DP IB Geography: SL

Your notes

Flooding & Flood Mitigation

Contents

Flood Hydrographs

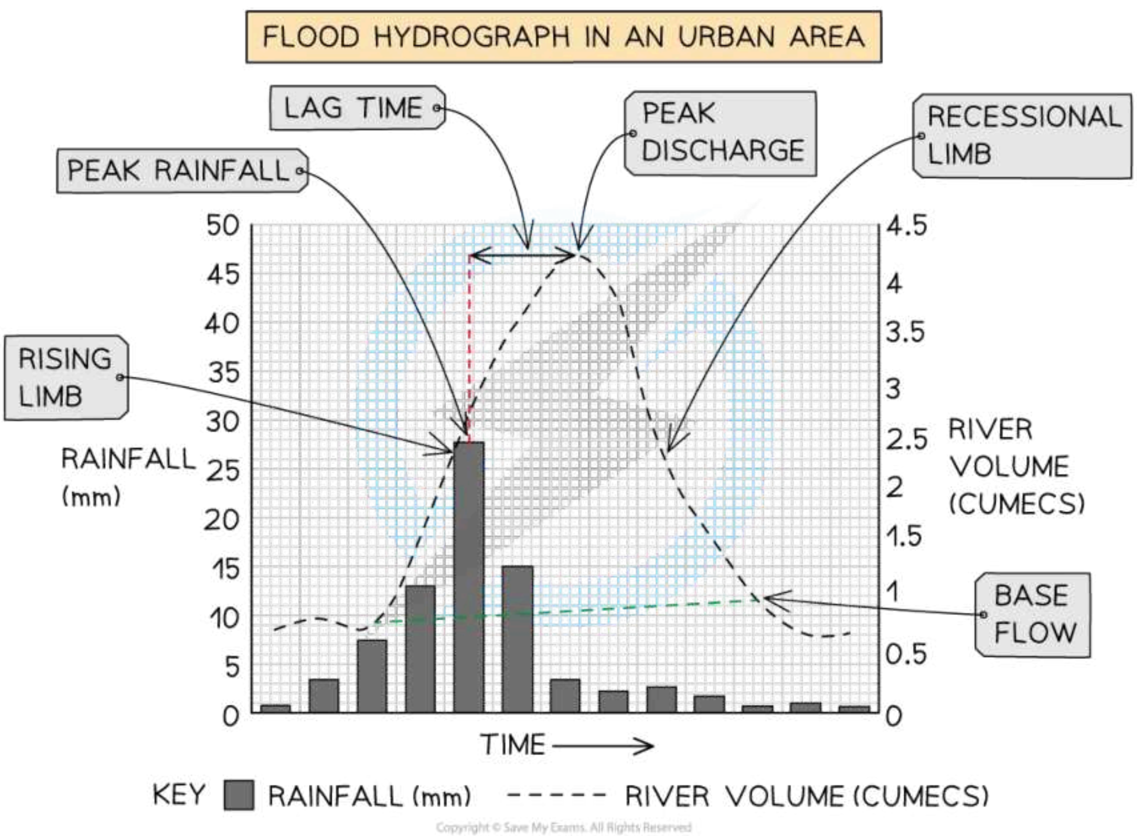
Your notes

Flood Hydrographs

Hydrograph characteristics

- Flood hydrographs show how a river channel responds to a storm event
- They compare two variables:
  - Rainfall received during an event in mm
  - River discharge in m^3/sec (cumecs)

A flood hydrograph



A flood hydrograph

- **Rising limb:**

- Indicates the speed of water is increasing in the channel
- Indicates the amount of discharge
- In a flash flood, the rising limb will be steep
- In small drainage basins, the response is rapid
- It is steep in urbanised areas

- **Peak flow or discharge:**
  - This is the maximum amount of water held in the channel
  - In large basins, discharge will be high
  - There are lower infiltration rates in steep catchments
  - There is more throughflow in flat catchments
- **Lag time:**
  - The time between peak rainfall and peak discharge
  - Influenced by stream order, basin shape and steepness
- **Run-off curve:**
  - Shows the relationship between overland flow and throughflow
  - Overland flow dominates when rainfall is strong and the surface is impermeable
- **Base flow:**
  - When groundwater seeps into the channel
  - The main, long-term supply of a river's discharge
- **Recessional or descending limb:**
  - Shows the speed that water level drops in the channel
  - It is influenced by local aquifers
  - It is influenced by local geology
  - Larger catchments have less-steep recessional limbs
- **Hydrograph size:**
  - The higher the rainfall the greater the discharge
  - The larger the basin size the greater the discharge

