Samyak
An Institute For Civil Services

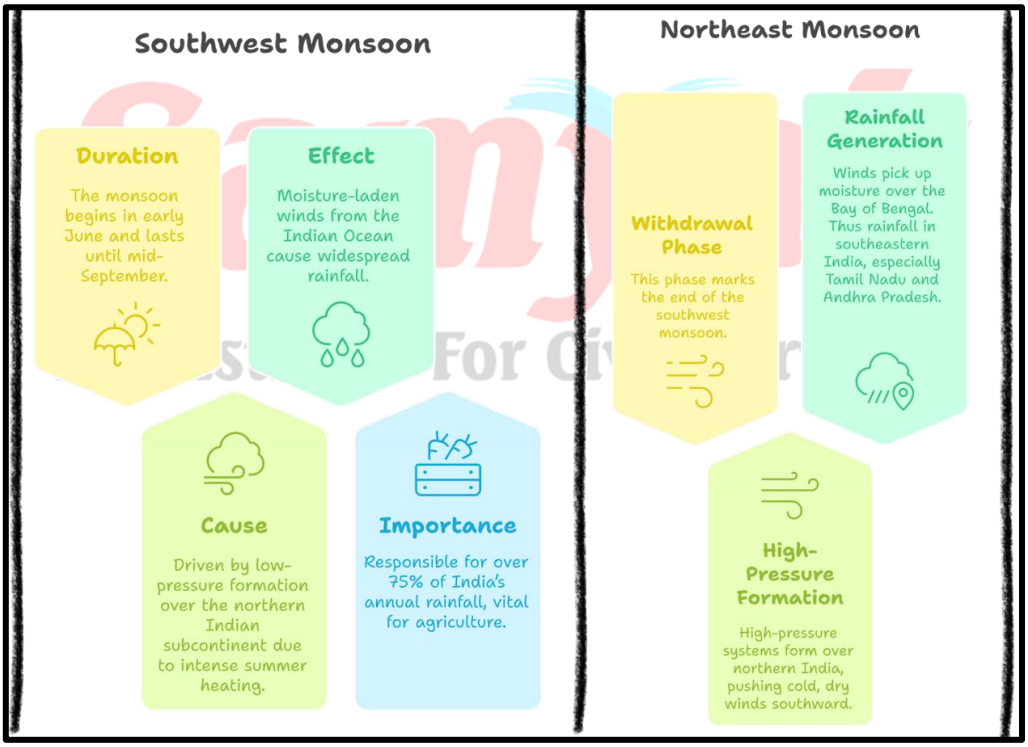
LECTURE 9 – INDIAN GEOGRAPHY: CLIMATE AND FOREST

INDIAN MONSOON

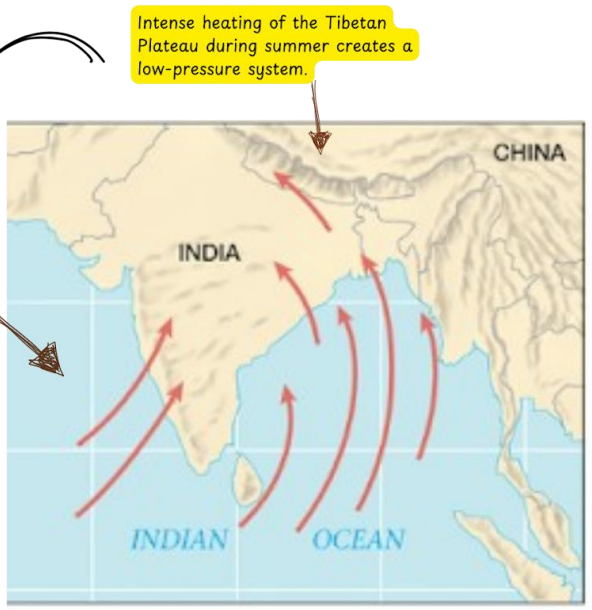
- The Indian monsoon is characterized by seasonal wind patterns that bring essential rainfall to the subcontinent, replenishing water sources and sustaining agricultural production.
- The term "monsoon" originates from the Arabic word *mausim*, meaning “season.”
- Monsoon winds are basically **seasonal winds that reverse their direction according to the change in season**. They are hence, **periodic winds.**
- It is primarily driven by temperature and pressure variations between land and ocean, resulting in distinct wet and dry seasons.

TYPES OF MONSOON IN INDIA

India experiences two primary monsoon systems:



