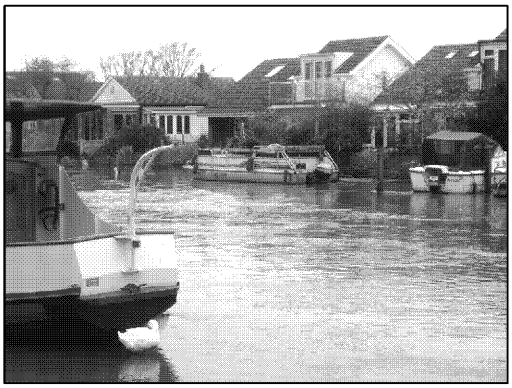
1953 – On 31st January a large storm surge came up the Thames from the North Sea, causing a devastating flood which killed around 300 people.

February 2014

The most recent significant flooding of the Thames was in the winter of 2014, when the UK was subject to the worst sequence of storms in 20 years. These storms caused the Thames to burst its banks across the counties of Berkshire, Oxfordshire and Surrey, causing widespread disruption for the villages and towns in these areas.

Facts:

- The Thames reached its highest water level in 60 years!
- 14 severe flood warnings were declared along the Thames
- Around double the average rainfall fell in many areas around the Thames
- Around 1,700 homes were affected just in the Thames Valley
- Overnight, from 8th–9th February, 150 people were rescued from their homes in Surrey
- In the village of Datchet in Berkshire, 10,000 sandbags were distributed



Physical Influences on the River Thames

We have already explored how fluvial processes such as erosion and deposition affect the River Thames, but what other physical processes can influence the river and its flow? This section will explore this in relation to the two significant physical influences of geology and climate.

Geology:

The geology of the River Thames affects its discharge and velocity, and the landforms that can be found along the river.

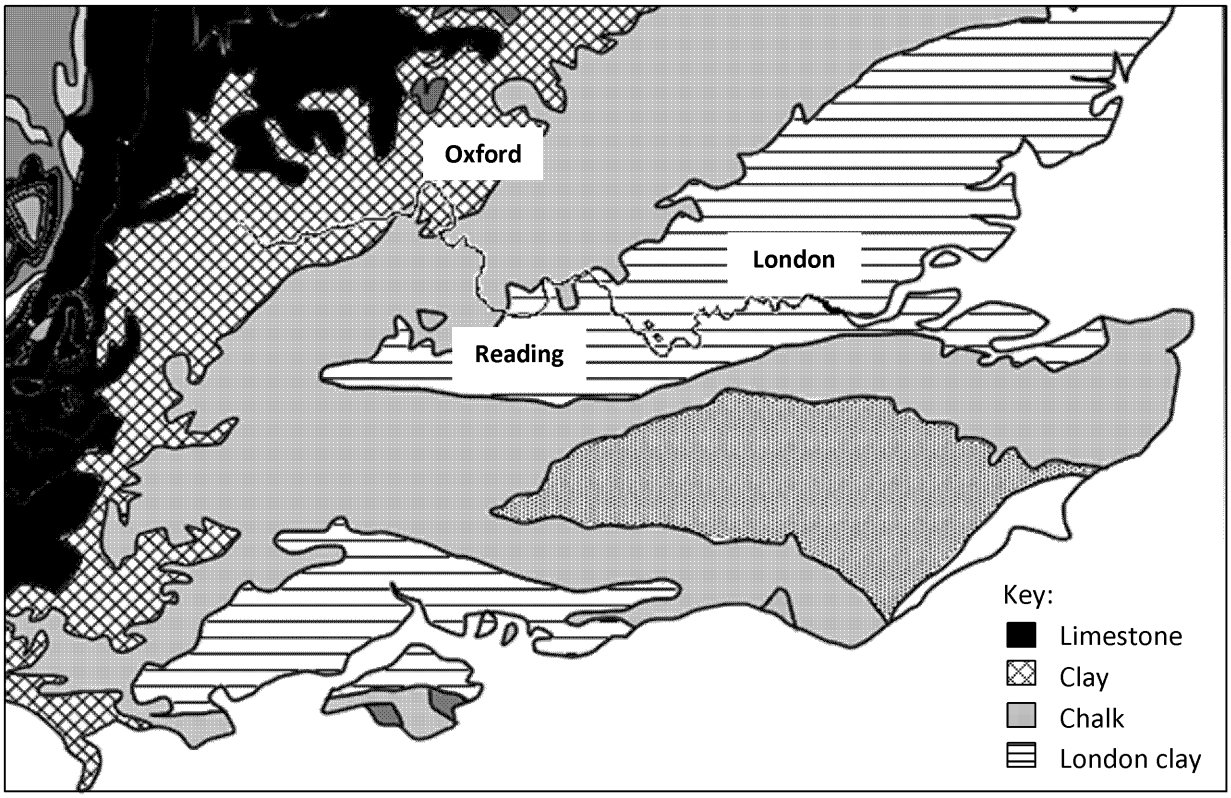


Figure 8 The geology of south-east England

The geology around the source is limestone rock, a relatively hard porous rock. The river then flows over clay in Oxford. Clay is an impermeable rock so does not soak up any water; this means that when the river is at high discharge it is more likely to flood where it flows over clay. As the river leaves Oxford, the geology of the area changes to chalk. Chalk is a permeable rock; therefore, it soaks up water (also known as an aquifer) and is used as a source of water for us. As the river flows into London it flows over London clay, which is again impermeable and more prone to flooding.

