

GEOGRAPHY OF INDIA

The word geography was coined by Eratosthenes, a Greek philosopher and mathematician, in 3rd century B.C. For his contribution in the discipline, he is regarded as the father of Geography.

Location: India as a country, a part of earth's surface, is located in the Northern-Eastern Hemispheres between $8^{\circ} 4' \text{ N}$ and $37^{\circ} 6' \text{ N}$ latitudes and $68^{\circ} 7' \text{ E}$ and $97^{\circ} 25' \text{ E}$ longitudes. If the islands are taken into consideration, the southern extent goes up to $6^{\circ} 45' \text{ N}$.

- In India, Tropic of Cancer ($23^{\circ} 30' \text{ N}$ latitude) passes through eight states namely (from west to east) Gujarat, Rajasthan, MP, Chhattisgarh, Jharkhand, West Bengal, Tripura and Mizoram.
- **Time:** the $82^{\circ} 30' \text{ E}$ longitude is taken as the Indian Standard Time meridian as it passes through middle (Allahabad) of the country. It is equal to 5 hours and 30 minutes ahead of GMT. Same longitude is used by Nepal and Sri Lanka.

Size and Shape: India is the 7th largest country in the world with an area of 3287263 sq. km (32.87 lakh sq. km=3.287 million sq. km), after Russia, Canada, China, USA, Brazil and Australia. It constitutes 0.64% of the total geographical area of the world and 2.4% of the total land surface area of the world.

- The area of India is 20 times that of Britain and almost equal to the area of Europe excluding Russia.
- Rajasthan (342000 sq. km) is the largest state of India while as Goa (3700 sq. km) is the smallest.
- Among the Union territories, Andaman and Nicobar Islands (8000 sq. km) and Lakshadweep (3 sq km) claim the largest and smallest area.
- India is 2nd largest populous (1.21 billion, 2011 census) after China. It constitutes 17.44 % of the world population.
- India has almost quadrangular shape. It measures 3214 km from north to south and 2933 km from west to east.
- The western, northern, eastern and southern most points are called as Gaur Mota (in Kachchh Gujarat), Indira col (in POK Kashmir), Kibithu (in Arunachal) and Indira Point or Pygmalion Point (in Great Nicobar Islands). The southernmost tip of mainland is Kanyakumari in Tamil Nadu.

Frontiers: India's total land frontier is 15200 km. It shares international border with seven countries namely, Pakistan, Afghanistan (80 km=shortest one), China, Nepal, Bhutan, Myanmar and Bangladesh (4096 km= longest one).

- India-Afghanistan and Pakistan-Afghanistan border is called as Durand line. India-Pakistan border is referred as Radcliffe line and India-China border (eastern section=1140 km) as McMahon Line.
 - Practically, the border between India and Pakistan is called as Line of Control (LOC) and that China-India as Line of Actual Control (LAC).
 - India's total maritime boundary is 7516.6 km. Excluding islands, the coastline is 6100 km only. The names of coastal states are Gujarat, Maharashtra, Goa, Karnataka, Kerala, and Tamil Nadu (in west) and Andhra Pradesh, Orissa and West Bengal (in east).
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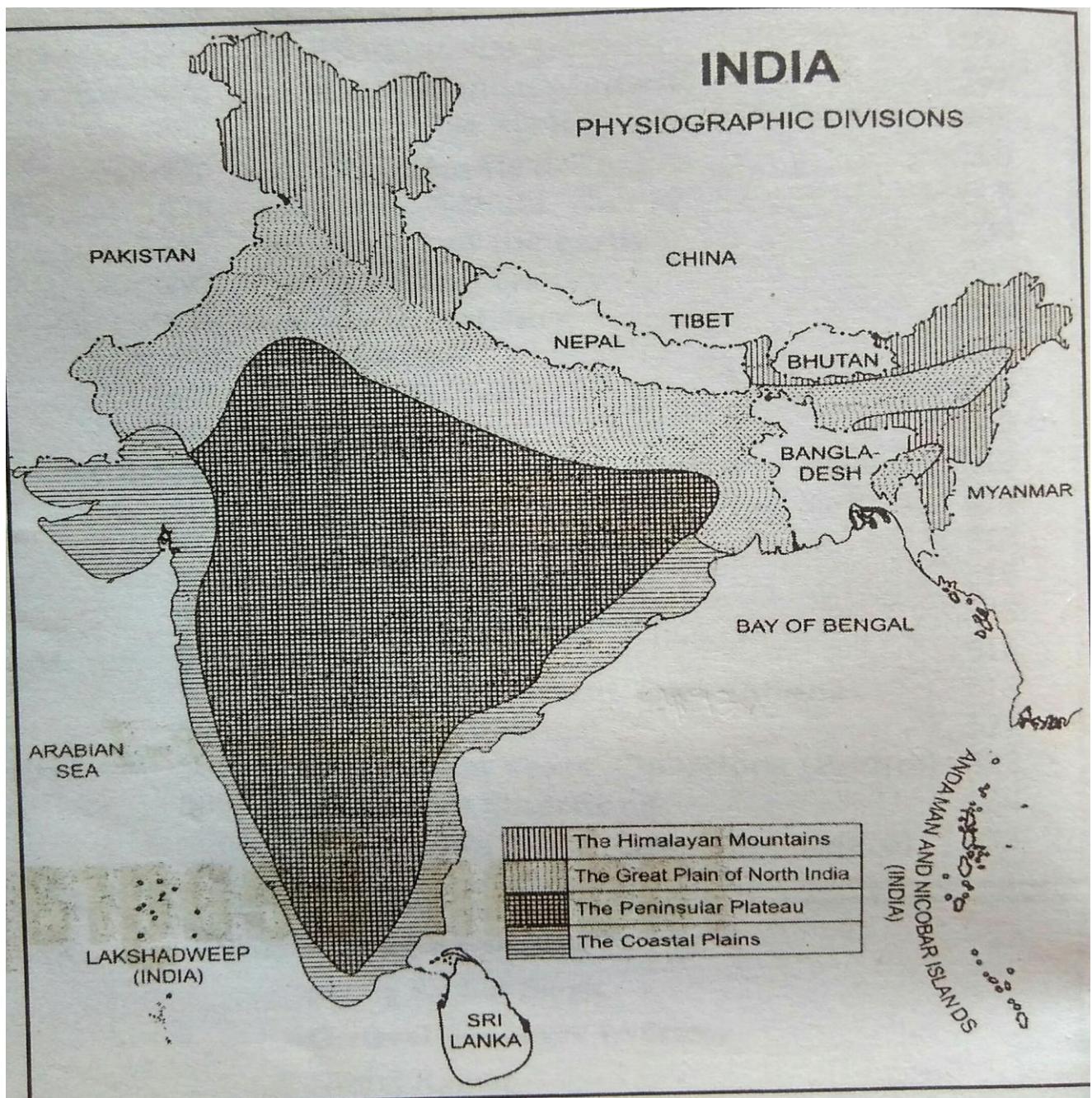
Physiography of India

In layman's language, the physical features like mountains, plains, plateaus, valleys, etc constitute the physiography.

- The physical features are formed due to the action and/or interaction of endogenetic (inside the earth) such as volcanism, diastrophism, etc. and exogenetic (outside the earth i.e., in atmosphere) such as erosion, mass movement, deposition, etc. processes.
- In India, out of the total area, 10.6% is occupied by mountains, 18.5% by hills, 27.7% by plateaus and 43.2% by plains.

➤ India is divided into five broad physiographic regions:

- 1) The Northern Mountains, 2) The Great Northern Plains, 3) The Peninsular Uplands/Plateaus, 4) The Coastal Plains and 5) The Islands.



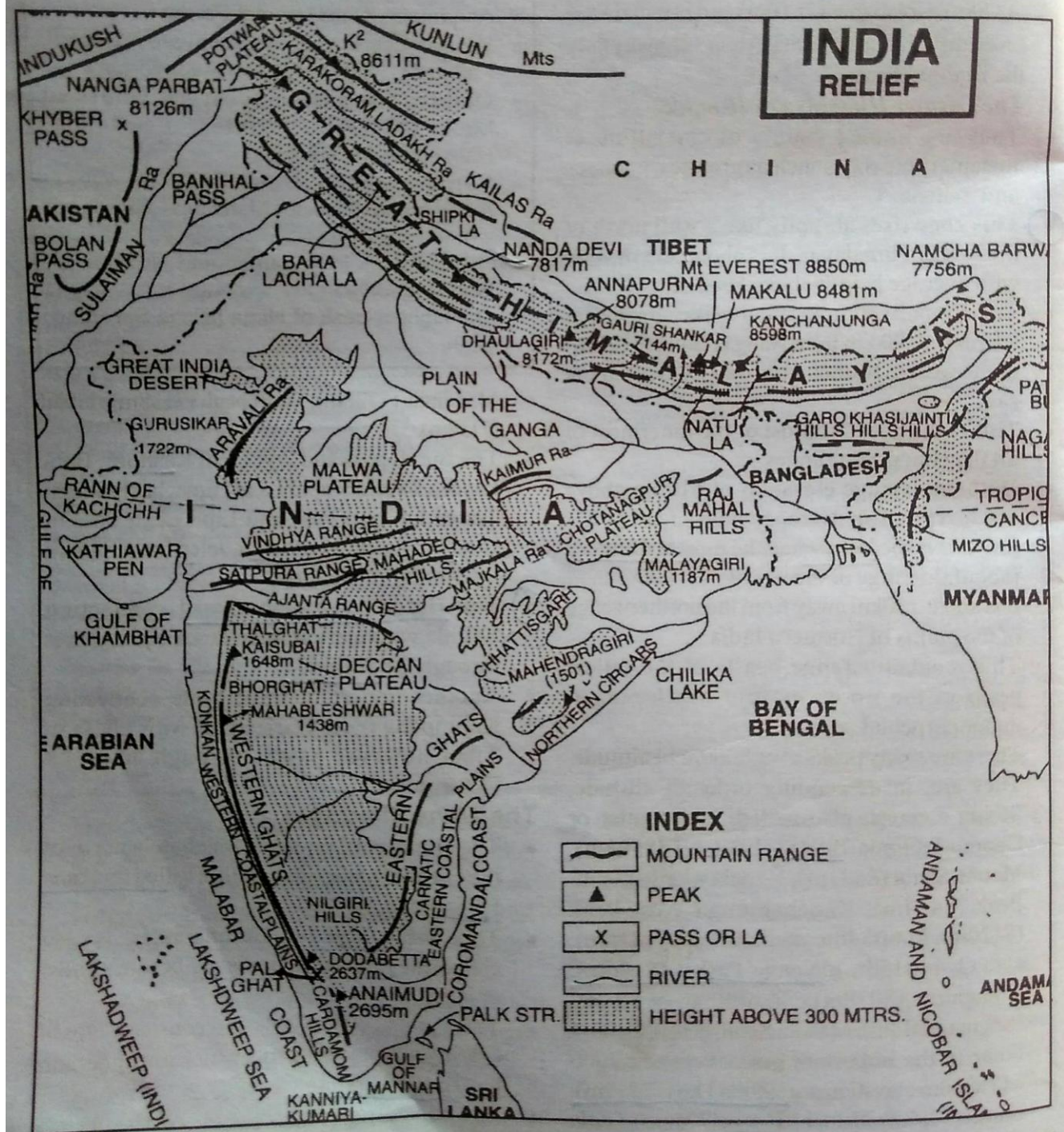
1) The Northern Mountains: These Mountains were formed due to the folding (convergence of two continental plates-Eurasian Plate and Indo-Australian Plate).