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River regimes

- A **river regime**, also known as an **annual hydrograph**, shows the pattern of **seasonal variation** in river discharge over a year
- Different conditions in different locations produce different levels of discharge over the course of a year, such as:
  - Changes in evapotranspiration – big swings in discharge in tropical rivers relate to the wet and dry seasons
  - Rock and soil type – permeable rocks reduce discharge most of the year
  - Vegetation cover
  - Amount of precipitation – spring increases often suggest melting snow
- **Yukon river regime**:
  - In winter months, the Arctic soils are frozen solid
  - Limited throughflow or surface run-off means the river flow is reduced
  - Snowmelt in the spring contributes to rising river levels
  - When permafrost melts the soils release water into the drainage basin
  - Yukon has a short summer and the catchment starts to refreeze, leading to a gradual drop in the river level

Graph showing annual discharge of the River Yukon, Alaska

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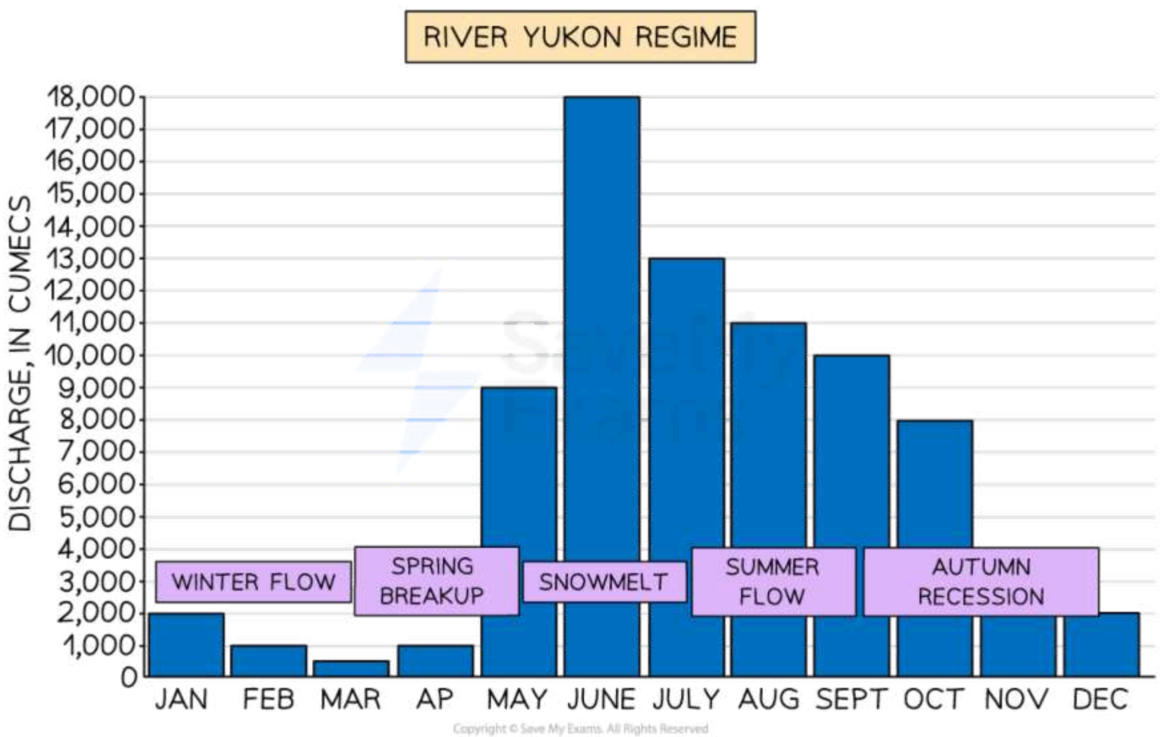

Graph showing annual discharge of the River Yukon, Alaska

Factors Affecting Flood Risk

- When rivers cannot contain all the water they are transporting a flood will occur
- Water flows out of the channel onto the floodplain
- The **recurrence interval** is the frequency of flood events
- Very large flooding events occur infrequently
- Causes of flooding can be physical or human