FACTORS INFLUENCING AND MECHANISM OF INDIAN MONSOON

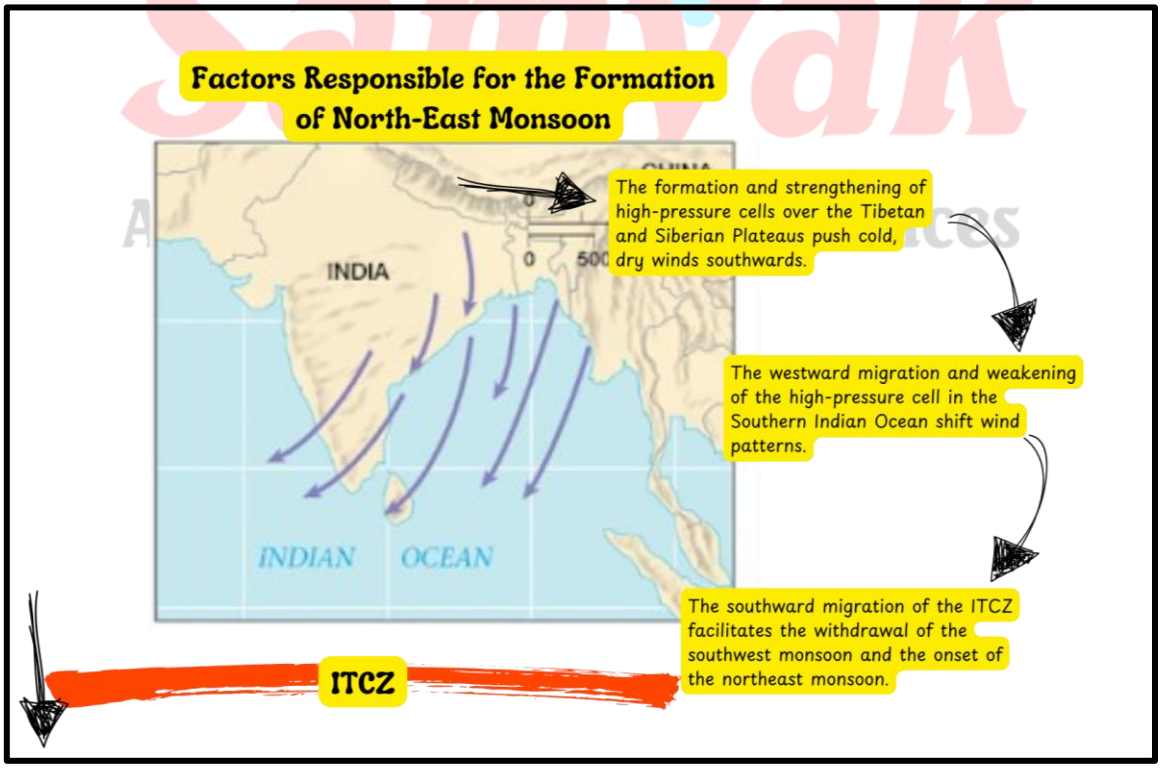


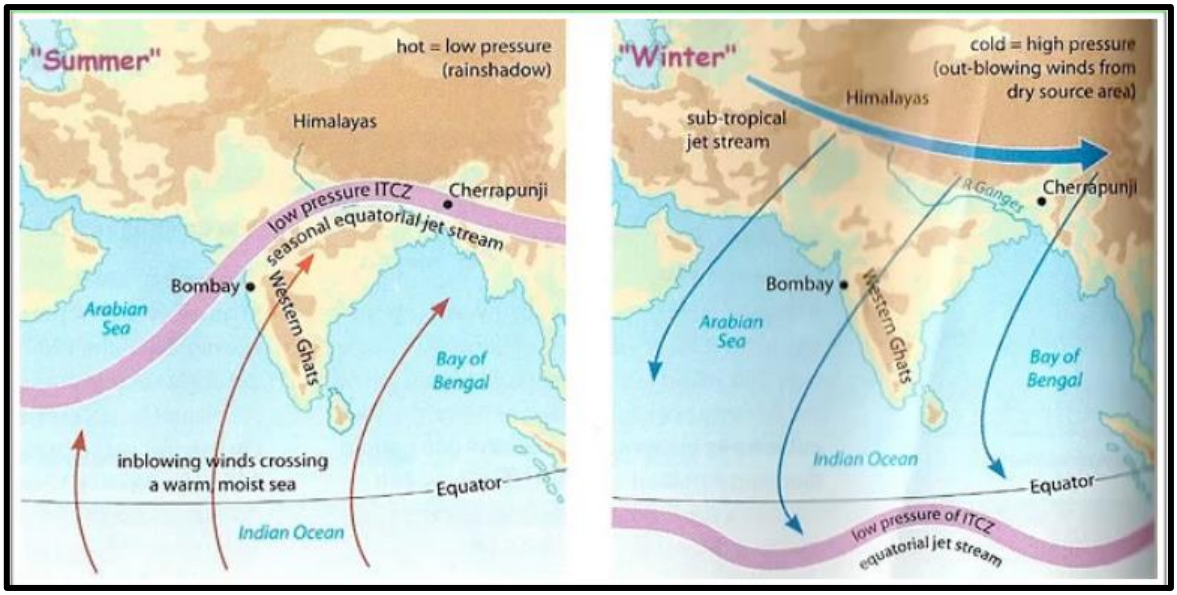
Factors Influencing the Onset of South-West Monsoon

1. The Subtropical Jet Stream (STJ) shifts northwards, allowing monsoon winds to advance.
2. The Tropical Easterly Jet (African Easterly Jet) develops over the Indian subcontinent, strengthening monsoon winds.
3. The Inter-Tropical Convergence Zone (ITCZ) moves northwards, drawing in moisture-laden winds.

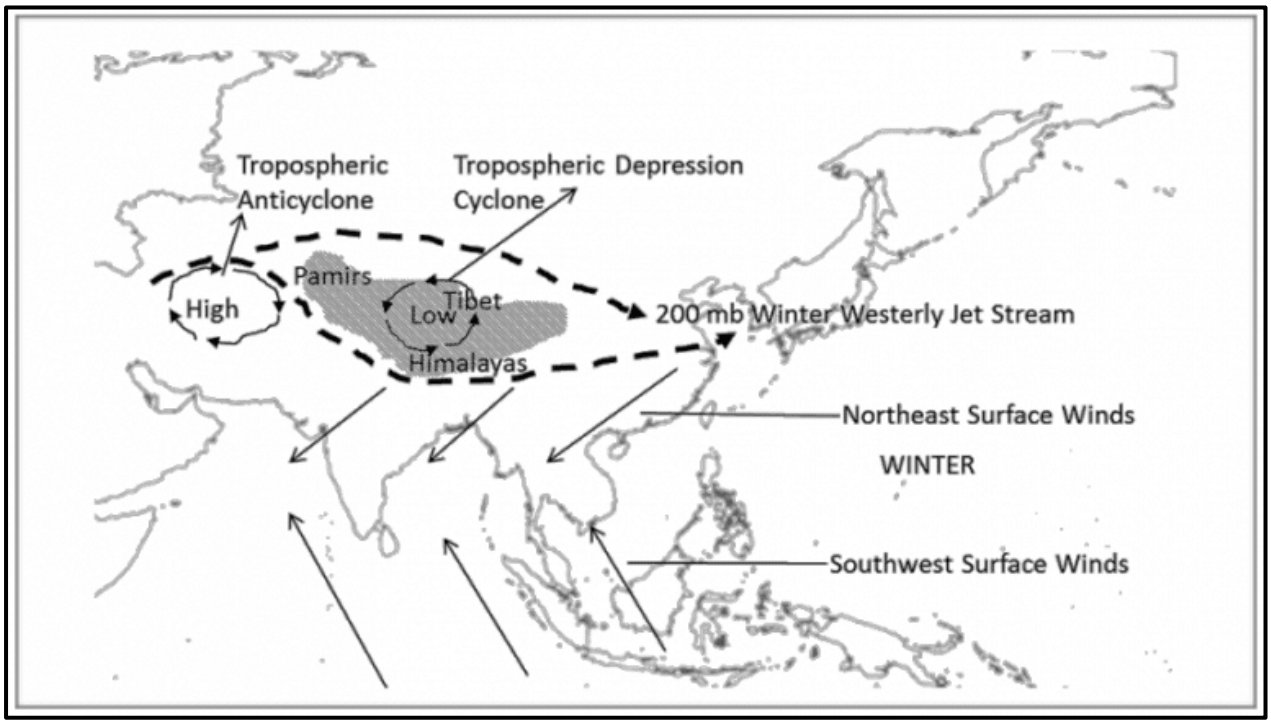
Factors Affecting the Intensity of South-West Monsoon

