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INDEX

1. Geographical Extent and Frontiers 2-3
2. Structure and Physiography of India 4-12
3. Drainage System 13-17
4. Climate 18-20
5. Indian Monsoon 21-25
6. Natural Vegetation 26-28
7. Soils 29-32
8. Agriculture 33
9. Minerals 34-35
10. Industries 36-38
11. Natural Hazards and Disaster 39-43

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Geographical Extent and Frontiers

India as a Geographical Unit:

- Geographical Extent: $8^{\circ} 4' N$ to $37^{\circ} 6' N$ latitude and $68^{\circ} 7' E$ to $97^{\circ} 25' E$ longitude.

Northern Most Point:

- Indira col, Siachen glacier in Karakoram range.

Easternmost Point :

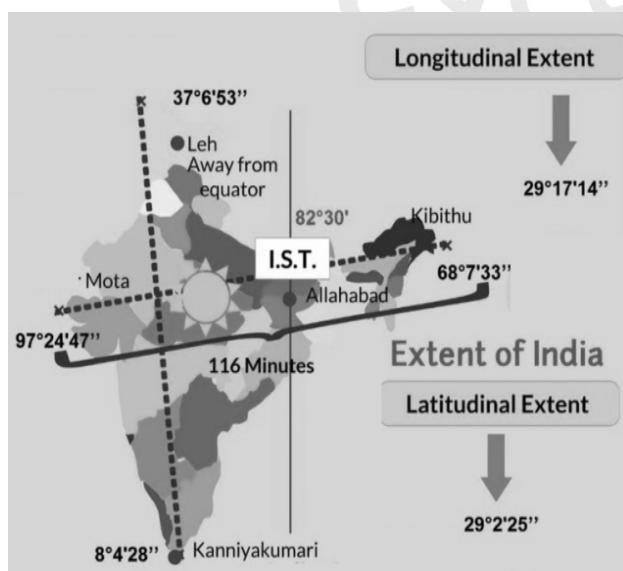
- The tiny town of Kibithu in Arunachal Pradesh.

Westernmost Point:

- Ghaur Moti, located in the Kutch District of Gujarat.

Southernmost Point:

- Indira Point in Great Nicobar Island in the Andaman Sea. Kanyakumari is southernmost in Indian mainland.
- India has **15106.7 Km** of land border and a coastline of **7516.6 Km**.



India's Frontiers:

- India's longest border is with **BANGLADESH** and shortest border is with Afghanistan (**PoK touches Afghanistan**).

Neighbouring Countries	Bordering States
Afghanistan	Jammu and Kashmir (Pakistan-Occupied Area).

China	Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh.
Bangladesh	West Bengal, Mizoram, Meghalaya, Tripura and Assam.
Bhutan	West Bengal, Sikkim, Arunachal Pradesh and Assam.
Myanmar	Arunachal Pradesh, Nagaland, Manipur and Mizoram.
Nepal	Bihar, Uttarakhand, Uttar Pradesh, Sikkim and West Bengal.
Pakistan	Jammu and Kashmir, Punjab, Rajasthan and Gujarat

Important Passes:

State	Pass
Jammu and Kashmir	Zoji La it is in Zaskar range, Banihal pass
Himachal Pradesh	Shipki La ,Bara-Lacha Pass, Rohtang pass
Uttarakhand	Manali, Lipulekh, Niti pass
Sikkim	Nathu La , Jelep La
Arunachal Pradesh	Bomdi La, Dihang pass
Western ghats	Thalghat , Bhorghat, Pal ghat

Important Boundary Line:

Boundary Line	Countries
Radcliffe Line	Between India and Pakistan
Mac Mohan Line	Between India and China
Durand Line	Between Pakistan and Afghanistan
49th Parallel	Between USA and Canada
38th Parallel	Between North and South Korea
Hohenberg Line	Between Germany and Poland
Maginot line	Between France and Germany
Oder Neisse Line	Between Germany and Poland



Tropic of Cancer lies at 23.50 degree North in India passes through 8 states and nearest cities to it are.

1. Gandhinagar (**Gujarat**) - 23.10 N
2. Jaipur (**Rajasthan**) - 26.55 N
3. Bhopal (**M.P**) - 23.16 N
4. Raipur (**Chhattisgarh**) - 21.16 N
5. Ranchi (**Jharkhand**) - 23.11 N
6. Kolkata (**W.B**) - 22.34 N
7. Agartala (**Tripura**) - 23.51 N
8. Aizawl (**Mizoram**) - 23.36 N

Indian Standard Time: GMT + 05:30 or 82.5° longitude East of Greenwich passing through Mirzapur of Uttar Pradesh is Indian Standard line which passes through 5 states of India.

1. Uttar Pradesh
2. Madhya Pradesh
3. Chhattisgarh
4. Odisha
5. Andhra Pradesh

Important cities through which IST line passes are, Mirzapur, Handi, Korba, Chunar, Junagarh, Jaunpur etc.

In India **meeting point** of Tropic of cancer and IST line is at the Sanjay Gandhi National Park forest land of Chattisgarh.

India as a Tropical Country:

The temperate part (north of Tropic of Cancer) is twice the area of tropical part. But **India has always been treated as a tropical country** for two different reasons – **physical** and **cultural**:

Physical Reasons:

- The country is separated from the rest of Asia by Himalayas.
- Its climate is dominated by the tropical monsoons and the temperate air masses are blocked by Himalayas.

Entire area south of Himalayas is essentially tropical from climatic point of view:

- Although the night temperature in winter at several places in North India may come down to the level of those prevailing in temperate lands, yet clear skies and intense insolation raise the day temperatures to a tropical level.

Cultural Reasons:

- Settlements, diseases, agricultural and primary economic activities are all tropical in nature.
- Hence, It is **primarily because of Himalayas that India is a tropical country**.



Structure and Physiography of India

- Earth is approximately 460 million years old. Overtime it has undergone many changes brought about primarily by the **endogenic** and **exogenic forces**.
- These forces have played a significant role in giving shape to various **surface** and **subsurface features** of earth. Indian plate was south of equator, millions of years ago. It was much larger in size and the Australian plate was a part of it.
- Over millions of years, this plate broke into many parts and **Eurasian plate** moved towards south eastern direction and Indian plate to the north.
- This northward movement of the Indian plate is still continuing and it has significant consequences on physical environment of Indian subcontinent.

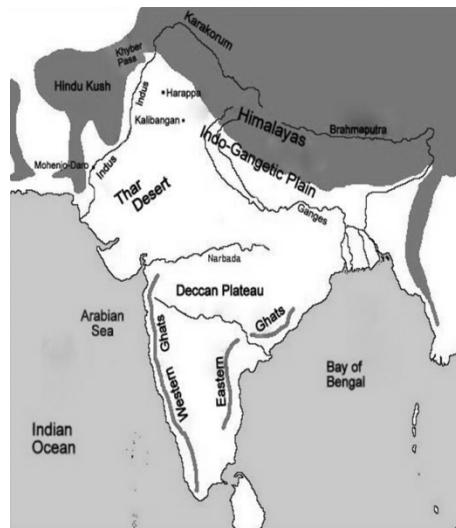


- It is primarily through the interplay of these **endogenic** and **exogenic** forces and **lateral movements** of plates that present geological structure and geomorphologic processes active in the Indian subcontinent came into existence.
- Based on the variations in its geological structure and formations, India can be divided into **three geological divisions**. These divisions follow the physical features:

(i) The Peninsular Block

(ii) The Himalayas and other Peninsular Mountains

(iii) Indo-Ganga-Brahmaputra Plain.



(i) The Peninsular Block:

Peninsular Block Extension:

- The northern boundary of the Peninsular Block - line running from Kachchh along the western flank of the Aravali Range near Delhi and then roughly parallel to the Yamuna and the Ganga as far as the Rajmahal Hills and the Ganga delta.
- KarbiAnglong and Meghalaya Plateau in the northeast and Rajasthan in the west are also extensions of this block.
- The north-eastern parts are separated by Malda fault in West Bengal from Chotanagpur plateau.

(i) Peninsular block formation

- The Peninsula is formed by a great complex of very ancient gneisses and granites, which constitutes a major part of it.
- As a part of the Indo-Australian Plate, it has been subjected to various vertical movements and block faulting. The rift valleys of the Narmada, the Tapi and the Mahanadi and the Satpura block mountains are some examples of it.
- The Peninsula mostly consists of relict and residual mountains like the Aravali hills, the Nallamala hills, the Javadi hills, the Veliconda hills, the Palkonda range and the Mahendragiri hills, etc.



- The river valleys here are shallow with low gradients. Most of the **East flowing** rivers form deltas before entering into the Bay of Bengal. The deltas formed by the Mahanadi, the Krishna, the Kaveri and the Godavari are important examples.

(ii) The Himalayas and other Peninsular Mountains

- The Himalayas are young, weak and flexible in their geological structure unlike the rigid and stable Peninsular Block.
- Consequently, they are still subjected to the interplay of exogenic and endogenic forces, resulting in the development of faults, folds and thrust plains.
- These mountains are tectonic in origin, dissected by fast-flowing rivers which are in their youthful stage.
- Various landforms like gorges, V-shaped valleys, rapids, waterfalls, etc. are indicative of this stage.

(iii) Indo-Ganga-Brahmaputra Plain

- The third geological division of India comprises the plains formed by the river Indus, Ganga and Brahmaputra.
- Originally, it was a geo-synclinal depression which attained its maximum development during the third phase of the Himalayan mountain formation approximately 64 million years ago.
- Since then, it has been gradually filled by the sediments brought by the Himalayan and Peninsular rivers.
- The relief and physiography of India has been greatly influenced by the geological and geomorphological processes active in Indian subcontinent.

Physiography:

- Physiography of an area is the outcome of structure, process and the stage of development.

- The north has a vast expanse of rugged topography consisting of a series of mountain ranges with varied peaks, beautiful valleys and deep gorges.
- The south consists of stable table land with highly dissected plateaus, denuded rocks and developed series of scarps.
- In between these two lies vast north Indian plain.

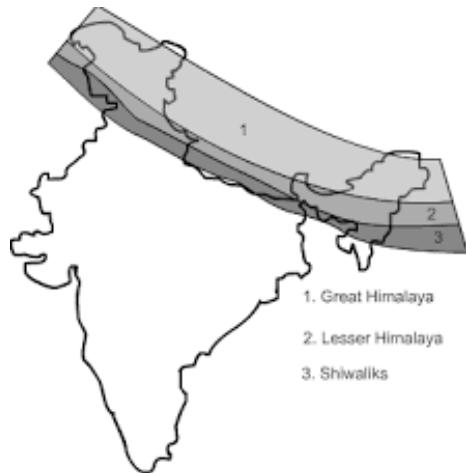
Based on these macro variations, India can be divided into following physiographic divisions:

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

A. The North and North-eastern Mountains

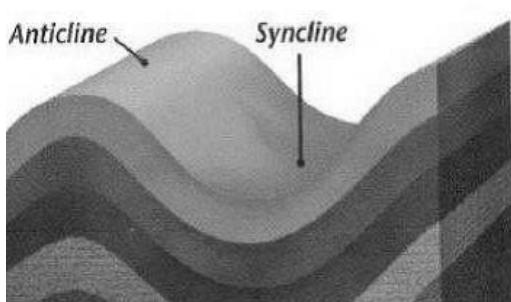
- The North and North-eastern Mountains consist of Himalayas and the North-eastern hills.
- The Himalayas consist of a series of parallel mountain ranges.
- The general orientation of these ranges is from northwest to the southeast direction in the northwestern part of India.
- Himalayas in the Darjiling and Sikkim regions lie in an east west direction, while in Arunachal Pradesh they are from southwest to the northwest direction.
- In Nagaland, Manipur and Mizoram, they are in the north south direction.
- The approximate length of the Great Himalayan range, also known as the central axial range, is 2,500 km from east to west, and their width varies between 160-400 km from north to south.
- Himalayas stand almost like a strong and long wall between the Indian subcontinent and the Central and East Asian countries. Himalayas are not only the physical barrier, they are also a climatic, drainage and cultural divide.

- Some of the important ranges are the **Greater Himalayan range** (which includes the Great Himalayas and the Trans-Himalayan range), the **Middle Himalayas** and the **Shivalik**.



Shivalik Range:

- Located in between the Great Plains and **Lesser Himalayas**. The altitude varies from **600 to 1500 metres**.
- Runs for a distance of 2,400 km from the **Potwar Plateau (west)** to the **Brahmaputra valley (east)**.
- The width of the Shiwaliks varies from 50 km in Himachal Pradesh to less than 15 km in Arunachal Pradesh.
- They are an almost unbroken chain of low hills except for a gap of 80-90 km which is occupied by the valley of the **Tista River** and **Raidak River**.
- Valleys are part of synclines and hills are part of anticlines or anti-synclines.



Middle Himalayas or Himachal:

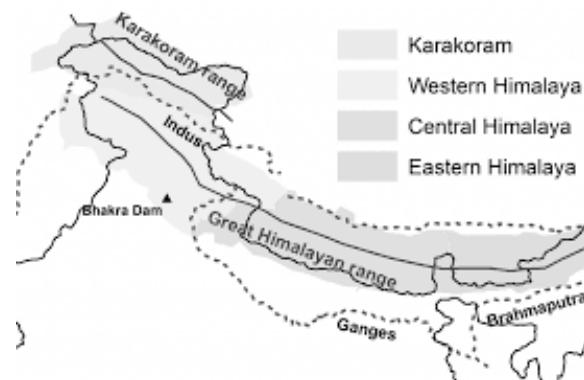
- In between the Shiwaliks in the south and the Greater Himalayas in the north.
- The Lower Himalayan ranges** are 60-80 km wide and about 2400 km in length.
- Elevations vary from **3,500 to 4,500 m** above sea level.
- The Lower Himalayas** have **steep, bare southern slopes (steep slopes prevent soil formation)** and gentler, forest covered northern slopes.

Great Himalayas:

- Also known as Inner Himalaya, Central Himalaya or Himadri.
- It is mainly formed of the crystallines (granites and gneisses) overlaid by metamorphosed sediments (limestone). This mountain arc convexes to the south just like the other two ranges.
- The Himadri terminates abruptly at the syntaxis bents. One in the **Nanga Parbat** in the north-west and the other in the **Namcha Barwa** in the north-east.

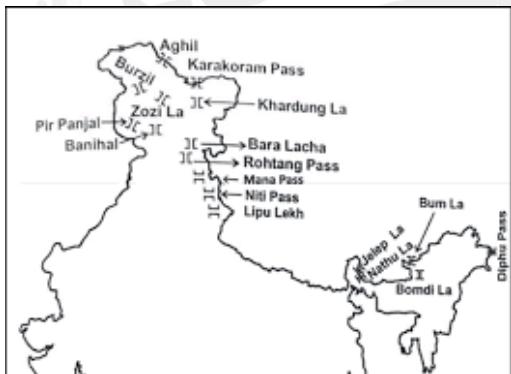
Himalayas can be divided into the following Sub-divisions:

- Kashmir or Northwestern Himalayas
- Himachal and Uttarakhand Himalayas
- Darjiling and Sikkim Himalayas
- Arunachal Himalayas
- Eastern Hills and Mountains.



1. Kashmir or North-Western Himalayas:

- It lies between the Indus and the Ravi river. Comprise a series of ranges such as the Karakoram, Ladakh, Zaskar and PirPanjal.
- The northeastern part of the Kashmir Himalayas is a cold desert, which lies between the Greater Himalayas and the Karakoram ranges.
- Between the Great Himalayas and the PirPanjal range, lies the world famous valley of Kashmir and the famous Dal Lake.
- Important glaciers of South Asia such as the Baltoro and Siachen are also found in this region.
- The Kashmir Himalayas are also famous for **Karewa** formations, which are useful for the cultivation of Zafran, a local variety of saffron.
- Some of the **important passes** of the region are Zoji La on the Great Himalayas, Banihal on the PirPanjal, Photu La on the Zaskar and Khardung La on the Ladakh range.



