Rivers

Case Study 4. The Three Gorges Dam, China (for flood protection AND HEP)

Facts:

- Yangtze River 3rd longest river in the world, the source is the Himalayas and flows into the East China Sea in Shanghai
- In 1998, it caused 3000 deaths and 30 million people homeless from Yangtze flood (reasons it should be built/introduction)
  - an area the size of New Zealand was flooded
- Floods regularly, unpredictable

Aim

- Generates HEP
- improve river transport upstream, easier for trading
- the dam helps prevents floods
- ~~help with irrigation of crops~~

Advantages (Economic, social and environmental)

- 100 million people on the lower course/downstream of river protected as water discharged through dam when necessary - SOCIAL
- HEP needed for China's growing industry and for domestic use too, provides 10% of China's electricity through HEP (China uses 40% world power)
  - This will decrease China's dependency on fossil fuels and therefore reduce greenhouse gases and other harmful substances released into the atmosphere - ENVIRONMENTAL
  - Electricity generated will help the economic development of cities nearby such as Chongqing with a population of 3 million people e.g provide better water, sewage system etc - SOCIAL
- thousands of construction jobs were created - SOCIAL/ECONOMIC
- Becomes a tourist attraction overtime to witness its significance - ECONOMIC
- Improved shipping as larger boats (up to 10,000 tonnes) can travel upstream to Chongqing -ECONOMIC

Disadvantages (Economic, social and environmental)

- 1.3 million people relocated often without adequate compensation - SOCIAL
  - Most of the land used for resettlement is over 800m above sea level, where the climate is colder and the soil can barely support farming
- 4 cities, 8 towns and 356 villages submerged, such as Fuling (population of 80,000) and Wanxian (population of 140,000) will be flooded - SOCIAL
- Temples and sacred places will be flooded, 8000 cultural sites are destroyed - SOCIAL
- untreated human and industrial waste will not be washed away downstream into the sea, but will stay and pollute the river instead - ENVIRONMENTAL
- Silt builds up behind dam so does not fertilize fields downstream - SOCIAL
- Risk of earthquakes due to the pressure created by the huge weight of water in the reservoir behind the dam; the dam is built near a fault - SOCIAL
- 39 billion to build it which would divert money from other development -ECONOMIC
- Loss of species like the Yangtze river dolphin mainly due to increased river traffic and pollution - ENVIRONMENTAL

Case Study. Pakistan Flood 2010, Indus River

Causes:

Environmental factors:

- Heavy rainfall and monsoon patterns causing the river to fill up quickly
- rossby wave (blocked jet stream, therefore made the monsoon stay)

- la niña event
  - temperature in Indian Ocean increases which speeds up evaporation, creating lots of moisture in air. These moisture get blown across to the Indus River, then it turns into clouds and rain.
- climate change

<u>Human factors:</u>

- Deforestation
  - Pakistan is known to have one of the highest rate of deforestation in the world. Only 5% of Pakistan is now occupied by forest due to timber harvesting. Due to the lack of vegetation to intercept the precipitation, flooding occurs.
- embankments were built to protect from small floods initially, but at that time it actually kept water from flowing back into the bank, causing more of a disaster to the communities.
- poorly maintained irrigation canals by the local Pakistani farmers made floods worse.

effects:

- At least 2000 people died
- 20 million Pakistanis were affected (over 10% of the population), 6 million needed food aid
- Whole villages were swept away, and over 700,000 homes were damaged or destroyed
- Hundreds of thousands of Pakistanis were displaced, and many suffered from malnutrition and a lack of clean water
- 5000 miles of roads and railways were washed away, along with 1000 bridges
- 160,000km^2 of land were affected. That's at least 20% of the country
- About 6.5 million acres of crops were washed away in Punjab and Sindh provinces
- Power supplies and roads were wiped out, making it difficult for rescuers to arrive

human response:

- Appeals were immediately launched by international organization, like the UK's Disasters Emergency Committee – and the UN – to help Pakistanis hit by the floods
- Many charities and aid agencies provided help, including the Red Crescent and Medicines Sans Frontiers
- Pakistan's government also tried to raise money to help the huge number of people affected
- But there were complaints that the Pakistan government was slow to respond to the crisis, and that it struggled to cope
- Foreign Governments donated millions of dollars, and Saudi Arabia and the USA promised $600 million in flood aid. But many people felt that the richer foreign governments didn't do enough to help
- The UN's World Food Program provided crucial food aid. But, by November 2010, they were warning that they might have cut the amount of food handed out, because of a lack of donations from richer countries
- $815 million dollars has been pledged by multiple countries around.
- Much of this money came from the West, especially the United States , United Kingdom and European Union. According to the OCHA, as of 25 August 2010, the US pledged 25.1 per cent of total humanitarian assistance, with the UK and European Commission following at 10.4 per cent and 8.7 per cent. Saudi Arabia was the next largest donor after the US with a share of 12 per cent.
- The government has also set up many relief camps around the country to give people food, shelter and water.
- Many people around the world have donated numerous amounts of money to the repair and help of the people affected by the flood. Many people have also visited the country bringing with them food and water to give to the people
- More than 700,000 people fled the areas that the flood hit and have taken their belonging to find
- The government has already set aside money to build flood defense systems and ways to warn people if another flood is to happen.

- 155,200 trees have been planted to prevent erosion
- 19,667 people have been given shelter

Kallang and Singapore Rivers

- Singapore receives 2357.8mm of rain annually
- Kallang River is 10km long, the source is Lower Peirce Reservoir and the mouth is Marina reservoir

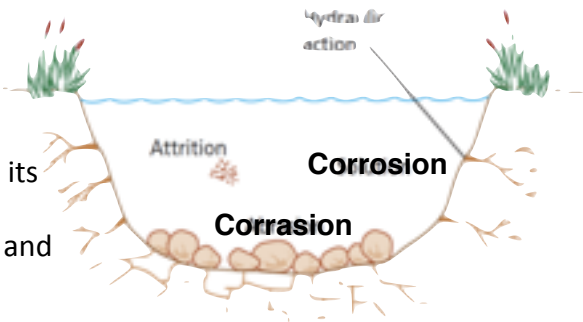
- Covering the ground with concrete and cutting down trees increase the rate of surface runoff because water from the river can get out of the channel easily.
- Canal: artificial waterway being straightened to help river get to the mouth faster
- Storm drain: carry excess water away

Methods of river management used in Singapore

- Building storm drains and canals to avoid flooding by getting rid of rainwater faster
- straightening rivers (canalization) to get the river to the sea or a reservoir faster
- creating reservoirs or underground storage tanks to increase the capacity of storage and to control water flow with gates
- Building flood barriers around buildings to protect the buildings from flooding
- Porous pavements allow water to infiltrate
- Planting trees and making laws to stop people cutting down trees around reservoirs so more water is absorbed into the soil as the vegetation can intercept the flow. Also, the roots of the plants that are outside can prevent landslide and stop soil erosion.
- Building flood protection dams to control water level surges and holding back flood water
- Installing green roofs and rain gardens in public and private buildings allow plants to absorb more water to reduce the amount of surface runoff
- Making rules for buildings that ground floors should be used for carparks to stop carparks being flooded
- flood alert systems and giving people information to make people aware and be prepared