- They are young mountains mainly composed of sedimentary rocks of marine origin. Girdling the country on its north and north-eastern sides, they are spread mainly in the states of Jammu and Kashmir, Himachal, Uttarakhand, Sikkim, Arunachal Pradesh, Nagaland, Manipur, and Mizoram.
- Their width varies from 500 km in Kashmir to 240 km in Arunachal Pradesh.
- In the NW, they are connected with Pamir Knot (a centre and meeting place of many great mountain ranges) that is called the Roof of the World.
- These mountains are divided into three mountain ranges:

A) Himalayan mountains, B) Trans Himalayas and C) Purvanchal/Eastern Hills

- **A) Himalayan mountains:** Literally, Himalaya means abode of snow. These are youngest fold mountains of the world. Their total length is 2500 km covering an area of 5 lakh sq. km with width varying from 240-320 km.
 - They were formed in three successive stages from 70 million years to 10 million years before present and that is why we have three Himalayan ranges as:
 - a) **Siwalik (Outer or Sub-Himalaya):** It is the southernmost and youngest (10 mya) mountain range of Himalayas that touches the Northern Plains. It extends from Indus gorge to Brahmaputra Valley for a length of 2400 km. Its width varies from 8-45 km and average height is <1300 m amsl.
 - It is formed of loose sedimentary rocks and is known by Jammu hills in J & K, Dundwa range in Uttarakhand and Churia Muria in Nepal.
 - It is characterized with tectonic valleys called as duns or dhars such as Dehra, Kotah, etc.
 - Tista and Raidak rivers have jointly formed a gap of 80-90 km in Siwalik range through erosion.
 - b) **Lesser or Middle Himalaya or Himachal:** This range lies to the north of Siwalik range and is 80 km wide and its average height is 1300-5000 m. It consists of unfossiliferous sediments or metamorphosed rocks.
 - It consists of following ranges (from west to east):
 - Pir Panjal range (J & K)----longest range in Middle Himalaya
 - Dhauladhar range (Himachal)
 - Mussoorie (Uttarakhand)
 - Nagtiba and Mahabharat ranges (Nepal)
 - Famous hill resorts on this range are Shimla, Mussoorie, Ranikhet, Nainital, Darjeeling, etc.
 - Along the slopes are found a number of pastures called mergs in J & K (such as Gulmarg, Yusmarg,) and Bugyal and Payar in Uttarakhand.
 - Famous Banihal Pass (2835 m) and Pir Panjal Pass (3480m) are located on it.
 - Kashmir Valley (135 km long in NW-SE direction and 40 km wide in middle) is located between Pir Panjal range (Middle Himalaya) and Greater Himalaya (or we say Great Kashmir Himlaya).
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- **c) Greater or Inner Himalayas or Himadri:** This mountain range located to the north of Middle Himalaya is tallest/highest one in the world and rises like a wall. Its average altitude is 6100 m and is 25km wide.
 - It runs in an arc like shape from Nanga Parbat (8126 m) in POK Kashmir in west to Namcha Barwa (7756 m) in Arunachal Pradesh in east.
 - It is loftiest and most continuous mountain range of the world. It has world's highest mountain peak called as Mount Everest (8848m) in Nepal. This peak is also known as Peak XV, Sagarmatha (in Nepal) or Chomolangma (in China). Lhotse I (8501m), Mount Akalu (8481 m), Kanchunjunga South Peak (8474 m), etc. are its other important peaks.
 - Zojila (connecting Kashmir with Ladakh), Shipki La (connecting Shimla with Gartok, Tibet) and Jelep La (connecting Kalimpong, Sikkim with Lhasa, Tibet).
 - **B) Trans Himalayas:** These are located to the north of Greater Himalayas. These are also known as Tibetan Himalayas because most part lies in Tibet. Their total length is 1000 km.
 - They include Zaskar, Ladakh, Kalaish and Karakoram ranges.
 - Karakoram is most important one. It has world's second highest peak called as K₂ (8611 m), or Qogir or Godwin Austen. Its length is 800 km. It houses the largest glaciers of the world after Polar ice caps such as Siachen (75 km), Biafo, Boltoro, Hispar, etc.
 - Ladakh Plateau (5000 m) is located in Trans Himalayas.
 - **C) Purvanchal or the Eastern Hills:** After crossing the Dihang gorge in Arunachal Pradesh, the Himalayas take a sudden southward turn and form a series of low hills in the shape of a crescent with its convex side towards west. They are called Purvanchal because they are located in eastern part and form India's boundary with Myanmar.
 - They are known by local names such as Patkai Bum (Arunachal Pradesh), Naga Hills, Manipur hills, Mizo hills, etc. Saramati (3826 m) in Naga Hills is highest peak in Purvanchal.
 - Blue Mountain is found in Mizo Hills.
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2) The Great Northern Plains: This physiographic region covers an area of 7.8 lakh sq. km. It is an aggradational plain formed by alluvial deposits of Indus, Ganga and Brahmaputra river systems.

- It lies between the Northern Mountains in the north, the Peninsular Uplands in the South, the Ravi and Sutluj in the west and Ganga Delta in the East. Its total length is 2400 km and depth is 1300-1400 m.
- Its width varies from 500 km in Punjab-Rajasthan Plains to 90-100 km in Assam Valley.
- **Divisions:** On the basis of characteristics of alluvium, surface gradient, drainage, etc., the Great Northern Plains are divided into following:

- **Bhabar:** It lies along the foot of Siwaliks. It has 8-16 km width. It consists of gravel and unassorted sediments deposited by rivers. Because of high porosity, the streams disappear. It is not suitable for agriculture.
- **Terai:** South of Bhabar lies a 15-30 km wide marshy tract called Terai where streams reappear. It is a zone of excessive dampness, thick forests, rich wildlife and malarial climate.
- It is relatively suitable for agriculture.
- **Bangar:** It represents older alluvium and lies above flood-limit of plains. It consists of clay, sand and calcareous matter called kankar.
- **Khadar/Bet:** It is the younger or newer alluvial plain characterized with light color and deficiency of calcareous matter.
- **Delta:** It is simply extension of Khadar into water.

➤ **Regional Divisions:** Regionally, Great plains are divided into four sub-plains as follows:

1. **Rajasthan Plains/Indian Desert:** It includes Marushtali (dead land=true desert=arid area) and Rajasthan Bagar areas (Steppe lands=semi arid) to the west of Aravallis. It is a sandy plain. Luni is only flowing river in this area. It slopes from east to west towards Indus basin.
2. **Punjab-Haryana Plain:** It extends from Punjab (Punjab means an area of five waters or rivers i.e., Jehlum, Chenab, Ravi, Sutluj and Beas) to Yamuna. This plain is drained by Sutluj, Beas and Ravi rivers. It is famous for doabs like Bist doab (between Beas and Sutluj) and Bari doab (between Beas and Ravi). It slopes towards west (Indus) and south (Rann of Kachch).
3. **Ganga Plain:** It is the largest part of Indian plain. It extends from Yamuna to Bangladesh for the length of 1400 km covering the states of UP, Bihar and West Bengal. It is drained by Ganga and its tributaries. It slopes gently towards Bay of Bengal. Its altitude varies from 271 m in Saharanpur to 3 m in Sagar Islands.
4. **Brahmaputra Plain/Assam Valley:** It is drained and formed by Brahmaputra and its tributaries. It is known for largest river island of the world named as Majuli (352 sq. km).

3) The Peninsular Uplands/Plateaus: It is the largest physiographic division of India. It covers an area of 16 lakh (nearly half of the total area of country) sq. km. It is composed of old crystalline, igneous and metamorphic rocks. It is the mineral storehouse of India. Delhi ridge in the northwest (extension of Aravalis), the Rajmahal hills in the east, Gir range in the west and the Cardamom hills in the south constitute the outer extent of the Peninsular plateau.

- Narmada River which flows through a rift valley/fault divides the region into two unequal parts: the northern smaller part called as central highlands and southern larger part as Deccan Plateau. The north-eastern part called Shillong/Meghalaya Plateau is separated from main plateau by a fault called Malda Gap/Fault. It comprises of Garo, Khasi and Jaintia hills.
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- **Central Highlands:** They refer to a group of oldest relict mountains with altitude varying from 600-900 m. They include Aravalli, Vindhya, and other hills. Aravallis cover them from west in NE to SW direction for a distance of 800 km from Delhi to Palanpur representing the relict of one of the world's oldest fold mountains. Gurushikhar (1722m) is highest peak in Aravallis. Malwa plateau and Bundelkhand plateau fall in this region. The slope is towards north and west.
- **Deccan Plateau:** This is the largest unit of Peninsular plateau covering an area of 5 lakh sq. km. It is formed of volcanic/lava material during Cretaceous (60 million ya) period and is bounded by Satpuras in north, Western Ghats in west and Eastern Ghats in east. It is triangular in shape and slopes towards east with average altitude of 600 m. It comprises of Maharashtra plateau, Karnataka plateau, Telangana plateau and Rayalseema plateau. It is covered by black soil which is famous for cotton cultivation. It is drained by four river systems of Mahanadi, Godavari, Krishna and Cauvery.
- **Chhotanagpur Plateau** is famous for Gondwana coal and other mineral deposits. It is drained by Damodar, and other rivers.
- **Chhattisgarh Plain** is the only plain in the whole Peninsular uplands. It is a saucer shaped depression drained by Mahanadi River. The area is characterized by red and yellow soils.
- **Western Ghats**, locally known as Sahyadri in Maharashtra, Nilgiri hills in Karnataka and Tamil Nadu and Anaimalai hills and Cardamom hills in Kerala, are continuous escarpments that run parallel to western coast of India for about 1600 km in north-south direction from the mouth of Tapi river (Gujarat) to Cape Camorin (Kanyakumari, Tamil Nadu). They form the real watershed of the Peninsula. They are Block Mountains formed due to down warping of part of land into the Arabian Sea. Anai Mudi (2695 m) is the highest peak in Sahyadris and whole of South India. In the Nilgiri hills, Western Ghats join the Eastern Ghats. Doda Beta (2637 m) is the highest peak in Nilgiris.
- **Eastern Ghats** are the discontinuous hills starting from Mahanadi in Orissa to Vagai in Tamil Nadu having heterogeneous character and heavily eroded by rivers of Mahanadi, Godavari, Krishna and Cauvery. Some of the important hills include Javadi hills, Velikonda hills, Nallamalai hills and Mahendragiri hills. Mahendra Giri (1501 m) is the highest peak in Eastern Ghats.