1. Strong low-pressure over Tibet and high-pressure over the southern Indian Ocean determine monsoon strength.
2. The Somali Jet (Findlater Jet) transports moisture-laden winds to the Indian subcontinent.
3. The Somali Current (Findlater Current) influences oceanic circulation, impacting monsoon intensity.
4. The Indian Ocean branch of the Walker Circulation affects wind patterns and monsoon strength.
5. The Indian Ocean Dipole (IOD) modulates monsoon variability by altering sea surface temperatures.

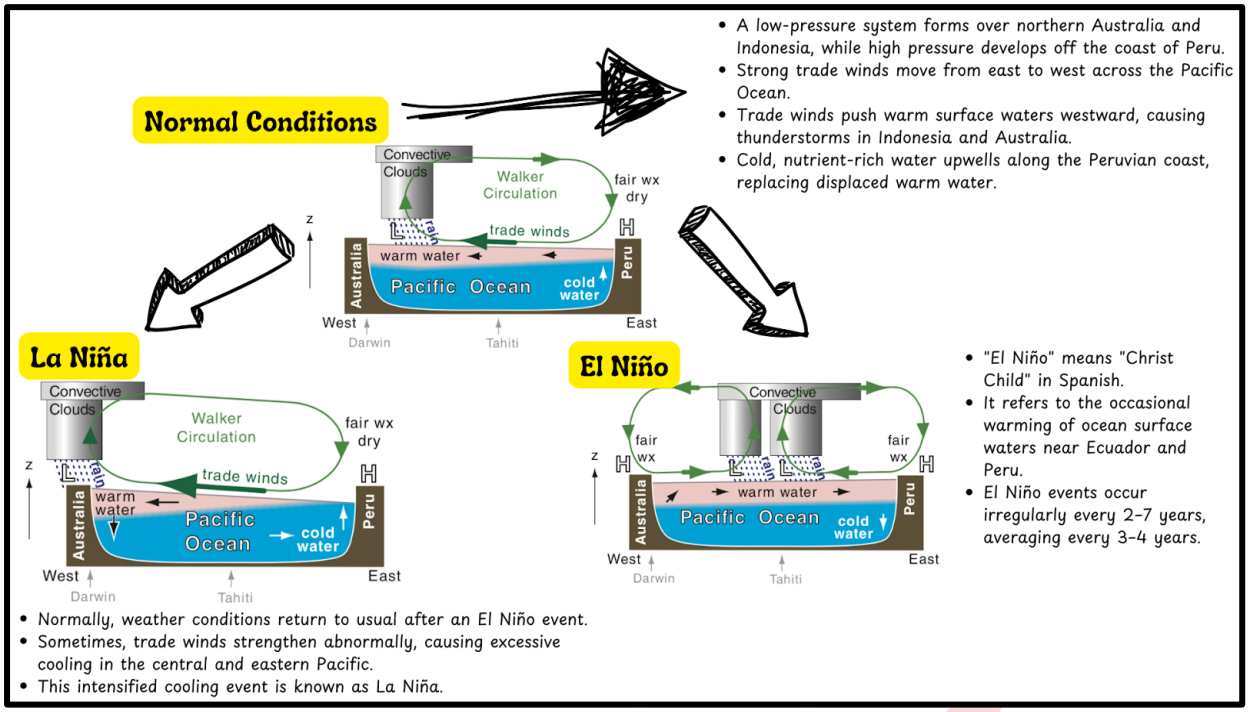




- The presence of the high-pressure area, east of Madagascar, approximately at 20°S over the Indian Ocean. The intensity and position of this high-pressure area affect the Indian Monsoon.
- The Tibetan plateau gets intensely heated during summer
    - Warm air rises above and creates High Pressure belt in the upper air above Tibetan plateau.
    - This results in **strong vertical air currents**
    - Air spreads from High Pressure belt and sinks over Indian Ocean around 30°S and 70°E.
    - This movement from Tibet to Indian Ocean is known as **Tropical Easterly Jet (TEJ)**. This jet drives monsoonal winds towards Indian subcontinent and intensifies South West monsoon.
    - The area over Indian Ocean where TEJ sinks is known as **Mascarene High.**
    - **Tropical Easterly Jetstream is also a major reason why there are no cyclones during Monsoon**



