IASBABA



# [INDIAN DRAINAGE SYSTEM]

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# Indian Drainage

Hello Friends in this part we will discuss about the natural drainage of India. In order to understand a natural drainage system, it is first important to understand what exactly drainage is.

# Drainage:

**Drainage** is the natural or artificial removal of a surface's water and sub-surface water from an area. The tendency of water is to flow down the slope.

## Natural Drainage Systems:

In geomorphology, **drainage systems**, also known as **river systems**, are the patterns formed by the streams, rivers, and lakes in a particular drainage basin. They are governed by the topography of the land, whether a particular region is dominated by hard or soft rocks, and the gradient of the land. Geomorphologists and hydrologists often view streams as being part of drainage basins. A drainage basin is the topographic region from which a stream receives runoff, through flow, and groundwater flow. The number, size, and shape of the drainage basins found in an area vary.

Drainage systems are regarded as the Fundamental geomorphic as well as hydrological units for a systematic study of river basins mainly due to the following reasons:

- They can be placed in an orderly hierarchy.
- They are aerial units whose geomorphological and hydrological characteristics can be measured quantitatively.
- They can be treated as working systems with energy inputs of climatological variables like temperature and rainfall and output of river discharge as runoff.

## Process of formation of drainage system:

Water naturally travels downhill, pulled by the force of gravity, to collect in streams, which eventually carry the water back to the ocean. Streams are fed by the seepage of groundwater, melting of ice, lakes and surface runoff from precipitation.

When rainfall occurs too quickly to be absorbed in the ground, water travels directly over the surface as overland flow.

**Sheet Flow**: Where the soil or rock surface is smooth, the flow may be in a form of continuous thin film, called **Sheet flow.**

**Rills:** If the ground is rough or pitted, overland flow may be made of a series of tiny rivulets, connecting one water filled hollow to another. These are called the **rills**.

**Streams:** These rills down the slope, connects with each other and starts flowing in channels which later form big streams.

**This network of streams and the sloping ground surfaces next to the channels that contribute overland flow to the streams are together called drainage systems.**

**Note:** Kindly understand and remember the above the definition of drainage system. This sums up the whole story.

## Stream Channel:

It is trough shaped by the force of flowing water. A channel may be so narrow that you can jump across it or in case of Brahmaputra river it can be as wide as 12 km.

Scientists and geographers who study streams measure them by their **cross section area (A),** which depends on the width (w) and depth (d) of their channels.

Two other key characteristics are **stream velocity (V),** which measures how rapidly the water is flowing in the stream and **discharge (Q),** which measures the volume of water per unit of time passing through a cross section of the stream at that location.

The **slope gradient** (S) of the stream is also an important characteristic which defines the velocity, discharge and turbulence of the stream.

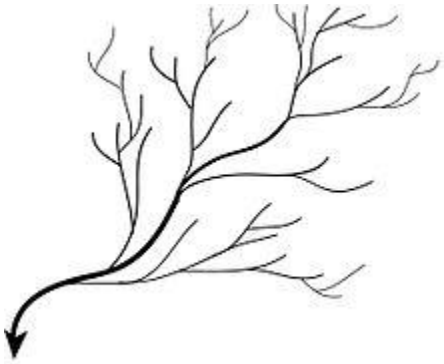
## Drainage Pattern:

A **geometric arrangement** of streams in a region, determined by slope, differing rock resistance to erosion, climate, hydrological variability and structural controls of the landscape is known as a drainage pattern.

In simple terms, drainage pattern refers to the **design** which a river and its tributaries form together from source to its mouth.

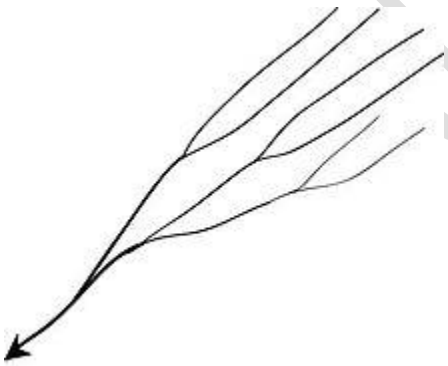
According to the shape of the tributaries following types of Drainage patterns are found:

**Dendritic drainage pattern**



- Dendritic drainage systems are the most common form of drainage system.
- In a dendritic system, there are many contributing streams (analogous to the twigs of a tree), which are then joined together into the tributaries of the main river (the branches and the trunk of the tree, respectively).
- They develop where the river channel follows the slope of the terrain. Dendritic systems form in V-shaped valleys; as a result, the rock types must be impervious and non-porous.

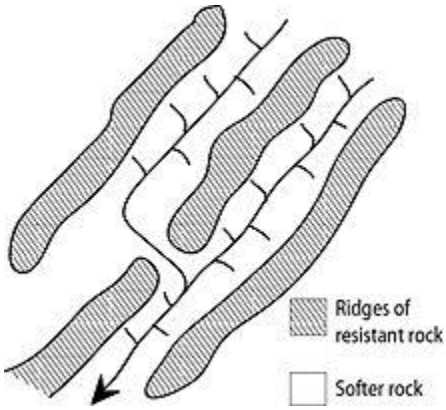
**Parallel drainage pattern**



- A parallel drainage system is a pattern of rivers caused by steep slopes with some relief. Because of the steep slopes, the streams are swift and straight, with very few tributaries, and all flow in the same direction.
- This system forms on uniformly sloping surfaces, for example, rivers flowing southeast from the Aberdare Mountains in Kenya.

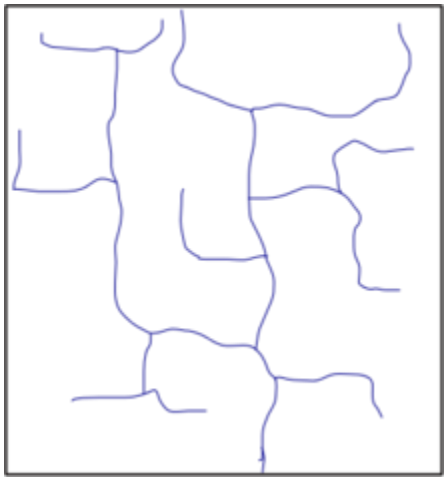
- Parallel drainage patterns form where there is a pronounced slope to the surface. A parallel pattern also develops in regions of parallel, elongate landforms like outcropping resistant rock bands.
- A parallel pattern sometimes indicates the presence of a major fault that cuts across an area of steeply folded bedrock.

**Trellis drainage pattern**



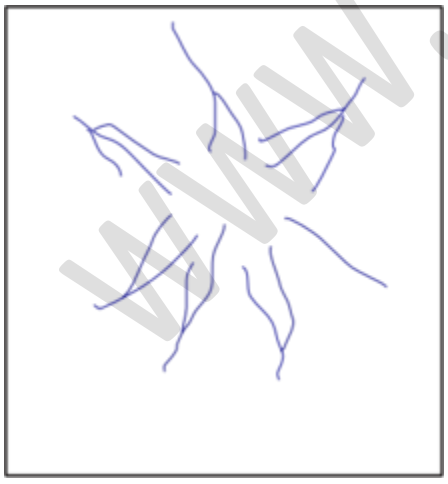

- The geometry of a trellis drainage system is similar to that of a common garden trellis used to grow vines.
- As the river flows along a strike valley, smaller tributaries feed into it from the steep slopes on the sides of mountains.
- These tributaries enter the main river at approximately 90 degree angle, causing a trellis-like appearance of the drainage system.
- This pattern is found usually in old degraded areas like Chota Nagpur plateau, Deccan plateau etc.

**Rectangular drainage pattern**



- Rectangular drainage develops on rocks that are of approximately uniform resistance to erosion, but which have two directions of joining at approximately right angles.
- The joints are usually less resistant to erosion than the bulk rock so erosion tends to preferentially open the joints and streams eventually develop along the joints.
- The result is a stream system in which streams consist mainly of straight line segments with right angle bends and tributaries join larger streams at right angles.

**Radial drainage pattern**



In a radial drainage system, the streams radiate outwards from a central high point. Volcanoes usually display excellent radial drainage. In India it is nicely exhibited by Amarkantak mountain.

**Centripetal drainage pattern**

- The centripetal drainage system is similar to the radial drainage system, with the only exception that radial drainage flows out versus centripetal drainage flows in.
- When streams from surrounding area come towards on sink in the middle it is called centripetal drainage.

**Deranged drainage pattern**

- A deranged drainage system is a drainage system in drainage basins where there is no coherent pattern to the rivers and lakes. It happens in areas where there has been much geological disruption. The classic example is the Canadian Shield.
- During the last ice age, the topsoil was scraped off, leaving mostly bare rock. The melting of the glaciers left land with many irregularities of elevation, and a great deal of water to collect in the low points, explaining the large number of lakes which are found in Canada. The drainage basins are young and are still sorting themselves out. Eventually the system will stabilize.
- In India deranged pattern is very rare.

**Annular drainage pattern**

- In an annular drainage pattern streams follow a roughly circular or concentric path along a belt of weak rock, resembling in plan a ring-like pattern.
- It is best displayed by streams draining a maturely dissected structural dome or basin where erosion has exposed rimming sedimentary strata of greatly varying degrees of hardness.
- In India many small Himalayan streams show this pattern.

**Angular drainage pattern**

Angular drainage patterns form where bedrock joints and faults intersect at more acute angles than rectangular drainage patterns. Angles are both more and less than 90 degrees.

The Drainage Patterns are also categorized on the factor that whether the stream is confirming to the geology of a place or not.

### Accordant Drainage Pattern –

A drainage system is described as accordant if its pattern correlates to the structure and relief of the landscape over which it flows.

This means that streams confirms to the slope of a place.

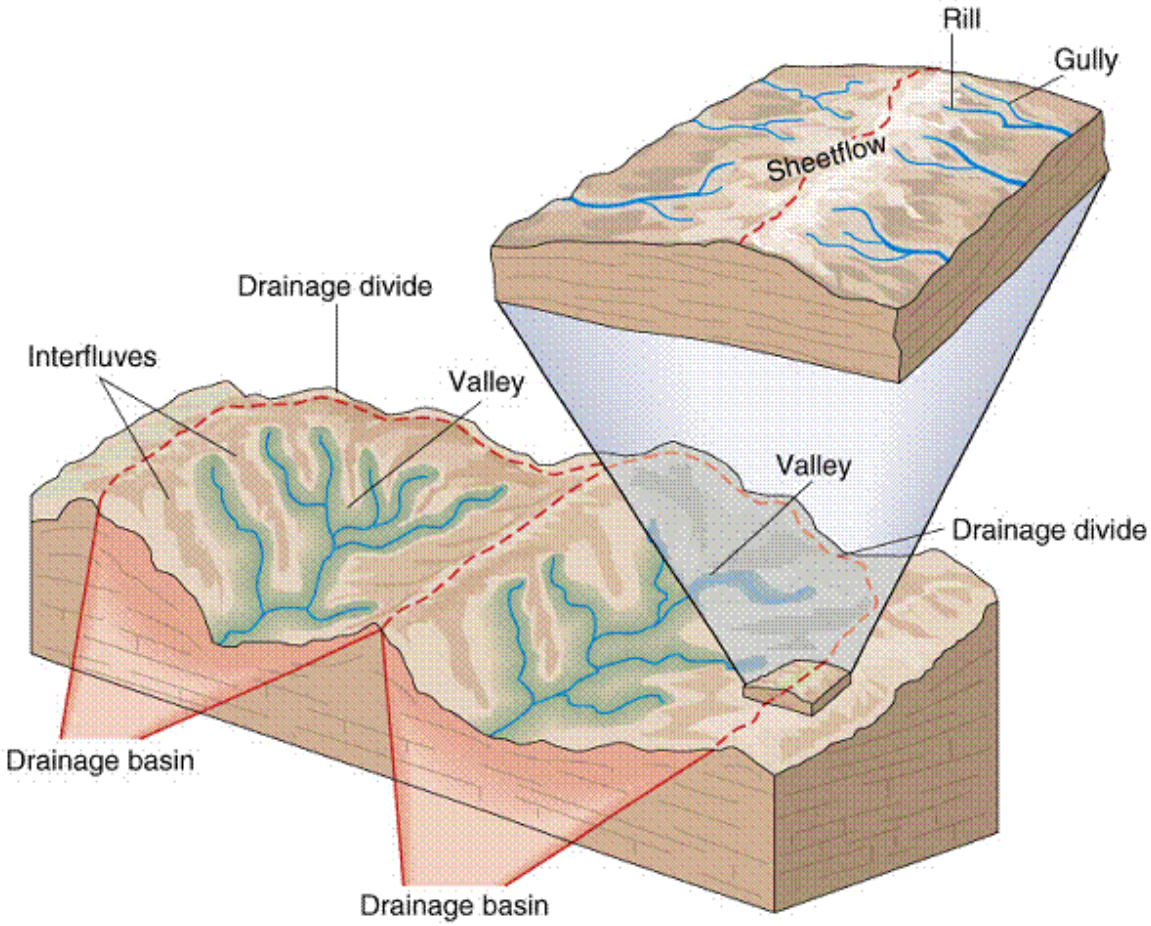
### Discordant drainage patterns

A drainage pattern is described as discordant if it does not correlate to the topography and geology of the area. Discordant drainage patterns are classified into two main types: **antecedent** and **superimposed**, while anteposition drainage patterns combine the two.

