River Basin Landscape Case Study: The River Severn

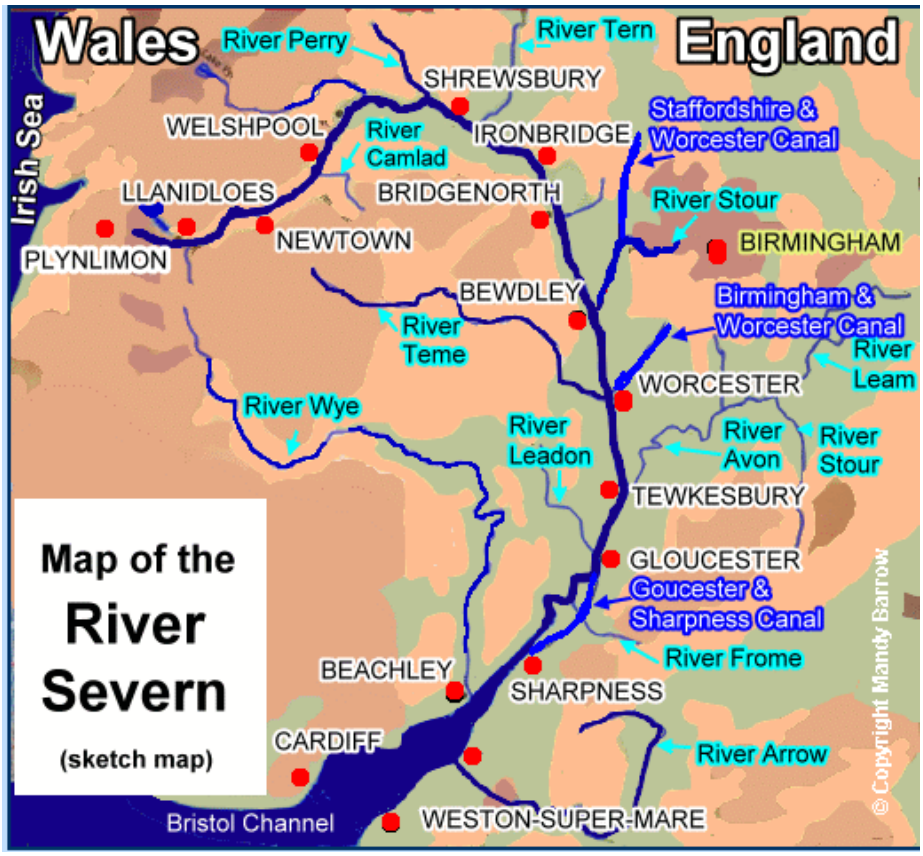
[a] Locating the drainage basin

Wiki page about the source and mouth

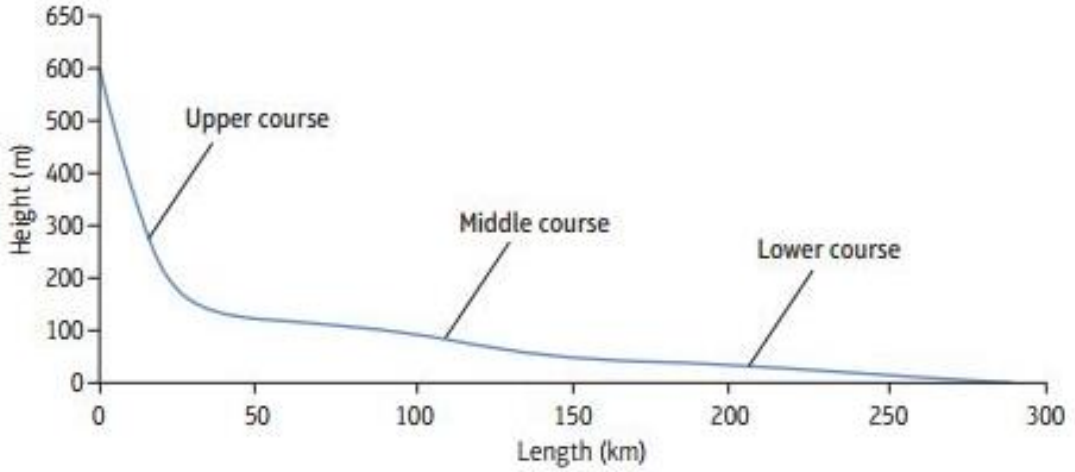
https://en.wikipedia.org/wiki/River_Severn

Did you know?