Physical factors affecting flood risk

Table of Physical Factors Affecting Flood Risk

Physical	Influence on Flood Risk
Precipitation type and intensity	Intensive rainfall produces overland flow Intense rain compacts the ground, reducing infiltration

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	Low intensity rainfall will most likely percolate the soil, reducing the peak of the flood Rapid melting of snow can cause high rates of overland flow
Temperature and evapotranspiration	Warm air can hold more water Higher temperatures lead to more evaporation, which means less water in the rivers
Antecedent moisture	If the ground is saturated, overland flow will quickly be produced
Drainage basin and shape	Smaller drainage basins respond more quickly to rainfall conditions Circular basins respond more quickly to floods than linear basins
Drainage density	Urban basins with sewers flood very quickly
Slopes	Steeper slopes create more flooding
Vegetation type	Deciduous trees lose their leaves and therefore there is less interception
Land use	Impermeable surfaces increase overland flow
Porosity of rocks and soils	Chalk and gravel are permeable and allow for percolation

Human factors affecting flood risk

Urbanisation

- Urbanisation increases the magnitude and frequency of floods in three ways:
  - Creating impermeable surfaces, such as roads
  - Creating gutters and sewers, which increase drainage density
  - Riverside facilities reduce **carrying capacity**
- Urbanisation has a greater impact on the lower section of the drainage basin due to there being more urbanisation in this section
- There are hydrological effects of urbanisation:

- The removal of trees can decrease evapotranspiration and interception
- The construction of houses and other commercial businesses can increase peak discharge
- The construction of storm drains will provide local relief but this may aggravate flood problems lower down the river

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Deforestation

- Similar impact to urbanisation
- Deforestation can increase flood run-off
- Deforestation decreases channel capacity due to an increase in deposition in the channel
- In the Himalayas, there is evidence that changes in flooding and increased silt is due to high monsoon rains and unstable terrain
- Deforestation occurs over a broad area

Channel modification

- Channelisation creates new channels
- Channelisation speeds up water movement, reducing lag time
- Enlarging channels through levees allows more water to be carried
- The purpose of channelisation is to reduce the threat of floods
- Small-scale and medium-sized floods can be reduced through the use of levees
- Breaks can occur in levees when hurricanes cause severe floods
- **Scouring** allows the river to carry more water

Flood Prediction & Mitigation

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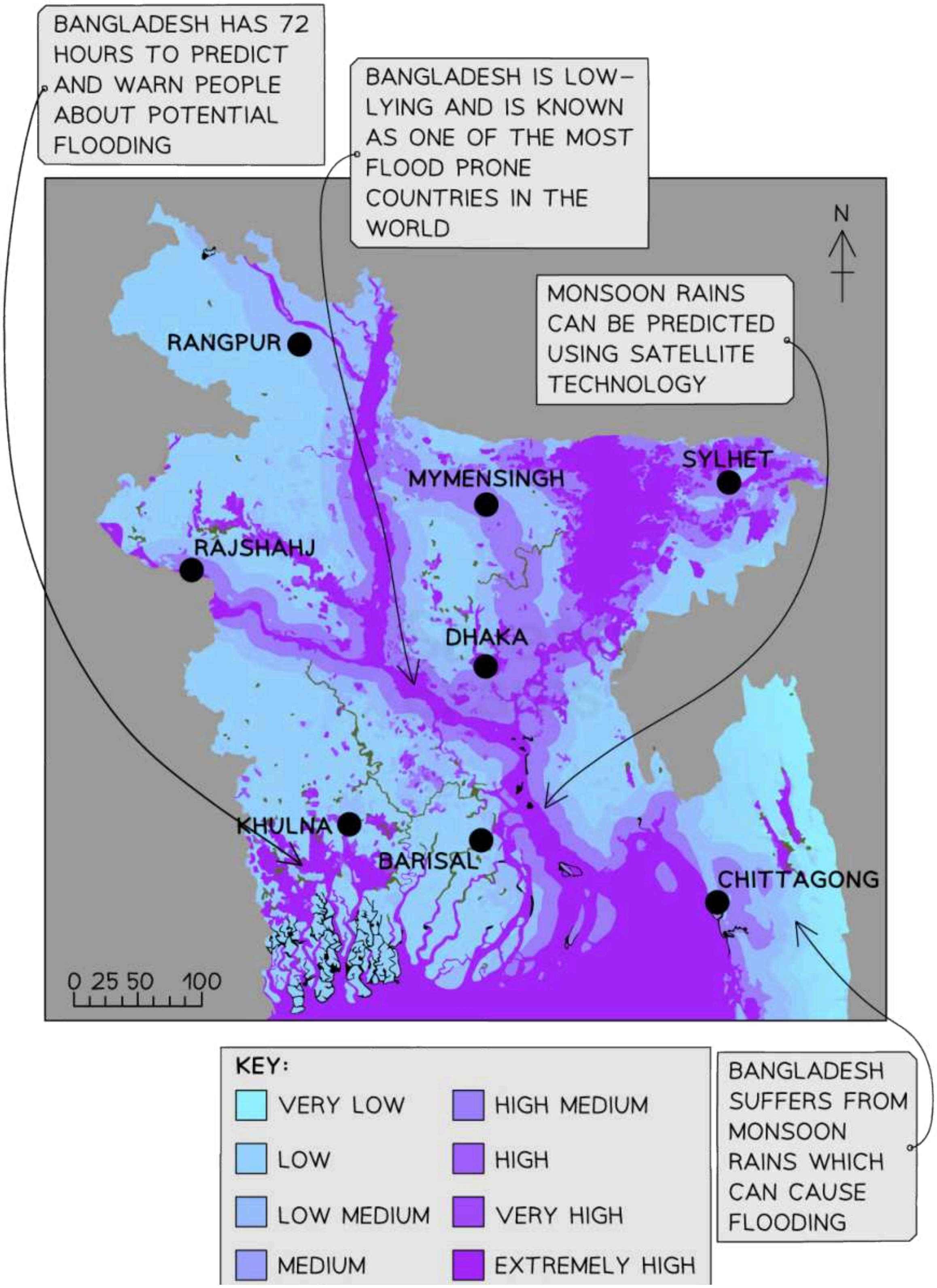
Flood Prediction

