Single-Thread and Multi-Thread River System

Mains: *GS I – Salient features of World's Physical Geography*

Why in News?

Recently, the geographers at the University of California Santa Barbara (UCSB) have reported in a paper published in Science that they have solved the mystery of river splits.

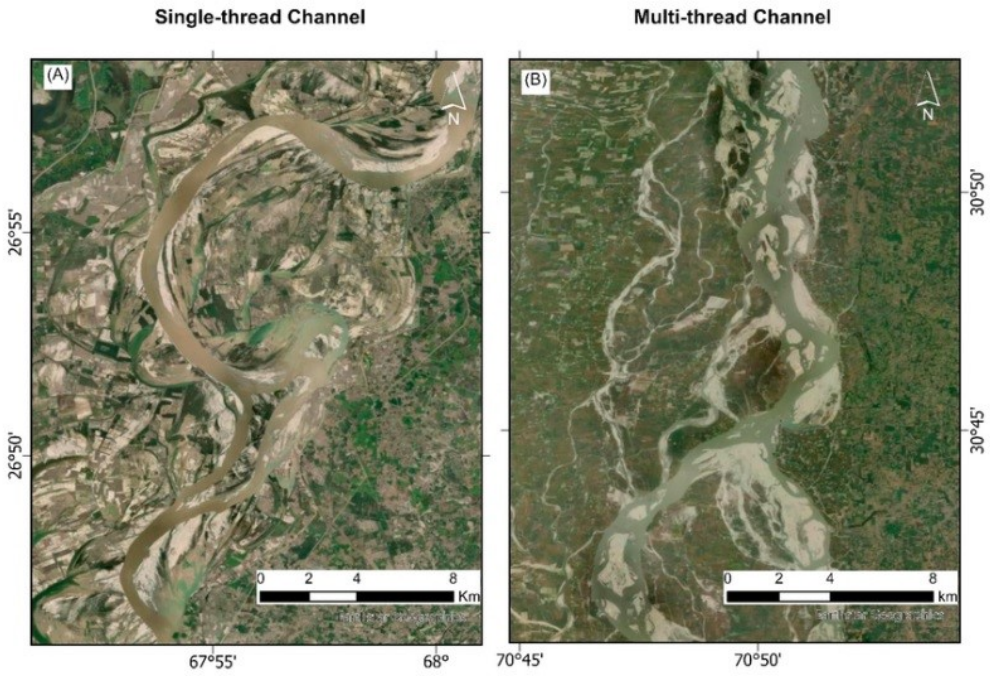
What was the research methodology?

- **Use of satellite** – To understand why some rivers flow in a single channel while others split into many threads, the researchers turned to satellites.
- They studied 36 years of global Landsat images, covering the period from 1985 to 2021.
- **Rivers studied** – From a worldwide survey of nearly 400 river sections, they chose 84 that were wide enough and moved at a speed suitable for their analysis.
- These included both single-thread and multithread rivers across different climates, slopes, and water flows.
- **Particle image velocimetry** – It is a computer technique called, which tracked small changes in images from year to year.
- This helped scientists measure how much a riverbank eroded and how much material accreted on the opposite side.
- **Pictures to maps** – They converted the satellite pictures into maps showing where land was dry and where it was covered by water.
- **Comparison** – By comparing thousands of cross-sections of the rivers over time, they generated millions of small vectors that recorded the directions and speeds of erosion and accretion.
- **Combining the data** – They combined all this data more than 4 lakh measurements of erosion versus accretion to test whether the two processes balanced out.
- This allowed them to discover the patterns that caused single or multithread rivers.
- **Result of the study** – They discovered the physical mechanism that causes there to be two types of rivers.

What are the two types of rivers?

- **Two types** – The rivers are classified into
  - Single-thread
  - Multi-thread
- **Single-thread rivers** – They are characterised by equilibrium between bank erosion and bar accretion.

- Material lost from one bank is balanced by the material deposited on the other, maintaining a stable width.