- Some of the important **fresh lakes** such as Dal and Wular and **salt water lakes** such as Pangong Tso and Tso Moriri are also in this region.
- This region is drained by the river Indus, and its tributaries such as the Jhelum and the Chenab. **Jhelum** in the valley of Kashmir is still in its **youth stage and yet forms meanders** – a typical feature associated with the mature stage in the evolution of fluvial land form.

2. Himachal and Uttarakhand Himalayas:

- It lies between the Ravi in the west and the Kali (a tributary of Ghaghara) in the east.
- Drained by two major river systems of India, i.e. Indus and Ganga.
- Himalayas is an extension of the Ladakh cold desert, which lies in the Spiti subdivision of district Lahul and Spiti.
- All the three ranges of Himalayas are prominent in this section also.
- These are the Great Himalayan range, the Lesser Himalayas (which is locally known as Dhaoladhar in Himachal Pradesh and Nag Tibba in Uttarakhand) and the Shiwalik range from the North to the South.
- The two distinguishing features of this region from the point of view of physiography are the Shiwalik and 'Dun formations'.
- Some important duns located in this region are the Chandigarh-Kalka dun, Nalagarh dun, Dehra Dun, Harike dun and the Kota dun, etc.
- Dehra Dun is the largest of all the duns with an approximate length of 35-45 km and a width of 22-25 km.
- In the Great Himalayan range, the valleys are mostly inhabited by the Bhotia's. These are nomadic groups who migrate to Bugyal's (the summer grasslands in the higher reaches) during summer months and return to the valleys during winters.
- The famous 'Valley of flowers' is also situated in this region. The places of pilgrimage such as the Gangotri, Yamunotri, Kedarnath, Badrinath and Hemkund Sahib are also situated in this part. The region is also known to have five famous Prayags.

3. The Darjiling and Sikkim Himalayas

- Bordered by Nepal Himalayas in the west and Bhutan Himalayas in the east. It is relatively small but is a most significant part of the Himalayas.

- Known for its fast-flowing rivers such as Teesta, it is a region of high mountain peaks like Kanchenjunga (Kanchengiri), and deep valleys.
- The higher reaches of this region are inhabited by Lepcha tribes while the southern part, particularly the Darjiling Himalayas, has a mixed population of Nepalis, Bengalis and tribal from Central India.
- The British, taking advantage of the physical conditions such as moderate slope, thick soil cover with high organic content, well distributed rainfall throughout the year and mild winters, introduced tea plantations in this region.
- Absence of the Shiwalik formations.** In place of Shiwaliks here, the '**duarformations**' are important, which have also been used for the development of tea gardens.

4. The Arunachal Himalayas

- Extend from the east of the Bhutan Himalayas up to the Diphu pass in the east.
- The general direction of the mountain range is from southwest to northeast.
- Some of the important mountain peaks of the region are Kangtu and NamchaBarwa.



- These ranges are dissected by fast-flowing rivers from the north to the south, forming deep gorges. **Bhramaputra** flows through a deep gorge after crossing **Namcha Barwa**. Some of the important rivers are **Kameng, Subansiri, Dihang, Dibang and Lohit**. These are perennial with the high rate of fall, thus, having the highest hydro-electric power potential in the country.
- An important aspect of the Arunachal Himalayas is the numerous ethnic tribal community inhabiting in these areas.
- Some of the prominent ones from west to east are the Monpa, Daffla, Abor, Mishmi, Nishi and the Nagas. Most of these communities practise Jhumming. It is also known as shifting or slash and burn cultivation.
- This region is rich in biodiversity which has been preserved by the indigenous communities.
- Due to rugged topography, the inter-valley transportation linkages are nominal. Hence, most of the interactions are carried through the duar region along the Arunachal-Assam border.

5. The Eastern Hills and Mountains

Part of Himalayan mountain system having their general alignment from the north to the south direction.

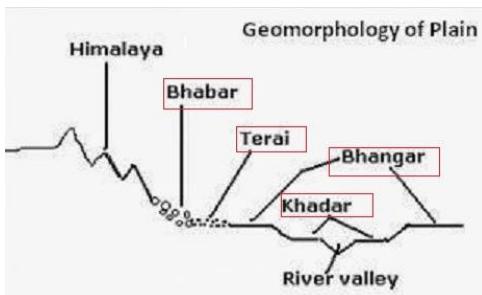


- They are known by different local names. In the north, they are known as Patkai Bum, Naga hills, the Manipur hills and in the south as Mizo or Lushai hills.
- These are low hills, inhabited by numerous tribal groups practising Jhum cultivation.

- The **Barak** is an important river in Manipur and Mizoram.
- The physiography of **Manipur** is unique by the presence of a large lake known as '**Loktak**' lake at the centre, surrounded by mountains from all sides. Mizoram which is also known as the '**Molassis basin**' which is made up of soft unconsolidated deposits.
- Most of the rivers in Nagaland form the tributary of the Brahmaputra.
- While two rivers of Mizoram and Manipur are the tributaries of the **Barak** river, which in turn is the tributary of Meghna.
- Rivers in eastern part of Manipur are tributaries of Chindwin, which in turn is a tributary of the Irrawaddy of Myanmar.

B. The Northern Plains:

- Formed by the alluvial deposits brought by the rivers – the Indus, the Ganga and the Brahmaputra. Extend approximately 3,200 km from the east to the west. Average width of these plains varies between 150-300 km.
- From the north to the south, these can be divided into three major zones: the **Bhabar**, the **Tarai** and the **alluvial plains**.
- The alluvial plains can be further divided into the **Khadar** and the **Bhangar**.

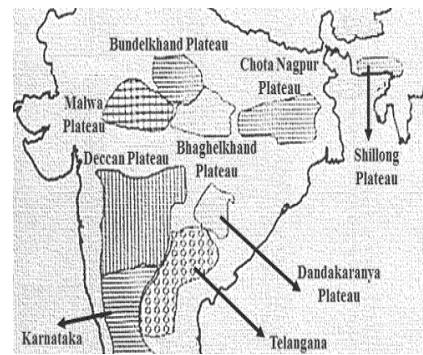


- Bhabar** is a narrow belt ranging between 8-10 km parallel to the Shiwalik foothills at the break-up of the slope. As a result of this, the streams and rivers coming from the mountains deposit heavy materials of rocks and boulders, and at times, **disappear** in this zone.

- South of the Bhabar is the **Tarai**belt, with an approximate width of 10-20 km where most of the streams and rivers **re-emerge** creating marshy and swampy conditions known as the Tarai.
- Bhangar** old alluvium deposit and **khaddar** new alluvium deposit.
- These plains have characteristic features of mature stage of fluvial erosional and depositional landforms such as sand bars, meanders, ox- bow lakes and braided channels. The Brahmaputra plains are known for their riverine islands and sand bars.
- Most of these areas are subjected to periodic floods and shifting river courses forming braided streams.
- The mouths of these mighty rivers also form some of the **largest deltas** of the world, for example, the famous **Sunderbans delta**.

c. The Peninsular Plateau

- Rising from the height of 150 m above the river plains up to an elevation of 600-900m is the irregular triangle known as the Peninsular plateau.
- 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.
- However, an extension of this is also seen in the northeast, in the form of **Shillong and Karbi-Anglong plateau**.
- The Peninsular India is made up of a series of plateau such as the Hazaribagh plateau, the Palamu plateau, the Ranchi plateau, the Malwa plateau, the Coimbatore plateau and the Karnataka plateau, etc.



- This is one of the oldest and the most stable landmass of India.
- The general elevation of the plateau is from the west to the east, which is also proved by the pattern of the flow of rivers.
- Some of the important physiographic features of this region are tors, block mountains, rift valleys, spurs, bare rocky structures, series of hummocky hills and wall-like quartzite dykes offering natural sites for water storage.
- The western and north-western part of the plateau has an emphatic presence of **black soil**.
- This Peninsular plateau has undergone recurrent phases of upliftment and submergence accompanied by crustal faulting and fractures. (**The Bhima fault** needs special mention, because of its recurrent seismic activities).
- The north-western part of the plateau has a complex relief of ravines and gorges. The ravines of Chambal, Bhind and Morena are some of the well-known examples.

On the basis of the prominent relief features, the Peninsular plateau can be divided into three broad groups:

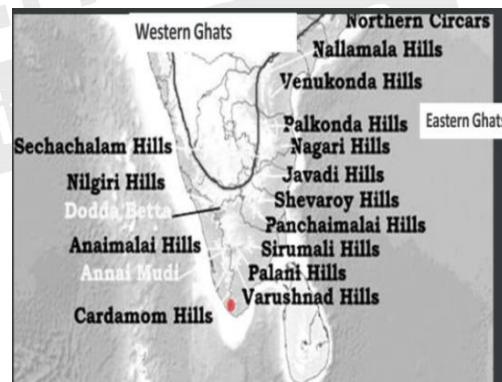
1. The Deccan Plateau
2. The Central Highlands
3. The North-eastern Plateau.

1. The Deccan Plateau:

- This is bordered by the Western Ghats in the west, Eastern Ghats in the east and the Satpura, Maikal range and Mahadeo hills in the north.
- Western Ghats** are locally known by different names such as **Sahyadri in Maharashtra**, **Nilgiri hills in Karnataka** and **Tamil Nadu** and **Anaimalai hills and Cardamom hills in Kerala**.
- Western Ghats are comparatively higher in elevation and more continuous than the Eastern Ghats.



- Their average elevation is about 1,500 m with the height increasing from north to south. 'Anaimudi' (2,695 m), the highest peak of Peninsular plateau is located on the Anaimalai hills of the Western Ghats followed by Dodabetta (2,637 m) on the Nilgiri hills.
- Most of the Peninsular rivers have their origin in the Western Ghats.



- Eastern Ghats** comprising the discontinuous and low hills are highly eroded by the rivers such as Mahanadi, the Godavari, the Krishna, the Kaveri, etc.





- Some of the important ranges include the Javadi hills, the Palconda range, the Nallamala hills, the Mahendragiri hills, etc.
- The Eastern and the Western Ghats meet each other at the Nilgiri hills.

2. The Central Highlands:

- They are bounded to the west by the Aravali range.
- The Satpura range is formed by a series of scarped plateaus on the south, This forms the northernmost boundary of the Deccan plateau. It is a classic example of the **relict mountains** which are highly denuded and form discontinuous ranges.
- The extension of the Peninsular plateau can be seen as far as Jaisalmer in the West, where it has been covered by the **longitudinal sand ridges and crescent-shaped sand dunes** called **barchans**.
- This region has undergone metamorphic processes in its geological history, which can be corroborated by the presence of metamorphic rocks such as marble, slate, gneiss, etc.

3. The North-Eastern Plateau:

- It is an extension of Peninsular plateau. It is believed that due to the force exerted by the north-eastward movement of the Indian plate at the time of the Himalayan origin, a huge fault was created between the Rajmahal hills and the Meghalaya plateau.
- Later, this depression got filled up by the deposition activity of the numerous rivers. Today, the Meghalaya and Karbi Anglong plateau stand detached from the main Peninsular Block.

The Meghalaya plateau is further sub-divided into three:

- (i) The Garo Hills; (ii) The Khasi Hills; (iii) The Jaintia Hills, named after the tribal groups inhabiting this region.
- An extension of this is also seen in the Karbi Anglong hills of Assam. Similar to the Chotanagpur plateau, the Meghalaya plateau is also rich in mineral resources like coal, iron ore, sillimanite, limestone and uranium.

- This area receives maximum rainfall from the south west monsoon. As a result, the Meghalaya plateau has a highly eroded surface. Cherrapunji displays a bare rocky surface devoid of any permanent vegetation cover.

D. The Indian Desert:

- To the northwest of the Aravali hills lies the Great Indian desert. It is a land of undulating topography dotted with longitudinal dunes and barchans.
- This region receives low rainfall below 150 mm per year; hence, it has arid climate with low vegetation cover. It is because of these characteristic features that this is also known as Marusthali. Low precipitation and high evaporation makes it a water deficit region.
- Luniriver flowing in the southern part of the desert is of some significance.
- There are some streams which disappear after flowing for some distance and present a typical case of **inland drainage** by joining a lake or playa.
- The lakes and the playas have brackish water which is the main source of obtaining salt.

E. The Coastal Plains:

- On the basis of the location and active geomorphological processes, it can be broadly divided into two:
 - Western coastal plains.
 - Eastern coastal plains.

a. Western Coastal Plains:

- 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.
- Because of this submergence it is a **narrow belt** and provides natural conditions for the development of **ports and harbours**. Kandla, Mazagaon, JLN port Navha Sheva, Marmagao, Mangalore, Cochin, etc. are some of the important natural ports located along the west coast.

Western coast may be divided into following divisions.,

1. Kachchh and Kathiawar coast in Gujarat.
 2. Konkan coast in Maharashtra.
 3. Goa coast and Malabar coast in Karnataka and Kerala respectively.
- The rivers flowing through this coastal plain **do not form any delta**.
 - **The Malabar coast** has got certain distinguishing features in the form of '**Kayals**' (backwaters), which are used for fishing, inland navigation and also special attraction for tourists.

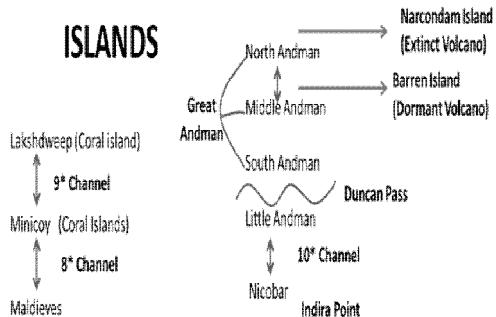
b. Eastern Coastal Plains.

The eastern coastal plain is broader and is an example of **an emergent coast**.

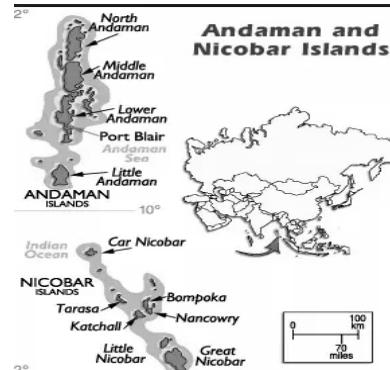
- There are well- developed deltas here, formed by the rivers flowing eastward in to the Bay of Bengal. These include the deltas of the Mahanadi, the Godavari, the Krishna and the Kaveri.
- Because of its emergent nature, it has **less number of ports and harbours**. (The continental shelf extends up to 500 km into the sea, which makes it difficult for the development of good ports and harbours).

F. The Islands:

- There are two major island groups in India – one in the Bay of Bengal and the other in the Arabian Sea.



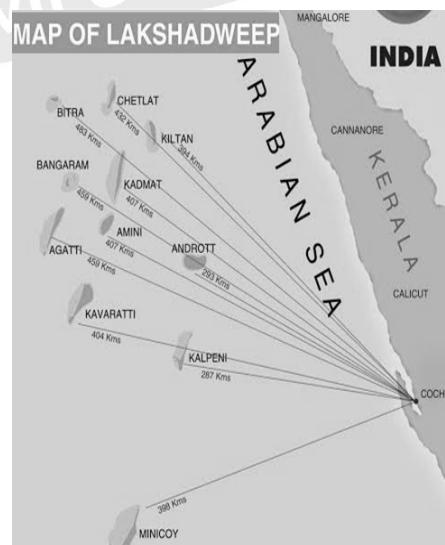
- The Bay of Bengal island groups consist of about 572 islands/islets.
- These are situated roughly between 6°N - 14°N and 92°E - 94°E .