4) The Coastal Plains: On the basis of location and geomorphological processes, coastal plains are broadly divided into:

- **1) Western Coastal Plains:** These are located between Arabian Sea in the west and Western Ghats in the east and extend from Rann of Kachch up to Cape Camorin for 1840 km. They are narrow plains with only exception of Gujarat plains.
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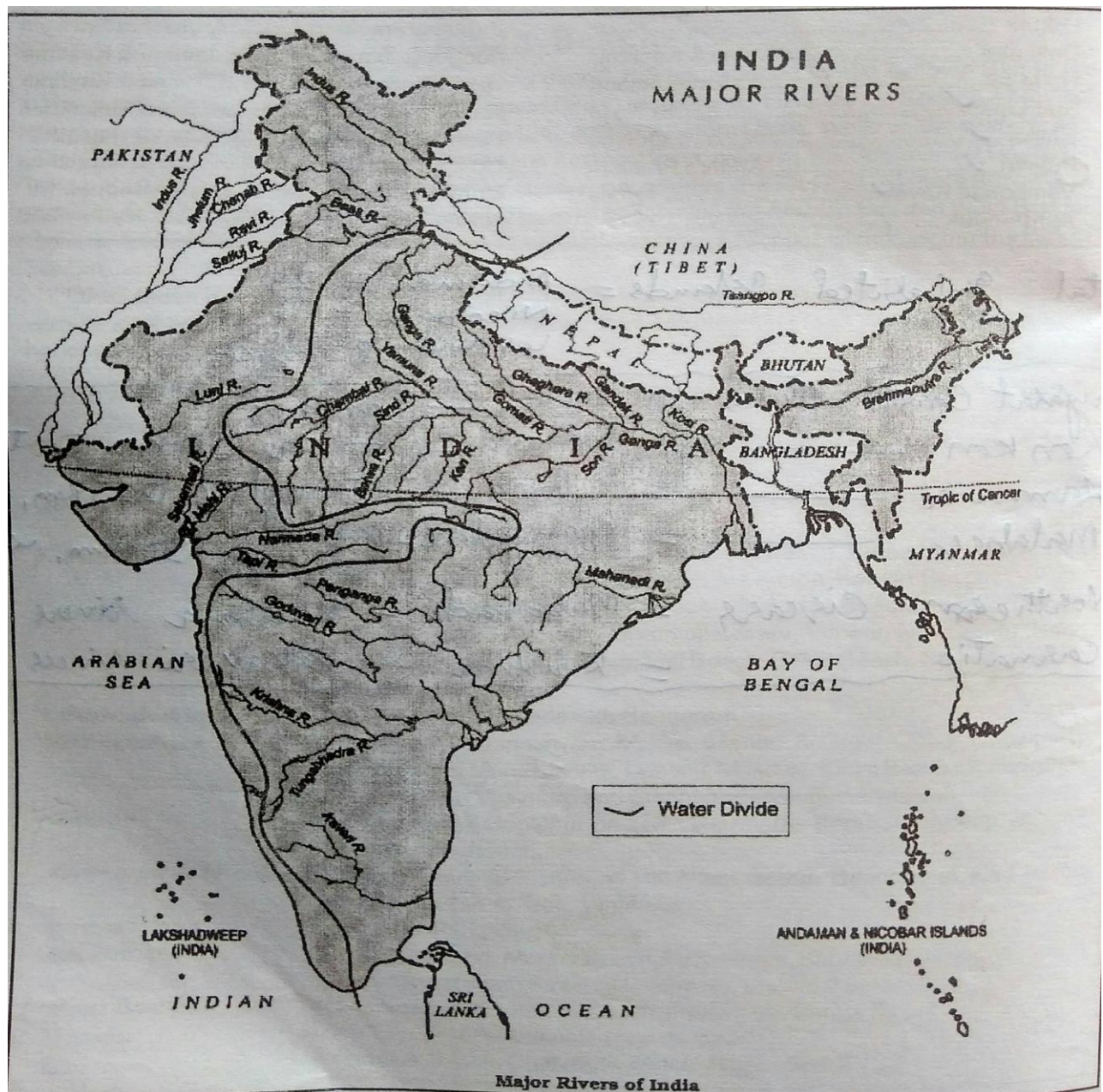
- Extending from the Gujarat coast in the north to the Kerala coast in the south, the western coast may be divided into following divisions – the Kachchh and Kathiawar coast in Gujarat, Konkan coast in Maharashtra, Goan coast or Kanara coast in Karnataka, and Malabar/Kerala coast in Kerala. Gujarat (1215 km) has longest coastline among states.
 - The western coastal plains are narrow in the middle and get broader towards north and south.
 - The rivers flowing through this coastal plain do not form any delta. The Malabar Coast is characterized with '*Kayals*' (backwaters).
 - The western coastal plains are an example of submerged coastal plain. It is believed that the city of Dwaraka which was once a part of the Indian mainland situated along the west coast is submerged under water.
- **2) Eastern Coastal Plains:** These are located between Bay of Bengal in the east and Eastern Ghats in the west and extend from Ganga Delta up to Cape Camorin for 1800 km.
- Compared to the western coastal plain, the eastern coastal plain is broader and wider and is an example of an emergent coast. Because of its emergent nature, it has less number of ports and harbours. They are formed of recent alluvium.
 - There are well developed deltas of the Mahanadi, the Godavari, the Krishna and the Kaveri.
 - They include the Utkal plains, Andhra plains and Tamil Nadu plains.
 - These are famous for beaches such as Marina in Chennai and Chilka Lake (biggest in India) in Orissa.
- **5) The Islands:** India has a total of 247 islands. There are two major island groups in India –one in the Bay of Bengal called as Andaman and Nicobar Islands and the other in the Arabian Sea called as Lakshadweep Islands. Saddle peak (732 m) located on Andaman islands is highest peak.
- **1) Andaman and Nicobar Islands:** It comprises of two Island groups: Andaman group and Nicobar group separated by 10⁰ Channel. Duncan Passage separates Little Andaman from Great Andaman. They have greater coastline (1962 km) than Gujarat state.
- The Middle Andaman is largest island in the group.
 - Most of the islands are continuation of Arakan Yoma Mountains.
 - The volcanic islands include the Barren Island and Narcondam.
- **2) Lakshadweep Islands:** These are tiny coral islands and separated from Maldives by 8⁰ Channel. The northern, central and southern islands groups within this island group are called as Amindivi, Laccadive and Minicoy (smallest as well) islands.

Drainage/River Systems of India

The annual yield of water in the rivers of the country is 1.858 trillion cubic metres. Among the rivers the greatest contribution from Brahmaputra (33.8%) followed by Ganga (25.2%), Godavari (6.4%), and etc. more than 90% river water reaches into Bay of Bengal and rest into Arabian Sea or becomes inland

drainage. The area that contributes water to a river is its basin. There are three types of river basins in India:

- Major river basins ($\geq 20,000$ sq. km) account for 58% of total run-off.
 - Medium river basins (2,000-20,000 sq. km) account for 7% of total run-off.
 - Minor river basins ($< 2,000$ sq. km) account for 8% of the total run-off of the country.
- On the basis of origin, the rivers of India are divided into: Himalayan Rivers and Peninsular Rivers.
- **Himalayan rivers** are antecedent (i.e., originated before formation of Himalayas) and form deep gorges and valleys. They have large basins and are youthful in nature. They are fed by glaciers and so are perennial. There are three famous river systems: Indus, Ganga and Brahmaputra.
 - **Peninsular rivers** are consequent and form shallow valleys. They have small basins and are in maturity stage. They are fed by rain and so are seasonal and non-perennial. There are six famous river systems: Narmada, Tapi, Mahanadi, Godavari, Krishna and Kaveri (Cauvery).



❖ **Himalayan River Systems**

❖ **Indus River System:** It is one of the largest river basins of the world, covering an area of 11, 65,000 sq. km (in India it is 321, 289 sq. km and a total length of 2,880 km (in India 1,114 km).

The Indus also known as the Sindhu, is the westernmost of the Himalayan rivers in India

- It originates from a glacier near Bokhar Chu in the Tibetan region at an altitude of 4,164 m in the Kailash Mountain range. In Tibet, it is known as '*Singi Khamban*'; or Lion's mouth.
- After flowing in the northwest direction between the Ladakh and Zaskar ranges, it passes through Ladakh and Baltistan. The Indus receives a number of Himalayan tributaries such as the Shyok, the Gilgit, the Zaskar, the Hunza, the Nubra, the Shigar, the Gasting and the Dras. It finally emerges out of the hills near Attock where it receives the Kabul River on its right bank.
- The river flows southward and receives 'Panjnad' a little above Mithankot. The Panjnad is the name given to the five rivers of Punjab, namely the Satluj, the Beas, the Ravi, the Chenab and the Jhelum. It finally discharges into the Arabian Sea, east of Karachi. The Indus flows in India only through the Leh district in Jammu and Kashmir.
- **Jhelum** rises from a spring at Verinag situated at the foot of the Pir Panjal in Anantnag.
- The **Chenab** is the largest tributary of the Indus. It is formed by two streams, the Chandra and the Bhaga. Hence, it is also known as Chandrabhaga.
- The **Ravi** rises west of the Rohtang pass in the Kullu hills of Himachal Pradesh.
- The **Beas** originates from the Beas Kund near the Rohtang Pass. It enters the Punjab plains where it meets the Satluj near Harike.
- The **Satluj** originates in the Rakas lake near Mansarovar at an altitude of 4,555 m in Tibet where it is known as Langchen Khambab. It passes through the Shipki La on the Himalayan ranges and enters the Punjab plains. It feeds the canal system of the Bhakra Nangal project.

❖ **Ganga River System:** The Ganga is the most important river of India both from the point of view of its basin and cultural significance. Its total basin is 8, 61, 404 sq. km (26.3% of total area of country) and its length is 2525 km in India. It rises in the Gangotri glacier near Gaumukh (3900 m) in the Uttarakhand. Here, it is known as Bhagirathi.