Climate:

The discharge of the Thames is actually lower than you might expect despite being a large basin. This is partly due to the climate being fairly dry in south-east England, with only 690 mm of rainfall per year compared to the UK average of 897 mm. Due to the relative scarcity of water in the region and the natural water stores that lie in the chalk, a large amount of water is extracted for drinking water and sewage treatment. In fact, it is said that from source to mouth the Thames will go through eight people!! Most of the year the water level in the Thames is quite low. So what is it about the climate that can change this and cause the river to flood?

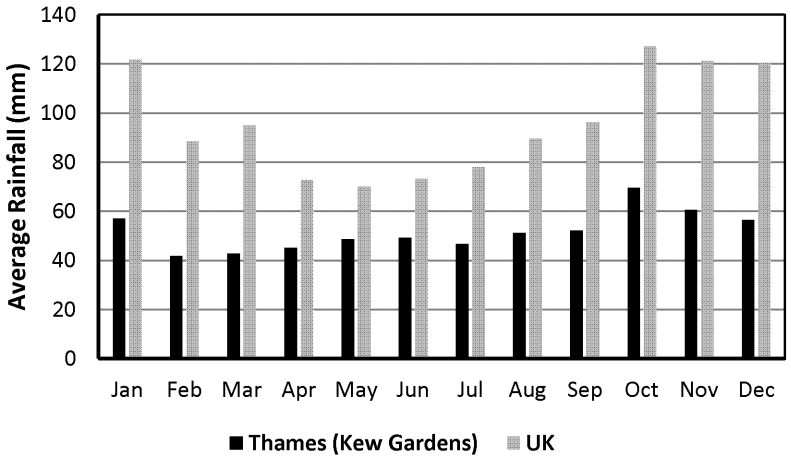


Figure 9 Average rainfall graph of UK and along the Thames

1. Heavy rainfall
   As we have seen, when heavy rain does happen it can cause the Thames to flood rapidly, such as in February 2014.

2. Storm surges
   These occur in the Thames when an area of low pressure travels down the east coast of the UK. With this area of low pressure come strong winds that push the sea inland and up the river. This can cause very high tides and consequently flooding. This is what caused the 1953 floods.

Another thing to consider for the future is how **climate change** might be influencing the River Thames. According to experts, the tides of the Thames are rising around 60 cm every 100 years. If the tide continues to rise at this rate or faster it could have significant effects on the river and the land around it. On top of sea level rise, it is likely that more rainfall will occur in the winter months and more frequent storms may also occur. The Environment Agency predicts that these factors will increase the flood risk of properties in the Thames catchment by 20%!

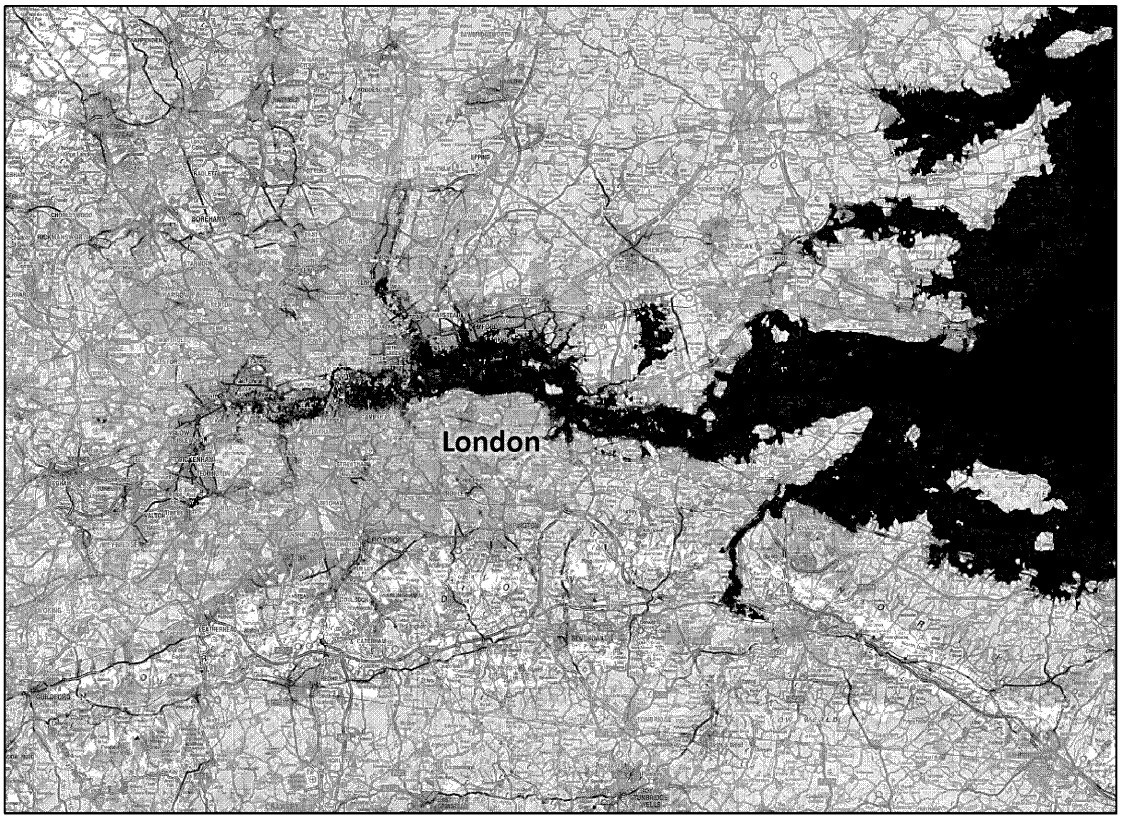


Figure 10 London with a six-metre rise in sea level

Human Influences on the River Thames

Human activities have heavily influenced the River Thames for thousands of years. When the Romans first invaded Britain, they saw how the Thames could be useful for trading and travel and so began building a settlement there, which they named Londinium. Since then, the Thames has been central to bringing wealth to the country. Throughout human history, the Thames has been shaped considerably by human activity.