The River Severn is the longest UK river, at 354 km long, including its **estuary**. With its large drainage basin and many tributaries, the Severn has the biggest UK discharge, reaching 107 cumecs near Gloucester.



[b] Landforms along the Severn



Upper course: Source, v-shaped valley, waterfall, gorge

Middle course: meanders (including slip off slopes and river cliffs), ox-bow lakes

Lower course: flood plain, mouth

[c] How are these landforms influenced by geology and climate?

The Upper course

The source of the River Severn is on the slopes of the Plynlimon Hills, 610m a.s.l. Here in the welsh hills, annual rainfall exceeds 2500mm and run off is high, due to the steep upland slopes. The geology is mainly hard rocks, like shale, which is impermeable and grit. Near the source the channel is narrow and shallow and full of angular stones, so friction with the bed and banks slows the river down. The river mainly erodes vertically, forming a V shaped valley with steep slopes, where processes such as soil creep and mass movement are active.

The Middle Course

As the Severn leaves the upland areas and flows downstream towards Shrewsbury, the climate changes. Rainfall drops to below 700mm per year. The rocks are softer and more permeable including sandstones, conglomerates and gravel. The river is wider and deeper. The river now erodes sideways (lateral erosion) as well as downwards, so the valley becomes wider and flatter, creating a flood plain. Deposition occurs on the inside bends of meanders and

during flooding. Sediment in the river is becoming smaller and rounded. As more tributaries join the Severn, its discharge increases.

The Lower Course

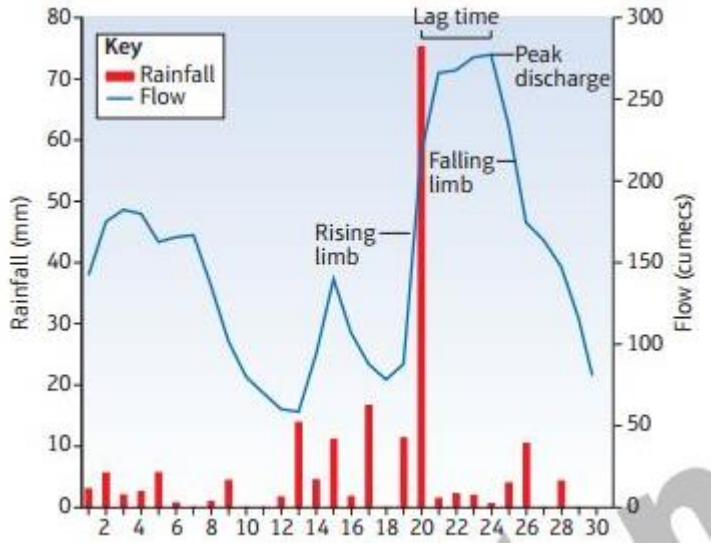
The geology in the lower Severn valley is mainly soft mudstone and lias covered with alluvium, sand and gravel. The river channel is much wider, 70m by the time it gets to Tewkesbury. Because the channel is wide and deep there is less friction, so velocity is at its highest. Major tributaries increase the discharge even more. Lateral erosion continues to widen the river. Deposition occurs, especially at the river mouth where the flow is slowed by the sea.

[d] How does the drainage basin respond to rainfall?