- At Dev Prayag, Bhagirathi meets Alaknanda, hereafter, it is known as Ganga. Pindar joins at Karna Prayag and Mandakini or Kali Ganga at Rudra Prayag. Ganga debouches into plains at Haridwar.
 - The left tributaries of Ganga are Ramganga, Gomti, Kali, Gandak, Kosi, and Mahanadi.
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- Its right bank tributaries are Yamuna, Chambal, Damodar and Son. Yamuna joins Ganga at Allahabad. Beyond Farakka, it is known as Padma in Bangladesh.
 - It bifurcates and is known as Bhagirathi-Hooghly in West Bengal and Padma-Meghna in Bangladesh. Finally, it meets Brahmaputra and forms world's largest delta called as Sunderbans or Ganga-Brahmaputra delta (58,752 sq. km).
 - Kosi is called as Sorrow of Bihar and Damodar as Sorrow of Bengal as these rivers cause floods in the states.
 - **Yamuna** is the largest tributary of Ganga. It rises from Yamnotri glacier in Uttarakhand.
 - **Chambal** is famous for badland topography caused by excessive erosion.
- ❖ **Brahmaputra River System:** The Brahmaputra (Son of Brahma) rises in the Chemayundung glacier in the Kalaish range in Tibet and moves in eastward direction up to Arunachal Pradesh. At Namcha Barwa, it takes southward and south-westward turn and enters India west of Sadiya town. Here, it receives the waters of Dibang and Lohit and is named as Brahmaputra. In Tibet, it is called as Tsangpo (Purifier). Tista is its captured tributary.
- It looks like 'Delta in reverse' where it meets Dibang and Lohit.
 - Its total length is 2900 km and is one of the longest rivers of the World.
 - Near Gwalpara, it enters Bangladesh as Jamuna and meets Padma at Goalundo.
 - In Assam, it has a braided channel and gives birth to river islands. Majuli (352 sq. km) is the largest river island of the world.
 - It is a navigable river with boats sailing at an altitude of 4000 m. National Waterway-2 is on the Brahmaputra River from Sadiya to Dhubri.
 - It is largest river of India in terms of volume of water and Ganga is longest.
- ❖ **Peninsular River Systems:** There are three directions of these rivers. Narmada, Tapi, and Mahi flow westward and debouch into the Arabian Sea. The Mahanadi, Godavari, Krishna and Kaveri flow eastward and drain into the Bay of Bengal. Some rivers originating in the north of the Peninsula such as Chambal, Son, Betwa, Damodar etc. join Ganga and flow into Bay of Bengal.
- ❖ **Mahanadi:** The Mahanadi rises near Sihawa in Raipur district of Chhattisgarh and runs through Orissa to discharge its water into the Bay of Bengal. It is 858 km long and its catchment area spreads over 1.42 lakh sq. km. It mainly drains Chhattisgarh and Orissa/Odisha.
- Hirakud Dam is built on this river.
- ❖ **Godavari:** It is the largest river system of Peninsular India and is called as Dakshina Ganga or Vridha Ganga. It rises in Trimbak plateau in the Nasik district of Maharashtra and discharges its water into the Bay of Bengal. It is 1,465 km long with a catchment area of 3.13 lakh sq. km.
- The Penganga, the Indravati, the Pranhita, and the Manjra are its principal tributaries.
 - Drains the states of Maharashtra, Madhya Pradesh, Chhattisgarh, Orissa and Andhra Pradesh.
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- It forms a large delta of lobate shape.
- ❖ **Krishna:** It is the second largest east flowing Peninsular River which rises near Mahabaleshwar in Sahyadri. Its total length is 1,401 km. The Koyna, the Tungbhadra and the Bhima are its major tributaries. It drains the states of Maharashtra, Karnataka and Andhra Pradesh.
 - Koyna dam is made on Koyna River, its tributary. It forms delta of arcuate shape.
- ❖ **Kaveri:** It rises in Brahmagiri hills of Kogadu district in Karnataka. Its length is 800 km and it drains an area of 81,155 sq. km in Tamil Nadu, Karnataka and Kerala. Since the upper catchment area receives rainfall during the southwest monsoon season (summer) and the lower part during the northeast monsoon season (winter), the river carries water throughout the year with comparatively less fluctuation than the other Peninsular Rivers.
 - It is most revered and sacred river of South India. Sivasamudram waterfall is on this river.
 - 90-95% of its irrigation and power potential stands harnessed.
- ❖ **Narmada:** It is the largest of all the west flowing rivers of the Peninsula. It rises from Amarkantak plateau in Shahdol district of Madhya Pradesh. Flowing in a rift valley between the Satpura in the south and the Vindhyan range in the north, it forms Dhuandhar waterfall near Jabalpur. Its length is 1310 km. The Sardar Sarovar Project has been constructed on this river.
 - Aliabet is the largest island in the estuary of the Narmada.
- ❖ **Tapi:** It originates from Multai in the Betul district of Madhya Pradesh and is known as 'the twin' or handmaid of Narmada. Tapi and Narmada drain into Gulf of Khambat in Arabian Sea.
- ❖ **Luni (Salt River or Lonari or Lovanavari):** It is largest river system of Rajasthan rising from Aravallis. Its water is brackish. It drains into Rann of Kachchh.
- ❖ **Mahi, Sharavati, Sabarmati, Varahi and Periyar** are the other west flowing rivers. Kunchikal Falls (455 m high), the highest waterfalls in India, are on Varahi River in Karnataka.

Climate/Weather of India

Climate is average of atmospheric conditions over a long period of time. The climatic elements or atmospheric conditions such as temperature, rainfall, etc. are influenced by latitude, relief/altitude, distribution of land and water, and the like. As we know that Tropic of Cancer passes through middle of the country and monsoons play a significant role in determining the climate of the country, India is par excellence a tropical monsoon country.

➤ Extremes in the Climate of the Country:

- In June, the day temperature at Barmer, Rajasthan is 48° - 50° C while it is 22° C at Gulmarg.
 - In December, the night temperature may dip to -40° C at Dras or Kargil while it may be 20° - 22° C at Thiruvananthpuram or Chennai.
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- Mawsynram in Meghalaya receives as high as 1221 cm of annual rainfall while at Jaisalmer the annual rainfall rarely exceeds 12 cm. A single day rainfall in Garo hills exceeds the 10 years of rainfall in Jaisalmer.
- The coastal areas Mumbai, Konkan, etc. have equable climate while the interior areas like Delhi, Agra, etc suffer from extremes.

➤ **Factors Influencing the Climate of India:** It is influenced by number of factors:

- **Location and Latitudinal Extent:** Most part of the country is located in the tropical latitudes and some areas in north in temperate latitudes. High temperatures are experienced to the south of Himalayas and mild and cool temperatures in the Himalayan states.
 - **Distance from the Sea:** The coastal areas have equable/mariline climate while the interior locations have extreme or continental climate. More than 300 cm annual rainfall in Western Ghats and less than 25 cm in Rajasthan.
 - **The Northern Mountain Ranges:** They protect India from cold and dry winds of Central Asia in winter and help in bringing rain. They act as climatic divide between Indian sub-continent and Central Asia.
 - **Mountains/Relief:** The relief has a great bearing on the elements of climate. Since, we know that temperature decreases with altitude (6.5°C/km), Ooty has cool climate than other peninsular areas. The hill stations in Himalayas have cool weather as compared to places in plains though on same latitude. But, in India, the relief plays another very important role and i.e., in the causing and distribution of rainfall. Generally, rainfall decreases from windward side to leeward side of the Western Ghats and from Bengal delta towards Northwest and from Himalayan slopes towards plains.
 - **Monsoons Winds:** It is the most determining factor of Indian climate and is named after as monsoonal climate. Since, monsoons are seasonal; India is characterized with different weather seasons. The SW monsoons from Arabian Sea and Bay of Bengal cause rainfall almost in the entire country in summer and NE monsoons in Caromandel coast in winter.
 - **Jet Streams:** The upper air circulation in the form of Westerly Jet streams brings Western disturbances to NW and North India in winter and helps in onset and reversal of monsoons.
 - **Tropical Cyclones and Western Disturbances:**
 - Tropical cyclones, the very low pressure centers, originate both in the Arabian and the Bay of Bengal during July-August and October-November seasons and influence the weather conditions.
 - The western disturbances are the low pressure centers that originate from Mediterranean Sea and move eastwards under the influence of westerly Jet Streams and cause rainfall/snowfall in North India after crossing Iran, Iraq, Afghanistan and Pakistan. **They** play a good role in determining the climate of J & K. They also cause rains in Punjab, Haryana, UP, Himachal, Uttarakhand, Sikkim and Arunachal Pradesh
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- **El Nino:** It is the oceano-climatic phenomenon characterized with complex changes in the Pacific Ocean mainly accumulation of warm water along the Peru coast. It has negative impact on monsoons.
 - **La Nina:** After El Nino, the condition returns to normal and accumulation of cold water in the eastern and central part of Pacific Ocean which is referred as La Nina. It has positive impact on monsoons. It is the harbinger of heavy monsoon showers in India.
 - **Southern Oscillation:** It has been noticed that whenever the surface level pressure is high over the Indian Ocean, there is low pressure over the Pacific Ocean and vice-versa. This relationship of high and low pressure over the Indian and the Pacific Oceans is called SO. When the winter pressure is high over the Pacific Ocean and low over the Indian Ocean, the SW monsoons in India tend to be stronger and the reverse is true.
 - **Monsoons, Mechanism and Types:** The term monsoon has been derived from the Arabic word “mausam” meaning season or the Malayan word “monsun” meaning season. Thus, the monsoons are the seasonal winds which completely reverse their direction of flow with the change of season. They flow from sea to land during summer in SW-NE direction called as SW monsoons and from land to sea during winter in NE-SW direction called as NE monsoons.
 - The monsoons are experienced in the tropical area roughly between 20°N and 20°S. To understand the mechanism of the monsoons, the following facts are important: (a) The differential heating and cooling of land and water creates low pressure on the land mass of India while the seas around experience comparatively high pressure. (b) The shift of the position of Inter-Tropical Convergence Zone (ITCZ) in summer over the Ganga plain (this is the equatorial trough normally positioned around 20°N of the equator- also known as monsoon trough during the monsoon season. (c) The presence of the high pressure area over Madagascar approximately at 20°S over the Indian Ocean. The intensity and position of this high pressure area affects the Indian monsoon. (d) The Tibetan plateau gets intensely heated during summer which results in strong vertical air currents and the formation of high pressure over the plateau of about 5 km above sea level. (e) The movement of the westerly Jet-stream to the north of the Himalayas and the presence of the tropical easterly jet over the Indian peninsula during summer.
 - **South West Monsoons/Summer Monsoons:** They are divided into two branches after striking the Peninsular plateau. Their onset is characterized with sudden burst.
 - **Arabian Sea branch:** This branch strikes Western Ghats at right angles and causes heavy orographic rainfall on the windward slopes with a pronounced rain-shadow belt on the leeward slopes. Though the winds penetrate deep inside the plateau but the intensity of rainfall goes on decreasing towards inside. A smaller branch of this branch moves through Kachchh plains upto J & K without causing any rainfall in the way since they move parallel to the Aravallis.
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- **Bay of Bengal branch:** This branch mainly influences the SE Asian countries like Indonesia, Malaysia, etc. A part of it enters India through Bengal Delta and causes heavy rainfall in Mawsynram (1221 cm) flanked by Garo, Khasi and Jaintia hills. Another part of this moves in SE-NW direction guided by Himalayas causing rainfall in the foothills and northern plains. The intensity of rainfall decreases from east to west and from north to south in the northern plains because of increase in distance from the source of moisture.
 - **Arabian Sea branch** is more powerful than **Bay of Bengal branch** because the size of Arabian Sea is bigger and whole of Arabian Sea branch enters India while most part of Bay of Bengal branch impacts SE Asian countries.
 - **North East or Retreating Monsoons:** Towards the end of September, the high pressure builds in NW India, ITCZ shifts towards south and anticyclonic conditions are set and thus winds start blowing from land to sea in a gradual manner. They are generally dry but pick up moisture from Bay of Bengal and cause rainfall in coastal Tamil Nadu, Karnataka, Orissa and Kerala.
 - **Theories:** Classical and Modern and Recent views
 - **Classical Theory/Thermal Concept:**
 - Although monsoons are mentioned in our old scriptures like the Rig Veda and in the writings of several Greek and Buddhist scholars, the credit for first scientific studies of the monsoon winds goes to the Arabs. Near about the tenth century, Al Masudi, an Arab explorer from Baghdad, gave an account of the reversal of ocean currents and the monsoon winds over the north Indian Ocean. Date of commencement of monsoons at several places was reported by Sidi Ali in 1554 A.D.
 - In 1686 the famous Englishman Sir Edmund Hailey explained the monsoon as resulting from thermal contrasts between continents and oceans due to their differential heating. Accordingly, Hailey conceived summer and winter monsoons depending upon the season.
 - (a) **Summer Monsoon:** In summer the sun shines vertically over the Tropic of Cancer resulting in high temperature and low pressure in Central Asia while the pressure is still sufficiently high over Arabian Sea and Bay of Bengal. This induces air flow from sea to land and brings heavy rainfall to India and her neighboring countries.
 - (b) **Winter Monsoon:** In winter the sun shines vertically over the Tropic of Capricorn. The north western part of India grows colder than Arabian Sea and Bay of Bengal and the flow of the monsoon is reversed.
 - Hailey's ideas are basically the same as those involved in land and sea breezes except that in the case of the monsoon day and night are replaced by summer and winter, and the narrow coastal strip and adjacent sea are replaced by large portions of continents and oceans.
 - **Modern Theories:** Hailey's classical theory based on differential heating of land and water as the main driving force of the monsoon winds dominated the scene for about three centuries. However, the
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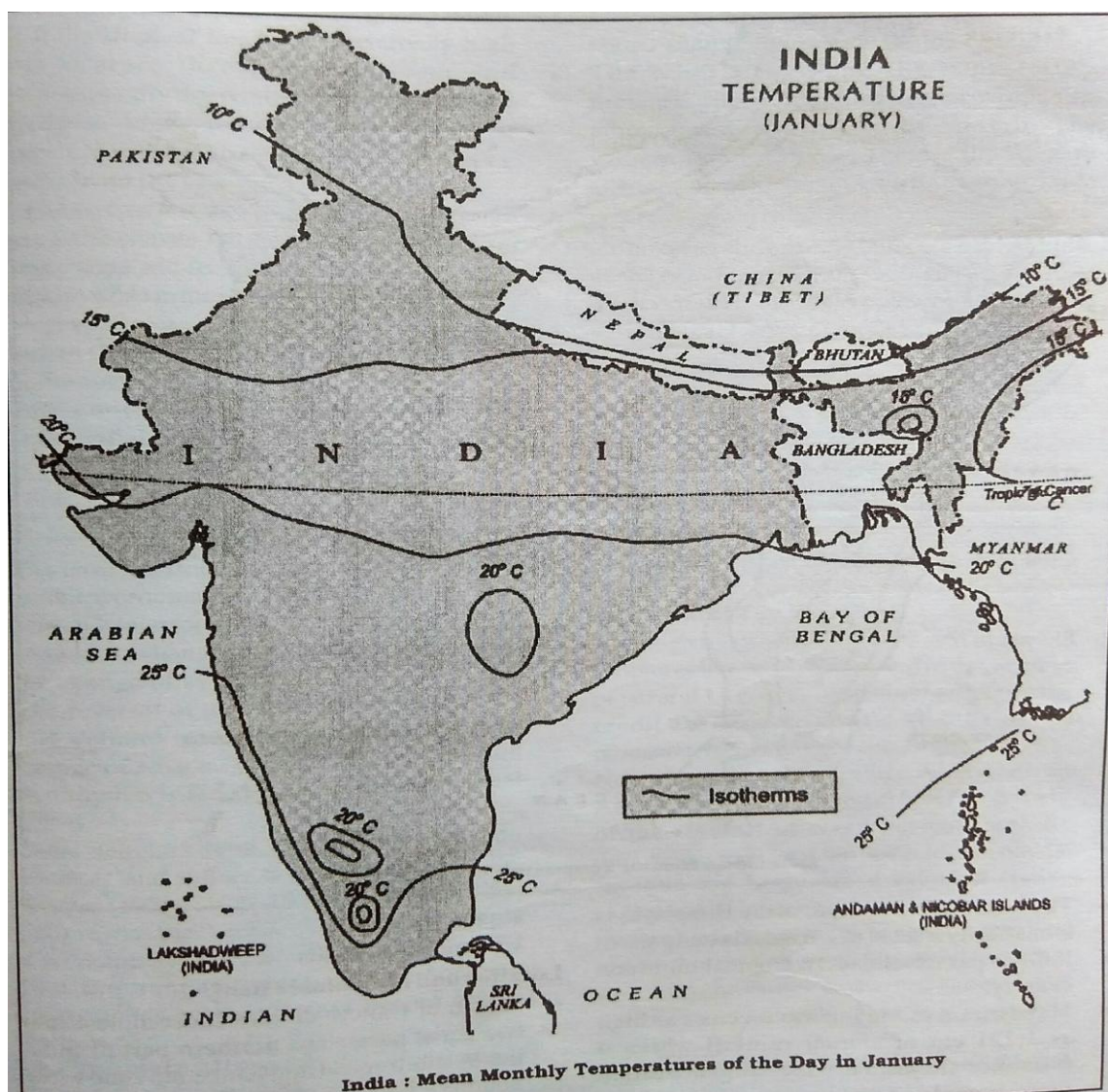
monsoons do not develop equally everywhere and the thermal concept of Hailey fails to explain the intricacies of the monsoons. Besides differential heating, the development of monsoon is influenced by the shape of the continents, orography, and the conditions of air circulation in the upper troposphere. Therefore, Hailey's theory has lost much of its significance and modern theories based on air masses and jet streams are becoming more relevant. Although Hailey's ideas have not yet been out-rightly rejected, studies during the last five decades have thrown much light on the genesis of the monsoons.

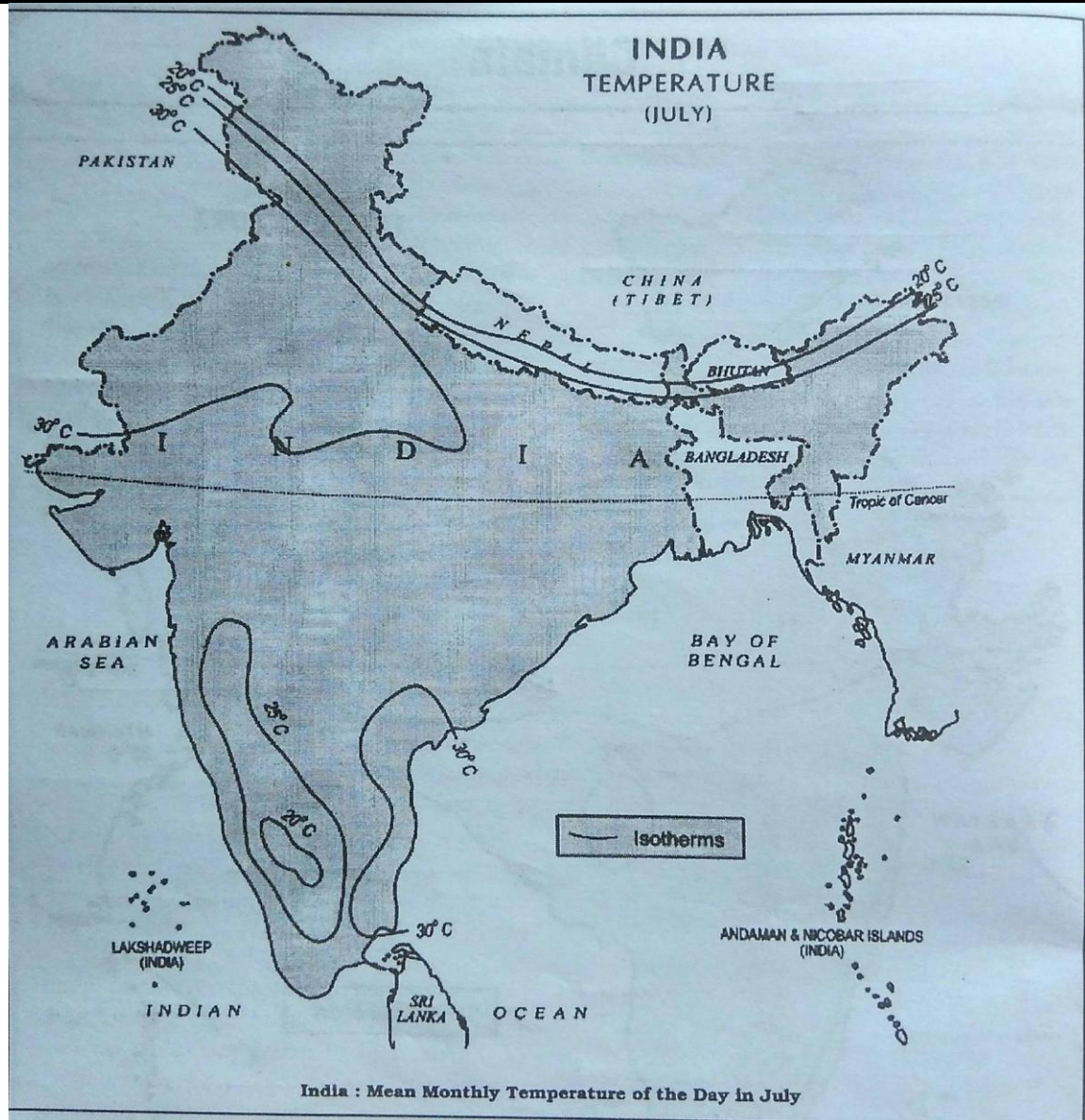
- During these years, Flohn, Thompson, Stephenson, Frost, M.T. Yin, Hwang, Takahashi, E. Palmen, C. Newton and Indian meteorologists including P. Koteswaram, Krishnan, Raman, Ramanathan, Krishna Murti, Rama Rattan, Ramaswami, Anant Krishnan, etc. have contributed a lot to the study of the monsoon winds.
 - **Air Mass Theory/ITCZ Concept:** The southeast trade winds in the southern hemisphere and the northeast trade winds in the northern hemisphere meet each other near the equator. The meeting place of these winds is known as the Inter-Tropical Convergence Zone (ITCZ).
 - Satellite imagery reveals that this is the region of ascending air, maximum clouds and heavy rainfall. The location of ITCZ shifts north and south of equator with the change of season. In the summer season, the sun shines vertically over the Tropic of Cancer and the ITCZ shifts northwards.
 - The southeast trade winds of the southern hemisphere cross the equator and start flowing from southwest to northeast direction under the influence of Coriolis force. These displaced trade winds are called south-west monsoons when they blow over the Indian sub-continent. The front where the south-west monsoons meet the north-east trade winds is known as the Monsoon Front.
 - In the month of July the ITCZ shifts to 20°- 25° N latitude and is located in the Indo-Gangetic Plain and the south-west monsoons blow from the Arabian Sea and the Bay of Bengal. The ITCZ in this position is often called the Monsoon Trough.
 - H. Flohn of the German Weather Bureau, while rejecting the classical theory of origin of monsoons suggested that the tropical monsoon of tropical Asia is simply a modification of the planetary winds of the tropics. He thinks of the thermal low of northern India and the accompanying monsoon as simply an unusually great northward displacement of the Northern Inter-Tropical
 - Convergence Zone (NITCZ). The seasonal shift of the ITCZ has given the concept of Northern Inter-Tropical Convergence Zone (NITCZ) in summer (July) and Southern Inter-Tropical Convergence Zone (SITCZ) in winter (Jan.). The fact that the NITCZ is drawn to about 30° latitude may be associated with the unusually high temperature over north India.
 - According to this interpretation the main westerly current of the monsoon is simply the expanded equatorial westerlies which lie embedded in the great mass of tropical easterlies or the trade winds. NITCZ is the zone of clouds and heavy rainfall.
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➤ **Jet Stream Theory:**

