Hydrological characteristics + processes

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Keywords

- Hydrology: https://quizlet.com/cn/769956187/flash-cards/
- Water cycle / hydrological cycle: https://quizlet.com/cn/769960409/flash-cards/
- River: https://quizlet.com/cn/769960839/flash-cards/

Three states of water in the cycle

- Ice
- Liquid water
- Water vapour

Types of precipitation

- Rain
- Snow
- Sleet
- Hail

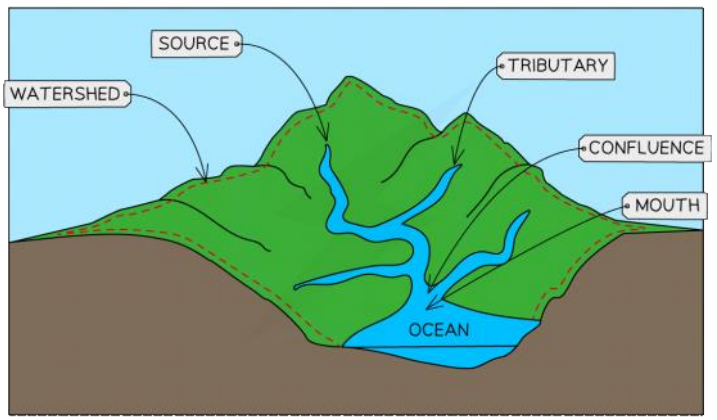
Fog and mist

- Fog
  - Denser, less visibility
- Mist
  - See through, quite thin
- Formed when water vapour is condensed at ground level

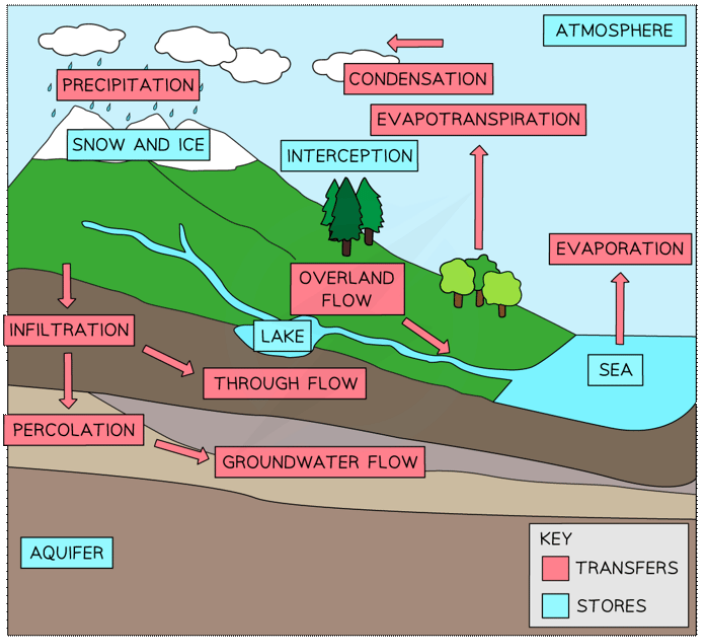
Clouds

- 3 types of clouds
  - Cirrus clouds
    - High altitude, thin clouds
    - Like horsetail
  - Cumulus
    - White, fluffy clouds
    - Look like cauliflower
  - Stratus
    - Form in layers
    - Cause rain when they are grey
- Alto: high up
- Nimbo / nimbus: grey and black, causes rain

Drainage basin

- 

Hydrological cycle flows

- 

Upper course

- Characteristics
  - Valley
    - Steep sided
    - Narrow
    - V shaped
  - Vegetation
    - Grassland
  - River channel
    - Steep gradient
    - Narrow and shallow
    - Flowing straight and down the slope
  - Low flow
    - Few tributaries have added water to the main river
  - Large and angular bedload
  - Low velocity
    - High friction
    - Low flow
  - Low discharge
    - Small cross section (low flow)
    - Low velocity
- Processes
  - Vertical erosion is the dominant process
  - Traction and saltation is the main transportation type

Middle course

- Characteristics
  - Valley
    - Gentle slope on sides
    - Wide
  - Vegetation
    - Farmland
  - River channel
    - Gentle gradient
    - Wide and deep

