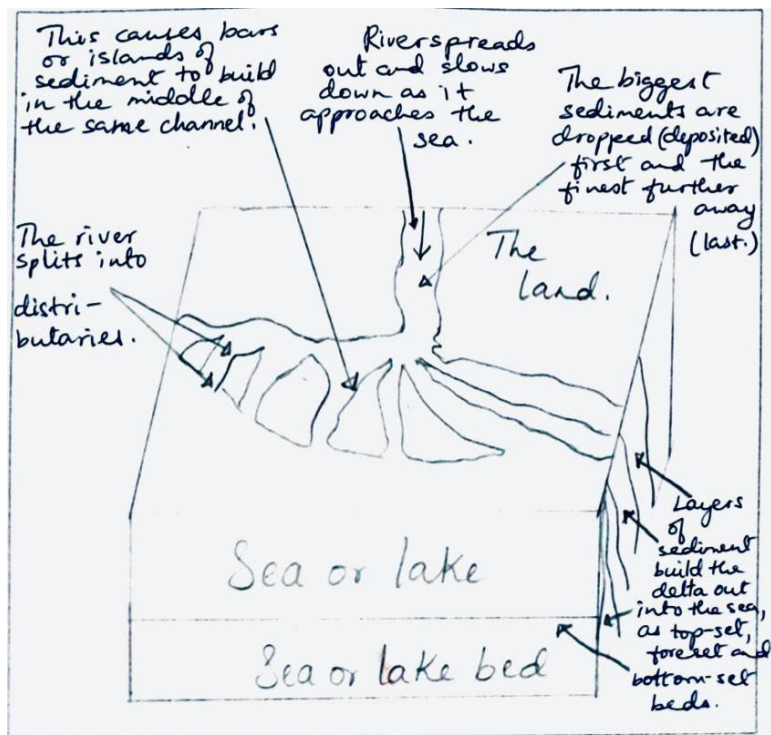


**(1) Explain how a delta is formed. Include a fully labelled diagram or diagrams.**

1. Rivers typically contain their highest sediment loads near their mouth, where they meet seas and oceans. As the river enters a body of water its velocity decreases and loses strength and hence can no longer carry the sediment.
2. At the mouth of the river, the flow of water becomes increasingly lateral. This lateral movement of water reduces hydraulic radius and increases wetted perimeter
3. This causes sediment to be deposited, as does flocculation where clay sediments join together, gain in mass and sink. Consequently, new land is built up.
4. Over time sediment builds up. This can create small islands that split the channel in the same way as braided streams.
5. This continues until the river splits, forming more distributaries and thus more islands.
6. Vegetation colonises these deltas. Vegetated islands impose more friction on flood waters, which focuses water and sediment into the neighbouring channels and increases erosion in non-vegetated areas.
7. If sediment is fine-grained, bird's foot deltas can be created. If sediment is coarse-grained, arcuate deltas form.

Diagram



**(2) For a named river you have studied, describe the hazards and difficulties of living close to it. Name of river- Ganges**

- River erosion
- Marshland
- Mosquitoes

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- Difficulty crossing river
- Flooding
  - Transport problems
  - Contaminated water
  - Homes destroyed
  - Deaths
- The Ganges is an extremely polluted river due to the human, animal and industrial waste dumped into it along its 2505km course. 1/3rd of India's population lives near the river, and many frequently become sick with intestinal infections from the water.
- Rising water level in Ganga has led to reverse flow in Varuna river- a minor tributary of the national river- leading to flooding in low lying areas of Varanasi.
- Bangladesh is a low lying country in South Asia that is situated in the delta of the Ganges-Brahmaputra-Meghna confluences. Around 80% of the country is situated on the low-lying floodplain called the Bangladesh Plain. The 1998 floods caused the destruction of 700,000 crops, 20% reduction in economic production. And made 20 million homeless as houses were destroyed. The death toll was over 1000
- There were outbreaks of typhoid in some villages because of the poor sanitation and pollution in the river.
- River bank erosion is a common problem in river channels in the deltaic tracts and is widespread throughout the course of the Ganges in West Bengal, especially in the Malda district. Official reports show that on an average 8 km<sup>2</sup> of land is engulfed annually by the river in West Bengal.