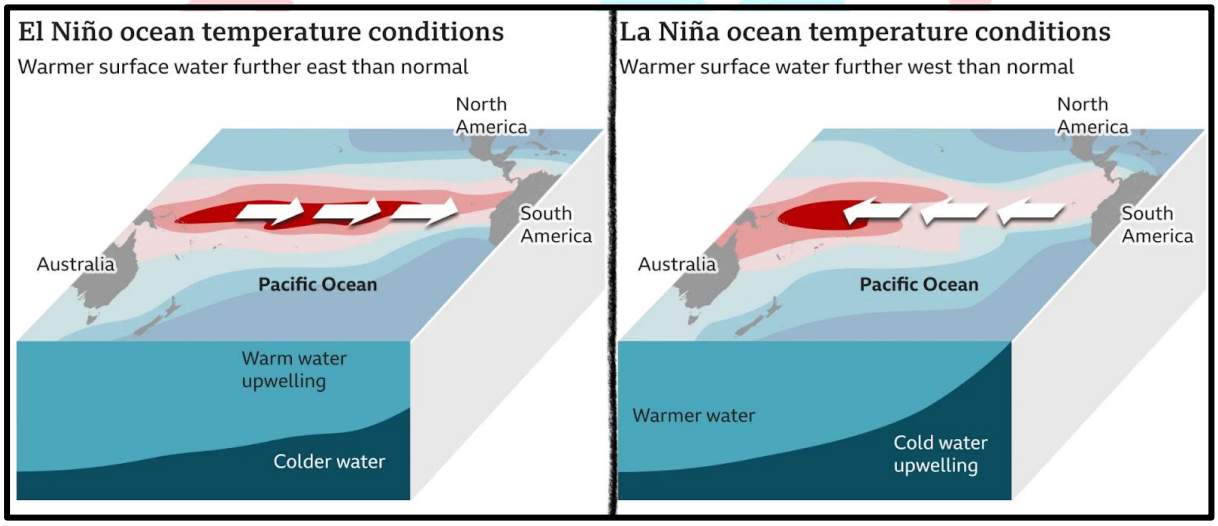
Role of El-Nino and La-Nina



- A low-pressure system forms over northern Australia and Indonesia, while high pressure develops off the coast of Peru.
- Strong trade winds move from east to west across the Pacific Ocean.
- Trade winds push warm surface waters westward, causing thunderstorms in Indonesia and Australia.
- Cold, nutrient-rich water upwells along the Peruvian coast, replacing displaced warm water.

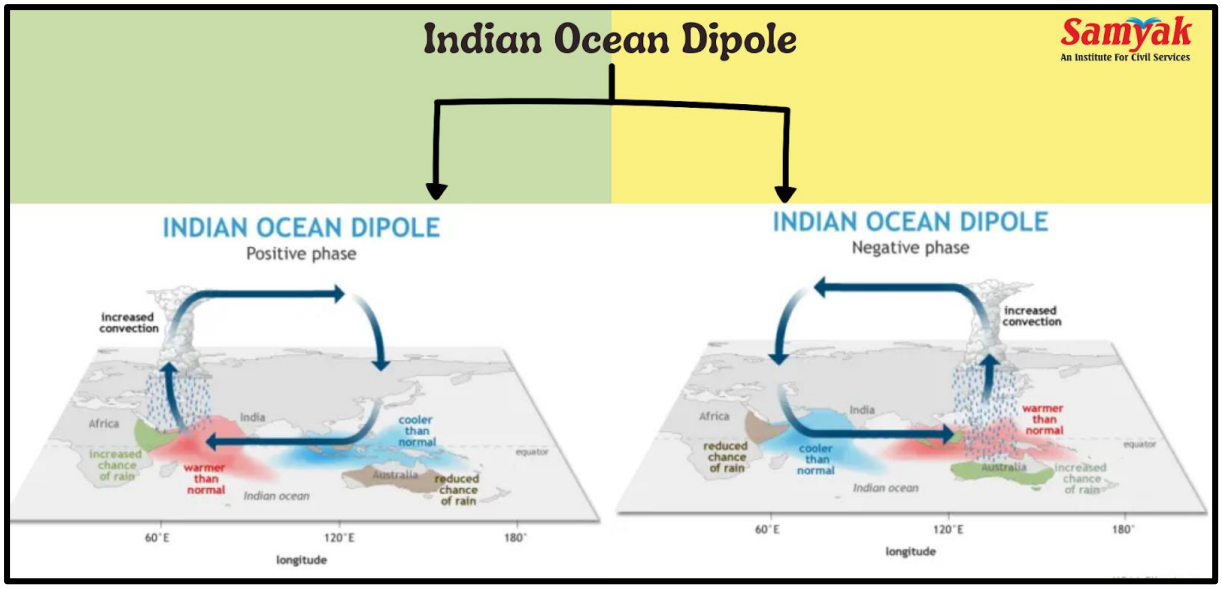
- Normally, weather conditions return to usual after an El Niño event.
- Sometimes, trade winds strengthen abnormally, causing excessive cooling in the central and eastern Pacific.
- This intensified cooling event is known as La Niña.

- "El Niño" means "Christ Child" in Spanish.
- It refers to the occasional warming of ocean surface waters near Ecuador and Peru.
- El Niño events occur irregularly every 2–7 years, averaging every 3–4 years.