As London developed, the increasing deforestation and urbanisation of the area has only made the river more prone to flooding due to the increase in impermeable surfaces being built.

Figure 11 River Thames in 1746

For centuries, the Thames was heavily polluted by the vast amount of sewage being thrown into it. In 1957, the river was pronounced as dead because the levels of pollution meant it could no longer support life. Thankfully, people no longer toss their sewage into the river and it now contains over 120 species of fish and occasionally the odd seal or dolphin.

There are 45 locks and weirs along the Thames river. These help make the river easy for boats to travel down as well as controlling the flow of water downstream. Their construction has also made the river narrow and deeper, which has had further effects on the flow of the river.

Figure 12 A lock along the Thames

Another way the discharge of the Thames has been affected is through the number of water treatment plants that extract the water for drinking water and sewage treatment. In recent years, demand for water has been growing in the region and this could mean even more strain is put on the river itself, further affecting its discharge.

However much human activities have shaped the Thames, there is still an element of the Thames shaping us through the constant threat of flooding. One of the biggest ways, therefore, that we try to influence the Thames is through flood management.

Flood Management

Due to the 13 million people living in the Thames Basin and the significance of some of the cities and towns, the Thames has been subject to plenty of flood management plans. This has come mostly in the form of hard engineering due to the scale and importance of the areas that need protecting.

Why is flood management needed?

In the Thames Estuary alone, there are around 1.25 million people and £200bn worth of property at risk of flooding. London transport, schools and hospitals are all also at risk. On top of this there are many important cultural sites, such as the Houses of Parliament and City Hall, which lie on the banks of the river. Further upstream, past the tidal section of the river, there are more major cities and towns at risk. The frequent floods over the last 20 years have increased the pressure to do something about this risk. Each section of the river has its own management strategies that are helping to alleviate the threat and damage of flooding.

The Flood Defence Plans

The Thames Barrier 	After the destruction of the 1953 floods in London, plans were put in place to create a barrier for flood protection from the tidal river. In 1982 the Thames Barrier was opened, stretching across 520 metres with gates 20.1 metres high. The barrier was very cleverly designed so that in normal tide the river is still navigable so any boats can get through. However, when a very high tide or storm surge is due to hit, the gates close, protecting the city from the high volumes of water.
Embankments and Flood Walls 	For centuries there were desires to build embankments along the Thames to help protect the growing city of London from the water. Eventually, in the nineteenth century, embankments were built in Victoria and Chelsea, both with sewerage systems running underneath them. In building the embankments on the foreshore of the river, they reclaimed 89,000 m^2 of land and hence made the Thames narrower. In addition to the embankments, flood walls stretch around 100 miles down the river Thames. When the Thames Barrier was built, 11 miles of flood defences were also strengthened downstream.
River Diversion Schemes 	Upstream from London, there have been various river diversion schemes put in place. These consist of man-made rivers that help to alleviate the amount of discharge in the main river. This is achieved by diverting some of the water on a different course before rejoining the river again downstream. Jubilee River is one example of this. It was built in the late 1990s around the areas of Maidenhead, Eton and Windsor. It is approximately 7.2 miles long and acts much like a natural river. The aim of the Jubilee River was to divert the water around the towns to protect 3,000 properties.

The Impacts

Social:

- The schemes are helping to protect many properties, transport systems and cultural landmarks that are key sites for London and the whole of the UK.
- There seems to be a lack of public awareness about the flood risks of the Thames and this means that people are not very prepared for the impacts of any flooding. So despite the flood management schemes they may still be at risk.
- The Jubilee River diversion was criticised after the 2014 floods for actually making the flooding worse for some residents. Although it alleviated the flooding in some towns, it actually made flooding worse in others.

Economic:

- Although these hard engineering schemes cost large amounts of money, the cost of damage from any floods in London would far exceed that of the cost of flood defence. It is, therefore, more economically beneficial to put the defences in place.
- However, the flood defences are in need of repairs, which can cost considerable amounts of money.
- There is also continued pressure to build more houses as the UK's population continues to grow. This means more and more houses are planned for the floodplains around the Thames. Despite the defence schemes, they could still be at risk if proper protection is not put in place.

Environmental:

- The construction process of many of these engineering schemes can mean the loss of some natural habitats.
- How climate change may affect the flood defence schemes is something that needs to be seriously considered. The Thames Barrier, for example, may need to adapt as sea levels rise or as storms become more frequent. Before 2014, the barrier had only been closed 124 times since 1984. However, during the winter storms of 2014, the barrier closed a staggering 50 times! Does this suggest that the high tides and storm surges are increasing at a rate that the flood defences may not be able to cope?