        - Meandering and downslope flow
    - Smaller and rounder load due to attrition
- Processes
    - Vertical erosion decreasing in importance
    - More lateral erosion and deposition
    - Suspension is the main transportation type

Lower course

- Characteristics
    - Valley
        - Very gentle slopes on sides
        - Very wide
    - Vegetation
        - Farmland
    - River channel
        - Almost flat
        - Widest and deepest
        - Meandering and downslope flow
    - High flow
        - Many tributaries have added water to the main river
    - Bedload is small and rounded due to attrition
    - Fastest velocity
        - Less friction with the smooth and deep river channel
        - High flow
- Processes
    - Deposition is more important than erosion
        - Fine material deposited
    - Lateral erosion because the river is cutting sideways

River processes

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Keywords

- https://quizlet.com/cn/769205279/flash-cards/

Erosion processes

- Hydraulic action
  - Power of fast flowing water breaks up the rock and removes pieces
  - Water flows into cracks in the rock and compresses the air
  - When water flows out the air expands rapidly, it implodes and over time breaks up the rock
- Abrasion
  - Sand and stones carried by the river water are thrown at the river bank or bed
  - They weaken the rock, causing pieces to be removed
- Solution
  - Some rock types dissolves in water e.g. limestone and chalk
  - Some rock types does not dissolve e.g. granite and basalt
- Attrition
  - The load carried by the river smashed together and become smaller and rounder
  - (Not eroding the river bank and bed)

Factors affecting rate of erosion

- High velocity
  - More load carried in the water
    - More abrasion
  - Faster flow
    - More hydraulic action and solution
- Resistant rock
  - e.g. granite / basalt
  - Formed by solidified lava
  - No pores - no hydraulic action
  - Not dissolving in the water - no solution
  - Harder
- Less resistant rock
  - e.g. limestone / clalk
  - Have pores
  - Dissolves in the water
  - Softer

Transportation process

- Traction
  - Larger and heavier particles are rolled along the river bed
  - Boulders and cobbles
- Saltation
  - Lighter particles are bounced along the river bed
  - Pebbles and gravel
- Suspension
  - The smallest and lightest particles are carried by the water
  - Make the water muddy or cloudy
  - Sand and silt
- Solution
  - Particles which have been dissolved are carried as a solution in the water
  - Cannot see the particles
  - Mostly happens in areas of limestone or chalk

    - Clay
- There is more load carried downstream
    - More velocity = more energy = more load

Load particle sizes

- Heavy
    - Boulders > cobbles
    - Hard to pick up
- Medium sized
    - Pebbles > gravel > sand
    - Sand is the easiest to pick up because it has light individual pieces
- Smallest / finest size
    - Silt > clay
    - Clay is the easiest to transport
    - Stick together so heavier than sand, harder to pick up

Reasons for deposition

- Losing energy because the river slows down
    - Gradient decreases
    - Meets a large body of water
    - River floods covers the flood plain during a flood so the water is shallower
        - More friction
    - River is returning to normal flow after a heavy storm

Sequential deposition

- The load is deposited in order of its size with the largest particles first
- Clay is not deposited
    - It is too light

Deposition at mouth

- Most deposition is done at the mouth
    - Carries most load at the mouth
    - Loses energy when meeting the sea
- Flocculation
    - The salt causes the clay particles to stick together when the river meets the sea and is in contact with salt water
    - Clay particles become heavier so they are then deposited

Discharge

- Discharge = width × depth × speed (m^3/s)
- Higher downstream
    - Greater depth
    - Greater width
    - Highest speed

River landforms

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Keywords

- https://quizlet.com/cn/769952217/flash-cards/

Positions

- Upper course
  - Interlocking spurs
  - Potholes
  - Rapids
  - Waterfalls
  - Gorges
  - V-shaped valley
- Middle or lower course
  - Meanders
  - Oxbow lakes
  - Braided channels
  - Levees and floodplains
- Mouth of the river
  - Deltas
  - Estuaries

Interlocking spurs formation

- Caused by the river winding round pieces of harder rock
- The low discharge and slow velocity of the water does not have enough energy to erode through them