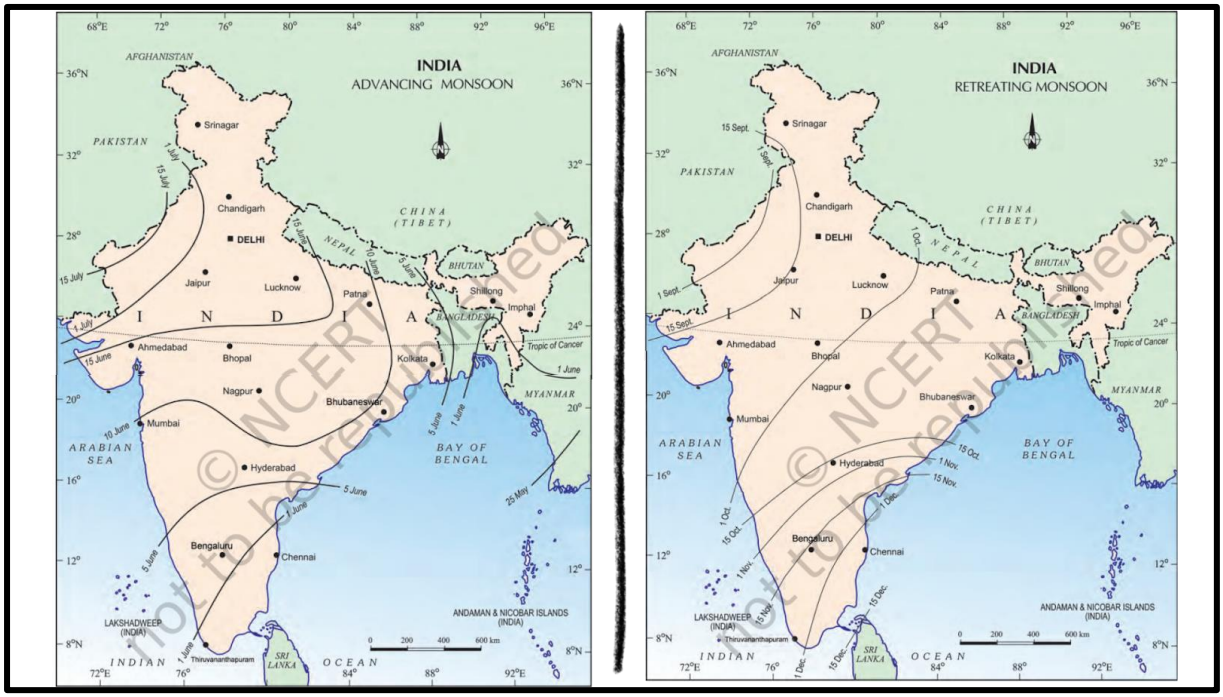
ROLE OF INDIAN OCEAN DIPOLE

- It the **difference in sea surface temperature** between two areas (or poles, hence a dipole) i.e., a western pole in the Arabian Sea (western Indian Ocean) and an eastern pole in the eastern Indian Ocean south of Indonesia.
- It **develops in the equatorial region of Indian Ocean** from April to May peaking in October.



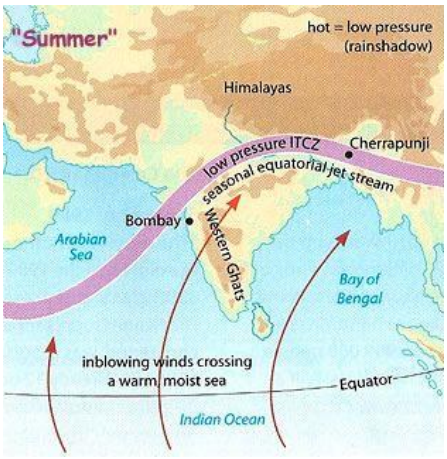
- **Positive Indian Ocean Dipole**
  - In this, winds over the Indian Ocean blow from east to west (from Bay of Bengal towards Arabian Sea).
  - These **results in the Arabian Sea (western Indian Ocean near African Coast) are much warmer** and eastern Indian Ocean around Indonesia becoming colder and dry.
  - **Results in more cyclones than usual in Arabian Sea.**
- **Negative Indian Ocean dipole**
  - In this, winds over the Indian Ocean blow from West to East (from Arabian Sea towards Bay of Bengal).
  - These results in the (**Eastern Indian Ocean) are much warmer** and western Indian Ocean around Arabian sea becoming colder and dry.
  - **Results in more cyclones than usual in Bay of Bengal**

INDIAN MONSOON CYCLE



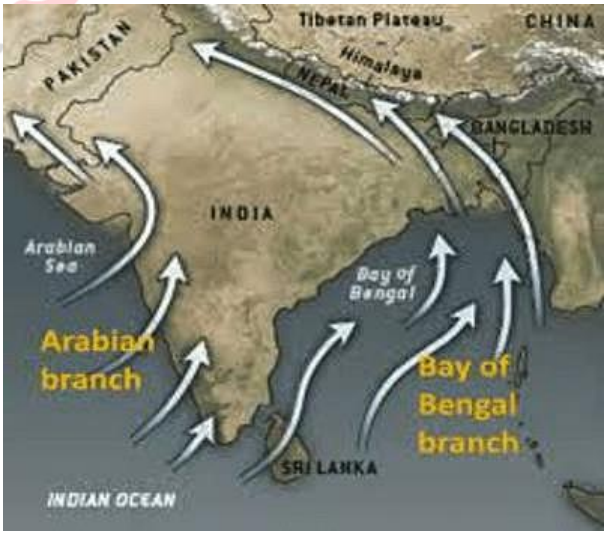
Onset of Monsoon (S-W Monsoon)

- 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.
- This Low Pressure attracts the southeast trade across the equator with other factors (mentioned above) being favorable.



Advance of Monsoon - The southwest monsoon splits into two branches,

- **Arabian Sea Branch**
  - The monsoon winds originating over the Arabian Sea further split into three branches:
  - **One branch is obstructed by the Western Ghats** - windward side of Ghats receives very heavy rainfall and leeward side receive little rainfall.
  - **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.
  - **A third branch of this monsoon wind strikes the Saurashtra Peninsula and the Kutch**. It then passes over west Rajasthan and runs along the Aravallis, causing only a scanty rainfall. In Punjab and Haryana, it too joins the Bay of Bengal branch.



- **The Bay of Bengal branch**
  - **Arakan Hills in Myanmar deflects this branch towards Indian Subcontinent.** From here, this branch splits into two under the influence of the Himalayas and the thermal low in northwest India.
  - 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.

- The **Tamil Nadu coast remains dry during this season** because it is situated in the rainshadow area of the Arabian Sea branch of the southwest monsoon and lies parallel to the Bay of Bengal branch of the southwest monsoon.

Break in the Monsoon

- During the southwest monsoon period after having rained for a few days, if rain fails to occur for one or more weeks, it is known as a break in the monsoon.
- **Reasons-**
  - **If the rain-bearing storms are not very frequent** along the monsoon trough or the ITCZ over Northern India
  - Over the west coast the dry spells are associated with days **when winds blow parallel to the coast.**
  - **Cyclonic originating head of Bay of Bengal and their crossing into the mainland** may result in Bay of Bengal branch of SW monsoon winds getting drawn into cyclonic depression resulting in dry spells in SE parts of Ganga plains.