- Jet stream is a band of fast moving air from west to east usually found in the middle latitudes in the upper troposphere at a height of about 12 km. The wind speeds in a westerly jet stream are commonly 150 to 300 km p.h. with extreme values reaching 400 km p.h. Jet stream is the latest theory regarding the origin of the monsoons and has earned world wide acclaim from the meteorologists.
 - M.T. Yin (1949), while discussing the origin of the monsoons expressed the opinion that the burst of monsoon depends upon the upper air circulation. The low latitude upper air trough shifts from 90° E to 80° E longitude in response to the northward shift of the western jet stream in summer. The southern jet becomes active and heavy rainfall is caused by south-west monsoons.
 - Yin's ideas are well recognized by Pierre Pedelaborde (1963), in his book entitled 'The Monsoon'. In winter, the western jet stream flows along the southern slopes of the Himalayas but in summer it shifts northwards, rather dramatically, and flows along the northern edge of the Tibet Plateau. The periodic movements of the Jet stream are often indicators of the onset and subsequent withdrawal of the monsoon.
 - P. Koteswaram (1952), put forward his ideas about the monsoon winds based on his studies of upper air circulation. He has tried to establish a relationship between the monsoons and the atmospheric conditions prevailing over Tibet Plateau.
 - **Seasonal Rhythm of India: IMD (Delhi)** has identified four seasons in India:
 - **Summer Season:** It is called pre-monsoon season and extends from March to June.
 - High temperature and low humidity (dry air) and low pressure are its chief characteristics. High temperature (50.5⁰ C) is recorded in Rajasthan at Alwar.
 - Hot, dust laden and strong wind called as loo blows over Indian plains.
 - Norwesters or Kalbaisakhis/black storms characterized with thunderstorms and wind speeds of 60-80 km/h occur from mid-March to mid-April and cause rainfall. They are called Tea showers in assam, Mango showers in Andhra Pradesh and Tamil Nadu and Cherry blossoms in Karnataka. 1% rainfall occurs during this season.
 - **Rainy Season/Monsoon Season/South West monsoon season/wet season/hot-wet season:**
 - It extends from June to September. High heat, high humidity, extensive clouding, and heavy rains are its features.
 - Due to heavy rains, temperature falls down. Still highest temperatures of 32⁰ C are experienced in Thar Desert of Rajasthan.
 - Winds called SW monsoons blow in SW-NE direction. Around 75% of total rainfall occurs in this season.
 - **Cool Season/Autumn/Retreating Monsoon Season:** It extends from September to November. It begins with the withdrawal of the SW monsoons in September.
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- The SW monsoons reach NW India last of all but withdraw from there first of all. With the withdrawal of SW monsoons, clouds disappear, sky becomes clear and temperature once again rises. Average temperature varies from 25°C - 30°C .
 - Winds called NE Monsoons blow from land to sea. Since, they are generally dry and cause no rainfall. But, in coastal areas of Eastern coast of India called as Coromandel Coast, rainfall occurs because of these winds. Kerala has bi-modal pattern of rainfall.
 - This season is characterized with devastating cyclones originating in Bay of Bengal with greater frequency in the month of October.
- **The Cold Weather Season/Winter Season:** It extends from November to March.
- Northern parts of the country have below 21°C . Dras is coldest place in India. The southern parts have warm temperatures.
 - High air pressure prevails over large parts of NW India due to low temperature. So, winds blow from NW India (1019 mb) to south India (1013 mb).
 - In this season, three to five western disturbances are experienced per month that cause rains/snow in North Himalayan and foothill states.





- The average rainfall in India is 118 cm.
- The Indian Flood Commission is named as Rashtriya Barh Ayog. Floods are caused by heavy rains due to cloud bursts and tropical cyclones, deforestation, siltation in rivers, etc. One-eighth (12.5%) of the total area is flood prone. The largest flood prone areas are in UP, Bihar, etc.
- Drought is a situation when the mean annual rainfall is less than 75% of the normal rainfall of the area. It is reduction in rainfall/moisture below normal requirement. The largest drought prone areas are in Rajasthan, Gujarat, Maharashtra (rain shadow area), Karnataka, etc.

Koeppen's Classification of Climatic Regions of India

Koeppen's Classification of Climatic Regions of India is an empirical classification based on mean annual and mean monthly temperature and precipitation data. Koeppen identified a close relationship between the distribution of vegetation and climate. He selected certain values of temperature and precipitation and related them to the distribution of vegetation and used these values for classifying the climates.

Koeppen recognized five major climatic groups, four of them are based on temperature and one on precipitation.

The capital letters: A, C, D and E delineate humid climates and B dry climates.

The climatic groups are subdivided into types, designated by small letters, based on seasonality of precipitation and temperature characteristics.

The seasons of dryness are indicated by the small letters: f, m, w and s, where

f – no dry season,

m – monsoon climate,

w – winter dry season and

s – summer dry season.

The above mentioned major climatic types are further subdivided depending upon the seasonal distribution of rainfall or degree of dryness or cold.

a: hot summer, average temperature of the warmest month over 22°C

c: cool summer, average temperature of the warmest month under 22°C

f: no dry season

w: dry season in winter

s: dry season in summer

g: Ganges type of annual march of temperature; hottest month comes before the solstice and the summer rainy season.

h: average annual temperature under 18°C

m (monsoon): short dry season.

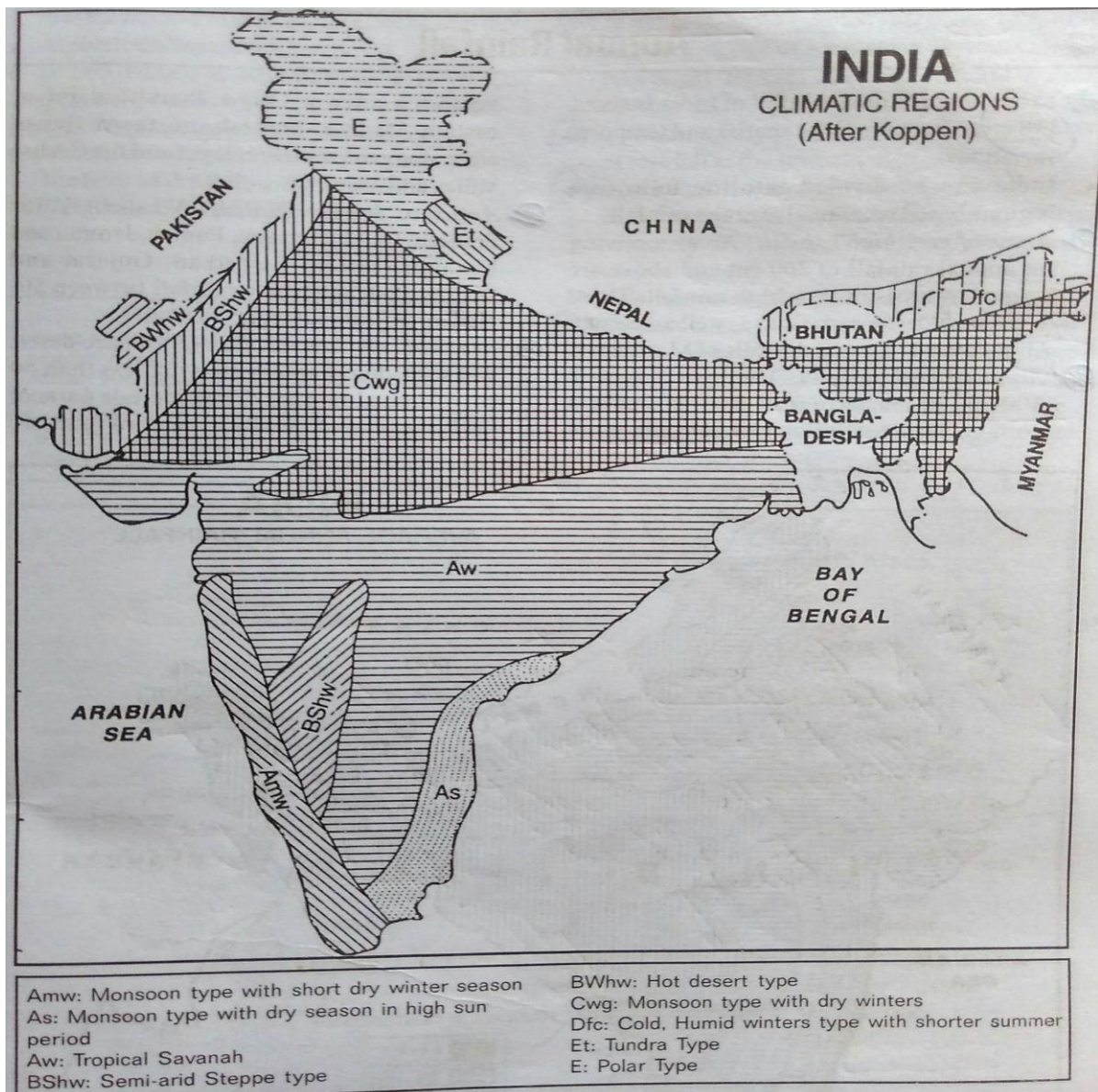
The capital letters S and W are employed to designate the two subdivisions of dry climate: semi-arid or Steppe (S) and arid or desert (W).

Capital letters T and F are similarly used to designate the two subdivisions of polar climate: tundra (T) and icecap (F).