- The entire group of island is divided into two broad categories – the Andaman in the north and the Nicobar in the south.
- However, some smaller islands are volcanic in origin. **Barren island**, the only **active volcano** in India.
- These islands receive convectional rainfall and have an equatorial type of vegetation.

The islands of the Arabian Sea:

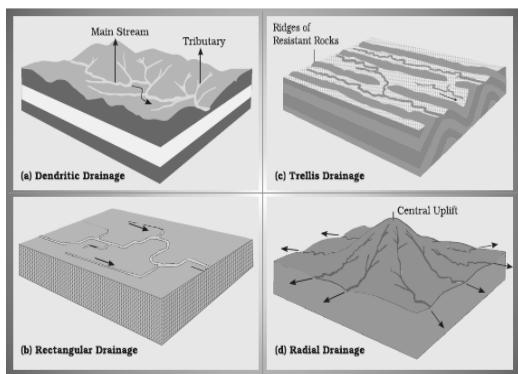
- Include Lakshadweep and Minicoy. These are scattered between 8°N - 12°N and 71°E - 74°E longitude, they are coral origin.



- There are approximately 36 islands of which 11 are inhabited.
- Minicoy is the largest island with an area of 453 sq. km.
- The entire group of islands is broadly divided by the **Eleventh degree channel**, north of which is the Amini Island and to the south of the Canannore Island.

Drainage System

- Flow of water through well-defined channels is known as '**drainage**' and the network of such channels is called a '**drainage system**'.
- Perennial (always with water)
- Ephemeral (water during rainy season, and dry during other seasons)
- A river drains the water collected from a specific area, which is called its '**catchment area**'.
- An area drained by a river and its tributaries is called a **drainage basin**.
- The boundary line separating one drainage basin from the other is known as the **watershed**.
- The catchments of large rivers are called **river basins (larger area)** while those of small rivulets and rills are often referred to as **watersheds (Smaller Area)**.
- The drainage pattern resembling the branches of a tree is known as **Dendritic** Ex: the rivers of northern plain.
- When the rivers originate from a hill and flow in all directions, the drainage pattern is known as **Radial**. Ex: Amarkantak range
- When the primary tributaries of rivers flow parallel to each other and secondary tributaries join them at right angles, the pattern is known as **Trellis**.
- When the rivers discharge their waters from all directions in a lake or depression, the pattern is known as **Centripetal**.



- On the basis of **discharge of water (orientations to the sea)**, it may be grouped into:
 - Arabian Sea Drainage**
 - Bay of Bengal Drainage**
- They are separated from each other through the Delhi ridge, the Aravallis and the Sahyadris.
- Nearly **77 per cent** of the drainage area consisting of the Ganga, the Brahmaputra, the Mahanadi, the Krishna, etc. is oriented towards the **Bay of Bengal** while **23 per cent** comprising the Indus, the Narmada, the Tapi, the Mahi and the Periyar systems discharge their waters in the **Arabian Sea**.
- On the basis of **the size of the watershed**, the drainage basins of India are grouped into three categories:
 - Major river basins** with more than **20,000 sq. km** of catchment area. It includes 14 drainage basins such as the Ganga, the Brahmaputra, the Krishna, the Tapi, the Narmada, the Mahi, the Pennar, the Sabarmati, the Barak, etc.
 - Medium river basins** with catchment area between **2,000-20,000 sq. km** includes 44 river basins such as the Kalindi, the Periyar, the Meghna, etc.
 - Minor river basins** with catchment area of less than **2,000 sq. km** include fairly good number of rivers flowing in the area of low rainfall
- On the basis of **the mode of origin, nature and characteristics**, the Indian drainage may also be classified into,
 - Himalayan Drainage**
 - Peninsular Drainage**.

A. Himalayan Drainage:

- The Himalayan drainage system has evolved through a long geological history. It mainly includes the Ganga, the Indus and the Brahmaputra river basins.
- Rivers of this system are **perennial**. These rivers pass through the giant gorges carved out by the erosional activity carried on simultaneously with the uplift of the Himalayas.
- Course of these rivers is highly tortuous, but over the plains they display a strong meandering tendency and shift their courses frequently.

Ex: River Kosi, also known as the 'sorrow of Bihar', has been notorious for frequently changing its course.

- It is opined that in due course of time Indo-Brahma River was dismembered into three main drainage systems,
 - The Indus and its five tributaries in the western part
 - The Ganga and its Himalayan tributaries in the central part
 - The stretch of the Brahmaputra in Assam and its Himalayan tributaries in the eastern part.

The dismemberment was probably due to the Pleistocene upheaval in the western Himalayas, including the uplift of the Potwar Plateau (Delhi Ridge), which acted as the water divide between the Indus and Ganga drainage systems.

Likewise, the down-thrusting of the Malda gap area between the Rajmahal hills and the Meghalaya plateau during the mid-pleistocene period, diverted the Ganga and the Brahmaputra systems to flow towards the Bay of Bengal.

1. The Indus System



- One of the largest river basins of the world originates from Kailash Mountain range. In Tibet, it is known as 'SingiKhamban'; or Lion's mouth.

After entering J&K it flows between the **Ladakh** and the **Zaskar Ranges**. The **Gilgit, Gartang, Dras, Shiger, Hunza** are the other Himalayan tributaries of the Indus.

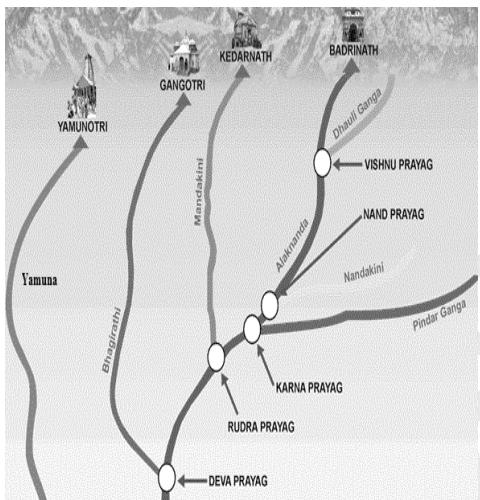
- The **Jhelum**, an important tributary of the Indus, rises from a spring at **Verinag** situated at the foot of the PirPanjal. It flows through Srinagar and the Wular lake.
- The **Chenab** is the largest tributary of the Indus, formed by two streams, the Chandra and the Bhaga, which join at Tandi near Keylong in Himachal Pradesh. Hence, it is also known as Chandrabhaga.
- The **Ravi** has its source in **Kullu hills** near the **Rohtang Pass** in Himachal Pradesh. It drains the area between the **Pir Panjal** and the **Dhaola Dhar ranges**.

• The **Beas** originates near the **Rohtang Pass**

- The **Satluj** originates in the Rakas lake near **Mansarovar**, in Tibet where it is known as LangchenKhambab. It comes out of a gorge at Rupar. It passes through the **Shipki La** on the Himalayan ranges and enters the Punjab plains. It is an antecedent river.

2. The Ganga System

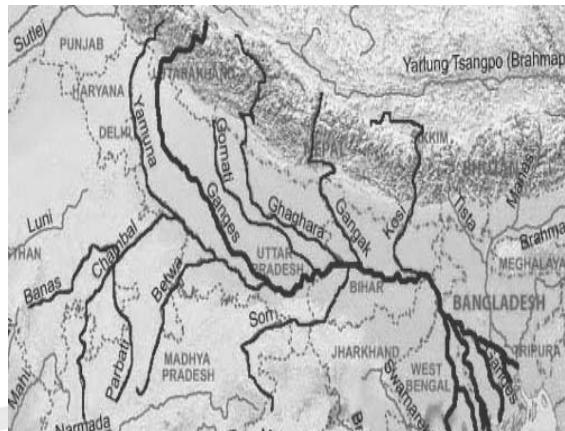
- It rises in the **Gangotri glacier near Gaumukh** (3,900 m) in the Uttarkashi district of Uttarakhand. Here, it is known as the Bhagirathi.
- At Devprayag, the Bhagirathi meets the Alaknanda; hereafter, it is known as the Ganga. The Alaknanda has its source in the Satopanth glacier above Badrinath. The Ganga enters the plains at Haridwar. The figure given below shows various regions where confluence places of initial rivers which form Ganga as a whole:



- The important left bank tributaries are the Ramganga, the Gomati, the Ghaghara, the Gandak, the Kosi and the Mahananda. The river finally discharges itself into the Bay of Bengal near the Sagar Island.
- The **Yamuna**, the western most and the **longest tributary** of the Ganga, has its source in the **Yamunotri glacier**. It joins the Ganga at Prayag (Allahabad).
- The **Chambal** rises near Mhow in the Malwa plateau of Madhya Pradesh. Chambal is famous for its badland topography called the Chambal ravines.
- The **Gandak** comprises two streams, namely Kaligandak and Trishul ganga. It rises in the **Nepal Himalayas**.
- The **Damodar** occupies the eastern margins of the Chotanagpur Plateau where it flows through a rift

valley and finally joins the Hugli. The Barakar is its main tributary. Also known as the sorrow of Bengal.

- The **Mahananda** is another important tributary of the Ganga rising in the **Darjiling hills**.
- The **Son** is a large south bank tributary of the Ganga, originating in the **Amarkantak plateau**.



3. The Brahmaputra System:

- The **Brahmaputra**, one of the largest rivers of the world, has its origin in the **Chemayungdung glacier** of the Kailash range near the Mansarovar lake.
- It is called Tsangpo, in Tibet, which means 'the purifier'.
- The Brahmaputra enters into Bangladesh near Dhubri. In Bangladesh, the Tista joins it on its right bank from where the river is known as the jamuna. It finally merges with the river Padma, which falls in the Bay of Bengal.
- The Brahmaputra is well-known for floods, channel shifting and bank erosion. This is due to the fact that most of its tributaries are large, and bring large quantity of sediments owing to heavy rainfall in its catchment area.
- Teesta**- Major tributary of Brahmaputra, rises from Sikkim also known as lifeline of Sikkim.
- Lohit**- Tributary of Brahmaputra, flows through Arunachal Pradesh. Along with river Dihang merges into Brahmaputra.

- **Major tributaries** - Dihang, Lohit, Subansiri, Teesta, Meghna (Barack in Assam), Manas

B. The Peninsular Drainage System:

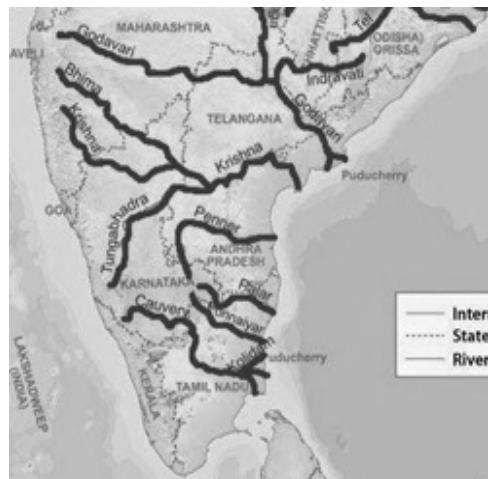
- Older than the Himalayan rivers. Evident from the **broad, largely-graded shallow valleys**
- The Western Ghats running close to the western coast act as the water divide between the major Peninsular Rivers, discharging their water in the Bay of Bengal and as small rivulets joining the Arabian Sea. Most of the major Peninsular Rivers except **Narmada and Tapi** flow from west to east.
- The Chambal, the Sind, the Betwa, the Ken, the Son, originating in the northern part of the Peninsula belong to the Ganga river system.
- The other major river systems of the peninsular drainage are – the Mahanadi the Godavari, the Krishna and the Kaveri.
- Peninsular rivers are characterised by **fixed course, absence of meanders and non-perennial flow of water**. The Narmada and the Tapi which flow through the rift valley are, however, exceptions.

Evolution of Peninsular Drainage System:

Three major geological events in the distant past have shaped the present drainage systems of Peninsular India:

1. **Subsidence of the western flank** of the Peninsula leading to its **submergence** below the sea during the early tertiary period.
2. **Upheaval of the Himalayas** when the northern flank of the Peninsular block was subjected to subsidence and the consequent trough faulting. The Narmada and The Tapi flow in trough faults and fill the original cracks with their detritus materials. Hence, there is a lack of alluvial and deltaic deposits in these rivers.
3. **Slight tilting of the Peninsular block** from northwest to the south-eastern direction gave orientation to the entire drainage system towards the Bay of Bengal during the same period.

River Systems of the Peninsular Drainage:



- The **Mahanadi** rises near Sihawa in **Raipur district of Chhattisgarh** and runs through Odisha to discharge its water into the Bay of Bengal. It drains through Madhya Pradesh, Chhattisgarh and Odisha.
- The **Godavari** is the largest Peninsular river system. It is also called the Dakshin Ganga. It rises in the **Nasik district of Maharashtra** and discharges its water into the Bay of Bengal. Its tributaries run through the states of Maharashtra, Madhya Pradesh, Chhattisgarh, Odisha and Andhra Pradesh.

The Penganga, the Indravati, the Pranhita, and the Manjra are its principal tributaries.

- The **Krishna** is the second largest east-flowing Peninsular river which rises near **Mahabaleshwar in Sahyadri**. The Koyna, the Tungabhadra and the Bhima are its major tributaries. It drains through Maharashtra, Karnataka and Andhra Pradesh.
- The **Kaveri** rises in **Brahmagiri hills** of Kodagu district in Karnataka. 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.

It drains through Karnataka, Kerala and Tamil Nadu. Its important tributaries are the Kabini, the Bhavani and the Amravati.



West Flowing Rivers:



- The **Narmada** originates on the western flank of the **Amarkantak plateau**. Flowing in a rift valley between the Satpura in the south and the Vindhyan range forms Dhuandhar waterfall near Jabalpur.
- The **Tapi** is the other important westward flowing river. It originates from **Multai** in the **Betul district** of Madhya Pradesh. It drains through Maharashtra, Madhya Pradesh, Gujarat.
- Tawa River** rises from the Satpura Range of Betul in MP. This river is the longest tributary of River Narmada.
- Sharavati River** originates from the Shimoga district of Karnataka. The Jog Falls is created by the Sharavati River.
- Mahi** river originates from Dhar district of Madhya Pradesh and flows through Madhya Pradesh, Rajasthan, and Gujarat. Drains in to Gulf of Cambay
- Sabarmati** is the name given to the combined stream of **Sabar** and **Hathmati**. It originates in Aravalli's. The Sabarmati basin extends over states of Rajasthan and Gujarat.

Note:

Ghaggar is the most important river of **inland drainage**. It is a seasonal stream which rises on the lower slopes of the Himalayas and forms boundary between **Haryana and Punjab**.

Largest river basin in India – Ganga > Godavari > Mahanadi > Krishna > Narmada



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Climate

- **Weather** is the momentary state of the atmosphere which changes quickly while **climate** refers to the average of the weather conditions over a longer period of time.
- **Monsoon** connotes the climate associated with **seasonal reversal in the direction of wind**. India has hot monsoonal climate which is the prevalent climate in south and South-east Asia.

Factors Determining the Climate of India:

Factors Related to Location and Relief

1. Latitude

Northern part of the India lies in **sub-tropical and temperate zone** and the part lying south of the Tropic of Cancer falls in the tropical zone. The tropical zone being nearer to the equator, experiences high temperatures throughout the year with small daily and annual range of temperature.

Area north of the Tropic of Cancer being away from the equator experiences extreme climate with high daily and annual range of temperature.

2. Himalayan Mountains

Himalayas in the north along with its extensions act as an effective climatic divide. The towering mountain chain provides an invincible shield to protect the subcontinent from the cold northern winds.

- Himalayas also trap the monsoon winds, forcing them to shed their moisture within the subcontinent

3. Distribution of Land and Water:

- India is flanked by the Indian Ocean on three sides in the south and girdled by a high and continuous mountain-wall in the north.
- As compared to the landmass, water heats up or cools down slowly. This **differential heating of land and sea** creates different air pressure zones in different seasons in and around the Indian subcontinent. Difference in air pressure causes reversal in the direction of monsoon winds.