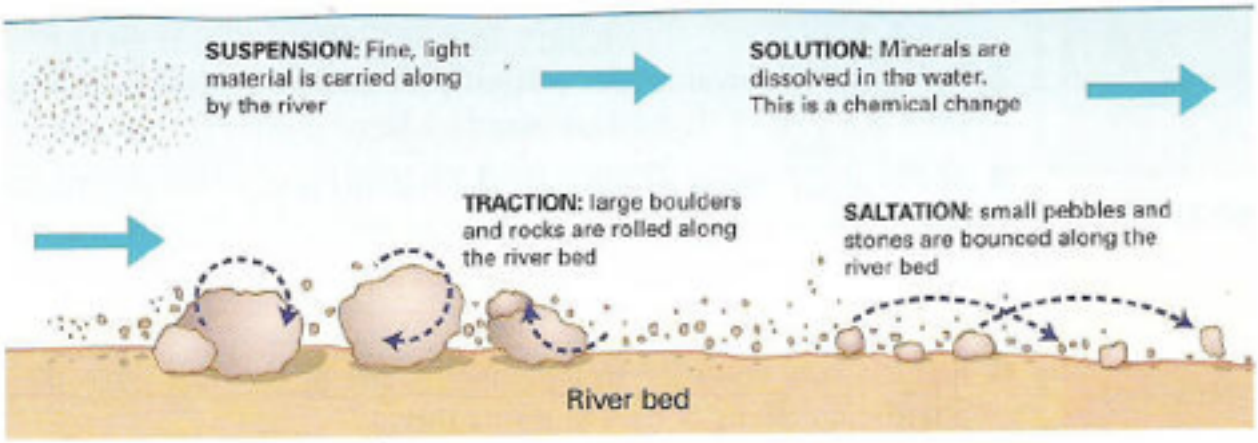
Source: The start of river, normally found in mountainous areas
Mouth: The end of the river, this is normally where a river enters the sea, but it can be where it enters a lake
tributary: a small river that flows into a bigger river
Confluence: where two rivers join/meet
estuary: the section of the river near the mouth that is tidal
distributary: branches off and flows out of a stream or river
catchment area: the area of land that drains into one river and its tributaries
watershed: the dividing line between two drainage basins/ catchment area
bed: the bottom of the river channel
bank: the sides of the river channel, a river has two banks
channel: the route course that a river flows

Erosion: the process of wearing something away
Corrasion: the process of a river's load crashing and rubbing into a river's banks and bed causing pieces to break off
Corrosion: The process of water dissolving a river's load as well as its bed and banks (chemical action)
Hydraulic action: water and air getting into cracks in a river banks and



bed causing erosion through increased pressure
Attrition: when rocks and pebbles being carried by the river knock together and are broken down to form smaller particles

Transportation: the river can transport material when it has excess energy.
Traction: the process of large pieces of load rolling along a river bed
Saltation: the process load bouncing along a river bed
Suspension: The process of smaller pieces of load being carried in a river's flow
Solution: the process of material being transported in a solution



The speed of rivers is slower in the upper course and gradually increases as you go near the mouth. This is because the cross-section of the river is smaller near the source so there is greater friction when rocks rub against each other and the river bed in the shallow area. Near the mouth, less energy is lost due to friction, the river channel has become wider and deeper.
The slope of the river will normally get less steep as it travels from the source to the mouth.

Human Impacts on the hydrological cycle
Deforestation: When humans cut dow trees, there is less interception and therefore less canopy drip and stem flow. This means that more precipitation falls directly onto the surface increasing the number of temporary surface storages and surface run-off. Deforestation tends to increase the risk of flooding because water reaches the ground and rivers quicker,causing the ground to become saturated and rivers to flood.
Urbanization and construction: when houses and roads are built, impermeable surfaces are created, this means there is less infiltration and more surface run-off. However, buildings can also intercept precipitation and humans can build artificial drains which can reduce flooding by redirecting water away from vulnerable areas.
Dams: create artificial surface storages (reservoirs). They can reduce the velocity and discharge of rivers by regulating the amount of water released with gates. Because they can regulate the amount of water released they can also reduce the risk of flooding.