V shaped valley formation

- The river bed is more prone to erosion
- The river eroded downwards
- Sides of the river channel are weakened and become prone to collapse
- The sides collapse and create the V shape

Rapids formation

- Slightly steeper gradient in the river
- The river bed is rocky and uneven so it causes rough white water (turbulent water)

Waterfall formation

- Horizontal layer of more resistant rock above a layer of less resistant rock
- Soft rock is eroded faster by hydraulic action, creating an undercutting beneath the hard rock
- Overhanging rock layer collapses because there is no support underneath and becomes fallen rock
- Abrasion from the fallen rocks and hydraulic action erode vertically to create a plunge pool
- Waterfall retreats upstream, leaving a steep-sided gorge

Potholes formation

- Smooth, rounded holes in the bedrock of the river bed
- About 30cm across
- Stones are trapped in currents in the water
- Erode small holes in the river bed by abrasion
- The stones get trapped in the holes
- Turbulent flow of water swirl them around in the hole
- They continue eroding the hole, making them deeper and larger

Meanders formation

- Water in a river flows in a corkscrew pattern called helical flow
- Faster flow in the outside of the flow
    - Thalweg is found close to the outside bank
    - Outside bank being undercut by lateral erosion such as abrasion and hydraulic action
    - Forms a steep river cliff and deepens the channel on the outside of the bend
- Slower flow in the inner bank due to the friction when moving inside
    - Deposits sediment such as sand and shingle on the slip off slope
    - Form point bar
- The cross section of the channel is asymmetrical
    - Shallower on the inside and deeper on the outside

Oxbow lakes formation

- Meanders migrate towards each other due to erosion on outside of bends
- Neck between the meanders is eroded and become very narrow
- New straighter and more efficient channel formed during a flood
- Deposition of sediment due to lack of energy
    - Water now takes the quickest route
    - In slow flowing old channel and where it attempts to re-join straighter channel
    - Blocks the end of the meander and separates it from the river
- Leaves an oxbow lake with stagnant water
    - Eventually dry up and leave an meander scar

Floodplain and levees formation

- Erosion
    - The fastest flow erodes the outer bank and slightly downstream bank
    - Meanders migrate downstream creating flat valley
    - Floodplain is created
- Deposition
    - When the river floods and covers the floodplain, the water loses speed because of the increased friction with the ground and shallow water
    - The river loses energy and deposits the load it is transporting
    - The largest, heaviest material like pebbles and gravels are deposited first
        - They build up the river banks forming levees
    - The smaller lighter material like silt is deposited further away from the river to form the floodplain
    - The deposited material is called alluvium and forms fertile soil

Deltas formation

- The river carries a lot of load because it had been flowing over a long distance
    - Lots of load from erosion upstream
    - High discharge in lower course so lots of load can be carried
- It slows down when it hits the sea and loses energy so lots of load is deposited
- The sediment is not removed by the sea because it has a coastline with low energy waves
- The river channel divides into many distributaries
    - The river deposit its load in the centre of the channel
    - Water are forced to flow sideways
- The river deposits its load sequentially with the largest particles first (gravel → sand → silt)
- Flocculation
    - The salt causes particles of clay to clump together so they become heavier and deposit
- Shapes
    - Arcuate: triangular e.g. Nile Delta
    - Bird's foot: look like fingers of deposition growing out into the sea e.g. Mississippi delta

Estuaries

- Occurs when the mouth of the river is tidal
    - The water changes height from low tide to high tide every 12 hours

- The water in the river mouth is salty because it is a mixture of river and sea water
- The river loses energy when it flows into the sea and deposits sediments to form mudflats
- Sometimes the mud is colonised by vegetation which can survive in the salty environment and forms salt marshes
    - These plant can survive even when the water covers them at high tide