4. Distance from the Sea:

With a long coastline, large coastal areas have an equable climate. Areas in the interior of India are far away from the moderating influence of the sea. Such areas have extremes of climate.

5. Altitude

Temperature decreases with height. Due to thin air, places in the mountains are cooler than places on the plains.

6. Relief

The physiography or relief of India also affects the temperature, air pressure, direction and speed of wind and the amount and distribution of rainfall.

The windward sides of Western Ghats and Assam receive high rainfall during June-September whereas the southern plateau remains dry due to its leeward situation along the Western Ghats.

Factors Related to Air Pressure and Wind:

1. Distribution of air pressure and winds on the surface of the earth
2. Upper air circulation caused by factors controlling global weather and the inflow of different air masses and **jet streams**
3. Inflow of western cyclones generally known as **disturbances** during the winter season and tropical depressions during the south-west monsoon period into India, creating weather conditions favourable to rainfall.

Mechanism of Weather in the Winter Season:

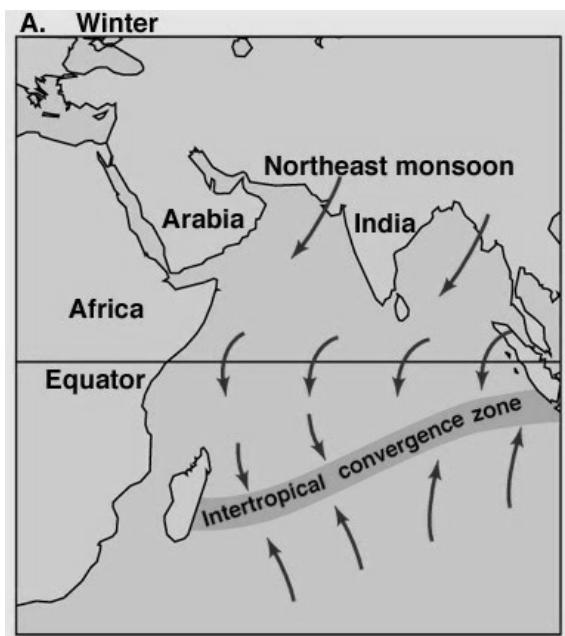
Surface Pressure and Winds:

In winter months, the weather conditions over India are generally influenced by the distribution of pressure in Central and Western Asia.

A **high pressure** centre in the region lying to the north of the Himalayas develops during **winter**. This centre of high pressure gives rise to the flow of air at the low level from the north towards the Indian subcontinent, south of the mountain range.

The surface winds blowing out of the high pressure centre over Central Asia reach India in the form of a dry continental air mass.

These continental winds come in contact with trade winds over north-western India.



Jet Stream and Upper Air Circulation:

Higher up in the lower troposphere, about three km above the surface of the earth, a different pattern of air circulation is observed.

The variations in the atmospheric pressure closer to the surface of the earth have no role to play in the making of upper air circulation.

All of Western and Central Asia remains under the influence of westerly winds along the altitude of 9-13 km from west to east. These winds blow across the Asian continent at latitudes north of the Himalayas roughly parallel to the Tibetan highlands. These are known as **jet streams**.

Jet streams are fast-moving winds in the upper atmosphere which influences the global atmospheric phenomenon.

A Tibetan highland acts a barrier in the path of Jet streams as a result it gets bifurcated. One of its branches blows north of Tibetan highland and southern branch blows in an eastward direction, south of the Himalayas thereby influencing winter weather in India.

Western Cyclonic Disturbance and Tropical Cyclones:

The western cyclonic disturbances which enter the Indian subcontinent from the west and the northwest during the winter months originate over the Mediterranean Sea and are brought into India by the westerly jet stream.

An increase in the prevailing night temperature generally indicates an advance in the arrival of these cyclones disturbances.

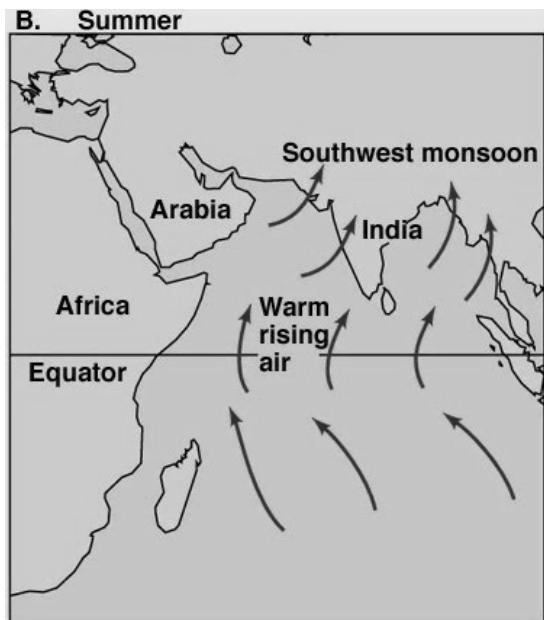
Tropical cyclones originate over the Bay of Bengal and the Indian Ocean. These tropical cyclones have very high wind velocity and heavy rainfall and hit the Tamil Nadu, Andhra Pradesh and Orissa coast. Most of these cyclones are very destructive due to high wind velocity and torrential rain that accompanies.

Mechanism of Weather in the Summer Season

Surface Pressure and Winds:

As the summer sets in and the sun shifts northwards, the wind circulation over the subcontinent undergoes a complete reversal at both, the lower as well as the upper levels. By the middle of July, the low pressure belt nearer the surface [termed as Inter Tropical Convergence Zone (ITCZ)] shifts northwards, by this time, the westerly jet stream withdraw from the Indian region.

It is generally believed that there is a cause and effect relationship between the ITCZ and jet stream. The ITCZ being a zone of low pressure attracts inflow of winds from different directions. The maritime tropical air mass (mT) from the southern hemisphere, after crossing the equator, rushes to the low pressure area in the general south-westerly direction. It is this moist air current which is popularly known as the southwest monsoon.



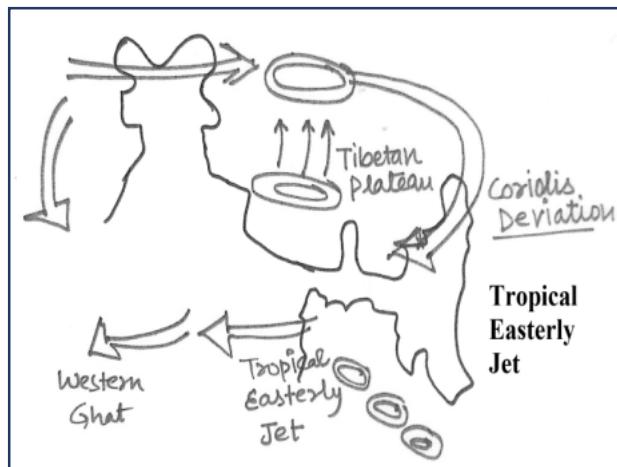
Jet Streams and Upper Air Circulation:

An easterly jet stream flows over the southern part of the Peninsula in June. The easterlies normally do not extend to the north of 30 degree N latitude in the upper atmosphere.

Easterly Jet Stream and Tropical Cyclones:

The easterly jet stream steers the tropical depressions into India. These depressions play a significant role in the distribution of monsoon rainfall over the Indian subcontinent. The tracks of these depressions are the areas of highest rainfall in India.

The frequency at which these depressions visit India, their direction and intensity, all go a long way in determining the rainfall pattern during the southwest monsoon period.



The Inter Tropical Convergence Zone (ITCZ):

A low pressure zone located at the equator where trade winds converge, and so, it is a zone where air tends to ascend.

In July, the ITCZ is located around 20°N-25°N latitudes (over the Gangetic plain), sometimes called the **monsoon trough**.

This monsoon trough encourages the development of thermal low over north and northwest India. Due to the shift of ITCZ, the trade winds of the southern hemisphere cross the equator between 40° and 60°E longitudes and start blowing from southwest to northeast due to the Coriolis force. It becomes southwest monsoon.

In winter, the ITCZ moves southward, and so the reversal of winds from northeast to south and southwest, takes place. They are called northeast monsoons.

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Indian Monsoon

Onset of the Monsoon

- During April and May when the sun shines vertically over the Tropic of Cancer, the large landmass in the north of Indian Ocean gets intensely heated. This causes the formation of an intense low pressure in the north-western part of the subcontinent.
- Since the pressure in the Indian Ocean in the south of the landmass is high as water gets heated slowly, the low pressure cell attracts the southeast trades across the Equator.

These conditions help in the northward shift in the position of the ITCZ. The southwest monsoon may thus, be seen as a continuation of the southeast trades deflected towards the Indian subcontinent after crossing the Equator. These winds cross the Equator between 40°E and 60°E longitudes.

After withdrawal of westerly jet streams, easterly jet stream sets in at 15 degree N, thereby resulting in burst of monsoon in India.

Entry of Monsoon into India:

The southwest monsoon sets in over the Kerala coast by 1st June and to reach Mumbai and kolkata 10th and 13th June.

Rain-bearing Systems and Rainfall Distribution

There seem to be two rain-bearing systems in India.

1. In Bay of Bengal causing rainfall over the plains of north India.
2. Arabian Sea current of the south- west monsoon which brings rain to the west coast of India. Much of the rainfall along the Western Ghats is orographic as the moist air is obstructed and forced to rise along the Ghats.

The intensity of rainfall over the west coast of India is, however, related to two factors:

- (i) The offshore meteorological conditions.
- (ii) The position of the equatorial jet stream along the eastern coast of Africa.

Frequency of tropical depressions depends on position of ITCZ/ monsoon trough.

Break in the Monsoon:

During the south-west monsoon period after having rains for a few days, if rain fails to occur for one or more weeks, it is known as break in the monsoon. These dry spells are quite common during the rainy season.

These breaks in the different regions are due to different reasons:

- (i) In northern India rains are likely to fail if the rain-bearing storms are not very frequent along the monsoon trough or the ITCZ over this region.
- (ii) Over the west coast the dry spells are associated with days when winds blow parallel to the coast.

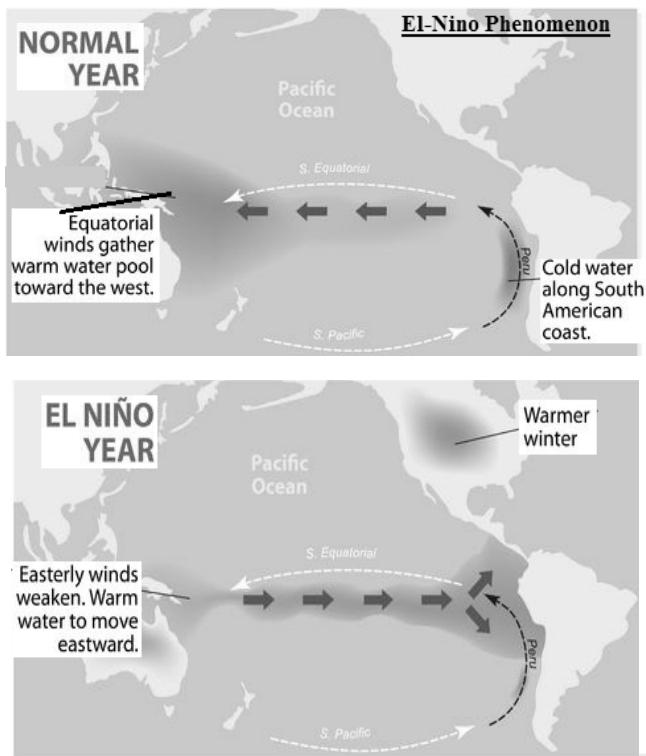
El-Nino and the Indian Monsoon:

El-Nino is a complex weather system that appears once every three to seven years, bringing drought, floods and other weather extremes to different parts of the world.

The system involves oceanic and atmospheric phenomena with the appearance of **warm currents off the coast of Peru in the Eastern Pacific** and affects weather in many places including India.

El-Nino is merely an extension of the warm equatorial current which gets replaced temporarily by cold Peruvian current or Humbolt current. This current increases the temperature of water on the Peruvian coast by 10°C. This results in:

- (i) Distortion of equatorial atmospheric circulation
- (ii) Irregularities in the evaporation of sea water
- (iii) Reduction in the amount of planktons which further reduces the number of fish in the sea



The word El-Nino means 'Child Christ' because this current appears around Christmas in December. December is a summer month in Peru (Southern Hemisphere).

The Rhythm of Seasons:

The climatic conditions of India can best be described in terms of an annual cycle of 4 seasons:

1. Cold weather season
2. Hot weather season
3. Southwest monsoon season
4. Retreating monsoon season

1. The Cold Weather Season:

Temperature:

- The cold weather season sets in by mid-November in northern India. **December and January** are the coldest months in the northern plain.
- There are three main reasons for the excessive cold in north India during this season:

- (i) States like Punjab, Haryana and Rajasthan being far away from the moderating influence of sea experience **continental climate**.
- (ii) The **snowfall** in the nearby Himalayan ranges creates cold wave situation;
- (iii) The **cold winds** coming from the Caspian Sea and Turkmenistan bring cold wave along with frost and fog over the north-western parts of India.
- The Peninsular region of India, however, **does not have any well-defined cold weather season**. There is no seasonal change in the distribution pattern of the temperature in coastal areas because of **moderating influence of the sea and the proximity to equator**.

Pressure and Winds:

By the end of December (22nd December), the sun shines vertically over the Tropic of Capricorn in the southern hemisphere. The weather in this season is characterised by feeble high pressure conditions over the northern plain.

Rainfall:

Winter monsoons do not cause rainfall as they move from land to the sea.

1. They have **little humidity**
2. Due to **anti cyclonic** circulation on land, the possibility of rainfall from them reduces. So, most parts of India do not have rainfall in the winter season.

However, there are some exceptions to it:

- (i) In North-western India, some weak temperate cyclones from the Mediterranean sea cause rainfall in Punjab, Haryana, Delhi and western Uttar Pradesh.
- (ii) During October and November, northeast monsoon while crossing over the Bay of Bengal, picks up moisture and causes torrential rainfall over the Tamil Nadu coast, southern Andhra Pradesh, southeast Karnataka and southeast Kerala.

2. The Hot Weather Season:

Temperature:

With the apparent northward movement of the sun towards the Tropic of Cancer in March, temperatures start rising in north India. **April, May and June** are the months of summer in north India. In the coastal regions, the north-south extent of isotherms parallel to the coast confirms that temperature does not decrease from north to south rather it increases from the coast to the interior.

Pressure and Winds:

The summer months are a period of excessive heat and falling air pressure in the northern half of the country. Because of the heating of the subcontinent, the ITCZ moves northwards occupying a position centred at 25°N in July.

A sudden contact between dry and moist air masses give rise to local storms of great intensity associated with violent winds, torrential rains and hailstorms.

1. Mango Shower:

Towards the end of summer, there are pre monsoon showers common in Kerala and Karnataka locally, they are known as mango showers, since they help in the early ripening of mangoes

2. Blossom Shower:

With this shower coffee flowers blossom in Kerala and nearby areas

3. Nor Westers:

These are dreaded evening thunderstorms in Bengal and Assam. Their notorious nature can be understood from the local nomenclature of 'kalbaisakhi'. These showers are useful for tea, jute rice cultivation. In Assam, these storms are known as Bardolichheerha

4. Loo:

Hot, dry and oppressing winds blowing in the northern plains from Punjab to Bihar with higher intensity.

3. The Southwest Monsoon Season

Increase of temperature in **May** over the north-western plains, the low pressure conditions over there get further intensified.

By early June, they are powerful enough to attract the trade winds of Southern Hemisphere coming from the Indian Ocean. These southeast trade winds cross the equator and enter the Bay of Bengal and the Arabian Sea. Passing over the equatorial warm currents, they bring with them moisture in abundance.