- It can be difficult to predict floods
- Flood prediction requires different types of data, including:
  - Real-time rainfall levels
  - Knowledge about the type of storm producing moisture
  - Knowledge about the characteristics of the river's drainage basin
- Weather satellites and radars are used to predict river flooding
- They help to identify the areas most vulnerable to flooding

Flood prediction in Bangladesh


BANGLADESH HAS 72 HOURS TO PREDICT AND WARN PEOPLE ABOUT POTENTIAL FLOODING
BANGLADESH IS LOW-LYING AND IS KNOWN AS ONE OF THE MOST FLOOD PRONE COUNTRIES IN THE WORLD
MONSOON RAINS CAN BE PREDICTED USING SATELLITE TECHNOLOGY
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RANGPUR
SYLHET
MYMENSINGH
RAJSHAHJ
DHAKA
KHULNA
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KEY:
VERY LOW
LOW
LOW MEDIUM
MEDIUM
HIGH MEDIUM
HIGH
VERY HIGH
EXTREMELY HIGH
BANGLADESH SUFFERS FROM MONSOON RAINS WHICH CAN CAUSE FLOODING

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Flood prediction in Bangladesh

- Warnings can be given through social media about potential flooding
- Flooding is becoming more frequent as a result of climate change

Improving flood prediction

- Improved flood prediction can be achieved by:
  - Mapping of channels
  - More detailed collection of meteorological information
  - More sharing of information about the risk of flooding between countries who share international drainage basins

Flood Mitigation

- The two main categories of flood management are hard and soft engineering:
  - Hard engineering involves building structures or changing the river channel
  - Soft engineering works with natural processes of the river and surrounding environment
  - Soft engineering is increasingly popular
  - Soft engineering is an example of mitigation where schemes aim to minimise damage rather than trying to prevent flooding

Type of Engineering	Advantages	Disadvantages
Dams	Hold back water during times of flood Release water when flood risk is reduced	Increase in loss of water due to evaporation Channel erosion Possible spread of diseases such as malaria

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Afforestation	Could increase interception and reduce overland flow Could possibly soak up excess rainwater	Young trees cannot absorb or intercept as much as more mature trees Most trees lose their leaves in the winter and so interception reduction is decreased
Channel modification	Can be done via straightening and enlargement Enlarging the cross-sectional area increases the bankfull discharge and hydraulic radius Velocity can increase if meanders are removed	Expensive May have to remove buildings to complete channel modification
Levee strengthening	Can protect buildings in the surrounding areas from flooding Barriers are less expensive than channel modification Can be used to divert water to less valuable land	