River Landforms

River Long Profile		
Upper Course	Middle Course	Lower Course
steep	open and gentle sloping valley with floodplain	open and gentle sloping valley with floodplain
narrow and shallow river channel	wider and deeper channel	flat and wide floodplain
high bed load	suspended sediments	wide, deep channel

Features		
V-shaped valleys and interlocking spurs	meanders	oxbow lakes
rapids	oxbow lakes	deltas
waterfalls	river cliffs	floodplains
gorges	slip off slopes	levees

EROSIONAL LANDFORMS	DEPOSITIONAL LANDFORMS	EROSIONAL AND DEPOSITIONAL LANDFORMS
• Waterfalls • Gorges • Rapids • Potholes • V-shaped valleys • Interlocking spurs	• Deltas • Levees	• Meanders • Oxbow lakes • Floodplains

Meanders and Oxbow lake:
Meanders are bends in a rivers course. Water flowing around a meander moves fastest on the outside of the bend leading to erosion and the formation of a steep river cliff.

On the inside of the bend, water slows down leading to the deposition of sediment. This forms a gently-sloping slip off slope in the shallow water.

Lateral erosion by meanders leads the widening of the valley floor (floodplain). Meanders often migrate downstream and become wider and larger over time. Where there are well developed meanders, a river may take a short-cut across a narrow meander neck in times of flood and this leads to the creation of sections of abandoned river called ox-bow lakes. Over time, the ox-bow lakes dry up and leave just a meander scar.

Floodplains
A flood plain is the wide, flat area of land on either side of the river in its middle and lower course. A flood plain forms through both erosion and deposition. When material is deposited on the slip off slope of a meander it gradually builds up over time. When a river overflows its banks, water pours on to the floodplain and as it drains away fine material (alluvium) is deposited.

Levees
Levees are natural embankments of silt along the banks of a river, which are often several metres higher than the flood plain.

Deltas
A delta is a flat area of sand and silt built into the sea. When a river enters the sea carrying large volumes of fine material, the velocity slows and causes the load to be deposited in layers. Over time, the deposited material forms small islands separated by river channels called distributaries.

Waterfalls
- A waterfall is a steep drop in the course of a river. They form when a band of hard resistant rock (cap rock) lies over softer, less resistant rock.
- The softer rock is quickly eroded by hydraulic action and corrasion, causing the harder rock to be undercut.

- The hard rock overhangs until it can no longer carry its own weight.
- The overhang collapses and then breaks up in the water below.
- The great power of the water at the base of the waterfall causes a plunge pool to form.
- The bed of the river below the waterfall contains boulders eroded by splash back from behind the waterfall.

How do rivers erode?
Rivers can erode down into the ground and this is called vertical erosion.(v-shaped valleys) They can also erode side to side and this is called lateral erosion. (meanders) Erosion takes lots of energy, so is more likely to occur when the river has a high discharge or when it has a high speed. These conditions will happen after rain, when the slope is steep, when there is less friction slowing the river down, or where two rivers join. (confluence)

What determines the rate of river erosion?
The volume of the river: a small river will have a small water volume and will therefore carry a limited load
Gradient and velocity: The gradient of a slope determines the speed of water. The steeper the slope, the faster the water (the higher the velocity which results in vertical erosion)
Nature of the bed rocks: The more resistant a rock is, the less it will be eroded. Less resistant rocks will be eroded faster than hard, rough rocks. Where there is a resistant rock a river may curve around it, thus reducing the erosive energy.
Nature and amount of the load: Large/hard objects like boulders and tree trunks cause more erosion by corrasion than smaller softer pebbles.
The speed of water flow is faster in the middle of a cross-section because there is less friction against the river beds and banks.

How do rivers transport?
Rivers carry sediments along in different ways. The name for the material is load. The type of sediment found in a river will depend on the bed rock over which the river is flowing, as it is this that will have been eroded by the river. Rivers can transport in different ways.

How do rivers deposit?
Deposition happens when the river runs out of energy and it drops its load. This can happen on the bed of the river channel or at the side of the channel on the banks, or on the flat land next to the river (the flood plain). Rivers may run out of energy because they are flowing slowly, perhaps because they have not much water in them or if there is a lot of friction slowing the river down. This might happen when the river floods over a floodplain or it can also happen when the river meets the sea. The first sediment/load to be deposited consists of boulders and pebbles. The last load to be deposited is fine sediment.