1 GEOGRAPHY OF INDIA: AN INTRODUCTION

Physical Geography of India

Extent and Frontiers

- India is a very large country. It lies totally in the northern hemisphere, more precisely in the south-central region of the Asian continent. The mainland of India stretches across a large portion of the earth between ***latitudes 8°4'N and 37°6'N and longitudes 68°7'E and 97°25'E.***
- India, the ***seventh-largest*** nation in the world, is separated from the rest of Asia by mountains and the sea, giving it a unique geographical identity.
- The whole length of the mainland's coastline, including Andaman and Nicobar and Lakshadweep, ***is 7,516.6 km*** and India's land border is ***around 15,200 km long***.
- The young fold mountains in the northwest, north and northeast encircle India. It begins to taper and extend south of roughly 22° north latitude, dividing the Indian Ocean into the Arabian Sea on the west and the Bay of Bengal on the east.
- The mainland's latitudinal and longitudinal extent is around 30°. Despite this, it appears that the east-west extent is less than the north-south extent.
- There is a ***two-hour time difference between Gujarat and Arunachal Pradesh***. As a result, time is accepted as the standard time for the entire nation along the Standard ***Meridian of India (82°30'E),*** which passes through ***Mirzapur (in Uttar Pradesh***). As one travels from the south to the north, the latitudinal extent affects the length of day and night.

- Gujarat (Jasdan), Rajasthan (Kalinjarh), Madhya Pradesh (Shajapur), Chhattisgarh (Sonhat), Jharkhand (Lohardaga), West Bengal (Krishnanagar), Tripura (Udaipur) and Mizoram are the eight Indian states through which the ***Tropic of Cancer*** travels (Champhai).

Size and Extent	
East-West Extent of Main Land India (Including Pak occupied Kashmir-POK):	68°7' east to 97°25' east longitude.
South-North Extent of Main Land India:	8°4' north to 37°6' north latitude.
Locational Extent:	8°4' N to 37°6' N latitude and 68°7' E to 97°25' E east longitude.

Pygmalion Point, also known as ***Indira Point***, is the ***southernmost point of the nation and is situated at 6° 45′ north latitude.***

- ***3,214*** kilometres stretch ***north to south*** from Kashmir's Indira Col to Kanniyakumari.
- From the Rann of Kachachh to Arunachal Pradesh, there is a ***2,933 km east-west*** width.
- India is ***the seventh-largest nation*** in the world with a total area of ***32,87,263 sq*** km.
- India makes up around ***2.4% of*** the planet's ***total surface area***.
- The country is divided into two latitudinal parts by the Tropic of Cancer, which runs across the centre of the continent.
- The area ***north of the Tropic of Cancer is about twice*** as large as the area south of it.

Coastline of India

On three of its four sides, the sea encircles the nation of India. India's coastal lowlands run along its west and east coasts. India's coastal plains, which span up to 7516.6 km, fall into one of two categories:

Indian Eastern Coastal Plains

The eastern coastal plains pass through Andhra Pradesh and Odisha as they travel from West Bengal in the north to Tamil Nadu in the south. The eastern coastal plain contains the deltas of the Mahanadi, Krishna, Godavari and Cauveri rivers. The deltas are incredibly fertile and agriculturally productive. As a result, the River Krishna's delta is referred to as the "Granary of South India." Once more, the Eastern shore is split into these three sections:

1. ***The Utkal coast*** is substantially wider than the western coastal plains and receives a great deal of rainfall. It stretches between Chilika Lake and Kolleru Lake. Rice, coconut and bananas are a few of the crops grown here.
2. ***Andhra Coast:*** The Krishna and Godavari rivers flow through the Andhra coast, which stretches between the Kolleru Lake and Pulicat Lake.
3. ***Coromandel Coast:*** Between Pulicat Lake and Kanyakumari in Tamil Nadu is the Coromandel coast. Due to the north-east monsoons, this Indian coastline is dry in the summer and is wet in the winter.

The Pulicat Lake and Chilka Lake are significant geographical features on the east coast.

Western Coastal Plains of India

From Kerala in the south to Gujarat in the north, the Western Coastal Plains pass through Karnataka, Goa and Maharashtra. The western coastal plains are 10 to 25 km wide and extend approximately 1500 km north to south. Off the coast of Mumbai, the West Continental Shelf is at its widest. Oil is abundant in this area. There are numerous stunning lagoons along the Malabar Coast, which draw tourists there. Compared to the eastern coast, the western coast is narrower.

The western coast is further divided into four categories:

1. ***The coasts of Kachchh and Kathiawar*** were created by the sediment that the Indus River deposited. Kachchh was formerly a gulf. During the monsoons, the Kachchh region is separated into the Great Rann in the north and the Little Rann in the east by shallow water. Kathiawar, on the other hand, is located south of Kachchh.
2. ***Konkan coast:*** It stretches from Goa in the south to Daman in the north. The two main crops in this area are cashews and rice.
3. ***Kannada coast:*** It stretches between Marmagaon and Mangalore and is known as the Kannada coast.
4. ***Malabar coast:*** The comparatively broad Malabar coast stretches from Mangalore to Kanyakumari. In southern Kerala, this area also comprises of lagoons that run parallel to the coast.

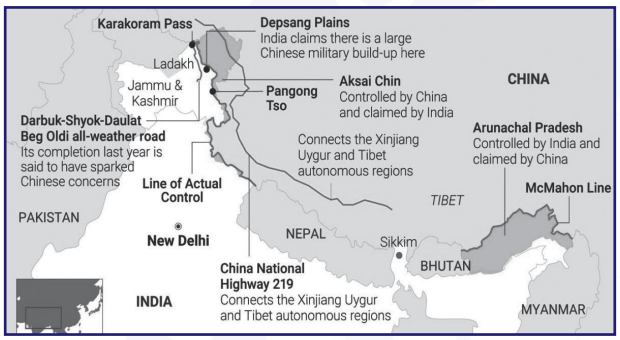
Borders of India

Name of the country	Length of the border (in km)
Bangladesh	4,096.7
China	3,488
Pakistan	3,323
Nepal	1,751
Myanmar	1,643
Bhutan	699
Afghanistan	106
Total	15,106.7

Border with China

- Next only to its border with Bangladesh, this is India's second-longest border.
- The Indian border with China is touched by five Indian states: Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh.
- The Sino-Indian border is typically broken down into three sections: I the Western sector; (ii) the Middle sector; and (iii) the Eastern sector.

The Western Sector: separates China's Sinkiang (Xinjiang) province to the Indian state of Jammu & Kashmir.



- The British attitude toward the state of Jammu and Kashmir is responsible for the western sector boundaries.
- The Aksai Chin district, Changmo valley, Pangong Tso and Sponggar Tso regions of northeastern Ladakh are all claimed by China, along with a strip that extends the full length of eastern Ladakh and is estimated to be about 5,000 square kilometres.
- The Huza-Gilgit region of North Kashmir is also claimed by China (ceded to it in 1963 by Pakistan).

The Middle Sector

Himachal Pradesh and Uttarakhand touch this border.

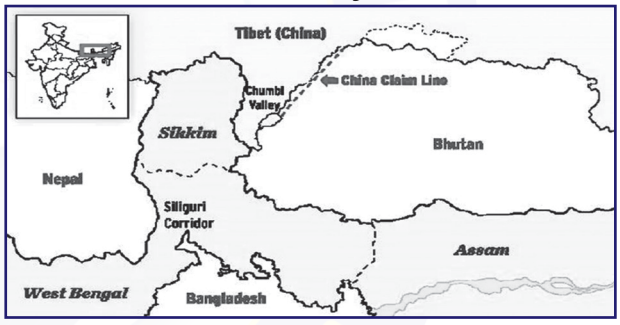
The Eastern Sector: The 1,140 km long border between India and China begins at the easternmost point of Bhutan and ends at the intersection of India, Tibet and Myanmar close to Diphu Pass (Talu Pass).

- In honour of Sir Henry Mc Mahon, then-foreign secretary of British India, who negotiated the border agreement between Great Britain and Tibet at the Shimla Accord in 1913–1914, this line is commonly referred to as the Mc Mahon Line.

The India-Nepal Boundary

- Uttarakhand, Uttar Pradesh, Bihar, West Bengal and Sikkim are the five Indian states that border Nepal. Between India and Nepal, there is free movement of people and products across the porous border.
- The majority of the Indo-Nepalese boundary follows roughly east-west along the foothills of the Shiwalik Range.

India-Bhutan Boundary



- Quite peaceful border and there is no boundary dispute between the two countries.

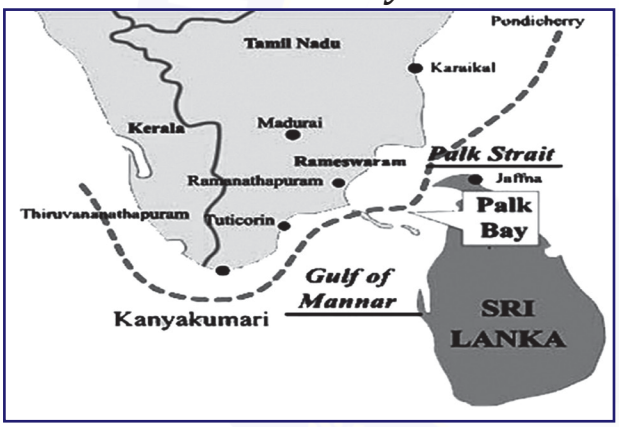
India-Bangladesh Border

- The longest border is that between India and Bangladesh, stretching 4,096 kilometres.
- The Radcliffe Award, which divided the former province of Bengal into two parts, was used to determine this boundary.

India-Myanmar Boundary

- This boundary roughly follows the watershed between the Brahmaputra and Irrawaddy.
- It travels through densely forested areas, passing through Mizo Hills, Manipur and Nagaland on the Indian side and Chin Hills, Naga Hills and Kachin State on the Myanmar side.

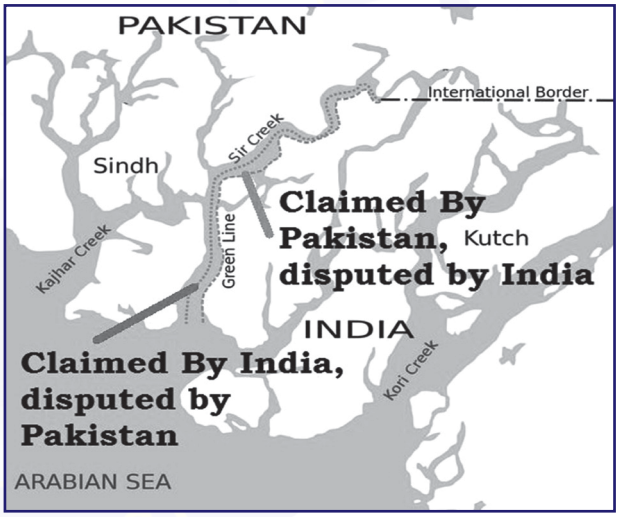
India-Sri Lanka Boundary



- The Palk Strait, a confined area of shallow water, separates India from Sri Lanka.
- Talaimanar on the Jaffna peninsula in Sri Lanka is only 32 kilometres from Dhanushkodi on the Tamil Nadu coast of India. Adam's Bridge is made up of a number of islets that connects these two places.

The Indo-Pakistan Boundary

- The country was divided in 1947 as a consequence of the Radcliffe award, whose chairman was Sir Cyril Radcliffe. This resulted in the Indo-Pakistan boundary.



- The two most contentious areas are Sir Creek and Jammu and Kashmir.

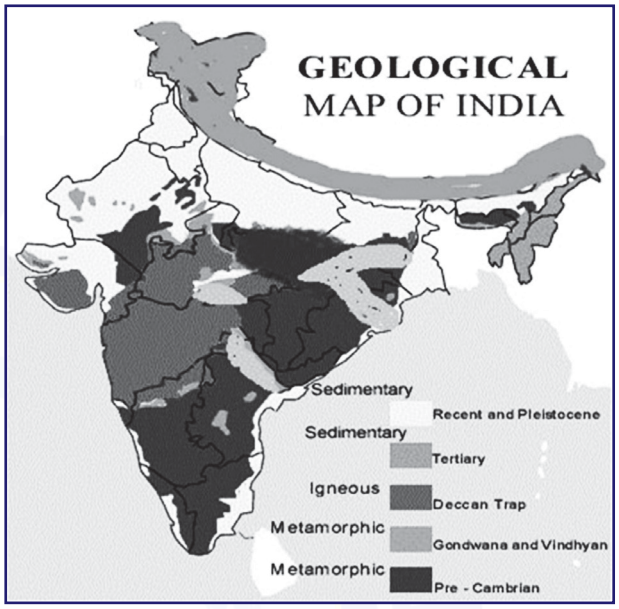
2 THE GEOLOGICAL STRUCTURE OF INDIA

Understanding the types and characteristics of rocks and slopes, the physical and chemical characteristics of soils, the availability of minerals and the resources for surface and subsurface water are all aided by a country's geological structure. However, it is crucial that we comprehend what a geological time scale entails before we can investigate the geological structure of India.

EON	ERA	PERIOD	MILLIONS OF YEARS AGO	KEY EVENTS
Phanerozoic	Caenozoic	Quaternary		Humans evolve
		Tertiary	1.6	
	Mesozoic	Cretaceous		
		Jurassic	138	Extinction of Dinosaurs
		Triassic		
	Paleaozoic	Permian	240	
		Carboniferous	330	Permian mass extinction
		Devonian		
		Silurian	410	
		Ordovician		Invertebrates become common
		Cambrian	500	
Proterozoic		Also known as Precambrian		
Archean			3500	
Hadean				Earliest life

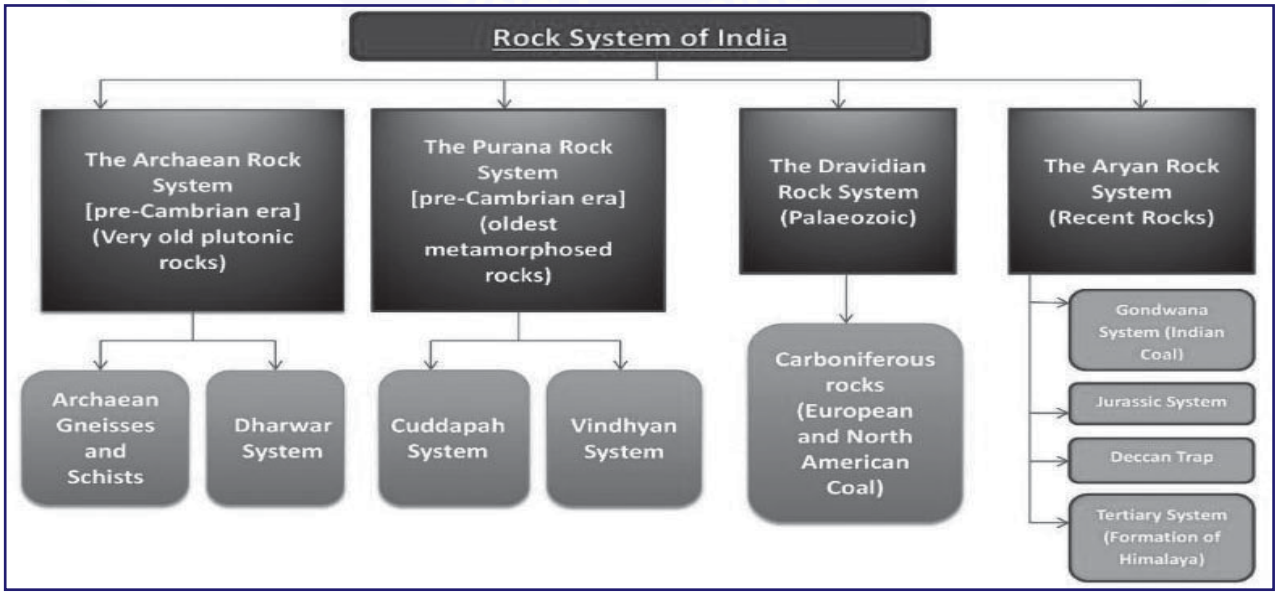
Rock System Based on Geological History of India

- The Archaean Rock System.
- The Purana Rock System.
- The Dravidian Rock System.
- The Aryan Rock System.



Archaean Rock System (Pre-Cambrian Rocks)

- Prior to 2.5 billion years ago, during the Precambrian Period, the upper crust of the earth's surface began to cool and solidify, which is reflected by the exposure of gneisses and granites, particularly on the Peninsula. This phase of tectonic evolution was the first.
- These comprise the Indian Craton's main mass (Block of Indian Subcontinent of Gondwanaland).



- The oldest rocks in the earth's crust are referred to as "Archaean," a word used by J.D. Dana in 1782.
- There are two systems of rocks in the Archaean group.
  - ***(a) Achaean System:*** Granites and Gneisses.
  - ***(b) Dharwar System:*** First Sedimentary Rocks.

Dharwar System

- From 4 billion to 1 billion years ago, the Earth was formed.
- Elevated metamorphic sedimentary rock system. [developed as a result of the metamorphism of Archaean gneisses and schists]
- They are the first rocks that undergo metamorphism.
- Found in great quantity in the Karnataka district of Dharwar.
- Because they contain valuable minerals like high-grade iron ore, manganese, copper, lead, gold, etc., these rocks are the most significant economically.

Purana Rock System

- The Purana rock system is the collective name for the Cuddapah and Vindhyan rock systems.
- They were created by the erosion and deposition of rocks from the Archean and Dharwar formations, which is thought to have occurred between 140 and 600 million years ago.
- Most of them are sedimentary in origin.

Cuddapah System

- Due to the extensive development of rock outcrops from the Cudappah district in Andhra Pradesh.
- They developed as a result of the deposition of sedimentary rocks like sandstone, limestone, etc. and clay in synclinal folds (between two mountain ranges).
- In Andhra Pradesh's Cuddapah district, outcrops can be best seen.
- Iron, manganese, copper, cobalt, nickel and other metal ores can be found in these rocks.
- They have significant limestone reserves of cement-grade.

Vindhyan System (1300-600 million years)

- The enormous Vindhyan mountains are where this system gets its name.
- The system consists of ancient sedimentary rocks that are 4000 metres thick and are superimposed on the Archaean base.
- Mainly unfossiliferous rocks and the Deccan trap covers much of this region.
- Panna and Golconda diamonds were mined from diamond-bearing regions in the Vindhayan system.
- It lacks metalliferous minerals but produces a lot of hard stones, decorative stones, limestone, pure glass manufacturing sand, etc.

Dravidian Rock System (Palaeozoic)

- In India, the Paleozoic rock formation, which dates back 600 to 300 million years, is known as the Dravidian systems. Due to the world's high-quality coal formation, it is also known as the Carboniferous rocks system.
- There are very few of these rocks on the Peninsular Shield and the majority of them are in the extra-Peninsular Himalayan and Gangetic regions (Umaria in Rewa).
- Dravidian rocks are primarily found in the areas of PirPanjal, Handwara, Lider Valley, Annatnag in Kashmir, Spiti, Kangra and Shimla in Himachal Pradesh and Gharwal and Kumayun in Uttarakhand.
- The Dravidian rocks mostly consist of talc, dolomite, marble, quartzites, slates, clays, sandstones and clays.

Carboniferous rocks (350 million years)

- Limestone, shale and quartzite dominate the 350 million year old Carboniferous rocks.
- Upper Carboniferous limestones are the main component of Mount Everest.
- In the Carboniferous era, coal first began to develop.
- In geology, carboniferous refers to a coal-bearing period. [The majority of coal found in India is not from the Carboniferous

period; excellent coal from the Great Lakes Region-USA, U.K. and Ruhr region is from the Carboniferous period]

Aryan Rock System

- The Aryan Group, which marks the start of the Upper Carboniferous period, has arrived at the start of the final, longest and most dramatic age, spanning from the Upper Carboniferous to the Holocene epoch.

Gondwana System: The Gonds, Telangana's and Andhra Pradesh's most primitive people, are where the Gondwana System gets its name.

- They are deposits that have been deposited on the surface of old plateaus in synclinal troughs.
- The laden troughs subsided as the sediments built up.
- Terrestrial plants and animals flourished in these troughs as fresh water and silt gathered there.
- Since the Permian epoch, this has occurred (250 million years ago)

Tertiary System

- About 60 to 7 million years ago, during the Eocene to Pliocene. characterised by the final disintegration of the former Gondwanan continent and the elevation of the Tethys geosynclines or Himalayas.
- The Himalayas were created and India's current shape took shape during the tertiary, making it the most important epoch in terms of geology.
- The Bengal and Ganges delta, the East coast and the Andaman Islands are all totally covered by the Tertiary Succession. The Salt Range, Potwar Plateau, outer Himalayan regions of Jammu and Punjab, Assam, Sind and Baluchistan are other places where they can be found. The Karewas of Kashmir, the Bhangra, the Khadar of the Gangetic plains and others are significant rock systems.

Physiographic division of India

Structure, process and developmental stage all contribute to an area's physiography. The physical attributes of India's geography are incredibly diverse. A huge area of rough topography can be found in the north, which is made up of a number of mountain ranges with a variety of peak shapes, lovely valleys and deep gorges. The southern portion of Earth is a stable tableland with deeply carved plateaus, bare rocks and extensive scarp systems. The enormous north Indian plain lies between these two.

Based on these macro variations, India can be divided into the following physiographic divisions:

- The Northern and North- Eastern Mountains.
- The Northern Plain.
- The Peninsular Plateau.
- The Indian Desert.
- The Coastal Plains.
- The Islands.

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3 PHYSIOGRAPHY OF INDIA

Northern Mountains

Division of the Himalayas: Formation of Himalayas explained in Continent – Continent Convergence.

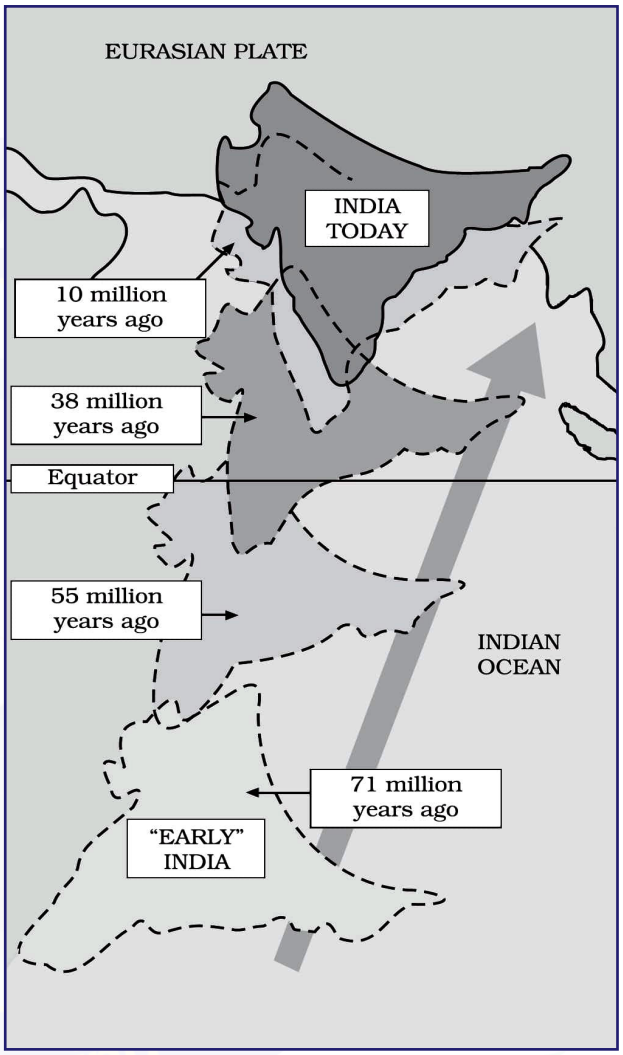
1. Shiwaliks or outer Himalayas.
2. Lesser or Middle Himalayas.
3. The Greater Himalayas.
4. The Trans-Himalayas – Tibetan Himalayas.
5. The Eastern Hills – Purvanchal: A chain of hills in North-East India.

Formation

- Many parallel or convergent ranges in series.
- A highly dissected topography (of a plateau or upland divided by a number of deep valleys) is created when the ranges are separated by deep valleys.
- In contrast to the northern slopes, the southern slopes have high gradients. From the northern side, climbing Mount Everest is less hectic. However, due to Chinese constraints, climbers must access Nepal's more difficult southern slopes.
- India, Nepal and Bhutan are home to the majority of the Himalayan ranges. The northern slopes are partially located in Tibet (trans-Himalayas) and the western extremities is located in Pakistan, Afghanistan and Central Asia.
- Three parallel ranges make up the Himalayas between Tibet and Ganga Plain.

Shiwalik Range

- Situated between the Lesser Himalayas and the Great Plains, Also known as outer Himalayas.
- The range of altitude is 600 to 1500 metres.
- From the Potwar Plateau to the Brahmaputra valley, a distance of 2,400 kilometres.
- While the northern slopes are gentle, the southern slopes are steep.



- From 50 km in Himachal Pradesh to less than 15 km in Arunachal Pradesh, the Shiwaliks' width vary.
- With the exception of an 80–90 km gap filled by the valleys of the Tista and Raidak rivers, they constitute a nearly uninterrupted series of low hills.
- Although Nepal's Shiwalik range is covered in thick forests from North-East India to the west (the amount of rainfall in the Shiwaliks decreases from east to west).

Middle or the Lesser Himalaya

- Between the Shiwalik Mountains in the south and the Greater Himalayas in the north.

- Essentially parallel to both ranges.
- Other names for it include Lower Himalaya and Himachal.
- The 60–80 km wide and 2400 km long lower Himalayan ranges are situated.
- There are elevations ranging from 3,500 to 4,500 m above sea level.
- Over 5,050 metres above sea level, several summits are blanketed in snow the entire year.
- The lower Himalayas are divided into southern slopes that are steep and bare (steep slopes prevent soil formation) and northern slopes that are gentler and covered in forest.
- The Nag Tibba and Mussoorie hills in Uttarakhand serve as a physical reminder of the Middle Himalayas.
- East of the Kosi River, the Sapt Kosi, Sikkim, Bhutan, Miri, Abor and Mishmi hills represent the lower Himalayas.
- The Middle Himalayan ranges are more friendly to human contact.

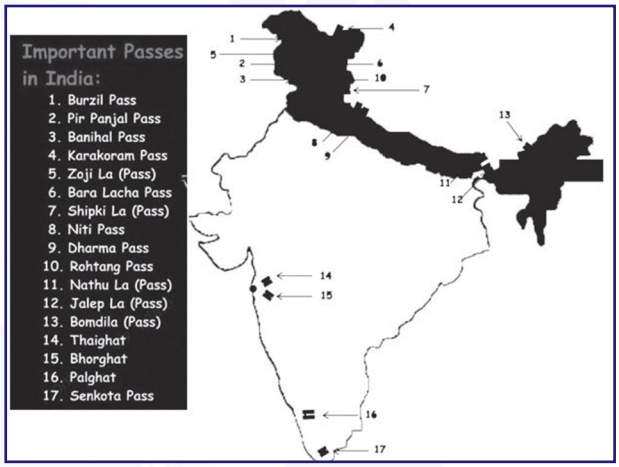
Majority of the Himalayan hill resorts like Shimla, Mussoorie, Ranikhet, Nainital, Almora and Darjeeling, etc. are located here.

The Great Himalaya

- Also known as Himadri, the Central Himalaya, or the Inner Himalaya.
- Averaging roughly 25 kilometres in width and 6,100 m above sea level in elevation.
- Granites and gneisses in the centre are what make up the majority of the structure, which is then covered with metamorphosed limestone sediments. The "Rock System"
- The hog back topography—a long, steep hill or mountain ridge—is created by the asymmetrical folds in this range, which have a high south slope and a mild north slope.
- Like the other two, this mountain arc convexes to the south.
- Abruptly comes to an end as the syntax bends. One is in the Namcha Barwa in the north-east and the other is in the north-Nanga west's Parbat.

Passes in the Greater Himalayas	
State	**Passes of Greater Himalayas**
Jammu and Kashmir	• Burzil Pass • Zoji La [La means pass]
Himachal Pradesh	• Bara Lacha La • Shipki La [The Hindustan- • Tibet Road connecting Shimla with Gartok in Western Tibet]
Uttarakhand	• Thaga La • Niti Pass • Lipu Lekh
Sikkim	• Nathu La • Jelep La [important trade route connecting Kalimpong (near Darjeeling) with Lhasa in Tibet, passes through Jelep La (4,386 m)]

Important Passes of India



The Trans Himalayas

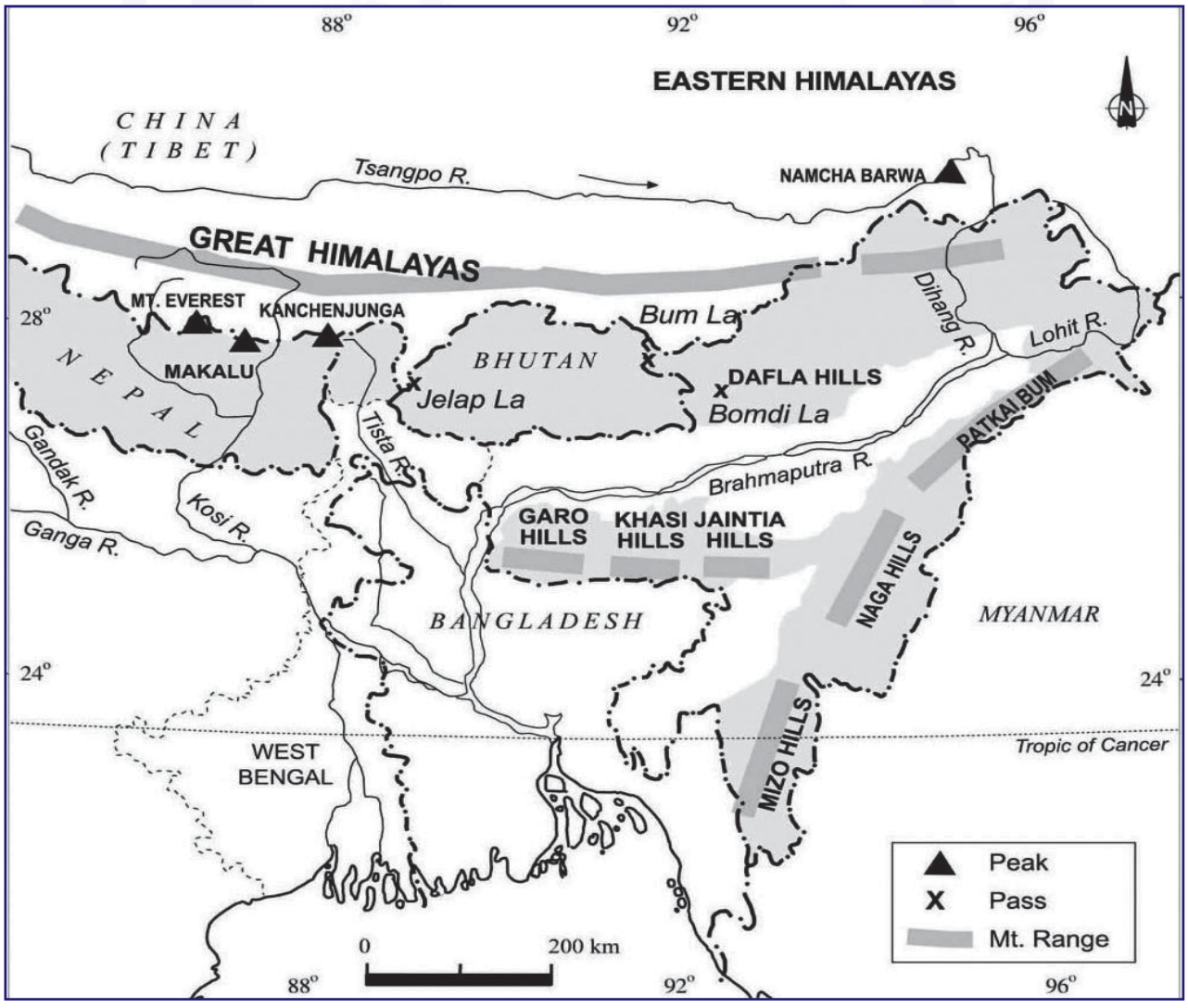
- North of the Great Himalayan range are the Himalayan ranges.
- Because the majority of it is in Tibet, it is also known as the Tibetan Himalaya.
- The primary ranges are the Zaskar, Ladakh, Kailas and Karakoram.
- It extends in an east-west direction for around 1,000 kilometres.
- 3000 metres above mean sea level is the average elevation.
- This region's typical breadth ranges from 40 km at the edges to around 225 km in the middle.
- In the Zaskar Range, the Nanga Parbat (8126 m) is a significant range.
- The Ladakh Range is located parallel to and north of the Zaskar Range. Just a few of the

peaks in this range reach heights of more than 6000 metres.

- The Kailas Range (Gangdise in Chinese) in western Tibet is an offshoot of the Ladakh Range. The highest peak is Mount Kailas (6714 m). River Indus originates from the northern slopes of the Kailas range.
- The northern most range of the Trans-Himalayan Ranges in India is the Great Karakoram Range also known as the Krishnagiri range.
- Karakoram Range extends eastwards from the Pamir for about 800 km. It is a range with lofty peaks [elevation 5,500 m and above]. It is the abode of some of the greatest glaciers of the world outside the polar regions.
- Some of the peaks are more than 8,000 metre above sea level. K2 (8,611 m) [Godwin Austen or Qogir] is the second highest peak in the world and the highest peak in the Indian Union.
- The Ladakh Plateau lies to the north-east of the Karakoram Range. It has been dissected into a number of plains and mountains [Soda Plains, Aksai Chin, Lingzi Tang, Depsang Plains and Chang Chenmo]

Purvanchal or Eastern Hills

- The Himalayas' southern extension, known as the Eastern Hills or The Purvanchal, runs along India's northeastern border.
- The Purvanchal is a group of relatively low hills that are formed when the Himalayas abruptly curve southward near the Dihang canyon.
- To the west, the Purvanchal Hills are convex.
- They stretch from Arunachal Pradesh in the north to Mizoram in the south along the border between India and Myanmar.



- The Patkai Bum Hills, which are composed of strong sandstone and range in elevation from 2,000 to 3,000 metres, merge with the Naga Hills, whose highest peak is Saramati (3,826 metres).
- The border between India and Myanmar is defined by Patkai Bum and Naga Hills.
- The Manipur hills, which are typically lower than 2,500 metres in elevation, are located south of the Naga Hills.
- Naga Hills and Manipur Hills are separated by the Barail mountain.
- The Indian peninsular block continues to the east as the Barail Range swings to the west and enters the Jaintia, Khasi and Garo hills. Rivers called the Ganga and Brahmaputra divide them from the main block.
- South of the Manipur Hills are the Mizo Hills (previously known as the ***Lushai hills***) which have an elevation of less than 1,500 metres. The highest point is the ***Blue Mountain (2,157 m)*** in the south.

Syntaxial Bends of the Himalayas

- From the Indus gorge in the west to the Brahmaputra gorge in the east, the Himalayas stretch in an east-west orientation.
- At these gorges, the Himalayan ranges make abrupt bends to the south. The Himalayan syntaxial bends are what these bends are known as.
- Near the Nanga Parbat, where the Indus river has carved a wide gorge, is where the western syntaxial bend is found.
- The Namche Barwa is close to the eastern syntaxial bend.

Besides the longitudinal divisions, the Himalayas have been divided on the basis of from west to east:

- The Kashmir /Punjab/ Himachal Himalayas.
- The Kumaun Himalayas.
- The Central/ Nepal Himalayas.
- The Assam/ Eastern Himalayas.

Kashmir /Punjab/ Himachal Himalayas

- The Punjab Himalayas are situated between the Satluj and Indus gorges.
- They have a 560 kilometre length and a 320 km width.
- The Shiwalik Mountains comprise its southern boundary and the Zaskar Range forms its northern limit.
- The Kashmir Valley is a syncline basin with ridge and valley morphology, produced by the lacustrine deposits of the River Jhelum.
- It has numerous ox-bow lakes, including Wular Lake, Dal Lake and others.
- It is also known as the "Vail of Kashmir," because the lacustrine deposits, or karewas, from Pulwama to Pampore, provide unique nutrients that aid in the growth of saffron.
- The area gets 100 cm of snow and rain during the winter.
- Alpine grasslands known as Bugyals or Marg, like Sonmarg or Gulmarg, are found among the sloping ranges of the Zaskar and Pir Panjal that surround it.
- It is also called "Heaven of the Earth"
- Other ranges are Ratanpir, which joins Pir Panjal.
- The only gateway to Kashmir is the Banihal pass which has the Jawahar tunnel (Second Largest in India)
- There are several passes in Greater Himalayas which connect Kashmir Valley to Ladakh and other regions like Burzil pass, Zozila pass.

Kumaun Himalayas

- The 320-kilometer-long Kumaun Himalayas are between the Satluj and Kali gorges.
- Nagtiba, Dhaula Dhar, Mussourie and portions of the Greater Himalayas are among the principal mountain ranges.
- Nandadevi, Kamet, Badrinath, Kedarnath, etc. are notable peaks.
- Particularly in Uttarkhand, there are numerous glaciers and ice caps that give rise to numerous rivers, like the Gangotri, Yamunotri, Pindari, etc.
- It has deodar forests between 1600 and 3200 metres above sea level and receives snowfall during the winter.
- Bhagirathi Plain and Doons are two significant basins in this area. Tectonic valleys include Kangra, Manali and Kulu.

- Hill stations are famous because of their climate and colonial heritage.
- This region has 200cm of rainfall and its more vegetated than the Kashmir Himalayas but prone to Seismicity and landslides because the rocks are fractured and fragile especially the lesser Himalayas is composed of loose rocks like shale, limestone and conglomerates.

Central/ Nepal Himalayas

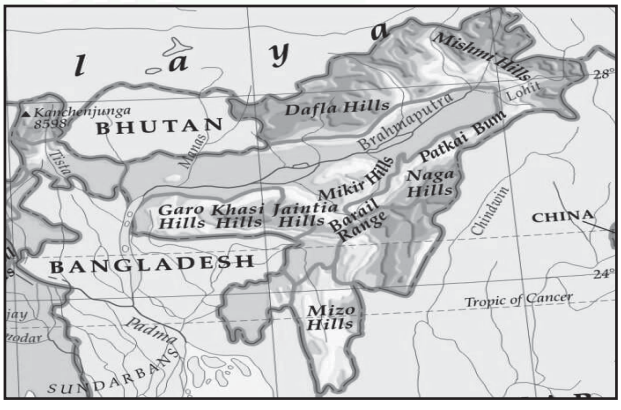
- Situated between the rivers Tista and Kali, which run west to east.
- It measures 800 kilometres.
- Here are some of the most well-known mountains in the world, including Mt. Everest (Sagarmatha), Kanchenjunga, Makalu, Annapurna, Gosainthan and Dhaulagiri.
- These mountains feature an orthoclinal layout and the Katmandu valley is well-known.
- In this area, the Lesser Himalaya is referred to as Mahabharat Lekh.
- Rivers like the Ghaghara, Gandak, Kosi, etc. cut through the mountain.
- Kathmandu and Pokhra lacustrine valleys lie between the Great and the Lesser Himalayas (previously, they were lakes).
- Beyond Narayani, the Shiwalik range is essentially nonexistent and very close to the lesser Himalaya to the east.

Assam/ Eastern Himalayas

- It is situated between the Tista River in the west and the Brahmaputra River (Dihang Gorges) in the east and it is 750 km long.
- The majority of the Eastern Himalayas are located in Bhutan and Arunachal Pradesh.
- Shiwalik Mountains and the Greater Himalayas are intertwined in numerous places.
- Rainfall totals over 200 cm and thin longitudinal troughs are typical.
- Fluvial erosion is clearly dominant in the Assam Himalayas as a result of abundant rainfall.
- However, due to its proximity to the tropics and deep jungle, ice caps and glaciers were not discovered.
- Since rocks are easily broken, earthquakes occur frequently.
- Tribes live there.
- Range names are equivalent to tribal names.
- Several raging rivers cut across these mountains.
- This area is heavily dissected.

Purvanchal

- Although structurally distinct from the main Himalayan mountains, it is regarded to be a component of the Himalayas geologically.
- The Brahmaputra valley is located north of the Purvanchal Range.
- Its Naga Hills contain Saramati, the highest mountain in the world.
- The only floating national park in the world is located at Loktak Lake in the Manipur Hills.
- National Park of Keibul-Lamjao.
- The highest point in the Mizo Hills, formerly known as the Lushai Hills, is Blue Mountain.
- These mountains are a product of the Arakan Yoma orogen.
- They contain shale, mudstone, sandstone and quartzite, among other loose and broken sedimentary rocks.
- The Himalayas' most shattered portion is this region.
- It is susceptible to earthquakes and landslides because of the Naga fault line.
- Densely forested, 150-200 cm of rain falls annually, however due to changing farming ecology ***is at stake.***



Significance of the Himalayas

1. ***Influence on Indian Climate:*** They prevent rain from falling in the North-Eastern Hills and the entire Ganga Plains because to their interception of the summer monsoons that originate from the Arabian Sea and Bay of Bengal.
    - To the north-west of India (Punjab, Haryana, etc.), they direct the monsoon winds. But because of Western Disturbances that originate in the Mediterranean regions, these areas get the most of the rainfall.
    - From the chilly continental air masses of central Asia, they shield the northern plains.
    - Sub-tropical Jet stream movement in the area is influenced by the Himalayas. In order to bring the monsoon to India, they split the jet stream, which is very crucial.
    - India would have been entirely a desert with very harsh winters if there had been no Himalayas.
2. ***Defense:*** The Himalayas act as a natural barrier for defence.
    - But the 1962 Chinese invasion of India decreased the Himalayas' importance as a line of defence.
3. ***Source of Rivers:*** In India, approximately half a billion people depend on the rivers that flow from the Himalayas. [This will be covered in further detail in the drainage system]
    - All of the rivers are dependable year-round water sources.
4. ***Fertile Soil:*** The swift flowing rivers from Himalayas bring enormous amount of silt (alluvium) which constantly enrich the Ganaga and Bramhaputra plains.
5. ***Hydroelectricity:*** The Himalayan region offers a number of natural sites with excellent hydroelectric power generation potential because of its topography and swift-moving perennial rivers. There are already several hydroelectric power facilities in existence. But doing all of this has a high environmental cost.
6. ***Mineral Resources in Himalayas:*** Potential coal and oil reserves can be found in geosynclinical deposits found in tertiary rocks. Kashmir is home to coal. Some locations in the Himalayas have deposits of copper, lead, zinc, gold, silver, limestone, semi-precious stones and precious stones. However, in order to fully utilise these resources, cutting-edge technologies are still needed.