Planning

- Personal insurance may not always be available for lower-income countries
- Sand bags
- Sealing doors and windows
- Placing electrical generators higher up in the building
- Building houses on stilts
- Flood insurance, if available
- Government officials can use **disaster aid**

Case Studies: Contrasting Examples of Flood Mitigation

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Case Study – Jakarta, Indonesia

Map of Jakarta, Indonesia

Map of Jakarta, Indonesia

- Jakarta is the current capital city of Indonesia

Causes of flooding

- It faces significant flooding challenges because:
  - There is rapid **urbanization**
  - Many parts of the city are below sea level
  - Many parts of the city have an average height of just seven metres above sea level
  - The city experiences both tidal and river flooding
  - About half of the city is sinking at a rate of nine inches per year

- Various factors affect the severity of flooding in the area:
  - Intense rainfall
  - Land **subsidence**
  - Poor urban planning

Impacts of flooding

- On 1st January 2020, Jakarta experienced over 400mm of precipitation
- **Ciliwung** and **Cisadane** rivers flooded:
  - In total, 66 people were killed
  - Around 60,000 people were displaced
  - In some parts of the city, floodwaters reached two metres
- Landslides in areas on the outskirts of Jakarta buried people and buildings
- Blackouts and lack of communication slowed the rescue efforts

Responses to flooding and mitigation

- **Cloud seeding planes** were used to increase rainfall over the oceans
  - This aimed to reduce the amount of rain over the land and therefore reduce flooding
- Over 11,000 health workers provided medical care
- Disinfectant sprayed to reduce the spread of disease
- Emergency shelters provided
- Strategies to mitigate future flooding included:
  - Widening and deepening the river channels to reduce flooding
  - Construction of the East Flood Canal
  - Jakarta Emergency Dredging Initiative to increase the capacity of the rivers
  - Creating more urban green spaces to reduce surface runoff and increase infiltration
  - Creating an advanced warning system which uses real-time alerts for residents and businesses
  - Community workshops for poorer communities living along the river to explain how to protect themselves from future flooding
  - Preparation for disaster response, including megaphones, life vests and emergency kits

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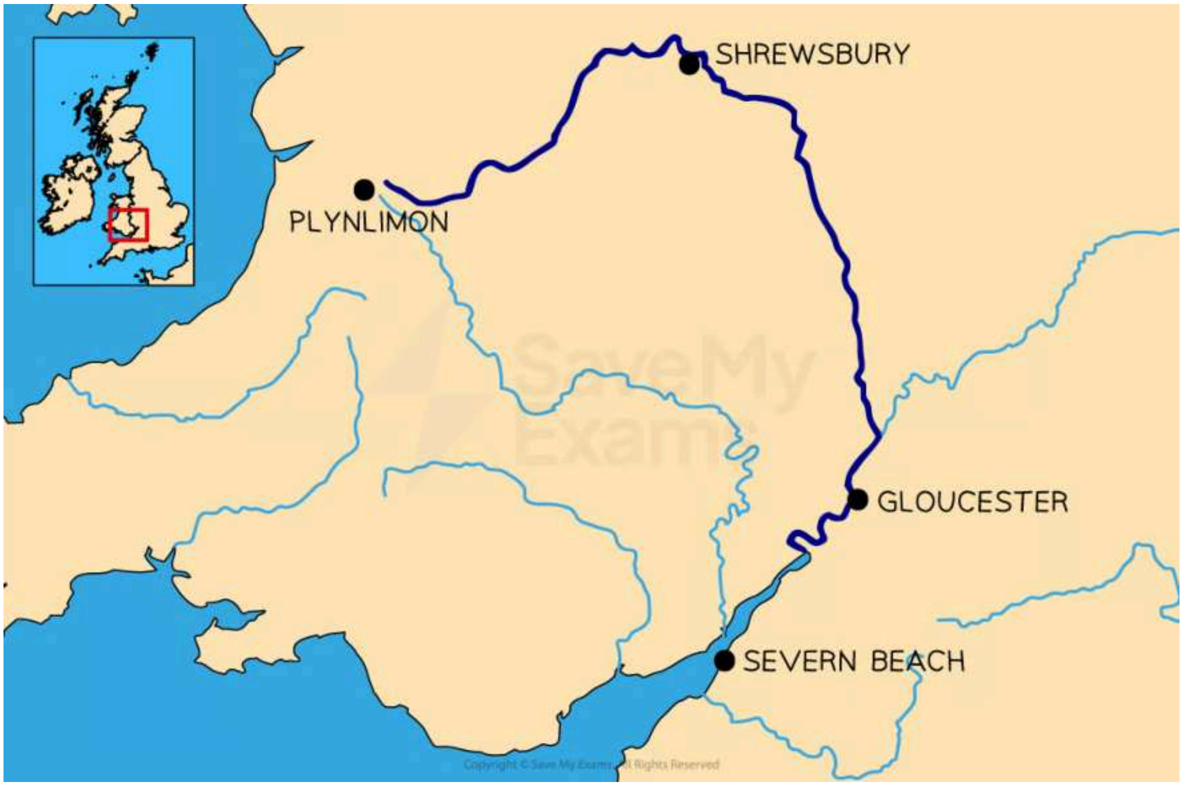
Case Study – River Severn, England