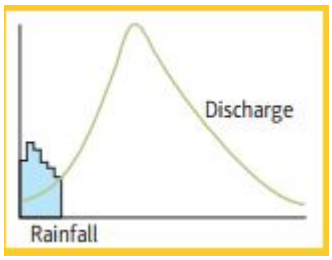
When it rains, how much rainfall reaches the river depends upon the amount and type of rainfall and what the drainage basin is like. A **hydrograph** is a way of showing how a river responds to a rainfall event.

On the following page is a hydrograph for the River Severn at Bewdley in July 2007. River flow is measured in cubic metres per second (cumecs). Note the delay between maximum rainfall and maximum river level. This is because only 5% of all rain falls directly in the river, in fact much of it infiltrates the soil or is intercepted by vegetation. The time difference between the maximum rainfall and the maximum river level is called the **lag time.** This hydrograph has a 'flashy' shape. This means the water level increases rapidly (steep rising limb) and decreases rapidly too (steep falling limb), this is probably where the term 'flash flooding' comes from. Some rivers have 'flat' hydrographs.

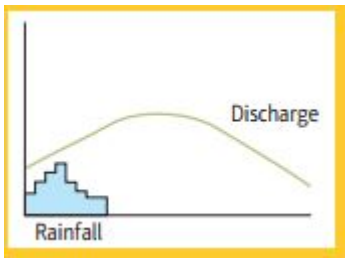
A hydrograph for the River Severn at Bewdley in July 2007



Flashy



Flat



The shape of the hydrograph is affected by a range of human factors and physical (natural) factors.

Precipitation amount	**Soil conditions** –	**Precipitation intensity**	**Soil type**
Urban or rural	**Antecedent conditions**	**Afforestation vs deforestation**	**Drainage basin shape**
Relief	**Geology**	**Soil depth**	**Vegetation**

Some examples of these factors include ……..

Precipitation amount – lots vs little	**Soil conditions** – eg frozen; saturated; dry	**Precipitation intensity** – short shower vs heavy rainstorm	**Soil type** eg clay or sand
Urban or rural (affects amount of roads and buildings and impermeable surfaces)	**Antecedent conditions** – has there been any rainfall in the run up to this period of rain	**Afforestation vs deforestation**	**Drainage basin shape** – in circular basins it takes longer for water to reach the channel
Relief – steep slopes vs gentle slopes or flat land	**Geology** – permeable or impermeable	**Soil depth** – deep vs shallow	**Vegetation** – very little/none vs lots of

[e] How do physical and human processes interact to cause flooding?

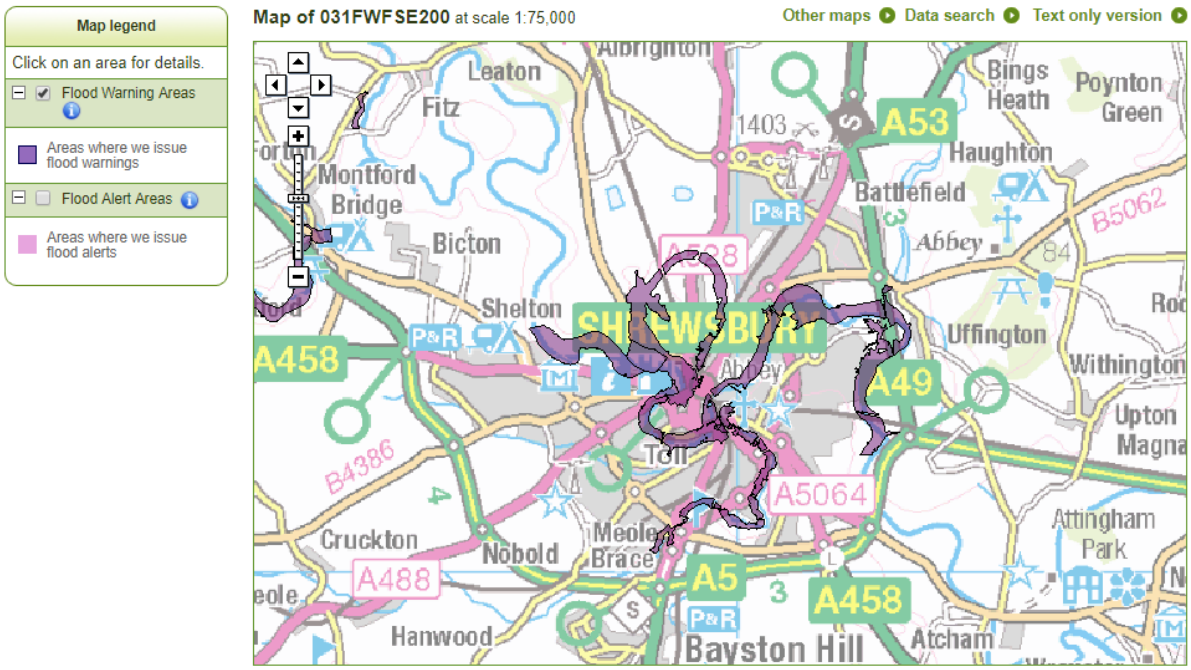
In the past the River Severn was a major waterway, which is why it became a trade route, which helps explain why so many settlements grew up alongside