In ***antecedent*** **drainage**, a river's vertical incision ability matches that of land uplift due to tectonic forces.

***Superimposed*** **drainage** develops differently: initially, a drainage system develops on a surface composed of 'younger' rocks, but due to denudative activities this surface of younger rocks is removed and the river continues to flow over a seemingly new surface, but one in fact made up of rocks of old geological formation.

## Drainage Basin:




A **drainage basin** or **catchment area** is any area of land where precipitation collects and drains off into a common outlet, such as into a river, bay, or other body of water.

The drainage basin includes all the surface water from rain runoff, snowmelt, and nearby streams that run downslope towards the shared outlet, as well as the groundwater underneath the earth's surface.

Drainage basins connect into other drainage basins at lower elevations in a hierarchical pattern, with smaller **sub-drainage basins**, which in turn drain into another common outlet.

The drainage basin acts as a funnel by collecting all the water within the area covered by the basin and channelling it to a single point. Each drainage basin is separated topographically from adjacent basins by a perimeter, the drainage divide, making up a succession of higher geographical features (such as a ridge, hill or mountains) forming a barrier.

Drainage basins are similar but not identical to hydrologic units, which are drainage areas delineated so as to nest into a multi-level hierarchical drainage system. Hydrologic units are defined to allow multiple inlets, outlets, or sinks. In a strict sense, **all drainage basins are hydrologic units but not all hydrologic units are drainage basins.**

## Endorheic Drainage Basins

Endorheic drainage basins are inland basins that do not drain to an ocean. Around 18% of all land drains to endorheic lakes or seas or sinks.

The largest of these consists of much of the interior of Asia, which drains into the Caspian Sea, the Aral Sea, and numerous smaller lakes. Other endorheic regions include the Great Basin in the United States, much of the Sahara Desert, the drainage basin of the Okavango River (Kalahari Basin), highlands near the African Great Lakes, the interiors of Australia and the Arabian Peninsula, and parts in Mexico and the Andes. Some of these, such as the Great Basin, are not single drainage basins but collections of separate, adjacent closed basins.

**Endorheic Drainage basin in Central Asia**

In endorheic bodies of standing water where evaporation is the primary means of water loss, the water is typically more saline than the oceans. An extreme example of this is the Dead Sea.

In India lakes of Rajasthan, Bhopal, Bangalore acts as inland sink are area around them act as endorheic drainage basin.

## Catchment Factors:

Catchment factors determine the amount of water flowing into the stream.

### Topography

Generally, topography plays a big part in how fast runoff will reach a river. Rain that falls in steep mountainous areas will reach the primary river in the drainage basin faster than flat or lightly sloping areas (e.g., > 1% gradient).

### Shape

Shape will contribute to the speed with which the runoff reaches a river. A long thin catchment will take longer to drain than a circular catchment.

### Size

Size will help determine the amount of water reaching the river, as the larger the catchment the greater the potential for flooding. It also determined on the basis of length and width of the drainage basin.

### Soil type

Soil type will help determine how much water reaches the river. Certain soil types such as sandy soils are very free-draining, and rainfall on sandy soil is likely to be absorbed by the ground. However, soils containing clay can be almost impermeable and therefore rainfall on clay soils will run off and contribute to flood volumes. After prolonged rainfall even free-draining soils can become saturated, meaning that any further rainfall will reach the river rather than being absorbed by the ground. If the surface is impermeable the precipitation will create surface run-off which will lead to higher risk of flooding; if the ground is permeable, the precipitation will infiltrate the soil.

### Land use

Land use can contribute to the volume of water reaching the river, in a similar way to clay soils. For example, rainfall on roofs, pavements, and roads will be collected by rivers with almost no absorption into the groundwater.

## Uses of Drainage Basin:

**Geopolitical Boundaries:**

Drainage basins have been historically important for determining territorial boundaries, particularly in regions where trade by water has been important.

**Hydrological studies:**

In hydrology, the drainage basin is a logical unit of focus for studying the movement of water within the hydrological cycle, because the majority of water that discharges from the basin outlet originated as precipitation falling on the basin.

**Topographical studies:**

Drainage basins are the principal hydrologic unit considered in fluvial geomorphology. A drainage basin is the source for water and sediment that moves from higher elevation through the river system to lower elevations as they reshape the channel forms.

Note: Fluvial landforms are the landforms made by running water on the surface.

**Ecological impact**

Drainage basins are important in ecology. As water flows over the ground and along rivers it can pick up nutrients, sediment, and pollutants. With the water, they are transported towards the outlet of the basin, and can affect the ecological processes along the way as well as in the receiving water source.

Quality of water determines the quality of life of flora and fauna and also the diversity in the stream.

**Resource Management:**

Rivers and streams are the most important source of fresh water. They are used for agricultural, industrial and household uses.

Controlling the drainage basin we can plan the use of fresh water accordingly. Also there are many resources that we obtain from these streams like fishes, inland navigation, aquaculture, sand mining etc.

**Disaster Management:**

Disasters like flash floods, cloud bursts, flooding etc can be mitigated by controlling the drainage basin.

# Indian Drainage

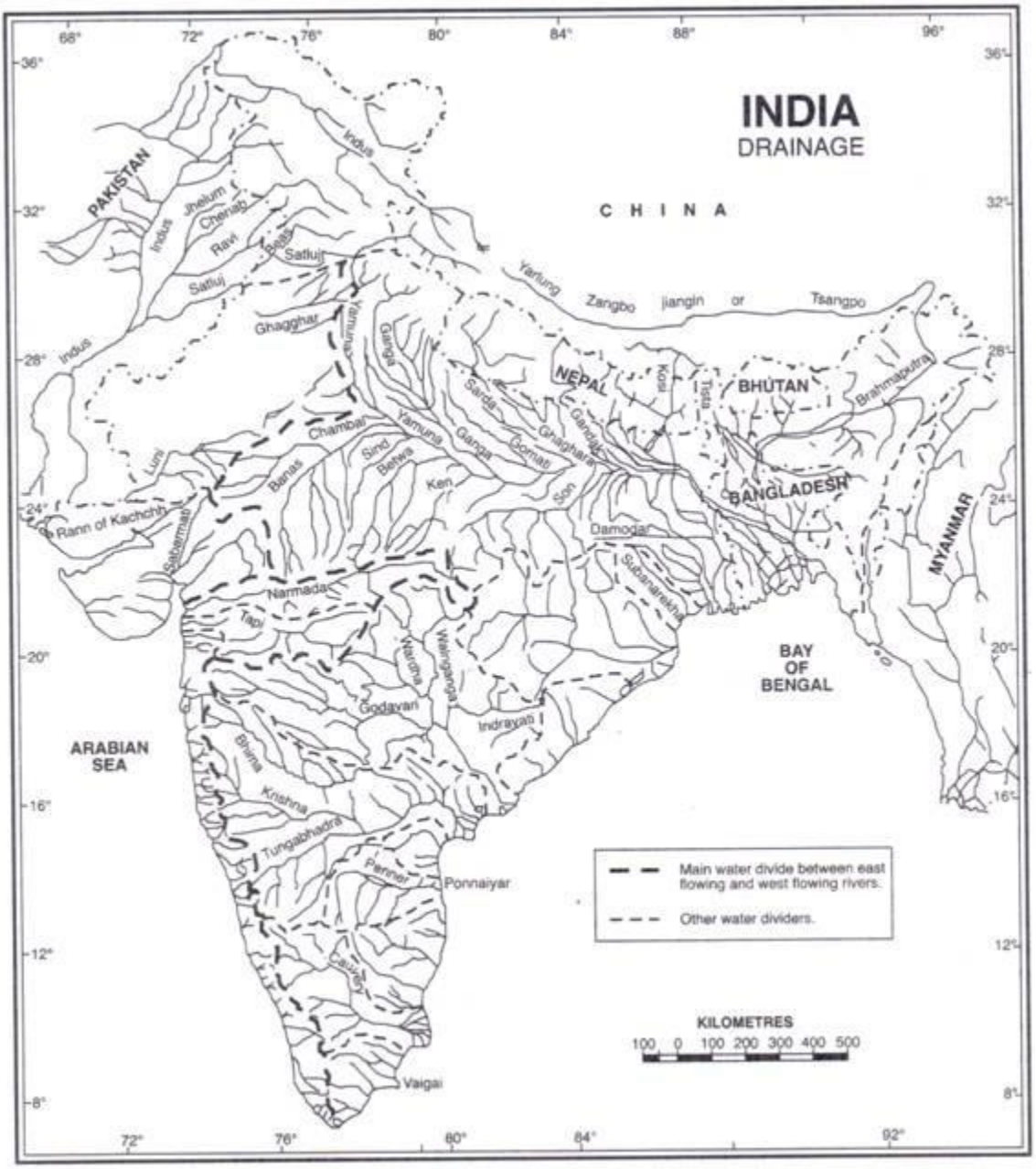



**FIG. 4.2.** India : Drainage

# Drainage Basins in India

Drainage basins of India can be classified on the basis of the size of drainage basin as well as the origin of rivers.

**1.) Classification of the basis of Size:**

On the basis of the size of catchment area, the river basins of India have been classified into three categories.

I. Large river basins: River basins with a catchment area of more than 20,000 sq km are known as large river basins.
II. Medium River basins: River basins with a catchment area between 20,000 sq km to 2000 sq km are known as medium river basin.
III. Minor river basin: River basins with a catchment area of less than 2000 sq km are known as minor river basin.

Details of Major river basins of India are as follows:

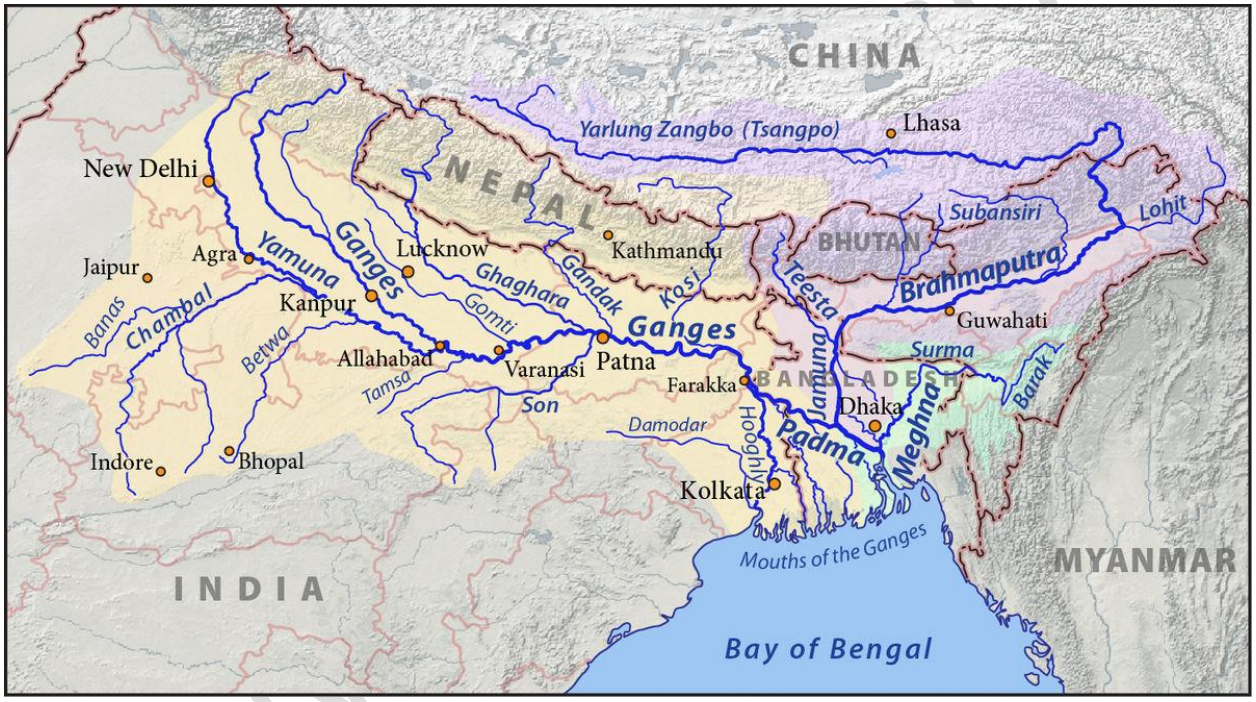
| River Basin | Basin Area ($km^2$) | Percentage area | Annual discharge ($m^3/km^2$) |
|---|---|---|---|
| Ganga | 861404 | 26.2 | 468700 |
| Indus | 321284 | 9.8 | 79500 |
| Godavari | 312812 | 9.5 | 118000 |
| Krishna | 258,948 | 7.9 | 62,800 |
| Brahmaputra | 258008 | 7.8 | 627000 |
| Mahanadi | 141589 | 4.3 | 66640 |
| Narmada | 98795 | 3.0 | 54600 |
| Kaveri | 87900 | 2.7 | 20950 |
| Tapi | 65150 | 2.0 | 17982 |
| Pennar | 55213 | 1.7 | 3238 |
| Brahmani | 39033 | 1.2 | 18310 |
| Mahi | 34481 | 1.0 | 11800 |
| Subarnarekha | 21895 | 0.7 | 7940 |
| Sabarmati | 19296 | 0.6 | 3800 |
| Medium and minor rivers | 711833 | 23.6 | - |

**2.) Classification on the basis of Origin:**

On the basis of origin, two broad drainage systems are recognized

1. The Himalayan Drainage
2. The Peninsular Drainage

## The Himalayan Drainage:




These rivers are again subdivided into two groups – **Trans Himalayan and Himalayan**.