Northern Plain

In India, the northern plains are the most recent physiographic feature. The Himalayan Frontal Fault divides them from the Shivaliks, which are to their south (HFF). The border is a wavy, erroneous line that runs along Peninsular India's northern frontier. The hills of Purvanchal surround the plains on their eastern side.

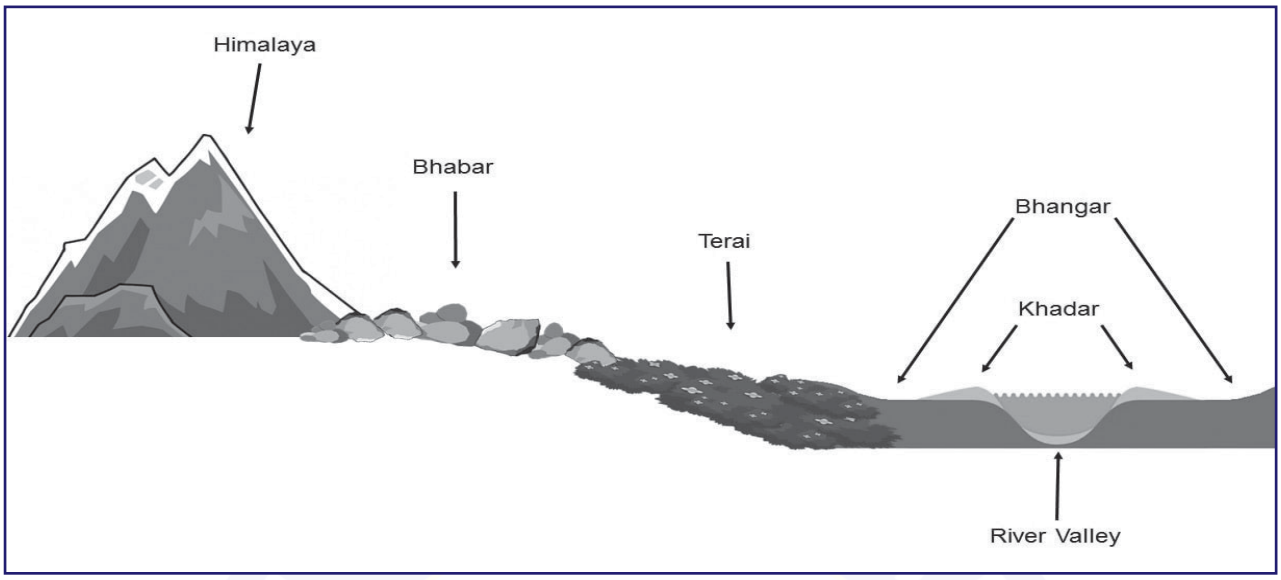
Northern Plain

- Alluvial deposits brought by rivers with origins in the Himalayan and Peninsular regions resulted in the formation of the great plains. From east to west, these plains cover a distance of about 3,200 km.
- Despite having relief features that span hundreds of kilometers, the Great Plains are remarkably uniform.
- Bluffs, levees, ravines and khols are used to break up the monotony.

Bhabar plains

Bhabar is a short region at the slope's break that runs parallel to the Shiwalik foothills for 8 to 10 km. Because of this, the streams and rivers that originate in the mountains often disappear in this area and leave behind heavy materials made of rocks and boulders.

Only enormous trees with deep roots are present in the area, which is unsuitable for cultivation. There are building materials available, including large boulders. Recently, footloose businesses have received encouragement.



Tarai plains: Marshy tracts emerge south of Bhabar; this area is known as Terai. This is home to a wide variety of wildlife and has a lush growth of natural greenery. To grow sugarcane, rice and wheat in Uttar Pradesh, these forests are cleared.

Bhangar Plains: It depicts the Older alluvium-formed uplands.

- The calcium-rich, dark-colored alluvium is known as kankar.
- Clay makes up the majority of Bhangar, however loam and sandy-loam can occasionally be found there as well.
- Saline and alkaline efflorescences known as Reh are present in dry places.

Khadar Plains: Younger alluvium of flood plains if the river is called Khadar. Its Alluvium is light in colour and poor in calcareous matter.

Delta plains: Its an extension of Khadar plains.

- Here uplands are called Chars and marshy land as Bils.

Regional Division of Northern Plains

Rajasthan Plains: These regions to the west of Aravalis include Marusthali and Rajasthan Bagar.

There are multiple brackish lakes in this area that were once under marine submergence but dried up with the ascent of the Himalayan phase.

Despite having numerous inland drainage systems, Luni is the only one that reaches the ocean. Luni starts out lovely and gets salty as it descends. Sand and dunes cover the area. A 25 cm Isohyet wall separates it from the Bagar area. Luni drains the fertile and semi-arid Bagar region in the south.

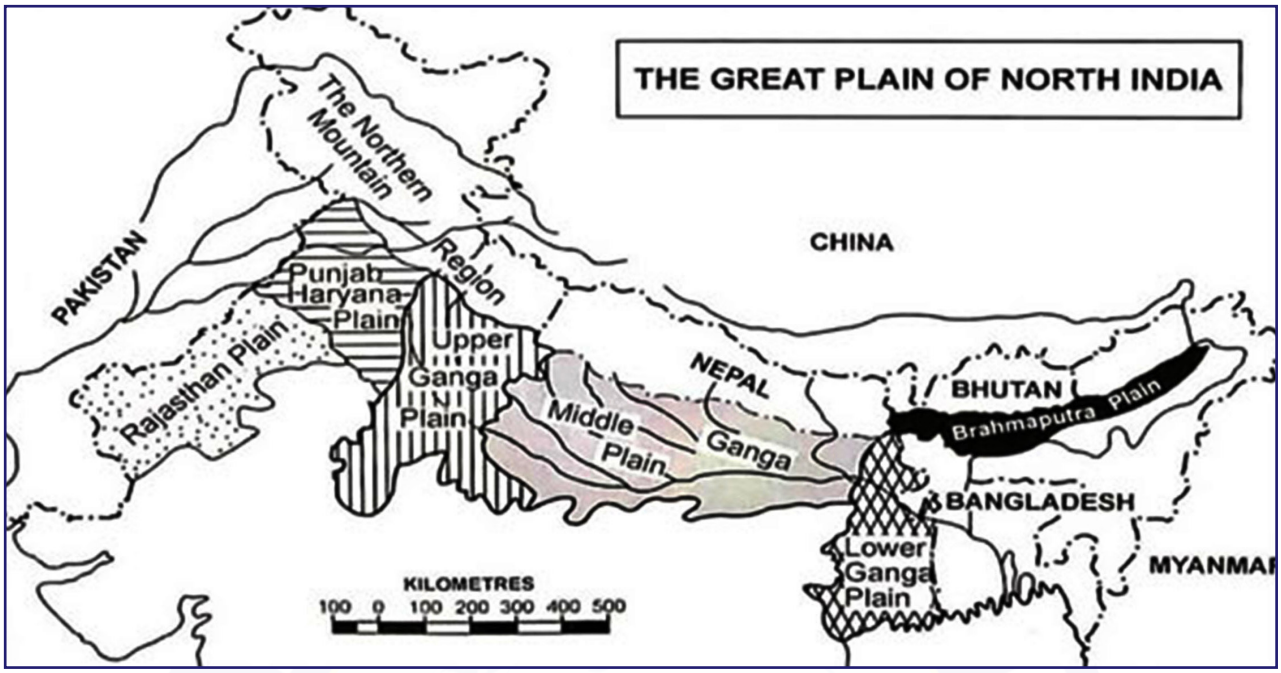
Punjab Haryana plain: These are created by rivers Satluj Beas and Ravi depositing sediment.

- Doabs, a name for the rich highlands between these rivers.
- Because of the little streams known as Chos, the northern half of the region has seen severe erosion.

Ganga plains: They extend from Yamuna river in west till Bangladesh.

- It is divided into:
  1. Upper Gangetic Plain.
     - This region has Ganga Yamuna Doab, Rohilkhand plain-Ramganga, Avadh plains-drained by ghagra and Gomati river.
  1. Middle Ganga Plain.
  2. Lower Ganga Plain:
     - It is formed by subduction of Rajmahal Garo gap and subsequent infilling by rivers. Monotonous surface is broken by Bils, Swamps, Marshes, Levees.

Brahmaputra Plains: Due to low gradient, numerous riverine Islands are formed Region is surrounded by high mountains on all sides.



Ganga-Brahmaputra Delta

The world's largest delta is located here.

In the delta region, the Ganga river splits into multiple waterways. Here, the ground slopes by only 2 cm per mile. The area is below mean sea level in two-thirds of it. [Highly susceptible to changes in sea level]

Estuaries, mud flats, mangrove swamps, sandbanks, islands and forelands are abundant on the seaward face of the delta.

Tidal woods cover a substantial portion of the coastal delta. Due to the Sundri tree's dominance in this area, these are known as the Sunderbans.

Significance of the Plain

- Half of all Indians live on this one-fourth of the nation's land.
- Flat terrain, perennial rivers that move slowly, fertile alluvial soils and a good climate encourage intensive agricultural activities.
- Punjab, Haryana and the western portion of Uttar Pradesh are now known as the "granary of India" because to the significant usage of irrigation (Prairies are called the granaries of the world).
- A dense network of highways and trains connects the whole plain, with the exception of the Thar Desert and this has sparked extensive urbanisation and industrialization.
- ***Cultural tourism:*** Hindus hold many sacred sites along the banks of rivers like the Ganga and the Yamuna in high regard. The Mahavira and Buddha religions as well as the Bhakti and Sufi movements thrived in this region.

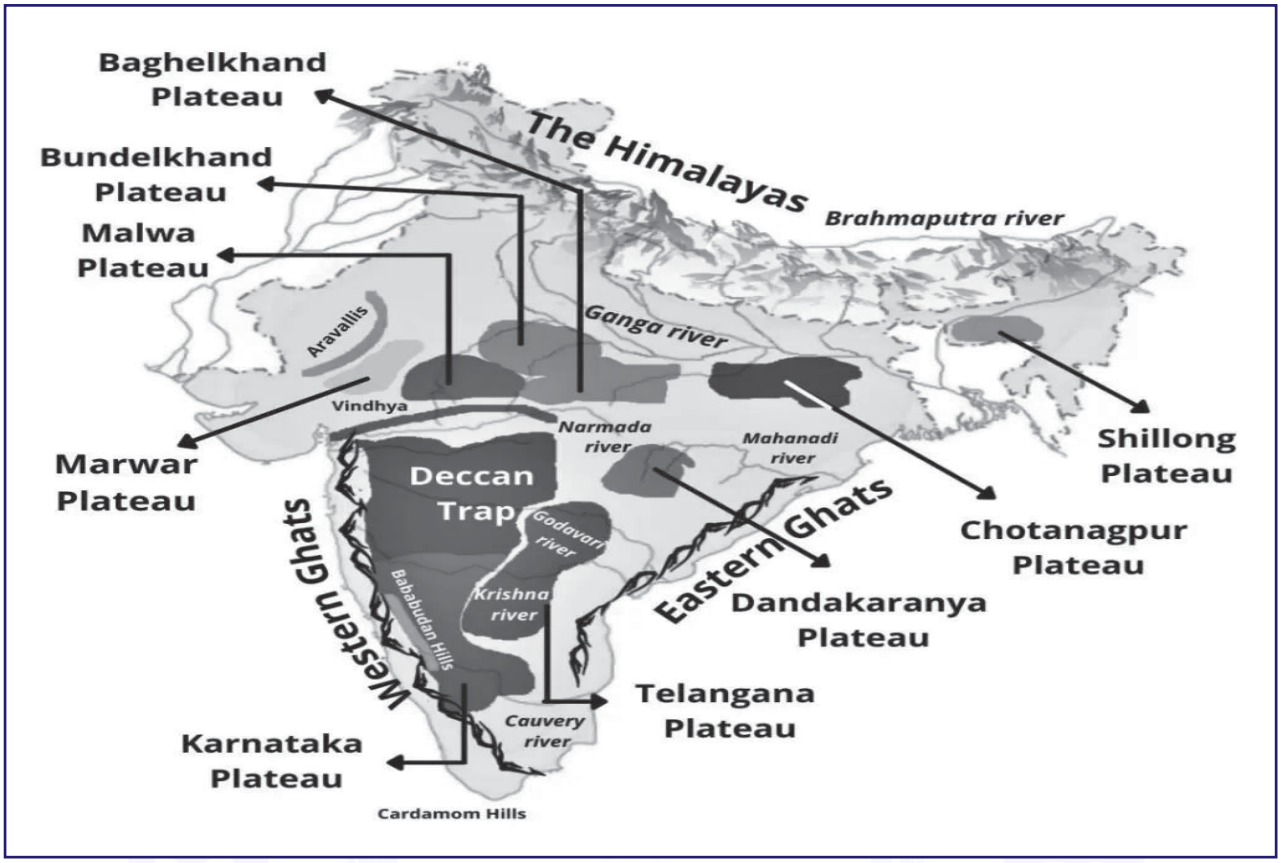
Indian Peninsular Plateau

Indian Peninsular Plateau (Deccan Plateau)

A plateau is a high expanse of land with a flat top. In the absence of a neighbouring plateau, plateaus frequently exist alone. A plateau is a flat, high landform that rises abruptly above its surroundings on at least one side, according to National Geographic.

Features of the Peninsular Plateau

- Roughly triangular in shape, with the southern boundary of the vast plain of North India serving as its foundation. The triangular plateau's highest point is at Kanniyakumari.
- It has a total size of around 16 lakh square kilometres (India as a whole is 32 lakh sq km).
- The plateau rises between 600 and 900 metres above sea level on average (varies from region to region).



- The majority of peninsular rivers run from west to east, which suggests that it is the general slope.
- The rift that forms in the Narmada-Tapti River, which runs from east to west, is an exception.
- One of the oldest landforms on the planet is the Peninsular Plateau.
- It is a very stable block made primarily of gneisses and schists from the Archaean era.
- Since its formation, it has been a shield that has remained stable and undergone few structural modifications.
- The Peninsular block has been on land for many hundred million years and has only occasionally been submerged by the water. The Peninsular Plateau is made up of a number of smaller plateaus, hill ranges, river basins and valleys.

Marwar Plateau or Mewar Plateau

- It is located in eastern Rajasthan. Marwar plateau is to the east of Aravalis and Marwar plain is to the west.
- It dips down eastward and has an average elevation of 250–500 m above sea level.
- Sandstone, shales and limestones from the Vindhayan era make up its composition.
- The Banas River and its tributaries, the Berach and Khari rivers, rise in the Aravali Range and flow northwest into the Chambal river. The plateau top resembles a rolling plain due to these rives' erosional activity.

Central Highland

- Madhya Bharat Pathar and Madhya Bharat Plateau are other names for this area.
- The Marwar or Mewar Upland is to the east of it.
- The Chambal river's basin, which flows through a rift valley, makes up the majority of the plateau.
- Its principal tributaries include the Banas, which flows through the Mewar plateau, the Parwan, which flows from Madhya Pradesh and the Kali Sindh, which originates in Rana Pratap Sagar.
- Sandstone makes up the rounded hills of the plateau's rolling terrain. Here are dense forests.
- The Chambal River's ravines, often known as its badlands, are to the north.

Bundelkhand Upland

- Yamuna River to the north, Malwa Plateau to the south, Madhya Bharat Pathar to the west and Vindhyan Scarplands to the east and south-east.
- It is the ancient highland of the "Bundelkhand gneiss," which is composed of granite and gneiss and is dissected (separated by a number of deep valleys).
- Consists of five districts in Uttar Pradesh and four in Madhya Pradesh.
- This region dips down from the Vindhyan Scarp toward the Yamuna River, with an average elevation of 300-600 m above sea level.
- A series of granite and sandstone hillocks, or small hills, serve as the area's identifying features.
- It has an undulating (wave-like surface) due to the erosive action of the rivers that flow through this area, making farming impossible.
- Streams like Betwa, Dhasan and Ken flow through the plateau.

Malwa Plateau

- The Aravali Range in the west, Madhya Bharat Pathar to the north and Bundelkhand to the east encircle the Malwa Plateau, which is essentially shaped like a triangle based on the Vindhyan Hills.
- This plateau contains two drainage systems: one that empties into the Arabian Sea (the Narmada, Tapi and Mahi) and the other that empties into the Bay of Bengal (Chambal and Betwa, joining the Yamuna).
- The Chambal and many of its right bank tributaries, including the Kali, the Sindh and the Parbati, drain it in the north. The higher courses of the Sindh, Ken and Betwa are also included.
- It is made of a sizable lava flow and coated with dark soils.
- The general slope is towards the north [decreases from 600 m in the south to less than 500 m in the north]
- This is a rolling plateau dissected by rivers. In the north, the plateau is marked by the Chambal ravines.

Baghelkhand

- The Baghelkhand is located north of the Maikal Range.
- Made of granite in the east and limestone and sandstone in the west.
- The Son river forms its northern border.
- The Son drainage system in the north and the Mahanadi river system in the south are separated by water in the middle of the plateau.
- The area is uneven, with an overall elevation range of 150 to 1,200 metres.
- The trough-axis is not far from the locations of the Bhanrer and Kaimur.

- The general horizontality of the strata demonstrates that there haven't been any significant disturbances in this region.

Chotanagpur Plateau

- The northern projection of the Indian Peninsula is represented by the Chotanagpur plateau.
- Mostly in Jharkhand, the northernmost region of Chhatisgarh and West Bengal's Purulia district.
- North-west of the plateau, the Son river feeds into the Ganga.
- The plateau is 700 metres above sea level on average.
- The majority of the rocks on this plateau are from Gondwana.
- The plateau has a radial drainage pattern because it is drained by various rivers and streams that flow in different directions. Discharge Pattern.
- Numerous drainage basins have formed along rivers such the Damodar, Subarnrekaha, North, South and Barkar.
- In a rift valley running from west to east across the centre of this area is the Damodar river.
- The Hazaribagh plateau, which is located north of the Damodar river, has an average elevation of 600 metres above mean sea level. Isolated hills dot this plateau. Due to extensive erosion, it resembles a peneplain.
- South of the Damodar Valley, on the Ranchi Plateau, the elevation is roughly 600 metres above mean sea level. Where Ranchi (661 m) is located, the terrain is mostly rolling.
- Monadnocks, an isolated hill or ridge of erosion-resistant rock towering above a peneplain, encroach on it in some locations. Conical hills include, for instance, Ayers Rock in Australia.
- The Rajmahal Hills, which define the Chotanagpur Plateau's northeastern border, are primarily made of basalt and are covered in basaltic lava flows.

Meghalaya Plateau

- Beyond the Rajmahal hills, to the east, the peninsular plateau stretches to Meghalaya or the Shillong plateau.
- This plateau is separated from the main block by the Garo-Rajmahal Gap.
- Down-faulting created this gap (normal fault: a block of earth slides downwards). Later, sediments left behind by the Ganga and Brahmaputa filled it.
- Archaean quartzites, shales and schists formed the plateau.
- The plateau dips southward toward the Surma and Meghna rivers and northward toward the Brahmaputra valley.
- Its western border roughly corresponds with the border with Bangladesh.
- The Khasi-Jaintia Hills (1,500 m), the Mikir Hills (900 m) and the Garo Hills (900 m) are the names of the western, middle and eastern portions of the plateau, respectively (700 m).
- Shillong (1,961 metres) is the highest point of the plateau.

Deccan Plateau

- About five lakh square kilometres make up its area.
- The Satpura and Vindhya in the north-west, the Mahadev and Maikal in the north, the Western Ghats in the west and the Eastern Ghats in the east define its triangle shape.
- It has a 600 m average elevation.
- The elevation varies from 500 m in the north to 1000 m in the south.
- The flow of its principal rivers serves as a good indicator of its general slope, which runs from west to east.
- This plateau has been separated into several smaller plateaus by rivers.

Maharashtra Plateau

- It makes up the Deccan Plateau's northern portion.
- The majority of the Deccan Traps are located in this area, which is largely underlain by basaltic rocks with volcanic origins.

- Weathering has given the land the appearance of a rolling plain.
- The horizontal lava sheets have produced characteristic Deccan Trap topography (step-like topography).
- Godavari, Bhima and Krishna's wide and shallow valleys are bounded on opposing sides by flat-topped, steep-sided hills and mountains.
- Regur, a black cotton soil, blankets the entire area.

Karnataka Plateau

- The Mysore plateau is another name for the Karnataka Plateau.
- Resides south of the plateau of Maharashtra.
- An average elevation of 600–900 metres gives the area the appearance of an undulating plateau.
- The Western Ghats run parallel to or across the general trend of the hills.
- The tallest peak, Mulangiri in the Baba Budan Hills of the Chikmaglur district, is 1913 metres high.
- Malnad and Maidan are the names of the two sections that make up the plateau.
- Kannada for "the Malnad" is "high country." Deep valleys covered with thick trees cut through it.
- On the other hand, the Maidan is made up of a rolling plain and small granite hills.
- In the south, where the Western Ghats and Eastern Ghats meet, the plateau narrows and combines with the Niligiri.

Telangana plateau

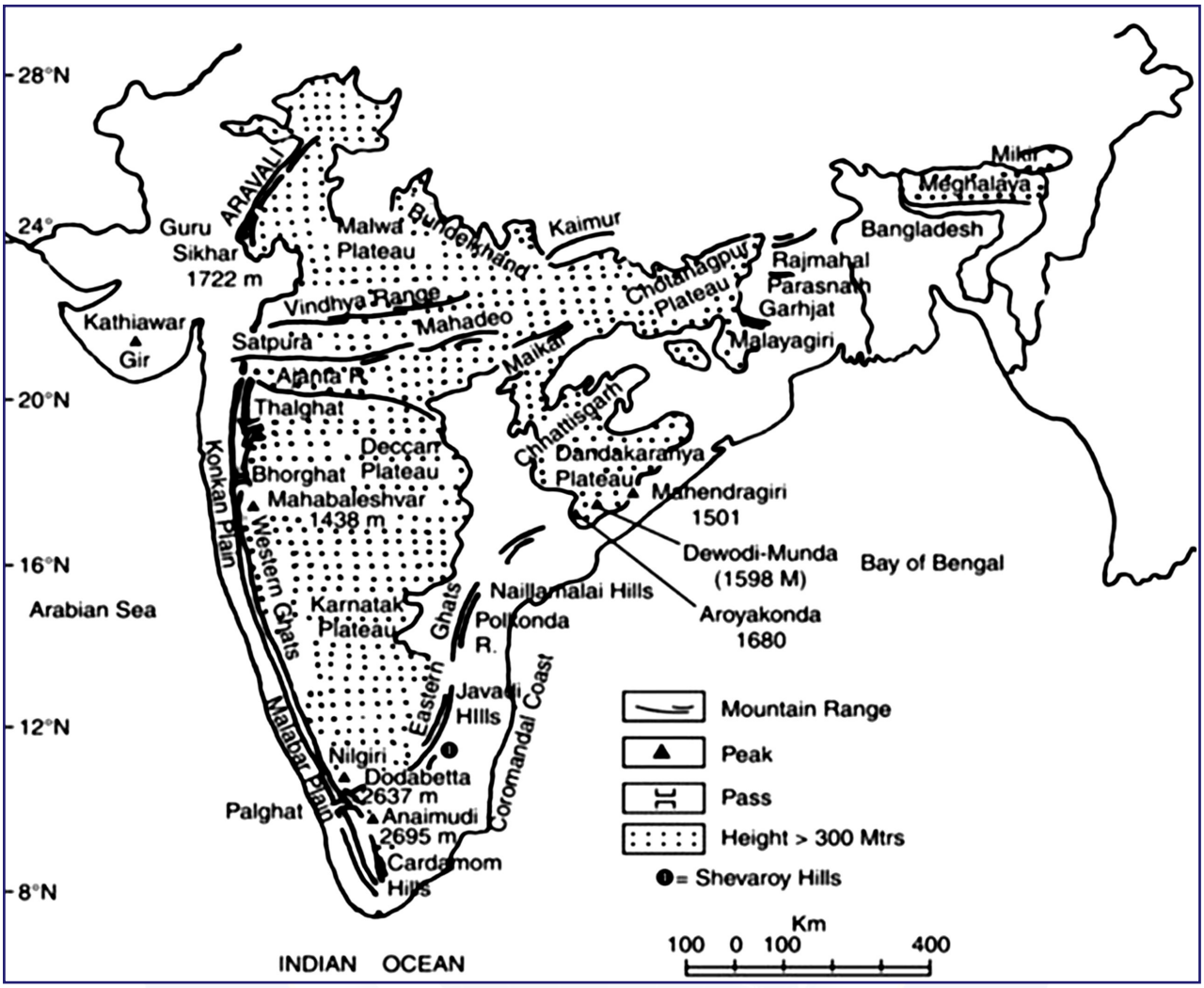
- Archaean gneisses make up much of the Telangana plateau.
- It has a 500–600 m elevation on average.
- In comparison to its northern twin, the southern section is higher.
- Three river systems—the Godavari, the Krishna and the Penneru—drain the area.
- Ghats and the Peneplains separate the entire plateau (a vast featureless, undulating plain which the last stage of deposition process).

Hill Ranges of the Peninsular Plateau

- In the peninsular region, relict-type hills predominate (residual hills).
- They are the remains of hills and horsts that were formed millions of years ago (horst: uplifted block; graben: subsided block).
- These hill ranges and various river valleys divide the Peninsular region's plateaus from one another.

Aravali Range

- They are arranged from northeast to southwest.
- They travel roughly 800 kilometres between Delhi and Gujarat's Palanpur.
- They are the oldest mountain range in India and one of the world's oldest (very old) fold mountains. Mountains in folds and mountains in blocks.
- Its summits were feeding glaciers after its formation in the Archaean Era (more than 100 million years ago) and several of them were likely higher than the Himalayas of today.
- They are now remnants of the world's oldest mountain, which was formed as a result of folding, after suffering severe weathering and erosion for millions of years.
- They proceed up to Hariddwar, which is hidden by the Ganga Plains' alluvium.
- The range is noticeable in Rajasthan (a continuous range that climbs to 900 m south of Ajmer), but it is less noticeable in Haryana and Delhi (characterized by a chain of detached and discontinuous ridges beyond Ajmer).
- Some geographers claim that one branch of the Aravalis continues through the Gulf of Khambhat to the Lakshadweep Archipelago and the other branch into the states of Andhra Pradesh and Karnataka.
- With only a few hills rising beyond 1,000 metres, its average elevation is only 400–600 metres.
- The range climbs to about 1,000 m at the south-westernmost point. The valley of the Banas here divides Mt. Abu (1,158 m), a minor mountainous block, from the main range.



Guru Sikhar (1,722 m), the highest peak, is situated in Mt. Abu.

Vindhyan Range

- It spans a distance of more than 1,200 kilometres from Jobat in Gujarat to Sasaram in Bihar, running almost parallel to the Narmada Valley.
- The Vindhyan Range ranges in elevation from 300 to 650 metres.
- The Vindhayan Range is mostly made up of old sedimentary rocks with horizontal bedding. The Bharner and Kaimur hills are a continuation of the Vindhyas to the east.
- Between the Ganga and the south Indian river systems, this range serves as a watershed.
- Within 30 kilometres of the Narmada, the rivers Chambal, Betwa and Ken have their sources.

Satpura Range

- Seven mountains make up the Satpura Range (the words "Sat" and "pura" both mean mountains).
- It flows nearly parallel to these rivers in an east-west direction, south of the Vindhyas and between the Narmada and the Tapi.
- It extends for around 900 kilometres.
- The Satpuras have been folded and upheaved in various places. They are referred to as "horst," or structural uplift.
- The highest peak is Dhupgarh (1,350 m) on the Mahadev Hills, close to Pachmarhi.
- The peak of Amarkantak (1,127 m) is also important peak.

Western Ghats (or The Sahyadris)

- Run 1,600 km from the Tapi valley (21°N latitude) to just north of Kanniyakumari (11°N latitude).

- The Western Ghats are a group of flat-topped, terraced hills with steep sides that front the Arabian Sea.
- This is a result of the lavas' horizontal bedding, which, after weathering, gave this mountain chain's relief a distinctive "landing stair look."
- From the Western Coastal Plain, the Western Ghats rise abruptly as a sheer wall to an average elevation of 1,000 m.
- However, when viewed from the Deccan tableland, they barely resemble mountains due to the gentle slope of their eastern flank.
- The Nilgiris, Anamalai and other regions south of Malabar have quite distinct landscapes because of their different geological structures.

The Northern Section

Important peaks include Kalasubai (1,646 m), which is close to Igatpuri, Salher (1,567 m), which is located about 90 km north of Nashik, Mahabaleshwar (1,438 m) and Harishchandragarh (1,424 m).

The Konkan Plains in the west and the Deccan Plateau in the east can be reached by road and rail through the crucial passes of Thal ghat and Bhor ghat.

The Middle Sahyadri: The Vavul Mala (2,339 m), the Kudremukh (1,892 m) and Pashpagiri (1,714 m) are important peaks.

The Nilgiri Hills which join the Sahyadris near the trijunction of Karnataka, Kerala and TN, rise abruptly to over 2,000m. They mark the junction of the Western Ghats with Eastern Ghats. Doda Betta (2,637 m) and Makurti (2,554 m) are important peaks of this area.

Southern Section

Anai Mudi (2,695 m) is the highest peak in the whole of southern India. Three ranges radiate in different directions from Anai Mudi. These ranges are the ***Anaimalai (1800-2000 m)*** to the north, the ***Palani (900-1,200 m)*** to the north-east and the ***Cardamom Hills*** or the ***Ealaimalai*** to the south.

Eastern Ghats

- Starting at the Mahanadi in Odisha and ending at the Vagai in Tamil Nadu, it is a chain of severely shattered and fragmented hills. Between the Krishna and the Godavari, they nearly vanish.
- They lack both structural coherence and physiographic continuity. As a result, these hill groups are typically regarded as separate units.
- The Eastern Ghats only exhibit real mountain character in the northern portion, between the Mahanadi and the Godavari. The Madugula Konda and Maliya ranges are included in this section.
- The Maliya range's peaks and ridges range in elevation from 900 to 1,200 metres, with Mahendra Giri (1,501 m) being the highest summit.
- Higher heights in the Madugula Konda range vary from 1,100 m to 1,400 m, with numerous summits topping 1,600 m.
- The Eastern Ghats lose their steep nature between the Godavari and Krishna rivers and are populated by Gondwana formations (KG Basin is here).
- The Nallamalai Range, often known as the Naxalite hideaway in Andhra Pradesh's Cuddapah and Kurnool districts, is where the Eastern Ghats resurface as a roughly continuous hill range with an elevation ranging from 600 to 850 metres.
- Palkodna range is the name of this range's southern section.
- Only the Javadi Highlands and the Shevroy-Kalrayan Hills, two unique landforms of 1,000 m elevation, are found in the southern hills and plateaus, which reach very low altitudes.
- At the state's boundary with Tamil Nadu, Karnataka's Biligiri Rangan Hills rise to a height of 1,279 metres.

Significance of the Peninsular Plateau

- There are enormous amounts of minerals like gold, mica, bauxite, copper, manganese and iron.

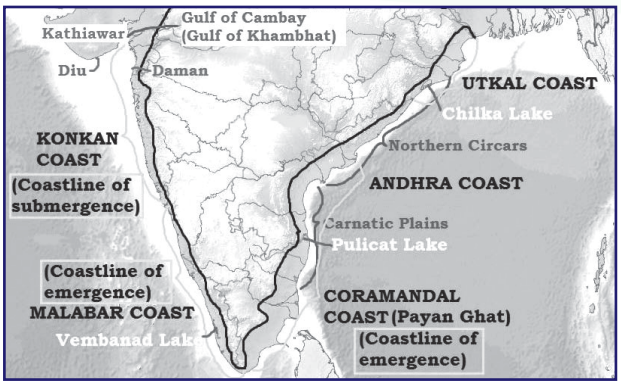
- The Peninsular Plateau contains 98% of India's Gondwana coal resources.
- Large reserves of slate, shale, sandstones, marbles, etc. are also present.
- Fertile black lava soil covers a sizable portion of the north-west plateau, making it ideal for cultivating cotton.
- Plantation crops including tea, coffee, rubber, etc. are suited for cultivation in a few hilly areas of south India.
- Rice can be grown in a few of the plateau's low-lying sections.
- The plateau's highlands are covered in a diversity of forest types that produce a wide range of forest products.
- The rivers originating in the Western Ghats offer great opportunity for developing hydroelectricity and providing irrigation facilities to the agricultural crops.
- The plateau is also known for its hill resorts such as Udagamangalam (Ooty), Panchmarhi, Kodaikanal, Mahabaleshwar, Khandala, Matheron, Mount Abu, etc.

Western and Eastern Coastal Plains of India

The Andaman, Nicobar and Lakshadweep islands are included in the 7516.6 km long Indian coastline, which also includes 6100 km of mainland coastline.

The faulting of the Gondwana land during the Cretaceous epoch is what gave India its straight and regular coastline.

13 states and Union Territories are located along India's coastline. The eastern coastal plains are situated along the Bay of Bengal, whereas the western coastal plains are along the Arabian Sea.



East coast of india

- Lies between the Eastern Ghats and the Bay of Bengal.
- It stretches all the way to Kanniyakumari from the Ganga delta.
- It is distinguished by the deltas of rivers including the Mahanadi, Godavari, Krishna and Cauvery.
- The Pulicat lake and Chilka lake are significant geographical features on the east coast.

Regional Names of The East Coast of India

- In Orissa (Odisha) it is known as ***Utkal coast***.
- From the southern limit of the Utkal plain, stretch the ***Andhra coast***.
- In the south of the Andhra plain is the ***Tamil Nadu coast.***
- The Tamil Nadu coast and parts of Andhra coast together are known as ***Coramandal Coast*** or ***Payan Ghat***

West Coast of India

- The west coast strip stretches from Cape Comorin in the south to the Gulf of Cambay (Gulf of Khambhat) in the north (Kanniyakumari).
- It is separated into I the Konkan coast (ii) the Karnataka coast (iii) and (iv) the Kerala coast (starting from north to south).
- It is composed of alluvium that was transported there by little streams coming from the Western Ghats.
- Coves (a very small bay), creeks (a short, sheltered waterway such as an inlet in a shoreline or channel in a marsh) and a few estuaries are scattered throughout. Underwater Landforms.
- The two largest estuaries are those of the Narmada and the Tapi.
- The Vembanad Lake is the largest of the lakes, lagoons and backwaters on the Kerala coast (Malabar Coast).

Coastlines

1. Coastline of Emergence.
2. Coastline of Submergence.

Coastlines of Emergence and Submergence

Either an uplift in the land or a decline in sea level creates the coastline of emergence. The converse situation applies to the coastline of submergence.

The characteristic features of emergence include bars, spits, lagoons, salt marshes, beaches, sea cliffs and arches. Underwater Landforms.

The Tamil Nadu coast on India's east coast, in particular, seems to be a coast of emergence.

On the other hand, India's west coast is simultaneously emerging and submerging.

Faulting has caused the northern portion of the coast to be submerged and the Kerala coast in the south is an example of an emerging coast.

Significance of the Coastal Plains

- The fertile soils that cover a significant portion of India's coastal plains are used to grow a variety of crops. The primary crop in these regions is rice.
- Along the seaside, coconut trees are abundant.
- There are both large and small ports throughout the entire length of the coast, which facilitate trade.
- There are alleged to be significant amounts of mineral oil in the sedimentary strata of these plains (KG Basin).
- Large amounts of MONAZITE, which is utilised in nuclear power, are found in the sands along the Keralan coast.
- The majority of coastal residents make their living through fishing.
- Gujarat's low-lying regions are renowned for their salt production.
- The backwaters of Kerala are popular travel locations. Goa has excellent beaches.

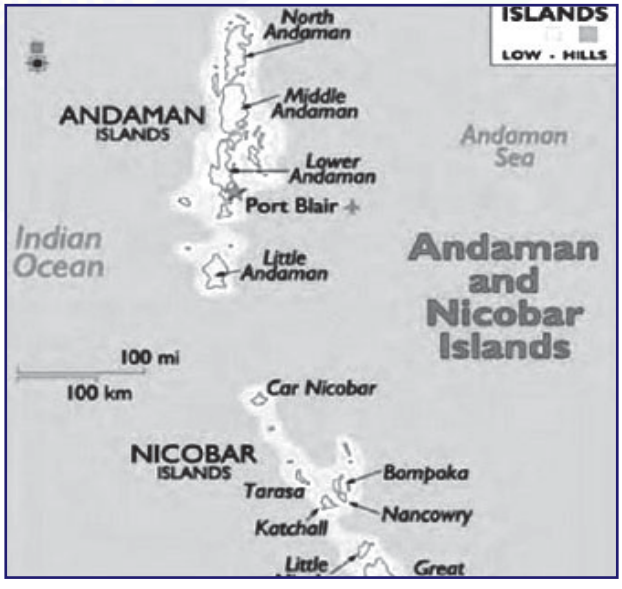
Indian Islands: Andaman & Nicobar Islands, Lakshadweep Islands & New Moore Island

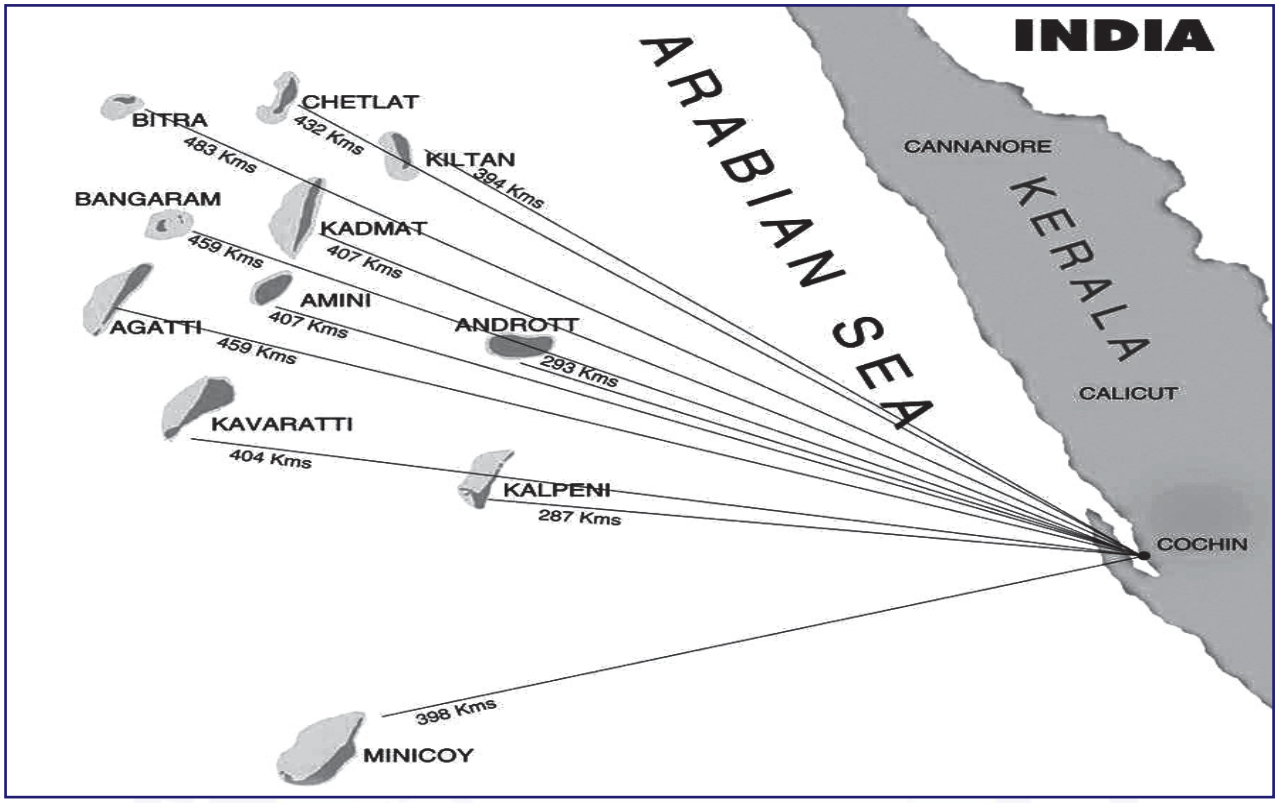
Indian Islands

- The Andaman and Nicobar Archipelago (A chain of islands with a shared origin) in the Bay of Bengal and the Lakshadweep islands in the Arabian Sea are India's two largest island groups.
- Similar to how the Himalayas were created, the Andaman and Nicobar Islands were created by the collision of the Indian Plate with the Burma Minor Plate, a piece of the Eurasian Plate.
- The Arakan Yoma range in Myanmar (also known as Andaman and Nicobar Islands) extends southerly from Purvanchal Hills.
- Coral islands make up the Lakshadweep Islands. They are a component of the Reunion Hotspot Volcanism.