Fact table

Location:	South England
Source:	Kemble, Cotswolds
Mouth:	Thames Estuary into the North Sea
Length:	346 km
Number of counties it crosses:	8
Number of towns and cities it goes through:	18
Basin size:	12,935 km^2
Tributaries:	38
Number of locks:	45
Number of bridges:	Over 200
Source height:	108 m above sea level
Population in basin:	13 million
Daily movement of tidal section:	7 metres every day
Discharge:	Lower course = 17.6 m^3/s Middle course = 39.7 m^3/s Lower course = 65.9 m^3/s
Landforms:	Meanders Terraces Floodplains Estuary
Bedload in lower course:	300,000 tonnes
Most recent major flood:	February 2014
Number of severe flood warnings in Feb 2014:	14
Number of sandbags used in Datchet:	10,000
Geology of the basin:	Limestone Clay Chalk London clay
Average rainfall in south-east England:	690 mm per year
Climate change impact:	Flood risk will increase by 20%
Flood management schemes:	Thames Barrier Embankments and flood walls River diversion strategies

ICT interactive page

Rather than type out these web links go to **zzed.uk/8799**

Videos:

The River Thames – Introduction:

- **https://www.youtube.com/watch?v=qc57XUmHDoo**

2014 Thames Floods:

- **http://www.bbc.co.uk/news/uk-26123674**
- **http://www.bbc.co.uk/news/uk-26114540**

Ariel Footage of Thames Floods, 2014:

- **http://www.bbc.co.uk/news/uk-26117373**

Thames Barrier:

- **https://www.youtube.com/watch?v=Dvg2asACsG0**

The Jubilee River:

- **https://www.youtube.com/watch?v=GwiUPaA9BDo**

News Stories:

ITV – Flooded River Thames:

- **http://www.itv.com/news/2014-02-11/in-pictures-residents-evacuated-as-river-thames-floods/**

The Guardian – How Safe is London from Flooding?

- **https://www.theguardian.com/cities/2015/feb/19/thames-barrier-how-safe-london-major-flood-at-risk**

The Guardian – Climate Change and the Thames

- **https://www.theguardian.com/world/2016/jul/07/great-tide-is-britain-equipped-cope-glbal-warming**

BBC – Criticism over River Jubilee

- **http://www.bbc.co.uk/news/uk-england-berkshire-25727040**

Springboards

Springboard 1

1. What river landform can be seen in this map of the Thames?
2. Explain how this landform is created.
3. Over time, what other river landform might form here?

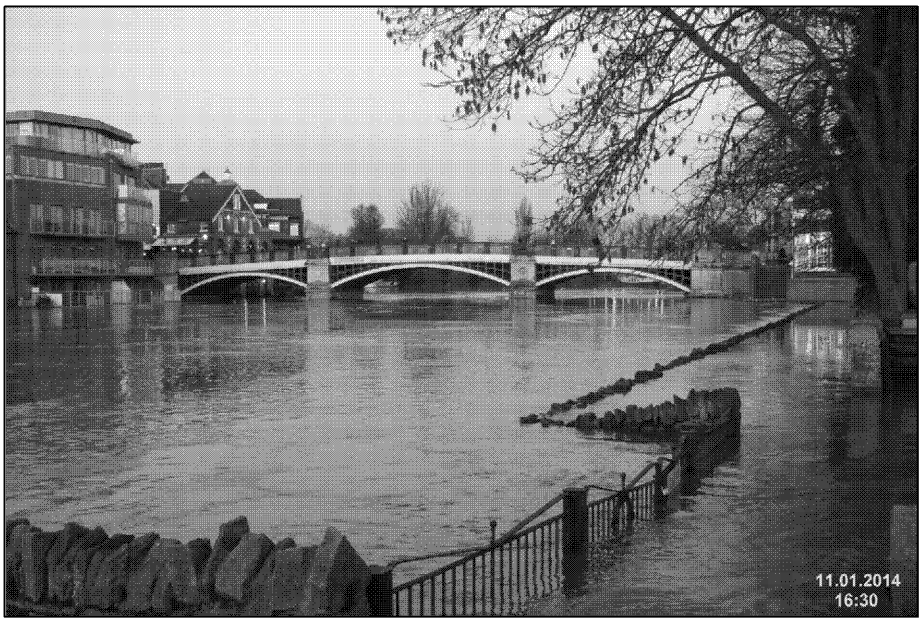
Springboard 2

1. Describe the features of an estuary.
2. Compare this image of the lower course of the Thames with your knowledge of the upper course.
3. What evidence does this image show of different fluvial processes?

Springboard 3

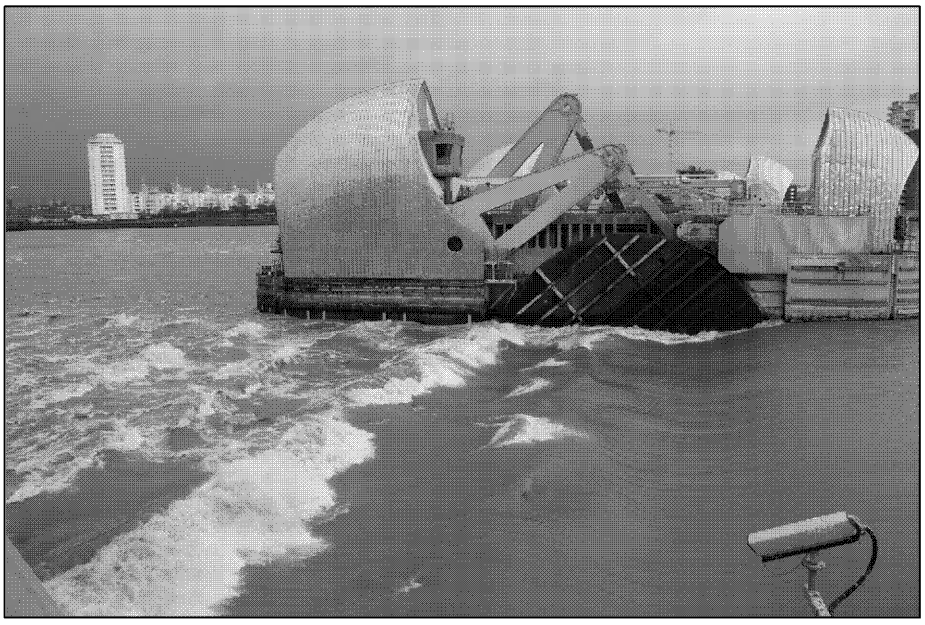
1. What does this image suggest about the relationship between London and the Thames?
2. Discuss whether London poses more of a threat to the Thames or vice versa.
3. Suggest the impact the flooding of the Thames could have on London.