The **Trans-Himalayan** Rivers originate beyond the Great Himalayas. These are the Indus, the Sutlej and the Brahmaputra rivers.

**Himalayan** rivers are those which originate in the Himalayas and flow through the Northern Plains, e.g., the Ganga, the Yamuna and their tributaries. These rivers are useful for irrigation and navigation and the lowlands drained by them have fertile alluvial deposits.

The Himalayan drainage system comprises of all the International Rivers of India i.e. Indus, Ganga and Brahmaputra.

Most of these rivers are perennial in nature obtaining their water from glaciers and rains. These rivers are in their youthful Stage carving out a number of erosional landforms like waterfalls, cataracts, rapids, gorges etc.

## Evolution Himalayan Drainage:

Note: Since the theory is given in NCERT, we are explaining it here in the module. However, the theories are not exactly important for GS perspective.

**First Theory:**

First theory was given by **Pascoe and Pilgrim** independently in 1919.

Hypothesis: They assumed that there was an ancient mighty river flowed from Assam to Punjab. This hypothetical ancient river was called the **Indo-Brahm** by E.H. Pascoe who thought that the present day Indus and Brahmaputra were the severed parts of the original river.

However, it was named as the **Shiwalik** River by E.G. Pilgrim who considered that the course of the primitive river is occupied by the present day Shiwalik hills.

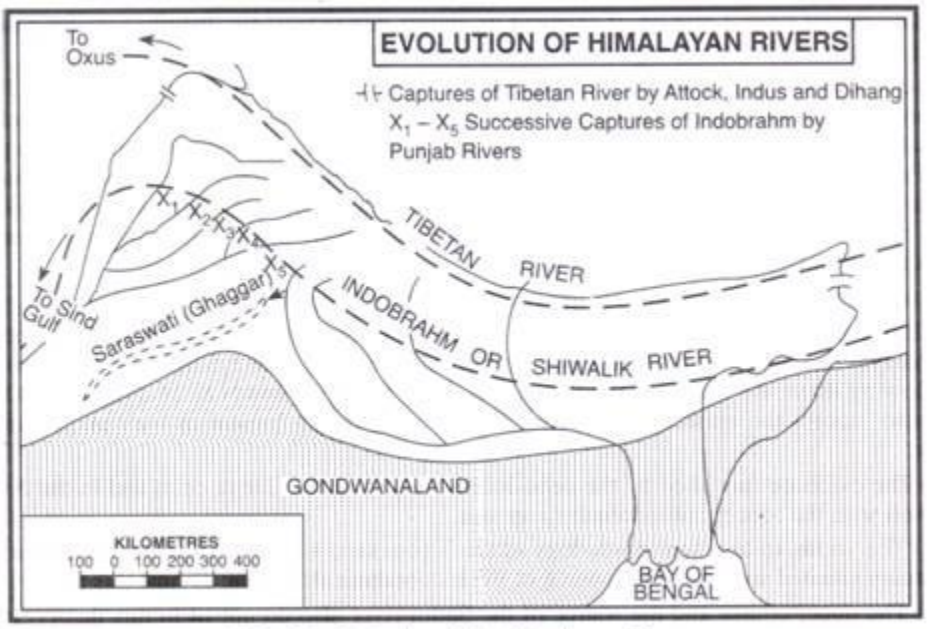



**FIG. 4.1.** Evolution of the Himalayan Rivers

The river came into being due to earth movements which took place in Tertiary period and is believed to be successor of the Himalayan Sea. In the Eocene Epoch a gulf extended from Sind

to Afghanistan and from there extended eastward and south-eastward through Kohat and Punjab to the neighbourhood of Nainital.

This gulf gave place to a great river. With its headwater consisting of portions of the Brahmaputra, this master stream flowed along the foot of the Himalayas first westward and then north-westward as far as north-western Punjab where it turned southward more or less along the course of the modern Indus, and emptied itself into the Arabian Sea.

**Later, this mighty stream got dismembered into the following systems and sub-systems:**

(a) The Indus,

(b) The five tributaries of the Indus in Punjab,

(c) The Ganga and its Himalayan tributaries, and

(d) The stretch of the Brahmaputra in Assam and its Himalayan tributaries.

**The dismemberment was the result of the following two events:**

(i) Upheavals in the western Himalayas including the Potwar Plateau in the Pleistocene age and

(ii) Headward erosion by the tributaries of the Indobrahma River.

As a result of the above mentioned dismemberment of the Indobrahma River, the Indus and its tributaries, the Ganga and its tributaries and the Brahmaputra and its tributaries came into being. It is supposed that the Yamuna was first a tributary of the Indus.

**Second Theory:**

Second theory was developed by **E. Ahmad** (1965 – 71).

He believed that the Tethys remained as a basin of sedimentation from the Cambrian to the Eocene period but the major portion of the Himalayan region as occupied by the Gondwana landmass.

The **first upheaval** of Himalayas in Oligocene time initiated the Himalayan Drainage.

As the formation of east-west ranges created east-west valleys, the rivers partly flowed along these valleys. This is indicated by the upper course of several rivers such as the Indus, the

Sutluj, the Brahmaputra, the Shyok, the Arun, etc. Since the whole of the Tethys was not fully raised to become land surface, there existed patches of sea along the margins and the drainage lines were not fully defined.

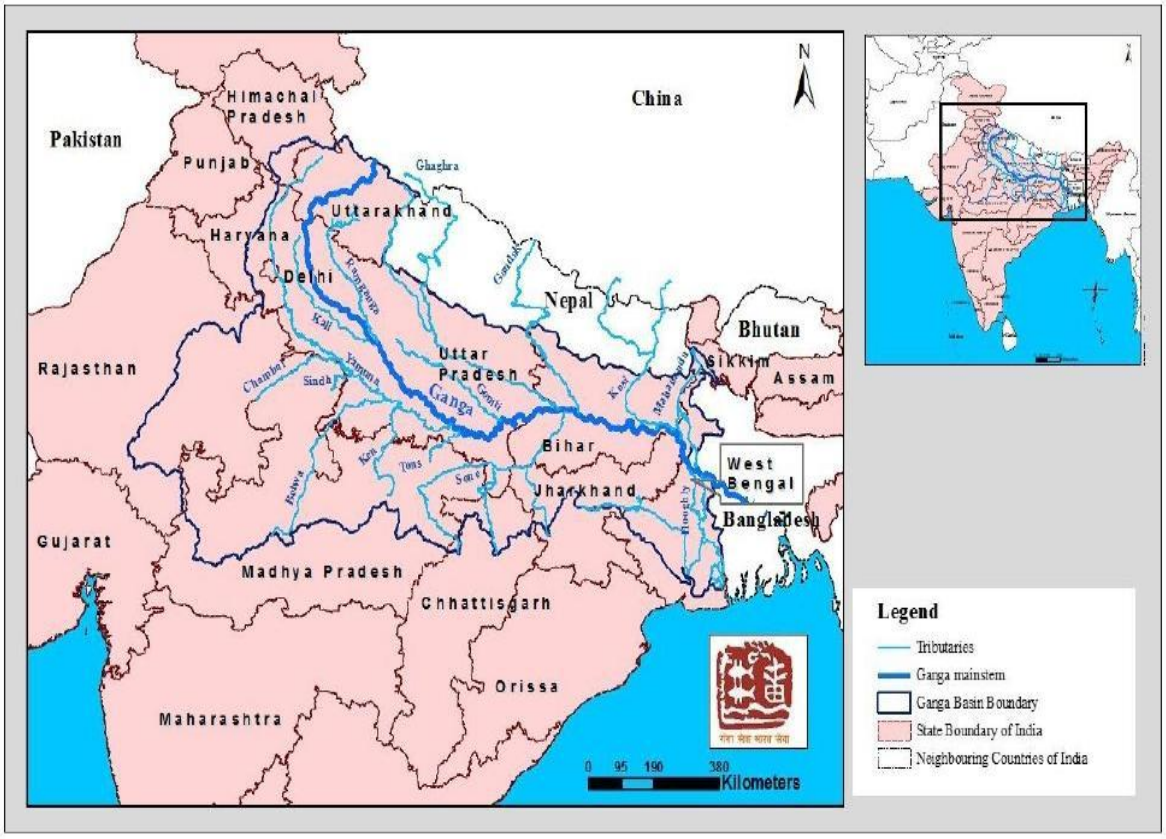
**The second Himalayan** upheaval during the mid-Miocene period increased the altitude of the medium mass and the bordering ranges. The remnant sea was also raised to form landmass. The rise in land resulted in greater and more invigorated drainage.

The **third Himalayan** upheaval during the Pleistocene period resulted in the folding of the Shiwalik foredeep into hill ranges. Also the height of earlier ranges and the Tibetan plateau was raised. The rise in the Tibetan plateau blocked the streams that had gone northward into the Tibetan sea.

These streams were diverted east or west which probably led to the formation of the trans-Himalayan master stream. This master stream was broken into two (the proto-Indus and the proto-Brahmaputra) by the formation of the Kailas Range. The uplift of the Shiwalik range gave rise to the last set of consequents originating on the crest of the range emptying into older streams.

# Important River Systems

## Ganga River System:




The **Ganga** is a trans-boundary river of Asia which flows through the nations of India and Bangladesh. The 2,525 km (1,569 mi) river rises in the western Himalayas in Uttarakhand, and flows south and east through the Gangetic Plain of North India into Bangladesh, where it empties into the Bay of Bengal.

It is the third largest river in the world by discharge.

**Course of Ganga:**

The main stem of the Ganges begins at the confluence of the **Bhagirathi** and **Alaknanda** rivers in the town of **Devprayag** in the Garhwal division of the Indian state of Uttarakhand.

Although many small streams comprise the headwaters of the Ganges, the six longest and their five confluences are considered sacred. The six headstreams are the Alaknanda, Dhauliganga, Nandakini, Pindar, Mandakini, and Bhagirathi rivers.

The five confluences, known as the Panch Prayag, are all along the Alaknanda. They are, in downstream order,

- Vishnuprayag, where the Dhauliganga joins the Alaknanda;
- Nandprayag, where the Nandakini joins;
- Karnaprayag, where the Pindar joins,
- Rudraprayag, where the Mandakini joins;
- Devprayag, where the Bhagirathi joins the Alaknanda to form the Ganges River proper.


**Panch Prayag**

After travelling 280 km from its source, the Ganga reaches Haridwar, debouches from the hills and enters plain area. From here it flows in south and south-east direction for a distance of 770 km to reach Allahabad. Here it is joined by the Yamuna which is its most important tributary.

It sweeps another 300 km eastwards to reach the Bihar plain. Near Rajmahal Hills it turns to the southeast and south of Farraka, it ceases to be known as the Ganga. It bifurcates itself into Bhagirathi-Hugli in West Bengal and Padma-Meghna in Bangladesh. After traversing 220 km further down in Bangladesh, the Brahmaputra (or the Jamuna as it is known here) joins it at Goalundo and after meeting Meghna 100 km downstream the Ganga joins the Bay of Bengal.