Andaman and Nicobar Islands

- The Andaman and Nicobar islands have an area of around 590 km2, spanning latitudes of 6° 45′ to 13° 45′ N and 92° 10′ to 94° 15′ E.
- North, Middle and South are the three main islands that make up the Andaman Islands.
- Little Andaman and South Andaman are separated by the Duncan passage.
- Ten Degree Channel divides the Nicobar group in the south from the Great Andaman group of islands in the north [Prelims 2014].
- The Andaman Nicobar Islands' capital, Port Blair, is located in South Andaman.
- The Great Nicobar is the biggest of the Nicobar islands. It is Indonesia's southernmost island and is extremely near to Sumatra. The farthest north is the Car Nicobar.
- There are no active volcanoes in mainland India; instead, the volcanic islands of the Barren and Narcondam are located to the north of Port Blair.





- Coral reefs encircle a few of the islands. A large number of them are covered in dense forests. Mountains can be found on most islands.
- The highest peak is Saddle peak (737 m) in North Andaman.

Lakshadweep Islands

- Three different types of islands can be found in the Arabian Sea.
- Isles of Amindivi (consisting of six main islands of Amini, Keltan, Chetlat, Kadmat, Bitra and Perumul Par).
- Two of the Laccadive Islands are Minicoy Island and the five major islands of Androth, Kalpeni, Kavaratti, Pitti and Suheli Par.
- Currently, these islands are referred to as Lakshadweep as a whole.
- There are 25 little islands that make up the Lakshadweep group.
- About 200–500 kilometres south-west of the Kerala coast, they are dispersed extensively.
- The Amendivi Islands are the farthest north and Minicoy Island is the farthest south.
- All are tiny "Atoll" islands that were formed from coral and are encircled by surrounding reefs.
- The Lakshadweep Islands are the biggest and most developed.
- The 4.53 sq km-sized island of Minicoy.
- The majority of the islands are low-lying and climb no higher than five metres above sea level (Extremely Vulnerable to sea level change).
- Their geography is flat and there are no relief features like hills, streams, valleys, etc.

New Moore Island

A small, deserted offshore sandbar landform known as a "marine landform" is located in the Bay of Bengal, close to the Ganges-Brahmaputra Delta region's coast.

After the 1970 Bhola cyclone, it first appeared in the Bay of Bengal. It repeatedly appears and then vanishes.

Both India and Bangladesh asserted sovereignty over the island despite the fact that it was uninhabited and lacked any permanent settlements or installations due to the possibility that it contained oil and natural gas.

The bigger argument over the Radcliffe Award technique of determining the marital border between the two countries included the issue of sovereignty as well.

4 DRAINAGE SYSTEMS OF INDIA

Indian River System

The majority of rivers empty their water into the Bay of Bengal. Some rivers cross the western portion of the nation before joining the Arabian Sea. Inland drainage is present in the Thar Desert, the northern Aravalli range and some areas of Ladakh. One of the three primary basins serves as the source of all major rivers in India:

- The Himalaya and the Karakoram range.
- The Chota Nagpur plateau and Vindhya and Satpura range.
- The Western Ghats.

Classification of Drainage Systems of India

(a) Drainage Systems Based on the Size of the Catchment Area:

- ***Division:*** Size of catchment area in sq km.
- ***Major river:*** 20,000.
- ***Medium river:*** 20,000 – 2,000.
- ***Minor river:*** 2,000 and below.

(b) Drainage Systems Based on Origin:

- The Himalayan Rivers: ***Perennial rivers:*** Indus, the Ganga, the Brahmaputra and their tributaries.
- The Peninsular Rivers: ***Non-Perennial rivers:*** Mahanadi, the Godavari, the Krishna, the Cauvery, the Narmada and the Tapi and their tributaries.

(c) Drainage Systems Based on the Type of Drainage

- The river systems of India can be classified into four groups viz.
  - Himalayan rivers, Deccan rivers and Coastal rivers that drain into the sea.
  - Rivers of the inland drainage basin (endorheic basin). Streams like the Sambhar in western Rajasthan are mainly seasonal in character, draining into the inland basins and salt lakes. In the Rann of Kutch, the only river that flows through the salt desert is the Luni.

(d) Drainage Systems Based on Orientation to the sea

- The Bay of Bengal drainage (Rivers that drain into the Bay of Bengal)(East flowing rivers)
- Arabian sea drainage (Rivers that drain into the Arabian sea)(West flowing rivers).
- The rivers Narmada (India's holiest river) and Tapti flow almost parallel to each other but empty themselves in opposite directions (West flowing).

Drainage basin: The drainage basin acts as a funnel by collecting all the water within the area covered by the basin and channeling it to a single point.

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

Drainage patterns: based on the shape and formation of river patters, there are different drainage patterns.

Discordant drainage patterns: If a drainage pattern does not match the topology (surface relief features) and geology (geological features based on both endogenetic and exogenetic movements) of the region, it is referred to as discordant.

Simply put, the river follows its original course regardless of topographic changes in a discordant drainage pattern.

There are two basic categories of discordant drainage patterns: antecedent and superimposed.

Antecedent Drainage or Inconsequent Drainage: The term "antecedent drainage"

refers to a type of drainage when a river slope and its surroundings are uplifted in part and the river continues to follow its original slope, sawing through the uplifted land like a saw [vertical erosion or vertical down cutting] and creating deep gorges. Indus, Sutlej, Brahmaputra and other Himalayan rivers that are older than the Himalayas themselves.

Superimposed or Epigenetic or Superinduced Drainage: A river flowing over a softer rock stratum eventually encounters the harder basal rocks but keeps moving down the original slope, appearing to have no connection to the harder rock bed. The term "superimposed drainage" refers to this sort of drainage.

The degree of rock hardness and softness, as well as the distribution of faults and fractures, have a significant impact on the drainage patterns (dendritic, trellis, etc.).

Damodar, the Subarnarekha, the Chambal, the Banas and the rivers flowing at the Rewa Plateau, rivers of eastern USA and southern France.

Concordant Drainage Patterns: In a concordant drainage pattern, the path of the river is highly dependent on the slope of the river and topography.

Classified into many types:

- ***Consequent Rivers:*** The rivers which follow the general direction of slope are known as the consequent rivers. Most of the rivers of peninsular India are consequent rivers.
- For example, rivers like Godavari, Krishna and Cauvery.
- ***Subsequent Rivers:*** A tributary stream that is eroded along an underlying belt of non-resistant rock after the main drainage pattern (Consequent River) has been established is known as a subsequent river.

The Chambal, Sind, Ken, Betwa, Tons and Son meet the Yamuna and the Ganga at right angles. They are the subsequent drainage of the Ganga drainage system.

- ***Dendritic:*** This is an irregular tree branch shaped pattern. Drainage which is branching or ramifying (branch out or cause to branch out) thereby giving the appearance of a tree.

  Examples: Indus, Godavari, Mahanadi, Cauvery, Krishna.
- ***Trellis Drainage Pattern:*** In this type of pattern the short subsequent streams meet the main stream at right angles and differential erosion through soft rocks paves the way for tributaries.

  Examples: The old folded mountains of the ***Singhbhum (Chotanagpur Plateau)***
- ***Angular Drainage Pattern:*** The tributaries join the main stream at acute angles.

  This pattern is common in Himalayan foothill regions.
- ***Rectangular Drainage Pattern:*** The main stream bends at right angles and the tributaries join at right angles creating rectangular patterns.

  Example: Colorado river (USA), streams found is the Vindhyan Mountains of India.
- ***Radial Drainage Pattern:*** the tributaries from a summit follow the slope downwards and drain down in all directions.

  Examples: Streams of Saurashtra region, Central French Plateau, Mt. Kilimanjaro.
- ***Parallel Drainage Pattern:*** The tributaries seem to be running parallel to each other in a uniformly sloping region.

  Example: Rivers of lesser Himalayas and the small and swift rivers originating in the Western Ghats that flow into Arabian Sea.
- ***Centripetal Drainage Pattern:*** in a low-lying basin the streams converge from all sides.

  Examples: streams of Ladakh, Tibet and the Baghmati and its tributaries in Nepal.

Himalayan River Systems

The Himalayan River systems are made up of the Ganga, the Brahmaputra and the Indus.

The Himalayan Rivers existed before the Himalayas were formed, that is, before the Indian Plate and Eurasian Plate collided. They were draining into the Tethys Sea, or "Antecedent Drainage." These rivers originated in what is now Tibet.

The deep gorges of the Indus, Satluj, Brahmaputra and other rivers amply demonstrate that they predate the Himalayas.

Indus River

- It originates in Tibet near Lake Manasarovar in the Glaciers of Kailash Range and runs northwest till it reaches the Nanga Parbhat Range.
- It measures roughly 2,900 kilometres in length. Its drainage area is approximately 1,165,000 square kilometres, of which more over half are in Pakistan's semiarid plains. Near the border with China, the Dhar River connects to it.
- It flows between the Ladakh and Zaskar Ranges after entering J&K. It passes through the areas of Gilgit, Baltistan and Ladakh.
- At Leh, the Zaskar River connects to it. At an altitude of roughly 2,700 m, the Shyok joins it close to Skardu.
- Other Indus tributaries in the Himalaya include the Gilgit, Gartang, Dras, Shiger and Hunza.
- It begins its rugged adventure near Attock, which is located north of the Nanga Parbat and travels over the Himalayas through a gorge that is 5181 metres deep. Right here, it makes a quick turn to the south (syntaxial bend).
- The Indus River enters the Kabul River from Afghanistan close to Attock. The Salt Range is then traversed when it flows through the Potwar plateau (South Eastern edge of Potwar Plateau).

Major Tributaries of Indus River

Jhelum River: A spring near Verinag in the southernmost region of the Kashmir Valley serves as the Jhelum's source.

- Enters Wular Lake from the north (north-western part of Kashmir Valley). It shifts its direction southward from Wular Lake. In the hills above Baramulla, the river flows into a gorge.
- In the Pir Panjal Range below Baramula, the river carves a sharply sloped, tight valley.
- The river turns sharply in a southerly direction towards Muzaffarabad.
- Then, for 170 km, it forms the border between Pakistan and India before emerging at the Potwar Plateau in the vicinity of Mirpur.
- It debouches into the plains close to the city of Jhelum after running through the Salt Range's spurs (emerging from a small, enclosed area into a large, open one).

Chenab River: The Zaskar Range's Lahul-Spiti region is where the Chenab originates, close to the Bara Lacha Pass.

- At a height of 4,900 metres, Chandra and Bhaga, two little streams on opposing sides of the pass, serve as the headwaters.
- The Pangi valley is traversed by the confluence of the Chandrabhaga and Pir Panjal streams in a north-westerly direction.
- It shaves a deep gorge close to Kistwar.
- Near Akhnur in Jammu and Kashmir, it enters the plain.
- By way of the Punjabi plains in Pakistan, it travels from here to Panchnad, where it joins the Satluj after receiving water from the Jhelum and Ravi rivers.

Ravi River: The Kullu Hills near the Rohtang Pass in Himachal Pradesh are where the Ravi originates.

- Between the Pir Panjal and the Dhaola Dhar mountains, it drains.
- It turns south-west after crossing Chamba and carves a deep valley in the Dhaola Dhar mountain.
- Near Madhopur, it reaches the Punjab Plains before moving on to Pakistan below Amritsar.
- In Pakistani Punjab, it empties into the Chenab just above Rangpur.

Beas River: At a height of 4,062 m above sea level, on the southern extremity of the Pir Panjal Range, close to the source of the Ravi, the Beas has its beginnings near the Rohtang Pass.

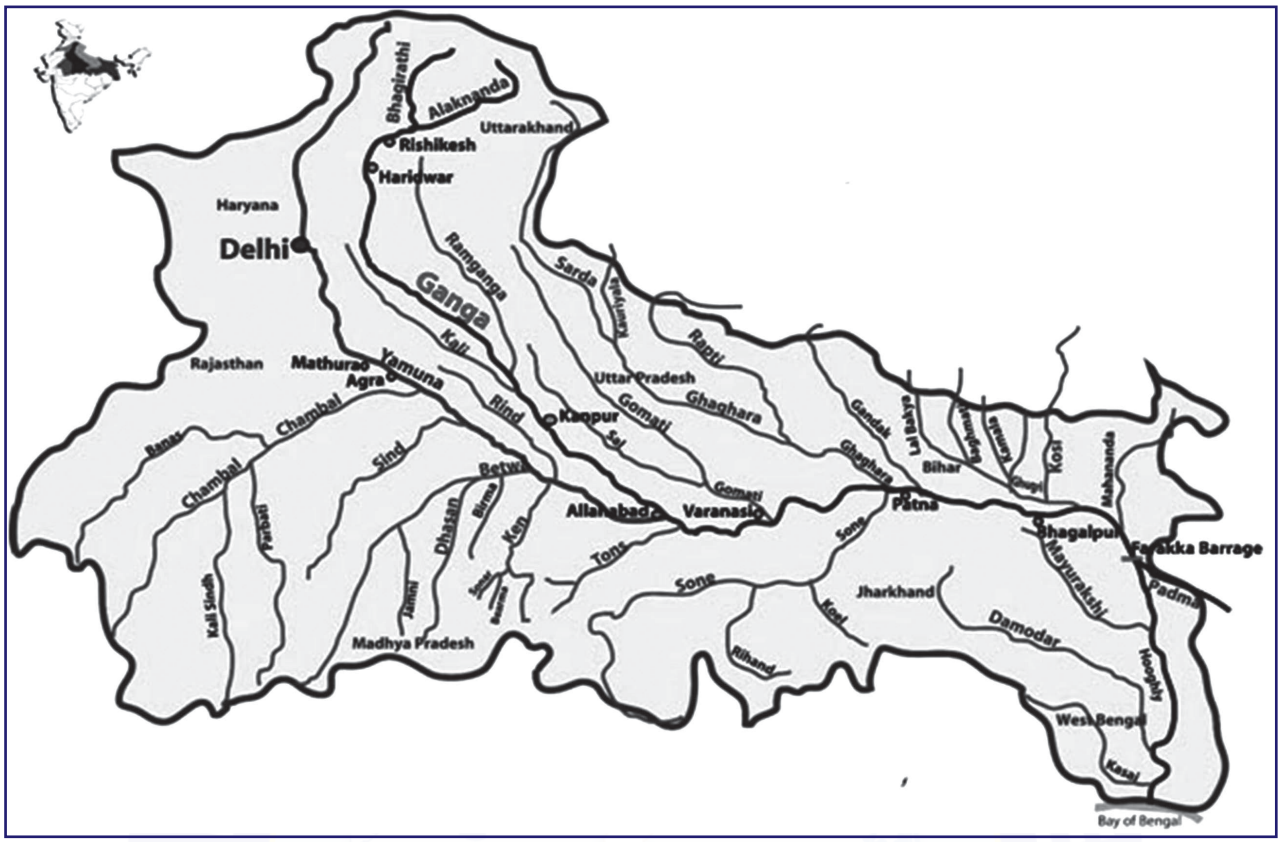
- It travels through the Dhaola Dhar mountain range before turning south-west and merging with the Satluj river in Harike in Punjab.
- It is a relatively short river, only 460 km long and entirely located within Indian territory.

Satluj River: Within 80 km of the Indus's source, the Satluj originates at a height of 4,570 m from the Manasarovar-Rakas Lakes in western Tibet.

- It follows the Indus' north-westerly course all the way to the Shipki La, which marks the border between Tibet and Himachal Pradesh.
- It cuts a gorge near Naina Devi Dhar, where the renowned Bhakra dam has been built, before crossing the Punjab plain.
- It bends west near Rupnagar (Ropar), enters the plain and meets the Beas at Harike.
- It constitutes the border between India and Pakistan for roughly 120 km, from close to Ferozepur to Fazilka.
- It gets the combined drainage of the Jhelum, Chenab and Ravi rivers as it continues on its trip. Just a few kilometres above Mithankot, it merges into the Indus.

Ganga River System

- In Uttar Kashi District of Uttarakhand, at a height of 7,010 metres, the Ganga originates as Bhagirathi from the Gangotri glacier.
- Bhagirathi and the Alaknanda River converge in Devaprayag.
- The river is known as Ganga from Devapryag.
- The Ganges was listed as the fifth-most polluted river in the world in 2007.
- Several fish and amphibian species, as well as the critically endangered Ganges river dolphin, are threatened by pollution (Blind Dolphin)



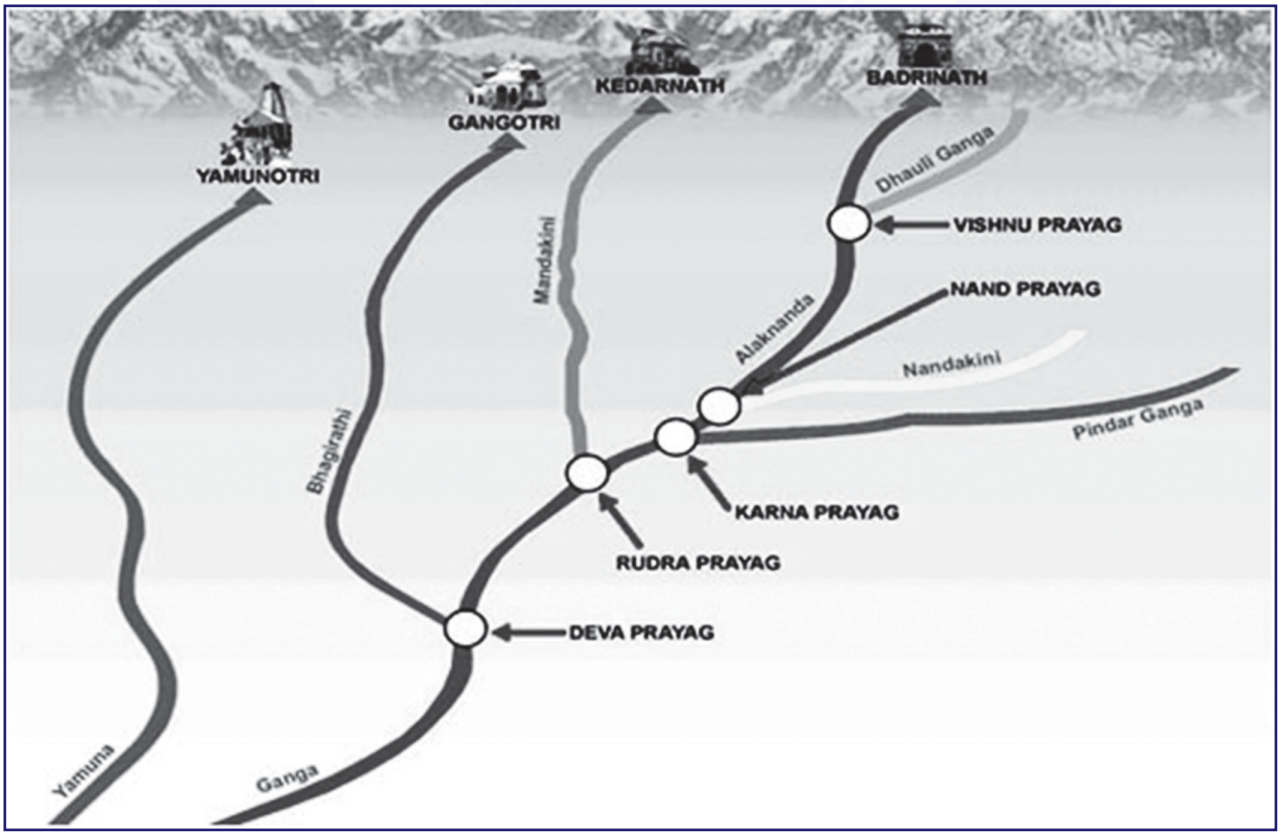
The Five Prayags

Devaprayag, the place of confluence ***of Bhagirathi river*** and Alaknanda river.

Rudraprayag, the place of confluence of ***Mandakini river*** and Alaknanda river.

Nandaprayag, the place of confluence of ***Nandakini rive***r and Alaknanda river.

Karnaprayag, the place of confluence of ***Pindar river and*** Alaknanda river.



Vishnuprayag, the place of confluence ***of Dhauliganga*** river and Alaknanda river.

Right Bank Tributaries of The Ganga

Most of them except Yamuna originate in the peninsular region.

Yamuna River :the biggest and most significant tributary.

- Its source is the Yamnotri Glacier, which is located on the Bandarpunch Peak in Uttarakhand's Garhwal area, at an elevation of roughly 6,000 metres.
- It crosses the Shiwalik, Mussoorie and Nag Tibba ranges.
- It leaves the steep region and enters plains close to.
- The Tons, which also originates from the Bandarpunch glacier, is its principal tributary in the higher reaches.
- It merges with the Ganga close to Allahabad's Triveni Sangam.
- It forms the extremely fertile Yamuna-Ganges Doab region in the Indo-Gangetic plain between itself and the Ganges.

Chambal River: The Chambal begins in the 700 m-high Janapao Hills of the Vindhyan Range.

- The Malwa Plateau is traversed by it.
- It merges into the Yamuna in Uttar Pradesh's Etawah district.
- A number of deep ravines have formed in the Chambal Valley, creating badland terrain and the river runs significantly below its banks as a result of severe erosion brought on by inadequate rainfall.
- ***Keoladeo National Park*** is supplied with water from ***Chambal river*** irrigation project.

Banas: A branch of the Chambal is the Banas.

- Its source is in the Aravali Range's southern region.
- Near Sawai Madhopur, on the border between Rajasthan and Madhya Pradesh, it joins the Chambal.

Sind River: The Sind originates in Vidisha Plateau of Madhya Pradesh.

- It flows for a distance of 415 km before it joins the Yamuna.

Betwa River: The Betwa rises in Bhopal district (Vindhyan Range) and joins the Yamuna near.

- It has a total length of 590 km.
- The Dhasan is its important tributary.

Ken River: The Ken river rising from the Barner Range of Madhya Pradesh joins the Yamuna near Chila.

Son River: The Son River rises in the Amarkantak Plateau.

- Its source is close to the origin of the Narmada.
- It passes along the Kaimur Range.
- It joins the Ganga near Danapur in Patna district of Bihar.

Left Bank Tributaries of The Ganga River

- These rivers originate in the Himalayas.
- The major tributaries apart from the Yamuna, are the Ramganga, the Gomati, the Ghaghra, the Gandak, the Burhi Gandak, the Bagmati and the Kosi.

Ramganga River: The Ramganga river rises in the Garhwal district of Uttarakhand.

It enters the Ganga Plain near Kalagarh.

Ghaghra River: South of Manasarovar in Tibet, it has its source close to Gurla Mandhata peak (river of the trans-Himalayan origin).

- In Western Nepal, it is known as the Karnaili.
- The Sarda, Sarju (Ayodhya is situated on its bank) and Rapti are some of its significant tributaries.
- Within a few kilometres of Chhapra in Bihar, the Ghaghara merges into the Ganga.

Kali River: Rises in the high glaciers of ***trans-Himalaya.***

- It forms the boundary between ***Nepal and Kumaon.***
- It is known as the ***Sarda*** after it reaches the plains near Tanakpur.

Gandak River: originates at a height of 7,620 m close to the Tibet-Nepal border.

- The Kali Gandak, the Mayangadi, the Bari and the Trishuli are some of its significant tributaries.

- As it descends towards the lowlands.
- At Hajipur in Bihar, it empties into the Ganga.

Burhi Gandak: Originates from the western slopes of ***Sumesar hills near the India-Nepal border***.

- It joins the Ganga near Monghyr town.

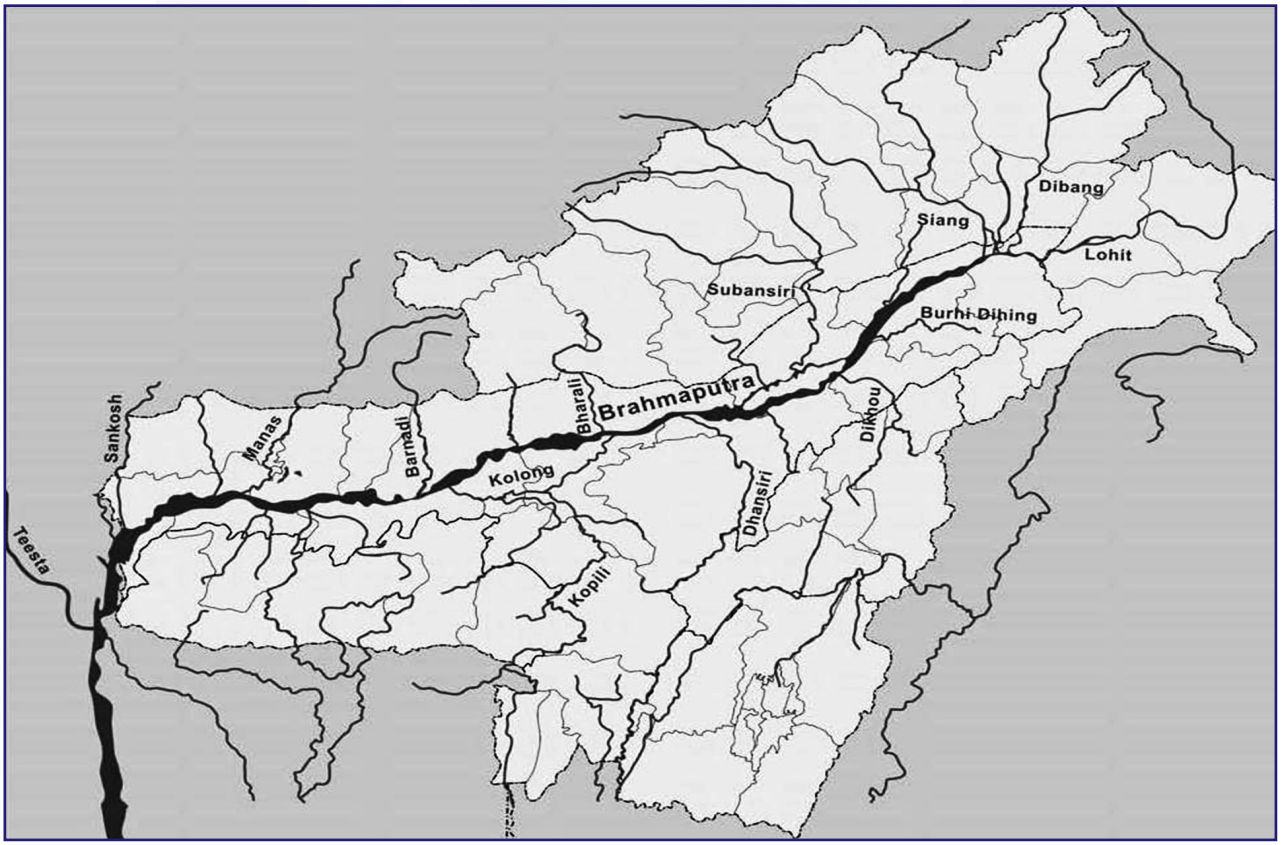
Kosi River: Sut Kosi, Tamba Kosi, Talkha, Doodh Kosi, Botia Kosi, Arun and Tamber are the seven streams that make up the Kosi river, which is also known as the Sapt Kaushik region of eastern Nepal.

- Three streams—the Tumar, Arun and Sun Kosi—are created when seven streams mix with one another.
- The Kosi is created in Triveni, which is located north of the Mahabharata Range.
- The river's channel is braided and constantly changes directions. In Bihar, this has caused numerous catastrophic floods and turned enormous expanses of arable land into waste land. As a result, the river is frequently referred to as "Bihar's Sorrow."

Brahmaputra River System

- A Brahmaputra (meaning the son of Brahma).
- Its length is 2,900 kilometres.
- Chemayungdung Glacier in the Kilas Range, located at a height of roughly 5,150 metres. Its source is extremely near the Indus and Satluj sources.
- The Manasarovar Lake and the Brahmaputra River's source are divided by Mariam La.
- In Southern Tibet, the Brahmaputra runs for around 1,800 kilometres eastward.
- Between the Great Himalayas in the south and the Kailas Range in the north, the Indus-Tsangpo Structure Zone forms a depression through which it travels through Tibet.
- The Tsangpo has a mild slope despite being extremely high in altitude. The river is slow moving and has a lengthy, 640 km wide navigable course.

Region	Name
Tibet	**Tsangpo** (meaning 'The Purifier').
China	**Yarlung Zangbo Jiangin.**
Assam Valley	**Dihang** or Siong, South of Sadiya: Brahmaputra.
Bangladesh	**Jamuna River.**
Bangladesh	**Padma River:** Combined Waters of Ganga and Brahmaputra.
Bangladesh	**Meghana:** From the confluence of Padma and Meghna.



Major Tributaries of the Brahmaputra River

Left bank – ***Dhansiri, Lohit, Dibang***

Right Bank – ***Subansiri, Kameng, Manas, Sankosh***

Subansiri River

- Subansiri River is also called as Gold River as it is famous for its gold dust.
- It flows through the Lower Subansiri District in Arunachal Pradesh.

Kameng River

- The Kameng River, which flows through West Kameng Area, Arunachal Pradesh and Sonitpur District of Assam, originates in the Tawang district of the eastern Himalayan ranges.
- East Kameng District and West Kameng District are separated by the Kameng.
- Near the Kameng River are the Pakhui Wildlife Sanctuary and Kaziranga National Park.

Manas River

- Between southern Bhutan and India, the Manas River flows across the Himalayan foothills.
- The river's overall length is 376 km, of which 272 kilometres are in Bhutan and 104 km are in Assam before it joins the massive Brahmaputra River at Jogighopa.
- The Royal Manas National Park in Bhutan and the adjacent Manas Wildlife Sanctuary are the two main reserve forest areas in the river valley.

Sankosh River

- It originates in northern Bhutan and flows across Assam before emptying into the Brahmaputra.
- The river's upper watershed is covered in glaciers. The middle and lower courses travel through valleys with a V-shape created out by flowing water.

Teesta River

- The river's source is the 5330-meter-high Tso Lhamo lake in North Sikkim, which is located in the Himalayas.
- The Teesta River's main tributary is the Rangeet River. The largest river in Sikkim is the Rangeet River. At Tribeni, the Rangeet River merges with the Teesta River.
- Up till Teesta Bazaar, the river flows past the town of Rangpo, which serves as the boundary between Sikkim and West Bengal.
- The river passes through Jalpaiguri before heading to Bangladesh's Rangpur District and finally joining the great Brahmaputra.

Dibang River

- One of the main tributaries of the Brahmaputra river is the river Dibang.
- Originating at an elevation of more than 5000 metres in the snow-covered southern Himalayas, near to the Tibetan border.
- In the Lower Dibang Valley district of Arunachal Pradesh, it emerges from the hills and moves into a plain area close to Nizamghat.
- Along the upper channel of the Dibang River are the Mishmi hills.

Lohit River

- Eastern Tibet is the source of the River Lohit.
- To reach the Siang at the apex of the Brahmaputra valley, the river travels through the Mishmi hills.
- The Lohit Valley is heavily forested, with alpine and subtropical species growing there.

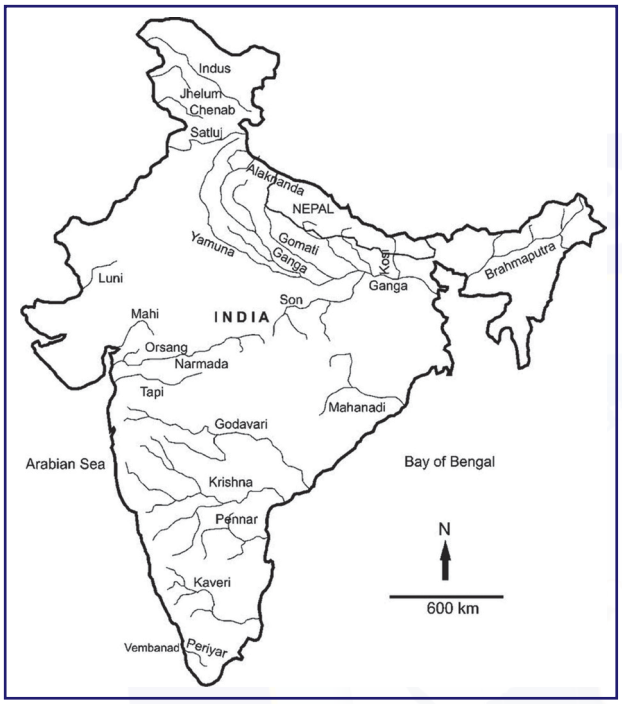
Dhansiri River

- It is the main river of Golaghat District of Assam and Dimapur District of Nagaland.
- It originates from Nagaland.

Peninsular River System

- ***Rivers that drain into Bay of Bengal: The Mahanadi, the Godavari, the Krishna, the Cauvery*** and several smaller rivers drains south-east into the Bay of Bengal.
- ***Rivers that drain into Arabian Sea: The Narmada, the Tapi, the Mahi*** flowing west as well as several small streams originating from the Western Ghats flow westwards into the Arabian Sea.

- ***Rivers that drain into the Ganges:*** Tributaries of the Ganga and the Yamuna such as the Chambal, the Betwa, the Ken, the Son and the Damodar flow in the north-easterly direction.



East Flowing Peninsular Rivers

Mahanadi River

- The Mahanadi basin drains an area of 1.4 lakh Sq.km. It includes the states of Chhattisgarh and Odisha as well as very tiny areas of Jharkhand, Maharashtra and Madhya Pradesh.
- It is bordered on the north by the Central India hills, on the south and east by the Eastern Ghats and on the west by the Maikala range.
- The Mahanadi ("Great River") travels 560 miles in total (900 km).
- Its source is located at an elevation of 442 metres in the northern foothills of Dandakaranya in the Chhattisgarh district of Raipur.
- After receiving the Seonath River, it turns east and enters Odisha state.
- At Sambalpur the Hirakud Dam (one of the largest dams in India) on the river has formed a man-made lake 35 miles (55 km) long.
- Puri, at one of its mouths, is a famous pilgrimage site.

Tributaries of Mahanadi River

- ***Left bank Tributaries***: The Seonath, the Hasdeo, the Mand and the Ib.
- ***Right bank Tributaries***: The Ong, the Tel and the Jonk.

Godavari River

- The Godavari, also known as Dakshina Ganga, is the largest river system in peninsular India.
- The Godavari basin covers around 3 lakh square kilometres across the states of Maharashtra, Andhra Pradesh, Chhattisgarh and Odisha, as well as lesser portions in Madhya Pradesh, Karnataka and the Union territory of Puducherry (Yanam).
- The basin is bordered on the north by the Satmala hills, the Ajanta range and the Mahadeo hills, on the south and east by the Eastern Ghats and on the west by the Western Ghats.
- About 80 kilometres from the Arabian Sea and at an elevation of 1,067 metres, the Godavari River originates near Trimbakeshwar in the Maharashtra district of Nashik.

Tributaries of Godavari River

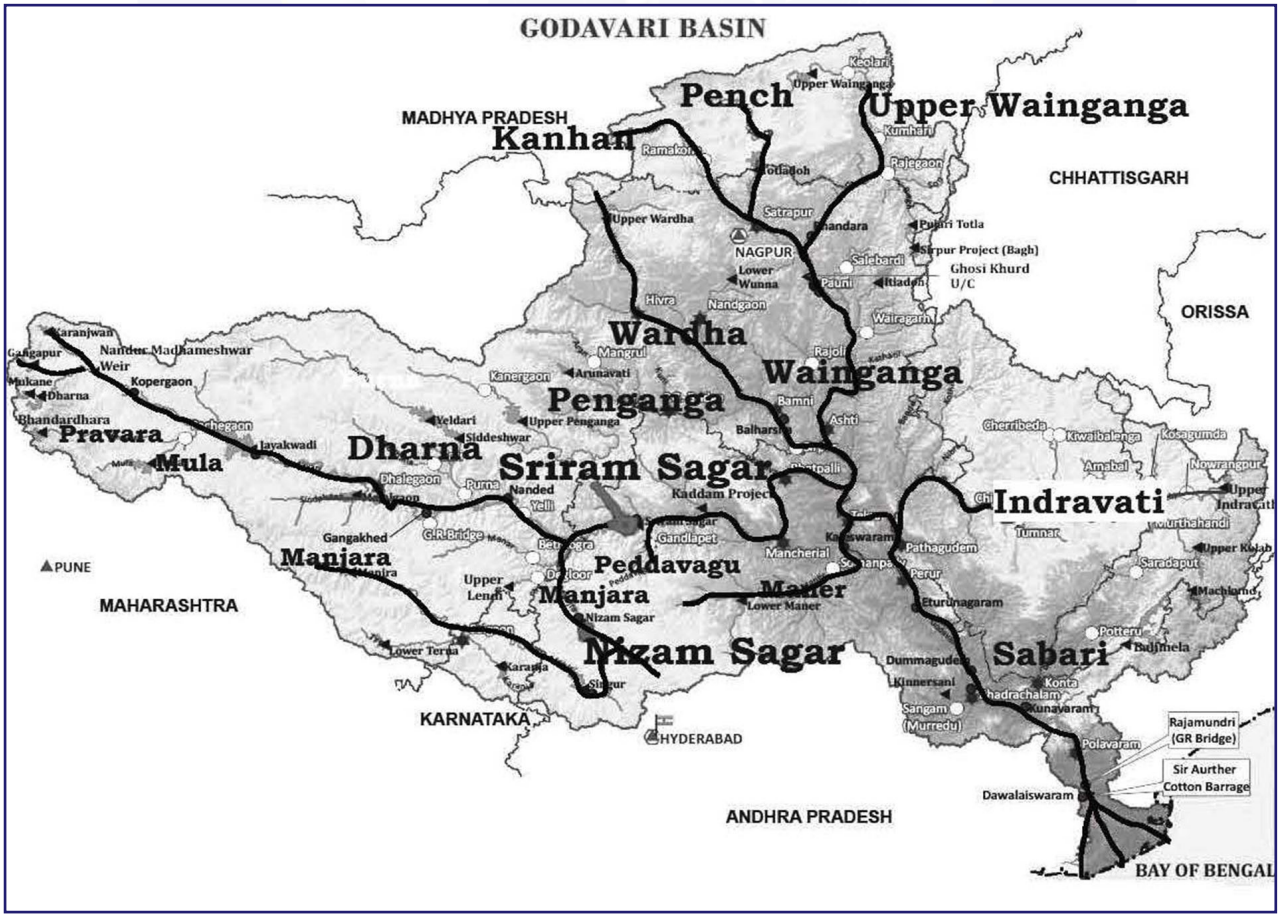
- Left Bank Tributaries: ***Dharna, Penganga, Wainganga, Wardha, Pranahita*** [conveying the combined waters of ***Penganga, the Wardha and Wainganga], Pench, Kanhan, Sabari, Indravati etc.***
- Right Bank Tributaries: ***Pravara, Mula, Manjra, Peddavagu, Maner*** etc.

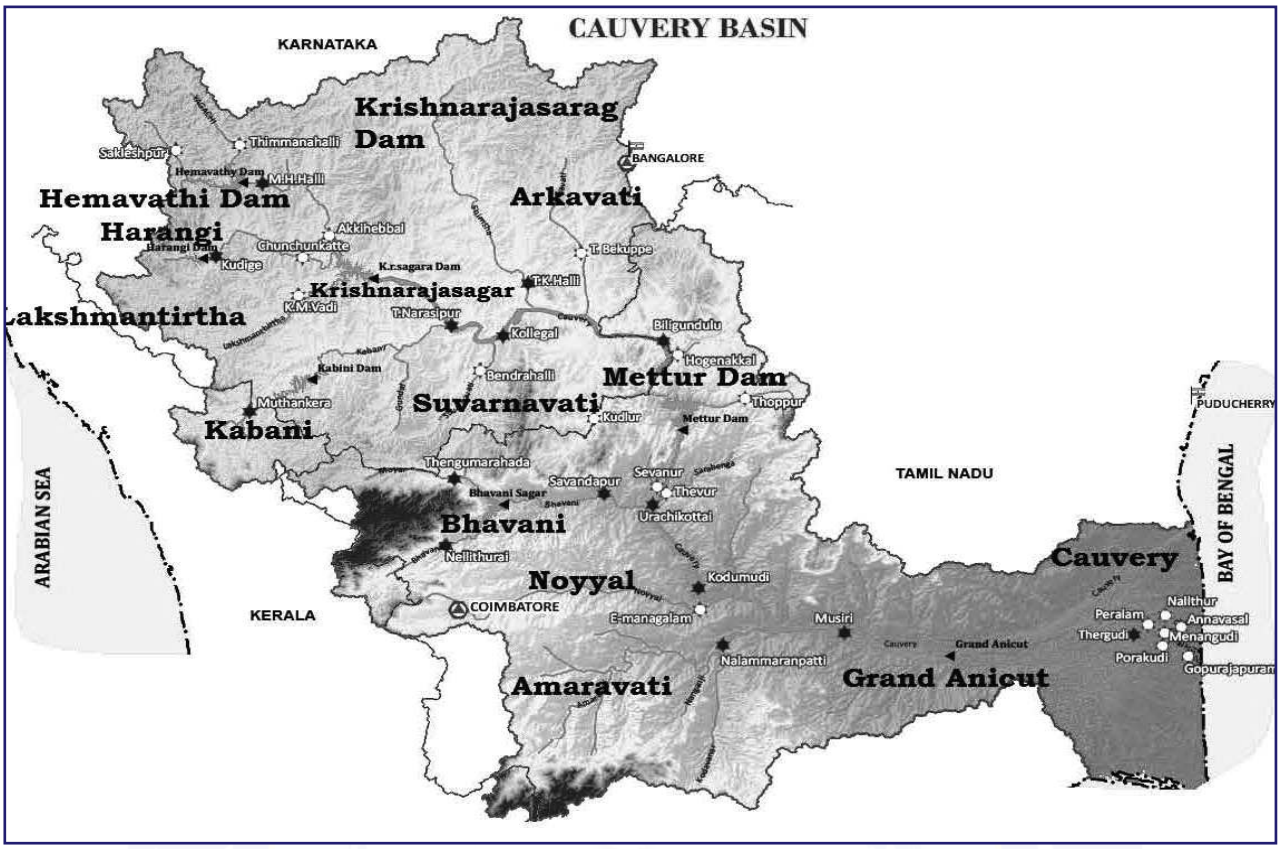
Krishna River

- The Krishna is the Peninsula's second-largest river that flows east.
- With a total area of 2.6 lakh sq. km, the Krishna Basin spans Andhra Pradesh, Maharashtra and Karnataka.
- It is bordered on the north by the Balaghat Range, on the south and east by the Eastern Ghats and on the west by the Western Ghats.
- At an elevation of 1,337 m, just north of Mahabaleshwar, the Krishna River emerges from the Western Ghats close to Jor village in the Satara district of Maharashtra.