Springboard 4



1. Suggest the causes behind the flooding of the Thames in this image.
2. Discuss the social, economic and environmental impacts this flooding may have caused.
3. Suggest some flood defence plans for the area in the image.

Springboard 5



1. Discuss why the Thames Barrier is so important to London.
2. Suggest other forms of flood defence that could be used in London.
3. Considering the potential impacts of climate change – what might the future of flood defence in London be?

Springboard Suggested Answers

Springboard 1

1	Meander
2	Meanders form through the fluvial processes of lateral erosion and deposition. As the gradient of the river has decreased, the water moves from bank to bank. The bank where the water is deepest and moving fastest is eroded. The sediment from this erosion is then deposited on the other side of the bank where the water is shallower and slower. This creates a meander and changes the course of the river.
3	An oxbow lake. This would form if the river flooded and formed a new straight channel making the meander no longer the course of the river.

Springboard 2

1	• Where the river meets the sea • Wide channel • Deep channel • Interesting habitats for wildlife • Lots of sediment • Any other valid point(s)
2	The lower course of the Thames has a very wide and deep channel. It holds the most sediment in the form of silt and fine particles. The lower course is at sea level. The upper course has a narrow and shallow channel. It carries a small bedload in the form of larger rocks. The upper course has a steeper gradient.
3	The image shows the evidence of deposition in the mud flats and silt that can be seen in the foreground. It also shows a very wide channel, which indicates lateral erosion.

Springboard 3

1	• The Thames and London are very interconnected. • Can see how London has formed around the Thames. The number of bridges shows this adaptation. • River still being used for transport etc. • Can see how the river has been manipulated with the flood walls / embankments. • Any other valid point(s).
2	London poses a threat to the Thames in the form of urbanisation, deforestation and pollution. These things have changed the way the river would naturally behave. We have also tried to control the river through flood management. However, the Thames itself poses a significant threat to London in the form of flooding that could cause a large amount of damage. It is also hard to predict exactly how the threat from the Thames will develop with climate change.
3	• Put over a million people's lives at risk • Could damage £billions worth of property • Damage to transport systems, such as the underground and overground rail services • Disrupt businesses • Damage important cultural sites • Any other valid point(s)

Springboard 4

1	• Heavy rain • Storms • Tidal surges • Geology of the riverbed • Human activities, such as the increase of impermeable surfaces due to urbanisation • Any other valid point(s)
2	Social: • Damage to personal property • Stop people from getting to work or school • Could cause hopelessness or despair over the damage to property and the community Economic: • Large cost of damage • Any damage to businesses means economic loss • Transport disruption causes economic loss Environmental: • Floods could have caused damage to any natural habitats or parks near the river • Could cause damage to sewers and, therefore, contaminate the floodwater
3	• Flood walls could be built or made taller • Embankments • Flood warning systems • River diversion scheme • Any other valid point(s)

Springboard 5

1	The Thames Barrier is London's main protection from tidal flooding • Protects significant amount of property and people • Protects significant cultural and political sites from flooding • Protects all the transport systems • Protects hospitals • Any other valid point(s)
2	• More floodwalls and embankments • Better flood warning system and preparedness • Modified buildings that cope well during floods • River diversions • Any other valid point(s)
3	With the potential of more frequent storms and sea level rise, flood defences in London will have to adapt to there being more floods. The Thames Barrier may need modifying to cope with being closed more often and with the rising sea level. Embankments and sea walls may need to be heightened. Residents of London will need to be more aware and prepared for the impacts of flooding.

Part 2: Exam Preparation

Summary

The River Thames

Introduction:

- The River Thames is a lowland river located in South England.
- It crosses eight counties from its source in the Cotswolds to its mouth into the North Sea.
- The basin is home to 13 million people and many major towns and cities, most notably London.
- It is England's longest river and the UK's second longest.
- It has a basin size of 12,935 km^2.
- The source is marked by a headstone in a field near the village of Kemble.
- The last 100 km of the river, as it flows through London, is tidal and moves up and down with the tide.

River profile and landforms:

- The size and shape of the Thames changes as you go downstream.
- It has quite a shallow gradient for its length as the source is only 108 metres above sea level.
- This means that the upper course does not have the usual features of an upper river and instead flows gently downhill.
- The upper course has a small discharge and its bedload is of large rocks.
- The middle course of the Thames is characterised by a wider and deeper channel than the upper course.
- Lateral erosion and its shallow gradient cause the river to meander.
- River terraces are also a feature of the middle course.
- The lower course is the river's widest and deepest section, with the largest discharge and bedload.
- It has features of both lateral erosion and deposition in the form of floodplains and an estuary as the river meets its mouth.