Before entering the Bay of Bengal, the Ganga, along with Brahmputra, forms the largest delta of the world between two arms: the Bhagirathi / Hugli and the Padma / Meghna covering an area of 58,752 sq km.

**This basin is shared by ten states.**

These states are Uttaranchal and Uttar Pradesh (34.2%), Madhya Pradesh and Chhattisgarh (23.1%), Bihar and Jharkhand (16.7%), Rajasthan (13.0%), West Bengal (8.3%), Haryana (4.0%) and Himachal Pradesh (0.5%). The Union Territory of Delhi accounts for 0.2% of the total area of the Ganga Basin.

The following table gives the details of important tributaries of Ganga:

| River | Place of origin | Tributaries | Multipurpose Projects | States | Facts |
|---|---|---|---|---|---|
| **Ganga** | Gangotri glacier at Uttrakand; Originate as Bhagirathi from Gangotri | **Right:** Son, Yamuna **Left:** Ramganga, Gomati, Ghaghara (Saryu), Gandak, Kosi, Mahananda **Distributary:** Hugli | Tehri dam, | Uttrakhand, Uttar Pradesh, Bihar, West Bengal | Ganga has the largest Catchment Area |
| **Ram Ganga** | Pauri, Gharwal district | | | Changes its course to the southwest direction after crossing the Shiwalik and enters into the plains of Uttar Pradesh near Najibabad. | Joins the Ganga near Kannauj |
| **Gomati** | North UP | | | Lucknow Meets Ganga at Saidpur, Varanasi Distt. | Only trib. To rise on the plains |
| **Ghaghra** | From Gurala Mandhata peak (South of Mansarovar) in Tibet-- Glaciers of Mapchachungo | **Headward Streams:** Kali (Sarda) Karnali Tila, Seti and Beri | Sharda Sahayak Project | Cuts a deep gorge at Shishapani | Ayodhya Faizabad Meets the Ganga at Chhapra |
| **Gandak** | Tibet-Nepal border- Between | Kali Gandaki Trishul Ganga | | Enters the Ganga plain in Champaran district of | Called Narayani in Nepal |

| | | | | | |
|---|---|---|---|---|---|
| | Dhaulagiri and Mount Everest and | | | Bihar<br>Merges with Ganga at Sonepur near Patna | Drains the central part of Nepal |
| **Kosi** | Sikkim-Tibet-Nepal Himalayas<br>Antecedent<br>Main Stream: **Arun** | Saptkoshi- 7 streams<br>Out of which 3 streams(Son+Arun+ Tamur) merges at Triveni-Mahabharata Range to form Kosi | Kosi Project (India and Nepal) | After crossing the Central Himalayas in Nepal, it is joined by the Son Kosi from the West and the Tamur Kosi from the east | Sorrow of Bihar<br>Snow covered areas-Huge vol. of water |
| **Son** | Amarkantak Plateau | Large south bank tributary<br>Rihand (Ramgarh Hills) | Rihand Valley Project-Govind Vallabh Pant Sagar<br>Banasagar Project | | Series of Waterfalls at the edge of the plateau |
| **Yamuna** | Yamunotri Glacier on Bandarpunch Peak-Garhwal, Uttarakhand | Tons- Right bank; Rises from Bandarpunch glacier<br>Chambal, Sind, Betwa, Ken | Confluence: Ganga & Yamuna-***Sangam*** | Delhi<br>Agra + Mathura (UP)<br>Uttranchal | Longest trib. Of Ganga |
| **Chambal** | Near Mhow in the Malwa plateau of Madhya Pradesh | Banas- from Aravalli | Rana Pratap Sagar<br>Gandhi Sagar<br>Jawahar Sagar Dam | Flows northwards through a gorge up wards of Kota. From Kota, it traverses down to Bundi, Sawai Madhopur and Dholpur, and finally joins the Yamuna | Badland Topography-Chambal Ravines |

| | | | | | |
|---|---|---|---|---|---|
| **Damodar** | Chotanagpur Plateau | Barakar | Damodar Valley Multipurpose Project<br>**Dams:**<br>R.Barakar: Tilaiya + Maithan<br>On R.Konar<br>R.Damodar: Panchet | | Once called as "Sorrow of Bengal"<br>Flows through a graben or a rift Valley |
| **Hugli** | Kolkata | Ajay | | | |
| **Sarda/ Saryu** | Milan glacier(Nepal Himalayas) | | | | Nepal-Goriganga<br>Indo-Nepal Border- Kali/ Chauk |
| **Mahanan da** | Rises in the Darjeeling Himalayas | | | Joins the Ganga as its last left bank tributary in West Bengal | |

## The Indus River System:


- It flows in north-west direction from its source **(Glaciers of Kailas Range –** Kailash range in Tibet near Lake Manasarovar**)** till the **Nanga Parbhat** Range.
- It's length is about 2,900 km. Its total drainage area is about 1,165,000 square km [more than half of it lies in semiarid plains of Pakistan]. It is joined by **Dhar River** near Indo-China border.
- After entering J&K it flows between the **Ladakh** and the **Zaskar Ranges**. It flows through the regions of Ladakh, Baltistan and Gilgit.
- The **gradient of the river in J&K is very gentle** (about 30 cm per km).
- Average elevation at which the Indus flows through JK is about **4000 m** above sea level.
- It is joined by the **Zaskar River at Leh** (these kind of points are important for prelims).
- Near **Skardu**, it is joined by the **Shyok** at an elevation of about 2,700 m.
- The **Gilgit, Gartang, Dras, Shiger, Hunza** are the other Himalayan tributaries of the Indus.
- It crosses the Himalayas (ends its mountainous journey) through a 5181 m deep gorge near **Attock**, lying north of the **Nanga Parbat.** It takes a sharp southerly bend here **(syntaxial bend).**
- **Kabul river** from Afghanistan joins Indus near **Attock.** Thereafter it flows through the **Potwar plateau** and crosses the **Salt Range** (South Eastern edge of Potwar Plateau).

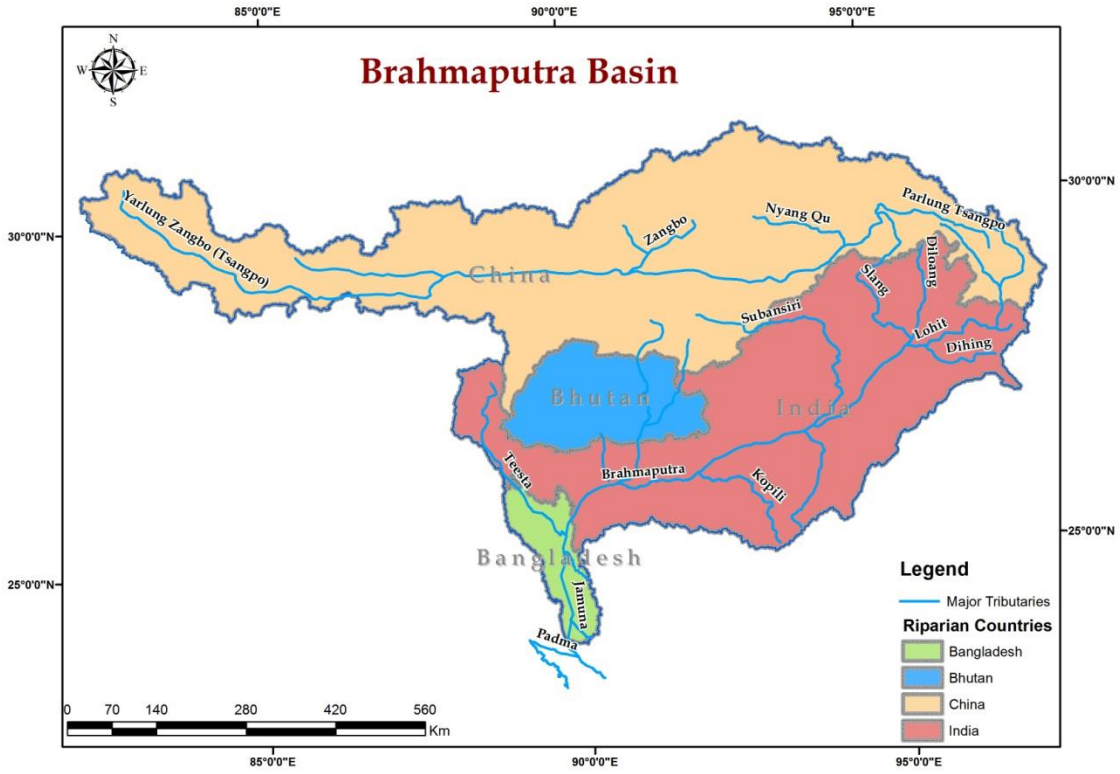
- Some of the important tributaries below Attock include the **Kurram, Toch** and the **Zhob-Gomal.**
- Just above **Mithankot**, the Indus receives from **Panjnad (Panchnad)**, the accumulated waters of the five eastern tributaries—the Jhelum, the Chenab, the Ravi, the Beas and the Satluj.
- The river empties into the Arabian Sea south of **Karachi** after forming a huge delta.

The following table gives the details of tributaries of Indus:

| | | | | | |
|---|---|---|---|---|---|
| **Jhelum**<br>*Vitasta (Rigveda)*<br>*Hydaspes (Greeks)*<br>*Veth (Kashmir)* | Verinag spring (Pir Panjal Range) | Kishanganga (Right)<br>Neelum<br>Kunhar<br>Poonch | Mangla Dam<br>Rasul Barrage | J&K | Joins Chenab near Jhang in Pakistan<br>Enters Pakistan near Baramulla |
| **Chenab**<br>*Asikini*<br>*Chandrabhaga* | Lahaul and Spiti district of Himachal Pradesh: **Bara Lacha** pass | Headward Tributaries: Chandra(Zozi La) + Bhaga (Baracha La)<br>R. Tavi | Salal Project<br>Dhulhasti Dam, Baglihar Dam<br>Trimmu Barrage | Himachal Pradesh, J&K | Largest tributary of Indus; Formed by the confluence of Chandra & Bhaga in H.P |
| **Ravi**<br>*Iravati*<br>*"The river of Lahore"* | Kullu hills, West to Rohtang Pass | R. Siul (Valley: Rich timber trees + *Garden of Chamba*)<br>R. Budhil<br>R. Nai/Dhona<br>***Battle of the ten kings*** was fought | Thein (Ranjit Sagar) Dam | J&K | Flows between Pir Panjal and Dhauladhar Ranges<br>Shahdara Bagh with the tomb of Jahangir and the Tomb of Noor Jahan |
| **Beas**<br>*Vipasha* | Near Rohtang Pass, Beas Kund- H.P (southern end at Pir Panjal) | Trib: Parbati<br>Created problems in Alexander's invasion of India<br>**2014 Beas River Tragedy:** Flood gates of the Larji dam were opened | Beas Project, Pong Dam<br>Pandoh Dam | Punjab<br>Haryana | Makes Kullu Valley<br>Meets Satluj near Harike<br>Kullu: On Tributary Parbati<br>Within India completely |

| | | | | | |
|---|---|---|---|---|---|
| **Sutlej**<br>*Shatdru* | Manasarovar-Rakas Lakes<br>Enters India through Shipki la Pass | Trib: Spiti<br>Proposal to build a 214-kilometre (133 mi) long heavy freight canal, to be known as the Sutlej-Yamuna Link (SYL) in India to connect the Sutlej and Yamuna rivers | Bhakra Nangal Project,<br>Harike,<br>Sirhind,<br>Gobind Ballabh Sagar,<br>Karcham Wangtoo Hydroelectric Plant,<br>Neptha Jhakhari Dam | Punjab,<br>HP,<br>North of the Vindhya Range,<br>South of the Hindu Kush segment of the Himalayas, and<br>East of the Central Sulaiman Range in Pak | Exposes a doubled inverted metamorphic gradient |
| **Shyok**<br>"The river of Death" | Originates from the Rimo Glacier, one of the tongues of Siachen Glacier | Tributary of R.Indus | Deposition of the thick Quaternary sediments—a treasure trove for geology researchers | Flows through northern Ladakh in India and the Ghangche District of Gilgit–Baltistan | Shyok Valley: Ladakh<br>Khardung La on the Ladakh Range lies north of Leh and is the gateway to the Shyok and Nubra valleys |

## The Brahmaputra River System:




The **Brahmaputra** is one of the major rivers of Asia, a trans-boundary river which flows through China, India and Bangladesh. As such, it is known by various names in the region.