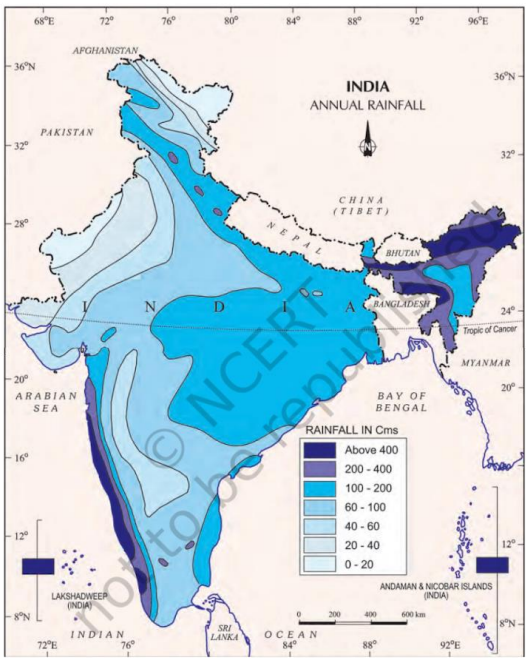
Retreating Monsoon (N-E Monsoon)

- **Unlike sudden burst of SW monsoon, retreat is gradual**.
- By the end of Sep, **ITCZ shifts Southward and SW Monsoon becomes weak**.
- In October, there are 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 '**October Heat**'.
- The winds blow from land to sea and these winds pick moisture from Bay of Bengal and cause rain in Tamil Nadu, Puducherry, Karaikal, Yanam, Andhra Pradesh, Kerala, Mahe, and south interior Karnataka from October to December.

Winter Rainfall

- The stable, **dry anti-cyclonic winds prevailing over the subcontinent after the retreat of the south-west monsoons** are not capable of causing precipitation in Northern India because they are free of moisture.
- However, the north-western parts of India—**Punjab and Ganga plains**—are invaded by shallow cyclonic disturbances moving from west to east and having their origin in the Mediterranean Sea. These are called "Westerly Disturbances' which travel across West Asia and Afghanistan before they reach India.
- These disturbances **cause upto 5 cm rainfall in Punjab and Kashmir and up to 2.5 cm over the Uttar Pradesh plains**. These showers are very good for the rabi crop, especially wheat and gram.

PRECIPITATION PATTERNS IN INDIA



- **Monsoon Duration:** Southern India receives monsoon early and for a longer duration than northern India.
- **Rainfall Distribution:** Rainfall decreases with increasing distance from the sea.
- **Average Rainfall:** India's average annual rainfall is 125 cm with spatial variations.

RAINFALL AREAS

- **High Rainfall Areas**: Western Ghats, Meghalaya hills, and sub-Himalayan northeast (>200 cm).
- **Medium Rainfall Areas:** Gujarat, Tamil Nadu, Odisha, Bihar, and northern Ganga plain (100-200 cm).
- **Low Rainfall Areas**: Western UP, Punjab, Rajasthan, Gujarat, and Deccan Plateau (50-100 cm).

Firstpost.

Arunachal Pradesh's Koloriang becomes contender for title of 'wettest place on Earth'

- **Location**: Kurung Kumey district, Arunachal Pradesh.
- **Geographical Setting:** Nestled in the Eastern Himalayas, surrounded by snow-capped peaks, lush valleys, and dense forests.
- **Elevation:** 1,000 meters above sea level.
- **Resident's Demand:** Urging the Indian Meteorological Department (IMD) to install rain gauges for accurate rainfall measurement.
- **Mawsynram,** East Khasi Hills (Meghalaya): officially holds the title of the wettest place on Earth.
- **Previously:** Cherrapunji held this title.

FORESTS IN INDIA

- Forest is the **second largest** land use in India next to agriculture. The forest cover of India is assessed as 80.9 million hectares which constitute **24.62 per cent** of the country's geographical area
- They range from **tropical rainforests** in the Western Ghats to **temperate forests** in the Himalayas. These forests serve as habitats for a variety of flora and fauna, including endangered species.
- Policies such as the **National Forest Policy (1988)** and the **Forest Conservation Act (1980)** emphasize conservation and sustainable management.

At present, in India, there is no clear nationally accepted definition of 'forest'. States are responsible for determining their definition of forests.

Constitution provisions relating to the forest

- Forest is included in **the Concurrent List in the (Seventh Schedule)** of the Constitution of India. **(42nd Amendment Act, 1976)**
- **Article 48 A** - State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country.
- **Article 51 A (g)** states that it shall be the fundamental duty of every citizen to protect and improve the natural environment including forests and Wildlife.

CLASSIFICATION OF FOREST TYPES

Based on administration

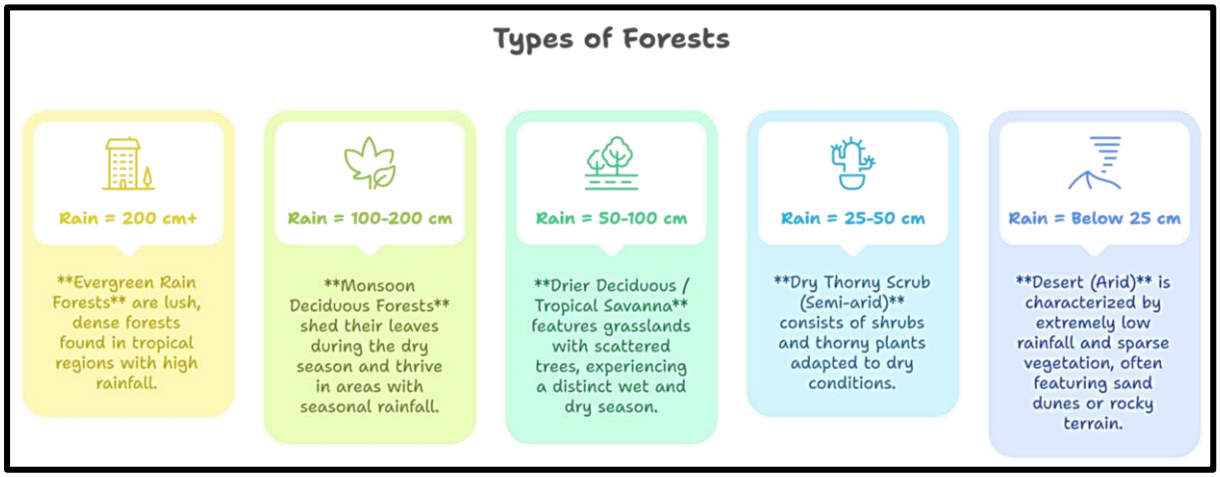
RESERVED FORESTS	PROTECTED FORESTS	UNPROTECTED FORESTS
Directly under the control of the government.	Looked after by the government.	Unclassified Forests.
No one is permitted to enter for the commercial grazing of cattle.	Locals are permitted to gather forest products and graze cattle without causing any significant harm.	No restriction on cutting trees or grazing cattle.
This category includes **53% of the nation's total forest area (TFA).**	Occupy about 29% of the TFA.	Occupy 18% of the TFA.