Flooding on the Thames:

- The Thames is prone to flooding. With the large population living in the basin and significant cities and landmarks the impact of flooding can be devastating.
- In the last century there have been 10 major floods, five of which occurred in the last 20 years.
- These floods can either be caused by the tide or by the river.
- In 1953 a large storm surge caused devastating floods along the Thames, where 300 people died.
- More recently, in 2014, major floods affected 1,700 homes in the Thames Valley. Fourteen severe flood warnings were issued as the Thames reached its highest level in 60 years.

Physical influences on the Thames:

- The geology and climate of the Thames have effects on the shape and flow of the river.
- The Thames flows over a variety of rock types. The chalk and limestone are permeable and allow water in, whereas the clay is impermeable.
- The river is more likely to flood over areas where clay is the bedrock.
- Despite the river being prone to flooding, South East England is actually a relatively dry region of the UK. However when heavy rain does hit it can cause flooding.
- Storm surges caused by low pressure in the North Sea can also cause tidal flooding of the Thames.
- Climate change could cause the Thames to flood more often with more frequent storms and sea level rise.

Human influences on the Thames:

- The Thames has been an important river throughout human history for commerce and trade and it helped to make London the city it is today.
- Humans have changed the Thames through activities such as urbanisation, pollution and water treatment.
- The main way humans have changed the Thames, however, is through flood management.
- This has mainly been in the form of hard engineering with the Thames Barrier, embankments, flood walls and river diversion schemes.
- Although it is expensive to build these defences, they are helping to save the significant costs of devastation from flooding.
- However, it is hard to predict whether climate change may render these defences useless.

The River Thames

Quick-fire Questions

1	Where is the Thames located?	
2	How long is the Thames?	
3	How big is the basin of the Thames?	
4	How many people live in the basin of the Thames?	
5	Where is the source of the Thames located?	
6	Where is the mouth of the Thames located?	
7	Where does the Thames become tidal?	
8	What does the long profile of a river show?	
9	How high is the source of the Thames above sea level?	
10	What is the discharge of the upper course of the Thames?	
11	Name one feature of the middle course of the Thames.	
12	What fluvial processes are happening in the middle course of the river?	
13	How much sediment does the lower course of the Thames hold?	
14	When was the last major flooding of the Thames?	

15	How many severe flood warnings were issued along the Thames?	
16	How many homes were affected in the Thames valley?	
17	Name an impermeable rock found in the Thames Basin.	
18	How much average rainfall does the south-east of the UK receive annually?	
19	Name one way climate change might affect the Thames Basin.	
20	Name one way human activities have influenced the Thames.	
21	What event inspired the creation of the Thames Barrier?	
22	How much land did the building of the embankments claim from the river?	
23	Name one social impact of the flood defence schemes along the Thames.	
24	Name one economic impact of the flood defence schemes along the Thames.	
25	Name one environmental impact of the flood defence schemes along the Thames.	

Quick-fire Answers

1	Where is the Thames located?	*South England*
2	How long is the Thames?	*346 km*
3	How big is the basin of the Thames?	*12,935 km²*
4	How many people live in the basin of the Thames?	*13 million*
5	Where is the source of the Thames located?	*In a field near Kemble in the Cotswolds.*
6	Where is the mouth of the Thames located?	*The Thames Estuary, going into the North Sea.*
7	Where does the Thames become tidal?	*Teddington Lock*
8	What does the long profile of a river show?	*The height of the river above sea level compared to its distance from the source.*
9	How high is the source of the Thames above sea level?	*108 metres*
10	What is the discharge of the upper course of the Thames?	*17.6 m³/s*
11	Name one feature of the middle course of the Thames.	*Meander* *River terraces*
12	What fluvial processes are happening in the middle course of the river?	*Lateral erosion and deposition*
13	How much sediment does the lower course of the Thames hold?	*300,000 tonnes*
14	When was the last major flooding of the Thames?	*February 2014*
15	How many severe flood warnings were issued along the Thames?	*14*
16	How many homes were affected in the Thames valley?	*1,700*

17	Name an impermeable rock found in the Thames Basin.	*Clay*
18	How much average rainfall does the south-east of the UK receive annually?	*690 mm*
19	Name one way climate change might affect the Thames basin.	*Sea level rise* *More frequent st*
20	Name one way human activities have influenced the Thames.	• *Urbanisation* • *Pollution* • *Extraction of* • *Locks and we*
21	What event inspired the creation of the Thames Barrier?	*The 1953 floods*
22	How much land did the building of the embankments claim from the river?	*89,000 m²*
23	Name one social impact of the flood defence schemes along the Thames.	• *Protects peop* • *Protects impo* • *Lack of public could be desp* • *The Jubilee R different area*
24	Name one economic impact of the flood defence schemes along the Thames.	• *Saves money* • *Although mo defences alre* • *Pressure to b on floodplains defences in pl*
25	Name one environmental impact of the flood defence schemes along the Thames.	• *Damage to na* • *Uncertainty defence schem modifications*