- It is also called Tsangpo-Brahmaputra (when referring to the whole river including the stretch within Tibet).
- With its origin in the Angsi glacier, located on the northern side of the Himalayas in Burang County of Tibet as the Yarlung Tsangpo River, it flows across southern Tibet to break through the Himalayas in great gorges (including the Yarlung Tsangpo Grand Canyon) and into Arunachal Pradesh (India).
- It flows southwest through the Assam Valley as Brahmaputra and south through Bangladesh as the Jamuna (not to be mistaken with Yamuna of India).
- In the vast Ganges Delta, it merges with the Padma, the popular name of the river Ganges in Bangladesh, and finally the Meghna and from here it is known as Meghna before emptying into the Bay of Bengal.

**Some of the important Tributaries of Brahmaputra are given in the following Table:**

| River | Place of origin | Tributaries | Formations | Facts |
|---|---|---|---|---|
| **Brahmaputra River**<br><br>**Tibet:** Tsang-po (Puifier)<br><br>**Bangladesh:** Jamuna<br><br>***Red river of India:*** Mixing of red coloured soil of Assam (Floods) | Kailash Range, near Manasarovar Lake-***Angsi Glacier*** (located on the northern side of the Himalayas in Burang County in China's Tibet Autonomous Region<br><br>(**Chemayung dung-disputed)**<br><br>Trans-boundary River<br><br>**States:** Arunachal Pradesh(Dihang), Assam, Meghalaya, Sikkim, Nagaland | Dibang, Lohit, Dhansari, Kapilli, Subanshri Sankos, Kameng, Manas, Raidak Teesta<br><br>Growth of the Ganges-Brahmaputra Delta is dominated by ***tidal processes*** | **Highly susceptible to channel migration and avulsion**<br><br>**Braided** Pattern (VA) Many riverine islands-<br><br>River island: ***Majuli*** Island, Assam<br><br>Exhibits a Tidal Bore<br><br>Navigable (most of its length)<br><br>B'putra + Ganga: **R.Padma**<br><br>Padma + Meghna: **R.Meghna** | W-of Sadiya: Dihang turns S-W & Lohit + Dibang joins it.<br><br>**Rare Male name:** 'Son of Brahmaputra'<br><br>**Imp. Urban Centres:** Pasighat Neamati Tezpur Guwahati<br><br>Highest point within the Brahmaputra basin: **Kanchenjunga**<br><br>**Battle of Saraighat, 1671:** Because of the river's narrow width<br><br>**Deforestation in the Brahmaputra watershed:**<br>Increased siltation levels,<br>Flash floods, Soil erosion<br>Kaziranga National Park(Assam)<br><br>The BrahMos missile, developed jointly by India and Russia, is partly named after the Brahmaputra river |

## Characteristics of Himalayan Rivers:

**Large Catchment area:** The drainage basin of the Himalayan Rivers covers an area of millions of square km.

**Youth Stage**: Himalayan Rivers are in their youth stage and have high erosive tendencies.

**Perennial character:** Himalayan Rivers receive their water from Glaciers and monsoon rains. Hence they have water across the year and not only in the rainy season.

**Deep gorges:** because of severe erosion, these rivers carve deep gorges on the mountains.

**High hydroelectric potential:** Since the rivers are coming from a height, they have high hydroelectric potential.

**Deltas:** They make large deltas as they carry a large amount to sediment down the course.

**Flooding:** Himalayan Rivers are prone to flooding in the lower course.

**Changing course:** Because of sudden increase in the water levels during monsoon. The Himalayan Rivers are prone to change in their course.

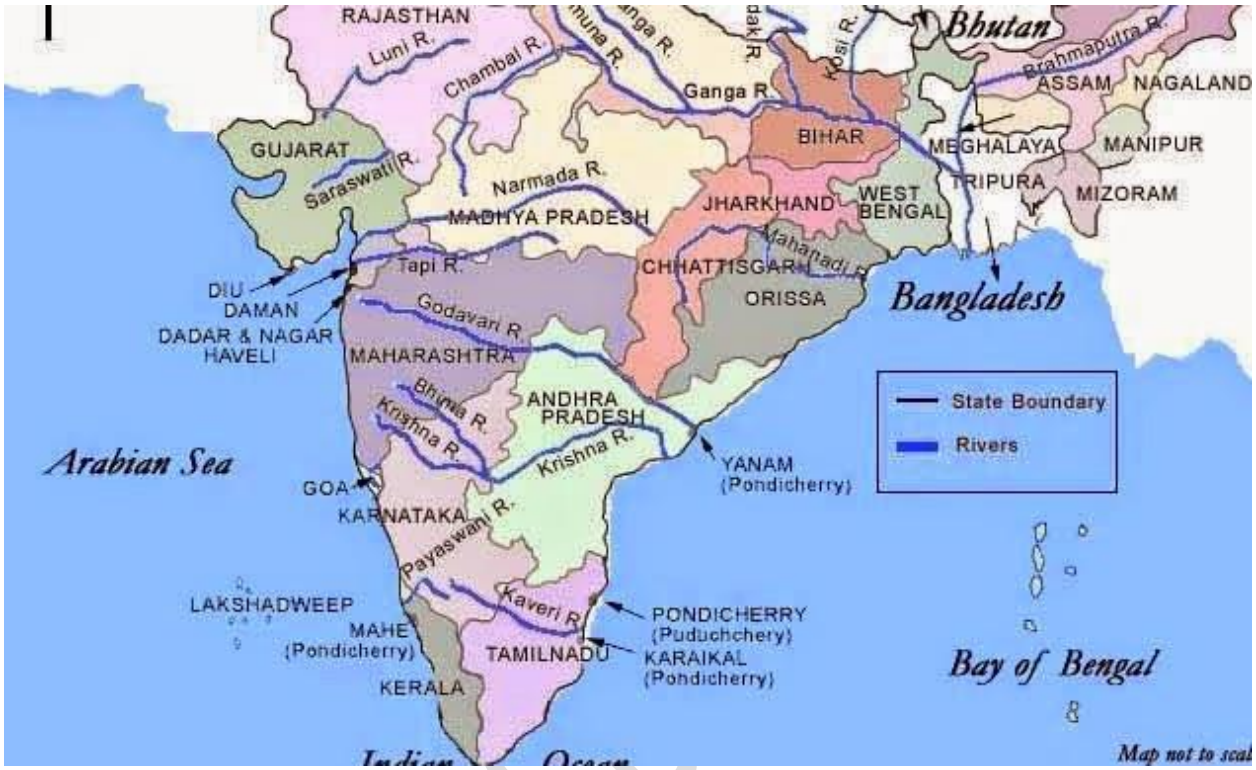
**Navigability:** Large Himalayan Rivers have enough water in them to support inland navigability.

**Meanders:** In their mature stage they form large meanders and ox – bow lakes.

**Think!!**

- **What are the important threats faced by the Himalayan rivers currently?**
- **Plans for Ganga cleaning have been going on for a very long time. What according to you is the problem that government has still not been able to clean it?**

# Peninsular Drainage:




Peninsular rivers are the rivers which have their origin in Peninsular India.

- These rivers have acquired maturity as suggested by broad, largely graded and shallow valleys and the fact that they have existed for a longer period than the Himalayan rivers, with the exception of limited reaches of some of the rivers where recent faulting has occurred.
- The beds generally have a subdued gradient, as the erosional forces do not act laterally.
- Most of the peninsular rivers flow eastwards, as the main watershed runs through the Western Ghats close to the west coast. The notable exceptions are the Narmada and Tapti which flow westwards in troughs, which are not of their own making.
- These facts are explained by assuming that the Western Ghats were the original watershed and their subsidence below sea has disturbed the generally symmetrical plan of the rivers on either side of the original watershed.

## Theory of Evolution of Peninsular Drainage:

There are differences in the opinion of geographers on the origin of peninsular drainage system. However, there are two accepted views.

**Theory 1:**

According to one hypothesis the existing Peninsula is the remaining half of a land mass, which had the Western Ghats very near its centre as its primeval water-shed for two drainage systems, one easterly and the other westerly.

Sometimes during the early Tertiary period half of the Peninsula lying west of the Western Ghats is presumed to have cracked and sunk beneath the Arabian Sea.

This was due to the formation of a great normal fault along the Western Ghats. This argument is supported by the straight coastline, steep slope, and absence of delta deposits along the Sahyadri coast.

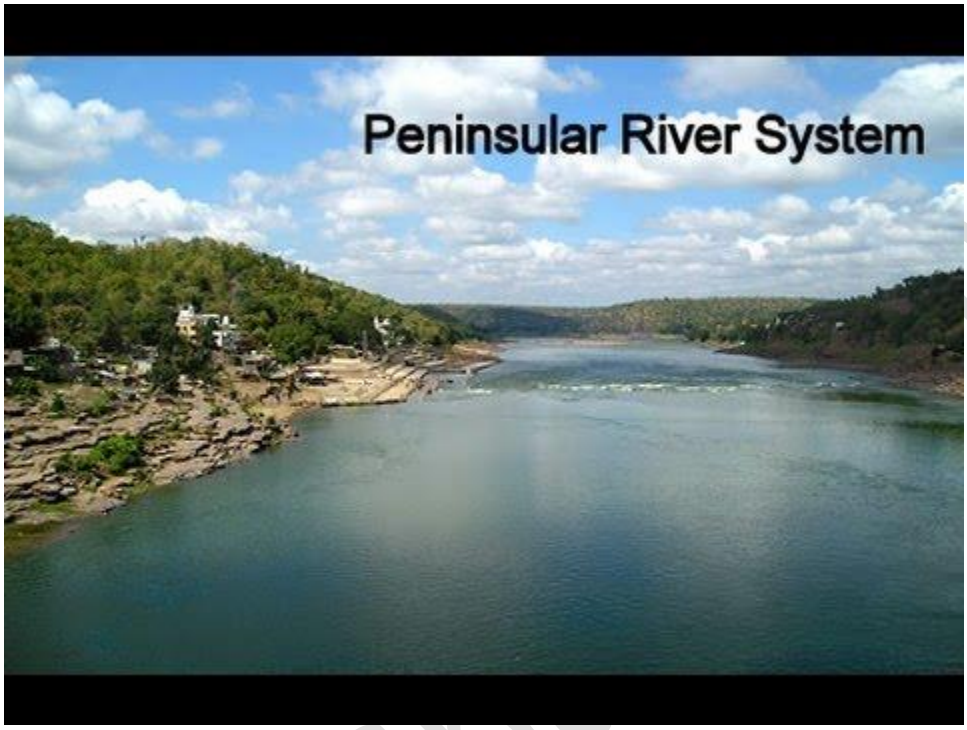
**Theory 2:**

There is a second probably theory which is supported by the exceptional flow of Narmada and Tapi in Rift Valleys.

These faults are said to have originated with the bending or 'sagging' of the northern part of the Peninsula at the time of the upheaval of the Himalayas.

During the same time the peninsular block, south of the cracks, tilted slightly eastwards, giving a new orientation to the entire drainage towards the Bay of Bengal.

## Peninsular Rivers:




Broadly they can be categorized as East Flowing Rivers and West Flowing rivers.

### East Flowing Rivers:

Some of the important East Flowing Rivers are:

**Mahanadi:**

- The Mahanadi rises in the Sihawa range in Chhattisgarh.
- It is 857 km long and drains an area of 1, 41,600 square kilometres in Chhattisgarh, Orissa, Bihar and Maharashtra.
- The left-bank tributaries of the Mahanadi include the Seonath, Hasdo, Mand and lb, while the Jonk, Ung, Tel are among the right-bank tributaries.

**Godavari:**

- The Godavari basin is the largest river system in the peninsula and second only to the Ganga system in India.
- It rises in the Nasik district of Maharashtra, and drains and area of 3, 12,812 square kilometres, half of which lies in Maharashtra.

- Besides Maharashtra, the basin is shared by Madhya Pradesh, Karnataka, Orissa and Andhra Pradesh.
- The Godavari flows for a length of 1,465 km and is often referred to as Vridha Ganga or Dakshina Ganga because of its large size and extent.
- The major tributaries of the Godavari are the Pravara, Purna, Manjra, Penganga, Wainganga, Wardha, Pranhita, Indravati, Maner and Sabari.

**Krishna:**

- The Krishna is the second largest east flowing Peninsular River.
- It rises from a spring near Mahabaleshwar. Its total length of 1,400 km and drainage basin area of 2, 58,948 is shared by Maharashtra (27%), Karnataka (44%) and Andhra Pradesh (29%) states.
- The Koyna, Yerla, Varna,Panchaganga, Dudhganga, Ghatprabha, Malprabha, Bhima, Tungabhadraand Musi are the main tributaries of the Krishna.
- The Tungabhadra consists of the Tunga and Bhadra rivers which originate in the western Karnataka and join just below Shimoga. Similarly the Tungabhadra meets the Krishna river near Kurnool town. It has a total length of 640 km with drainage area of 71,417 sq. km. Another tributary Bhima commands a catchment area of 76,614 sq. km.