Tributaries of Krishna River

- Right bank: ***the Ghatprabha, the Malprabha and the Tungabhadra.***
- Left Bank: ***the Bhima, the Musi and the Munneru.***
- The ***Koyna*** is a small tributary but is known for ***Koyna Dam***.





Cauvery River

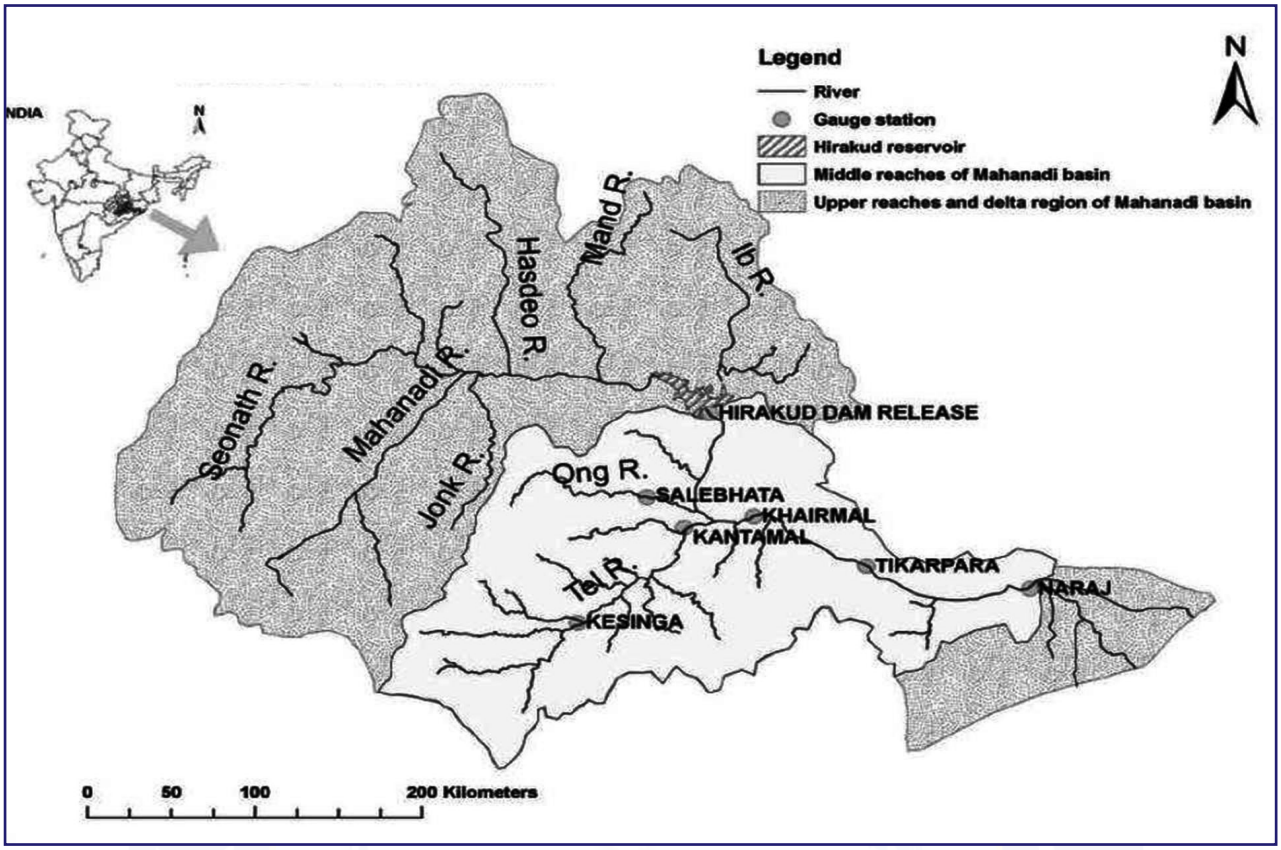
- The Kaveri (Cauvery) is referred to as "the Ganga of the South" or "the Dakshina Ganga."
- In the Kodagu (Coorg) region of Karnataka, the Cauvery River springs at a height of 1,341m at Talakaveri on the Brahmagiri mountain close to Cherangala village.
- It is bordered on the west by the Western Ghats, on the east and south by the Eastern Ghats and on the north by the hills dividing it from the Krishna basin and the Pennar basin.
- The Karnataka plateau is located in the north and the Tamil Nadu plateau is located in the south. The Nilgiris, an offshore range of the Western Ghats, extend eastward to the Eastern Ghats.
- The delta area is the most fertile tract in the basin. The principal soil types found in the basin are black soils, red soils, laterites, alluvial soils, forest soils and mixed soils. Red soils occupy large areas in the basin. Alluvial soils are found in the delta areas.
- The basin in Karnataka receives rainfall mainly from the S-W Monsoon and partially from N-E Monsoon. The basin in Tamil Nadu receives good flows from the North-East Monsoon.

Tributaries of the Cauvery River

- Left Bank: the Harangi, the Hemavati, the Shimsha and the Arkavati.
- Right Bank: Lakshmantirtha, the Kabbani, the Suvarnavati, the Bhavani, the Noyil and the Amaravati joins from right.
- The river descends from the South Karnataka Plateau to the Tamil Nadu Plains through the Sivasamudram waterfalls (101 m high).

Pennar River

- One of the main rivers in the peninsula is the Pennar, also known as Uttara Pinakini.
- In the Chikkaballapura district of Karnataka, the Pennar originates in the Chenna Kasava hill of the Nandidurg range and flows east before emptying into the Bay of Bengal.
- The river's whole length, from its source to where it empties into the Bay of Bengal, is 597 km.
- The Erramala range on the north, the Nallamala and Velikonda ranges of the Eastern Ghats on the east, the Nandidurg hills



on the south and the short ridge dividing it from the Vedavati valley of the Krishna Basin on the west, all encircle the fan-shaped basin.

- The other hill ranges in the basin to the south of the river are the Seshachalam [famous for Red Sanders] and Paliconda ranges.

Tributaries of Pennar River

- ***Left Bank:*** the Jayamangali, the Kunderu and the.
- ***Right bank:*** the Chiravati, the Papagni etc.

Subarnarekha

- The Subarnarekha originates in Jharkhand's Ranchi Plateau and, in its lower course, divides West Bengal from Odisha.
- Between the Ganga and Mahanadi deltas, it joins the Bay of Bengal to create an estuary. It is 395 kilometres long in total.

Brahamani River

- The Koel and Sankh rivers meet close to Rourkela, where they form the Brahmani river. It measures 800 kilometres in total.
- The Chhotanagpur plateau forms the basin's northern boundary. The Mahanadi basin forms its western and southern boundaries.
- Through the states of Jharkhand, Chhattisgarh and Orissa, the basin empties into the Bay of Bengal.

Ponnaiyar River

- In the states of Tamil Nadu, Karnataka and Andhra Pradesh, it only occupies a tiny region.
- The Eastern Ghats, including the Velikonda Range, the Nagari Hills, the Javadu Hills, the Shevaroy Hills, the Chitteri Hills and the Kalrayan Hills, encircle the Basin to the north, south and east. To the east is the Bay of Bengal.

Vaigai River

- There are various streams south of the Cauvery delta, with the Vaigai being the longest.
- Of the 12 basins between the Cauvery and Kanyakumari, the Vaigai basin is one of the more significant ones.
- The Palk Strait and Palk Bay border this basin on the east and the Varushanadu Hills, Andipatti Hills, Cardaman Hills and Palani Hills on the west.
- The Vaigai drains 7,741 square kilometres, all of which is located in Tamil Nadu.

West Flowing Rivers of The Peninsular India

- In Peninsular India, there are fewer and smaller west-flowing rivers than east-flowing rivers.
- The Narmada and the Tapi are the two main rivers that run west.
- This unusual behaviour is a result of the rivers' passage through faults (such as the linear rift, rift valley and trough) formed when the northern peninsula bent during the development of the Himalayas.
- The Vindhyas and Satpuras are paralleled by these flaws.
- There are several more rivers in Peninsular India that flow westward, including the Sabarmati, Mahi and Luni.
- It is noteworthy that the Peninsular rivers that empty into the Arabian Sea only create estuaries rather than deltas.
- This is due to the fact that the west flowing rivers, especially the Narmada and the Tapi flow through hard rocks and hence do not carry any good amount of silt.

Estuary

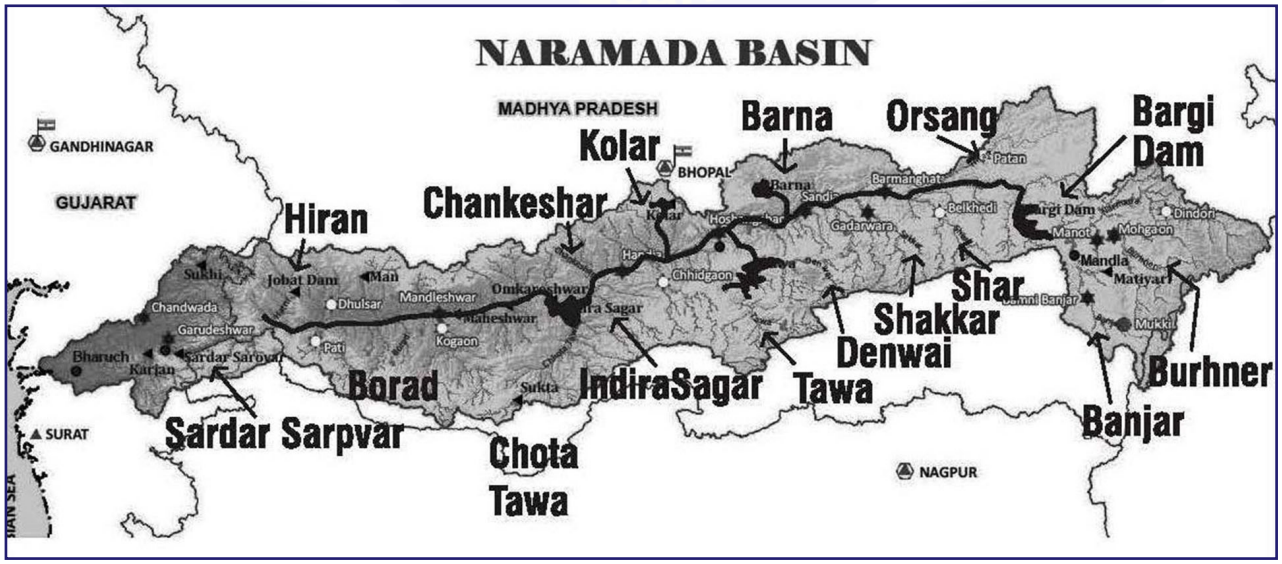
- An estuary is a coastal body of water that is partially contained where freshwater from rivers and streams combines with salt water from the ocean.
- Estuaries and the land that surrounds them are areas where freshwater and saltwater transfer from the land to the sea.

Narmada River

- The Narmada River is the largest west-flowing river in peninsular India.
- Between the Vindhyan Range in the north and the Satpura Range in the south, the Narmada River runs westward through a rift valley.
- At an elevation of roughly 1057 m, it rises from the Maikala range close to Amarkantak in Madhya Pradesh.
- With a total area of almost one million square kilometres, the Narmada basin spans the states of Madhya Pradesh, Gujarat, Maharashtra and Chhattisgarh.
- The Vindhya Mountains on the north, the Maikala Range on the east, the Satpura Mountains on the south and the Arabian Sea on the west define its borders.
- Its entire length, from its source in Amarkantak to its estuary in the Gulf of Khambhat, is 1,310 km.
- The river slopes down near Jabalpur where it cascades (a small waterfall, especially one in a series) 15 m into a gorge to form the Dhuan Dhar (Cloud of Mist) Falls.

Tributaries of Narmada River

- Right bank tributaries are the ***Orsang, the Barna and the Kolar***.
- A few left bank tributaries drain the northern slopes of the Satpura Range and join the Narmada at different places.



Tapti River

- The Tapti, also spelled Tapi, is Peninsular India's second-largest west-flowing river and is referred to as "the handmaid" or "the twin" of the Narmada.
- Originates at an altitude of 752 metres close to the Multai Reserve Forest in Madhya Pradesh.
- Flows through the Gulf of Cambay (also known as the Gulf of Khambhat) for roughly 724 km before emptying into the Arabian Sea.
- The Tapti River and its tributaries cross vast portions of Maharashtra, a minor portion of Madhya Pradesh and the states of Gujarat, Khandesh and Vidharbha.
- The basin, which is located in the Deccan plateau, is bordered to the north by the Satpura range, to the east by the Mahadev hills, to the south by the Ajanta Range and to the west by the Satmala hills.

Tributaries of Tapti River

- Right Bank: the ***Suki***, the ***Gomai***, the ***Arunavati*** and the ***Aner***.
- Left Bank: the ***Vaghur***, the ***Amravati***, the ***Buray***, the ***Panjhra***, the ***Bori***, the ***Girna***, the ***Purna***, the ***Mona*** and the ***Sipna***.

Sabarmati River

- With a total area of 21,674 sq km, the Sabarmati basin spans the states of Gujarat and Rajasthan.
- The Gulf of Khambhat, the Rann of Kutch and the Aravalli Hills form the southern, northern and northeastern borders of the basin, respectively.
- Sabarmati is a river that rises from the Aravalli hills in Rajasthan's Udaipur district, near the village of Tepur, at an elevation of 762 metres.
- Wakal, Hathmati and Vatrak are tributaries on the left bank.
- Branches off the right bank: the Sei.
- Projects: Major projects for the Sabarmati reservoir (Dharoi), Hathmati reservoir and Meshwo reservoir were finished during the plan period.

Mahi River

- With a total area of 34,842 sq km, the Mahi basin spans the states of Madhya Pradesh, Rajasthan and Gujarat.
- The Vindhya Mountains in the south, the Aravalli Hills in the north and north-west, the Malwa Plateau in the east and the Gulf of Khambhat on the west are its borders.
- Mahi is one of India's main interstate rivers that flows west.
- It is 500 metres above sea level and comes from the northern Vindhyas in Madhya Pradesh's Dhar district.

Luni River

- Due to the brackish nature of its water below Balotra, the Luni or the Salt River (Lonari or Lavanavari in Sanskrit) has earned its name.
- Western Rajasthan, which comprises the majority of a dry region, has just one significant river basin: Luni.
- The Luni river rises in the western Aravalli ranges at an elevation of 772 metres near Ajmer. It flows in a south-westerly direction for 511 kilometres across Rajasthan until emptying into the Rann of Kachchh (it gets lost in the marsh).

Ghaggar River – Inland Drainage

- The Ghaggar River is the most significant inland drainage river. It is a seasonal stream that originates on the lower Himalayan peaks and defines the border between Punjab and Haryana.
- After travelling 465 miles, it becomes lost in the desert dunes of Rajasthan close to Hanumangarh.
- This river was once an affluent of the Indus; the original channel's dry bed can still be found.
- The Tangri, Markanda, Saraswati and Chaitanya are its principal tributaries

5 CLIMATE

- India's northern region (north of the tropic of cancer) is located in the temperate area, yet its climate closely mimics that of a tropical country.
- The tall Himalayan mountain ranges divide the Indian subcontinent from the rest of Asia and prevent cold air masses from Central Asia from migrating southward.
- Because of this, the northern half of India has milder winters by 3 to 8 degrees Celsius than other regions at similar latitudes.
- Due to the sun's over-the-head position in the summer, the southern regions' climate resembles an equatorial region with a dry environment.
- The Thar, Baloch and Iranian Deserts produce a hot, dry wind known as "loo" that affects the north Indian plains, raising temperatures to a level comparable to that of the southern regions of the nation.
- As a result, India as a whole can be considered to have a tropical climate south of the Himalayas.
- The Arabian Sea and Bay of Bengal's seasonal wind reversals give India a typical tropical monsoon climate.
- Therefore, rather than just being tropical or half-temperate, the climate in India is, to be precise, tropical monsoon type (a separate wet and dry climate).

Features of Indian Climate

Rainfall

- The majority of the locations have distinct rainy and dry seasons, which define their climate. Some areas, like the Thar Desert and Ladakh, never experience rain.
- Region to region varies greatly in mean annual rainfall. In Meghalaya, Mawsynram and Cherrapunji receive about 1,000 cm of yearly precipitation, whereas in Jaisalmer, the annual precipitation rarely rises above 12 cm.
- Intense rainfall occurs in the Ganga delta and the coastal plains of Odisha in July and August, however the Coromandel Coast is dry during these times.

Temperature

- The variations in daily and annual temperatures are significant.
- The Thar desert has the widest diurnal temperature variations, whereas the Himalayan regions have the widest annual temperature variations.
- Coastal regions have the narrowest temperature variations, both daily and annually.
- In some areas of J&K, the temperature in December can drop as low as - 40°C, while the average temperature in many coastal locations is 20–25°C.
- Most regions get relatively chilly winters and severely hot summers.
- The winters are harsh in the Himalayan areas, whereas the summers are mild.

Factors Influencing Indian Climate

Latitudinal location

- India's weather is similar to that of a tropical nation.
- From 8°N to 37°N, the Indian subcontinent is covered.
- Tropical regions receive a lot of solar insolation because they are south of the Tropic of Cancer. In most places, winter temperatures are mild and summer temperatures are extremely high.
- However, the northern regions are located in a warm temperate region. They get considerably less sun insolation. However, the hot local wind known as "loo" causes summers to be just as hot in north India. Because of the cold waves that the western disturbances bring, winters are quite frigid.

- The Himalayas contain certain locations with exceptionally low wintertime temperatures.
- Coastal regions experience a moderate climate regardless of latitudinal position.

Distance from the Sea

- Coastal areas have an equable or mild climate, but interior areas lack the calming effect of the sea and have an extreme or continental climate.
- Rainfall is brought on by the monsoon winds, which first arrive in coastal areas.

Himalayas and Indian Climate

- This is the primary element that affects Indian climate.
- India and Central Asia are separated climatically by the Himalayas.
- India is shielded from the cold, dry air masses of Central Asia during the winter by the Himalayas.
- These mountain ranges serve as an efficient natural barrier for rain-bearing south-west monsoon winds during monsoon season.
- The Himalayas separate the Bay of Bengal branch of the monsoon winds into two branches, one flowing along the plains towards north-west India and the other towards South-East Asia.
- The monsoon winds would simply move into China without the Himalayas and the majority of north India would have been arid.

Monsoon Winds and Indian Climate

Important features of Indian Monsoons are:

1. Sudden onset (sudden burst).
2. Gradual progress.
3. Gradual retreat.
4. Seasonal reversal of winds.

A abrupt change in the seasons results from the monsoon winds turning completely around.

Abrupt transition from the sweltering summer to the monsoon or rainy season.

The entire nation receives rain thanks to the south-west monsoons that originate in the Arabian Sea and the Bay of Bengal.

Only along the Caromandel coast (TN coast) does the northeastern winter monsoon produce significant amounts of rainfall after absorbing moisture from the Bay of Bengal.

Indian Climate – Seasons

- The cold weather season or winter season.
- The hot weather season or summer season.
- The south-west monsoon season or Rainy season.
- The season of the retreating monsoon or cool season.

Winter Season in India

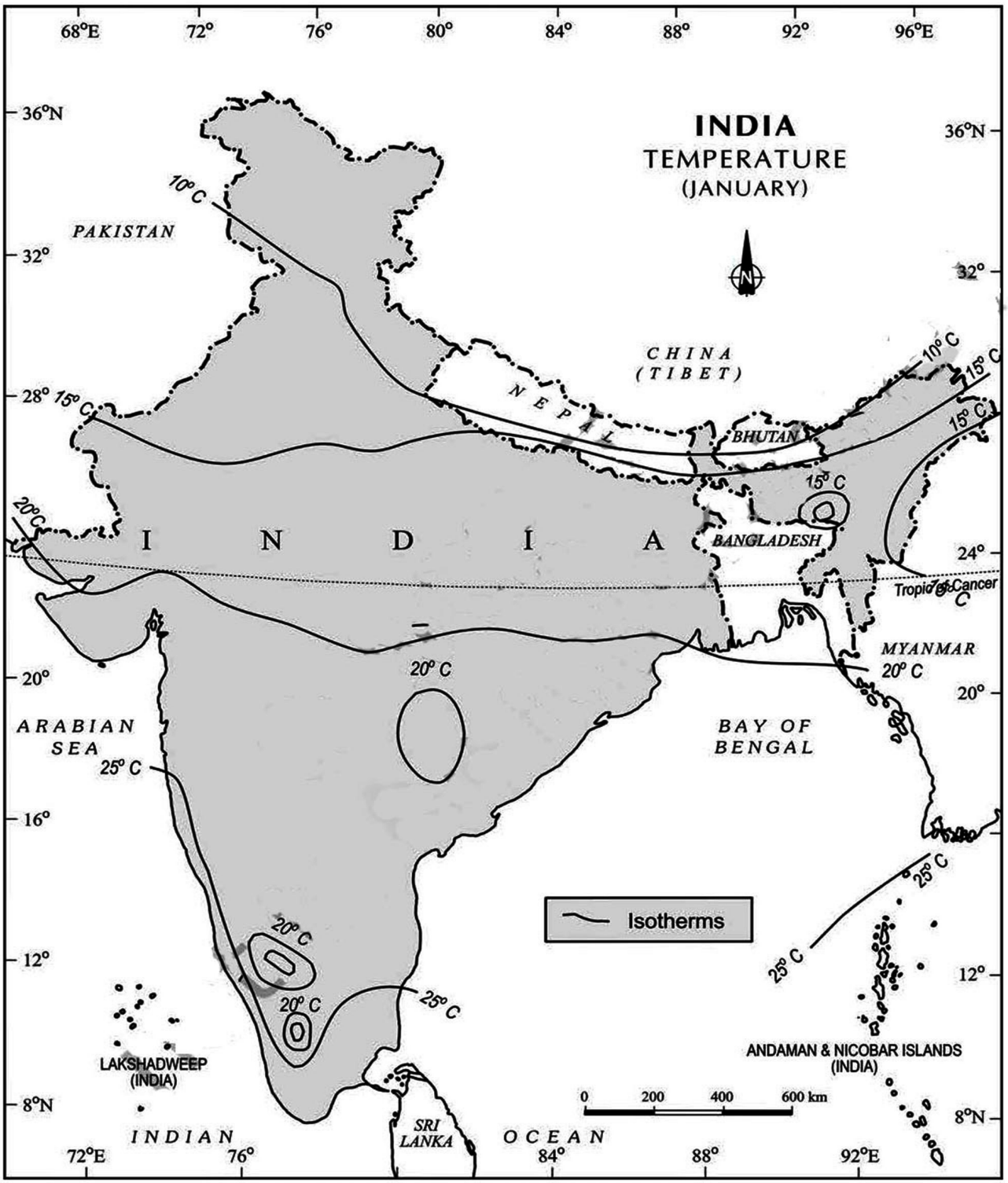
- The apparent path of the sun is south of the equator.
- Clear skies, nice weather, a wide range of temperatures, low humidity and cool, leisurely north-east trade winds.
- The country's interior, in particular, has a fairly wide diurnal temperature fluctuation.

Temperature in Winter Season

- The Tropic of Cancer and the isotherm of 20°C are nearly parallel.
- Temperatures south of this isotherm are above 20 °C. There is no clearly defined winter weather here. Temperatures in the 30°C range are usual in some areas of Tamil Nadu and Kerala.
- The winter weather is different to the north, where the average temperature is below 21°C.
- The Gangetic plains get a mean minimum temperature of 10°C, compared to 5°C over north-western India.

Pressure in Winter Season

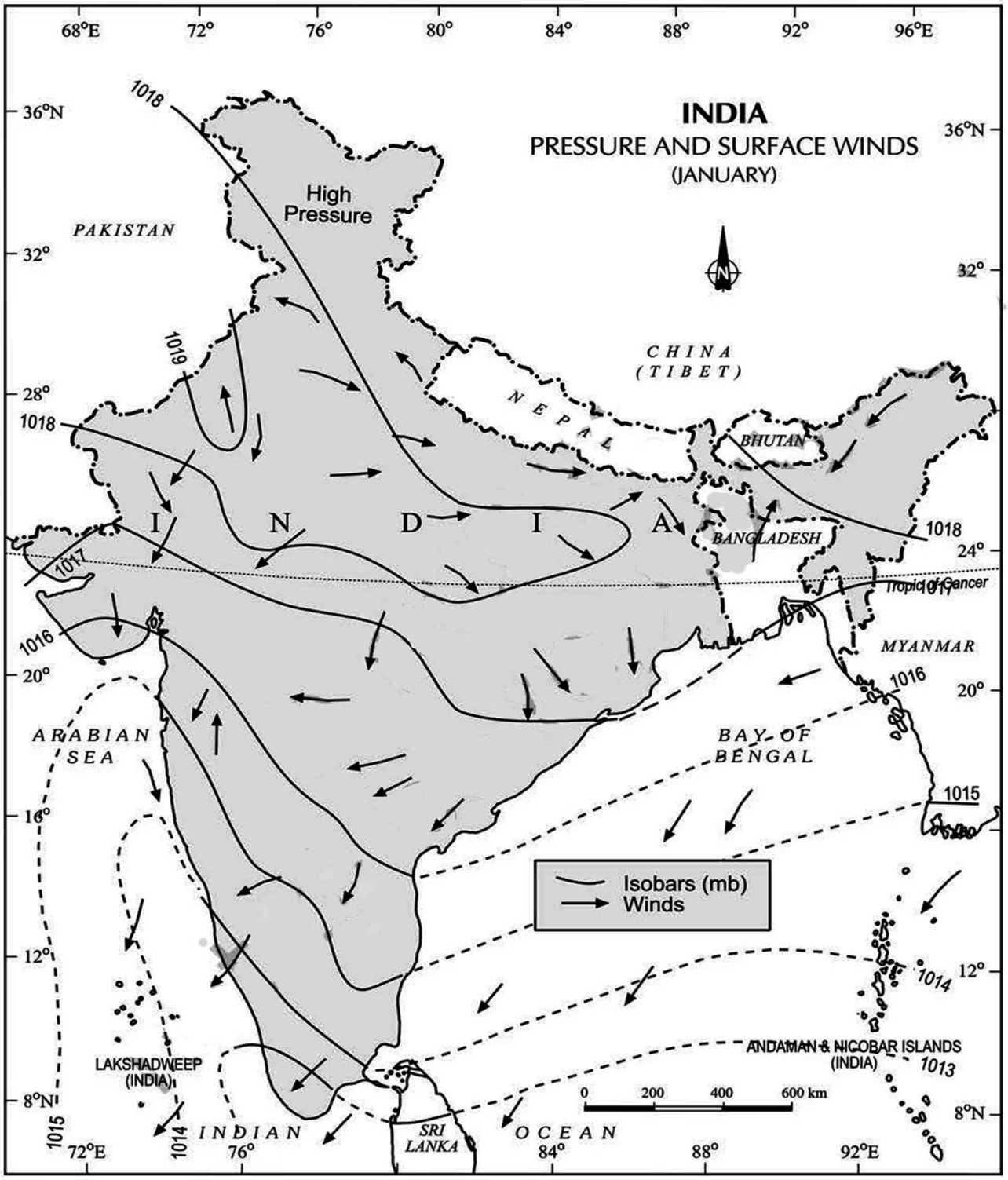
- Due to low temperatures and divergence brought on by the STJ ridge, high air pressure is present over much of north-western India.
- South India experiences lower pressure in comparison.
- The winds begin to blow from the south-east low pressure area to the north-west high pressure area. The low pressure gradient is the cause of the low wind velocity.
- Pressure gradient and physiography affect the wind's course.



India : Mean Monthly Temperatures of the Day in January

Western Disturbances in Winter Season

- The arrival of western disturbances frequently breaks the period of good weather in north-western and northern India.
- In Rajasthan, Punjab and Haryana, they get worse.
- They go eastward across the sub-Himalayan region, arriving at Arunachal Pradesh.
- In the Indus-Ganga plains, they bring light rain and in the Himalayan region, they bring snowfall.
- Widespread fog and cold waves that cause the minimum temperature to drop by 5° to 10°C below average are experienced after the disturbance has passed.
- Fog reduces visibility and makes travelling very difficult.



India : Pressure and Surface Winds (January)

Tropical Cyclones in Winter Season

- This is the time of year with the least tropical cyclones.
- With the progress of the season, tropical cyclones become less frequent.
- This is brought on by the low sea surface temperature and southward-most ITCZ exit.
- Tamil Nadu experiences severe rainstorms that originate in the Bay of Bengal.
- To get to the Arabian Sea, several of them cross the southern peninsula.
- Some storms that develop in the Arabian Sea travel north or west.

Precipitation in Winter Season

- In Tamil Nadu, south Andhra Pradesh, south-east Karnataka and south-east Kerala, the receding winter monsoons pick up some

moisture when crossing the Bay of Bengal (Usually in the first weeks of November).

- Between October and December, there is a 75 cm seasonal high in rainfall.
- The majority of it occurs in areas of Andhra Pradesh that are adjacent to Tamil Nadu's south-eastern coast. After that, it steadily drops.
- In north-west India, the western disturbances also bring a little rain.
- From the north and north-west to the east, the amount of rainfall gradually decreases (it is opposite in rainy season).
- Wintertime precipitation falls on India's northeastern region as well.

Summer Season in India

- March to June.
- High temperature and low humidity are the chief characteristics.
- Sometimes referred to as pre-monsoon period.

Temperature in Summer Season

- Due to the sun appearing to move between the equator and the Tropic of Cancer, there is a high amount of solar insolation.
- In March and April, the southern regions of the nation are noticeably warmer, whereas north India has greater temperatures in June.
- The southern regions see the warmest temperatures in March (40–45°C).
- In the northern areas of Madhya Pradesh, April had the maximum recorded temperature of nearly 45°C.
- Rajasthan experiences the greatest temperature in May, with records of up to 48°C being set there.
- Punjab and Haryana get the highest temperatures in June.
- The two highest recorded temperatures are 50.6°C on June 14, 1935, in Ganganagar and 50.5°C on May 10, 1956, at Alwar.
- High temperature and low humidity are the chief characteristics.
- Sometimes referred to as pre-monsoon period.
- The majority of heat waves originate in Rajasthan, Punjab and Haryana (location far away from the sea). They migrated from here to Bihar and Uttar Pradesh.
- Significant north westerly winds, which are brought on by a strong divergence in north-west India, stop the sea breeze from moving farther down the eastern coastal belt and induce heat waves across Odisha and Andhra Pradesh due to their lengthy voyage over hot terrain.
- By the end of April, heat waves start to occur and May is when they happen most frequently. They continue until the southwest monsoon arrives.
- Heat waves often last four to five days. However, because of the maritime conditions present there, heat waves are uncommon over the peninsula south of 13°N latitude.

Pressure in Summer Season

- The atmospheric pressure is low all over the country due to high temperature.
- But strong dynamically induced divergence over north-west India prevents the onset of south-west monsoons.

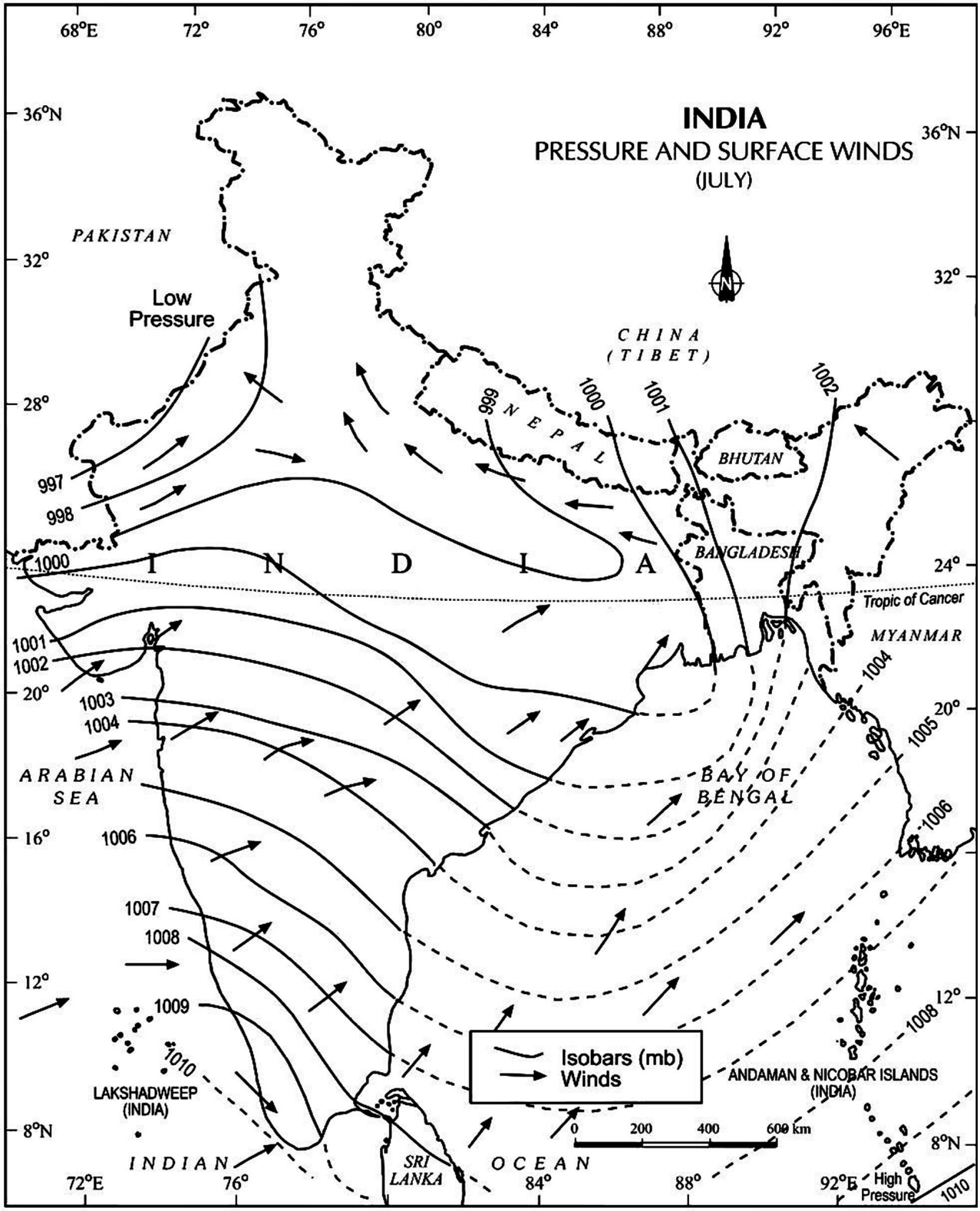
Winds in Summer Season

Loo: Iranian, Baloch and Thar deserts are where loo winds originate.

- High temperatures in northwest India during May and June create a sharp pressure gradient.
- The loo blows, also known as hot, dusty winds.
- The loo typically starts blowing at 9.00 AM, builds steadily and peaks in the late afternoon.
- It blows for days and moves at a speed of 30 to 40 km/h on average.

Andhis: Locally, andhis refers to the powerful dust storms that follow from the convective phenomenon (blinding storms). They move as though they were a solid wall of sand and dust.

- The wind often blows at 50 to 60 kmph and visibility is only a few metres.
- In Rajasthan, Haryana, Punjab, the Jammu area, Delhi, Uttar Pradesh, Bihar and Madhya Pradesh, these dust storms are frequent.



India : Pressure and Surface Winds (July)

- They don't last long. Following these storms, squalls and showers momentarily lower the temperature.

Precipitation in Summer Season

- Dust storms don't produce much rain in the northern regions of the nation.
- Snowfall from disturbances in the west is the major kind of precipitation in Kashmir.
- In Assam, West Bengal and Odisha, the nor'westers provide some rain. The amount of rain is heavy.
- The spring storm showers are the name given to the rain brought on by nor'westers.

- Assam refers to these brief periods of precipitation as "tea showers" because they are so beneficial for the development of tea, jute and rice.
- Thunderstorms bring rain on the coasts of Kerala and Karnataka.
- Because they are so helpful to the mango crop, these showers are known as "mango showers" in Tamil Nadu and Andhra Pradesh.

Indian monsoon

- The word "monsoon" is derived from the Arabic "mausin" or the Malayan "monsin," both of which imply "season."
- Monsoons are periodic winds that change direction according to the season. They are seasonal winds.
- The monsoon is a dual system of seasonal winds; in the summer, they blow from the sea to land and in the winter, they blow from the land to the sea.
- Some academics often treat the monsoon winds on a wide scale as both land and sea breeze.
- Convection cells on a massive scale are the Indian Monsoons.
- They are periodic or secondary winds that have a seasonal change in wind direction.
- India experiences the south-west monsoon in the summer and the north-east monsoon in the winter.
- A severe low pressure system that developed over the Tibetan plateau is what causes the south-west monsoons.
- High pressure cells over the Tibetan and Siberian plateaus are linked to the north-east monsoon.
- Most of India experiences significant rainfall brought on by the south-west monsoon whereas the north-east monsoon primarily affects the country's south-eastern coast (Southern coast of Seemandhra and the coast of Tamil Nadu.).
- The majority of the annual rainfall falls in countries like India, Indonesia, Bangladesh, Myanmar, etc. during the south-west monsoon season, as opposed to South East China, Japan, etc. during the north-east rainy season.

Mechanism of Indian Monsoons

There are several theories that tried to explain the mechanism of monsoons.

Classical Theory

- Scriptures like the Rig Veda make reference to the monsoon. The monsoon system, however, was not mentioned in these books.
- Arab traders conducted the initial monsoon winds scientific study.
- Monsoon patterns were crucial to Arab traders who travelled to India by sea and conducted business there.
- An Arab explorer named Al Masudi described how the monsoon winds and ocean currents across the north Indian Ocean reversed in the eleventh century.
- Sir Edmund Halley proposed in the seventeenth century that the monsoon was caused by thermal disparities between continents and oceans as a result of their differential heating.

Monsoon of summer : Summertime temperatures and low pressure in Central Asia are caused by the sun's apparent vertical journey over the Tropic of Cancer. Over the Arabian Sea and Bay of Bengal, the pressure is relatively high. As a result, in the summer, winds from the oceans blew toward landmasses. Heavy rains is brought to the Indian subcontinent by this air flow from the sea.

Monsoon of winter: The Tropic of Capricorn is directly in the line of sight of the sun throughout the winter. The Arabian Sea and Bay of Bengal become warmer than the northwestern region of India and the monsoon flow is reversed. The fundamental concept of classical theory is comparable to the production of land and sea breezes, with the exception that in the case of monsoons, day and night are substituted by summer and winter.

Drawback : The monsoons do not develop uniformly around the globe and Halley's thermal theory cannot account for all of their subtleties, including their sporadic delays in beginning and ending and abrupt bursts of rain.

Modern Theories

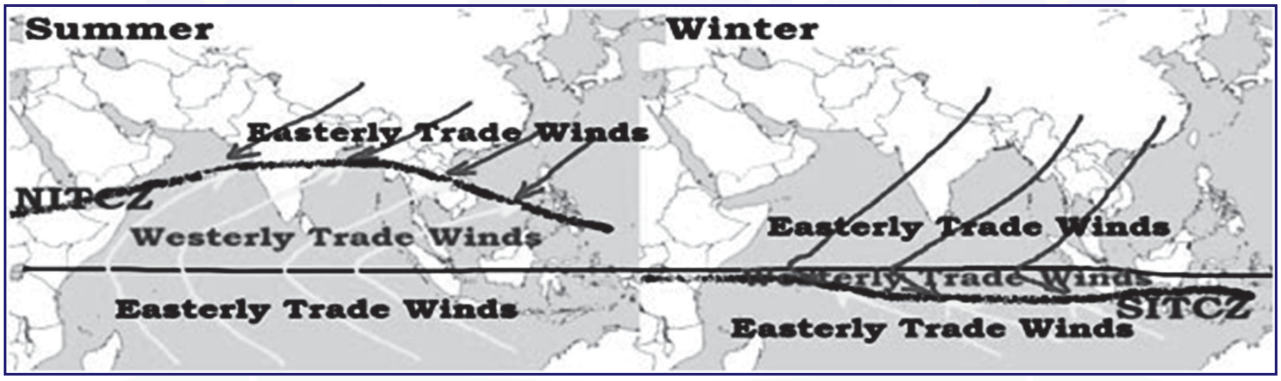
- Besides differential heating, the development of monsoon is influenced by the shape of the continents, orography (mountains) and the conditions of ***air circulation in the upper troposphere {jet streams}.***
- Therefore, Halley's theory has lost much of its significance and modern theories based on air masses and jet stream are becoming more relevant.