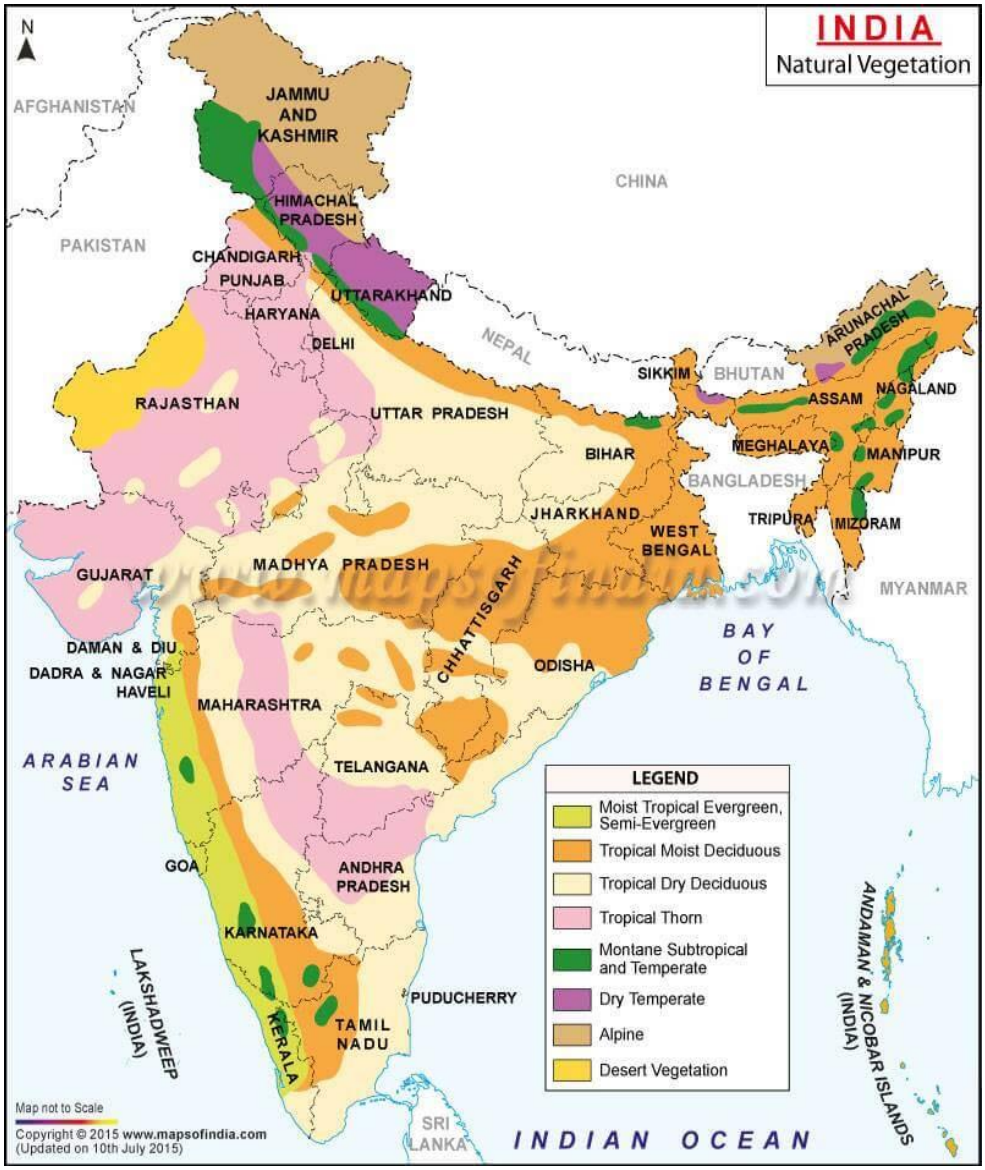
Based on Constitution

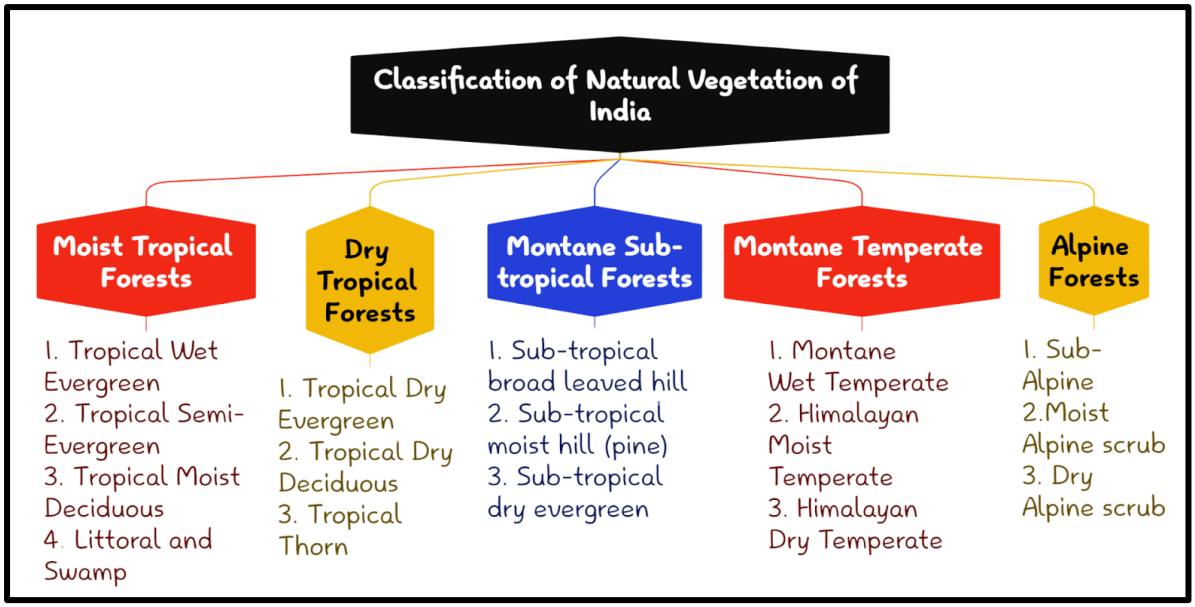
STATE FOREST	COMMERCIAL FOREST	PRIVATE FOREST
Include nearly all of the nation's significant forested areas and are completely controlled by the state or Central government.	Nearly all significant forest areas in the nation are owned and managed by local organisations (municipal corporations, village panchayats, district boards, etc.) and are completely under state or federal control.	Under private ownership.
Almost **94% of the TFA**	Cover 5% of the TFA.	Slightly more than 1% of the