**Pennar:**

- The Pennar basin lies between the Krishna basin and the Cauveri basin, and drains an area of 55,213 square kilometres, most of which lies in Karnataka.
- Its principal tributaries are the Jayamangali, Kunderu, Sagileru, Chitravati, Papagin, and Cheyyeru.

**Kaveri:**

- The Kaveri/Cauveri rises in the Brahmagir rage of the Western Ghats. It flows for a length of 800 km before falling into the Bay of Bengal near Kaveripattinam.
- It drains an area of 87,900 square kilometres, which is shared by Kerala, Karnataka and Tamil Nadu.
- The Cauveri basin is one of the most developed regions of India from the point of view of power and inigation.
- Ninety to ninety-five per cent of the total potential in these two spheres has already been exploited.

- The left-bank tributaries of the Cauveri include the Herangi, Hemavati, Shimsha and Arkavati, and the right-bank tributaries include the Lakshamantirtha, Kabini, Suvarnavati, Bhawani and Amravati.

**Think!!**

- **What is the point of contention between Tamil Nadu and Karnataka on sharing of Kaveri water?**
- **How are river disputes resolved in India?**

## West Flowing Rivers:

There are two large and important west flowing rivers in Peninsular India.

**Narmada:**

- The Narmada rises near Amarkantak in Madhya Pradesh and flows for 1,300 km, while draining an area of 98,796 square kilometres, most, of it lying in Madhya Pradesh.
- The Narmada basin is characterised by the lack of development of the tributary streams.
- The Narmada valley is gorge-like and full of rapids and waterfalls between Handia and Mandhata.
- The Kapildhara and Dhvandhar are the most important waterfalls.
- The Orisan is the major tributary and others include the Burhner, Banjar, Shar, Shakkar, Dudhi, Tawa on the south and the Hiran, Barna and the Kolar on the north.

**Tapti:**

- The Tapti is the second largest west-flowing peninsular river.
- It rises in the Betul district of Madhya Pradesh and while flowing for a length of 724 kilometres, it drains an area of 65,145 square kilometres in Madhya Pradesh, Maharashtra and Gujarat.
- The left-bank tributaries of the Tapti are Purna, Veghar, Girna, Bori and the Panjhra and those joining it on the right bank are the Aner, Betul, Ganjal, Arunavati and Gomai.

**Small West Flowing streams:**

There are also a large number of coastal streams draining the narrow coastal plains on the western edge of the peninsula. There are as many as 600 tiny streams which drain the western face of the Western Ghats alone.

The most important among these are the Mandovi, Zuari and Rachol in Goa; Kalinadi, Gangavalli-Bedti, Sharavati, Tadri and Netravati in Karnataka; Beypore, Ponnam, Bharatapuzha, Periyar and Pamba in Kerala.

All these streams have carved out narrow valleys with steep gradients and often descend to the plains in the form of cascades and waterfalls. The famous Jog Falls (271 metres) is on the Sharavati River.

**Jog Falls**

**Think!!**

- **Why do West flowing rivers form an estuary and not a delta?**

**Some of the small West flowing important rivers are as follows**:

## SMALLER RIVERS FLOWING TOWARDS THE WEST

**Shetruniji:** Rises near Dalkahwa in Amreli district

**Bhadra:** Originates near Aniali village in Rajkot district

**Dhadhar:** Rises near Ghantar village in Panchmahal district

**Vaitarna:** Rises from the Trimbak hills in Nasik district

**Kalinadi:** Rises from Belgaum district and falls in the Karwar Bay

**Bedti river:** Hubli Dharwar

**Sharavati:** Flows towards the west; Originates in Shimoga district of Karnataka

**Goa:** Mandovi + Juari

**Kerala:** Narrow coastline; Bharathapuzha (longest river of Kerela) rises near Annamalai hills (also known as Ponnani) + Periyar - Second largest river of Kerala + Pamba river- Falls in the Vemobanad lake

## Comparison between Himalayan and Peninsular rivers:

| | Peninsular Rivers | Himalayan Rivers |
|---|---|---|
| 1 | Rivers are very old. Some of them are as old as Pre – Cambrian period. | Rivers are young except some antecedent rivers like Indus, Brahmaputra, Satluj etc. |
| 2 | They are mostly consequent rivers | Many of them are inconsequent rivers like Indus, Satluj, Kali, Kosi etc. |
| 3 | These rivers have relatively smaller drainage basin. Godavari is an exception in this case. | These rivers generally have large basins. |
| 4 | The channels of these rivers are broad | The size of the channel changes drastically from origin to mouth. |
| 5 | There is hardly any vertical origin. | Both vertical and lateral erosions are significant. |
| 6 | They have low carrying capacity. | They carry a huge load of sediments. |
| 7 | These are mainly depositional agents. | They are very strong erosional as well as depositional agents. |
| 8 | They make shallow meanders | In the plains they make sharp meanders and ox bow lakes. |
| 9 | They are generally not navigable | They are generally navigable in plains. |
| 10 | They are mostly seasonal | They are perennial. |
| 11 | Most of them originate from western ghats and plateau | They have their origin in Himalayas. |
| 12 | They don't show headward erosion and river capturing | River capturing is a common phenomenon. |
| 13 | The East flowing rivers make deltas while west flowing rivers make estuaries. | They make only deltas. |
| | | |

## River Regimes:

The regime of a river is defined as the variability in its discharge throughout the course of a year in response to precipitation, temperature, evapotranspiration, and drainage basin characteristics.

In simple terms, the variation in the quantity of water flowing in a river throughout the year.

The variability in discharge over the course of a year is commonly represented by a hydrograph with mean monthly discharge variations plotted over the annual time scale. When interpreting such records of discharge, it is important to factor in the time scale over which the average monthly values were calculated. It is particularly difficult to establish a typical annual river regime for rivers with high interannual variability in monthly discharge and/or significant changes in the catchment's characteristics (e.g. tectonic influences or the introduction of water management practices).

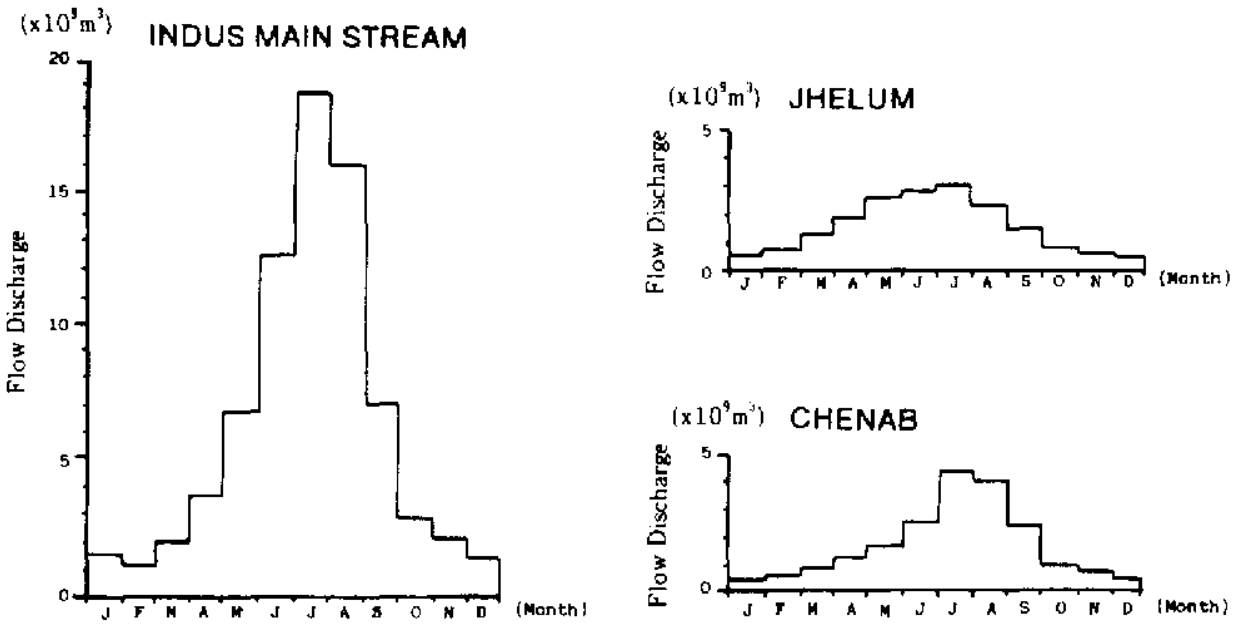
## Factors affecting a river's regime:

**Seasons:** There will be rise in discharge during rainy months and fall in the discharge in the dry months.

**Climate:** Rivers that pass through Mediterranean climate tend to have more than one peak periods, while rivers like Nile tend to have more water in summer because of melting of glacier in Mount Kilimanjaro.

**Geology:** Rivers flowing over porous beds tends to have low changes in peaks while a river flowing over hard non-porous rock will have sharp changes.

**Human Activities:** Anthropogenic activities like urbanization, deforestation etc. leads to more runoff and effects regimes by changing the peak and low flow of the channel.

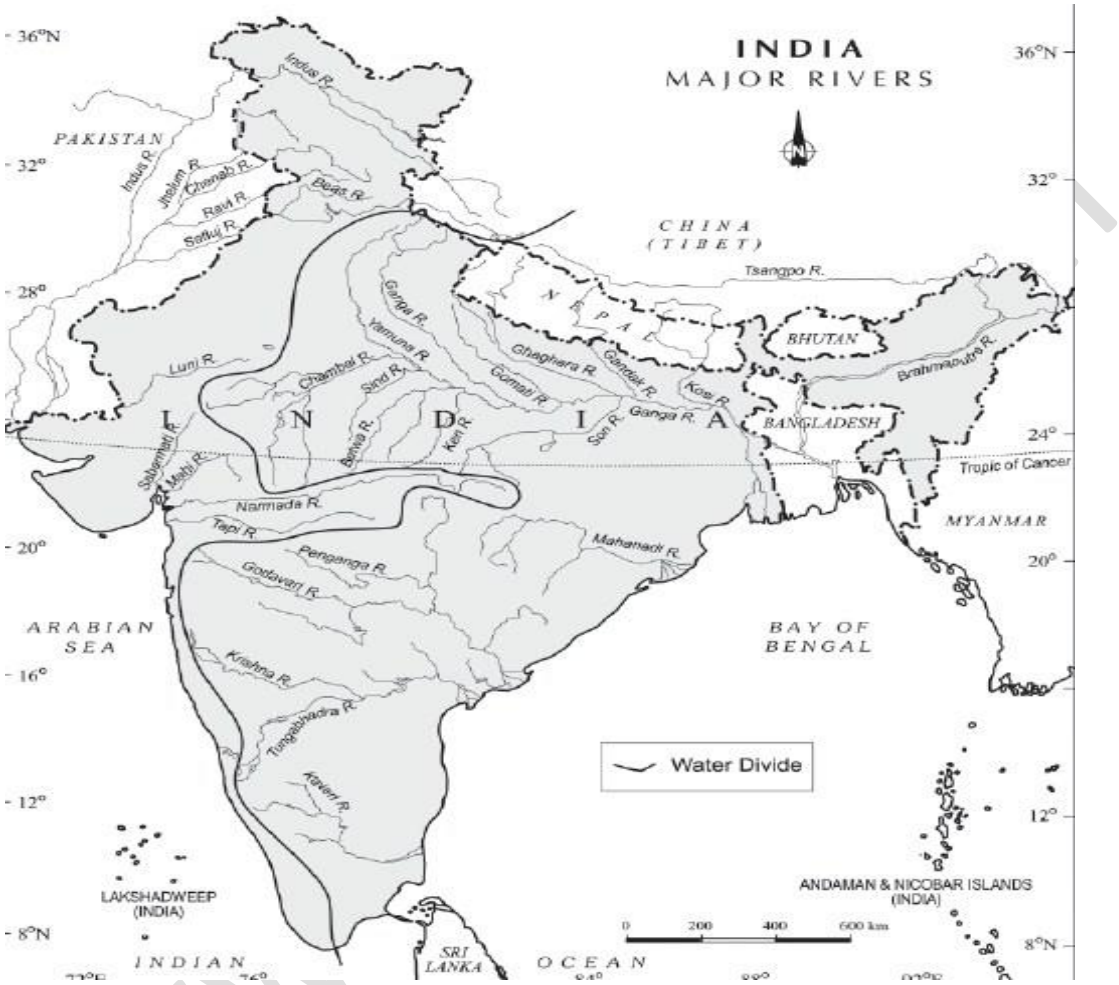



**Hydrographs showing River Regimes**

**Think!!**

- **How are river regimes of Himalayan Rivers different from Peninsular Rivers?**
- **Do you think interconnection of Rivers will have an impact on the river regimes of seasonal rivers of peninsula?**