Indian Monsoons – Role of ITCZ [Inter-Tropical Convergence Zone]

- Near the equator, the southeast trade winds from the southern hemisphere and the northeast trade winds from the northern hemisphere converge.
- The Inter-Tropical Convergence Zone is where these winds converge (ITCZ).
- This area experiences rising air, the most clouds and significant rainfall.
- With the change of the seasons, the ITCZ's location moves both north and south of the equator.
- The Tropic of Cancer receives vertical sunlight during the summer and the ITCZ moves northward.
- Under the influence of Coriolis force, the southeast trade winds of the southern hemisphere cross the equator and begin to blow in a southwest to northeast direction.
- When these displaced trade winds pass across the Indian subcontinent, they are referred to as south-west monsoons.
- The Monsoon Front is the area where the North-East Trade Winds and the South-West Monsoons collide (ITCZ). Along this front, it rains.

The Indo-Gangetic Plain, where the ITCZ shifts to in July, receives a south-west monsoon that originates from the Arabian Sea and the Bay of Bengal. When in this position, the ITCZ is frequently referred to as the Monsoon Trough (highest rainfall).

The Northern Inter-Tropical Convergence Zone (NITCZ) in summer (July - rainy season) and the Southern Inter-Tropical Convergence Zone (SITCZ) in winter have been designated as a result of the ITCZ's seasonal movement (Jan – dry season)



Indian Monsoon Mechanism – Jet Stream Theory

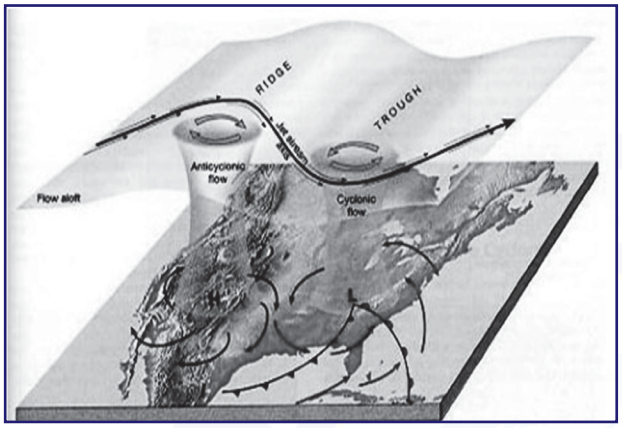
Indian Monsoon Mechanism – Modern Theory: Jet Stream Theory. Jet stream Theory is the latest theory regarding the origin of the monsoons and has earned worldwide acceptance from the meteorologists.

How Jet Streams Influence the Weather?

- Jet streams contain distinct peaks (ridges) and troughs.
- Where the warm air mass pushes up against the cold air mass is where ridges form. Troughs are formed when a cold air mass merges with warm air.
- On Earth, the area below the ridge is under high pressure, while the area below the trough is under low pressure.
- Because there is less temperature difference between the subtropics and the temperate region, the jet stream weakens, leading to this state.
- Typically, the trough region—the area just below the jet stream trough—creates cyclonic conditions (low pressure) at the

earth's surface, whereas the ridge regions do the opposite.

- These ridges and troughs give rise to jet streaks which are also responsible for cyclonic and anticyclonic weather conditions at the surface.



- The jet streak's outgoing winds are rapidly diverging, which lowers the pressure at the atmosphere's upper level (the tropopause). The winds from above quickly give way to the air below. In turn, this leads to the low pressure at the surface. The surrounding surface winds are forced to blow inwards due to the surface low pressure. The cyclonic rotation (cyclonic vortex) that depressions [low pressure cells] are connected with is produced by the Coriolis effect.
- Because of the high pressure at the top level of the atmosphere (Tropopause), the winds entering the jet streak are rapidly convergent. The result of this divergence (high pressure) at the surface is convergence at the upper troposphere.
- The anticyclonic rotation that clear weather is associated with is produced by the Coriolis effect.

Indian Monsoon Mechanism – Role of Sub-Tropical Jet Stream (STJ)

A small band of quickly moving air that travels from west to east is known as the sub-tropical jet stream.

At a height of roughly 12-14 kilometres, the STJ in the northern hemisphere flows between 25° and 35° N. (all this already discussed in previous posts on Jet Streams). (In this instance, we'll solely take STJ into consideration. On the Indian monsoons, Polar Jet has no effect.

A westerly jet stream typically has wind speeds between 150 and 300 km/h, with extreme values exceeding 400 km/h.

The upper air circulation, which STJ dominates, determines when the monsoons will burst.

Seasonal Migration of Sub-Tropical Jet Stream – STJ

While the STJ flows along the southern slopes of the Himalayas in the winter, it dramatically swings north in the summer and flows along the northern edge of the Himalayas in early June and along the northern edge of the Tibetan Plateau in late summer (July-August).

The monsoon's onset and subsequent retreat are frequently predicted by the Jet stream's periodic movement, which typically occurs when it shifts to the north of the Himalayas in a matter of days.

The subtropical jet's migration northward is the first sign that the monsoon season has arrived over India.

Sub-Tropical Jet Stream – STJ in Winter

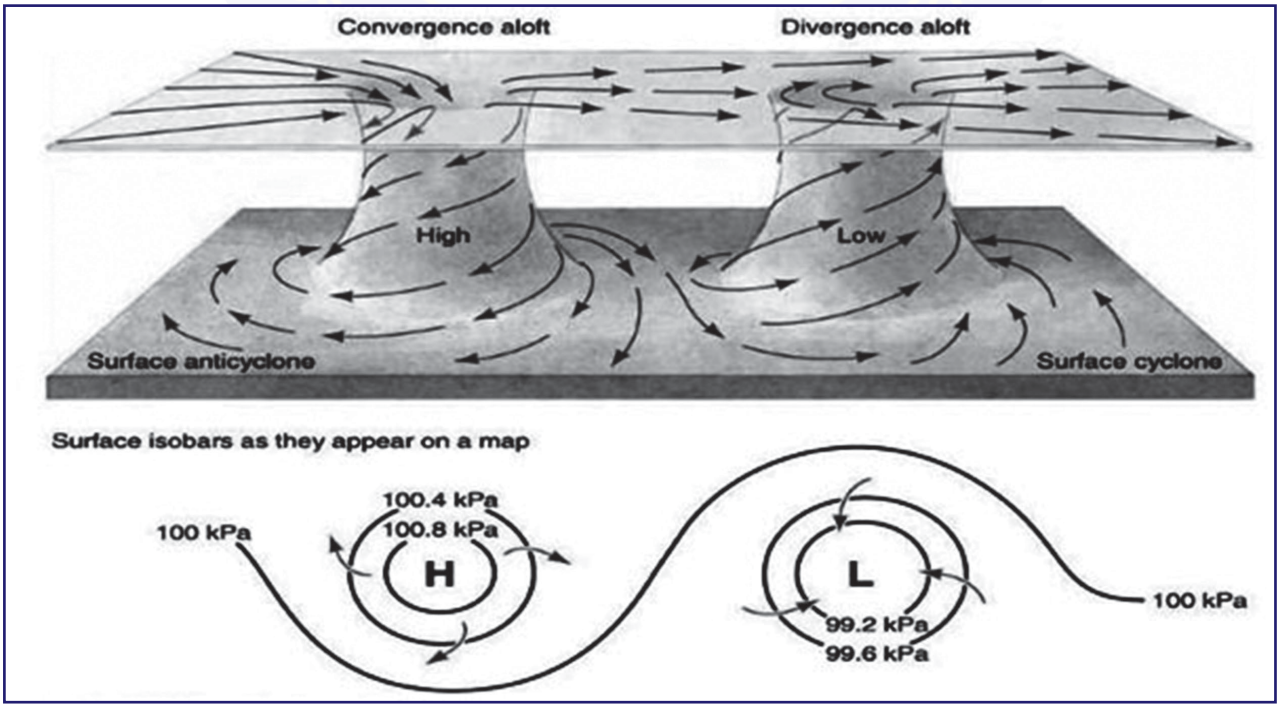
- During the winter, the subtropical zone is covered by a westerly jet stream that blows quite quickly.
- The Himalayan Mountains and Tibetan Plateau split this jet stream in two.
- Off the east coast of China, the two branches come together.
- The Tibetan Plateau's northern border gets blasted by this jet stream's northern branch.
- Along a latitude of 25° north, the southern branch blows south of the Himalayan mountains.
- The creation of the southerly jet is caused by a large latitudinal thermal gradient (differences in temperature), among other things.
- The southern branch is stronger, with an average speed of about 240 km compared with 70 to 90 km p.h. of the northern branch.
- Air subsiding beneath this upper westerly current gives dry out blowing northerly winds from the subtropical anticyclone over northwestern India and Pakistan.

Why do the south-west monsoons not occur in the winter?

- First, ITCZ departed India (the winds that blow over India are mostly offshore –– land to land or land to ocean –– so they carry no moisture).
- ***Reason number two:*** The southern branch of the STJ is powerful in the winter and is located south of the Himalayas. A high pressure area (sub-tropical high pressure belt) is created throughout the entirety of north India by the jet's ridge, which is located over the country's northwest. [In this way, jet streams affect the Indian Monsoon throughout the winter]
- ***Reason number three:*** is that Tibet is already under intense strain. [High Pressure from STJ with High Pressure from Tibet] causes a large divergence and no precipitation.

Sub-Tropical Jet Stream – STJ in Summer

- The STJ [upper westerlies] begin their northward march with the arrival of summer in the month of March.
- Despite waning in strength, the southerly branch of STJ is still located south of Tibet.
- Due to increased sun radiation and hot winds like loo, the weather in northern India becomes hot, dry and squally.
- With the STJ [upper westerlies] decreasing south of Tibet, the Equatorial Trough (ITCZ) moves northward over India, but the monsoon does not begin to blow until the upper-air circulation has changed to its summer pattern.
- By the end of May, the southern jet breaks and it is subsequently diverted to the north of the Tibet Plateau, causing a sudden burst of monsoons (the ridge moves northward into Central Asia, which causes high pressure over north-western India to move northward into Central Asia, which creates space for south-west monsoon winds). With the STJ's migration to the north, an Easterly jet appears over peninsular India.
- With the appearance of the Easterly jet, the upper air circulations are reversed [convergence in higher layers is replaced by divergence, divergence in lower layers is replaced by convergence and low pressure system is replaced by high pressure system]. In the high troposphere, easterly winds become quite active and are connected to westerly winds in the lower troposphere (south-west monsoon).
- Western and eastern jets flow to the north and south of the Himalayas respectively. The eastern jet becomes powerful and is stationed at 15° N latitude.
- This results in more active south-west monsoon and heavy rainfall is caused.

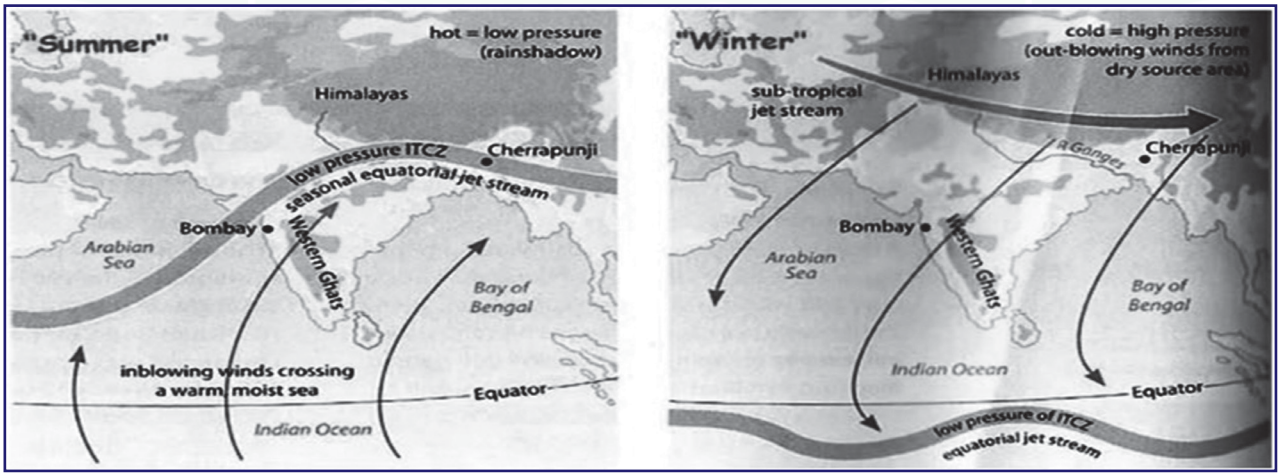


How do the Indian Monsoons respond to jet streams? Mechanism of the Indian Monsoon

- The Tibetan Plateau and the Indian subcontinent are being heated by the sun more and more as summertime draws near.
- The southern branch of the SJT, which runs south of the Himalayas, shifts to the north of the Himalayas during the height of summer (25th May – 10th June), along with the apparent northward movement of the sun.
- The SJT moves to the north of the Tibetan Plateau when the sun's position is ready to cross the Tropic of Cancer (June) (1st of Jun – 20th of June). Over the Tibetan Plateau, the ITCZ is about to reach its maximum position.
- The jet is initially hampered by the mountains' height, but after clearing their tops, it is able to resume its path over central Asia.
- An Easterly Jet forms over the Indian plains as a result of the SJT's shift to the north. Typically, it begins to form in the first week of June and lasts until the end of October.
- The upper troposphere traces it all the way to the west coast of Africa.
- The subtropical high pressure belt is moved north of the Tibetan Plateau by the SJT and ICTZ and the Indian plains experience a low pressure area due to the Easterly Jet (Easterly Jet creates anticyclonic conditions in upper troposphere).
- Sudden start of the south-west monsoons is caused by this low pressure in the northern plains and the strong low of the Tibetan Plateau (1st of Jun – 20th of June).
- The Tibetan plateau and the Indian Ocean (north of Madagascar) are where the monsoon cell is located (Low Pressure Cell).
- The subtropical easterly jet oscillates between peninsular India and the Indian plains during the summer, altering the intensity of rainfall from place to place.
- The STJ, which tends to blow south of the Himalayas during the months of March to May (Northwest India and the Plains region are inhabited by Subtropical High Pressure Belt), blocks the development of this cell. The influence of the low pressure cell above Tibet is reduced by this high pressure belt.
- The STJ is hindered from developing summer monsoons while it is in this position (the high pressure belt stays over north India).
- The sub-continental monsoon cell (Somali Jet) develops very quickly indeed, frequently within a few days, once the STJ is out of the way (high pressure belt migrates to the north of Tibet).
- A lower level tropical jet stream that carries moist air masses from the Indian Ocean feeds the cell with warmth and moisture.
- When the atmosphere over the Tibetan Plateau starts to cool (August to October), the monsoon season ends, allowing the STJ to return across the Himalayas.
- The subtropical high pressure band returns to the Indian plains with the ITCZ's shift to the south and the rain stops.

Retreating/Post Monsoons (The Transition Season)

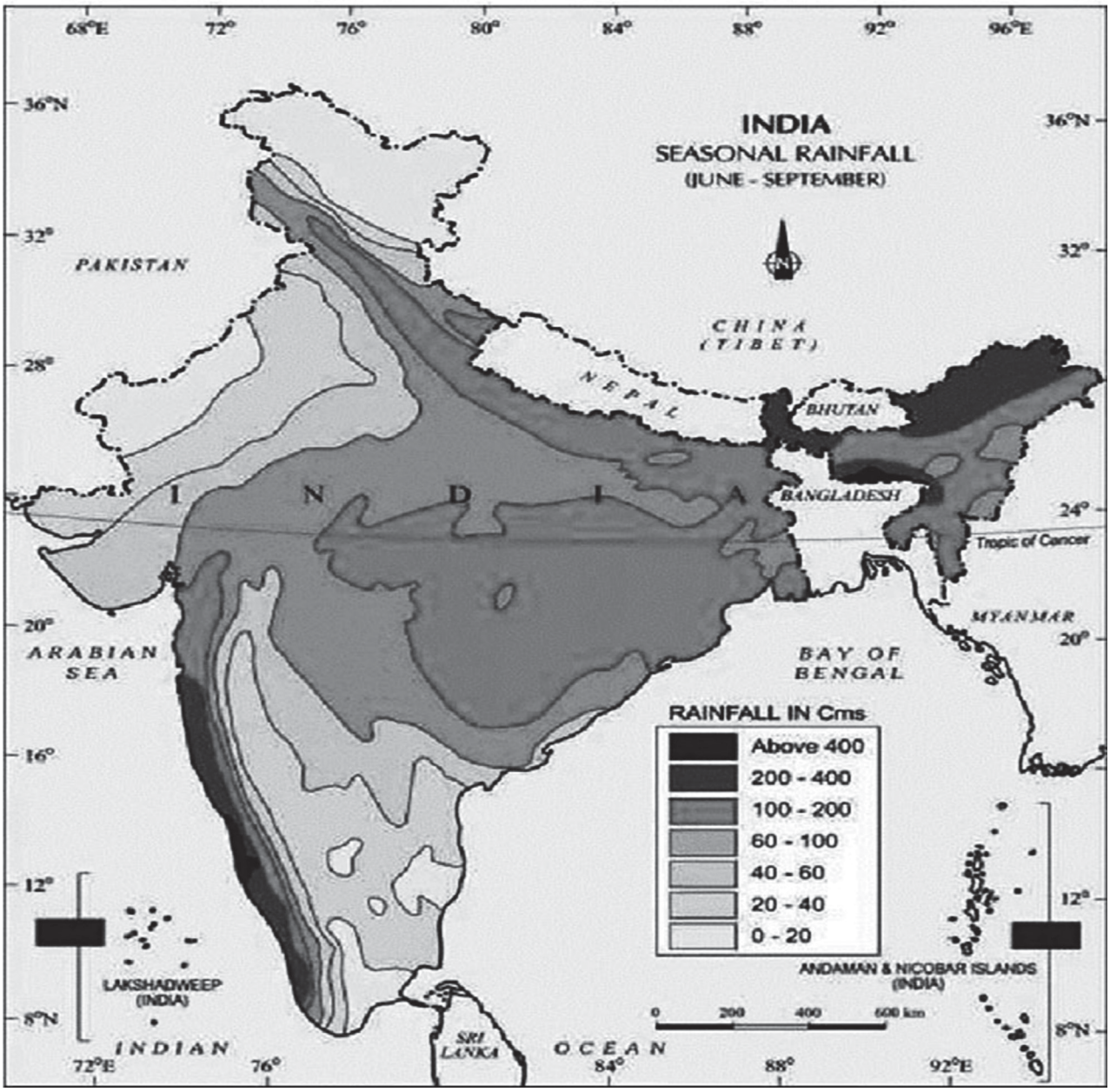
The monsoon trough or low-pressure trough over the northern plains weakens during the



months of October and November as a result of the apparent migration of the sun towards the south. High-pressure system gradually replaces this. The southwest monsoon winds begin to wane and ultimately wither away. The monsoon leaves the Northern Plains at the start of October. The months of October and November mark a changeover from the hot, wet season to the dry winter. Clear skies and an increase in temperature signal the monsoon's departure. Despite the hot days, the nights are cool and lovely. The soil is still damp. The weather gets somewhat unpleasant during the day because of the high temperatures and humidity. This is frequently called "October heat .

By the beginning of November, the low-pressure conditions over northwest India are moved to the Bay of Bengal. The incidence of cyclonic depressions that form over the Andaman Sea is linked to this change. These cyclones typically cross India's eastern coast, where they produce copious amounts of rain. These tropical cyclones frequently cause a lot of damage. Cyclones frequently strike the densely populated deltas of the Godavari, Krishna and Kaveri, resulting in significant loss of life and property. These cyclones can occasionally reach Bangladesh, West Bengal and Orissa's coasts. The majority of the Coromandel Coast's rainfall is caused by cyclones and depressions.

Rainfall Distribution:



6 NATURAL VEGETATION

Vegetation

Plants that are recognized as a species and regarded as a group are referred to as ***flora.*** Similarly, the term ***"fauna"*** refers to all of the animals that existed in a particular time, place, or environment.

On the other hand, vegetation describes the collection of plant species inside a specific biological or environmental framework. Compared to flora, which describes the species composition, it has a wider definition.

Natural vegetation is that portion of the plant kingdom that develops naturally, unaided by humans and adjusts in size, structure and requirements to the restrictions of the natural environment. Thus, developed crops and fruit orchards are not considered to be a natural element of the vegetation.

Virgin vegetation is that area of the natural vegetation that has not been altered by people. Inaccessible areas of the Himalayas, the Thar Desert and the Sunderbans are where you can find it in India. In other places, human habitation either converted wild vegetation into cultivated vegetation or weakened the wild vegetation.

The native or ***endemic*** species of the virgin Indian vegetation are known, whereas those introduced from abroad are referred to as ***exotic.***

Forest: The name "forest" refers to the region's ***"natural vegetation,"*** which has existed for thousands of years and supports a wide range of biodiversity, forming a complex ecosystem.

There are various types of forests, such as evergreen forests (composed primarily of evergreen tree species, i.e. species having leaves all year long) and deciduous forests (composed primarily of deciduous tree species, i.e. species which lose their leaves during specific months of the year), depending on physical, geographical, climatic and ecological factors.

Each type of forest creates a habitat for a certain animal community that has been adapted to dwell there.

The ***virgin vegetation,*** which is entirely Indian, is known as ***endemic or indigenous species,*** whereas that which has originated from outside India is referred ***to as exotic.***

A number of variables that affect the variety and distribution of wildlife and natural vegetation include:

1. Relief

(a) Land: The natural vegetation is impacted both directly and indirectly by the nature of the terrain. For instance, the vegetation in mountainous locations differs from that in plateau and plain regions.

While the undulating and difficult terrains are places where grassland and woodlands thrive and provide shelter to a diversity of wildlife, the rich ground is typically used for agriculture.

(b) Soil : Numerous varieties of vegetation can grow on various types of soil. Cactus and prickly shrubs grow in sand-based desert ecosystems, while mangroves and other deltaic plants grow in wet, marshy ecosystems. Conical trees grow on the hillside slopes where the soil is deeper.

(c) Temperature and Humidity: The primary determinants of the type and amount of vegetation are temperature and humidity. For instance, an evergreen forest thrives at high temperatures and high humidity, but thorny shrubs grow in high temperatures and low humidity (desert)

(d) Precipitation: Comparatively speaking, places with considerable rainfall have denser vegetation than those with light rainfall. See the following diagram to

comprehend how temperature and annual precipitation together affect a region's vegetation type.

(e) ***Photoperiod (Sunlight):*** The length of the light period relative to the darkness inside a day is referred to as photoperiod, also known as the light duration or day length. The changes in latitude, altitude, season and day length at various locations account for the variation in photoperiod. Trees grow more quickly in the summer because the days are longer.

(F) ***Altitude:*** Similar to how flora is distributed as latitude increases, elevation causes this. Generally speaking, "altitude mimics latitude," and there is a strong correlation between latitudinal and altitudinal zonation of climate and consequently, natural vegetation. For instance, despite having their summits covered in snow, Mount Kenya in east Africa and Mount Chimborazo in Ecuador both have their feet on the equator.

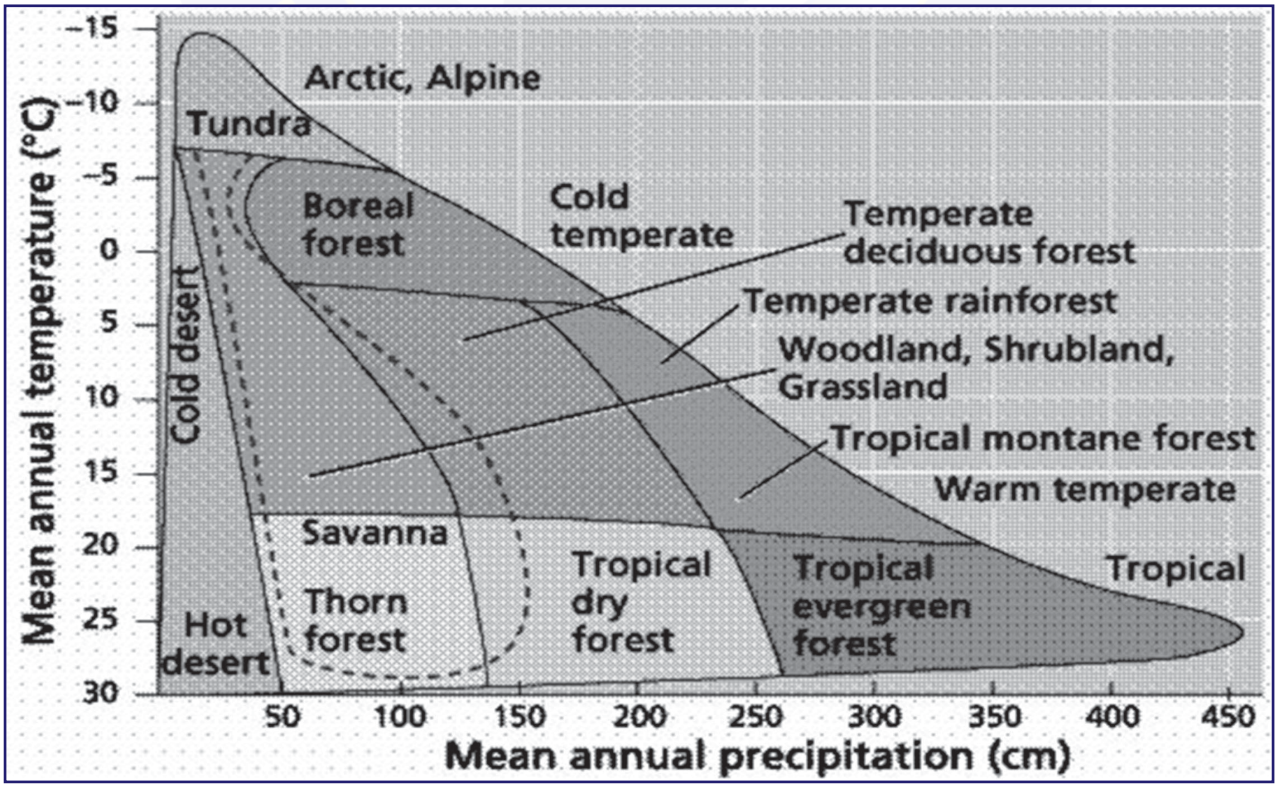
The link between vegetation and altitude was initially recognised by Alexander von Humboldt.

The Forest Types of India:

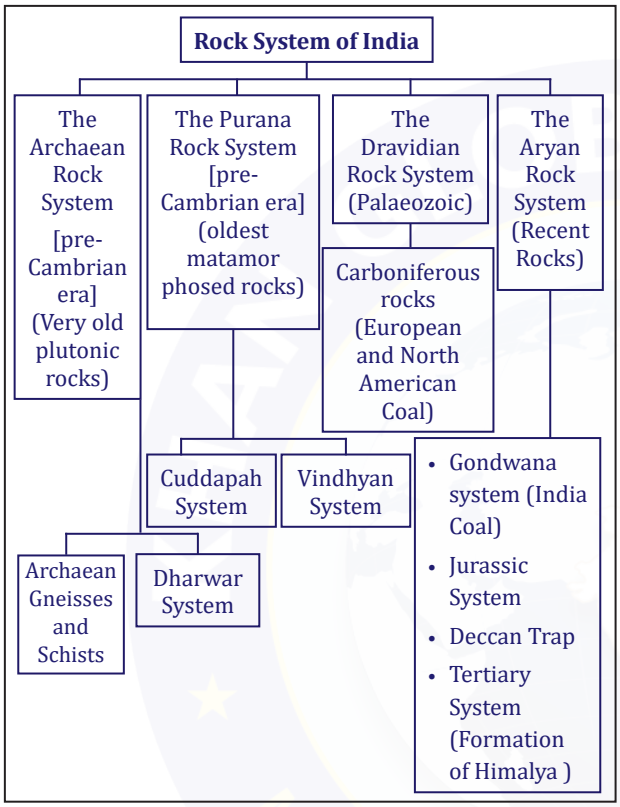
India is a country with a variety of climate zones, hence many types of natural plants have grown there. Having said that, rainfall plays a larger role in influencing the distribution of vegetation in India than temperature does (with the exception of the Himalayas). The distribution of seasonal rainfall and the length of the dry season both have a significant impact on the vegetation. In India, the following interrelationships are typically seen:

High rainfall regions (>200 cm) — Evergreen forests can be found in the Andaman and Nicobar Islands, the Western Ghats and north-eastern India. In regions where the monsoon season lasts for several months, these woods flourish. The times when trees blossom, bud and bear fruit are all arbitrary. Because of this, these forests have a year-round appearance of greenery, hence the term evergreen.

Moderate Rainfall (70-200 cm) — Deciduous woods can be found in areas with seasonal rainfall that is only moderately heavy and lasts for a few months. These kinds of woodlands predominate in areas where teak trees flourish. During the sweltering summer and winter seasons, deciduous trees lose their leaves.



Low Rainfall areas/ Semi-arid areas (Thorn forests are found in the semi-arid regions of India. The trees, which are sparsely distributed, are surrounded by open grassy areas. Apart from these, mangroves forests grow along the coast, especially in the river deltas. These plants are uniquely adapted to be able to grow in a mix of saline and freshwater



1. ***Tropical Evergreen Forests:*** Evergreen because trees don't have a set season for losing their leaves, blooming, or bearing fruit. These woodlands appear green all year round as a result. Elephants, monkeys, lemurs and deer are frequently spotted creatures in these jungles. The Assam and West Bengal jungles are home to the one-horned rhinoceros. These rainforests are also home to numerous birds, bats, sloths, scorpions and snails in addition to these creatures.

A. Tropical Wet Evergreen Vegetation:

Distribution: These woods can be found on the Andaman and Nicobar Islands, upper Assam through Cachar and the western slope of the Western Ghats.

Climate: They live in warm, humid climates with an average annual precipitation of above 250 cm and a brief dry season. Here, the average yearly temperature exceeds 22°C.

Characteristic Features:

1. Tropics' evergreen forests are well-stratified, with layers closer to the ground covered in creepers and bushes, then short-branched trees and finally a wide range of tall trees.
2. The trees in these forests grow to heights of 60 metres or more.
3. Semi-evergreen woods on the drier borders encircle the area.
4. A very diverse biosphere.
5. The wood harvested from these forests is strong and fine-grained.

These forests are home to significant ***species*** including Rosewood, Mahogony, Aini, Ebony, etc.

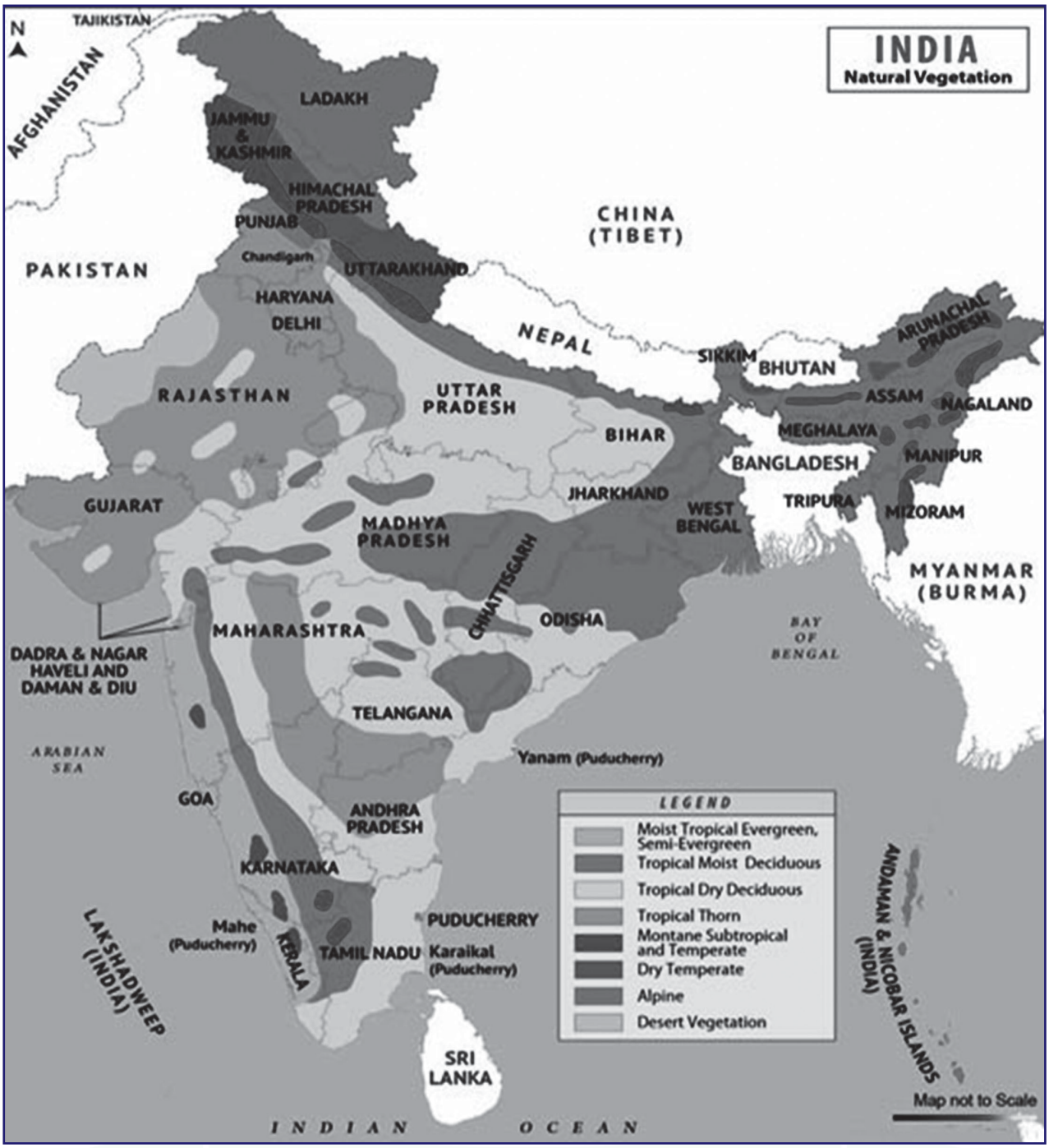
In Kerala, notable species include mesa, white cedar, jamun and canes. In Assam's forests, common species include bamboo, gurjan, jamun and agar.

B. Tropical Semi-Evergreen Vegetation:

Distribution: These forests, which constitute a transition between moist deciduous and evergreen forests, are found next to tropical wet evergreen forests. On the western coast, in Assam, on the eastern Himalayas' lower slopes and in the Andaman Islands, these forests can be found in regions with slightly lower precipitation and air humidity than those with tropical evergreen vegetation.

❒ ***Characteristic Features:***

1. Such woods contain a mix of moist deciduous and evergreen trees. These woodlands have an evergreen quality thanks to the undergrowing climbers.
2. The epiphytes are numerous, bamboos are less common and the climbers are heavy.
3. The term "epiphytes" refers to plants that rely on other plants for mechanical support (as opposed to nutrition), such as lichens, mosses, orchids and so forth.
4. A variety of huge trees with a propensity for gregariousness dominate the forest (i.e. growing in groups that are close together)



5. ***Adaptations of plants in certain regions:***
   1. ***Buttresses*** **-** Near the base of many tall trees are enormous ridges known as buttresses that can soar 30 feet in height before disappearing into the trunk.
   2. The bark is thicker and rougher and the canopy is less dense than that in the previous type. Also, the canopies are not continuous and species richness is lower.

The ***three main species*** are kail, hollock and white cedar. Aini, Laurel, Rosewood, prickly bamboo and other important species can be found in Kerala. Mango, Indian Chestnut, Champa and White Cedar are significant species found in northeastern India.

C. Tropical Dry Evergreen Vegetation:

Distribution:This type is only found along the coast of Tamil Nadu and in locations that receive rainfall from the north-east monsoon/winter monsoon of about 100 cm (October-December).

There is considerable botanical interest in the development of evergreen forests in regions with such minimal rainfall. The seasonal distribution of rainfall (winter rainfall) may be to blame for this vegetation.

Characteristic Features of this vegetation:

1. Low-lying trees (12 m)
2. A dense but small grass and shrub canopy.
3. No distinction between canopy layers.
4. Bamboos are scarce or nonexistent.

These forests are home to significant species including Neem, Jamun, Tamarind, Machkund, Khirni, Kokko, Ritha and Gamari Canes.

For farmland or casuarina plantations, the majority of the ground beneath these trees has been destroyed (Eucalyptus tree plantations)

2. Tropical Deciduous Vegetation

These are India's most common woods, often known as monsoon forests.

The ability of some plants to shed their leaves annually is referred to as "deciduous" behaviour. They are dispersed across areas that get 70 to 200 cm of rain annually.

The lion, tiger, pig, deer and elephant are frequent inhabitants of these forests. Here, a wide range of birds, lizards, snakes and tortoises can also be found. The only place on Earth where both lions and tigers have been proved to live in the wild is India.

These forests are further classified based on the availability of water as follows:

A. Tropical Moist Deciduous Vegetation

Distribution: It can be found in some areas of the Satluj-Ganga plains, the Himalayan foothills, the eastern slopes of the Western Ghats and eastern coastal plains and plateaus.

Climatic Conditions: It thrives where there is a dry season of 4 to 6 months, a mean annual temperature of 26°C to 27°C and an average relative humidity of 60-80%. There is also moderate rainfall of 150–200 cm in these places. It transitions to tropical semi-evergreen vegetation on its wetter boundaries and tropical dry deciduous vegetation on its drier margins.

Characteristic Features:

1. During the dry season, trees lose their foliage.
2. These woods typically have two to three layers.
3. dense vegetation.

Important Species: Sal, Teak, Sandalwood, Ajun, Ebony, Shisham, Hurra, Mahua, Amla, Semul, Mulberry and Kusum are the most prevalent trees.

B. Tropical Dry Deciduous Vegetation

Distribution: Eastern Rajasthan, Kathiawar, the Deccan Plateau's rain-shadow regions, central India and Punjab are where it can be found.

Climate conditions: Dry deciduous trees flourish in regions with low annual precipitation rates (less than 150 cm) and protracted dry seasons. It transitions from dry margins to thorn woods while transitioning from wet margins to moist deciduous.

Characteristic Features:

1. The trees in these forests are under 25 metres tall and a thin deciduous tree canopy covers the area. Both grass and shrubs make up the undergrowth.
2. The trees entirely lose their leaves as the hot, dry season (March to May) gets underway, leaving the forest looking like a wide grassland with naked trees all around.
3. These forests feature a parkland environment, where trees are more stunted and widely spaced and are interspersed with patches of grass, in the higher rainfall areas of the Peninsular plateau and the northern Indian plain.
4. Because of little rainfall and overgrazing, Rajasthan's western and southern regions have very little vegetation cover.

Common plants include Teak, Sal, Laurel, Palas, Khair, Tendu, Amaltas, Bel and Axlewood, among others.

3. Tropical Thorny Vegetation

Distribution: It can be found in Kachchh, neighbouring regions of Saurashtra, western Madhya Pradesh, southern portions of Punjab, western Haryana, western Uttar Pradesh, central and eastern Rajasthan and leeward Sahyadria.

Climatic conditions: 50 to 70 cm of rain in certain regions.

Characteristic feature

1. With long roots, small leaves, stems that store water and prickly spines that deter animals from touching or eating them, the plant life in this region is highly specialised to survive the harsh, arid conditions.
2. Open stunted (trees with 6 to 9 m in height) forest that transitions into xerophytic bush and deserts in western Rajasthan make up the region's natural vegetation.
3. In these forests, the majority of the year is spent with plants with no leaves, which exhibits scrub vegetation.
4. Plant adaptations: These xerophytic plants fight off drought using a variety of water-saving mechanisms, including waxy leaves, water-storing cells, hairs on the stalk and partial or entire replacement of leaves with thorns.
    - As the undergrowth, tufty grass can reach a height of 2 metres.
    - Trees are dispersed throughout, their lengthy roots reaching deep into the soil to draw rainwater.
    - To save water, the stems are succulent.
    - To reduce evaporation, leaves are typically thick and tiny in size.

Important Species: Babul, Acacia, Kokko, Khair, Khajuri, Ber, Neem, Khejri, Palas, etc. are examples of common species.

The typical wildlife in these woodlands includes rats, mice, rabbits, fox, wolves, tigers, lions, wild asses, horses and camels.

4. Subtropical Vegetation

A. Sub-tropical Broad-leaved Hill Forests:

Distribution : These forests can be found in Bengal and Assam together with other hill ranges including the Khasi, Nilgiri, Mahabaleshwar, Pachmarhi, Amarkantak and Parasnath on the lower slopes of the Himalaya.

Important Species: Common species in the eastern Himalayas include oak, chestnut, ash, birch and pine.

B. Sub-tropical Pine Forest

Distribution: The centre and western Himalaya are covered in subtropical Chir pine forests and the Khasi slopes are covered in Khasi pine forests.