(A) Single-thread channel pattern of the Indus River; (B) multi-thread channel pattern of the Indus River.

- **Multi-threaded rivers** – They consistently exhibit higher rates of erosion relative to the deposition on the opposite banks.
- This leads to the channel widening and eventually splitting. This imbalance, per the work, is the driving force behind multithreaded rivers.
- **Main factor** – It is*, erosion* is what drives the phenomenon of flow splitting in rivers.

> ***Erosion*** *is the geological process where Earth's surface materials, like soil and rock, are worn away and transported by natural forces such as water, wind, and ice*

What are the relevance of the study?

- **Features** – The two main types of rivers, single-thread and multi-thread, also feature different flood and erosion risks, ecosystem services, and water resources.
- **Disaster management** – These hazards and features are becoming more relevant as people and governments cope with more frequent and more intense water weather events.
- **Research** – The physical mechanism that dictates single versus multi-threading has been becoming a more important subject of research.
    - Previous research mostly examined where different types of rivers could be found.
    - Now researchers also focused on how these rivers changed over time.
- There is growing recognition that many rivers have historically transitioned from multi-channel to single-channel after *human interference.*

Human interference in river formation *includes damming, diking, sediment mining, clearing and snagging, and agricultural development.*

- **Correcting the misinterpretation** – For many decades, scientists have believed that single-channeled, meandering rivers needed vegetated banks to form and that plants and meandering rivers coevolved.
- Researchers reported that that idea is based on a misinterpretation of the sedimentary record.
- **Discovery of role of vegetation –** Vegetated River bends move in a different direction than unvegetated river bends, relative to the down-slope direction that the entire river flows.
- This renders the sedimentary deposits that unvegetated meandering rivers produce fundamentally different from the deposits of vegetated meandering rivers, even though they have the same form.
- Given a straight valley, vegetated river bends will move outwards toward the sides of the valley whereas unvegetated river bends will move down the valley, without moving sideways.
- Vegetation causes this difference in river movement mainly because it causes levees to form, which indirectly limits the sinuosity.
- In turn, sinuosity controls how and where bends of the river migrate.

Sinuosity *is the ability to curve or bend easily and flexibly.*

What are Insights for India?

- **Rivers studied** – The researchers considered ganga and Brahmaputra river stretches
- **Ganga** – The reaserch considered three stretches of the Ganga, near Patna, Farakka, and Paksey (Bangladesh).
- **Brahmaputra** – They examined stretches near Bahadurabad (Bangladesh), Pandu (India), Pasighat (India), and one further upstream in the Himalaya.
- **Findings on Brahmaputra** – The Brahmaputra is a classical braided river.
- The team also found that the Brahmaputra's threads eroded their banks fast.
- The shape of their channels is fundamentally unstable.
- The subchannels are prone to widen and split over years and decades, because the flow laterally erodes riverbanks faster than it deposits along them.
- The find went against the conventional wisdom that erosion and deposition are in equilibrium.
- It is very surprising and intriguing that multi-thread rivers laterally erode faster than they deposit.
- The study has unravelled a new sort of way that rivers can maintain their form, which is fuelled not by equilibrium but instead cycles of instability as sub-channels repeatedly widen and split over time.
- This fundamental instability is an important consideration for river management.
- **Reducing flood risk –** Along multi-thread rivers like the Ganga and the Brahmaputra, the rating curves used to measure river flows must be updated more frequently in

order as the channels change their shape.

- The problem in India is that in many parts, braided river sections have been artificially confined to single channels using built embankments.
- Multi-channel rivers require significantly less space and time to return to their natural state, leading to lower restoration costs.
- **Stressed on Nature-based solutions** – This includes measures that can significantly lower the risk of flooding in adjacent areas.
    - Removing artificial embankments
    - Restoring the river's connection with its natural floodplains
    - Creating vegetated buffer zones along riverbanks
    - Reactivating abandoned channels
    - Building wetlands in braided sections

Reference

The Hindu| Mechanism of River Flow and Split