After crossing the equator, they follow a south-westerly direction. That is why they are known as **southwest monsoons**.

The rain in the southwest monsoon season begins abruptly, thereby bringing down the temperature substantially. This sudden onset of the moisture-laden winds associated with violent thunder and lightning, is often termed as the **break or burst of the monsoons**.

The monsoon approaches the landmass in two branches:

- (i) The Arabian Sea branch
- (ii) The Bay of Bengal branch.

Monsoon Winds of the Arabian Sea:

The monsoon winds originating over the Arabian Sea further split into three branches:

- (i) Its one branch is obstructed by the Western Ghats. These winds climb the slopes of the Western Ghats from 900-1200 m. Soon, they become cool, and as a result, the windward side of the Sahyadris and Western Coastal Plain receive very heavy rainfall ranging between 250 cm and 400 cm.

After crossing the Western Ghats, these winds descend and get heated up. This reduces humidity in the winds. As a result, these winds cause little rainfall east of the Western Ghats. This region of low rainfall is known as the **rain-shadow area (orographic)**

- (ii) Another branch of the Arabian sea monsoon strikes the coast north of Mumbai. Moving along the

Narmada and Tapi river valleys, these winds cause rainfall in extensive areas of central India. Thereafter, they enter the Ganga plains and mingle with the Bay of Bengal branch.

- (iii) A third branch of this monsoon wind strikes the Saurashtra Peninsula and the Kachchh. It then passes over west Rajasthan and along the Aravallis, causing only a scanty rainfall.

Monsoon Winds of the Bay of Bengal:

The Bay of Bengal branch strikes the coast of Myanmar and part of southeast Bangladesh. But the **Arunachal Hills** along the coast of Myanmar **deflect** a big portion of this branch towards the Indian subcontinent.

- The monsoon, therefore, enters West Bengal and Bangladesh from south and southeast instead of south-westerly direction. From here, this branch splits into two under the influence of the **Himalayas and the thermal low** in northwest India.
- Its one branch moves westward along the Ganga plains reaching as far as the Punjab plains.
- The other branch moves up the Brahmaputra valley in the north and the northeast, causing widespread rains.
- Its sub-branch strikes the Garo and Khasi hills of Meghalaya. Mawsynram, located on the crest of Khasi hills, receives the highest average annual rainfall in the world.
- Here it is important to know why the **Tamil Nadu coast remains dry** during this season. There are two factors responsible for it:
 - (i) The Tamil Nadu coast is situated **parallel** to the Bay of Bengal branch of southwest monsoon.
 - (ii) It lies in the **rain shadow area** of the Arabian Sea branch of the south-west monsoon.

4. Season of Retreating Monsoon

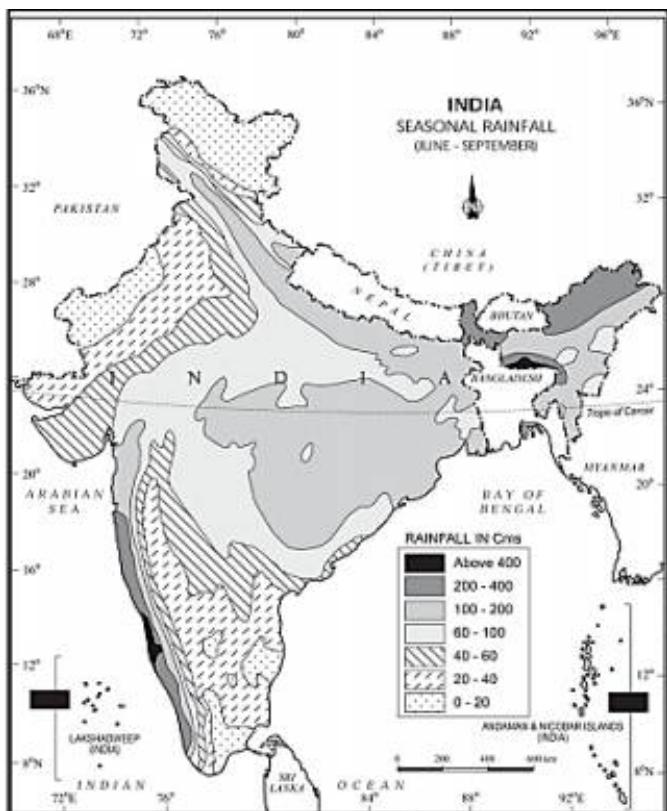
- The months of **October and November** are known for retreating monsoons.

- By the end of September, the southwest monsoon becomes weak as the low pressure trough of the Ganga plain starts moving southward in response to the southward march of the sun.
- The retreating southwest monsoon season is marked by **clear skies and rise in temperature**. The land is still moist. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive. This is commonly known as the **October heat**.
- The weather in the retreating monsoon is **dry in north India** but it is associated with rain in the eastern part of the Peninsula. Here, October and November are the雨iest months of the year.
- The **widespread rain** in this season is associated with the **passage of cyclonic depressions** which originate over the Andaman Sea and manage to cross the eastern coast of the southern Peninsula. These tropical cyclones are very destructive.

Characteristics of Monsoonal Rainfall:

- (i) Rainfall received from the southwest monsoons is **seasonal** in character, which occurs between June and September.
- (ii) Monsoonal rainfall is largely governed by **relief or topography**.
- (iii) The monsoon rainfall has a **declining trend with increasing distance from the sea**.
- (iv) The monsoon rains occur in wet spells of few days duration at a time. The wet spells are interspersed with rainless interval known as **Monsoonal breaks**.
- (v) The summer rainfall comes in a **heavy downpour** leading to considerable run off and soil erosion.
- (vi) Monsoons play a pivotal role in the agrarian economy of India because over **three-fourths of the total rain** in the country is received during the **south- west monsoon season**.
- (vii) Its spatial distribution is also uneven which ranges from 12 cm to more than 250 cm.

Distribution of Rainfall:



- The average annual rainfall in India is about 125 cm, but it has great spatial variations.
- Areas of High Rainfall:** The highest rainfall occurs along the west coast, on the Western Ghats, as well as in the sub-Himalayan areas in the northeast and the hills of Meghalaya. Here the rainfall exceeds 200 cm. In some parts of Khasi and Jaintia hills, the rainfall exceeds 1,000 cm. In the Brahmaputra valley and the adjoining hills, the rainfall is less than 200 cm.
- Areas of Medium Rainfall :** Rainfall between 100-200 cm is received in the southern parts of Gujarat, east Tamil Nadu, northeastern Peninsula covering Odisha, Jharkhand, Bihar, eastern Madhya Pradesh, northern Ganga plain along the sub-Himalayas and the Cachar Valley and Manipur.
- Areas of Low Rainfall:** Western Uttar Pradesh, Delhi, Haryana, Punjab, Jammu and Kashmir, eastern Rajasthan, Gujarat and Deccan Plateau receive rainfall between 50-100 cm.

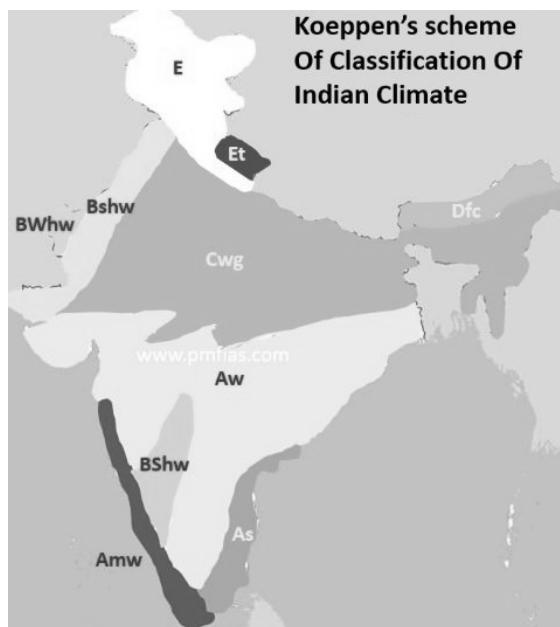
Areas of Inadequate Rainfall: Parts of the Peninsula, especially in Andhra Pradesh, Karnataka and Maharashtra, Ladakh and most of western Rajasthan receive rainfall **below 50 cm**.

- Snowfall is restricted to the Himalayan region.

Climatic Regions of India:

Major climatic types of India,

- Based on Koppen's Scheme:** Koppen based his scheme of Climatic classification on monthly values of temperature and precipitation.
- He identified five major climatic types, namely:
 - Tropical climates**, where mean monthly temperature throughout the year is over 18°C.
 - Dry climates**, where precipitation is very low in comparison to temperature, and hence, dry.
 - Warm temperate climates**, where mean temperature of the coldest month is between 18°C and minus 3°C.
 - Cool temperate climates**, where mean temperature of the warmest month is over 10°C, and mean temperature of the coldest month is under minus 3°C
 - Ice climates**, where mean temperature of the warmest month is under 10°C.



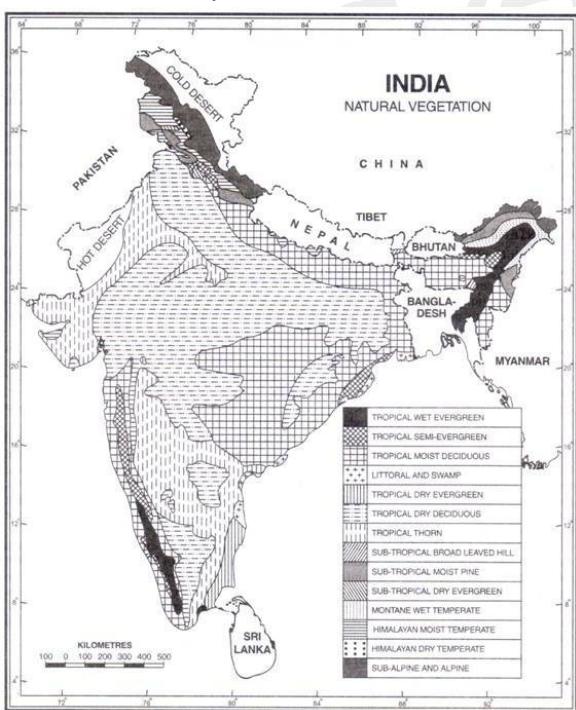
Natural Vegetation

Natural vegetation refers to a plant community that has been left undisturbed over a long time, so as to allow its individual species to adjust themselves to climate and soil conditions as fully as possible.

Himalayan heights are marked with **temperate vegetation**; the **Western Ghats** and the **Andaman Nicobar Islands** have **tropical rain forests**. The **deltaic** regions have **tropical forests and mangroves**. The **desert and semi desert** areas of Rajasthan are known for cactii, a wide variety of bushes and **thorny vegetation**

Types of Forests:

1. Tropical Evergreen and Semi Evergreen forests
2. Tropical Deciduous forests
3. Tropical Thorn forests
4. Montane forests
5. Littoral and Swamp forests



1. Tropical Evergreen Forests and Semi Ever Green Forests.

- Tropical Evergreen and Semi Evergreen Forests found in the western slope of the **Western Ghats**, hills of the **north-eastern region** and the **Andaman and**

Nicobar Islands found in warm and humid areas with an annual precipitation of **over 200 cm** and mean annual temperature above 22degree C.

- **Well stratified**, with layers closer to the ground and are covered with shrubs and creepers, with short structured trees followed by tall variety of trees up to height of 60cm.
- There is **no definite time for trees to shed their leaves**, flowering and fruition. As such these forests appear **green all the year round**.
- Species found in these forests include **rosewood, mahogany, aini, ebony**, etc.

Semi Evergreen Forests:

- Found in the less rainy, such forests have a mixture of **evergreen and moist deciduous trees**.
- The under growing climbers provide an evergreen character to these forests.
- Main species are **white cedar, hollock and kail**.

2. Tropical Deciduous Forests

- These are the **most widespread forests** in India, also called as monsoon forests. They are found in areas with rainfall of **70-200 cm**.
- On the basis of the availability of water, these forests are further divided into moist and dry deciduous.

The Moist Deciduous:

- Rainfall of **100-200 cm**. These forests are found in the northeastern states along the foothills of Himalayas, eastern slopes of the Western Ghats and Odisha.
- **Teak, sal, shisham, hurra, mahua, amla, semul, kusum, and sandalwood** etc. are the main species of these forests.

Dry Deciduous Forest:

Covers **vast areas** of the country, where rainfall ranges between **70 -100 cm**. found in rainier areas of the Peninsula and the plains of Uttar Pradesh and Bihar. The dry season begins, the **trees shed their leaves** completely.

- **Tendu, palas, amaltas, bel, khair, axlewood** etc. are the common trees of these forests.

3. Tropical Thorn Forests

- Found in the areas which receive rainfall **less than 50 cm**.
- These consist of a variety of **grasses and shrubs**. It includes semi-arid areas of south west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh.
- Plants remain leafless for most part of the year and give an expression of scrub vegetation.
- **Babool, ber, and wild date palm, khair, neem, khejri, palas**, etc. Tussocky grass grows upto a height of 2 m as the under growth.

4. 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,

- a. The Northern mountain forests
- b. The Southern mountain forests

a. Northern Mountain Forests:

- The Himalayan ranges show a succession of vegetation from the tropical to the tundra, which changes with the altitude.

Deciduous forests are found in the foothills of the Himalayas.

It is succeeded by the **wet temperate** type of forests between an altitude of 1000-2000m in the higher hill areas of West Bengal and Uttarakhand, **Evergreen broad leaf trees** such as oak and chestnut are predominant.

Between 1500-1750m, **Pine forests** are well developed, with Chir pine as a very useful commercial tree. Deodar, a highly valued endemic species grows mainly in the western part of the Himalayan range. Deodar is a durable wood mainly used in construction activity, similarly the chinar and the walnut, which sustain the famous Kashmir handicrafts belong to this zone blue pine and spruce appear at altitude of 2225 -3048 m.

At many place in this zone **temperate grass** lands are found. But in the higher reaches there is a transition to alpine forests and pastures. Silverfirs, junipers, pines, birch and rhododendrons, etc., occur between used extensively for transhumance by tribes like the Gujjars, the Bakarwals, the bhotiyas and the gaddis.

Southern slopes of the Himalayans carry a thicker vegetation cover because of relatively higher precipitation than the drier north -facing slopes at higher altitudes, mosses and lichens form part of **tundra vegetation**.

b. Southern Mountain Forests:

- Found in three distinct areas of Peninsular India viz; **the Western Ghats, the Vindhya and the Nilgiris**. As they are closer to the tropics, and only 1,500 m above the sea level, vegetation is temperate in the higher regions, and subtropical on the lower regions of the Western Ghats, especially in Kerala, Tamil Nadu and Karnataka.
- The temperate forests are called **Sholas** in the Nilgiris, Anaimalai and Palani hills. Some of the other trees of this forest of economic significance include **magnolia, laurel, cinchona and wattle**. Such forests are also found in the Satpura and the Maikal ranges.

5. Littoral and Swamp Forests

- India has a rich variety of wetland habitats. About 70 per cent of this comprises areas under paddy cultivation. Two sites — Chilika Lake (Odisha) and Keoladeo National Park (Bharatpur) are protected as water-fowl habitats under the **Convention of Wetlands of International Importance** (Ramsar Convention).

Forest Cover in India:

- The forest area covers 23.28 per cent of the total land area of the country.
- The **forest area** is the area notified and recorded as the forest land irrespective of the existence of trees, while the **actual forest cover** is the area occupied by forests with canopy.

Forest Conservation:

- Forest policy in 1952, which was further modified in 1988. According to the new forest policy, the Government will emphasise **sustainable forest management** in order to conserve and expand forest reserve on the one hand, and to meet the needs of local people on the other.