Important Species: Chir Pine is the most significant tree in the western Himalayas, whereas oak is found in the more humid regions. Wild Olives and different types of scrub are prevalent in Kashmir's dry regions (rainfall ranges from 50 to 100 cm).

Principal Characteristics

1. Almost the whole distribution zone of these forests is pristine.
2. There is also no discernible beneath story.

C. Sub-tropical Dry Evergreen Forest

Distribution: These woods are made up of xerophytic, prickly and small-leaved evergreen plants and are found in low-rainfall regions. These woodlands are confined to the northwest of the nation.

5. Temperate Vegetation

A. Himalayan Dry Temperate Vegetation

It is spread in the western Himalayan interior dry ranges.

Characteristic feature

Coniferous forests and xerophytic scrubs make up the majority of the landscape.

Rare are epiphytes and climbers. Coniferous trees are tall and straight and their leaves resemble tiny needles. Though some coniferous trees, like the larch, are deciduous in nature, most are evergreen.

Important species: The Chilgoza, Deodar, Oak, Maple, Ash and Olive are among the important species.

B. Himalayan Moist Temperate Vegetation

Distribution: Between 1500 and 3000 metres in the western Himalayas.

Characteristic Features: The trees are 30 to 50 metres tall and the undergrowth is primarily evergreen. On trees, moss and ferns are abundant.

Important species : Deodar, Spruce, Maple, Walnut, Poplar, Cedar, Chestnut, Birch, Oak, etc. are important species.

C. Montane Wet Temperate Vegetation

Distribution : Evergreen wet temperate forests can be found in the eastern Himalayas between 1800 and 2700 metres above sea level. South

India's Nilgiris, Annamalai and Palni hills also have these types of woods above 1500 metres in altitude. There are fewer trees and more epiphytes, mosses and ferns in the undergrowth, which is also denser.

Characteristic feature

High rainfall, mild summer temperatures and a chilly winter are all characteristic features. The rate of evaporation is low. Therefore, trees do not lose their leaves annually, or at least not all at once.

Important Species: Magnolia, Oak, Poplar, Elm, Laurel, Maple, Birch and mangolin.

6. Sub-Alpine and Alpine Vegetation

Distribution: It can be found in the eastern Himalayas above 2700 metres and in the western Himalayas over 3000 metres.

Important Species: . Rhododendron, Silver Fur, Juniper, Pine, Birch and other trees make up the dense scrubby forest.

Characteristic Features:

1. ***Alpine*** forests transition into alpine grasslands via bushes and scrub. These reach all the way to the snowline.
2. ***Bugyals:*** In Uttaranchal, at an elevation of between 3400 and 4000 metres, there are high altitude alpine grasslands or meadows known as bugyals. This category is known as "nature's own gardens." The area has either flat or sloping topography. Seasonal flowers and lush, green grass adorn the surface of these bugyals. Tribal herdsmen utilise them to pasture their animals. The alpine meadows are always blanketed in snow during the winter. The Bugyals display a riot of lovely flowers and grass throughout the summer. The environment of Bugyals is quite delicate. Examples of bugyals include:
   - Auli (near Joshimath) – A premier ski range is located here.
   - Gorso.
   - Kwanri Bugyal.
   - Bedni.
   - Panwali and Kush Kalyan.
   - Dayara.
   - Munsiyari Bugyal.

7. Littoral and Swamp Vegetation (Mangrove Vegetation/ Tidal Forests)

Distribution: The Ganga, Mahanadi, Godavari and Krishna rivers all have tidal deltas.

Mangrove vegetation is evergreen and thriving. More than 200 cm of rain falls each year in certain places.

Important Tree Species: Nipa, Keora, Sundari, Agar and Bhendi.

Important Animal Species: The most prevalent animals are turtles, crocodiles, gharials and snakes, creatures inhabited these jungles. The Ganga's tidal forests are home to the Royal Bengal Tiger.

Characteristic Features:

1. The majority of the trees are evergreen. Typically, they create tangled webs of arching roots that become visible during low tide.
2. This vegetation is adapted to the following two situations:
   High salinity of the water and recurrent flooding.
3. The existence of stilt roots, buttresses, pneumatophores and other such adaptations stand out among these.

Stilt roots (also called prop roots)

The mangrove trunk, branches, or already-existing stilt roots are all outgrown by stilt roots, also known as prop roots. The tip of stilt roots develops an underground root system as soon as they touch the ground, connecting the stilt root to the ground. Then, one or more additional stilt roots develop, growing arcuately into the air before running into the ground once more to develop an underground root system. This process is repeated several times.

Buttress Roots –

Huge trees are stabilised by the buttress roots that many trees in mangroves have developed. The buttress roots have a maximum height of ten meters. Buttress roots, also known as buttresses, do not continue to grow below the soil as they do above; instead, a substantial number of tiny roots sprout in the soil beneath the buttress root.

Pneumatophores - During high tides, the roots are depleted of oxygen due to soggy circumstances.

Mangrove roots can grow up vertically from the ground. The term pneumatophores refers to these specialised roots. When other roots are submerged under water during high tide, these ones have pores that allow the trees to breathe.

4. Mangrove plants perform an essential socio-economic purpose in addition to being best recognised for the rich aquatic life they support within their web of stilt roots. They serve as "green shields," protecting the coastline from storm and tsunami damage as well as sea erosion.
5. Mangroves provide a means of subsistence, primarily aquaculture, as well as fuel, building materials and medicinal plants. Additionally, they provide ecological functions such as coastal stabilisation, fish breeding grounds and heavy metal filtration.

Grasslands in India:

India lacks grasslands comparable to the Steppe, Pampas, or Savanna because of a brief monsoon season followed by a protracted, hot dry season. Without an intermediary park-like stage, the closed deciduous forest transitions into the thorny forest and there is no steppe-style grassland between the woods and the desert.

However, the following types of grassland are nearby:

1. ***Upland/Hilly Grassland:***
   (i) Himalayas (usually above 1000m height) (generally above 1000m height)
   (ii) Decan Plateau Hills 2 (Western Ghats in Karnataka where forests have been cleared)
   (iii) There are a lot of grassy slopes in the Nilgiris (grass is frequently dotted with tiny, isolated "shola" forests*).
2. ***Low Lands:*** the lowlands of the Indian states of Bihar, Assam, Haryana and Punjab.
3. ***Riverine Grasses:*** These can be found along river banks and offer grazing opportunities to cattle, particularly the bhabar Pasture in india .

Sholas

The Nilgiri Hills' mixed dense forests of tropical and temperate evergreen rainforest species are known as "***Sholas.***" Most of the shola woodland patches are located inUndulating montane grassland typically divides valleys from one another. The shola-grassland complex, also known as the mosaic, is composed of the shola and grassland.

Vegetation in the Himalayas:

The Himalayan ranges display an altitude-dependent succession of vegetation, ranging from tropical to tundra. The eastern and western Himalayas are comparable in terms of their vegetational zones.

However, compared to the western Himalayas, the eastern Himalayas contain more tropical features, a wider diversity of oaks and rhododendrons and fewer conifers.

Other distinctions include the fact that it rains more frequently and is warmer in this region of the Himalayas, as well as the fact that the tree line and the snow line are higher in the eastern Himalayas than they are in the western Himalayas.

The diversity of species and the density of the vegetation are likewise higher in the East.

Additionally, due to their considerably higher precipitation levels than the drier north-facing slopes, the southern slopes of the Himalayas have a thicker vegetative cover.

Legal or Administrative Classification:

The three main legal classifications of forests in India are, generally speaking, unclassified, protected and reserved. The boundaries of "reserved" and "protected" forests in India are established or specified by a legal notification published in a government gazette under the Indian Forest Act.

By definition, the government owns these forests. Unclassified forests are the remaining forest tracts, wastelands, or any other land that is "recorded" in land records as "forest" but is not listed in the government gazette as "reserved" or "protected" forests under the Indian Forest Act. Different Indian States have different levels of ownership and control over these resources.

Reserved Forests:

- The public is not permitted to enter these forests for the purpose of gathering wood or grazing cattle because they are directly under the control of the government.

- This category includes about 53% of the total forest area.
- Reserved forests are thought to be the most valuable in terms of protecting forests and wildlife.
- The majority of activities are prohibited in these forests unless specifically permitted.
- ***Protected Forests:***
  - The locals are permitted to gather fuel wood and timber and graze their cattle without seriously harming the government-managed forests, despite the fact that these forests are under government care.
  - They make up 29% of the country's total forest area.
  - Most activities, unless expressly forbidden, are permitted in these forests.
- ***Unclassed/Unclassified Forests:***
  - There are no restrictions on cattle grazing or tree cutting.
  - They take up 18% of the country's total forest land.
  - These are the additional forests and wastelands that are owned by both the government and private people and groups.
  - An very high proportion of the forests in all of the north-eastern states, as well as in some areas of Gujarat, are managed by local communities.

Because they are maintained for the purpose of providing timber and other forest products as well as for protective purposes, reserved and protected forests are known as permanent forest estates.

3. The Indian Forest Survey divides forest cover into four categories:
   1. ***Extremely dense forest:*** Any area covered in trees (including mangroves), with a canopy density of at least 70%.
   2. ***Moderately dense forest:*** Any area with a canopy density of between 40% and 70% of trees, including mangroves.
   3. ***Open forests:*** Any area with a canopy density of 10% to 40% or more, including mangrove cover.
   4. ***Scrubs:*** All forest lands that have inadequate tree growth, primarily small or stunted trees with a canopy density of less than 10%.

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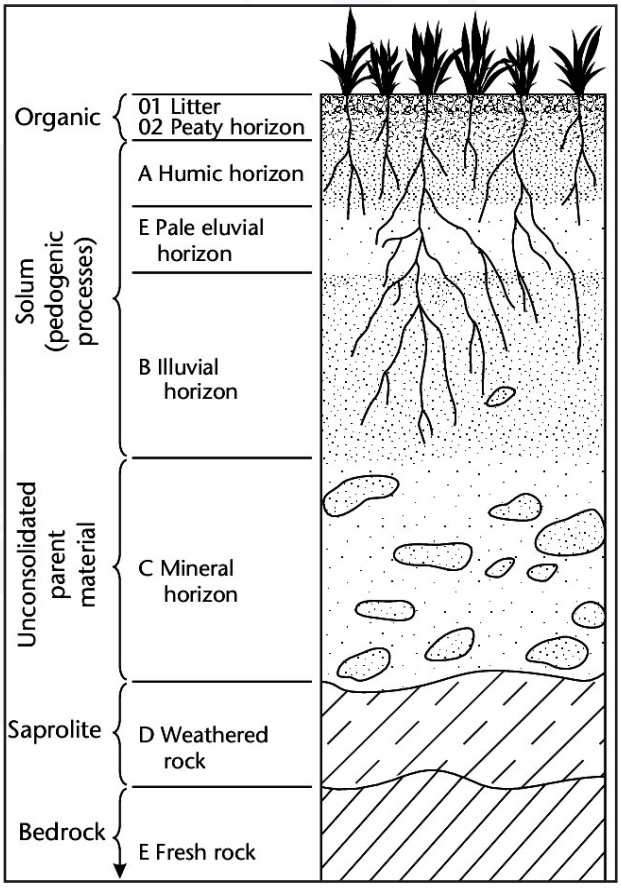
7 SOILS

- The thin top layer of the earth's crust known as soil is made up of rock and organic material particles.
- The study of soils in their natural settings is known as pedology. The natural process of soil creation known as pedogenesis encompasses a number of processes like weathering, leaching, calcification, etc.
- The parent rock type, surface relief, climate and native plants all play major roles in soil formation.
- As a result of the weather, water and wind breaking down rocks, soil is created. We term this process as weathering.

Soil Types

- The percentage of particles in the soil that are different sizes is used to categorise it.
- ***Sandy soil*** is defined as having a higher proportion of large particles.
- ***Clayey soil*** is defined as having a substantially larger proportion of fine particles.
- When the proportion of large and small particles in the soil is roughly equal, it is referred to as ***loamy soil***.
- The gaps between the sand grains allow water to swiftly drain through them. As a result, sandy soils are often thin, well-aerated and dry.
- Since clay particles are significantly smaller, they clump together firmly, leaving little room for air. In contrast to sandy soil, clay can hold water in the minuscule spaces between its granules. Clay soils therefore have little air. However, they are heavy because they can hold more water than sand-based soils.
- The ideal topsoil for plant growth is Sand, clay and silt, a different kind of soil particle, are all combined to form loamy soil. In river beds, silt accumulates as a deposit. The silt particles are sized somewhere between sand and clay.
- Cereals like wheat and gramme can be grown on both loamy and clayey soils. These soils are effective in holding onto water.
- Clay and organic matter-rich soils with a high capacity to hold water are appropriate for paddy.
- Loamy soils with good water drainage are necessary for growing lentils (masoor) and other legumes.
- For cotton, sandy loam or loam, which drain water easily and can keep lots of air, are more ideal.

Soil profile



O Horizon

- Layers with a heavy organic content.
- Undecomposed or only partially degraded litter can be found in some O layers (such as leaves, needles, twigs, moss and lichens).

- They could be sitting on top of mineral soil or organic soil.

A Horizon or Surface Soil

- It is a portion of the topsoil.
- Mineral and biological material coexist in this stratum.
- The most organic matter has accumulated and the most soil life is present in this layer of mineral soil.
- The iron, clay, aluminium, organic molecules and other soluble components in this layer have been depleted (eluvated).
- At the foot of the "A" horizon, a lighter-colored "E" subsurface soil horizon can be seen when depletion is severe.

E horizon

- Eluviated layer is represented by the letter "E."
- In the sand and silt sizes, there is a concentration of refractory minerals like quartz because this horizon has been considerably leached of clay, iron and aluminium oxides.
- Only older, well-developed soils have these, which typically appear between the A and B layers.

B Horizon or Subsoil

- It is a subsurface layer that shows how the parent material has been altered physically or chemically.
- All of the leached minerals from the horizons A and E are accumulated in this layer.
- In this horizon, which is the result of illuviation (the reverse of eluviation), iron, clay, aluminium and organic molecules collect.

Horizon C

- In this layer, weathered parent material—the parent material in sedimentary deposits—accumulates.
- Large, continuous rocks make up the stratum.
- The more soluble chemicals may gather in this layer (inorganic material).

R Horizon or Bedrock

- The bedrock layer at the bottom of the soil profile is referred to as this layer.
- R horizons are primarily made up of continuous masses of hard rock, unlike the layers above.
- In situ soil formation will have a lot in common with this bedrock layer.
- The other profiles are 50 feet or less apart from these bedrock regions.
- The Pedogenic Processes: The above-explained conversion from rocks to soils happens via four basic processes:
  1. Additions.
  2. Losses.
  3. Translocations.
  4. Transformations.

1. ***Additions :*** The majority of additions take place on the surface. The three that are most readily apparent are solar energy, climate-controlled water and organic material primarily sourced from flora.
2. ***Losses:*** Losses can come from the deep subsoil as well as the surface. For instance, water and carbon dioxide are lost by evapotranspiration and surface diffusion, respectively. On a more catastrophic scale, enormous quantities of soil may be swept away by erosion. The primary ways that materials are lost from the subsurface are suspended or dissolved in water, such as leaching.
3. ***Translocation:*** This term describes the actual physical movement of substances inside the soil. The material can move in any direction from and to any horizon and can take the shape of a solid, liquid, or gas. Clay, organic materials, iron and aluminium hydrous oxides, for instance, are frequently transferred from the surface horizon to a subterranean horizon.
   In contrast, salts are transported upward in solution in extremely dry climates by capillarity, while solid mineral particles are transported upward by frost action in extremely cold climates.
4. ***Transformation:*** As the aforementioned illustration of movement in additions, losses and translocations demonstrates. While transformations include a change in a soil component without any actual movement of the soil, Decomposition of biological materials, chemical weathering and physical weathering are included here.

Factors that influence soil formation in Indian Conditions

- Parent Material.
- Relief.
- Climate.
- Natural Vegetation.

Parent Material

- Parent materials are the bedrock that soils are created from.
- The parent material, in the majority of situations, dictates the soil's colour, mineral makeup and texture.
- The soil that is created in various situations might or might not share the same physical characteristics as the parent rock.
- Climate-related factors cause chemical alterations that have an impact on the soil's physical characteristics.
- Weathering is taking place on the rocks' exposed surface. The process turns the rocks into tiny grains, which act as a foundation for the formation of soil.

Relief

In regions with steep slopes, such as hilly regions, the borders of plateaus, etc., the relief is the most crucial component for soil formation.

- On slopes with little vegetation, soil formation is hampered by widespread soil erosion. Examples include Chambal ravines, higher altitudes in the Himalayas with little to no tree cover (mostly on the southern slopes), etc.
- Deep soils are typically present in low relief or gently sloping locations that suffer deposition. Think of the Indo-Gangetic plain.
- River basins with deep enough soil layers are the exceptions in the plateau.

Climate

- The most crucial elements in the development of soil are temperature and rainfall.
- They decide how well the parent material weathers, how much water seeps through the soil and what kinds of microorganisms are there.
- In the same kind of climate, the same soil may emerge from two different parent materials. Similar to this, the same parent material may result in two distinct soil types in two distinct climates.
- In moderately moist sections of the monsoonal zone, the crystalline granites generate laterite soil, while in drier places, non-laterite soil.
- Regardless of the parent rock, a hot summer and little rainfall create the black soil that can be found in some areas of Tamil Nadu.
- Sandstone and granite both produce sandy soil in Rajasthan's desert environment.
- In semi-arid and dry areas, evaporation is usually greater than precipitation. There isn't much vegetation and the soils are seriously deficient in humus. As a result, the soils are always pale in colour.
- Excessive evaporation causes soils in Rajasthan and the surrounding dry and semi-arid regions to accumulate lime. Because of this, the soil is of a pedocal character [Pedocal is a division of the zonal soil order. It is a type of soil that develops in dry and semiarid areas. It has minimal soil organic matter and is high in calcium carbonate.
- The deterioration of vegetation occurs slowly in the Himalayan region's frigid winters and the soils are naturally acidic.

Natural Vegetation

- The combined effects of relief and climate are reflected in natural vegetation.
- The expansion of vegetation has a significant impact on how soil forms and develops.
- The decomposed leaf matter enriches the soil with much-needed humus, enhancing its fertility.
- Some of India's greatest soils are found in the heavily wooded areas. In India, there is a close connection between the different types of vegetation and soil.

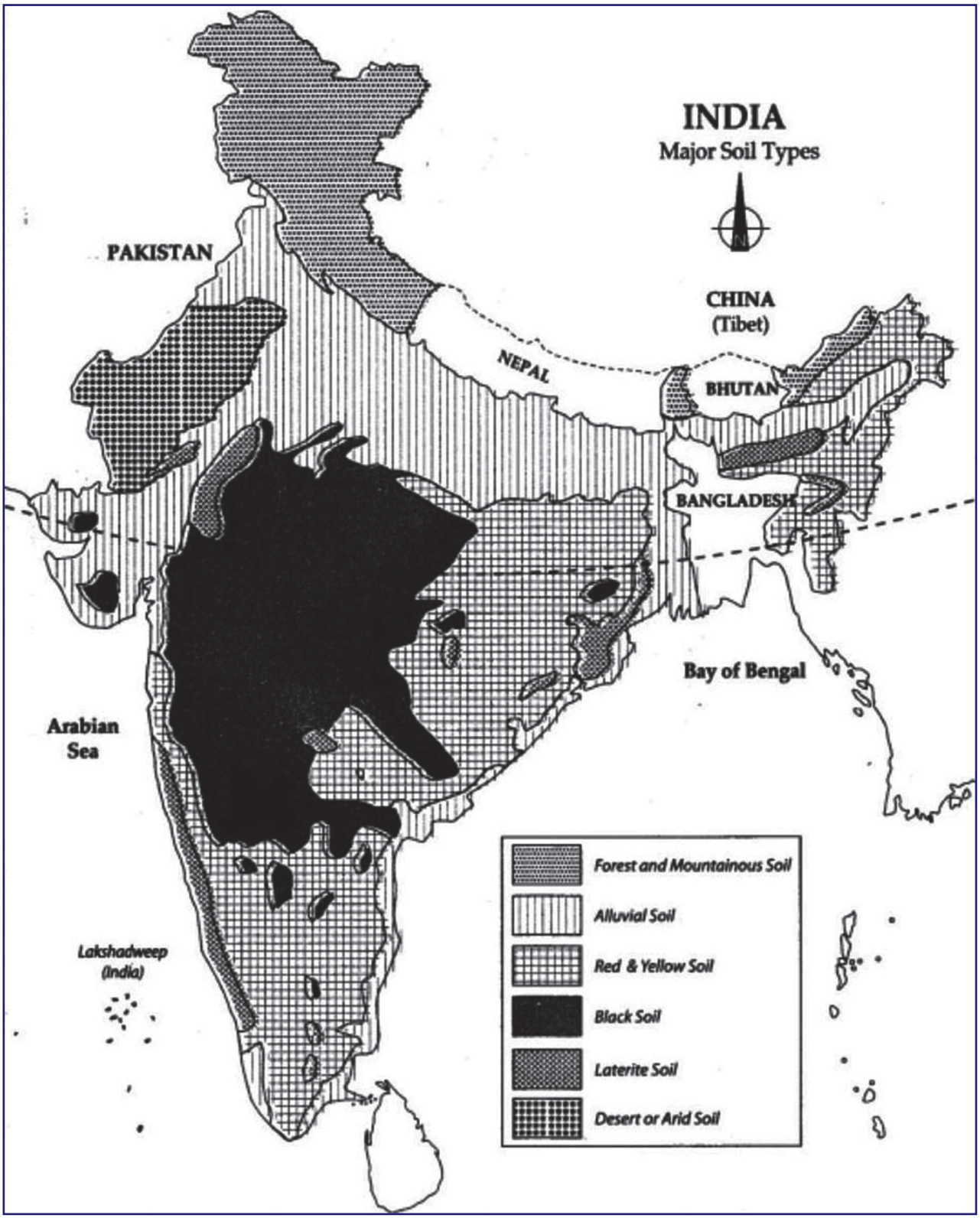
Major Soil Types of India

- According to geology, Indian soils can be broadly separated between soils from the peninsula and soils from outside the peninsula.
- The soils of Peninsular India are created by the in-situ, or directly from the underlying rocks, breakdown of rocks.
- Peninsular Indian soils are referred to as sedentary soils since they are only occasionally transferred and redeposited.

- Rivers and wind both contribute to the formation of the soils in the Extra-Peninsula. They go rather deep. They are frequently referred to ***as azonal or transferred soils***.

1. Alluvial Soils

- The Indo-Gangetic-Brahmaputra rivers' silt deposition is the primary cause of alluvial soil formation. Some alluvial deposits are created by wave action in coastal areas.
- The parent material is composed of Himalayan rocks. Therefore, these soils' parent material had a transportable origin.



- The largest soil group, they cover roughly 15 lakh sq km, or roughly 46% of the total area.
- They provide the most productive agricultural lands, supporting more than 40% of India's population.

- ***Characteristics of Alluvial Soils***
  - Because it is loamy (equal parts sand and clay), the soil is porous.
  - Good drainage and other agriculturally beneficial conditions are provided by porosity and texture.
  - The frequent floods continuously replenish these soils.
  - In general, nitrogen makes up a small fraction.
  - Potassium, phosphoric acid and alkalies are present in a sufficient ratio.
  - There is a large range in the ratio of iron oxide to lime.
  - Geologically, the alluvium of the Great plain of India is divided into newer or younger khadar and older bhangar soils.
- ***Crops in Alluvial Soils***
  - They are best suited for agriculture since they often have flat, uniform soils.
  - They respond well to canal, well and tube-well irrigation and are best suited to irrigation.
  - Rich harvests of rice, wheat, sugarcane, tobacco, cotton, jute, maize, oilseeds, vegetables and fruits are produced by them.
- ***Distribution of Alluvial Soils in India***
  - Except for a few locations where the top layer is obscured by desert sand, they are present everywhere over the Indo-Gangetic-Brahmaputra plains.
  - They also exist in the Mahanadi, Godavari, Krishna and Cauvery deltas, where they are referred to as deltaic alluvium (coastal alluvium)
  - The Narmada and Tapi rivers as well as Gujarat's northern regions have some alluvial soils.

2. Black Soils

- Volcanic rocks that originated in the Deccan Plateau are the source of the majority of the black soil (Deccan and the Rajmahal trap). Gneisses and schists make up the parent material of Tamil Nadu. While the latter are often shallow, the former are appropriately deep. High temperatures and little rain fall are prevalent in this area. As a result, it belongs to a soil category that is typical of the Peninsula's hot and arid regions.

- ***Characteristics of Black Soils***
  - The clay factor in a typical black soil is at least 62 percent and it is highly argillaceous (Geology (of rocks or sediment) consisting of or containing clay).
  - Black soils in uplands typically have low fertility, whereas they are quite fertile in lowlands.
  - The black earth holds a lot of moisture. Upon absorbing wet, it swells considerably. When it rains, the earth becomes extremely sticky, making it difficult to work on.
  - The earth shrinks and develops wide, deep fractures in the summer as the moisture evaporates. Moisture can still be retained in the bottom layers. The soil has exceptional fertility and the fissures allow oxygenation to reach significant depths in the soil.
  - Drying causes it to crack and take on a blocky form. (Self Ploughing)
- ***Chemical Composition***
  - 10% of alumina, 9%–10% of iron oxide, 6%–8% of lime and 3%–5% of magnesium carbonates.
  - Phosphates, nitrogen and humus are insufficient and potash levels are variable (less than 0.5%).
- ***Distribution***
  - Spread over ***46 lakh sq km (16.6 per cent of the total area) across*** Maharashtra, Madhya Pradesh, parts of Karnataka, Telangana, Andhra Pradesh, Gujarat and Tamil Nadu.

- ***Crops***
  - Crops that grow cotton do best in these soils. These soils are referred to as regur and black cotton soils for this reason.
  - The following important crops are also produced on the black soils: wheat, jowar, linseed, virginia tobacco, castor, sunflower and millets.
  - In areas with irrigation facilities, rice and sugarcane are also significant crops.
  - The black soils are also successful in supporting a wide variety of fruits and vegetables.
  - Without adding fertilisers and manures, this soil has been used for millennia to grow a range of crops with little to no signs of depletion.

3. Red Soils

- The second greatest area of the country is covered by this soil, which formed on Archean granite.
- The soil turns red due to the presence of ferric oxides, which are present as thin coatings on the soil particles.
- The horizon below is yellowish and the top layer of dirt is red.
- 18.5% of the area is covered.
- Sandy to clay and loamy textures.

- ***Characteristics of Red Soils***
  - The amount of rainfall varies greatly. Consequently, the soil has evolved into three different kinds.
  - 200 cm of rainfall on red and yellow soil in the northeast India's Nagaland, Mizoram, Manipur Hills and portions of the Malabar Coast require fast drainage.
  - Dry plateaus like those in Karnataka, Tennessee, Telangana and Rayalseema have red sandstone soil. - rainfall of 40 to 60 cm.
  - RedAlluvial Soil in river valleys is fertile.
  - Sandy, well-drained soil.
  - Rich in iron and potash but lacking in other minerals.

- ***Chemical Composition***
  - These soils are ***deficient in phosphate, lime, magnesia, humus and nitrogen.***
  - ***Distribution :*** From Tamil Nadu in the south to Bundelkhand in the north and from Raj Mahal in the east to Kathiawad in the west, they are primarily found in the Peninsula.

4. Laterite Soil

- In areas where the following criteria are met, this soil has developed. A laterite rock or structure is necessary for the development of laterite soils (laterites are high in iron and aluminium content). Alternating dry and wet seasons are best for this process.

- ***Characteristics***
  - Brown in colour and primarily made up of an amalgamation of hydrated iron and aluminium oxides.
  - Nodules that contain iron oxides are present.
  - Iron and aluminium are abundant, while nitrogen, phosphorus, potash, lime and magnesium are insufficient.
  - It has average humus and water-retention capabilities.
  - Bacterial activity has been quite strong and severe precipitation has caused humus to leach, resulting in a moderate to low humus content.

- ***Distribution***
  - The following areas in the nation have laterite soil: The Western Ghats (Goa and Maharashtra).
  - In Kerala's laterite plateau and the Belgam district of Karnataka.
  - In the Eastern Ghats, in the states of Orissa, Gujarat and MP's Amarkantak plateau and Jharkhand's Santhal Pangana divisions.

- ***Crops***
  - When manured and irrigated, some laterites are suitable for growing plantation crops like tea, coffee, rubber, cinchona, coconut, arecanut, etc.
  - In some areas, these soils support grazing grounds and scrub forests.

Forest Soil/ Mountain Soil

Formation – It is principally found on mountains with steeper slopes, high relief, shallow profiles.

- ***Characteristics:***
  - It has thin layers and poorly defined profiles and horizons.
  - Fast drainage has made it susceptible to soil erosion.
  - Although the humus content is acceptable and the organic content is abundant, other nutrients are insufficient.
  - When sand, silt and clay are together, the soil is described as loamy.
- ***Distribution***
  - They are often located above 900 metres in elevation in the Himalayas, Himalayan foothills, Western Ghats mountain slopes, Nilgiri, Annamalai and Cardamom highlands.
- ***Crops***
  - In the peninsular forest region, they are appropriate for plantations of tea, coffee, spices and tropical fruits.
  - The Himalayan forest region grows wheat, maize, barley and temperate fruits.
- ***Desert Soil***
- Mostly found in dry and semi-arid regions like Rajasthan, West of the Aravallis, Northern Gujarat, Saurashtra, Kachchh, Western sections of Haryana and Southern Punjab, this soil is deposited by wind action.
- It is deficient in moisture. Less humus is present and although nitrogen is initially scarce, some of it is now present in the form of nitrates.
- They have little organic substance and are sandy. The amount of living microorganisms is little.
- It contains a lot of iron. The phosphorus concentration is almost sufficient and abundant in bases and lime.
- It has relatively little moisture retention capacity and little soluble salts.
- This soil produces a high agricultural yield when watered.
- These are appropriate for less water-demanding crops like guar, bajra, lentils and feed.

Distribution– western Rajasthan, Rann of Kachchh, in patches in south Haryana and south Punjab.

- ***Saline and Alkaline Soil***
  - Alkali soil has a high concentration of NaCl.
  - The ground is barren.
  - Reh, Usar, Kallar, Rakar, Thur and Chopan are further names for them.
  - Rajasthan, Haryana, Punjab, Uttar Pradesh, Bihar and Maharashtra are the key locations for these.
  - This soil contains sodium sulphate and sodium chloride. It works well with leguminous plants.
  - Its formation and dispersal are both artificial and natural.
  - Natural - Includes the Rann of Kuchchh and the Rajasthani lakes that have dried up.
  - In the Palaya Basin, it has appeared (a clay basin in the midst of the desert)
  - Anthropogenic - It arose in Punjab and western UP as a result of poor agriculture.

Characteristics - Humus formation is nearly nonexistent due to a lack of moisture, humus and live microorganisms.

Peaty and Marshy Soil/Bog Soil

This soil originates from the ***areas where adequate drainage is not possible***. It is ***rich in organic matter and has high salinity.*** They are ***deficient in potash and phosphate.***

Features - Predominance of clay and muck, making it heavy.

- Rich in moisture content but with higher salt content and daily flooding from high tides, it has become unproductive soil.
- No biological activity because the amount of moisture is too high.

Distribution - It is typical of India's delta region.

- In addition to the delta region, Alleppey, Kerala, also has it (known as Karri along

the backwaters or Kayals of Kerala), Almora (Uttaranchal) (Uttaranchal)

Jute and rice can be grown over the Bengal Delta and large grains of rice, spices and rubber can be grown over the Malabar region.

The Indian Mangrove forests have benefited from it in certain ways.

Characteristics of Indian Soils

- Most soils are mature and ancient. Compared to the soils of the Great Northern Plain, the soils of the Peninsular Plateau are significantly older.
- Most organic components, mineral salts, humus and nitrogen are insufficient in Indian soils.
- While mountainous and plateau regions show limited soil cover, plains and valleys have thick soil layers.
- While some soils, like those found in alluvial and black soils, are fertile, others, like those found in laterite, the desert and alkaline soils, are not and do not produce good crops.
- Indian soils have been farmed for hundreds of years, but much of its fertility has been lost.

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8 ECONOMIC GEOGRAPHY AND POPULATION

Land Reforms and Land use pattern

Land reform: Land redistribution from the wealthy to the poor is typically referred to as land reform. Regulation of land ownership, use, operation, leasing, sales and inheritance is part of this. There are strong economic and political justifications for land reform in an agrarian economy like India where resources are scarce, land is distributed unevenly and a sizable pion of the rural population lives below the poverty line. Independence-era time pressures resulted in reformative laws from this angle.

Land reform in India, after Independence focused on the following features:

1. Abolition of intermediaries—zamindars, jagirdars, etc

- It was crucial to do this to cut the number of middlemen between the state and the cultivators.
- State laws were used to do this because it was covered by the Indian Constitution's state list.
- This particular reform was the most successful since it was able to strip the zamindars of their superior land rights and reduce their economic and political clout.
- About 20 million formerly tenant farmers became landowners once the zamindari system was abolished, adding to the amount of public land available for distribution to farmers who lack access to land.

  Large expanses of land were still under "personal cultivation," according to the Zamindars and the landlords made an attempt to minimise the effects of the efforts to abolish the zamindari system.

  Additionally, the zamindars in many locations designated a sizable amount of their property to be used for "personal agriculture," which led to the widespread eviction of tenants.

2. Tenancy reforms

- These were put into place to control rent, give tenants security of tenancy and grant them ownership.
- The changes decreased the amount of land that was under tenancy, but ultimately resulted in only a small proportion of tenants gaining ownership rights.
- Despite the steps taken, these laws were never successfully implemented.
- The plan materials' constant focus on this issue did not guarantee that all states would approve legislation granting tenants ownership rights.

3. Ceiling on Landholdings

- Land Ceiling Acts were created to formally establish the largest parcel of land that any one farmer or farm household could lawfully own.
- The ceiling was put in place to lessen the concentration of land in the hands of a select few.
- In order to implement this reform, the state was required to locate and seize any surplus land that each household had (beyond the ceiling limit) and transfer it to landless families and households in other designated groups, such as SCs and STs.
- Due to the numerous flaws in these laws, their usefulness was not actually realised.
- By separating big estates into smaller pieces, distributing them among their family and transferring them to benami holders, the landowners maintained control over their property.

4. Consolidation of Land Holdings

- A single plot is divided into fragments due to the growing demand for land and partition based on inheritance regulations.
- The main goal of consolidation is to reorganise scattered lands into a single plot.

- According to the plan, all the land in the hamlet was first combined into a single, compact block before being divided into smaller blocks and subsequently distributed to individual farmers.
- Farmers were able to concentrate on their resources in one location, which led to an increase in productivity.
- By cultivating land earlier and in fragmented land holdings, it cut labour costs, decreased litigation and decreased cultivation costs.
- Except in Punjab, Haryana and western Uttar Pradesh, the consolidation of holdings did not proceed with much success due to a lack of significant political and administrative support.

Economic arguments in favor of Land reforms

- Equity is the strongest justification for land reform.
- The majority of rural Indians live in poverty, thus it makes sense from an equitable standpoint to guarantee everyone access to property.
- Other justifications based on efficiency issues.
- Owner-cultivated land tends to be more productive than land under sharecropping tenancy, while small farms tend to be more productive than large farms.

Present situation in India

- After Independence, the aforementioned land reform initiatives were implemented, but they were only partially successful.
- Only 4% of the operated land may be transferred to farmers' ownership.
- Despite this lacklustre result, land reform regulations placed onerous limitations on the tenure of agricultural land.
- The development of agriculture in the nation has been negatively impacted by this. Landowners are hesitant to lease their property under a legal tenancy because they are worried about losing it forever.
- According to National Sample Survey Reports, 10 million hectares of land are cultivated informally by around 15 million tenants, 92% of whom are marginal farmers or landless labourers. They lack access to institutional loans, crop insurance and other benefits provided to farmers by government programmes, as well as security of tenancy.
- Many landowners who are unable to cultivate themselves prefer to leave their property fallow due to legislative constraints on tenancy.
- In India, there were 26.72 million hectares of fallow land in 2015–16.
- These limitations on access to arable land not only deny rural poor people opportunity to increase their incomes, but also negatively impact the expansion of the overall agriculture industry.
- The average holding size in 1970–1971 was 2.28 hectares (Ha), which decreased to 1.08 Ha in 2015–16 despite consolidation efforts.
- States with high population densities like Bihar, West Bengal and Kerala have substantially smaller holdings.

What changes are required from this angle?

- A simple formalisation of tenancy and cultivation of fallow land might revolutionise Indian agriculture.
- The Model Agricultural Land Leasing Act, 2016, published by the NITI Aayog has started the process of states enacting new legislation or making necessary amendments to their current laws on tenancy.
- Group loans can help informal tenants in the interim, pending the effective enactment of necessary laws.

  In Kerala, where renting out property is prohibited, some 250,000 squatters have formed joint liability entities. Banks provide agricultural loans to these organisations without official tenancy agreements. Such arrangements are permitted by the policies of the Reserve Bank of India and the National Bank for Agriculture and Rural Development without the need for a formal tenancy.
- The focus areas must also include building a repository for land records, digitising and integrating all documents pertaining to titles and encumbrances and formalising cadastral maps of all property parcels.

- Making public land disputes data available and defining a systematic timeframe for prompt resolution of property disputes, etc.
- NITI Aayog has also prepared a draft model Land Title Act, 2019. The draft model recommends conclusive land titles and for providing of State guaranteed ownership.
- Thus, with an aspirational goal of India becoming a $5-trillion economy by 2025, the imperative needed today is to unleash the power of land and reap fruits by bringing about the much needed Land Reforms.

Land use pattern

"Land Use Pattern" refers to the configuration or pattern of how the land is used.

- Many elements, including terrain characteristics, climate, soil, population density, technological aspects and socioeconomic factors, can influence how land is used.
- India has a total geographic area of roughly 328.73 million hectares, although data on land use only cover about 305.90 million hectares of that area.

The important types of land use in the country are as follows:

Net Sown Area (NSA); Net sown area refers to the cropped area for the year in consideration.

- This sort of land use is significant since it is essential for agricultural output.
- This is almost 6% of India's total reported area, or 141.58 million hectares, compared to the global average of 32%
- Population control is necessary since the amount of farmed land per person has severely decreased from 0.53 ha in 1951 to 0.11 ha in 2011–12.
- With 18.35 million ha, or around 12.96% of all India's reporting NSA, Rajasthan has the largest NSA, followed by Maharashtra.
- Punjab and Haryana have some of the greatest ratios of NSA to total area, with 82.6 and 80.5, respectively.

Area sown more than once: As the name suggests, more than one crop is grown here each year.

- A total of 198.97 ha was planted in crops in 2010–11, up from 185.34 million ha in 2000–01.
- In other words, from 44 million ha in 2000–01 to 57.39 million hectares in 2010–11, more land has been seeded more than once.
- ***Cropping Intensity = Gross Cropped Area/ Net Sown Area x 100.***
  - This sort of land is important because, because practically all arable ground has been converted to agriculture, the only method to enhance agricultural production is to intensify cropping, which can be accomplished by expanding the area seeded many times.
  - A sizable portion of the area falls under this category in the provinces of Punjab, Haryana, Uttar Pradesh, Bihar and the coastal regions.

Forest Area

- This covers all territory that has been legally designated as forest, or that is managed as forest, whether it is state-owned or privately held, wooded, or maintained as potential forest land.
- The forest area continues to contain the area of crops grown there as well as grazing grounds or regions that are open to grazing.
- About 23% of the stated area is covered by forests, a significant increase from 14% in 1950–1951.
- The reporting area of the forest is required to be 3% of the total land area, under the National Forest Policy of 1952.
- More land is reported to be covered in forest in Madhya Pradesh, Arunachal Pradesh, Odisha, Maharashtra and the Andaman & Nicobar Islands. Heavy rainfall and relief characteristics are to blame.
- In contrast, the states of Goa, Haryana, Punjab and Dadra and Nagar Haveli have less area in forests.

Permanent pastures and other grazing lands

- In total, permanent pastures and other grazing grounds cover 10.3 million ha.
- This represents around 4% of the country's entire reporting area.

- Given the huge number of animals in the nation, the space now used for pastures and other grazing sites is insufficient.
- Pastures cover almost one-third of the reporting area in Himachal Pradesh.
- In Madhya Pradesh, Karnataka, Gujarat, Rajasthan, Maharashtra and Odisha, the percentage ranges from 4 to 10%.
- In the other areas of the country, it is less than 3%.

Cultivable waste

- This is the land that is suitable for cultivation but isn't being used for it for various reasons.
- Due to limitations such a shortage of water, the soil's salinity or alkalinity, soil erosion, water logging, etc., it cannot be used.
- Formerly utilised for agriculture, the Reh, Usar, Bhur and Khola tracts in Uttar Pradesh, Punjab and Haryana as well as other regions of the nation had to be abandoned because of some soil inadequacies brought on by poor agricultural techniques.
- Cultivable waste land was predicted to make up roughly 5% of the total area in 2010–11.
- Gujarat (13.6%), Madhya Pradesh (10.2%), Uttar Pradesh (6.93%) and Maharashtra (6.83%) are the states having the most cultivable waste land.