it, especially at bridging points like Shrewsbury, Bewdley and Gloucester. These are often affected by flooding, more so as their populations have grown.

Flooding is a problem for Shrewsbury. The most recent flood occurred on the 10th of February 2014. Before that 2000 and 2007 were difficult years. In 2014, water levels reached 4.6 metres and affected many areas. Flooding occurs when a river carries more water than its channel can hold, so it 'bursts its banks.

Many of the Severn floods have been caused by catchment change. There has been an increase in the amount of impermeable surfaces as the town has developed and expanded. When Shrewsbury has a prolonged amount of rainfall, less water can infiltrate the soil, which increases the amount of surface run off. This water will run-off into the river and causing the river discharge to increase more quickly thus the chance of flooding is increased. The area where Shrewsbury sits was once dense forest. This was cleared to make way for the town. Vegetation such as trees can intercept and 'hold' rain water. Moreover, the trees can take up some of the water from the saturated soil and store it for themselves.

The winter of 2013/2014 was one of the wettest on record. The Shrewsbury area received 487mm of rainfall between 01/12/13 and 19/02/14, almost twice what it usually gets. The cause was a series of Atlantic storms that lashed the whole of the UK. After months of rain the ground was saturated (wet through) and water levels were dangerously high. The Environment Agency, issued flood alerts [see map below].



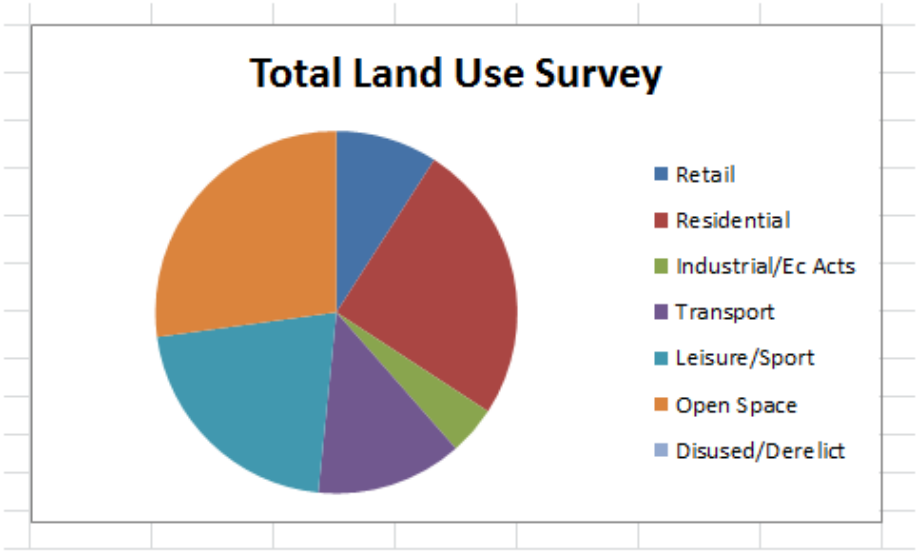
[f] How does flooding affect Shrewsbury? [river affects human activity]