➤ **Koeppen divided India into nine climatic regions making use of the above scheme.**

Koeppen's Scheme – Climatic Regions of India		
Climate type	Region	Annual rainfall
Amw (Monsoon type with short dry winter season)	Western coastal region, south of Mumbai	over 300 cm
As (Monsoon type with dry season in high sun period)	Coromandel coast = Coastal Tamil Nadu and adjoining areas of Andhra Pradesh	75 – 100 cm [wet winters, dry summers]
Aw (Tropical Savanah type)	Most parts of the peninsular plateau barring Coromandel and Malabar coastal strips	75 cm
BShw	Some rain shadow areas of Western Ghats, large part of	12 to 25 cm

(Semi-arid Steppe type)	Rajasthan and contiguous areas of Haryana and Gujarat	
BWhw (Hot desert type)	Most of western Rajasthan	less than 12 cm
Cwg (Monsoon type with dry winters)	Most parts of the Ganga Plain, eastern Rajasthan, Assam and in Malwa Plateau	100 – 200 cm
Dfc (Cold, Humid winters type with shorter summer)	Sikkim, Arunachal Pradesh and parts of Assam	~200 cm
Et (Tundra Type)	Mountain areas of Uttarakhand The average temperature varies from 0 to 10°C	Rainfall varies from year to year.
E (Polar Type)	Higher areas of Jammu & Kashmir and Himachal Pradesh in which the temperature of the warmest month varies from 0° to 10°C	Precipitation occurs in the form of snow

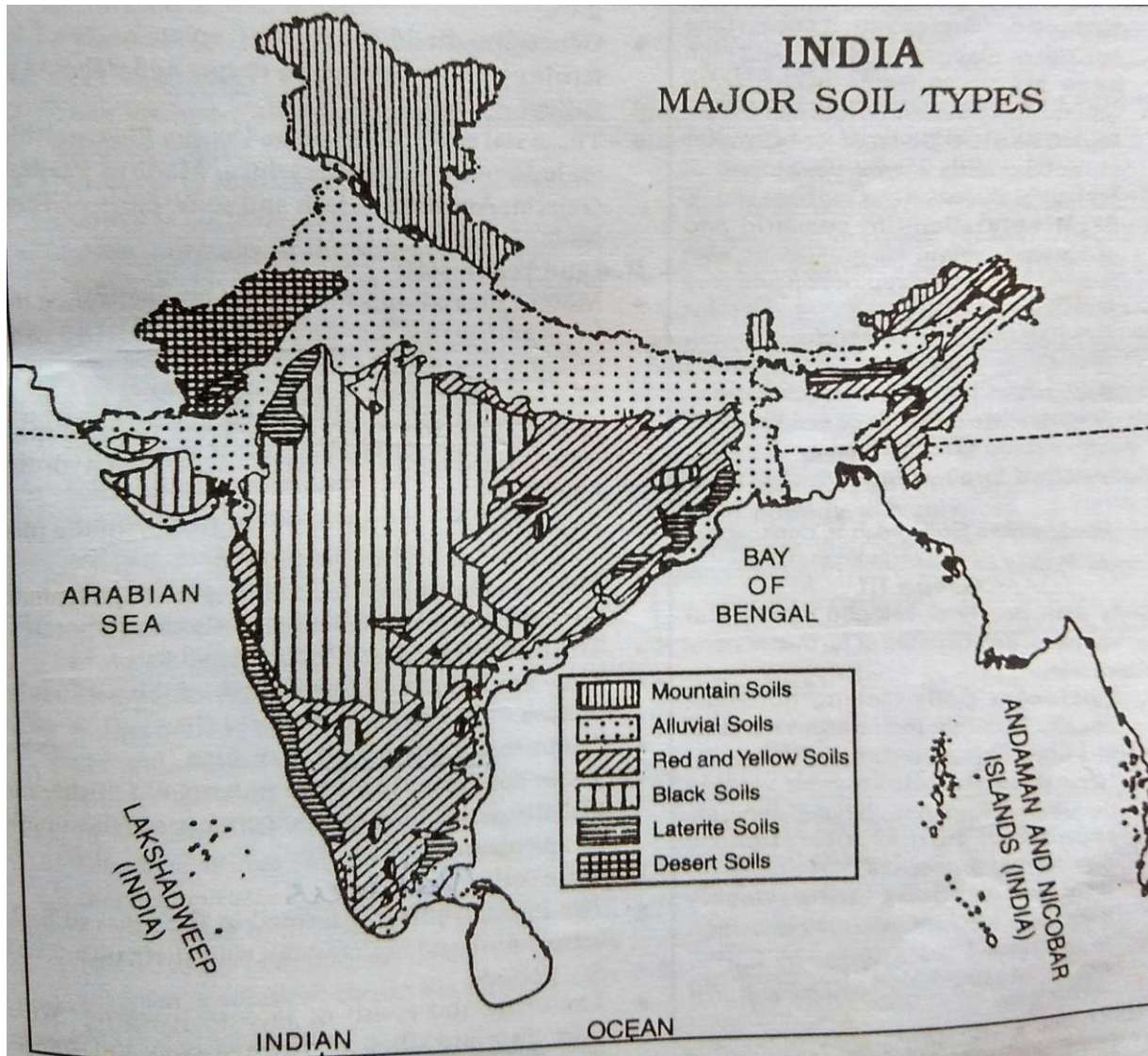


Soils of India

The upper thin, loose, weathered layer of the crust is called as Soil. The scientific study of the soils is called as Pedology and the soil formation process as Pedogenesis. Sub-soil or parent material is the unweathered hard layer under the soil. It is composed of solids, liquids and gases. The solids are both organic and inorganic in nature. Soils also contain colloids, oxides of iron (Limonite), oxides of Aluminium (Bauxite), etc.

- **Soil color** is determined with the aid of Munshell color chart.
 - **Soil acidity** is measured as per pH scale (0-14). 0 means extreme acidity and 14 means extreme alkalinity. Water has 7 (neutral) pH. pH value of 6.5 is ideal for cereals crops.
 - **Soil Texture** means ratio/proportion of sand, silt and clay in the soil. Loam is an ideal soil which as 40:40:20 (sand, silt and clay ratio). Texture determines soil characteristics such as water retention capacity, aeration, tillage, etc.
 - **Soil Formation Processes:**
 - **Weathering:** It is the breakdown and decomposition of rocks/parent material in situ. It is the first process/first step in soil formation.
 - **Translocation:** It refers to the material flow within the soil body.
 - **Eluviation** refers to downward transport of fine particles, minerals, etc.
 - **Illuviation** means accumulation of materials brought downward from A Horizon.
 - **Salinization/Alkalization:** Accumulation of salts and alkalies in the surface soil as a result of capillary action in dry environments where evaporation is greater than precipitation.
 - **Factors Controlling Soil Formation: Five Factors**
 - **Climate:** It is the most important factor controlling soil formation. Two elements of climate i.e., precipitation and temperature influence soil formation. Where rainfall exceeds evaporation, leached soils called pedalfers or laterites are formed due to removal of free calcium ions leaving behind iron and aluminium oxides. Where evaporation exceeds rainfall, salts and calcium ions accumulate in the soil due to capillary action giving rise to pedocals/saline soils/alkaline soils. Temperature helps in decomposition of organic matter due to bacterial activity.
 - **Parent Material:** It influences the color and composition of the soil. The red soils have red color because of iron oxides in the parent material. The black color of soil is because of titaxiferous oxides.
 - **Relief/Topography/Slope:** On steep slopes, the soils are shallow, coarse and immature. While as on gentle slopes and plain areas, the soils are deep, fertile and fine grained.
 - **Vegetation and other Biota:** Vegetation adds humus to the soil and binds it together. The soil biota keeps it healthy through aeration and other activities.
 - **Time:** Soil takes thousands of years to form.
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- **Major Soil Groups of India:** In ancient times, soils were classified into two main groups *Urvara* and *Usara*, which were fertile and sterile, respectively. In the 16th century A.D., soils were classified on the basis of their inherent characteristics and external features such as texture, colour, slope of land and moisture content in the soil. Based on texture, main soil types were identified as sandy, clayey, silty and loam, etc. On the basis of colour, they were red, yellow, black, etc. On the basis of genesis, colour, composition and location, the soils of India have been classified into:



- **Alluvial Soils:** These soils were formed of alluvium eroded and deposited by rivers. That means they are found in all river valleys. They cover all the Indian River plains.
- Cover 15 lakh sq. km (45.6%) of the total area of the country....largest.
 - They are found in UP, Bihar, West Bengal, Punjab, Haryana, and deltas of peninsular rivers. Sometimes, divided into bhangar, khaddar, etc.
 - Immature but fertile. They are rich in potash, phosphorus, organic matter, and deficient in nitrogen and humus. One thing should be kept in mind that all Indian soils except forest and peat soils lack nitrogen and humus content. Tarai soils of these soils are nitrogen rich.
 - Suitable for rice, wheat, sugarcane, jute, soyabean, etc.

- **Black Soils:** They are known as Regur soils (Telugu word Reguda) or Black cotton soils because cotton is main crop grown in these soils. They are formed volcanic material (basalt). Their black color is attributed to titaxiferous magnetite present in the parent material.
 - Cover 5.46 lakh sq. km (16.6%) of the total area of the country. They are found in Deccan Plateau in the states of Maharashtra, MP, parts of Karnataka, Andhra Pradesh, etc.
 - Mature and fertile soil. They contain iron, lime, and potash but lack nitrogen and humus.
 - They are highly retentive of moisture because of high clay content. They swell and become sticky in rainy season and shrink when dried. So, they are self ploughing soils.
 - **Red Soils:** They are derived from ancient crystalline and metamorphic rocks and develop a reddish color due to iron in parent material. It looks yellow when it occurs in a hydrated form.
 - Cover 3.5 lakh sq. km (10.6%) of the total area of the country. They are found in Tamil Nadu, parts of Karnataka and Maharashtra, MP, and NE states.
 - They are generally normally fertile but poor in nitrogen, phosphorous and humus.
 - Suitable for cotton, rice, wheat, etc. if fertilized and irrigated properly.
 - **Laterite Soils:** Laterite has been derived from the Latin word '*Later*' which means brick. Laterite soils are widely cut as bricks for use in house construction.
 - The laterite soils develop in areas with high temperature and high rainfall. These are the result of intense leaching due to rains. With rain, lime and silica are leached away, and soils rich in iron oxide and aluminium are left behind. Humus content of the soil is removed fast by bacteria that thrive well in high temperature.
 - They cover 2.48 lakh sq. km (7.5%) of the total area of the country and are found The laterite soils are commonly found in high temperature and rainfall areas of Maharashtra, Karnataka, Kerala, Tamil Nadu, Madhya Pradesh, Orissa and Assam.
 - These soils are poor in organic matter, nitrogen, phosphate and calcium, while iron oxide and potash are in excess. Hence, laterites are not suitable for cultivation; however, application of manures and fertilizers are required for making the soils fertile for cultivation.
 - **Arid and Semi-Arid Soils/Desert Soils:** They consist of sand (90-95%) and clay (5-10%) and are found in western part of Rajasthan and in parts of Punjab, Haryana and coastal states.
 - They are sandy in structure and saline in nature (salts accumulate in top soil). Lower horizons of the soil are occupied by kankar layers (the calcium carbonate deposits).
 - They are poor and contain little humus and insufficient nitrogen.
 - Drought resistant and salt tolerant crops like barley, rape, cotton, millets, etc are grown.
 - **Saline and Alkaline Soils:** These soils are known as usar, thur, kallar, reh, etc. They contain a larger proportion of sodium, potassium and magnesium, and thus, they are infertile, and do not support any vegetative growth. They have more salts, largely because of dry climate and/or poor drainage.
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- They occur in arid and semi-arid regions and in waterlogged and swampy areas and are found in western Gujarat, deltas of eastern coast and in Sunderban area of West Bengal.
- In such areas, especially in Punjab and Haryana, farmers are advised to add gypsum to solve the problem of salinity in the soil.
- They lack in nitrogen and calcium.
- **Peaty and Marshy Soils:** They are found in the areas of heavy rainfall and high humidity, where there is a good growth of vegetation. Thus, large quantity of dead organic matter accumulates in these areas, and this gives a rich humus and organic content to the soil. Organic matter in these soils may go even up to 40-50 per cent. It occurs widely in the northern part of Bihar, southern part of Uttaranchal and the coastal areas of West Bengal, Orissa and Tamil Nadu.
- **Forest Soils:** They are found on hill slopes covered by forests. They are very rich in humus, and are deficient in potash, and lime. The soils found in the lower valleys are fertile.