### **(3)For a named river you have studied, explain the causes of flooding. Named river- Ganges**

Heavy rainfall, Rainfall over a long period of time, Impermeable rocks, Rocks reach saturation level, Snow / ice melt, Deforestation, Urban development Storm surges High spring tides Cyclones – so coastal flooding idea fine at estuary Lack of river management

- In the upper Gangetic Plain in Uttar Pradesh, rainfall averages about 30–40 inches. Overall The Ganges basin receives nearly 1,000 mm of precipitation annually.
- Urbanisation on land makes it prone to flooding.
- Deforestation in the Himalayas reduced interception time, which shortened lag time and increased peak flow.
- The building of dams in India increased sedimentation in Bangladesh, which narrowed the channels.
- Pollution already in the rivers contributes to the floods. The Ganges is one of the most polluted rivers in the world.
- Snowmelt and higher sea levels due to global warming

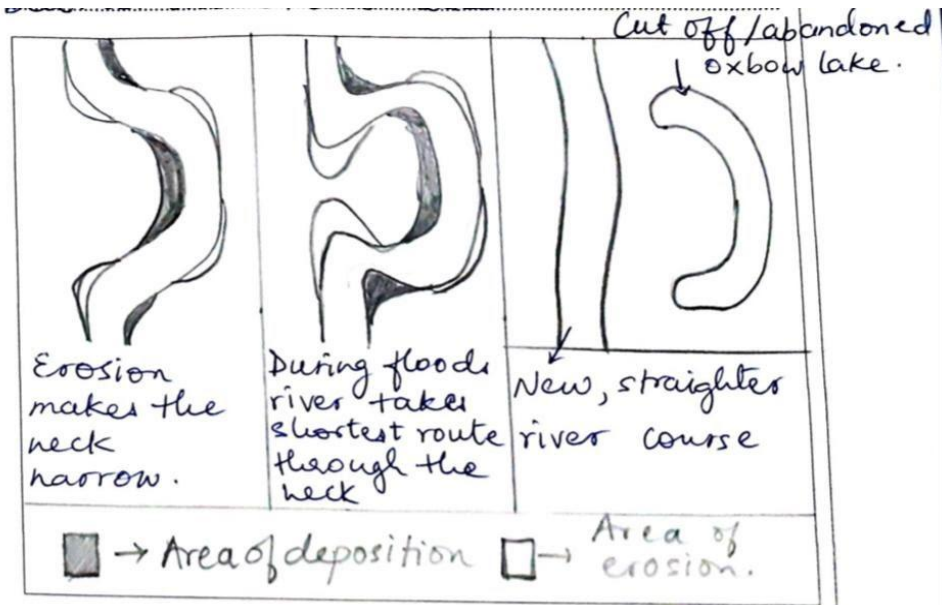
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- Removal of vegetation from the hilly slopes or over grazing by the domestic animals
- Deposition of silt washed down from bare and poorly covered hill slopes in the upper reaches of a river,
- Man-made obstructions to the free flow of rivers like bridges, embankments, etc.,
- Improper agricultural practices like shifting cultivation etc. and Failure of dams and artificial lakes created by advancing glacier tongues or landslides
- Often, flash floods are caused by the bursting of land-slides in downstream reaches. e.g. floods occurred in the Alaknanda river and Flood Studies of the Ganga river basin in India.
- Among all the Himalayan rivers joining the Ganga from the north, the major contributions come from the Kosi, Ghagra and Gandak and their tributaries joining the Ganga along its course through Gangetic plains. This bulk of water along with heavy silt load causes flooding in the main Ganga during the monsoon months in the States of east Uttar Pradesh, Bihar and West Bengal.

### **(4) Explain how an oxbow lake is formed. Include a diagram or series of diagrams.**

- Faster flow on outer bends
- Erosion on outer bends
- Neck of meander narrows/meander becomes more pronounced
- Cuts through neck in time of flood
- Former meander sealed by deposition
- Diagram
- Oxbow lakes are a result of lateral erosion caused by fast flow in the meanders.
- When a river meanders across flat land/plains, it is also eroding laterally (from side to side).
- The river flows faster on the outside bends and erodes them. So, the concave/outer banks erode over time. The force of the rivers flowing water wears away the land on the meander's outer banks.
- Silt and sediment build up on convex/inner banks. This build-up is called deposition.
- There is increased erosion during flood conditions, so the meanders become exaggerated and the neck of the meander narrows.
- The river breaks during a flood and creates a new channel and the old meander is sealed by deposition of silt and clay.
- This old meander becomes an oxbow lake.