These are the fieldwork results of a Geography student from 2016

Data Rep 1: Land Use Survey

Land Use Survey

Percentage of Site Allocated to Each Land Use	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	Total
Retail	0	0	20	10	75	0	0	0	0	0	0	0	105
Residential	0	0	0	40	0	0	0	0	45	95	20	90	290
Industrial/Ec Acts	0	10	0	0	0	0	0	0	0	0	40	0	50
Transport	1	90	0	5	0	0	5	5	10	5	30	0	151
Leisure/Sport	80	0	20	5	30	50	0	15	45	0	0	0	245
Open Space	19	0	20	40	0	50	95	80	0	0	0	10	314
Disused/Derelict	0	0	0	0	0	0	0	0	0	0	0	0	0



Almost half of the land use in Shrewsbury is open space or leisure/sport which is low value land. One third of the land is used for retail or residential which has a very high land value.

Open space and land used for leisure/sport can be abandoned or closed when the river has flooded. The level of damage will be very low although there may be a minor inconvenience for the people who usually use this space. However, the river is more likely to flood in the winter when these outdoor spaces are not likely to be used very much. This is an example of soft engineering and planned land use zoning.

This is socially sustainable because although there may be minor inconveniences for people, they won't be vulnerable to the flood. In addition, it is cost effective

(economically sustainable) as there aren't any maintenance costs and there's minimal disruption to natural habitats (environmentally sustainable).

[g] What is being done by humans to minimise the risk of flooding in Shrewsbury?

River (flood) management schemes fall into two categories, hard engineering and soft engineering.

Data Rep 3: River Management Survey

River Management Survey

Evidence that this area/site is being managed	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12	Total
None Present	N	N	N	N	N	N	N	N	N	N	N	N	12
Hard Engineering	BS	FBD	N	FBF & BS	D, BS	G & BS	BS	BS	BS	N	BS	N	9
Soft Engineering	V	N	N	V	N	N	N	V	N	V	N	V	5
Building Design Modified	RB	RB	N	RB	RB	N	RB	RB	RB	RB	RB	RB	10
Planned Land Use Zoning	LUZCP/OS	LUZCP	LUZB	N	N	LUZOS	LUZOS	LUZOS	LUZOS	P	LUZOS	LUZOS	10

Key

Hard Engineering

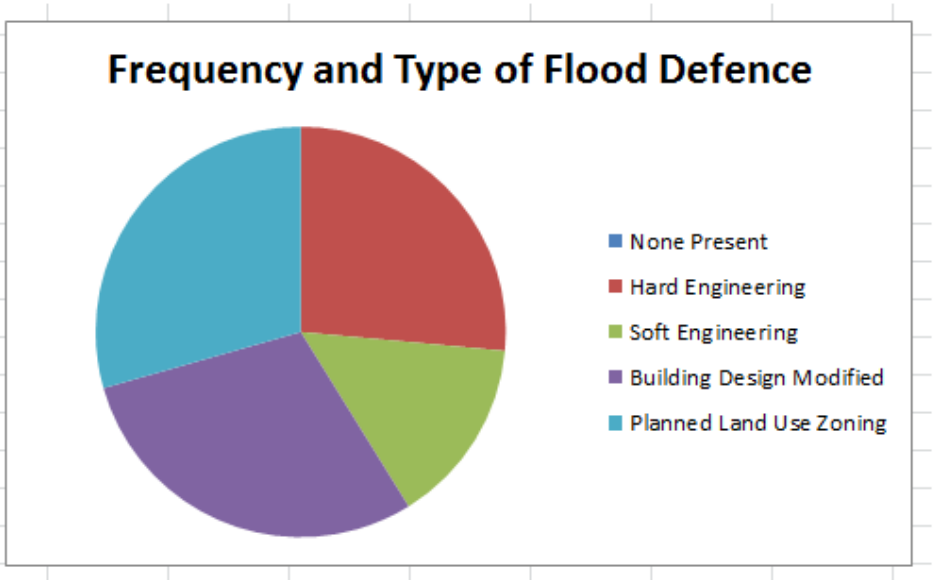
N=No
BS=Bank Strengthening
FBD-Flood Barriers (demountable)
FBF=Flood Barriers (fixed)
D=Drainage
G=Gabions
R=Raised Buildings