Social Forestry:

- Social forestry means the management and protection of forests and afforestation on barren lands with the purpose of helping in the environmental, social and rural development.
- Urban forestry** pertains to the raising and management of trees on public and privately owned lands in and around urban centres such as green belts, parks, roadside avenues, industrial and commercial green belts, etc
- Rural forestry** lays emphasis on promotion of agro-forestry and community-forestry.
- Agro-forestry** is the raising of trees and agriculture crops on the same land inclusive of the waste patches. It combines forestry with agriculture, thus, altering the simultaneous production of food, fodder, fuel, timber and fruit.
- Community forestry** involves the raising of trees on public or community land such as the village pasture and temple land etc
- Farm forestry** is a term applied to the process under which farmers grow trees for commercial and non-commercial purposes on their farm lands.

Forests of India

Forest Type	Distribution	Climatic Conditions	Characteristics	Species
Tropical Evergreen Forests	Rainy Slopes of Western ghats North-East India except Arunachal Pradesh. Eastern part of West Bengal and Odisha Andaman and Nicobar Islands	Rainfall >200cm Relative humidity > 70% Average temperature is about 24°C. Hot and	Height of trees is 40 to 60m Leaves are dark green and broad	Mahogany, Mahua, Bamboo, Cones, Ironwood, Kadam, Irul, Jamun, Hopea, Rubber tree, Toon,

		humid climate.		Telsur etc.
Tropical Moist Deciduous Forests	Eastern parts of Sahyadris (Western ghats) North Eastern part of Peninsula. Middle and lower Ganga valley	100 to 200cm rainfall per annum Moderate temperature.	30 to 40 m high trees. Due to deficiency of water, they shed their leaves in spring (onset of summer)	Sal, Teak, Arjun, Mulberry, Kusum, Sandalwood, Siris, Haldi, Khair, Mango, Banyan tree etc.
Foothills of Himalayas in Bhabar and Tarai region These cover about 20% India's forest area				

Tropical Dry Deciduous Forests	Large parts of Maharashtra and Andhra Pradesh. Parts of Punjab, Haryana and Eastern parts of Rajasthan. Northern and Western parts of Madhya Pradesh. Tamil Nadu. Southern parts of Uttar Pradesh.	50 to 100 cm rainfall. Moderate humidity.	6 to 15 m high. Roots are thick and long.	Teak, Sal, Bamboo, Mango, Acacia, Neem, Shisham etc.
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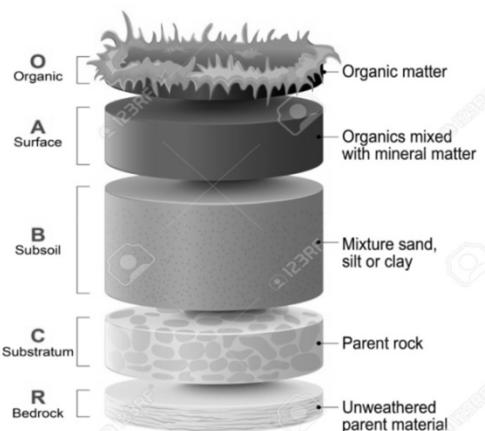
Dry Forests or Arid Forests	Rajasthan and adjoining areas of Haryana, Gujarat and Punjab. Rainshadow areas of peninsular India.	Low rainfall (less than 50cm per annum). Relative humidity is less	Thorny vegetation. Roots are very long. Leaves are small.	Cactus, Thorny bushes, Kikar, Babool, Date palm, Acacia, Khair, Euphorbias etc
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Mountainous forests or Himalayan Forest	In Himalayan Region	Due to increase of altitude the temperature decreases hence Himalayan forests contain all the varieties of world except equatorial forest	Each vegetation belt occurs at relatively 300m more height in Eastern Himalayas.	Sal, Teak, Chir, Deodar, Oak, Olive, Chestnut, Conifers, Spruce and Lirch etc.
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Soils

- The mixture of rock debris and organic materials which develop on the earth's surface.
- The major factors affecting the formation of soil are relief, parent material, climate, vegetation and other life-forms and time.
- Components of the soil are mineral particles, humus, water and air.
- Horizon A** is the topmost zone, where organic materials have got incorporated with the mineral matter, nutrients and water, which are necessary for the growth of plants.
- Horizon B** is a transition zone between the 'horizon A' and 'horizon C', and contains matter derived from below as well as from above. It has some organic matter in it, although the mineral matter is noticeably weathered.

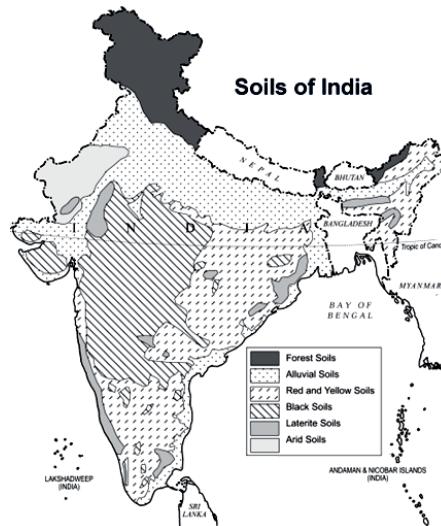
SOIL LAYERS



- Horizon C** is composed of the loose parent material. This layer is the first stage in the soil formation process and eventually forms the above two layers. This arrangement of layers is known as the **soil profile**.

Classification of Soils:

- In ancient times, soils used to be classified into two main groups – **Urvara** and **Usara**, which were fertile and sterile, respectively.



- Indian Council of Agricultural Research (ICAR) has classified the Indian soils into 8 categories .On the basis of **genesis, colour, composition and location**, the soils of India have been classified into:

1. Alluvial Soils:

- Alluvial soils are widespread in the northern plains and the river valleys. These soils cover about **40 per cent of the total area** of the country.
- They are depositional soils, transported and deposited by rivers and streams.
- Through a narrow corridor in Rajasthan, they extend into the plains of Gujarat. In the Peninsular region, they are found in deltas of the east coast and in the river valleys.
- They vary in nature from sandy loam to clay and are rich in potash but poor in phosphorous.

Bangar –old alluvium

Khaddar- new alluvium

Kankar –calcerous deposits

- Alluvial soils are intensively cultivated.

2. Black Soil

- Black soil covers most of the Deccan Plateau which includes parts of Maharashtra, Madhya Pradesh,



Gujarat, Andhra Pradesh and some parts of Tamil Nadu.

- These soils are also known as the 'RegurSoil' or the 'Black Cotton Soil'. Generally clayey, deep and impermeable.
- They swell and become sticky when wet and shrink when dried. So, during the dry season, these soil develop wide cracks like '**self ploughing**'.
- Because of this character of slow absorption and loss of moisture, the **black soil retains the moisture for a very long time**, which helps the crops, especially, the rain fed ones, to sustain even during the dry season.
- Chemically, the black soils are rich in lime, iron, magnesia and alumina. They also contain potash. But they lack in phosphorous, nitrogen and organic matter. The colour of the soil ranges from deep black to grey.

3. Red and Yellow Soil

- Red soil develops on crystalline igneous rocks in areas of low rainfall in the eastern and southern part of the Deccan Plateau. Yellow and red soils are also found in parts of Odisha and Chattisgarh and in the southern parts of the middle Ganga plain.
- The soil develops a reddish colour due to a wide diffusion of iron in crystalline and metamorphic rocks. It looks yellow when it occurs in a hydrated form.
- The fine-grained red and yellow soils are normally fertile, whereas coarse-grained soils found in dry upland areas are poor in fertility.
- They are generally poor in nitrogen, phosphorous and humus

4. Laterite Soil:

- Laterite has been derived from the Latin word 'Later' which means brick.
- The laterite soils develop in areas with **high temperature and high rainfall**. These are the result of intense leaching due to tropical rains. With rain, lime

and silica are leached away, and soils rich in iron oxide and aluminium compound are left behind.

- Humus content of the soil is removed fast by bacteria that thrives well in high temperature.
- Poor in organic matter, nitrogen, phosphate and calcium, while iron oxide and potash are in excess. Hence, laterites are not suitable for cultivation.
- **Red laterite soils** in Tamil Nadu, Andhra Pradesh and Kerala are more suitable for tree crops like cashewnut.
- The laterite soils are commonly found in Karnataka, Kerala, Tamil Nadu, Madhya Pradesh and the hilly areas of Odisha and Assam.

5. Arid Soils

- Arid soils range from red to brown in colour.
- They are generally sandy in structure and saline in nature.
- They lack moisture and humus. Nitrogen is insufficient and the phosphate content is normal. Lower horizons of the soil are occupied by 'kankar' layers because of the increasing calcium content downwards.
- The 'Kankar' (calcium)layer formation in the bottom horizons restricts the infiltration of water, and as such when irrigation is made available, the soil moisture is readily available for a sustainable plant growth.
- Arid soils are characteristically developed in western Rajasthan, which exhibit characteristic arid topography. These soils are poor and contain little humus and organic matter.

6. Saline Soils

- Also known as **Usara soils**. Saline soils contain a larger proportion of sodium, potassium and magnesium, and thus, they are infertile, and do not support any vegetative growth.
- They occur in arid and semi-arid regions, and in waterlogged and swampy areas.

- Their structure ranges from sandy to loamy.
- They lack in nitrogen and calcium.
- Saline soils are more widespread in western Gujarat, deltas of the eastern coast and in Sunderban areas of West Bengal.

7. Peaty Soils:

- 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.
- Soils are normally heavy and black in colour.
- Occurs widely in the northern part of Bihar, southern part of Uttaranchal and the coastal areas of West Bengal, Orissa and Tamil Nadu.

8. Forest Soils:

- Forest soils are formed in the forest areas where sufficient rainfall is available.
- They are Loamy and silty on valley sides and coarse-grained in the upper slopes.
- In the snow-bound areas of the Himalayas, they experience denudation, and are acidic with low humus content. The soils found in the lower valleys are fertile.

Soils in India:

Types of Soils	Area of Occurrence	Compositions	Crops grown
Alluvial	Punjab, Haryana, Uttar Pradesh, Bihar and Jharkhand	Rich in potash and lime but deficient in nitrogen and phosphoric acid	Large variety of Rabi and Kharif crops such as wheat, rice, sugarcane, cotton and jute etc
Black (or Regur soil)	Deccan plateau, valleys of Krishna and Godavari, Andhra Pradesh,	Rich in iron, lime, aluminium, magnesium, calcium but lacks in	Cotton, sugarcane, jowar, tobacco, wheat and rice

	Madhya Pradesh and Tamil Nadu	nitrogen, phosphorus and humus	
Red	Eastern parts of Deccan Plateau, Tamil Nadu, Goa, Odisha and Meghalaya	Rich in iron and potash but deficient in lime, nitrogen phosphorus and humus	Wheat, rice, cotton, sugarcane and pulses
Laterite	Summits of Eastern and Western ghats, Assam hills, Andhra Pradesh, Karnataka, West Bengal and Odisha	Rich in iron but poor in silica, lime, phosphorus, potash and humus	Tea, coffee, rubber, cashew and millets
Desert	West and North-West India, Rajasthan, North Gujarat and Southern Punjab	Rich in soluble salts, but deficient in organic matter	Generally unsuitable for cultivation, but with irrigation useful for cultivation of drought-resistant lime, millets, barley, cotton, maize and pulses
Mountain	Hills of Jammu and Kashmir, Uttarakhand and Assam hills	Rich in iron and humus, but deficient in lime	With fertilizers, tea, fruits and medicinal plants can be grown
Saline and Alkaline	Drier parts of Bihar, Jharkhand, Uttar Pradesh, Haryana, Punjab, Rajasthan and Maharashtra	Many salts such as sodium, magnesium and calcium	Unfit for agriculture
Peaty and Marshy	Kerala, coastal regions of Odisha, Tamil Nadu and Sunderbans of West Bengal	Contain large amount of soluble salts and organic matter, but lack in potash and phosphates	Useful for rice and jute cultivation

Soil Degradation:

- Defined as the decline in soil fertility, when the nutritional status declines and depth of the soil goes down due to erosion and misuse.
- Soil degradation is the main factor leading to the depleting soil resource base in India.


Soil Erosion:

- The destruction of the soil cover is described as soil erosion.
- The soil forming processes and the erosional processes of running water and wind go on simultaneously. But generally, there is a balance between these two processes. The rate of removal of fine particles from the surface is the same as the rate of addition of particles to the soil layer.
- **Wind and water** are powerful agents of soil erosion because of their ability to remove soil and transport it.
- Wind erosion is significant in arid and semi-arid regions.
- In regions with heavy rainfall and steep slopes, erosion by running water is more significant.
- **Sheet erosion** takes place on level lands after a heavy shower and the soil removal is not easily noticeable. But it is harmful since it removes the finer and more fertile top soil.
- **Gully erosion** is common on steep slopes. Gullies deepen with rainfall, cut the agricultural lands into small fragments and make them unfit for cultivation. A region with a large number of deep gullies or ravines is called a **badland topography**. Ravines are widespread, in the Chambal basin. They are also found in Tamil Nadu and West Bengal.
- **Deforestation** is one of the major causes of soil erosion.
- A fairly large area of arable land in the irrigated zones of India is becoming saline because of over- irrigation. The salt lodged in the lower profiles of the soil comes up to the surface and destroys its fertility.
- **Chemical fertilisers** in the absence of organic manures are also harmful to the soil. Unless the soil

gets enough humus, chemicals harden it and reduce its fertility in the long run.

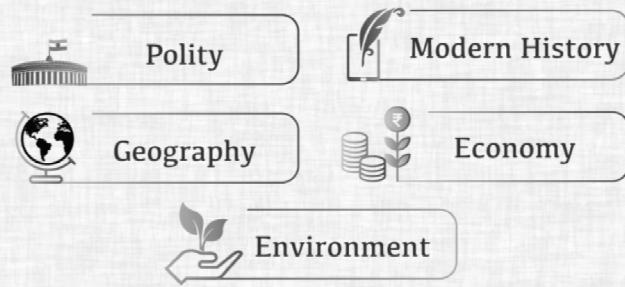
Soil Conservation:

- Soil conservation is a methodology to maintain soil fertility, prevent soil erosion and exhaustion, and improve the degraded condition of the soil.
- Over-grazing and shifting cultivation in many parts of India have affected the natural cover of land and given rise to extensive erosion. It should be regulated and controlled by educating villagers about the consequences.
- Contour bunding, Contour terracing, regulated forestry, controlled grazing, cover cropping, mixed farming and crop rotation are some of the remedial measures which are often adopted to reduce soil erosion.



READY RECKONER

Rapid Revision Notes


For more details

HYDERABAD Ashok Nagar : 9052 29 29 29
 Madhapur : 9052 49 29 29

BANGALORE 9121 41 29 29
 9121 44 29 29

Agriculture

Crop	Temperature	Rainfall	Soil
Rice	Not above 35°C	150-300 cm	Clayey or loamy
Wheat	19°-15°C (winter), 21°-26°C (Summer)	80 cm	Well-drained loams and clay loam
Cotton	21°-26°C, but not below 21°C, 200 frost free days	50-75 cm	Black soil (regar), alluvial or laterite soils
Sugarcane	20°-26°C	100-150 cm	Any type of soil that can retain moisture
Jowar	Not below 16°C	100 cm	Variety of soils including clayey and sandy
Jute	24°-35°C	Rainfall of 150cm, with 90% humidity	Light sandy or clayey loams
Tea	24°-30°C	125-375 cm, grown on hill slopes	Well-drained, deep friable loams or forest soils, rich in organic water
Coffee	15°-28°C	150-200 cm	Rich, well-drained friable loams containing good amount of vegetable mould
Bajra	25°-30°C	40-50 cm	Sandy loams, red and black soils
Ragi	20°-30°C	50-100 cm	Red, sandy loams and light black
Pulses	20°-25°C	50-75 cm	Dry, light soil
Rubber	25°-35°C	150-200 cm	Rich, well-drained soils
Tobacco	16°-40°C	50-100 cm	Well-drained loamy soil, alluvial or black soils

Three cropping seasons of India

1. Rabi:

- This season starts after the rainy season sowing begins in **September -October** and harvesting takes place in February – march.