## Classification of Drainage Basin according to the orientation to the Sea:




**The black line is showing the water divide of India**

On the basis of the orientation to the sea, the Indian River system has been divided into two major drainage systems:

- The bay of Bengal drainage
- The Arabian sea drainage

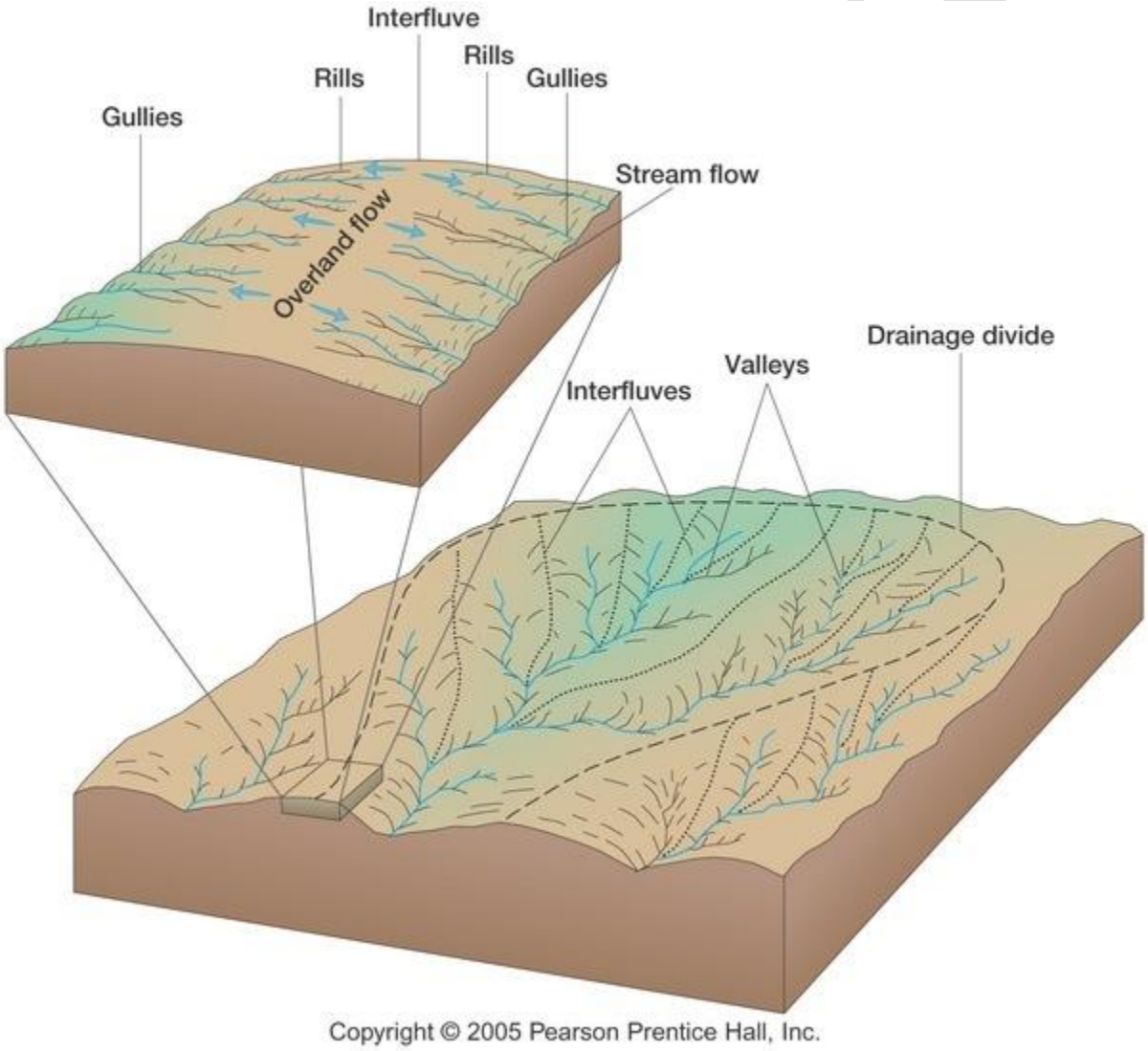
About 77% of the drainage area of the country is oriented towards the Bay of Bengal. Most of the major rivers of Himalayan and Peninsular drainage flows towards Bay of Bengal. For example- Ganga, Mahanadi, Godavari, Krishna, Kaveri etc.

23% of the country's surface flow, flows towards the Arabian sea. Some important west flowing rivers are Indus, Narmada, Tapi, Mahi, Sabarmati and numerous Rivers and streams which originates in Western Ghats.

## Drainage Divide:

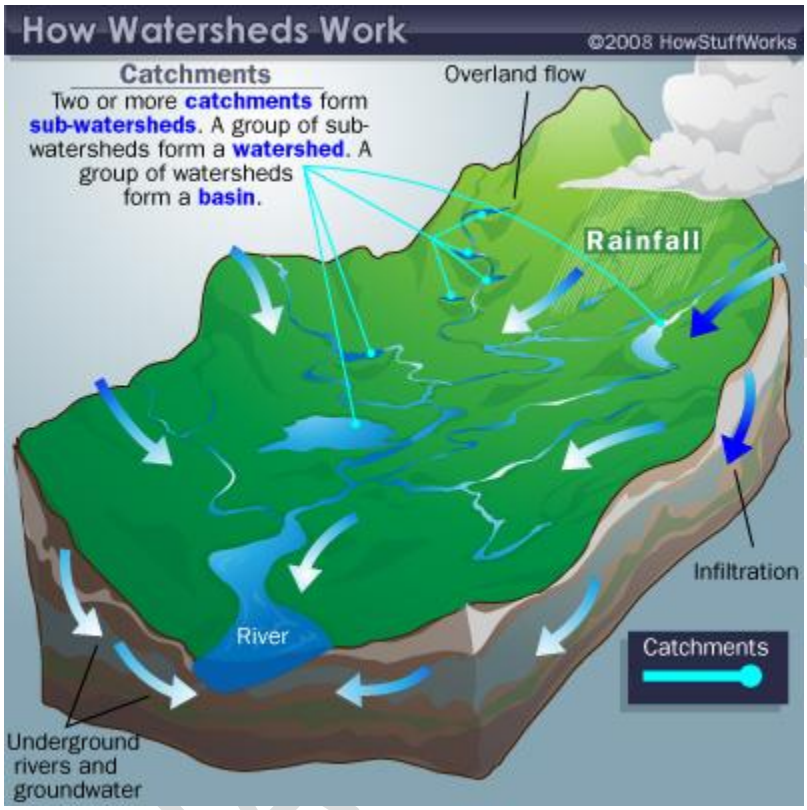
The Bay of Bengal and the Arabian Sea drainage systems are separated along a distinct divide which lies approximately along the Sahyadris, Amarkantak, Aravallis and the Satluj- Yamuna divide.

Adjacent drainage basins are separated from one another by a drainage divide. Drainage divide is usually a ridge or a high platform.



# Watershed Development in India:

## Watershed:




- The boundary line separating one drainage basin from the other
- Catchments of small rivulets and rills
- Cover smaller areas


**Watershed management of India**

Watershed is a geographical unit with a common natural drainage outlet.

The extent varies from 500 (micro-watershed) to 5000 ha (sub-watershed). For management purposes 5000 ha is considered as a unit of intervention.

Over the years the concept of watershed development has expanded from simple soil and water conservation to holistic natural resources development approach. Thus there is a paradigm shift from territory approach to a systemic approach of development.

### Need of Watershed Management:

Rain-fed agriculture accounts for 68% of India's cropped area providing livelihoods to 480 million people. With huge tract of land in the country falling under arid and semi-arid climatic region, Watershed Management is the only viable option to harness production requirement in the agricultural sector especially in the rain fed un-irrigated areas of the Country.

### Process:

- The Department of Land Resources, Ministry of Rural Development is implementing the Integrated Watershed Development Programme (IWMP) from 2009-10 with an objective to cover 55 million hectare of rain fed land by 2027.
- The program is being implemented in all the states of the country. The programme is financed by central and state government in the ratio of 90:10.
- The IWMP is the second largest watershed programme in the world after China.

- The programme envisages restoring the ecological balance by harnessing, conserving and developing degraded natural resources such a soil, vegetative cover & water through watershed management initiatives.
- The outcomes of IWMP are prevention of soil run-off, regeneration of natural vegetation, rain water harvesting and recharging of the ground water table.
- This enables multi-cropping and the introduction of diverse agro-based activities, which help to provide sustainable livelihoods to the people residing in the watershed area.

**Note: Watershed management will be dealt in detail in GS paper 3**

**Think!!**

- **A watershed is considered to be the basic unit of water management. What is the difference between a watershed and a drainage basin?**

## River Interlinking Program of India

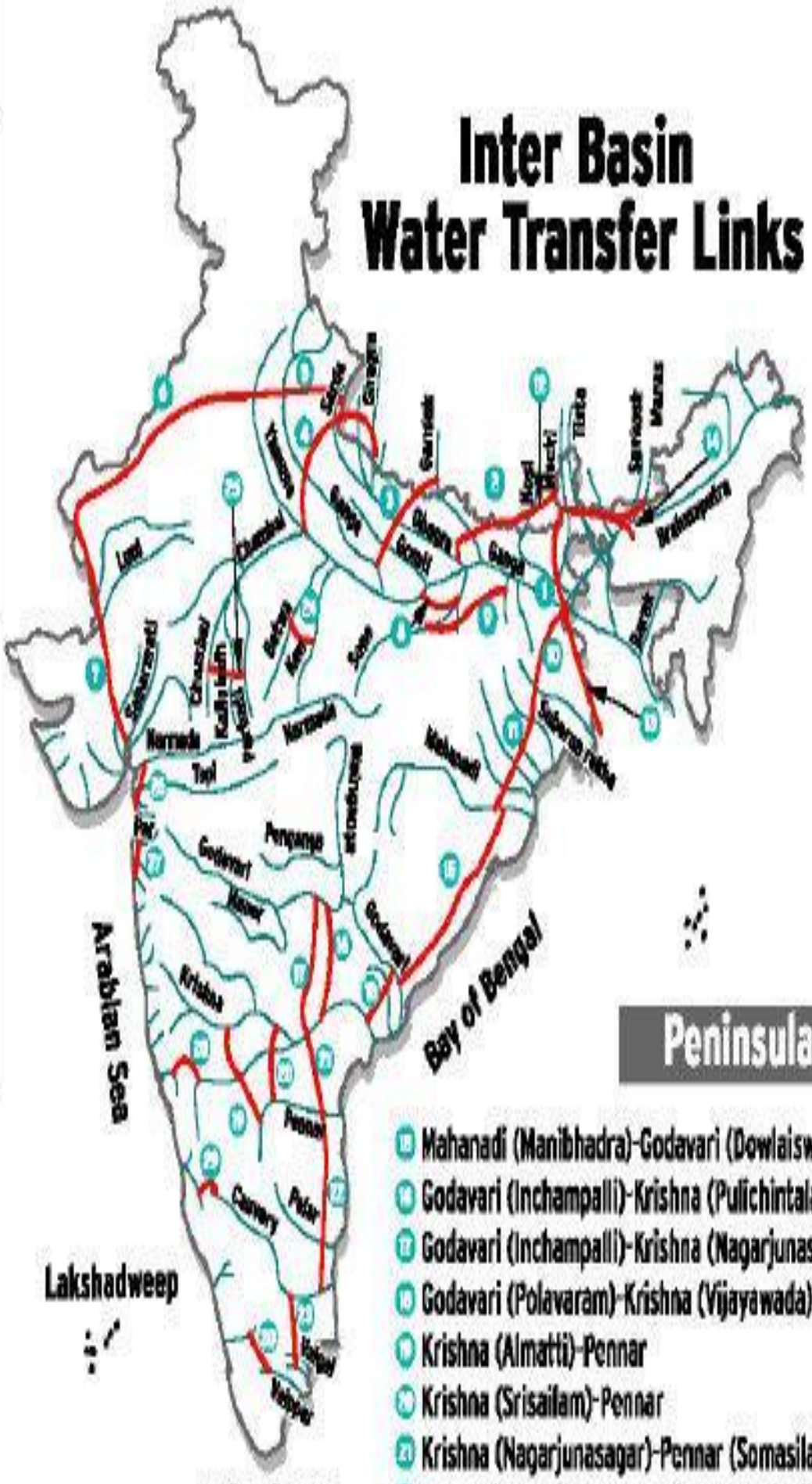
The **Indian Rivers Inter-link** is a proposed large-scale civil engineering project that aims to link Indian rivers by a network of reservoirs and canals and so reduce persistent floods in some parts and water shortages in other parts of India.