Extension Questions

1. Describe how the Thames changes from its source to its mouth.

2. Explain why the discharge of the river changes as you go downstream.

3. Suggest the social, economic and environmental impacts of the 2014 floods on the Thames.

4. Explain how geology and climate can influence the River Thames.

5. Suggest how climate change could impact the Thames in the future.

6. The Thames is the most densely populated river basin in the UK. In what ways does this affect the river?

7. Explain why flood management schemes are needed in the Thames Basin.

8. Explain why hard engineering schemes were chosen for flood defence on the Thames.

9. Suggest what the Thames would be like without any flood management.

10. Discuss whether you think the Thames flood management schemes are sustainable.

Extension Answers

1. The Thames changes in several ways as it flows from its source to its mouth.
   - At its source and in the upper course of the river it is a narrow, shallow channel with a low bedload. It is at its steepest here although it is not as steep as a usual upper river, meaning there are fewer landforms. The main process is lateral erosion that cuts down into the riverbed due to gravity.
   - In the middle section of the river the channel is wider and deeper. It has also gained more bedload and has greater velocity. Due to the shallower gradient in this section the river erodes laterally, forming features such as meanders.
   - The lower section of the river has the widest and deepest channel with the largest bedload. It holds its largest discharge and moves at its greatest velocity. The main process that occurs here is deposition with some lateral erosion, which has created floodplains.

2. The discharge of the river increases as the river flows from its source to its mouth.

   This is because all the tributaries in the basin drain into the river as it flows downstream.

   By the lower course, all the tributaries in the basin have drained into the main river and the discharge is at its greatest.

3. Social:
   - Damage to over a thousand homes
   - Emotional damage to the residents and communities where the flooding happened
   - Any other valid point(s)

   Economic:
   - Significant costs in damage to property and infrastructure
   - Travel disruptions cost the country money
   - More money to be invested in flood defence schemes
   - Any other valid point(s)

   Environmental:
   - Damage to natural habitats close to the river
   - Damage to sewers can contaminate floodwater and pose a health risk
   - Takes a while for ground to recover from the floodwater
   - Any other valid point(s)

4. Geology:
   - Impermeable rocks, such as the London clay, make the river more prone to flood in that area.
   - Permeable rocks, such as chalk, make flooding less common in that area. They also act as aquifers, which means people can extract water from them, which can affect the discharge of the river.

   Climate:
   - Storms and heavy rain can cause the river to flood.
   - Storm surges cause the tide to rise abnormally high in the tidal section of the river.

5. Impacts of climate change in the Thames:
   - More frequent storms could cause more flooding and more storm surges up the river.
   - Sea level rise could also cause more flooding.
   - Warmer and drier summers could decrease the discharge of the river naturally as well as unnaturally as more people demand more water.

6. Potential effects of large population in the Thames Basin:
   - More urbanisation and deforestation around the Thames causing the flood risk to increase.
   - It means the Thames has been adapted by human activity. For example, the considerable number of locks and weirs to make it easy to travel down.
   - More strain on the Thames to provide drinking water and water for sewage treatment.
   - More chance of the Thames becoming polluted.
   - Any other valid point(s).

7. Reasons for flood management on the Thames:
   - The high population – lots of people need protection.
   - London being such an important city it needs to be protected.
   - Cheaper to try to manage the floods than pay for the damage.
   - Floods also occur fairly frequently, making flood defence viable.
   - Any other valid point(s).

8. Reasons for choosing hard engineering:
   - There are many people and a lot of property and important infrastructure to protect and hard engineering is the most effective way of doing that.
   - Hard engineering techniques are known for being more successful than soft engineering techniques.
   - The cost of the damages from flooding would be significant so, despite the large costs of hard engineering, it is worth it.

9. The Thames with no flood management:
   - Considerable area of London would be prone to frequent flooding and, therefore, the city may have retreated. This would probably be true for various settlements around the Thames.
   - The river would be wider in places; for example, where embankments have been built on the old foreshores of the Thames.
   - There may be more meandering of the river.
   - Greater floodplains.

10. Sustainable:
   - They help to protect the towns and cities in the region over a long period of time.
   - They are effective in their job.
   - For the Thames it is economically and socially sustainable because it would cost a lot more in damages if the defences weren't in place.
   - Any other valid point(s).

   Unsustainable:
   - Because the schemes are hard engineering they can cause long term-damage to the environment during construction
   - They also stop the natural flow of the river.
   - They do not take into account how the river may change in the future. For example, with climate change more defences may be needed.
   - Any other valid point(s).

Exam-style Question

Supporting GCSE AQA Geography

Using **Figure 1** to help you, evaluate whether hard engineering is better than soft engineering for flood management.

[9 marks (+3 SPaG)]