Map of River Severn



Map of River Severn

Causes of flooding

- Storm Ciara produced **heavy rainfall** of 75mm in 48 hours in February 2020
- Storm Dennis added 125mm falling in the Severn's tributaries
- The **Met Office UK** advised that February 2020 was the wettest on record
- Some areas experienced a month of rain in 24 hours

Impacts of flooding

- Over 1600 properties were flooded in the West Midlands
- Homes were evacuated
- Impact on transport infrastructure due to road and rail closures

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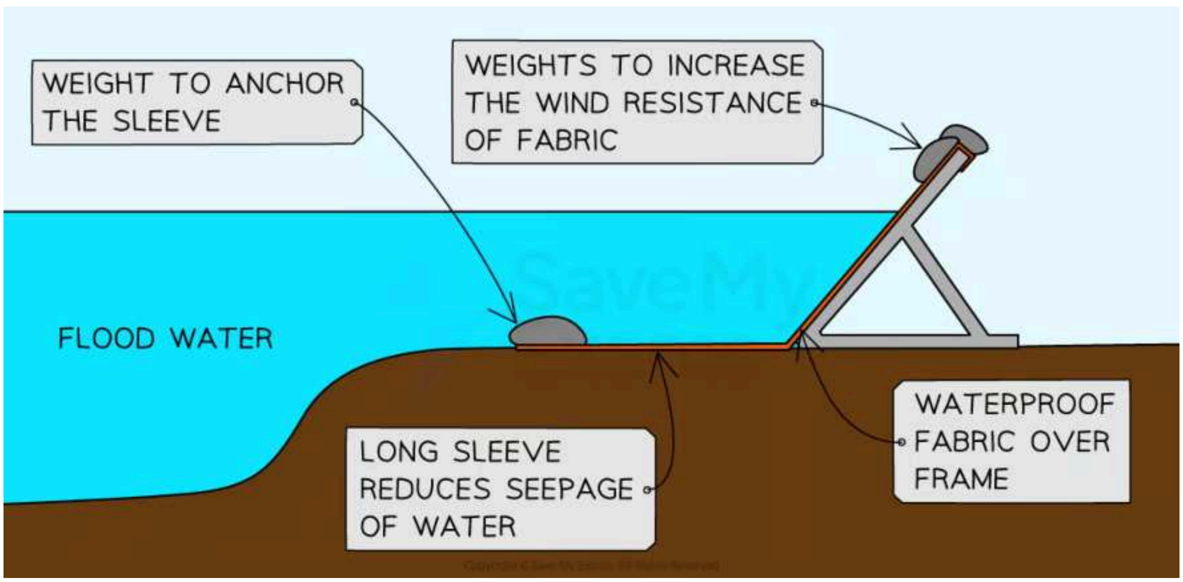
- Financial impact on businesses

Responses to flooding and mitigation

- Nearly 30,000 warnings were given to property owners by the Flood Warning Service
- Over 380 staff from the Environment Agency and DEFRA responding to incidents across the Midlands
- Over 86 Aid staff from across the country helped manage the flood risks at pumping stations and prepare evacuation plans
- An incident room was set up to help people affected
- Demountable barriers used to help reduce flooding



Demountable flood barrier

- A pumping station helped reduce surface runoff
- Reservoirs being pumped down to reduce water levels
- Strategies to mitigate future flooding include:
  - £4.5million now being invested along the catchment area to reduce flooding
  - Construction of embankments
  - Additional culverts to let surface water out and stop river water coming in
  - Afforestation

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