River landforms diagrams

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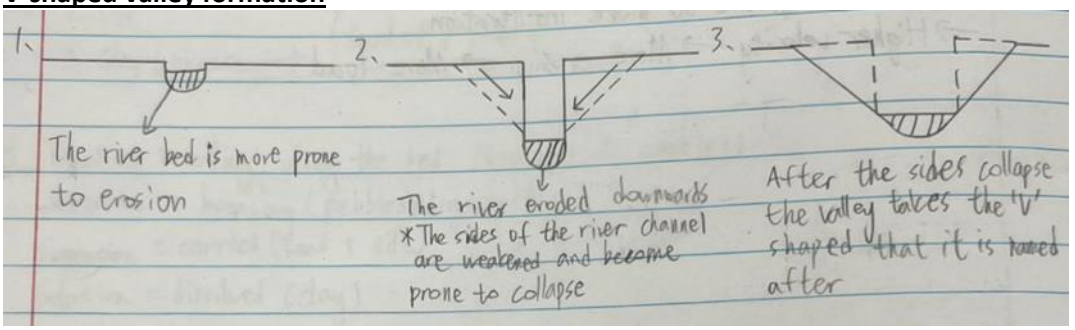
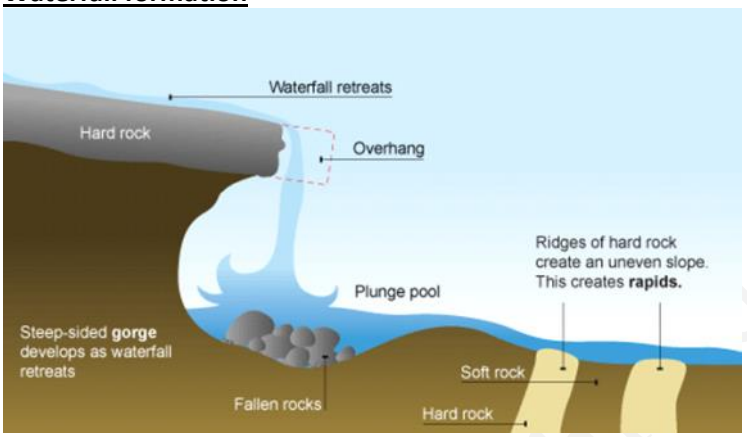
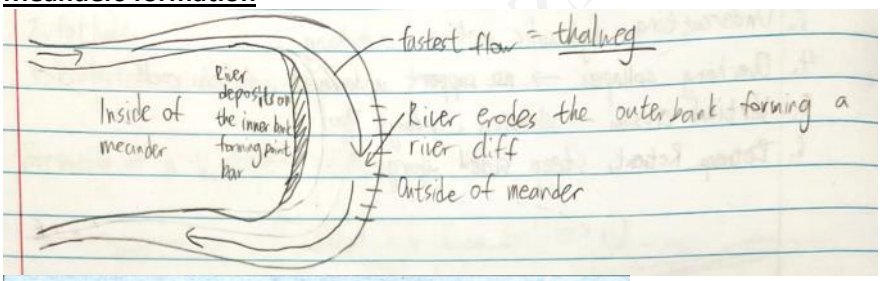
V-shaped valley formation