Interlinking of River (ILR) programme is of national importance and has been taken up on high Priority.

The mission of this programme is to ensure greater equity in the distribution of water by enhancing the availability of water in drought prone and rainfed area.

- Under the National Perspective Plan (NPP) prepared by Ministry of Water Resources, NWDA has already identified 14 links under Himalayan Rivers Component and 16 links under Peninsular Rivers Component for inter basin transfer of water based on field surveys and investigation and detailed studies.
- Out of these, Feasibility Reports of 14 links under Peninsular Component and 2 links (Indian portion) under Himalayan Component have been prepared.

# Inter Basin Water Transfer Links




## Himalayan component

1. Manas-Sankosh-Tista-Ganga
2. Kosi-Ghagra
3. Gandak-Ganga
4. Ghagra-Yamuna
5. Sarda-Yamuna
6. Yamuna-Rajasthan
7. Rajasthan-Sabarmati
8. Chunar-Sone Barrage
9. Sone dam-southern tributaries of Ganga
10. Ganga-Damodar-Subernarekha
11. Subernarekha- Mahanadi
12. Kosi-Mechi
13. Farakka-Sunderbans
14. Jogighopa-Tista-Farakka (alternative to 1)

Water transfer link

## Peninsular component

15. Mahanadi (Manibhadra)-Godavari (Dowlaiswaram)
16. Godavari (Inchampalli)-Krishna (Pulichintala)
17. Godavari (Inchampalli)-Krishna (Nagarjunasagar)
18. Godavari (Polavaram)-Krishna (Vijayawada)
19. Krishna (Almatti)-Pennar
20. Krishna (Srisailam)-Pennar
21. Krishna (Nagarjunasagar)-Pennar (Somasila)
22. Pennar (Somasila)-Cauvery (Grand Anaicut)
23. Cauvery (Kattalai)-Vaigai-Gundar
24. Ken-Betwa
25. Parbati-Kalisindh-Chambal
26. Par-Tapi-Narmada
27. Damanganga-Pinjal
28. Bedti-Varda
29. Netravati-Hemavati
30. Pamba-Achankovil-Vaippar

Source: National Water Development Agency

## Benefits of River Linking:

Proponents of the rivers inter-linking projects claim the answers to India's water problem is to conserve the abundant monsoon water bounty, store it in reservoirs, and deliver this water – using rivers inter-linking project – to areas and over times when water becomes scarce. Beyond water security, the project is also seen to offer potential benefits to transport infrastructure through navigation, as well as to broadening income sources in rural areas through fish farming.

## Concerns:

**High Cost:** The project is estimated to cost India almost 4 times of its GDP to get completed.

**Ecological and environmental issues:** Interlinking will cause large scale deforestation and loss of wildlife. Also if the access of water is removed from the rivers, it will have an adverse impact on the life forms in that river.

**Displacement of people:** a large number of people staying in the valleys will have to be displaced. This is a major sociological concern and will have effect on the demography of a place where these people are rehabilitated.

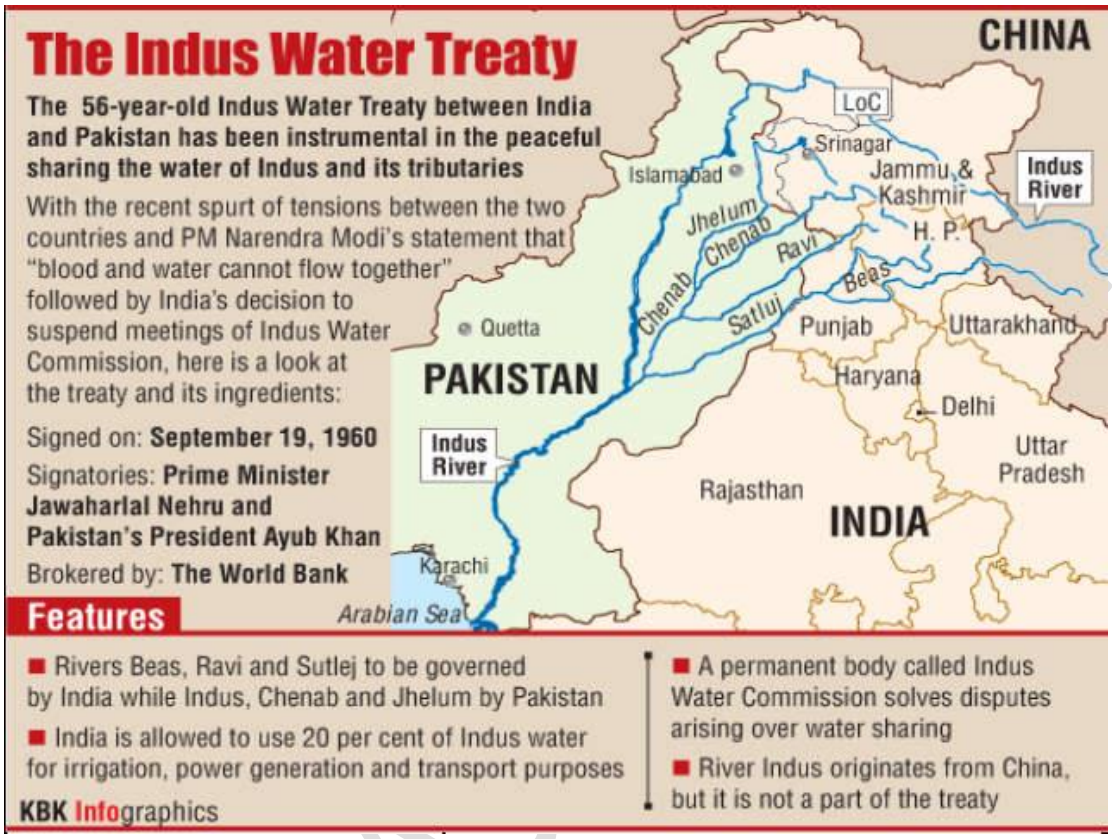
**Geological activities:** You need to understand that this is a river that we are talking about and not a small canal. The new streams will have an impact on the rock structure. The will carve new landforms.

**International Concerns:** Ganga and Brahmaputra are international rivers. There is no provision of diversion of river water in international laws. For the success of this project, Bangladesh's cooperation is required.

**Think!!**

- **River linking projects have been a huge success in smaller countries with almost uniform topography.**
- **But with the vastness of India and undulating surface, do you think river linking project is a right move?**
- **What will be the ecological impact of River linking project?**
- **What will be the impact of India's river linking project on Bangladesh?**

## Indus Water Treaty:




The six rivers of the Indus basin originate in Tibet and flow across the Himalayan ranges to end in the Arabian Sea south of Karachi. Preceding partition, it was one common network for both India and Pakistan. However, while partition managed to draw terrestrial borders, the question of how to divide the Indus waters was something that needed to be worked out. Since the rivers flowed from India to Pakistan, the latter was unsurprisingly threatened by the prospect of being fed by the former.

In 1960, the two countries reached a decisive step with the intervention of the World Bank wherein precise details were laid out regarding the way in which the waters would be distributed. The components of the treaty were fairly simple.

The three western rivers (Jhelum, Chenab and Indus) were allocated to Pakistan while India was given control over the three eastern rivers (Ravi, Beas and Sutlej).

While India could use the western rivers for consumption purpose, restrictions were placed on building of storage systems. The treaty states that aside of certain specific cases, no storage and irrigation systems can be built by India on the western rivers.

For more information kindly go through the following link:

http://mea.gov.in/bilateral-documents.htm?dtl/6439/Indus

**Think!!**

- **Indus Water Treaty is considered to be one of the most successful treaties of the World. Do you think it is a fair deal with India?**
- **What are the recent concerns regarding the IWT?**

# Inland Water Ways:

India has an extensive network of **inland waterways** in the form of rivers, canals, backwaters and creeks. The total navigable length is 14,500 km (9,000 mi), out of which about 5,200 km (3,200 mi) of the river and 4,000 km (2,500 mi) of canals can be used by mechanized crafts.

Freight transportation by waterways is highly under-utilized in India compared to other large countries and geographic areas like the United States, China and the European Union.

The total cargo moved (in tonne kilometers) by the inland waterway was just 0.1% of the total inland traffic in India, compared to the 21% figure for United States.

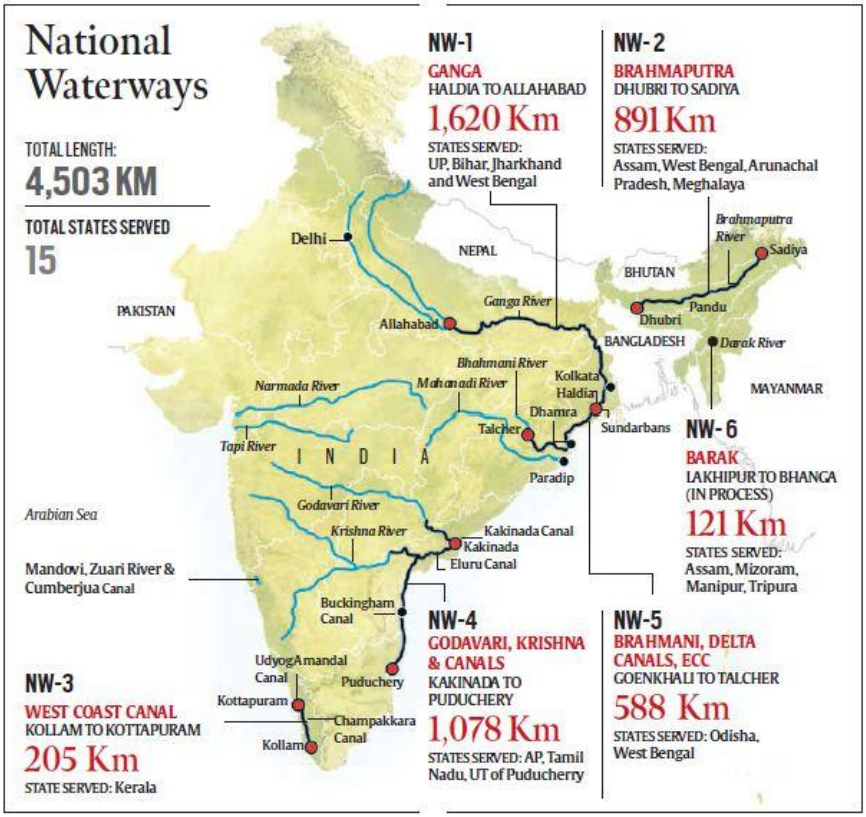
Cargo transportation in an organized manner is confined to a few waterways in Goa, West Bengal, Assam and Kerala.

Cost of water transportation in India is barely 50 paise a kilometer, as compared to ₹1 by railways and ₹1.5 by roads.

Hence water transportation is receiving significant attention in recent times since logistics cost in India is one of the highest among major countries - it is 18% in India versus 8-10% in China and 10-12% in European Union.

Inland waterways in India consist of the Ganges (Ganga)–Bhagirathi–Hooghly Rivers, the Brahmaputra, the Barak River, the rivers in Goa, the backwaters in Kerala, inland waters in Mumbai and the deltaic regions of the Godavari - Krishna rivers. About 44 million tons of cargo is moved annually through these waterways using mechanized vessels and country boats.

## National Waterways of India:



| National Waterways | Extent | Kilometer | River |
|---|---|---|---|
| **NW 1** | Allahabad-Haldia stretch | 1620km | Ganga-Bhagirathi-Hoogly |
| **NW 2** | Sadiya-Dhubri stretch | 891km | Brahmaputra |
| **NW3** | Kottapuram-Kollam stretch | 205km | West Coast Canal |
| **NW 4** | Kakinada Puducherry Canal + Godavari + Krishna | 1995km | Krishna, Godavari |
| **NW 5** | TalcherDhamra | 585km | Brahmani |
| **NW 6 (Proposed)** | Lakhipur to Bhanga | 121km | Barak |

**Think!!**

- **Inland water ways are highly underdeveloped in India. What do you think are the major reasons for that?**
- **Do you think colonial legacy is responsible for underdevelopment of Inland water ways?**

## Conclusion:

Dear friends we have tried to include all important aspects of Indian Drainage which have not been clearly given in NCERT and other sources. Also we have tried to include the issues related to drainage system which have been there in News for quite some time.

You need to understand that this is a Value Add material and not a replacement for the basic text of NCERT. We hope that you enjoy reading it and find it very lucid to understand.

***Happy Reading***

***All the Best***

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