Fallow lands

- All land that was cultivated but is currently uncultivated falls under this category.
- There are two types.
- Current fallow.
- Fallow other than current fallow.
- Current fallow is defined as lasting one year, while fallow lasting between two and five years is referred to as "fallow other than current fallow."
- Current Fallow Land made up 5% of the area that was reported in 2010–2011.
- Additionally, 3% of the stated areas were fallow other than the current fallow.
- With an area of 1.7 hectares, Rajasthan has the largest "fallow other than current fallow" area, followed by Andhra Pradesh and Maharashtra.
- Andhra Pradesh has the largest area that is now fallow.

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9 ANIMAL HUSBANDRY, FISHERIES AND AQUACULTURE

Animal husbandry

Animal husbandry is the controlled raising, handling and breeding of domestic animals, as well as the enhancement of their attributes as desired by humans.

- It is the area of agriculture that deals with raising animals for their meat, fibre, milk, or other goods.
- It entails daily maintenance, selective breeding and livestock rearing.
- Animal husbandry is a significant source of income for many farmers in India.
- They provide large-scale self-employment options, especially for women, small and marginal farmers and landless labourers.
- The industry produces meat, eggs, milk and other nutritious foods at low cost for millions of Indians.
- It is also a fantastic source of by-products from raw materials like hides and skins, bones, blood, fat, etc.
- The finest protection against the whims of nature, such as drought, starvation and other natural calamities, has historically been provided by the animals for Indian farmers.

Role of Animal Husbandry in Indian Economy

- Livestock is the primary source of income for almost 20.5 million people, or about two-thirds of rural communities.
- Additionally, it employs around 8% of India's population.
- The industry makes up 25.6% of all of agriculture's GDP and contributes 11% to GDP.

Important livestock resource data for India

- With around 535.78 million cattle owners, India leads the world.
- 109.85 million buffaloes make up the majority of the world's total buffalo population.
- 148.88 million goats make up the second-largest population of goats.
- The world's second-largest market for poultry.
- Third-largest nation in terms of sheep population and the world's second-largest aquaculture nation (74.26 millions).
- Fifth in terms of the number of chickens and ducks (851.81 million).
- 2.5 lakh camels, ranking tenth in the world's camel population.

Major products by the Animal Husbandry sector in India

Dairy: India had about 192.5 million cattle in FY 2019. Additionally, India possessed 9.1 million pigs, 109.9 million buffaloes, 74.3 million sheep, 148.9 million goats and 109.9 million buffaloes.

- Estimated milk output for FY 2018–19 was 187.7 million tonnes.
- West Bengal has the most livestock, followed by Uttar Pradesh and Madhya Pradesh, according to the 20th Livestock Census.
- The majority of buffaloes live in Uttar Pradesh, then Rajasthan and Gujarat.
- India is the world's second-biggest producer of cow milk and the world's largest producer of milk.
- Uttar Pradesh, Tamilnadu, Madhya Pradesh, Maharashtra, Punjab, Kerala, Karnataka and Bihar generate almost two-thirds of the world's cow milk.
- The production of milk immediately after Independence was low and within six decades it increased rapidly; the phenomenon which has been named as ***White revolution*** and as ***Operation Flood.***
- To encourage, organise and plan dairy development through cooperatives, the ***National Dairy Development Board (NDDB***) was established in 1965.

- By setting up farmer-owned and -managed dairy cooperative societies, the largest integrated dairy development initiative in the world aimed to create connections between rural milk producers and urban consumers.
- The ***World Bank*** provided financial support and the ***European Economic Community*** provided commodity support for the initiative.

The ***schemes launched*** to address the issues in the Diary sector are:

National initiative for the development of the dairy industry (NPBBDD)

This initiative was initiated in 2014 to offer farmers with on-site artificial insemination and to promote native breeds to save them from extinction.

Mission Rashtriya Gokul

This effort, which was started in 2014 with the goal of enhancing milk output and productivity through improved nutrition and farm management, aims to preserve and conserve indigenous bovine breeds.

National dairy plan

To meet national milk demand and to provide access of organised processing industry to rural organic milk producers.

1. ***National mission on bovine productivity***
   - This was launched in 2016, to increase the milk productivity of bovine resulting in the higher overall national production.
2. ***Meat***
   - 5.9 million tonnes of meet are produced annually in the nation, with 54% coming from goats and sheep, 26% from cattle, buffalo and 7% from pigs.
   - The remaining 13% is provided by chickens.
   - India's greatest meat-producing state, Uttar Pradesh, accounts for more than 19% of the nation's total meat production.
3. ***Poultry***
   - Chickens, ducks, geese, turkeys and other domestic fowl raised for their meat, eggs and feathers are referred to as poultry.
   - The majority of India's poultry birds, or roughly 18.2% of all poultry birds, are in Andhra Pradesh and Telangana.
   - The largest egg producers are also Andhra Pradesh and Telangana.
   - From completely unorganised farming practises to a commercial production system using technology breakthroughs, this sector has arisen.
   - India is currently one of the world's top five producers of chicken meat.
   - In order to provide the necessary services, such as farmer skill upgradation training, central organisations for poultry development have been established.
   - To support state poultry farms and promote the growth of rural poultry, the "***Poultry Development Scheme"*** is being implemented.
4. ***Sericulture***
   - This includes raising silk worms and growing mulberry trees.
   - Mulberry, tropical tasar, oak tasar, eri and muga are the five types of commercial silks that are known to be produced; muga, with its distinctive golden yellow shimmer, is solely produced in India.
   - In the five states that make up the majority of the nation's silk-producing regions—Karnataka, Andhra Pradesh, Assam and Bodoland, West Bengal, Jharkhand and Tamil Nadu—mulberry sericulture is primarily practised.
   - Mulberry, Oak Tasar, Muga and Eri are the four different types of silk that are uniquely produced in the North East.
   - India is the world's second-largest producer of silk. Mulberry generated the four types of silk that were produced in 2020–2021 in the greatest amounts.
   - The industry is labor-intensive and gives many people in rural areas gainful employment.

- Policy actions performed to advance the silk industry.

Rashtriya Krishi Vikas Yojana includes sericulture as an associated agricultural activity. This makes it possible for sericulturists to take use of the program's benefits for all of their sericulture endeavours, including reeling.

Anti-dumping taxes being imposed on Chinese raw silk.

In order to raise the quality standards for the production of silkworm seeds, ***the Central Silk Board (Amendment) Act, Rules and Regulations*** have been notified by the Indian government. MGNREGA guidelines have also been developed to aid farmers who grow sericulture.

Aquaculture

The term "aquaculture" describes the regulated production of aquatic animals and plants.

Aquaculture is defined by the Food and Agriculture Organization (FAO) as the production of aquatic species such as fish, crustaceans, molluscs and aquatic plants.

It falls under the following groups.

- Aquaculture in freshwater.
- Aquaculture on the coast.
  - Sea fish farming.
  - Aquaculture in brackish waters.

Types of Aquaculture

1. ***Freshwater aquaculture:*** The "Central Institute of Freshwater Aquaculture" has made significant contributions to catfish and freshwater shark breeding and rearing. A significant aspect of aquaculture is the production of freshwater shrimp or prawns for human consumption.
   States like West Bengal, Odisha and Andhra Pradesh practise this type.
2. ***Brackish water farming:*** In West Bengal, this primarily refers to human-impounding coastal marshes known as ***"bheries."***It is also practised in Kerala and is referred to there as "pakkali."
   After the launch of an ***All India Coordinated Research Project (AICRP)*** on "***Brackish Water Fish Farming" by ICAR***, this method of aquaculture has gained recognition.
3. ***Shrimp farming:*** Shrimps from the sea are raised here for human consumption. The establishment of the ***Brackishwater Fish Farmers' Development Authority*** in maritime states has greatly aided the development of shrimp farming in Andhra Pradesh, Odisha, Tamil Nadu, Kerala and West Bengal.
   The Andhra Pradeshian district of Nellore produces so much shrimp that it has acquired the title of Shrimp Capital of India.
4. ***Mariculture:*** This area of aquaculture focuses on growing marine organisms for food and other items in ponds, tanks, enclosed seas, open ocean, or enclosed seas. The three main food items are fish, prawns and oysters.
   A few examples of non-food items are fish meat, nutritional agar, jewellery and cosmetics.
5. ***Integrated Multi-Trophic Aquaculture:*** This kind uses leftovers from one species as raw materials for another Fed To establish balanced systems for environmental and economic sustainability as well as social acceptability, aquaculture (ex. fish, shrimp) is integrated with inorganic extractive (ex. seaweed) and organic extractive (ex. shellfish).
6. ***Fish farming:*** These entail large-scale commercial fish farming in tanks or other water enclosures. The most common fish species raised for fish farming include salmon, catfish, cod, carp and trout.
7. ***Paddy-cum-fish culture***: Fish are raised on rice fields that are inundated with water during paddy sowing in several areas of the country. Strong dykes or field barriers are built to stop fish from escaping during floods. Research has demonstrated that the paddy-fish cultivation system is effective at reducing methane and other GHG emissions. Due to the fact that the soggy rice fields in the North East provide a natural habitat for fish, the practise of growing fish from the rice fields likely began with the beginning of rice cultivation itself.
   Co-culture systems improve the lives of progressive farmers and poor rural residents while lowering greenhouse gas emissions and increasing farm profitability.

Fisheries in India

- India is the world's second-largest producer of inland fish and the third-largest producer of fish overall.
- Over 14 million workers employed totally, partially, or in ancillary operations are provided by the sector.
- From 2014–15 to 2018–19, the average yearly growth in fish output in India was 7.53%.
- India contributes 7.58% of the world's total fish production, making it one of the top producers in the world.
- The sector provides 7.28% (2018–19) to the agricultural GVA and 1.24% to India's Gross Value Added (GVA).
- With an outstanding average annual growth rate of roughly 10% in recent years, the export of marine products reached 13.93 lakh metric tonnes and a value of Rs 46,589 crores (USD 6.73 billion) during the 2018–19 fiscal year.

Measures taken to improve the fisheries sector

National Policy on Marine Fisheries, 2017' (NPMF) This offers recommendations for advancing the "Blue Growth Initiative," which aims to usher in the "***Blue Revolution" (NeeliKranti***) by sustainably utilising fisheries wealth from the nation's marine and other aquatic resources for enhancing the lives and livelihoods of fishermen and their families.

Blue revolution: With the goal of increasing overall fish production responsibly and sustainably for economic prosperity, the restructured Blue Revolution Plan Scheme for Integrated Development and Management of Fisheries has been approved with a total central outlay of Rs 3000 crore for implementation over a five-year period (2015–16 to 2019–20).

- To update the fishing industry, paying particular attention to innovative technology.
- To ensure nutritional and food security.
- To create jobs and gain money from exports.
- To promote inclusive growth and support aquaculture and fishing farmers.

The Blue Revolution scheme has the following ***components:***

- National Fisheries Development Board (NFDB) and its activities.
- Development of Inland Fisheries and Aquaculture.
- Development of Marine Fisheries, Infrastructure and Post-Harvest Operations.
- Strengthening of Database & Geographical Information System of the Fisheries Sector.
- Institutional Arrangement for Fisheries Sector.
- Monitoring, Control and Surveillance (MCS) and other need-based Interventions.
- National Scheme of Welfare of Fishermen.

Pradhan Mantri Matsya Sampada Yojana (PMMSY)

- Approved in 2020, this is a scheme to bring about Blue Revolution through sustainable and responsible development of fisheries sector in India.

This sector has enormous potential to help India reach its goal of a $5 trillion GDP. Therefore, more innovative, scientific fishing, post-processing and marketing-related strategies are required to boost the Indian fisheries sector.

10 WATER RESOURCES

One of the most valuable natural resources and a crucial component of a nation's socioeconomic development is water. Water is used for a variety of things, including drinking, bathing, washing, irrigation and industrial processes. Therefore, it is a necessary component of life.

Water covers over 71% of the surface of the globe.

India's Water Resources

- India makes up 4% of the world's water resources and around 2.45% of its surface area.
- India's primary source of fresh water is rainfall.
- India receives 4000 cubic kilometres of water from precipitation alone (including snowfall), most of which is lost to evaporation and plant transpiration.
- However, there are fewer utilisable water resources available due to numerous topographic restrictions and uneven distribution of water resources through time and location.

The availability from surface water and replenishable groundwater is 1,869 cubic km.

Out of this only 60% can be put to beneficial uses; Thus, the total utilisable water resource in the country is only 1,122 cubic km.

Area of the country as % of World Area	2.4%
Population as % of world Population	17.1%
Water as % of World water	4%
Rank in per capita availability	132
Rank in water quality	122
Average annual rainfall	1160 mm (world average 1110 mm)
Range of distribution	150-11690 mm
Range Raniny days	5-150 days, Mostly during 15 days in 100 hrs
Range PET	1500- 3500 mm
Per capita water availability (2010)	1588m^3

Water is available on earth in two different forms.

Surface WaterGround Water

Surface Water: On Earth, this form can be found as rivers, lakes, ponds, canals, etc.

Rivers are the most significant source of surface water among them. India is fortunate to have many large, medium-sized and small-sized rivers.

In all of India's river basins, the mean annual flow is thought to be 1,869 cubic km.

However, only roughly 690 cubic km (32%) of the available surface water can be used due to topographical, hydrological and other limitations.

13 of them, with a combined catchment area of 252.8 million ha, are important rivers.

With a catchment area of around 110 million ha, the Ganga-Brahmaputra-Meghna system is the largest of the great rivers.

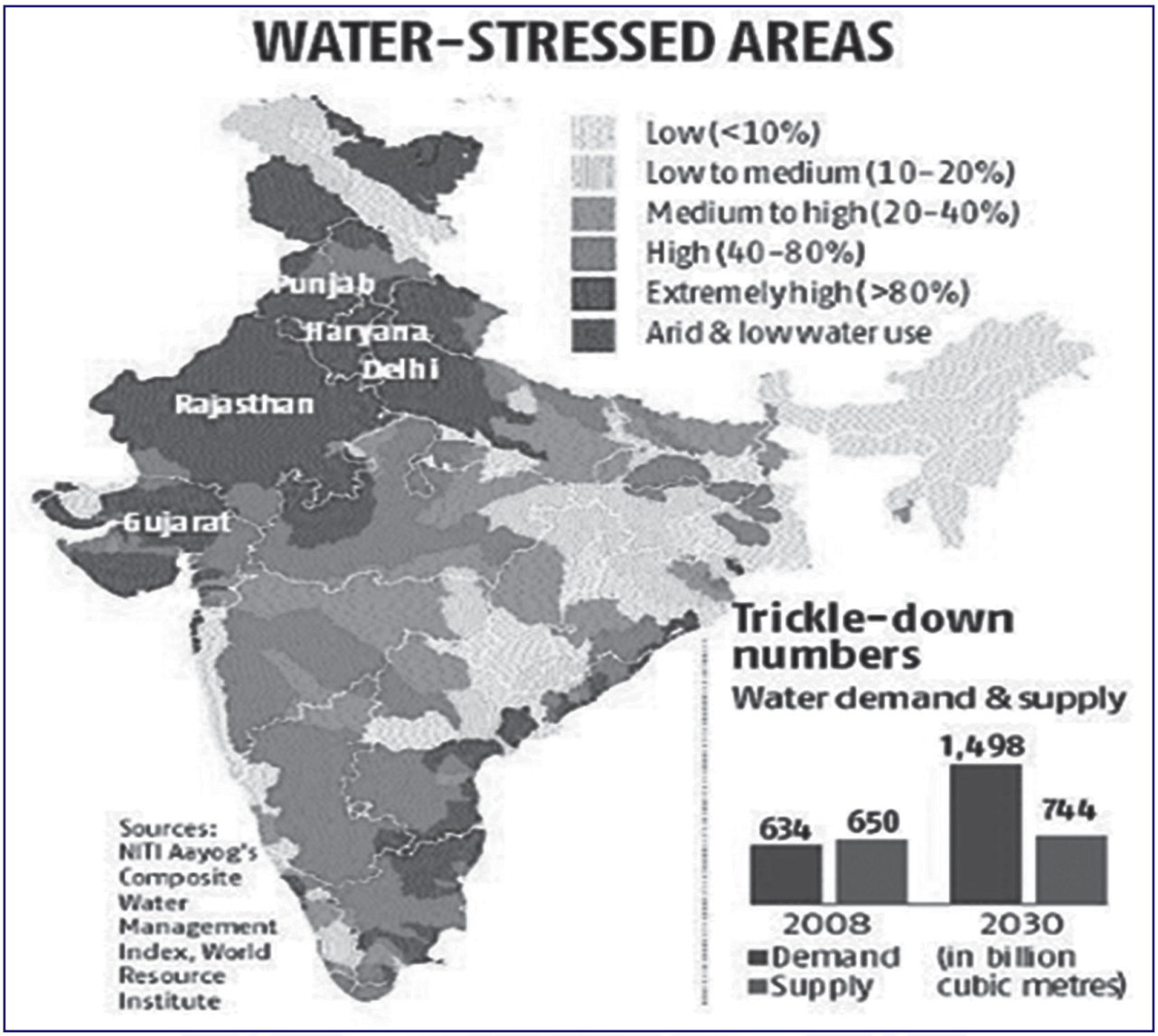
- About 40% of utilizable surface water resources are in the Ganga-Brahmaputra-Meghna System.

Ground Water: A portion of the rainwater percolates through the rocks and soils and becomes groundwater that is accessible to us.

According to the most recent estimate, the nation's annual replenishable ground water resource is anticipated to be 433 billion cubic metres (bcm), of which 399 bcm is thought to be suitable for development for a variety of uses. About 46% of these are replenishable groundwater resources and two of these are the Ganga and Brahamaputra basins.

The level of groundwater utilisation is relatively high in the river basins lying in north-western region and parts of south India.

- The states of Punjab, Haryana, Rajasthan and Tamil Nadu use a lot of groundwater.



- But certain states, including Chhattisgarh, Odisha, Kerala and others, only use a small percentage of their groundwater potential.
- Moderate groundwater use is occurring in states like Gujarat, Uttar Pradesh, Bihar, Tripura and Maharashtra.
- Additionally, the peninsular plateau area, which is mostly made up of hard rocks, is not very conducive to the exploitation of ground water resources.

Water Demand and Utilisation

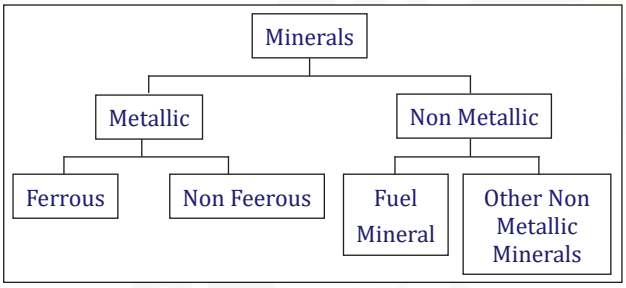
- India has historically had an agrarian economy and relied on agriculture for around two thirds of its population.
- At the moment, irrigation needs dominate India's water demand.
- The majority of surface and groundwater use is for agriculture, which uses 89% of the surface water and 92% of the groundwater.
- While the percentage of the home sector is higher (9%) in surface water utilisation as compared to groundwater, the share of the industrial sector is only allowed to use 2% of surface water and 5% of groundwater.

Conclusion Water is one of the most basic, widely used and exploited natural resources and it is perhaps on par with the other essential natural resources for life's survival. Although India has abundant water resources, most of it is getting wasted due to mismanagement, pollution, lack of wastewater management and other such reasons. Water, being the most important resource for survival, should be conserved. The Government as well as the common masses has to work hand in hand in order to conserve water

11 MINERAL RESOURCES

India is blessed with an abundance of different minerals. India has been favoured in providing a wide variety of minerals due to its large size and diverse geological formations.

According to estimates, India is home to close to 100 minerals, of which 30 might be regarded as significant.



Metallic Minerals

- These contain metals in them. Iron ore, copper, Manganese, Nickel, etc. are important examples.
- These are further divided into.
  - **(a)** ***Ferrous Minerals:*** These have iron content in them.
    Iron-ore, Manganese, chromite, tungsten, nickel, cobalt are important examples.
  - **(b)** ***Non-Ferrous Minerals:*** These do not have iron content.
    Gold, silver, copper, lead, bauxite, tin, magnesium are important examples.

Non-Metallic Minerals

- These do not contain metal.
- Limestone, nitrate, potash, dolomite, mica, gypsum are important examples.
- Coal and petroleum are also non-metallic minerals. They are used as fuel and hence are known as mineral fuels.

There are ***five major mineral belts*** in India namely:

- Northern Belt.
- Central Belt.
- Southern Eastern region.
- South Western region.
- North-Western region.

Northern Belt: The Northern Belt comprise of the following regions-

Chhota Nagpur Plateau: Minerals found in this region is Kynite (100%), Iron (90%), Chromium (90%), Mica (75%), Coal (70%).

Manganese, copper and limestone are some other minerals found in this region.

Assam Petroleum reserve: This region comprises the reserves of petroleum and lignite coal, tertiary coal, etc.

Central belt: This region comprises the ***Chhattisgarh and Maharashtra region*** which is the extension of the Chhota Nagpur plateau.

- There are ***huge reserves of Iron and limestone*** in Chhattisgarh.
- ***Godavari-Wardha valley*** with ***huge coal reserves*** lies in this region.

South Eastern region

Eastern Karnataka: In this region, Bellary and Hospet are known for their iron reserves.

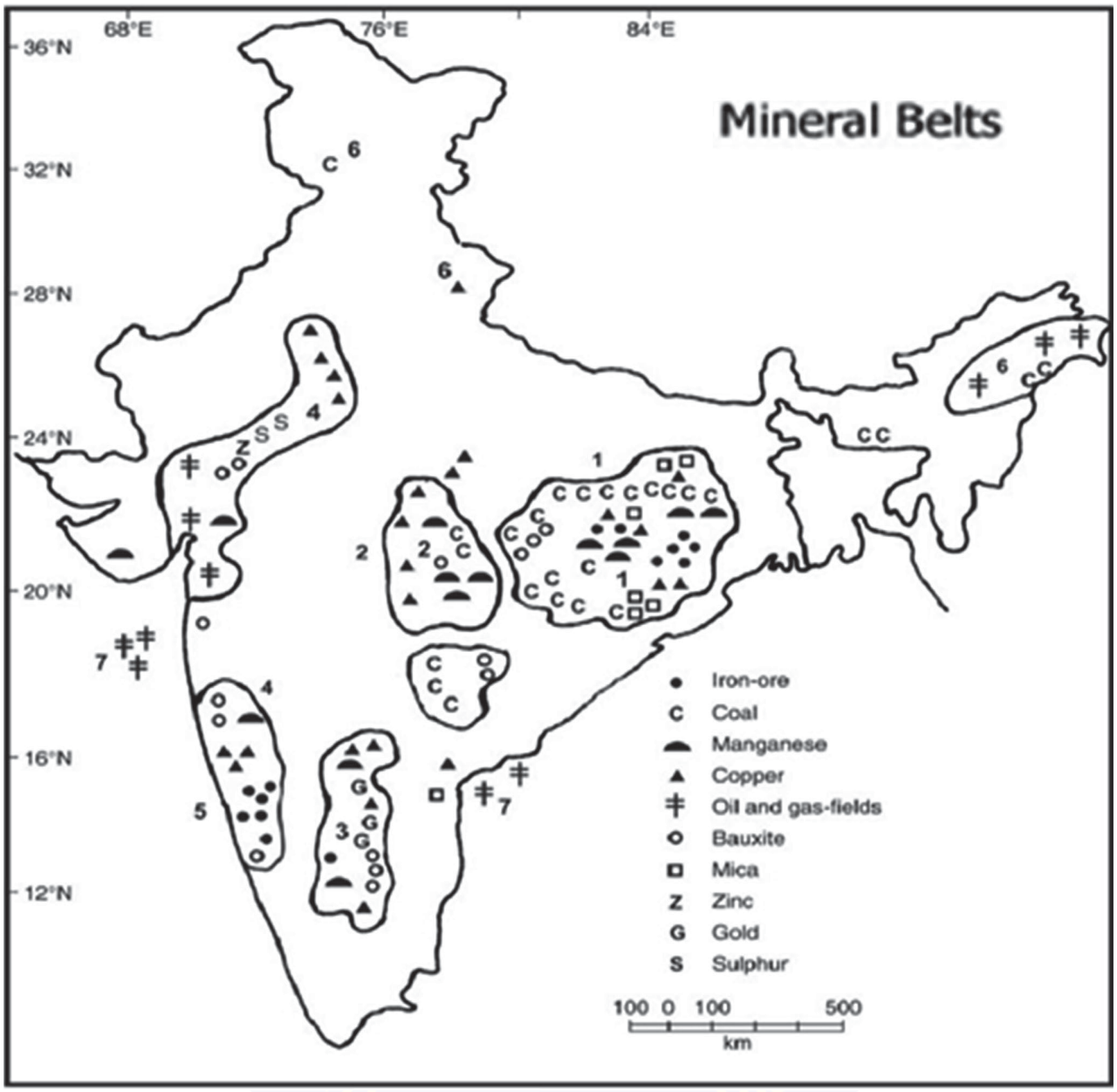
Andhra Pradesh: Cuddapa and Kurnool region are major mining centres. Nellore in Andhra Pradesh is known for Mica reserves.

Telangana: Telangana is known for Bauxite reserves.

Tamil Nadu: Tamil Nadu has the highest ***lignite coal*** reserves in India.

South Western region

- ***Karnataka: Dharwad region of Karnataka*** is known for its high mineral reserves.
  - Shimoga, Chitradurg, Yumkur, Chikmaglur are some other areas with high mineral reserves.
- ***Goa is known for its rich iron reserves.***
- ***Ratnagiri in Maharashtra also has iron reserves.***



North Western region

This region consists of the areas Rajasthan and Gujarat along the Aravalli Range. Gujarat is known for its petroleum deposits. Gujarat and Rajasthan both have rich sources of salt.

Example: Salt from Kutchh and Playa Lake of Rajasthan.

Rajasthan is rich in building stones i.e. sandstone, granite, marble. Gypsum and Fullers earth deposits are also extensive. Dolomite and limestone provide raw materials for the cement industry.

Iron Ore: It is a metal that is widely used and the foundation of contemporary civilisation. Ore is where iron is extracted and different varieties of ore contain varying amounts of iron.

Haematite: This contains about 70% metal found in the peninsular Indian rock systems of Dharwad and Cuddapah.

States like Odisha, Jharkhand, Chhattisgarh and Andhra Pradesh contain the majority of it. Karnataka, Maharashtra and Goa have the highest concentration in the western part.

Magnetite

Second-best ore, varied in metallic content from 60 to 70%. These are found in the Dharwad and Cuddapah systems and have a magnetic quality.

Karnataka, Andhra Pradesh, Rajasthan, Tamilnadu and Kerala have the majority of the reserves.

Limonite

These are subpar ores since they only contain 40–60% iron metal. These can be found in the Kangra Valley of Himachal Pradesh, the Raniganj Coal Field, Garhal in Uttarakhand and Mirzapur in Uttar Pradesh.

Reserves

- Haematite and Magnetite are two most important iron ores in India.
- About 97% of magnetite ore resources are located in four states of Karnataka (73%), Andhra Pradesh (14%), Rajasthan (5%) and Tamilnadu (4.9%).
- Major source of Haematiteare located in Odisha, Jharkhand, Chhatisgarh.

Production and distribution

- India is the 4th largest world producer ofiron ore.
- The major iron ore belts in India are listed below:
  - Odisha-Jharkhand belt.
  - Durg-Bastar-Chandrapur belt in Chattisgarh.
  - Ballari-Chitradurga-Chikkamagaluru-Tumakuru belt in Karnataka.
  - Maharashtra-Goa belt.

Orissa is the largest producer of Iron ore in India. Orissa accounts for over half of India's iron ore production, produced 120 million tonnes during the 2019/2020 year.

2. Manganese

- It serves as a fundamental raw material for the production of alloys and is a crucial mineral for the production of iron and steel.
- After Zimbabwe, India has the second-largest manganese ore deposits in the world.
- India is the fifth-largest producer of manganese ore after Brazil, Gabon, South Africa and Australia. The total manganese ores are spread among Odisha (44%) and Karnataka (22%), Madhya Pradesh (13%), Maharashtra (8%) and Andhra Pradesh (4%), as well as Jharkhand and Goa (3% each).
- The primary states that produce manganese are Maharashtra, Madhya Pradesh, Odisha, Andhra Pradesh and Karnataka.
- Less than 1/5 of total production is exported, while more than 4/5 of it is consumed domestically.

3. Copper

- Copper ore can be found in veins, dissemination and bedded deposits in both older and younger rock formations.
- Because most ores only contain a little amount of the metal, mining for copper is an expensive endeavour.
- Indian ore grade typically averages less than 1% metal content, compared to the 2.5% global average.
- Around half of the nation's copper ore is found in Rajasthan, followed by Madhya Pradesh and Jharkhand.
- Andhra Pradesh, Gujarat, Haryana, Karnataka, Maharashtra, Meghalaya, Nagaland, Odisha, Sikkim, Tamilnadu, Uttarakhand and West Bengal are responsible for the remaining states.
- Rajasthan and Madhya Pradesh are India's top two copper-producing states in terms of production.
- The production of copper ore in the country always falls short of our requirements and India has to import copper from other countries; of which the major supply comes from USA, Canada, Zimbabwe, Japan and Mexico.

5. Nickel

- The significant amounts of nickiliferous limonite are found in the Jajapur area of Odisha. It doesn't naturally occur free and is found in conjunction with copper.
- In Jharkhand, nickel is found in sulphide form.
- Other significant nickel deposits can be found in Rajasthan, Kerala and Karnataka.
- Odisha contains 92% of the world's nickel reserves.
- Karnataka, Nagaland and Jharkhand each receive a portion of the rest.

6. Lead and Zinc

- Due to its malleability, softness, weight and poor heat conductivity, lead is an extensively utilised metal.

- It doesn't naturally occur as a free compound but rather as a cubic sulphide called galena.
- Galena is found in veins in calcareous slates, sandstones and limestones.
- Lead and zinc are both present in zinc, which is a mixed ore that is found in veins with galena and other sulphide ores.
- The highest lead-zinc ore reserves are in Rajasthan, followed by Andhra Pradesh, Madhya Pradesh, Bihar and Maharashtra.
- Gujarat, Meghalaya, Odisha, Sikkim, Tamil Nadu, Uttarakhand and West Bengal have resources as well.
- Rajasthan is the source of almost the entire production.

7. Bauxite

- Bauxite is a crucial mineral for the production of aluminium.
- Odisha is the state with the most bauxite resources in the nation, with 52% of the total, followed by Andhra Pradesh, Gujarat, Chattisgarh, Maharashtra, Madhya Pradesh and Jharkhand.
- Odisha is the top producer in terms of output, followed by Chattisgarh.

8. Gold

- Due to its widespread use, it is a precious metal that is also used to make jewellery and serves as an international money.
- Karnataka has the largest reserves in terms of metal content, followed by Rajasthan, reserves, Bihar, Andhra Pradesh and Jharkhand.
- Karnataka is the top producer in terms of output, followed by Andhra Pradesh.
- In addition to the mines in the aforementioned regions, some gold is also extracted from the sands and gravels of various rivers.
- Placer deposits are referred to as such deposits.
- Sands from Kerala's Subarnarekha River and other rivers are used to extract alluvial gold.

9. Silver

- Agentine, stephanite and pyargyrite are the main silver ore minerals.
- It can also be discovered mixed with a variety of other metals, including copper, lead, gold, zinc, etc.
- The primary source of production is the Zawar mines in Rajasthan's Udaipur district.
- Karnataka and Andhra Pradesh both generate a little amount of silver.

2. Non-Metallic Minerals

1. Mica

- Major mica-bearing ores can be found in Andhra Pradesh, Bihar, Jharkhand, Maharashtra and Rajasthan. Due to its insulating qualities, it is a valuable mineral in the electrical and electronics industry.
- Rajasthan, Odisha, Maharashtra, Bihar and Jharkhand are next in line, each with a 41% part of the nation's mica resources.
- India is the only country with a monopoly on the production of mica, accounting for about 60% of global production.
- Rajasthan, Jharkhand and Andhra Pradesh are the three states that produce the most mica in India.
- India is the world's largest exporter of mica in addition to being its greatest producer.

2. Limestone

- Rocks made of calcium carbonate or magnesium carbonate are linked to this.
- They are sedimentary in nature and can be found in nearly all geological time periods, from the Precambrian to the Recent, with the exception of Gondwana.
- Karnataka is the most resource-rich state, accounting for 28% of all resources. It is followed by Andhra Pradesh, Rajasthan, Gujarat, Meghalaya and Chhattisgarh.
- Six states—Andhra Pradesh and Telangana, Rajasthan, Madhya Pradesh, Gujarat, Tamil Nadu and Karnataka—produce over three-fourths of the country's total limestone.

3. Dolomite

- Limestone that contains more than 10% magnesium is referred to as dolomite.
- The distribution of this resource includes Madhya Pradesh (29%) and the states of Andhra Pradesh, Chattisgarh, Odisha, Karnataka, Gujarat, Rajasthan and Maharashtra.
- The major producer of dolomite in India, Chhattisgarh accounts for more than 30% of the nation's total output.

- Dolomite is primarily used economically in the metalworking industry as refractories and flux in blast furnaces.

4. Asbestos

- This is highly valuable commercially because of its fibrous structure, ability to break down into filaments and high tensile strength.
- A little amount of asbestos is produced in Jharkhand, Madhya Pradesh, Chhattisgarh, Tamil Nadu, Gujarat, Uttarakhand and Nagaland. Almost all of the asbestos in India is produced in two states: Rajasthan and Andhra Pradesh.

5. Kyanite

- This material is found in metamorphic aluminous rocks and is employed in the glass, cement, electrical, refractory, ceramic and metallurgical sectors.
- The greatest deposit of kyanite in the world is found in India, with Andhra Pradesh alone accounting for more than 78% of the nation's resources, followed by Karnataka (13%) and Jharkhand (6%).
- The remaining 3% of resources are in West Bengal, Kerala, Maharashtra, Rajasthan and Tamil Nadu.
- The two states that produce the most kyanite are Maharashtra and Jharkhand.

6. Gypsum

- It is a hydrated calcium sulphate that is found in beds as a white, opaque or translucent mineral in sedimentary formations like limestones, sandstones and shales.
- The cement industry and the production of ammonia sulphate fertiliser are its two main uses.
- It is utilised in the ceramics industry to create moulds and plaster of Paris.
- Rajasthan has 81% of the resources in the states and Jammu & Kashmir has 14%.
- The remaining 5% of resources are located in Tamil Nadu, Gujarat, Himachal Pradesh, Karnataka, Uttarakhand, Andhra Pradesh and Madhya Pradesh.
- In India, Rajasthan produces the most gypsum, followed by Tamil Nadu and Jammu & Kashmir.

7. Diamonds

- These are used extensively in jewellery and for cleaning the surfaces of metals, minerals and cutting gems.
- Cutting edges of drills used for mineral exploration and mining are where diamonds are most commonly employed in industry.
- The primary diamond-bearing regions are the Anantpur district in Andhra Pradesh and the Panna belt in Madhya Pradesh.
- The Raichur-gulbarga belt in Karnataka is one region with recent field discoveries.

8. Atomic Minerals

- Two important atomic minerals are uranium and thorium.
- The Department of Atomic Energy in India established the Atomic Mineral Directorate (AMD), which is in charge of conducting geological exploration of deposits of uranium and thorium.
- These minerals give the nuclear industry the foundation it needs.
- Jharkhand, Chhattisgarh, Madhya Pradesh, Andhra Pradesh and Meghalaya are among the Indian states with uranium reserves.
- Uranium and Thorium have been discovered in the study of magnetic rock samples from the Nubra-Shyok valley in Ladakh.
- According to the study, the amount of uranium present in these rocks is unusually high when compared to the 0.1% or even less found in ore discovered elsewhere in the nation.
- On the east and west coasts, as well as in some locations in Bihar, the monazite sands also contain uranium deposits.
- The largest concentration of Monazite sand is on the Kerala coast.
- Kerala, Jharkhand, Bihar, Tamil nadu and Rajasthan are the main producers of Thorium in India.

9. Salt

- Rocks, brine springs, wells, salt pans in lakes and seawater are all sources of salt.
- In Gujarat and Himachal Pradesh's Mandi area, rock salt is extracted.
- Salt is produced in Gujarat, Maharashtra and Tamil Nadu using sea brine.
- Nearly half of our salt is produced on the Gujarat coast.

❖❖❖❖

12 ENERGY RESOURCES

Fuels including coal, oil, gas, uranium and electricity can all be used to produce energy.

Two categories of energy resources exist:

Conventional: Conventional sources include wood, coal, petroleum, natural gas, cattle dung cake and electricity.

Non-conventional: energy sources include solar, wind, tidal, geothermal, biogas and atomic energy, for instance.

Firewood and animal dung cake are the most often used fuels in rural India.

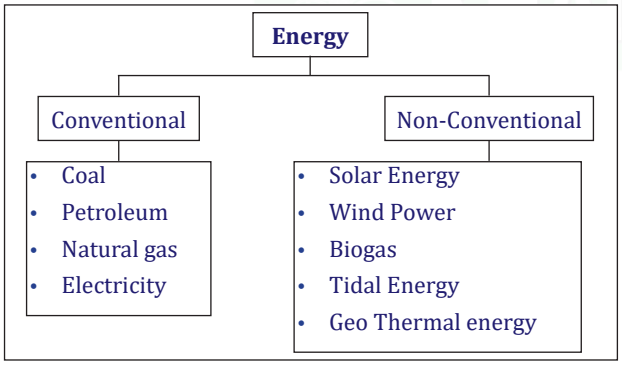
More than 80% of India's energy requirements are satisfied by three fuels: coal, oil and solid biomass.

The growth of industry and power generation has been powered by coal, which is still the most significant single fuel in the energy mix.

With rising car ownership and usage of roads for transportation, oil consumption and imports have expanded dramatically.

Despite being a declining part of the energy balance, fuelwood, in particular, is still widely used as a cooking fuel.

660 million Indians have yet to fully shift to modern, clean cooking fuels or technology, despite recent successes in expanding LPG access in rural areas.



Conventional Energy: They are non-renewable in nature, which means that once a sample of a conventional energy source has been depleted, it cannot be used again.

Coal: In India, coal is the fossil fuel that is most widely accessible. It provides a sizable share of the nation's energy needs.

- It is used to supply energy to business and homes as well as to produce power.
- India's commercial energy requirements are largely met by coal.
- Plant material has been compressed for millions of years to produce coal.
- Due to the degree of compression, as well as the depth and length of burial, coal can be found in a variety of shapes.
- Plants that die in marshlands make peat.
- It has a minimal heating capacity, little carbon content and moisture content.
- India is the world's second-largest consumer of coal, accounting for around 84.8 percent of global consumption of 1,139,471,430 tonnes.
- India imports 22% of the coal it consumes.

Petroleum

- The majority of petroleum discoveries in India are linked to tertiary rock strata anticlines and fault traps.
- Oil is trapped in the crest of the upfold in areas where there are folds, anticlines, or domes.
- The limestone or sandstone that makes up the oil bearing stratum is porous, allowing oil to pass through it. Non-porous intervening layers prevent the oil from rising or sinking.
- Additionally, petroleum can be found in rock types with and without pores that form fault traps.
- Gas often floats above oil because it is lighter than it.
- Mumbai High, Gujarat and Assam are significant oil production regions in India.

- India is the third-largest oil user in the world, using roughly 4.6% of the 97,103,871 barrels per day that are used globally.
- 96 percent of India's oil usage is imported.

Natural gas

- Natural gas is the fuel of the twenty-first century because of its low carbon dioxide emissions, making it a fuel with positive environmental effects.
- The Krishna-Godavari basin has been found to contain considerable natural gas resources.
- The Gulf of Cambay's discoveries have increased the reserves of Mumbai High and related fields along the west coast.
- Significant natural gas resources can also be found in large quantities on the Andaman and Nicobar Islands.
- The largest consumer of natural gas in India during the fiscal year 2021 was the fertiliser sector.
- India's annual natural gas consumption as of 2017 was 1,957,546 million cubic feet.

Electricity

- Two main processes are used to generate electricity: hydroelectricity, which is created when water flows through turbines and thermal power, which is created when fuels like coal, oil and natural gas are burned.
- Hydroelectricity is produced by swiftly moving water, a renewable resource.
- In India, a number of multipurpose projects, such as the Bhakra Nangal, Damodar Valley Corporation and the Kopili Hydel Project, create hydroelectric electricity.
- Thermal electricity is produced from coal, oil and natural gas.
- Thermal power plants use fossil fuels that are not renewable to produce energy.
- In India, utilities produced 1,383.5 TWh of gross electricity in fiscal year (FY) 2019–20, while non-utilities produced 1,598 TWh of total electricity.
- The gross power consumption per person in FY2019 was 1208 kwHz.

Non-Conventional Sources of Energy

Natural processes continuously replenish renewable energy sources, often known as non-conventional energy.

These aren't where the pollution comes from.

Solar Energy

- Solar energy is produced by sunlight. Depending on the kind of power needed, the photovoltaic cells are exposed to sunlight.
- The energy is utilised to heat food and distil water.
- In various parts of India, some sizable solar power plants are being constructed, which would lessen the dependency of rural residents on dung cakes and firewood.
- Resulting in the preservation of the environment and a sufficient supply of manure for agricultural use.
- From 2.6 GW in March 2014 to 30 GW in July 2019, solar power capacity has increased by more than 11 times in the last five years.
- In India, solar costs are presently extremely competitive and at grid parity.