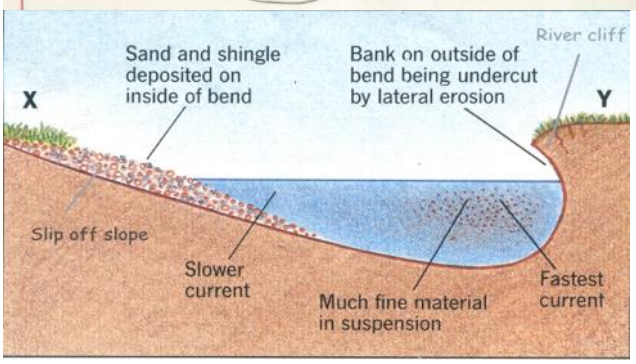
- 

Waterfall formation

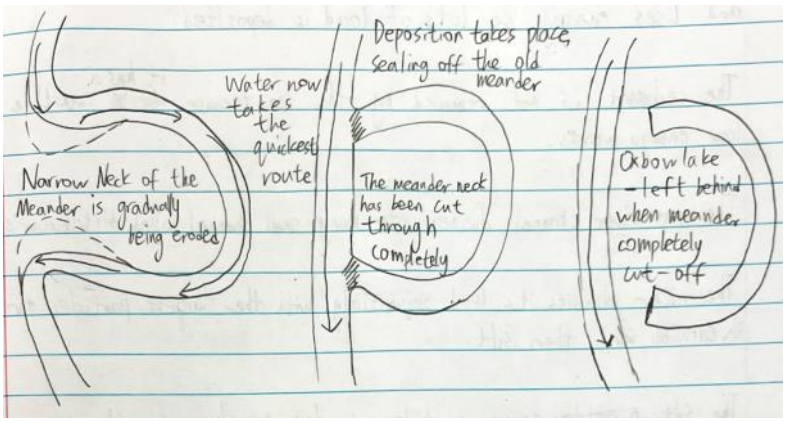
- 

Meanders formation

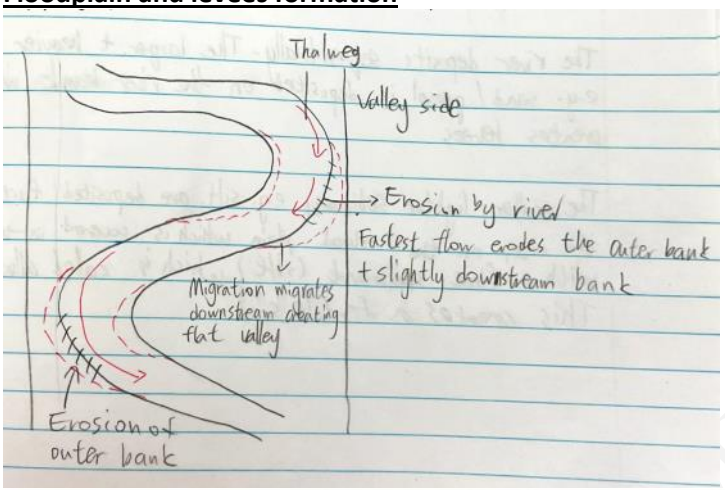
- 

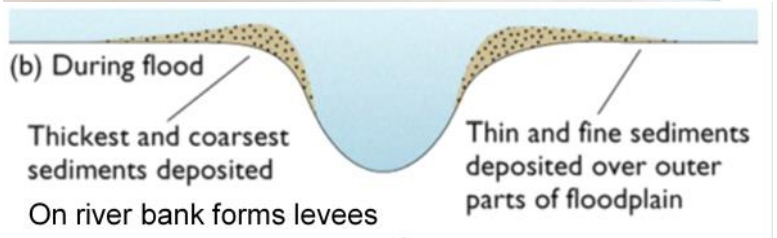
- 

Oxbow lakes

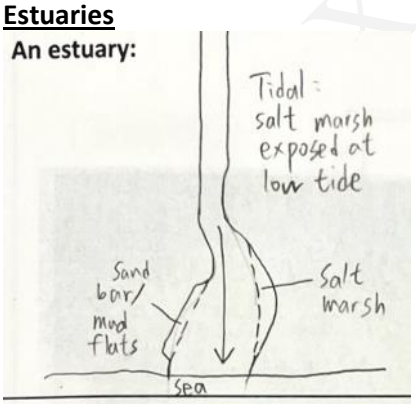
- 

Floodplain and levees formation

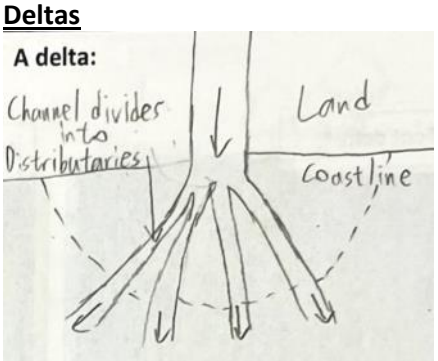
- 

- 

Estuaries

- 

Deltas

- 

Opportunities and hazards of rivers

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Keywords

- https://quizlet.com/cn/782365379/flash-cards/?new

Opportunities

- Flat land
  - The floodplain is a large area of flat land
  - Easier to build houses and factories
- Fertile soils
  - When rivers flood the sediment they deposit is called alluvium
  - Creates fertile soils so there is high crop yield
- Water supply
  - River water is fresh and can be used for irrigating crops
  - More food can be grown even in areas where there is low rainfall
  - The water can also be used for domestic use and in factories for cooling or cleaning machines
- Transport
  - Large rivers can be used as transport routes for shipping goods from inland areas to the sea port
- Fishing
  - Fish are an important source of protein
- Hydroelectric power
  - Rivers can be dammed and the power of the river used to turn turbines
  - Create a cheap, clean source of electricity