Diagram



**(5) For a named river you have studied, describe the benefits of living on or close to its floodplain or delta. Name of river -Mekong**

Fertile soils

- Transport routes
  - Flat land
  - Domestic water supply
  - Irrigation
  - Fishing
  - Jobs in tourism
  - Jobs in industry
  - Locational details, named places alongside river/country name/area, etc.
- The Mekong river is the longest river in Southeast Asia. It has a length of about 2,700 miles.
  - The Mekong river drains more than 313,000 square miles of land into the south China sea.
  - Living near the Mekong River has several benefits as it plays a crucial role in the economies of LMB Countries (Thailand, Laos, Cambodia and Vietnam). It supports one of the world's largest inland fisheries, which has a total economic value estimated at [US\\$17 billion](#) – about three per cent of the region's combined gross domestic product.
  - Fisheries are most economically important to Cambodia and Laos, where the sector constitutes 18 and 12.8 percent of the economy respectively. Associated secondary industries, such as fish processing, markets, fuel and equipment sales as well as boat building, contribute at least another US\$3.6 to US\$7.4 billion annually.
  - Millions of subsistence fishing communities also depend on the waterway for their survival.
  - The river is also a source of irrigation for all four LMB countries

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- The Mekong River has between 175 and 250 gigawatts of technically feasible energy available for exploitation. Hydropower dams, if constructed, could provide massive economic stimulus for the region, producing energy, raising national incomes, creating employment and lifting people out of poverty.
- Over 70 million people live within the LMB. Of the 12 million households living in the region, 80 percent depend directly on the river for their food and livelihoods.
- The river plays a central part in the livelihoods of rural people and is an important resource for food and water security.
- The Mekong region is Asia's rice bowl: in 2014 lower Mekong countries (Myanmar, Laos, Cambodia, Thailand and Vietnam) produced more than 100m tonnes of rice, around 15% of the world's total. The region's fertile soil depends on nutrient-rich sediment that the Mekong carries downriver, mainly during the rainy season from June to October; more than half the sediment in central Cambodia comes from China.
- The river and the nutrients it brings also support the world's biggest inland fishery, accounting for a quarter of the global freshwater catch, feeding tens of millions of people.
- Due to its connectivity and geographical location, the Mekong river provides strong trading links and provides several transport routes especially for tourists.
- The region also boasts remarkable diversity. There are more than 20,000 types of plants, nearly 2,500 animal species etc; making the area a tourist hotspot as it provides connections to wildlife and nature.
- The area also encompasses various cultures (due to the migration of people because of the presence of transport routes provided by the river) and this also provides to be advantage for tourists to visit the area.
- In its more gentle and lower stretches near Laos and Thailand, the Mekong's flat land is helpful for rice farmers and other industries related to fishing to locate in these areas.

### **(6)For a named river you have studied, describe what has been done to reduce the risk of flooding. Name of river -Mekong**

- Dams/reservoirs
- Levees Overflow/flood relief channels
- Dredging
- Afforestation
- Warnings, Evacuation plan, Flood gates etc.
- Specific details of schemes etc.
- Annual floods in the Vietnamese Mekong River Delta not only bring great benefits for local inhabitants and the regional economy but also constitute a major safety risk
- Extreme floods cause losses of human lives and severe damages to crops and infrastructures For example, the historic flood in 2000, a 50-year flood

with estimated economic losses of over US\$ 200 million, illustrates the delta's high vulnerability to extreme floods