- Wheat, barley, pulses and some oil seeds are grown in rabi season.

2. Kharif

- Season begins with onset of monsoons in **June -July**.
- The crops grown in the rainy season and harvesting takes place after the retreat of monsoon in September – October.
- Rice, maize, millets, Groundnuts, cotton and jute are in the Kharif season.

3. Zaid

- This is the summer season for growing crops which remain till **April, May, and June**.
- Products are mainly vegetables and fruits.

Major Crops and Producing States

Crop Type	Crop Name	Major Producers
Cereals	Wheat	Uttar Pradesh, Punjab and Madhya Pradesh
	Rice	West Bengal and Uttar Pradesh
	Barley	Maharashtra, Uttar Pradesh and Rajasthan
	Bajra	Maharashtra, Gujarat and Rajasthan
Cash Crops	Sugarcane	Uttar Pradesh and Maharashtra
	Poppy	Uttar Pradesh and Himachal Pradesh
Oil Seeds	Coconut	Kerala and Tamil Nadu
	Linseed	Rajasthan, Madhya Pradesh and Haryana
	Groundnut	Gujarat, Andhra Pradesh and Tamil Nadu
	Rape seed and Mustard	Rajasthan, Madhya Pradesh and Haryana
	Sunflower	Karnataka, Andhra Pradesh and Maharashtra
Fibre crops	Cotton	Maharashtra and Gujarat
	Jute	West Bengal and Bihar
	Silk	Karnataka and Kerala
	Hemp	Madhya Pradesh and Uttar Pradesh
Plantations	Coffee	Karnataka and Kerala
	Rubber	Kerala and Karnataka
	Tea	Assam and Kerala
	Tobacco	Gujarat, Maharashtra and Madhya Pradesh
Spices	Pepper	Kerala, Karnataka and Tamil Nadu
	Ginger	Kerala and Uttar Pradesh
	Turmeric	Andhra Pradesh and Odisha



Minerals

Minerals generally occur in the Earth's crust in the form of ore. It is mined, extracted, processed and utilised for the economic benefits of the society.

Metallic Minerals

Iron:

India stands first in iron ore reserves in Asia. Iron ore is mainly distributed in the peninsular India.

Varieties of Iron Ore:

- Magnetite: The best quality iron ore containing 72% of pure Iron.
- Haematite: Contains 60-70% of pure Iron
- Limonite: Contains 40-60% of pure Iron
- Siderite: Contains less than 40% of pure Iron

Distribution of iron ore- Karnataka, Odisha, Chattisgarh, Goa, Jharkhand.

Manganese:

- It is used for smelting of Iron and also for making alloys containing Manganese.
- India has second largest manganese reserves after Zimbabwe.
- India is the fifth largest producer of Manganese in the world.
- Manganese reserves in India are found in Odisha (44%), Karnataka (22%), Madhya Pradesh (13%), Maharashtra (8%).

Copper:

- It is widely utilised by electrical industry for manufacturing wires and other electrical equipments. It is also added with gold to impart strength.
- Major share of Copper production comes from Madhya Pradesh(58%), Rajasthan(32%) and Jharkhand(11%).
- Major copper mining centres are at Singhbhum (Jharkhand), Malanjkhand(MP), Khetri-Singhana and Alwar(Rajasthan), Kho-Dariba and Delwara-Kirovli.

Bauxite:

- It is the ore of Aluminium.

- Major producers of Bauxite are Kalahandi and Koraput belt of Odisha (36%), Gujarat (20%), Maharashtra (13%) and Jharkhand (13%).
- NALCO, BALCO and HINDALCO are major companies engaged in mining of Bauxite in the country.

Gold:

- India's share in the world gold production is less than one percent.
- Karnataka is the leading producer of gold accounting for 99% of total production and the rest comes from Jharkhand.
- Major gold fields in India: Kolar (Karnataka), Huttī (Karnataka), Ramgiri (Andhra Pradesh).

Other Metallic Minerals:

- Diamond is found in Panna belt of Madhya Pradesh, Raichur-Gulbarga districts of Karnataka.
- Silver is produced from Zawar mines of Udaipur district of Rajasthan.

Non Metallic Minerals:

Non metallic minerals are used in a large variety of industries; the major industries being cement, fertilizers, electricals, etc.

Coal :

Also called as Black gold, it is originated by organic wood.

Types of coal on the basis of carbon content,

Anthracite is the best quality of coal which carries 80 to 95 per cent carbon content. It ignites slowly with a blue flame. It has the highest calorific value. It is found in small quantity in Jammu and Kashmir.

Bituminous carries 60 to 80 per cent of carbon content and a low level of moisture content. It is widely used and has high calorific value. It is found in Jharkhand, West Bengal, Odisha, Chhattisgarh and Madhya Pradesh.

Lignite is often brown in colour. It carries 40 to 55 per cent carbon content. It is an intermediate stage which happens during the alteration of woody matter into coal. It has high moisture content so it gives smoke when

burnt. It is found in Rajasthan, Lakhimpur (Assam), and Tamil Nadu.

Peat has less than 40 per cent carbon content. It is in the first stage of transformation from wood to coal. It has low calorific value and burns like wood.

Mica:

- Mica's insulating properties have made it a valuable mineral in electrical and electronics industry. It can withstand high voltage and has low power loss factor.
- India contributes about 60 per cent of world's total production.
- Andhra Pradesh is the largest mica producing state of India.

Limestone:

- Limestone is used for a large variety of purposes. Of the total consumption, 75 per cent is used in cement industry, 16 per cent in iron and steel industry and 4 per cent in the chemical industries. Rest of the limestone is used in paper, sugar, fertilizers, glass, rubber and ferromanganese industries.
- Over three-fourths of the total limestone production in India is from six states, Madhya Pradesh, Rajasthan, Andhra Pradesh, Gujarat, Chhattisgarh and Tamil Nadu.

Asbestos:

- The name 'Asbestos' denotes two different minerals, namely, Ampibole and Chrysotile.
- Chrysotile accounts for 80% of asbestos of commercial use.
- Andhra Pradesh is the largest producer of Asbestos in India.

Dolomite:

- Limestone with more than 10% Magnesium is called Dolomite.
- Dolomite is used in Iron and Steel industry (more than 90%), followed by Fertilizer (4%), Glass (2%) and steel (1%).
- Chhattisgarh is the leading producer of Dolomite (28%), followed by Andhra Pradesh (23%), Odisha (13%) and remaining 36% by other states.

Gypsum:

- Gypsum is mainly used in making Ammonia sulphate fertilizer and in cement industry.
- Bulk of production of Gypsum comes from Rajasthan (99%) and the remaining 1% from Jammu and Kashmir and Gujarat.

Atomic Minerals

Uranium:

- Uranium deposits occur in Jaduguda of Singhbhum and Hazaribagh districts of Jharkhand, Gaya district of Bihar and Saharanpur district of Uttar Pradesh.
- India accounts for only 2% of world Uranium production.

Thorium:

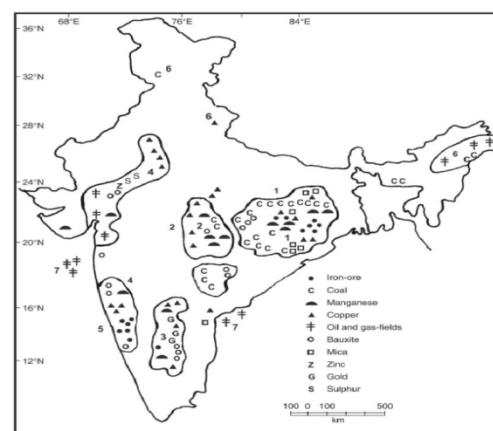
- It is found in the Monazite sands of Placer deposits of coastal regions.
- Although Monazite sands are found in east and west coast, the largest concentration is on the Kerala coast.
- Thorium is also extracted from Thorianite.
- Kerala, Jharkhand, Bihar, Tamil nadu and Rajasthan are the major producers of Thorium.

Beryllium:

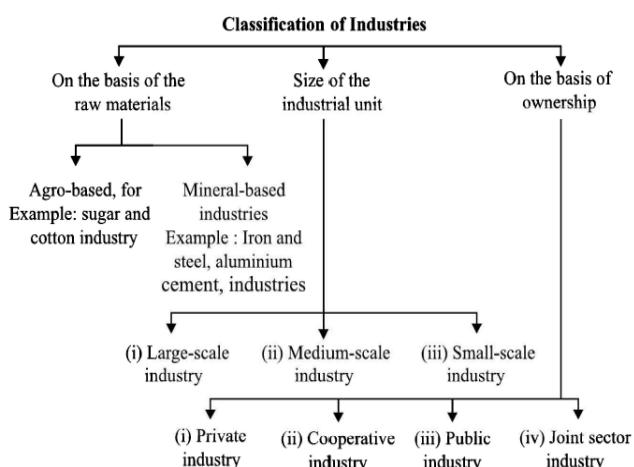
- Beryllium oxide is used as moderator in nuclear reactors.
- India has sufficient reserves of Beryllium.

Lithium and Zirconium:

- Lithium is a light metal which is distributed in the states of Jharkhand, Madhya Pradesh and Rajasthan.
- Zirconium is found in Kerala coasts and in alluvial deposits of Ranchi and Hazaribagh of Jharkhand.



Industries



Factors responsible for the location of Industries,

- Raw Material:** Industries using weight-losing raw materials are located in the regions where raw materials are located.
- Power:** Power provides the motive force for machines, and therefore, its supply has to be ensured before the location of any industry.
- Market:** Markets provide the outlets for manufactured products. Heavy machine, machine tools, heavy chemicals are located near the high demand areas as these are market orientated. Cotton textile industry uses a non-weight-losing raw material and is generally located in large urban centres, e.g. Mumbai.
- Transport:** Earlier industries were located only in metro cities that was because of better transport network. Now due to growing web of transport infrastructure, industries are being set up in interior part.
- Labour:** Industries require skilled labour. In India, labour is quite mobile and is available in large numbers due to our large population.
- Industrial Policy:** Government of India provides lots of incentives to industries locating in backward areas.

Footloose Industries:

Footloose industry can be located at any location without effect from factors

Major Industries in India:

1. The Iron and Steel Industry:

Importance	Raw materials	Reason for Location	Location
Almost all sectors of the Indian industry depend heavily on the iron and steel industry for their basic infrastructure.	iron ore and coking coal, limestone, dolomite, manganese, fire clay	All these raw materials are gross (weight losing), therefore, the best location for the iron and steel plants is near the source of raw materials	In India, Chhattisgarh, Northern Orissa, Jharkhand and West Bengal, which is extremely rich in high-grade iron ore, good quality coking coal and other supplementing raw materials

Important iron and steel industries are, Rourkela – Odisha – Germany, Bhilai – MP – Soviet Union, Durgapur – West Bengal – UK, Bokaro – Bihar – Soviet Union

2. The Cotton Textile Industry:

Historical Significance	It is one of the traditional industries of India. India was famous worldwide for the production of muslin, a very fine variety of cotton cloth, calicos, chintz and other different varieties of fine cotton cloth.
Reasons for development	a) it is a tropical country and cotton is the most comfortable fabric for a hot and humid climate. b) Large quantity of cotton was grown in India. c) Abundant skilled labour required for this industry was available in this country
Factors responsible for locations	<ul style="list-style-type: none"> Cotton is a "pure" raw material which does not lose weight in the manufacturing process. So other factors, like, power to drive the looms, labour, capital or market may determine the location of the industry. Kolkata due to its port facilities Lower labour costs: Ujjain, Bharuch, Agra, Hathras, Coimbatore and Tirunelveli. Abundant availability of hydropower for the mills
Current position	<ul style="list-style-type: none"> Presently, the major centres of the cotton textile industry are Ahmedabad, Bhiwandi, Solapur, Kolhapur, Nagpur, Indore and Ujjain Maharashtra, Gujarat and Tamil Nadu are the leading cotton producing states. Tamil Nadu has the largest number of mills and most of them produce yarn rather than cloth. Coimbatore has emerged as the most important centre with nearly half the mills located there

3. Sugar:

Importance	India-largest producer of both sugarcane and canesugar . khandasari and gur or jaggery are also prepared from sugarcane. Sugar industry is a seasonal industry because of the seasonality of raw materials.
Location	Sugarcane is a weight-losing crop. Its sucrose content begins to dry during haulage after it has been harvested from the field. Sugar factories hence, are located within the cane producing regions. Maharashtra is leading producer followed by UP and TN.

4. Petrochemical Industries:

Need	Types of raw materials it provides	Locations
In 1960s, demand for organic chemicals increased so fast that it became difficult to meet this demand. At that time, petroleum refining industry expanded rapidly. Many items are derived from crude petroleum, which provide raw materials for many new industries, these are collectively known as petrochemical industries	(i) polymers, (ii) synthetic fibres, (iii) elastomers, (iv) surfactant intermediate	Mumbai is the hub of the petrochemical industries. Cracker units are also located in Auraiya (Uttar Pradesh), Jamnagar, Gandhinagar and Hajira (Gujarat), Nagothane, Ratnagiri (Maharashtra), Haldia (West Bengal) and Vishakhapatnam (Andhra Pradesh)

Polymers are made from ethylene and propylene. These materials are obtained in the process of refining crude oil.

5. Chemical industries

Chemical industry	Products Manufactured	Location of the Industry
<ul style="list-style-type: none"> Chemicals industry in India is highly diversified, covering more than 80,000 commercial products. It is broadly classified into Basic chemicals, Specialty chemicals, and Agrochemicals. India's proximity to the Middle East, the world's source of petrochemicals feedstock, makes for economies of scale. India is a strong global dye supplier, accounting for approximately 16% of the world production of dyestuff and dye intermediates. Fertilisers, insecticides and pesticides. 		<ul style="list-style-type: none"> Major plants producing sulphuric acid are located at Khetri, Alwaye (Kerala), Mumbai, Kolkata, Burnpur and Jamshedpur. Major plants are located at Mithapur, Dharangadhra and Porbandar—all in Gujarat. The Hindustan Organic Chemicals Limited at Rasayani (Maharashtra) produces the chemicals required for drugs, dyestuffs and synthetic rubber.

6. Cement

	Features of the industry <ul style="list-style-type: none"> India is the second largest producer of cement in the world. India's cement industry is a vital part of its economy, providing employment to more than a million people, directly or indirectly. The housing and real estate sector is the biggest demand driver of cement, accounting for about 65 per cent of the total consumption in India. The other major consumers of cement include public infrastructure at 20 per cent and industrial development at 15 per cent. They are located in the states of Andhra Pradesh, Rajasthan and Tamil Nadu.
	Cement industry in India comprises of 125 large cement plants and over 300 mini cement plants having total installed capacity of 148.28 million tonnes and 11.10 million tonnes per annum respectively.

Major Industrial Regions in India:



Ports of India:



About 7500 long coast line of India served by 12 major and other medium, minor ports.

Port	State and Port Information
Kandla	Gujarat, tidal port
Mumbai	Maharashtra, biggest port with natural and well sheltered harbours
Jawaharlal	Maharashtra, decongest Mumbai port
Marmagao	Goa, major iron ore export
New Mangalore	Karnataka, major iron ore export
Kochi	Kerala, natural harbour
Tuticorin	Tamil Nadu, natural harbour
Chennai	Tamil Nadu, oldest artificial port
Vishakhapatnam	Andhra Pradesh, deepest land locked and well protected port
Paradip	Orissa, major iron ore export
Haldia	West Bengal, decongest Kolkata port
Kolkata	West Bengal, riverine port located on Hooghly river



**Prelims cum Mains
Cracked in 1st Attempt**

All India
Rank

470



NEELAM LALIT ADITYA

For More Details Contact
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[Madhapur: 9052 49 29 29]

BANGALORE: 9121 41 29 29 9121 44 29 29

Natural Hazards and Disasters:

- **Disasters-** Disaster is an undesirable occurrence resulting from forces that are largely outside human control, strikes quickly with little or no warning, which causes or threatens serious disruption of life and property.
- **Natural Hazards** are elements of circumstances in the Natural environment that have the potential to cause harm to people or property or both.
- As compared to natural hazards, natural disasters are relatively sudden and cause large scale, widespread death, loss of property and disturbance to social systems and life over which people have a little or no control.