River flooding

- When the water in their channel reaches the top of the banks which is called bankfull discharge
- Then the river water overflows the banks and covers the floodplain

Causes of river flooding

- Physical causes
  - (short leg time)
  - Short period of heavy rainfall
    - The water cannot infiltrate fast enough into the ground because the ground is saturated
    - The water quickly reaches the river as surface runoff so there is a short lag time
    - The river cannot transport it away quickly enough
  - Long period of rainfall
    - The soil and rock are saturated
    - Any further rainfall cannot infiltrate into the soil and so runs off quickly to the river so short lag time
    - River cannot transport water away fast enough
  - Snowmelt in spring
    - Snow melts quickly and lots of water reach the channel quickly
  - Impermeable rock (geology)
    - Rainwater will not percolate into the ground but will reach the river quickly by surface runoff
  - Steep relief
    - Gravity will cause rainwater to run off quickly to the river because water does not have time to infiltrate
  - Small drainage basin
    - Water will enter the river quickly
    - Short lag time
- Human activity

- Agriculture
    - Soil is left unused and exposed to the elements
    - Water takes less time to reach the river by surface runoff because exposed land discourages infiltration
- Deforestation
    - Less vegetation so less interception
    - Ground become saturated faster
    - More surface runoff, water reach river quickly
- Urbanisation
    - Lots of impermeable soil
    - Water reach river quickly by surface runoff
- Climate change
    - Global warming is increasing the number of extreme storms and heavy rainfall events
    - The glaciers which are the source of many rivers are melting faster so increasing the amount of water in rivers

Cause of flashy hydrographs

- = Short leg time
- Heavy, intense rainfall
- Steep relief (steep slopes)
- Ground is already saturated so rainwater cannot infiltrate
- Impermeable rock so the water cannot percolate
- Lack of vegetation so less water is intercepted
- Urbanisation so ground surface is impermeable concrete

Impacts of flooding

- Social
    - Deaths and injuries
    - Homes destroyed so people displaced
    - Schools destroyed so loss of education
    - Water contaminated causing water borne diseases e.g. cholera
    - Power lines destroyed so electricity is cut
- Economic
    - Roads flooded so limited access to businesses
    - Factories / shops flooded so loss of days working
    - High cost to rebuild them
- Environmental
    - Destruction of natural habitats
    - Animals (wild) killed or injured
- Benefits (all 3 categories)
    - Fertile soil from alluvium deposition
        - High crop yield
    - Ground water supplier refilled
        - More water for plant / animal / factories / drinking / domestic use

Management of river flooding

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Method to control the flood

- Artificial levees
  - Builds up the banks of the river to increase the size of the river channel cross section
  - More water can be stored in the channel and stops flooding happening as quickly
  - Usually made of concrete so they are strong, but in LEDC often made of earth or mud
- Land use planning
  - Important buildings such as hospitals and schools are built far from the river
  - Floodplains are used for recreational use e.g. parks and golf courses
- Afforestation
  - Increase interception
  - Some of the water returns to the atmosphere through evapotranspiration
    - More unlikely and slower to become saturated
  - Less water reach the river and reach more slowly
- Dredging the channel
  - Remove sediments from the river bed
  - Makes the river deeper so its channel can hold more water
- Straightening the channel
  - Remove meanders and make the river run straighter
  - Shortens the river so that the river flows faster and water is removed from the area faster
  - May cause more flooding downstream
- Bridge design
  - Build bridges that are slim and streamlined
  - Allowing water to pass through the area of river more quickly
- Dams and reservoirs
  - Build a dam to store water in a reservoir
  - Water is the released steadily
- Creating natural areas
  - e.g. wetlands
  - Soak up some of the flood water
- Overflow channels or spillways
  - Extra river channels or spare land near the river
  - Extra water can be diverted and stored there during a flood