Soft Engineering

V=Vegetation

Land Use Zoning

LUZCP=Car Park
LUZOS=Open Space
LUZB=Set Back Buildings



Just over a quarter of all flood management used in Shrewsbury is hard engineering. Almost two thirds of the flood defences are either building design

modified or planned land use zoning. All sites have at least one type of management strategy present. 75% of the sites have hard engineering present and 42% have at least one example of soft engineering present. 83% of the sites have modified buildings and planned land use zoning.

It seems that Shrewsbury has prioritised soft engineering over hard engineering. This may be because hard engineering is more expensive and has higher maintenance costs. Additionally, it is difficult to install and may damage natural habitats. Soft engineering is less expensive and ensures that habitats aren't damaged. However, where Shrewsbury has used hard engineering, it is mostly small-scale bank reinforcement and is fairly visually unobtrusive. There is one large-scale hard engineering scheme at Frankwell (demountable flood barriers).

Soft engineering is more economically sustainable for Shrewsbury as it isn't as expensive and doesn't have high maintenance costs like hard engineering does.

"In conclusion, I believe that the soft engineering strategies in Shrewsbury are sustainable as only minor inconveniences may be cause for people when the land floods. They are economically and environmentally sustainable as the flood doesn't cause damage to buildings or property that would be expensive to repair.

The hard engineering strategies may not be seen as sustainable as they can be very expensive and can be seen as 'aesthetically displeasing'. However, in the long-term they will save money that would have had to be spent on repairing damage done by the flood (economically sustainable). Additionally, there aren't very many hard engineering strategies used in Shrewsbury and they aren't very obvious unless you know they're there. They are socially sustainable as they protect people from injury and death. Because of this, I would say the hard engineering strategies are mostly sustainable, although they may not be totally environmentally sustainable as they are made of non-natural materials which have released CO2 emissions during manufacturing. Therefore, I believe the flood defences in Shrewsbury are mostly sustainable." [KG 2016 ADA Geography student].

Humans managing flooding

Demountable barriers can be put in place during a flood to stop the water from causing damage, injury and death.

Although, the initial cost is very expensive, the barriers will save money in the long-term that would have to be spent on repairing damage.

The barriers are designed to 'blend in' with the surrounding environment so they're not 'eye-sores' to people. Outcome = SUSTAINABLE

A pumping station is used to pump the water out of the town quicker to prevent flooding.

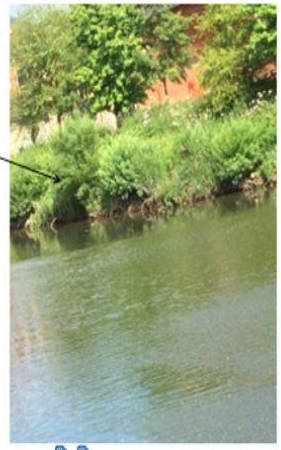
Although this may work for Shrewsbury, it may cause problems further downstream which means it is not sustainable.