Wind power

- Water pumps for irrigation systems are typically powered by wind energy, which is produced by harnessing the wind's energy.
- India is the second-largest nation in terms of wind energy production.
- The largest wind farm cluster, which stretches from Nagercoil to Madurai, is in Tamil Nadu.
- Major wind farms are also present in Andhra Pradesh, Karnataka, Gujarat, Kerala, Maharashtra and Lakshadweep, in addition to these.
- The overall wind power potential of the nation is 302 GW at 100 metres and 695.50 GW at 120 metres above the ground, according to a recent assessment.
- With regard to installed wind capacity, the nation is now ranked fourth in the globe and produced around 60.149 billion units in 2020–2021.

Geothermal Energy

- Geothermal energy is the name for the heat and power produced by using heat from the Earth's interior.
- Because the Earth becomes hotter as you travel deeper inside it, geothermal energy exists.
- In such cases, the groundwater heats up because it absorbs heat from the rocks.
- It is so hot that it condenses into steam when it reaches the earth's surface.
- This steam creates electricity by turning turbines.
- Two geothermal energy capturing pilot projects have been constructed in India. One is in the Parvati Valley in Manikaran, Himachal Pradesh and the other is in the Puga Valley, Ladakh.
- India has a sizable geothermal energy potential; it is estimated that India has a geothermal power potential of around 10,000 MW, which could be utilised for a variety of purposes.

Nuclear or Atomic Energy

- It is made by altering the arrangement of atoms.
- A significant quantity of energy is released during such a transition in the form of heat, which is subsequently utilised to produce electricity.
- Atomic and nuclear energy are produced using the elements uranium and thorium, which are found in the Aravalli Mountains of Rajasthan and Jharkhand, respectively.
- Thorium concentrations in Kerala's monazite sands are also significant.
- India's fifth-largest source of electricity is nuclear power. With around 23 nuclear reactors spread throughout seven power plants across the country, India is also placed seventh in terms of the number of nuclear reactors, generating 6780 MW of nuclear energy.

Hydro Power Energy Sources

- Hydropower or hydroelectricity is the process of turning the kinetic energy of moving water into electricity.
- Hydropower is a renewable type of energy because it uses water to produce electricity rather than consuming it outright, leaving this essential resource available for other uses.
- The cheapest and cleanest source of electricity is hydropower, but building major dams comes with a number of environmental and socioeconomic drawbacks, as seen in the Tehri, Narmada and other projects. On the other hand, little hydropower is unaffected by these problems.
- In India, there are 197 hydroelectric facilities.
- In India, authority grew at the end of the nineteenth century. In 1897, electricity was introduced to Darjeeling and in 1902, a hydropower plant in Shivasamudram, Karnataka, was opened.
- India's installed utility-scale hydroelectric capacity was 46,000 MW as of March 31, 2020, accounting for 12.3 percent of the country's total utility power production capacity.

Tidal Energy

- Utilizing the force of the ocean's tides results in tidal energy. This supply hasn't been used yet because there aren't any efficient methods available.
- You could harness ocean tides to generate electricity.
- On either side of inlets, floodgate dams are built.
- Ideal locations for utilising tidal energy in India include the Gulf of Khambhat, the Gulf of Kachchh in Gujarat on the western coast and the Gangetic delta in the West Bengali Sunderban regions.
- India has an estimated 54 gigawatts (GW) of ocean energy potential, of which 12.45 GW are from tidal power and the rest from waves (41.3 GW)
- By the years 2022 and 2030, India hopes to have 175 GW of installed capacity.

Energy Consumption in India

- By 2040, as India's Gross Domestic Product (GDP) increases to $8.6 trillion, it is expected that the country's primary energy consumption would have quadrupled.

- India will account for nearly a quarter of the world's energy consumption between 2019 and 2040, which is the fastest-growing market.
- Its expansion of renewable energy is second-fastest. China is in the lead.
- India's electricity grid will surpass that of the EU by the year 2030.
- By 2040, India's per capita ownership of automobiles would have increased fivefold, making it the country with the fastest-growing oil consumption.
- India's rising energy needs will make it more dependent on imported fossil fuels, as domestic oil and gas production has been stagnant for years despite government plans to increase both renewable energy and petroleum exploration and production.
- India's oil demand is expected to increase by 74% to 8.7 million barrels per day by 2040.
- By 2040, India will be the fastest-growing natural gas market, with demand more than doubling.
- India's electrical industry is now dominated by coal, which accounts for more than 70% of total generation.
- Demand for coal is expected to increase to 772 million tonnes by 2040, up from the current 590 million tonnes.
- India has the fastest-growing global energy consumption between 2019 and 2040, accounting for about a quarter of it.
- It has the second-highest rate of renewable energy expansion. China is in first place.

Conclusion

Coal, petroleum, natural gas, uranium and electricity are all fuel materials that may be used to create energy. Energy saving methods are being used in order to lessen society's environmental effect. Remember that conserving energy immediately benefits the environment. All forms of fuels used in the modern world, whether for heating, electrical energy generation, or other types of energy conversion activities, are considered energy resources.

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13 POPULATION AND GROWTH TRENDS – DENSITY, SEX RATIO, LITERACY, TRIBES AND RACIAL GROUPS IN INDIA

- A population is a distinct collection of people, whether that group is made up of a nation or a population that shares a certain trait.
- India is the second most populous nation in the world, after China, with a total population of 1,210.2 million as per the 2011 census.
- India is home to around 17.5% of the world's population, but only making up 2.4% of the planet's land area.
- According to a United Nations population report, despite a notable slowdown in recent years, India's population growth is still outpacing China's and is predicted to do so by 2028.
- India is anticipated to overtake China as the world's most populated nation after 2030.
- Censuses are used worldwide to obtain information on the population.
- A census count provides a spectrum of the population at a specific period, taking into account a wide range of demographic, social and economic factors.
- The first census in India was conducted in 1872, however it was not synchronised or thorough.
- In 1881, the first comprehensive and synchronised census that provided crucial demographic information for the entire nation was carried out.
- Since then, censuses are typically held every ten years.
- In terms of counting from 1872, the 2011 census is the sixteenth in India and the seventh after Independence.

Growth of Population: Basic concepts

Growth Rate :This is the net change in population between two points of time and is expressed in percentage.

Natural growth: The difference between the natural birth-rate and death-rate is called the natural growth of population.

Migratory growth: This growth of population is caused by migration of people.

Positive growth: When birth rates are higher than death rates, or when people migrate in, it results in positive growth.

Negative growth: This happens, when birth rates are lower than death rates; and when people migrate out.

Population growth in India

- Since 1901, there have been significant ***demographic divides***, as far as trends in population growth are concerned.
  - These significant turning points are the census years of 1921, 1951 and 1981.

Thus, the demographic history of India can be classified into the following four distinct phases:

Period of Stagnant population (1901-1921)

- During most of the 19th century, India witnessed sporadic, irregular and slow growth of population which drifted to 20th century until 1921.
- Thus, the population growth during this period can be termed as ***stagnant***, when compared to the growth rates during consequent periods.
- The high birth rate was balanced by high death rates during this period.
  - The ***high mortality*** during this period was the result of large scale deaths due to epidemics of influenza, plague, small pox, cholera, etc.
  - In addition, food shortages, loss of Indian lives during first World War, emigration of people to Africa contributed to lesser population growth rate as well.
- In fact, the census of 1921 recorded a ***negative growth rate*** of -0.31%, which happened only once throughout the demographic history of India.

- It is because of this decline in population, that the year 1921 is called the ***'Demographic Divide'*** in the demographic history of India.

Period of Steady Growth (1921-1951)

- During this period, the population increased from 251 million to 361 million, registering a growth of 47.3%
  - Thus, this period is called the period of ***steady growth rate.***
- The mortality rate reduced in India, as a result on improvement in general health and sanitation conditions after 1921.
  - The decline of death rates during this time, can be attributed to the distribution system as well, where the improved transportation delivered timely supply of food, to drought and famine stricken areas.
- On the contrary, the crude birth rate continued to stay at an abnormally high level.
  - Hence, population growth during this period is called the ***mortality induced growth.***

Period of Rapid High Growth (1951-81)

- After 1951. there was a steep fall in the mortality rate, but the fertility remained stubbornly high.
- Therefore, this period experienced very high rate of population growth and is often referred to as the ***Period of Population explosion.***
- The unprecedented growth rate was due to the accelerated developmental activities and further ***improvement in health facilities.***
  - The living conditions of people improved enormously and death rates declined.
  - Thus, this was ***fertility induced growth*** during this period.

Period of High Growth Rate with definite signs of slowing down (1981-2011)

Although the rate of growth was still very high, it started declining after 1981.

This declining trend marks the beginning of the new era in the country's demographic history.

The declining trend of birth rates during this period, were due to the official efforts of the state in birth control and people's own inclination for smaller families.

Although India's population growth rate continues to decline since 1971 (the year recorded highest ever growth rate of 2.48%/annum), yet India's population growth rate is much higher as compared to that of China, USA, Brazil etc.

Indian Population growth in tune with classical theory of Demographic transition

- During most of the 19th century, India witnessed a fluctuating but stagnant growth of population, which drifted into the 20th century until 1921.
- Thereafter, the country passed through all phases of demographic transition and is now widely believed to have entered the final phase, which is characterized by declining fertility.
- However, the ***UN Department of Economics and Social Affairs*** has estimated that India's population will continue to increase till 2050, after which it will start decreasing by the end of 21st century.

Spatio-Temporal Variations in Population growth

- The ***average population*** growth rate of 17.64% during 2001-11 doesn't give true picture, as there are differences in the growth rate with reference to space and time.
  - Hence the need to assess the ***spatio-temporal*** variations in population growth.
- The phenomenon of ***low growth*** has spread beyond the boundaries of the southern states during 2001-11, where in addition to Andhra Pradesh, Tamilnadu and Karnataka in the south, Himachal Pradesh and Punjab in the north, West Bengal and Odisha in the east and Maharashtra in the west have registered growth rate between 11-16% in 2001-11.
- ***Among smaller states*** and ***Union territories***, Dadar and Nagar Haveli, Daman & Diu registered the ***highest growth rate*** of 55.5% and 53.54% respectively, between 2001-11.
- A glaring down trend in the growth rate has been observed in ***Nagaland***, where there has been a steep fall in growth rate from 64.53% in 1991-2001, to negative growth rate of -0.47% in 2011 census.
- The second minimum growth rate of 4.86% has been recorded in ***Kerala.***
  - This state has reached ***high level of demographic transition*** and can be compare to the advanced countries of Europe and America.
- States which have registered ***very high growth rate*** of over 20% include – Bihar (25%), Jammu & Kashmir (23%), Chhattisgarh (22%) and Jharkhand (22%)
  - Other small states with higher growth rate are Meghalaya (27%) and Arunachal Pradesh (25%).

Census 2021

- The ***Census of 2021*** in India, will be a ***digital*** one.
- ***The home ministry*** has said that ***Census 2021*** will be carried out using a mobile phone app.

- It will be used to collect data by school teachers who will double up as enumerators during the Census exercise.
- The ministry also said that a Census portal has been developed.
- This is going to be ***16th Census*** as reckoned from 1872 and ***eighth after Independence.***

- There will also be a provision ***for self-enumeration*** this year.
  - The individual will fill in the required details with the help of relevant codes for each field. After self-enumeration is done, an identification number will be sent on the registered number provided by the individual.
  - The same ID number can be shared with the enumerator, which will help the official to sync the data automatically.
- However, The field activities related to thecensus 2021 exercise in the country have been ***postponed*** due to the ***COVID-19 pandemic.***

Density of Population

- Density of population is a better measure of understanding the variation in the distribution of population.
  - It is expressed as the number of people per unit area.
- According to the census of 2011 ,the ***population density*** of India is 382 people/ square km.
- The main cause of worry is that the Indian population density has been ***consistently increasing*** since 1921.

One of the most important aspects of India's population is its uneven distribution.

On one hand, population in India is highly concentrated in some pockets, such as in highly urbanized, industrialized and in areas of high agricultural productivity.

While on the other hand, there are virtually demographic deserts in high mountains, arid lands, thickly forested areas and in some remote corners of the country.

Major factors influencing the distribution and density of population

1. Terrain

- This is a potent factor which influences the ***concentration*** and growth of population.
- In general, ***plain areas*** encourage higher density of population, as compared to mountain regions.
  - It is because of this reason, that ***Himalayas*** which occupy 13% of India's land area, support only 1-2% of country's population.
  - Also, the great plain of North India which cover less than one-fourth of country's land area, is home to more than half of India's population.

2. Climate

- The twin elements of ***rainfall and temperature***, play an important role in determining the population of an area.
- Extremes of climate aren't favorable, while a moderate climate favors population concentration.
- It is said that, ***'the population map of India follows its rainfall map".***
  - As we move from Ganga-Brahmaputra delta in the east, to the Thar desert in the west, the amount of rainfall and density of population decreases.
- An ***exception*** to this, is the north-western region of India comprising of Punjab, Haryana and Western Uttar Pradesh, where high population concentration is evident because of the developed irrigation facilities.
- Since India is a ***tropical country***, temperature is fairly high and ***does not play as important role*** as is done by rainfall except in extreme areas.

3. Soil

- This factor plays an important role in an overwhelmingly ***agricultural country*** like India.
- In the northern plain of India, where soil in enriched by the great rivers, high population density is found.

- Similarly, the coastal plains with fertile soils have high population density.

- On other hand, deserts, mountains with infertile soil have lesser densities.

4. ***Water Bodies***
   - Water is a basic necessity for irrigation, industries, transport and domestic use.
   - And rivers are a greatest source of fresh water.
   - Hence, most population is concentrated in river valleys.
5. ***Mineral resources***
   - The higher population densities in the Chhota Nagpur plateau region and adjoining regions of Odisha are largely due to availability of minerals.
6. ***Industries***
   - Industrial growth offers massive employment opportunities and acts as a great magnet to attract people, resulting in higher densities.
   - Major causes of high density in West Bengal, Bihar, Jharkhand, Odisha, Maharashtra and Gujarat is the phenomenal growth of Industries in these states.
7. ***Transport***
   - The northern plains of India has a dense network of transport routes and hence is a densely populated region.
   - The peninsular plateau has moderate network of transport routes and is moderately populated area.
   - The Himalayan region badly lacks transport facilities and is sparsely populated.
8. ***Urbanization***
   - All urban areas are marked by high density of population, as evident in cities of Bangalore, Chennai, Mumbai and Delhi.

Distribution of Population in India

- ***Uttar Pradesh*** has the largest population of 199.5 million; followed by Maharashtra (112.3 million), Bihar (103.8 million), West Bengal (91.3 million) and Andhra Pradesh including Telangana (84.6 millions).
  - These five states account for about half of the country's population.
- According to the 2011 Census.
  - ***Sikkim*** has the ***smallest*** population among all the Indian states.
  - Delhi with 16.75 million has the largest population among all the Union territories.

14 LITERACY

The Population Commission of United Nations considers the ability, to both read and write a simple message with understanding in any language, a sufficient basis for classifying a person as Literate.

According to Census of India, "person aged seven and above, who can both read and write with understanding in any language, is treated as literate".

It was decided at the 1991 Census that all Children in the age group 0-6, would be treated as illiterate by definition and the population aged seven years and above only would be classified as literate or illiterate.

It should be noted clearly that, it is not necessary that to be treated as literate, a person should have received any formal education or acquired any minimum educational standard.

- Generally two types of it are calculated as below:
  - ***Crude Literacy rate*** = ((No of literate persons)/Total population)*100.
  - ***Effective literacy rate*** = ((Number of Literate persons aged 7 and above)/ Population aged 7 and above)*100.
  - Here, Effective literacy rate and literacy rate will be used interchangeably.

Literacy rate-Trends

- The effective literacy rate for India ***in Census 2011***, works out to ***74.04%.***
- The corresponding figures for ***male and female are 82.14% and 65.46%*** respectively.
- Improvement in Literacy rates when compared with 2001.
- Overall improvement – 9.21%.
- Improvement of literacy rate in male – 6.88%.
- Improvement of literacy rate in female – 11.79%.
- Literacy rate in urban areas was higher 87.7% than rural areas with 73.5%, according to 2011 Census.

Literates and Illiterates by Gender

- One of the interesting feature of Census 2011 is that out of total literates added during the decade, females out number males.
- The decadal (from 2001-2011) increase in number of literates among males is 31.98%; while the corresponding increase in case of females is of 49.1%.
- The above two changes are a clear indication of the fact that ***gender gap in literacy is shrinking*** in the country.
- ***Lakshadweep*** (96.11%) hold the first position in the country with respect to male literacy rate; while Kerala (96.02%) ranks second.
  - Bihar (73.39%) state has recorded the lowest male literacy rate.
- ***Kerala*** state holds the first rank, in female literacy with 91.98%.
  - Rajasthan (52.66%) state has recorded the lowest female literacy rate.

Regional Variations in Literacy Rates

Kerala ranks first in the country with a literacy rate of 93.91%, closely followed by Lakshadweep (92.28%) and Mizoram (91.58%).

Bihar with a ***literacy rate of 63.82% ranks*** last in the country, preceded by Arunachal Pradesh (66.95%) and Rajasthan (67.06%).

The gap in literacy rates of males and females is lowest in Meghalaya (3.1 percentage points) and less than 5 percentage points in the States of Kerala and Mizoram and between 5 to 10 percentage points in A&N Island, Chandigarh, Goa, Lakshadweep Nagaland, Punjab and Tripura.

The gap in literacy rates of males and females is highest in the State of Rajasthan (27.1 percentage points) and much more in the States of Chhattisgarh, Dadra & Nagar Haveli, Jammu & Kashmir, Jharkhand and Uttar Pradesh.

15 RACIAL GROUP IN INDIA

- Our present day population is a conglomeration of people belonging to different racial groups with different backgrounds.
- These people entered India from different parts of the world, at different points in time, adopting various land and water routes.
- Almost all the major races of the world are visible in India, as a result of which the country is said to have a varied and diverse ethnic composition.

1. *The Negritos*

- According to the Geographers, these were the earliest occupants of India.
  - Also, they have expressed their view that Negroid people migrated to India from Africa and established their language on the soil of India.
- These features are met with particularly amongst the Andaman islanders, the Uralis of Nilgiri Hills, Kadors of Kochi, Pullayans of Palni Hills, etc.
  - The tribes like the Angami Nagas in the North-East and Badgis in Rajmahal Hills in Jharkhand possess their traits.
- The race is characterized by short stature, darkchocolate brown skin, woolly hair, bulbous forehead, broad flat nose and slightly protruding jaws.

2. *The Proto-Australoids*

- These are believed to have come to India from the East Mediterranean area (Palestine), soon after the Negritos.
- Presently, they constitute the bulk of the population in many isolated parts of central and southern India.
- The Veddahs, Irulas and Sholagas are their true representatives.
  - The Bhils, Kols, Badagas, Korwas, Mundas, Bhumjis of the highlands of the Central India and the Chenchus, Kurumbas, Malayans and Yeruvas of South India may all be treated as their representatives as well.
- According to some Anthropologists, these people on their arrival pushed, displaced and supplanted the Negritos to shift to more inaccessible, remote and less hospitable areas, where they are found even today.
- In physical appearance, they more or less resemble the Negritos with the exception of woolly hair.
  - Their other physical characteristics are bulbous forehead, broad flat nose and slightly protruding jaws.

3. *The Mongoloid*

- It is believed that China is the homeland of the Mongoloid race, from where they were pushed southward into the Malaya Peninsula and Indonesia.
- They entered India through the passes in the northern and eastern mountains.
- Presently, they occupy large areas in Ladakh, Sikkim, Arunachal Pradesh and other parts of East India.
- Their physical characteristics include a round and broad head, face with very high cheek bones and a long flat nose, with little or no hair on the face and the body.
- The tribes of Garo, Khasi, Jaintia, Lipchas, Chakmas, Naga belong to this race.

- They are further classified as:
  - Paleo-Mongoloids– They were the first of the Mongoloids who came to India. These people are settled mainly in the border areas of the Himalayas. They are found mostly in Assam and the adjacent states.

- Tibeto-Mongoloids– These people came from Tibet and are settled mainly in Bhutan, Sikkim, areas of north-western Himalayas and beyond the Himalayas in which Ladakh and Baltistan are included.

4. The Mediterraneans

- This racial stock came to India from eastern Mediterranean region or South West Asia.
- They are believed to have migrated during the third and second millennium BC.
- Their physical characteristics include medium stature, dark skin and long head.
- In all probability, they first settled in North-western India and started practicing agriculture there; post which they were pushed into central and southern India by subsequent immigrants.
- Presently, they form the bulk of population of south India and a considerable proportion in northern India.
- The Mediterranean were the chief architect of the Indus Valley civilization as is evident from the excavations of Mohenjo Daro and Harappa.

5. The Nordics

- They spoke the Aryan language and migrated to India sometime during the second millennium BC.
- The main concentration of these people is in the north-western part of the country.
- They are a predominant type in Punjab, Haryana and Rajasthan
- The main characteristics of this race are long head, fair complexion, well developed nose and a well-built strong body.

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16 INDUSTRIES

On the basis of Strength of Labor

1. Large scale Industry.
   - These employ a large number of labourers in each unit.
   - Cotton and Jute textile industries are large scale Industries.
2. Medium scale Industries.
   - These employ neither large nor very small number of labourers.
   - Cycle industry, Electronic Industry are some examples of this type.
3. Small scale Industries.
   - These are owned and run by individuals, which employ small number of labourers.

On the basis of raw material and finished goods

1. Heavy Industries.
   - These use heavy and bulky raw-materials and produce products of the same category.
   - Iron and Steel Industry, present a good example of heavy industries.
2. Light Industries.
   - These use light raw materials and produce light finished products.
   - Electric fans, sewing machines are light industries.

On the basis of Ownership

1. Private sector Industries.
   - Industries owned by individuals or firms such as Tata groups, can be grouped under this category.
2. Public Sector Industries.
   - Industries owned by the state and its agencies like Bharat Heavy Electricals limited, Durgapur Steel Plant belong to this category.
3. Joint Sector Industries.
   - Industries owned jointly by the private firms and the state or its agencies such as 'Oil India Limited', belong to this group.
4. Co-operative sector Industries.
   - These are owned and run co-operatively by a group of people who are generally producers of raw materials.
   - Sugar mills owned and run by farmers belong to co-operative sector Industries.

On the basis of source of raw material

1. Agro based Industries.
   - These are those Industries which obtain raw-material from agriculture.
   - Cotton textile, Jute, Sugar, Vegetable oil are the industries of this category.
2. Mineral Based Industries.
   - These receive raw materials primarily from minerals such as iron and steel, aluminum, etc.
   - Cement Industry falls into this category.
3. Pastoral based Industries.
   - These are dependent on animals for their raw materials.
   - Hides, skins, bones, horns, diary, etc. are some of the examples.
4. Forest based Industries.
   - Paper card-board, rayon, tanning of leather, basket industries are included in this category.

Miscellaneous Industries

1. Village Industries.
   - These are usually located in villages and primarily cater to the needs of the rural people.
   - They usually employ local machinery and engage in activities such as oil extraction, grain grinding and agricultural implements.

2. Cottage Industries.
   - Industries where artisans set-up the implements in their own houses, work with wood, cane, brass, stone, etc. belong to this category.
   - Handloom, khadi and leather work at artisans' house fall in this category.
3. Consumer goods Industries.
   - These convert raw materials or primary products into commodities directly used by the people.
   - Textiles, Bakery products, sugar, etc. are some of the examples.
4. Ancillary Industries.
   - The manufacture parts and components of these Industries, are used by big industries for manufacturing heavy articles like trucks, buses, railway engines, tractors, etc.
5. Capital-Intensive Industries.
   - These require huge investments for their functioning.
   - Iron and steel, cement and Aluminum are examples of capital intensive Industries

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17 TRANSPORT AND COMMUNICATION

- Transport is a system in which passengers and goods are carried from one place to another.
- Development of cheap and efficient means of transport is necessary for the progress of a large and developing country like India.
- Transport routes are the basic ***economic arteries*** of the country.
  - And hence, the amount of traffic moving in a country is a measure of its progress.
- India is a vast country with ***long distances*** from Kashmir in North to Kanniyakumari in the south; Kandla in the west to Kohima in the East.
  - In addition, India has ***great diversity*** in economic, social, cultural and ethnic structure.
  - Hence, a ***well-knit transport system*** is essential to bring about unity in diversity.

Railways

- Indian railway system is the main artery of the country's inland transport.
- Railways virtually form the life-line of the country, catering to its needs for large scale movement of traffic, both freight and passenger, thereby contributing to economic growth and also promoting national integration.

Development and growth of Indian Railways

- The first railway line was opened for public traffic in 1853, between Mumbai and Thane.
- At present, India has the ***second largest railway network in Asia*** and ***the fourth largest in the world***; after USA, Russia and China.
  - But, ***India tops*** world's leading countries with regard to passenger/ kilometre carried.
- 'Indian Railways' is the largest public sector undertaking of the country, comprising vast network stations and route length with fleet of locomotives, passenger vehicles etc.
- Since its inception in 1853, Indian Railways has played a vital role in the economic, Industrial and social development of the country.

Distribution of Indian Railways

1. The North Indian Plain.
   - This region has a dense network of railways from Amritsar to Haora.
   - Dense population, development of Industry & Agriculture, large scale Urbanisation have helped in development of Railways.
2. The peninsular plateau.
   - The whole of peninsular plateau has hilly and plateau terrain, which hinders the development of railways.
   - The population density is also moderate here.
   - For such reasons, except, Saurashtra and Tamil Nadu, a relatively open and more lose network has developed here.
3. The Himalayan region.
   - The rugged terrain, hill and valley topography, backward economy and sparse population are factors responsible for the sparse rail network in the region.
   - Also, there are practically no railway line in North-Eastern states of Meghalaya, Tripura, Arunachal Pradesh, Mizoram, Manipur and Nagaland.
     - These areas have rough terrain with thick forests.
     - Hence, construction of railways under these condition is a difficult and costly affair.

The coastal plains

- There is distinct contrast in rail network between eastern and western coastal plains.
- The Eastern Coastal plain is quite wide and permits the construction of railway.
  - But, such network has been eluded in the Western coastal plain, due to the structure and relief of the area.

Significance of the Indian Railways

- Railways provide the cheapest and most convenient mode of passenger transport both for long distance and suburban traffic.
- Railways have played a significant role in the development and growth of Industries. Growth of textile Industry in Mumbai, Jute Industries around Kolkata are largely due to development of railway network in these areas.
- Agriculture also owes its growth to railways to a great extent. Now farmers can sell their agricultural produce to distant places.
- Railways have been helpful in removing isolation between cities and countryside; and have played a significant role in dissemination innovations and new ideas.
- Railways are particularly suited for long distance journey; and hence provide a strong medium of national integration.
- Railways carry relief and rescue teams to the affected areas, during times of natural calamities. Hence, they play a part in mitigating the sufferings of the people.
- Railways help in facing man-made calamities like social, political, religious disturbances, insurgency, etc. It facilitates easy movement of police, troops, defence equipment etc, during times of emergency.

Metro Rail

- Metro Rail offers fast, cheap and comfortable journey in metropolitan cities of India.
- It helps in reducing pressure on the existing road transport and provides clean and eco-friendly transport at the local level.
- It is a part of rapid mass transport; and first rapid transit system in India was the Kolkata Metro, which started operations in 1984.
- The Delhi Metro was India's first Modern Metro and third rapid transit system in India, which started its operations in 2002.
- After the success of Metro Rail in Delhi, other cities like Bengaluru, Hyderabad, have planned to ease the public transit system.

Government Initiatives to improve Railways Sector in India

- In June 2021, the Central Government approved the implementation of a 235 km semi high-speed rail corridor between Pune and Nashik in Maharashtra. The cost of building this project will be Rs. 16,039 crore.
- In April 2021, Indian Railways completed the arch closure of the under-construction Chenab Bridge which is the world's highest railway bridge. Chenab Bridge is 1315 m long and will be 35 meters higher than Eiffel Tower in Paris.
- In July 2020, the Ministry of Railways has invited Request for Qualifications (RFQ) for private participation in operating passenger train services across 109 Origin Destination (OD) routes.
- On September 22, 2020, Indian Railways sanctioned a feasibility study for seven bullet train projects – all open to PPP investments.

Roadways

- Roads have been in India for the last 5000 years.
- In the early stages of Indian History, Ashoka and Chandragupta made efforts to construct roads; but the real progress was made during the Mughal Period.

Importance

- Roads play a very important role in the transportation of goods and passengers for short & medium distances.
- Road transport system establishes easy contact between farms, fields, factories and markets and provides for door to door service.
- Roads can negotiate high gradients and sharp turns, which railways cannot do. As such, roads can be constructed in hilly areas too.

- Roads act as good feeders to railways. Without good and sufficient roads, railways cannot collect sufficient produce to make their operation possible.

According to their functional classification, India's roadways can be divided into four groups:

National Roads

- The Ministry of Road Transport and Highways is the owner of the network of trunk roads known as the National Highways in India.
- The National Highways Authority of India (NHAI), the National Highways and Infrastructure Development Corporation Limited (NHIDCL) and the public works departments (PWD) of state governments are responsible for building and maintaining it.
- These routes connect the state capitals, major cities, significant ports and connect with border roads. They are intended for interstate and strategic defencemanoeuvres.
- These are the foundation of India's road infrastructure and the backbone of all forms of road transportation.
- As of March 2021, India had 151,019 kilometres (93,839 mi) of national highways.

Distribution

- National Highway 1 is the name of the significant Sher Shah Suri Marg in historical terms. National Highway 7 is the longest and connects Varanasi with Kanniyakumari; it connects Delhi and Amritsar.
- Maharashtra, followed by Rajasthan and Uttar Pradesh, has the nation's longest national highway, according to data from the "Ministry of Road Transport and Highways."

Major initiatives

- The ***National Highways Development Project*** (NHDP) started in 1998, is a project to upgrade, rehabilitate and widen major highways in India to a higher standard.
- The ***Golden Quadrilateral*** (***GQ***) project initiated in 1999, is a national highway network connecting most of the major industrial, agricultural and cultural centres of India. It forms a quadrilateral connecting the four major metro cities of India, viz., Delhi (north), Kolkata (east), Mumbai (west) and Chennai (south).
- The ***BharatmalaPariyojana*** ('India garland project') is a centrally-sponsored and funded Road and Highways project of the Government of India.
  - Bharatmala Project will interconnect 550 District Headquarters (from current 300) through a minimum 4-lane highway by raising the number of corridors to 50 (from current 6) and move 80% freight traffic (40% currently) to National Highways by interconnecting 24 logistics parks, 66 inter-corridors (IC) of total 8,000 km (5,000 mi), 116 feeder routes (FR) of total 7,500 km (4,700 mi) and 7 north east Multi-Modal waterway ports.
  - The umbrella programme will subsume all existing Highway Projects including the flagship National Highways Development Project (NHDP).

State Highways

- These are constructed and maintained by state governments and join the state capitals with district headquarters and other important towns.
- These roads constitute about 3.5% of the total road length in India.
- Although construction and maintenance of state highways is the responsibility of the concerned state governments, yet with the revamping of the Central Road Fund (CRF) in 2000, the Centre provides financial assistance for development of state roads.
- Further, central government provides 100% grant for inter-state connectivity and 50% grant for projects of economic importance from CRF.

Distribution

- ***Maharashtra*** has the maximum length of state highways, followed by Karnataka, Gujarat, etc.

District Roadways

- These roads join the district headquarters with other places of the district.
- Development and maintenance of these roads fall within the purview of Zila Parishads.
- Maharashtra is at the top, in this category.

Village roads

- These are mainly the responsibility of village panchayats and connect the villages with the neighboring towns and cities.
- These are generally dusty tracks and become muddy and unserviceable during the rainy season.
- A new thrust was given to Village roads when the ***Pradhan Mantri Gram SadakYojana (PMGSY)*** was launched in December 2020.
    - This is a 100% Centrally Sponsored Scheme, to provide rural connectivity to unconnected habitations with a population of 500 persons or more (250 people in case of hilly, desert and tribal areas).

Border Roads

Border roads organization (BRO) was set up in 1960, for accelerating economic development and strengthening defense preparedness through rapid and coordinated improvement of roads in the north and North-Eastern border areas.

This Border Roads Organisation (BRO) has constructed and black-topped the highest road in the world at Umlingla Pass in Eastern Ladakh. The highest motorable road in the world is situated at an altitude of 19,300 feet.

6. Urban Roads

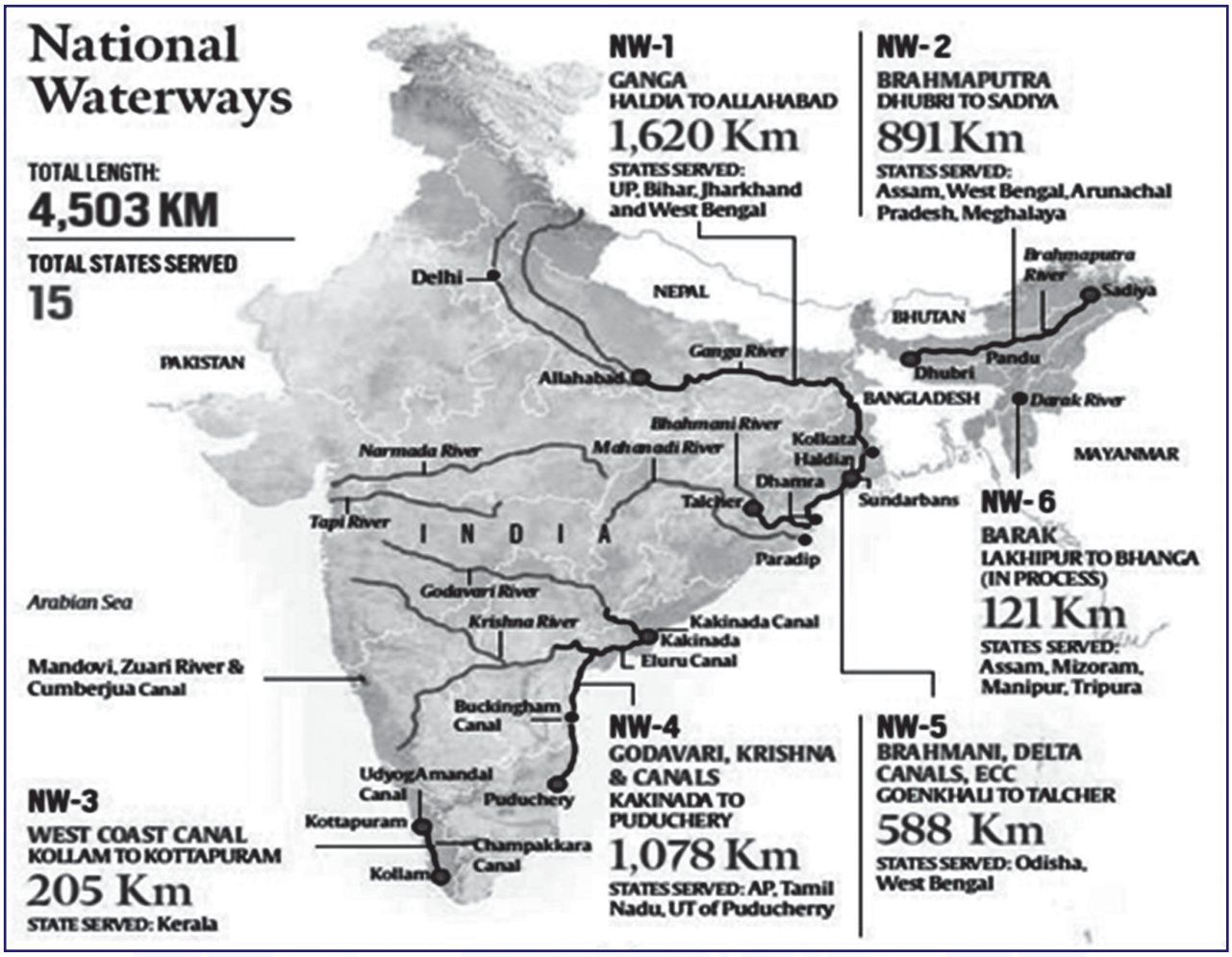
This is a road within the limits of the area of municipality, military cantonment, port or railway authority.

Water transport

- Before the advent of Railways, Inland Waterways were the chief mode of transportation.
- Waterways are the ***cheapest means*** of transport and are most suitable for carrying heavy and bulky materials having low specific cost.
- Water transport is ***a fuel efficient*** and ***environmental friendly*** mode of transportation which has vast employment generation potential.
- However, it suffered a great deal at the hands of roadways and Railways, because it could not compete with the speed of road and rail transport.
- Currently, coastal and inland waterways contribute ***6% of the country's freight*** modal mix, while adjacent developing economies, such as Bangladesh (16%) and Thailand (12%) have a higher share of water-based transport, highlighting the scope for improvement for India.
- The exclusive ***jurisdiction*** of the Central Government is only in regard to shipping and navigation on inland waterways declared to be '***national waterways***' by an act of Parliament. Utilisation/sailing of vessels, in other waterways, is within the ambit of the ***concurrent list*** or is in the jurisdiction of the respective state governments.

Inland Water Transport in India

- To harness the potential of IWT, ***Inland Waterways Authority of India*** (IWAI) was established in 1986 and since has been working towards development and regulation of inland waterways.
- In order to increase the significance of Inland Waterways and to improve their efficiency, the Government has identified few important Waterways, which are given the status of ***National Waterways.***
- From only five waterways recognised as National Waterways (NWs), the government of India notified 106 additional waterways as National Waterways, by the ***National Waterways Act, 2016.***



Advantages of Inland Waterways

- A well-coordinated inland waterways network could bring a fundamental alteration in the logistics scenario of the country.
- Waterways can decongest roads, including highways by moving cargo away.
- Waterways do not involve challenges associated with land acquisition, which has always been a sensitive issue, causing time and cost overruns of numerous projects.
- Waterways are a cheaper mode of transportation vis-à-vis the available alternatives, significantly reducing the point-to-point cost of goods.
- As per a study carried out by RITES in respect to the Integrated National Waterways Transportation Grid, one litre of fuel will move 24 tons through one kilometre on road, 95 on rail and 215 kilometres on inland water transport.

Shipping

- India has had a glorious past with respect to shipping.
  - Indian maritime trade flourished in ancient times.
  - Indian boats and ships have been sailing in the Indian ocean for the last 4,000 years taking merchandise to the Middle East.
- Currently, shipping plays a significant role in the transport sector of the country's economy.
  - Nearly ***90% of India's trade Volume*** (77% in terms of value), is moved by sea making shipping the backbone of trade and economic growth.
- Today, India has the largest merchant shipping fleet among the developing countries.

Coastal Shipping

- This involves movement of goods and passengers from one port to another port within a country.
- India's long coastline, array of ports on the east & west coast; and a large & resilient

domestic economy provides a perfect ecosystem for the country to develop a substantial coastal shipping industry.

- In India, domestic movement happens primarily through road, followed by railways and a meagre share is through waterways. Hence, Coastal shipping can be a great enabler to develop economy and reduce logistics costs as evident from the experiences in other developed regions.
- The European Union experience has demonstrated that cost of coastal movement of cargoes was about 20 percent and 40 percent that of road and rail movement, respectively. Hence, the need to capitalise when there is a long coastline resource at hand, for India.
- Currently, in India, the coastal shipping primarily handles POL, coal and iron ore, which account approximately 80 percent of the total coastal movement.

Ports in India

- There are 13 major and 200 medium and small ports in India.
- The major ports are under the supervision of the Central Government, while the minor ones are managed by the concerned state Governments.
- The 13 major ports handle about 90% of our foreign trade.
- The major ports on the west coast are Mumbai, Jawaharlal Nehru, Kandla, Marmagao, Mangalore and Kochi.
- The ports on the east coast are Kolkatta/ Haldia, Paradwip, Vishakapatnam, Chennai, Ennore and Tuticorin.

Air transport

- Air Transport is the fastest mode of transport which has reduced distances and has led to drastic shrinking of the world.
  - This mode of transport is indispensable when speed and time are the main constraints.
- Air transport is very ***essential*** for a vast country like India, where distances are so long and the terrain and climatic conditions so diverse.
- Air transportation in India made a humble beginning in 1911, when mail operation commenced over a very short distance of 10km between Allahabad and Naini.
- Indian national airways was formed in 1933 and it introduced air services between Karachi and Lahore.
- At the time of independence, there were four companies namely Tata Sons limited/Air India, Indian National Airways, Air services of India and Deccan Airways.

India Aviation Industry

- India had the world's third-largest civil aviation market in 2017.
- India is expected to overtake China and the United States by 2030, according to the International Air Transport Association (IATA).
- Despite this growth, much of the country's aviation potential remains untapped.
- IndiGo, Air India, SpiceJet and GoAir are the major carriers in order of their market share.
- The Ministry of Civil Aviationis responsible for civilian aviation, through regulatory oversight by the Directorate General of Civil Aviation (DGCA).

Aviation sector under Make in India

Aviation sector is one of the 25 sectors which has been identified under the Make in India scheme.

100% FDI has been allowed under automatic route for both Greenfield as well as brownfield projects.

Indian airports are emulating the Special Economic Zone (SEZ) Aerotropolis model to enhance revenues. The model focuses on revenues from retail, advertising, vehicle parking, security equipment and services.

UDAN Scheme

The scheme is aimed at enhancing connectivity to remote and regional areas of the country and making air travel affordable.

It is a key component of Centre's National Civil Aviation Policy, launched in 2016.

Under the scheme, nearly half of the seats in Udan flights are offered at subsidised fares and the participating carriers are provided a certain amount of viability gap funding (VGF) – an amount shared between the Centre and the concerned states