- Thailand, Cambodia and Vietnam signed the 1995 Agreement on the Cooperation for the Sustainable Development of the Mekong River Basin. Under the Agreement, issues such as flooding are clearly important as they relate to the natural environment, flow maintenance, economic well being and living standards
- Seeking a means to mitigate the damages, a mathematical flood forecasting model was first introduced to the Chao Phraya River Basin in 1975. In 1981, the flood forecasting system for other river basins was established to a large extent, such as Nam Pong, Nam Chi, Nam Mun in the Northeast and Mae Khlong in the West.
- Several government agencies and institutions are involved in developing and implementing hydrological forecasts. The Electricity Generating Authority of Thailand (EGAT) is responsible for reservoir regulation.
- Long term investment in various types of flood control works are required, which may include:
  - gates preventing back up of high flood waters;
  - reservoirs and retention dikes to protect urban areas and agricultural lands;
  - widening and deepening of tributaries and natural drains;
  - diversion channels; and
  - retention ponds and retarding basins.
  - Levees, dams, dredging, afforestation

The various storage reservoirs established or planned in the country for hydropower development (see Table 3) will provide valid options to reduce high discharges caused by excessive rainfall of short duration.

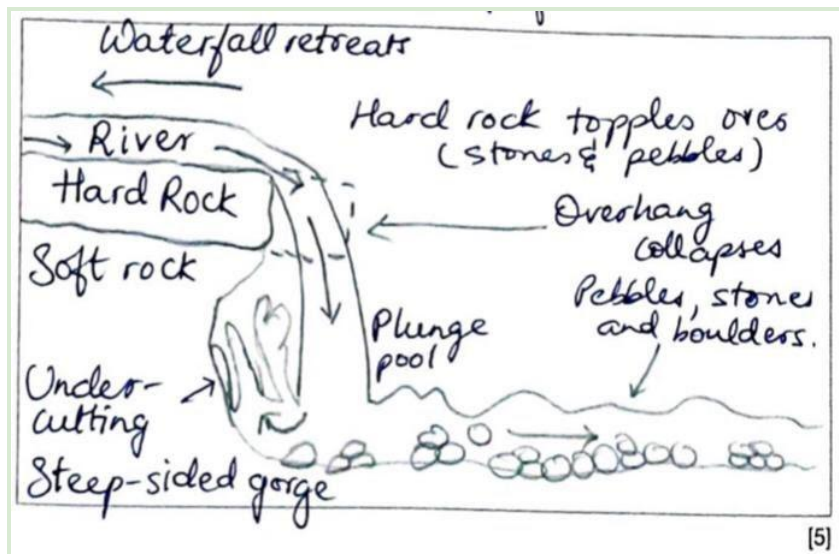
### **(7)Waterfall formation**

A waterfall is formed in areas where a layer of hard rock lies over soft rock. There are alternating layers of hard and soft rock.

- As the waterfalls, the soft rock is eroded much more quickly than the hard rock (as the soft rock is more susceptible to erosion as opposed to hard rock), therefore undercutting the hard rock.
- As erosion continues, the hard rock is further undercut forming an overhang (a step)
- Abrasion and hydraulic action erode the ground (surface) to create a plunge pool
- Over time the plunge pool gets bigger, increasing the size of the overhang until the hard rock is no longer supported and it ultimately collapses.
- The collapsed rocks and boulders fall (crash) into the plunge pool, and swirl around, causing more erosion of the soft rock and a much deeper plunge pool.

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- Over time, this process is repeated and the waterfall moves upstream.
- A gorge (a narrow, steep-sided valley with a stream running through it) is formed as the waterfall retreats.



### (8) Changes in the course of a river

#### Upper course

- V shaped cross profile
- Steep gradient ; steep long profile
- Situated in a narrow valley
- Shallow and fast flowing
- Low discharge
- Processes include vertical erosion weathering transport and traction
- Less load, Larger individual load
- Features include waterfalls, rapids, potholes, gorges and interlocking spurs
- Low hydraulic radius
- Deposition is mineral

#### Middle course

- V shaped but less steep
- Higher discharge than upper course
- High velocity
- Processes include vertical and horizontal saltation, erosion, meanders, transport and some deposition on the inner bends of the meanders
- Meanders and floodplains start to form
- Wider and deeper due to erosion
- Smaller load

#### Lower course

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- Wider broader deeper valley
- Higher velocity
- High discharge
- Total load is higher but individual particles smaller
- Deposition more prominent than erosion
- Solution and suspension take place
- High hydraulic radius
- Smoother river bed
- More meanders less steep valley
- Oxbow lakes levees floodplains deltas and terraces
- Most efficient