Raised buildings prevent damage to houses if the river was to flood. Outcome = SUSTAINABLE

Land Use Zoning – the land is used for open space or leisure/sport activities so it is allowed to flood during the winter when it is unlikely that the land will be being used.
Trees and vegetation – when it rains, the water will be intercepted.
Grass – the grass allows the water to be infiltrated into the ground when it rains.

Bank strengthening

Vegetation intercepts the rainfall and grassed areas allow excess water to infiltrate rather than contribute to the base flow of the river.

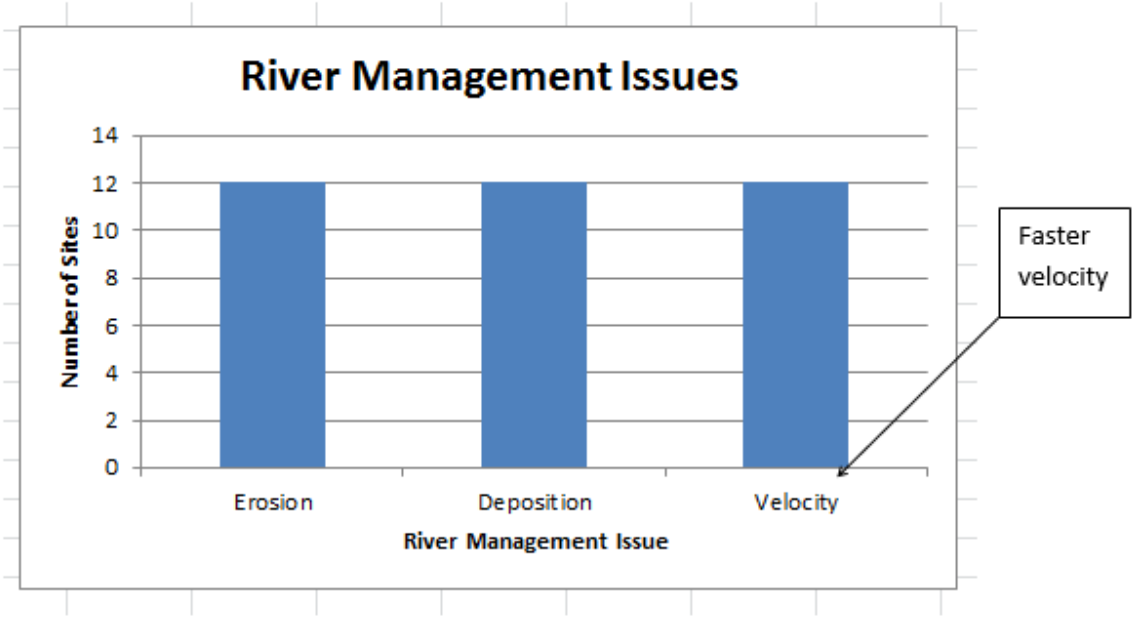


Demountable barriers

Demountable barriers

Data Rep 4: Impacts of Flood Defences on River Processes

River Management Issues Survey evidence that flood management is changing river processes?	S1	S2	S3	S4	S5	S6	S7	S8	S9	S10	S11	S12
Erosion	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes	Yes
Deposition	No	No	No	No	No	No	No	No	No	No	No	No
Velocity	Faster	faster	Faste	Faster	Faste	Faster	Faster	Faster	Faster	Faste	Faster	Faster



All 12 sites showed evidence of erosion, deposition and a faster velocity.

Some management strategies are designed to straighten the river bank and therefore increase the speed of the river. This is good for Shrewsbury as it means the water will travel out of the town quicker, meaning the river is less likely to flood in Shrewsbury. Other river management strategies are designed to strengthen and raise the river banks. This helps Shrewsbury when the river rises as the management strategies are still in place and also means that floodwater is contained for longer to give time for people to modify behaviour/vulnerability, which is socially sustainable.

By increasing the velocity, the water flows through the town quicker which is sustainable for Shrewsbury. However, this may cause problems downstream so therefore it isn't entirely sustainable.