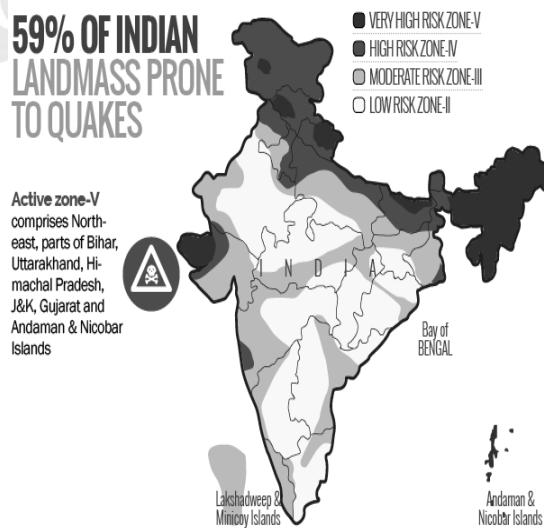
Earthquakes:

- Earthquakes that are of tectonic origin have proved to be the most devastating and their area of influence is also quite large.
- These earthquakes result from a series of earth movements brought about by a sudden release of energy during the tectonic activities in the earth's crust.
- The Indian plate is moving at a speed of one centimetre per year towards the north and north eastern direction and this movement of plates is being constantly obstructed by the Eurasian plate from the north. As a result of this, both the plates are said to be locked with each other resulting in accumulation of energy at different points of time. Excessive accumulation of energy results in building up of stress, which ultimately leads to the
- Some of the most vulnerable states are Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim, and the Darjeeling and subdivision of West Bengal and all the seven states of the northeast
- Recently, some earth scientists have come up with a theory of emergence of a fault line and energy build-up along the fault line represented by the river

Bhima(Krishna) near Latur and Osmanabad (Maharashtra) and the possible breaking down of the Indian plate.

- National Geophysical Laboratory, Geological Survey of India, Department of Meteorology, Government of India, along with the recently formed National Institute of Disaster Management, following five earthquake zones:

 1. **Very high damage risk zone-** North-east states, areas to the north of Darbhanga and Araria along the Indo-Nepal border in Bihar, Uttarakhand, Western Himachal Pradesh (around Dharamshala)
 2. **High damage risk zone-** the remaining parts of Jammu and Kashmir, Himachal Pradesh, Northern parts of Punjab, Eastern parts of Haryana, Delhi, Western Uttar Pradesh, and Northern Bihar fall under the
 3. **Moderate damage risk zone**
 4. **Low damage risk zone**
 5. **Very low damage risk zone**



Most of the areas that can be considered safe are from the stable landmass covered under the Deccan plateau.

Earthquake Hazard Mitigation:

- (i) Establishing earthquake monitoring centres (seismological centres) for regular monitoring and fast dissemination of information among the people in the vulnerable areas. Use of Geographical



Positioning System (GPS) can be of great help in monitoring the movement of tectonic plates.

- (ii) Preparing a vulnerability map of the country and dissemination of vulnerability risk information among the people and educating them about the ways and means minimising the adverse impacts of disasters.
- (iii) Modifying the house types and building- designs in the vulnerable areas and discouraging construction of high-rise buildings, large industrial establishments and big urban centres in such areas.
- (iv) Finally, making it mandatory to adopt earthquake-resistant designs and use light materials in major construction activities in the vulnerable area.

Tsunami:

- Earthquakes and volcanic eruptions that cause the sea-floor to move abruptly resulting in sudden displacement of ocean water in the form of high vertical waves are called tsunamis (harbour waves) or seismic sea waves.
- Normally, the seismic waves cause only one instantaneous vertical wave; but, after the initial disturbance, a series of after waves are created in the water that oscillate between high crest and low trough in order to restore the water level.
- The speed of wave in the ocean depends upon the depth of water. **It is more in the shallow water than in the ocean deep.**
- As a result of this, the impact of tsunami is less over the ocean and more near the coast where they cause large-scale devastations. Therefore, a ship at sea is not much affected by tsunami and it is difficult to detect a tsunami in the deeper parts of sea
- Thus, these are also called Shallow Water Waves. Tsunamis are frequently observed along the Pacific ring of fire, particularly along the coast of Alaska, Japan, Philippines, and other islands of South-east

Asia, Indonesia, Malaysia, Myanmar, Sri Lanka, and India etc.

Tropical Cyclone:

- Tropical cyclones are intense low-pressure areas confined to the area lying between 30° N and 30° S latitudes, in the atmosphere around which high velocity winds blow.
- Horizontally, it extends up to 500-1,000 km and vertically from surface to 12-14 km. A tropical cyclone or hurricane is like a heat engine that is energised by the release of latent heat on account of the condensation of moisture that the wind gathers after moving over the oceans and seas.

Some initial conditions for the emergence of a tropical cyclone are:

1. Large and continuous supply of warm and moist air that can release enormous latent heat.
2. Strong Coriolis force that can prevent filling of low pressure at the centre (absence of Coriolis force near the equator prohibits the formation of tropical cyclone between 0 ° -5 ° latitude).
3. Unstable condition through the troposphere that creates local disturbances around which a cyclone develops.
4. Finally, absence of strong vertical wind wedge, which disturbs the vertical transport of latent heat.

Structure of Tropical Cyclone:

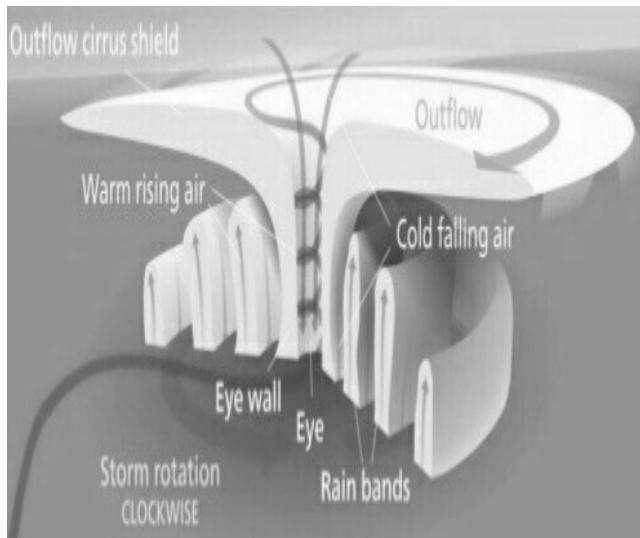
- The centre of the cyclone is mostly a warm and low-pressure, cloudless core known as eye of the storm. Expansion of the wind belt is about 10-150 km from the centre.

Spatial-temporal Distribution of Tropical Cyclone in India:

- Owing to its Peninsular shape surrounded by the Bay of Bengal in the east and the Arabian Sea in the west,

the tropical cyclones in India also originate in these two important locations.

- Though most of the cyclones originate between 10°-15° north latitudes during the monsoon season, yet in case of the Bay of Bengal, cyclones mostly develop during the months of October and November.
- Originate between 16°-2° N latitudes and to the west of 92° E. By July the place of origin of these storms shifts to around 18° N latitude and west of 90°E near the Sunderban Delta. A surge is generated due to interaction of air, sea and land. The cyclone provides the driving force in the form of very high horizontal pressure-gradient and very strong surface winds. The sea water flows across the coast along with strong winds and heavy downpour.

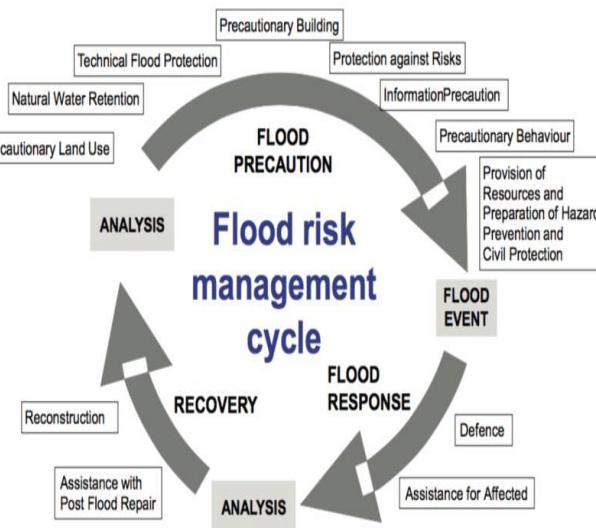


Floods:

- The causes of floods are well-established. Relatively slow in occurrences and often, occur in well-identified regions and within expected time in a year. Floods occur commonly when water in the form of surface run-off exceeds the carrying capacity of the river channels and streams and flows into the neighbouring low-lying flood plains.
- Floods can also be caused due to a storm surge (in the coastal areas), high intensity rainfall for a considerably longer time period, melting of ice and snow, reduction in the infiltration rate and presence

of eroded material in the water due to higher rate of soil erosion.

- Though floods occur frequently over wide geographical area having disastrous ramifications in many parts of the world, floods in the South, Southeast and East Asian countries, particularly in China, India and Bangladesh, are frequent and equally disastrous.
- RashtriyaBarhAyog (National Flood Commission) identified 40 million hectares of land as flood-prone in India Assam, West Bengal and Bihar are among the high flood-prone states of India.



Droughts:

- The term 'drought' is applied to an extended period when there is a shortage of water availability due to inadequate precipitation, excessive rate of evaporation and over-utilisation of water from the reservoirs and other storages, including the ground water.
- Drought is a complex phenomenon as it involves elements of meteorology like precipitation, evaporation, evapo-transpiration, ground water, soil moisture, storage and surface run-off, agricultural practices, particularly the types of crops grown, socio-economic practices and ecological conditions.

Types of Droughts:

- **Meteorological Drought:** It is a situation when there is a prolonged period of inadequate rainfall marked with mal-distribution of the same over time and space.
- **Agricultural Drought:** It is also known as soil moisture drought, characterised by low soil moisture that is necessary to support the crops, thereby resulting in crop failures.
- **Hydrological Drought:** It results when the availability of water in different storages and reservoirs like aquifers, lakes, reservoirs, etc. falls below what the precipitation can replenish.
- **Ecological Drought:** When the productivity of a natural ecosystem fails due to shortage of water and as a consequence of ecological distress, damages are induced in the ecosystem.

Drought Prone Areas in India

Extreme Drought Affected Areas:

- Most parts of Rajasthan, particularly areas to the west of the Aravali hills, i.e. Marusthali and Kachchh regions of Gujarat fall in this category.

Severe Drought Prone Area:

- Parts of eastern Rajasthan, most parts of Madhya Pradesh, eastern parts of Maharashtra, interior parts of Andhra Pradesh and Karnataka Plateau, northern parts of interior Tamil Nadu and southern parts of Jharkhand and interior Orissa are included in this category.

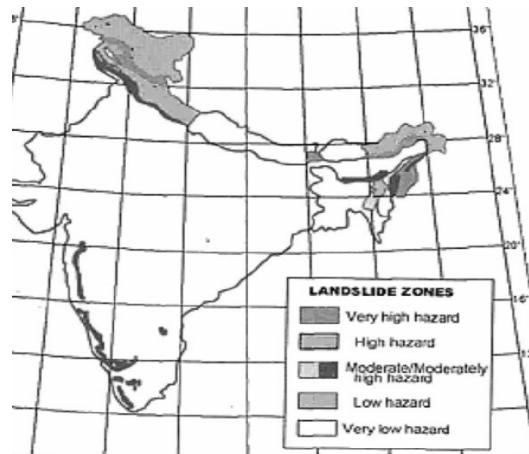
Moderate Drought Affected Area:

- Northern parts of Rajasthan, Haryana, southern districts of Uttar Pradesh, the remaining parts of Gujarat, Maharashtra except Konkan, Jharkhand and Coimbatore plateau of Tamil Nadu and interior Karnataka are included in this category

Landslides:

A landslide is defined as the movement of a mass of rock, debris, or earth down a slope

Landslide Vulnerability Zones



Very High Vulnerability Zone:

- Highly unstable, relatively young mountainous areas in the Himalayas and Andaman and Nicobar, high rainfall regions with steep slopes in the Western Ghats and Nilgiris, the north-eastern regions, along with areas that experience frequent ground-shaking due to earthquakes, etc. and areas of intense human activities, particularly those related to construction of roads, dams, etc. are included in this zone.

High Vulnerability Zone:

- Areas that have almost similar conditions to those included in the very high vulnerability zone are also included in this category.
- All the Himalayan states and the states from the north-eastern regions except the plains of Assam are included in the high vulnerability zones.

Moderate to Low Vulnerability Zone:

- Areas that receive less precipitation such as Trans-Himalayan areas of Ladakh and Spiti (Himachal Pradesh), undulated yet stable relief and low precipitation areas in the Aravali, rain shadow areas in the Western and Eastern Ghats and Deccan plateau also experience occasional landslides.

- Landslides due to mining and subsidence are most common in states like Jharkhand, Orissa, Chhattisgarh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Goa and Kerala.

Mitigation of landslides:

- It is always advisable to adopt area-specific measures to deal with landslides.
- Restriction on the construction and other developmental activities such as roads and dams, limiting agriculture to valleys and areas with moderate slopes, and control on the development of large settlements in the high vulnerability zones, should be enforced. This should be supplemented by some positive actions like promoting large-scale afforestation programmes and construction of bunds to reduce the flow of water.
- Terrace farming should be encouraged in the north-eastern hill states where Jhumming (Slash and Burn/Shifting Cultivation) is still prevalent.

Inland Waterway:

Inland Waterway 1	Allahabad-Haldia stretch of Ganga-Bhagirathi-Hooghly river system
Inland Waterway 2	Sadiya-Dhubri stretch of the Brahmaputra River (Assam)
Inland Waterway 3	Kottapuram-Kollam stretch of the West Coast Canal, Champakara Canal and Udyogmandal Canal (Kerala)
Inland Waterway 4	Kakinada-Pondicherry along Godavari and Krishna River system
Inland Waterway 5	Talcher-Paradip (Odisha)
Inland Waterway 6	Lakhipur to Bhanga on the River Barak (Assam - Proposed)

River Projects and Their Beneficiary States

River	Purpose	Beneficiary States
Sutlej	Power and irrigation	Punjab, Himachal Pradesh, Haryana and Rajasthan
Damodar	Power, irrigation and flood control	Jharkhand and west Bengal
Mahanadi	Power and irrigation	Odisha
Tungabhadra	Power and irrigation	Andhra Pradesh and Karnataka
Krishna	Power and irrigation	Andhra Pradesh and Telangana
Gandak	Power and irrigation	Bihar, Uttar Pradesh, Nepal (joint venture of India and Nepal)
Kosi	Flood control, Power and irrigation	Bihar
Ganga	Power and irrigation, avoid accumulation of silt to improve navigation	West Bengal
Beas	Power and irrigation	Rajasthan, Haryana Punjab and Himachal Pradesh
Sutlej, Beas, andrav i	Irrigation	Rajasthan, Punjab and Haryana
Chambal	Power and irrigation	Madhya Pradesh and Rajasthan
Tapti	Irrigation	Gujarat
Tapti	Power and irrigation	Gujarat
Tawa (Narmada)	Irrigation	Madhya Pradesh
Godavari	Irrigation	Telangana
Malaprabha	Irrigation	Karnataka