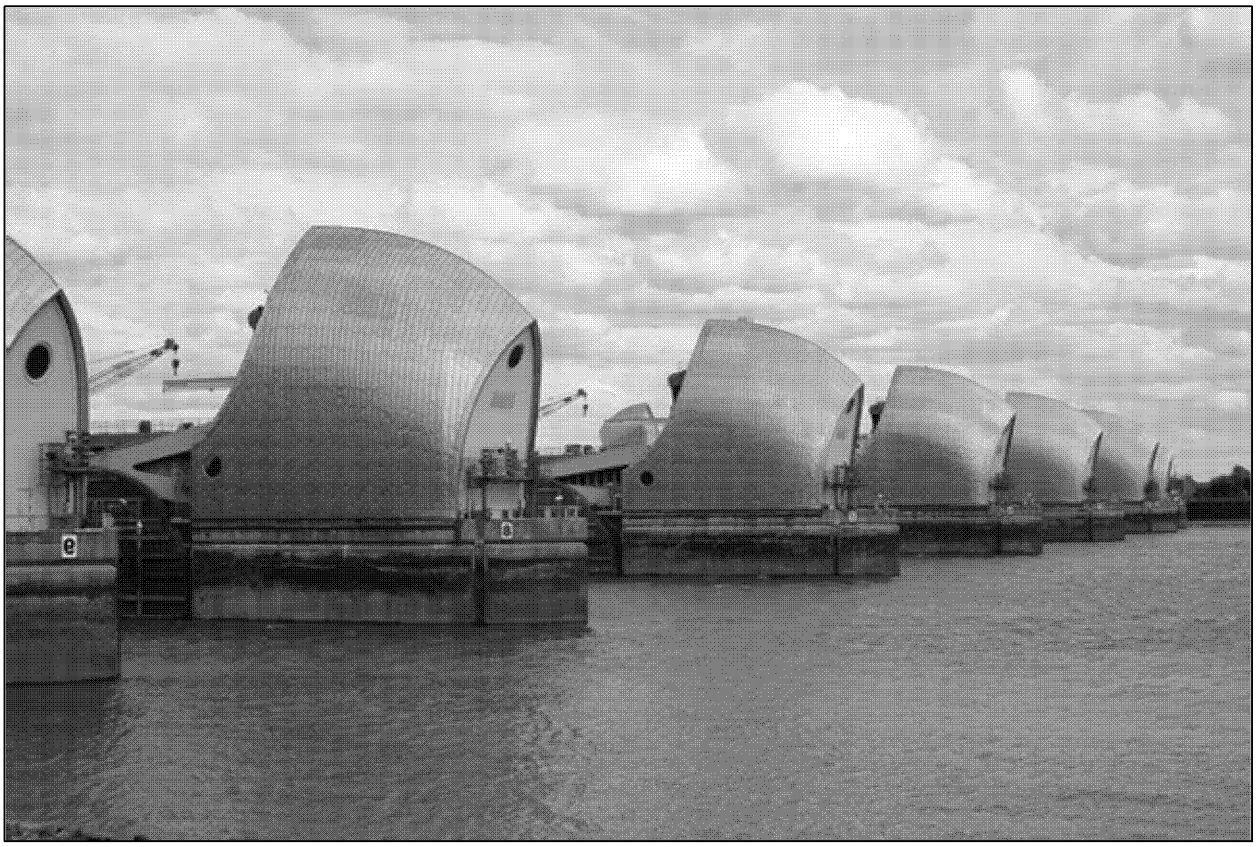


Figure 1 The Thames Barrier is an example of hard engineering used along the River Thames

Level Marking

Level	Mark	Description
1	1–3	• The student evidences basic knowledge of the topic in question. (AO1) • The student evidences limited understanding of the connections that exist between places, environments and processes. (AO2) • A limited ability to evaluate is evidenced through basic application of knowledge and understanding. (AO3)
2	4–6	• The student evidences some knowledge of the topic in question. (AO1) • The student evidences good understanding of the connections that exist between places, environments and processes. (AO2) • A reasonable ability to evaluate is evidenced through adequate application of knowledge and understanding. (AO3)
3	7–9	• The student evidences thorough knowledge of the topic in question. (AO1) • The student evidences a firm understanding of the connections that exist between places, environments and processes. (AO2) • A strong ability to evaluate is evidenced through logical application of knowledge and understanding. (AO3)

Indicative Content

- Students should offer an evaluation of the effectiveness of hard engineering techniques for flood management compared to soft engineering techniques.
- They may use specific examples of flood management schemes.
- Figure 1 is merely a guide towards examples of hard engineering strategies for flood management.
- Question requires students to apply the advantages and disadvantages of soft and hard engineering in flood management.
- The student should also clearly demonstrate a comparative assessment of hard and soft engineering strategies for flood management. Lower-level marks will be given for students who do not form an argument.

Suggested Content

Using the examples from the River Thames flood management schemes.

For hard engineering	For soft engineering
• Hard engineering schemes are generally more effective in protecting against the risk of flooding than soft engineering. For example, the Thames Barrier is very effective in stopping London from flooding by controlling the amount of water in the river. • Despite the costs of hard engineering being greater than soft engineering, the cost of clearing up after a flood would be far greater than the cost of putting these defences in place. • However, it does depend on what is at stake along the river. For example, hard engineering along the Thames is vital for protecting London. • Climate change could cause more flooding, which could increase the need for more hard engineering defences and at the same time mean that many of the hard engineering we already have in place won't be able to cope.	• Soft engineering, however, is far cheaper than hard engineering as well as being more sustainable. • Hard engineering flood defences also need costly repairs fairly regularly. • Putting hard engineering in place can just cause a worse flooding problem elsewhere. For example, the river diversion scheme on the Thames caused worse flooding in a different town. • Despite all the hard engineering along the Thames, there is a lack of public awareness about flood risks which means people are not prepared for the impacts of flooding. Public awareness is something that soft engineering techniques focus on. • The construction process of building hard engineering can cause damage to the environment. Soft engineering is less damaging towards the environment.

Spelling, Punctuation and Grammar (SPaG) – Total of 3 marks.

For 1 mark:
- Student shows some ability to spell and punctuate correctly.
- Student shows limited use of grammar to convey their argument.
- Student utilises a basic range of geographical phrases.

For 2 marks:
- Student generally uses good spelling and punctuation throughout.
- Student shows some accurate use of grammar to convey their argument well.
- Student utilises an adequate range of geographical phrases.

For 3 marks:
- Student uses correct spelling and punctuation throughout.
- Student shows accurate use of grammar to clearly convey their argument.
- Student utilises a broad range of geographical phrases.