Natural Vegetation

India is a land of great variety of natural vegetation. Himalayan heights are marked with temperate vegetation; the Western Ghats and the Andaman Nicobar Islands have tropical rain forests, the deltaic regions have tropical swamp forests and mangroves; the desert and semi desert areas of Rajasthan are known for cacti (thorny) vegetation.

- Climate, soil and topography influence the natural vegetation. Climate especially rainfall determine the vegetation zones of India.
- Areas receiving 200 cm or more rainfall per annum have evergreen rain forests.
- Monsoon (moist) deciduous forests dominate in areas having rainfall from 100-200 cm.
- Dry deciduous trees or tropical savanna are found in areas having 50-100 cm of rainfall.
- Areas with less than 50 cm rainfall have dry thorny scrub and open bushes.
- As temperature decreases with altitude in Himalayan region, vegetal cover changes from tropical to sub-tropical, temperate and finally alpine.

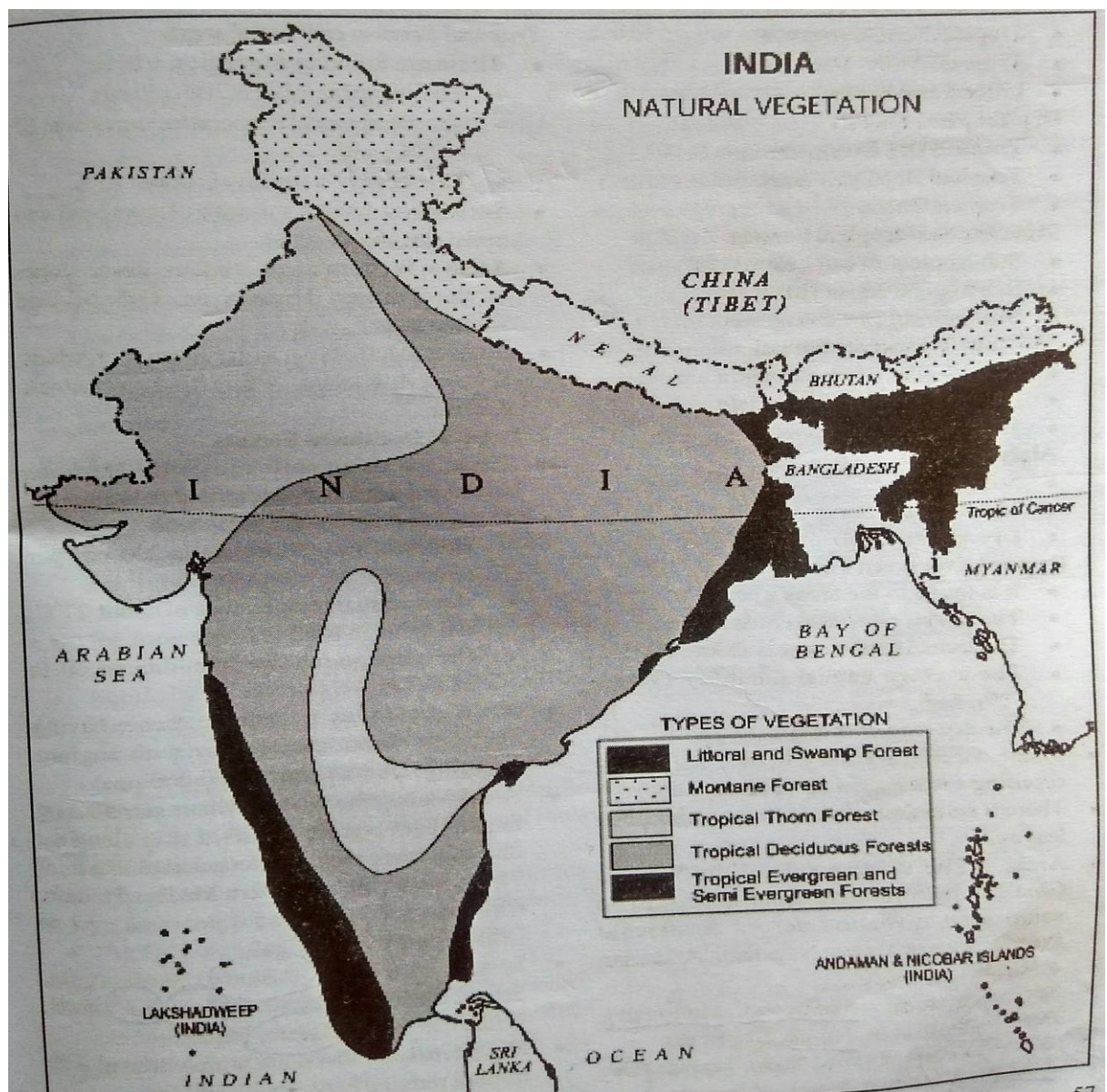
On the basis of certain common features such as predominant vegetation type and climatic regions, Indian forests can be divided into the following groups:

- **Tropical Evergreen and Semi-Evergreen Forests:** These forests are found in the western slope of the Western Ghats, hills of the northeastern region and the Andaman and Nicobar Islands.
 - They are found in warm and humid areas with an annual precipitation of over 200 cm and mean annual temperature above 22°C.
 - Tropical evergreen forests are well stratified, with trees of up to 60 m or above height.
 - There is no definite time for trees to shed their leaves, and so appear green all the year round.
 - Species found in these forests include rosewood, mahogany, aini, ebony, etc.
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- Main species of Semi-Evergreen forests are white cedar, hollock and kail.
- Britishers changed these forests for their vested interests.

➤ **Tropical Deciduous Forests (Moist and Dry):** These are the most widespread forests in India. They are also called the monsoon forests.

- They spread over regions which receive rainfall of 70-200 cm.
- *The Moist deciduous forests* (100-200 cm rainfall): These forests are found in the northeastern states along the foothills of Himalayas, eastern slopes of the Western Ghats and Orissa. Teak, sal, and sandalwood etc. are the main species of these forests.
- *Dry deciduous forest* (70 -100 cm): These forests are found in rainier areas of the Peninsula and the plains of Uttar Pradesh and Bihar. As the dry season begins, the trees shed their leaves completely. Khair, axlewood, etc. are the common trees of these forests.



- **Tropical Thorn Forests:** Tropical thorn forests occur in the areas which receive rainfall less than 50 cm. It includes semi-arid areas of south west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh. Important species found are babool, ber, and cactii, khair, etc.
 - **Montane Forests:** In mountainous areas, the decrease in temperature with increasing altitude leads to a corresponding change in natural vegetation. Mountain forests can be classified into two types, the northern mountain forests and the southern mountain forests.
 - The Himalayan ranges show a succession of vegetation from the tropical to the tundra (alpine), which change in with the altitude. Tropical deciduous in foothills (<1000 m), followed by temperate forests (1000-2000 m) such as pine, chinar, walnut, etc., temperate grasslands, and finally Alpine forests (3000-4000 m) such as silver fir, juniper, rhodhdendrons, etc.
 - In Peninsular region, vegetation is temperate in the higher regions and subtropical on the lower regions. The temperate forests are called *Sholas* in the Nilgiris, Anaimalai and Palani hills.
 - **Littoral and Swamp Forests:** They occur in and around the deltas, estuaries and creeks. They survive both in fresh and brackish waters. For instance, mangroves which are salt tolerant (halophytes) tropical swamp forests mainly found in West Bengal (Sunderban delta), Gulf of Kutch in Gujarat, etc. Main species are sundari, agar, bhendi, etc.
 - **Classification Scheme for Forest Cover Estimation: As per ISFR, 2015**
 - Very Dense Forest (2.61% of total area): Lands with tree canopy density of 70% or above.
 - Moderately Dense Forest (9.59%): Lands with tree canopy density between 40% and 70%.
 - Open Forest (9.14%): Lands with tree canopy density between 10% and 40%.
 - Lands having tree canopy density below 10% are named as scrub/degraded forests (1.26%).
 - Non-forest (77.40%): water bodies and other lands.
 - **Distribution of Forest (Area and Cover):** The minimum desired area for a tropical country like India is about 33%. Further, it should be about 60% in mountainous areas and 20% in plain areas.
 - The total forest and tree cover is 79.42 million hectare, which is 24.16 percent (forest cover=21.34% and tree cover=2.82%) of the total geographical area.
 - The India State of Forest Report (ISFR) 2015 states that forest and tree cover has increased by 5, 081 sq km. While the total forest cover of the country has increased by 3, 775 sq km, the tree cover has gone up by 1, 306 sq km.
 - The major increase in forest cover has been observed in open forest category mainly outside forest areas, followed by Very Dense Forest.
 - Madhya Pradesh has the largest forest cover (77, 462 sq km) in the country, followed by Arunachal Pradesh (67, 248 sq km) and Chhattisgarh (55, 586 sq km).
 - Haryana has least forest cover followed by Punjab (States). Daman and Diu has lowest (UTs).
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- Mizoram (88.93%) has the highest forest cover in percentage terms, followed by Lakshadweep (84.56%) to their respective total state/UT areas.
- Jammu and Kashmir is largest producer of timber while as Karnataka is largest producer of fuelwood in India. MP is largest producer of gums and tendu leaves. Arunachal Pradesh leads in resin production and Jharkhand in lac.