Preparing the population

- Flood warning systems
  - Gives people time to prepare and evacuate
- Education & awareness
  - People know what to do during a flood
- Train emergency services
  - To respond effectively to rescue people
- Flood shelters
  - Safe, dry place for people to stay
- Emergency aid
  - Help in the form of food, water, shelter

Bangladesh flooding

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Basic info

- LEDC
- One of the poorest countries in Asia
- Having a drainage basin that covers over 1 million km^2
- Most of the land is a delta from two main rivers: Ganges and Brahmaputra

Causes of flooding in Bangladesh

- Physical
  - Many large rivers including Ganges + Brahmaputra flow through Bangladesh with high discharges
  - Low lying flat land
    - It is formed of large, flat flood plains and delta created by these large rivers
    - 25% of Bangladesh is less than 1 m altitude
  - Snowmelt from the Himalayas takes place in late spring & summer, heavy monsoon rains happen at the same time
    - The rivers have a high peak discharge
  - Tropical storms/ cyclones bring heavy rains and coastal flooding
- Human
  - Deforestation of the Himalaya
    - Reducing interception rates which increases run off to the rivers
    - Short lag time
  - Urbanisation on the flood plain e.g. in Dhaka
    - Increased amount of run off to the rivers
    - Urbanisation has reduced the lag time and peak flow has greatly increased so flooding is more frequent
  - Climate change / global warming
    - Increased snow melt in the Himalaya, increase peak discharge
    - Increased number of cyclone storms in the region
  - Poorly maintained flood defences
    - e.g. artificial levees collapse in times of high river discharge

Impacts of flooding in Bangladesh

- In 2007 flood
- Over 1,100 people killed
- Many deaths caused by drowning, landslides and snakebites
- 2 million acres of agricultural land was damaged and crops lost
- 10 million people were estimated to have been displaced
- the main highway connecting Dhaka to the rest of the country was flooded isolating the capital
- 2/3 of the land was flooded
- 100,000 people had caught dysentery / diarrhoea
- Rice crops were devastated TWICE that year so farmers did not have time to recover their losses and replant
- Food insecurity caused some people to die from starvation
- $150 million of aid was sought by Bangladesh
- $300 million of crops were damaged in the initial floods
- Sundarbans threatened
  - National park with protected species and a natural coastal defence

Methods of managing flooding in Bangladesh

- Artifacial levees
  - They built 350km of artificial levees costing $6 billion

    - Some of the levees are built of mud but increasingly they are using concrete to reinforce the natural levees
    - These increase the size of the cross section of the river channels so they can hold more water
- Dams and reservoirs
    - They built 7 large dams Bangladesh to store excess water e.g. Kaptai dam
    - Holds back the monsoon rainfall in a reservoir
    - So they would not flood the surrounding areas
- Flood satellite imaging systems have been developed
    - More accurately predict flooding and allow more warnings to be given to the people
    - They are monitoring hydrographs and rainfall patterns in the major drainage basins
- Building 500 flood shelters
    - Built on pillars so they won't be overflowed when it is flooding
    - People can go there and it prevents injuries and deaths
- Setting up flood early-warning systems
    - People can evacuate the area beforehand
    - People are instructed of what to do in the middle of flooding
- Others
    - Flood action plan set up in 1989, funded by world bank
    - Negotiations to reduce deforestation in Nepal, funding tree planting programmes

Opportunities of living by rivers in Bangladesh

- Trade
    - The rivers are used for transportation of goods
    - Encourage trade between the capital city of Dhaka and the port city of Chittagong
- Industry
    - Factories are built along the riverside
    - River water used in the industrial process for cleaning and cooling machines.
- Agriculture
    - Water from the rivers is used for irrigating crops
    - The flat floodplains of the delta are very fertile because of the alluvium deposited during the flood
    - This causes high crop yields provide a source of food and cash crops for export e.g. rice and jute
        - Bangladesh can grow 3 crops a year
- Fish / shrimp
    - From the river and shrimps farmed in flooded fields provide an excellent source of protein
    - Sold for export