Coverage.		Cover in TFA.

On the basis of Average Rainfall







FORESTS	CLIMATE	CHARACTERISTICS	FOUND IN
Tropical Moist Evergreen Forest	➢ **Rainfall** – above 250 cms ➢ **Average Temperature** – 25 to 27 deg Celsius ➢ Dry Season is distinctly short	➢ Do not shed their leaves – Evergreen ➢ **Species** – Mahagony, Rosewood, Mesua, Ebony, Jackfruit, Betelnut Palm ➢ **Mesosphytic**: Plants adopted to neither too dry nor too wet type climate.	➢ Western Ghats ➢ Andaman & Nicobar Islands ➢ North – Eastern Region
Tropical Semi Evergreen Forest	➢ Annual Ranifall – 200- 250 cm ➢ Mean annual temperature varies from 24°C to 27°C ➢ The dry season is not short like in tropical evergreen forests.	➢ **Transitional forests** between tropical wet evergreen forests and tropical deciduous forests. ➢ **Less dense.** ➢ They are **more gregarious** [living in flocks or colonies – more pure stands] than the wet evergreen forests. ➢ **Species** are laurel, rosewood, mesua, thorny bamboo, white cedar, Indian chestnut, champa, mango	➢ Western coast ➢ Assam ➢ Lower slopes of the Eastern Himalayas ➢ Odisha ➢ Andamans.
Tropical Dry Evergreen Forest	➢ Annual rainfall of 100 cm [mostly from the north-east monsoon	➢ Short statured trees, up to 12 m high, with complete canopy. ➢ Bamboos and grasses not conspicuous ➢ **Species** - jamun, tamarind,	➢ Along the coast of Tamil Nadu

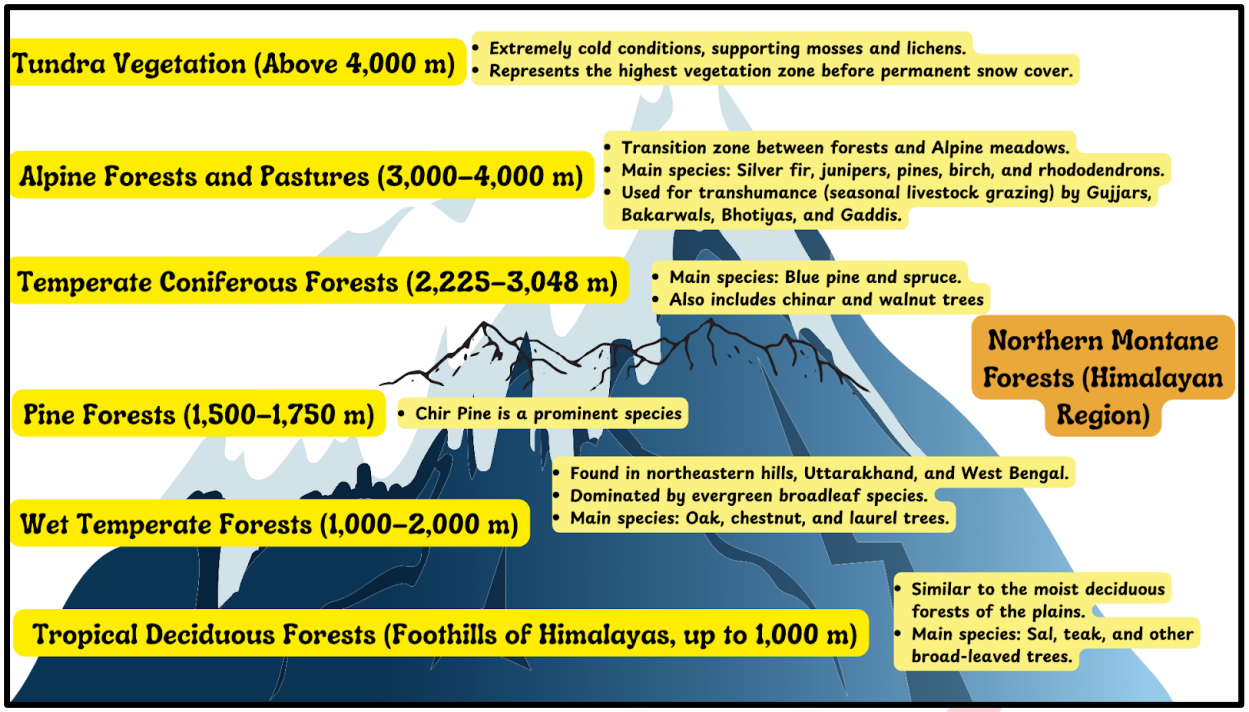
	winds in October – December]. ➢ Mean annual temperature - 28°C.	neem, etc. ➢ Most of the land under these forests has been cleared for agriculture or **casuarina plantations.** ➢ **Casuarina** – o Ability to **fix atmospheric nitrogen**. o Planting along coast help in checking high speed wind force impact o Reduce wasteland	
Tropical Moist Deciduous Forest	➢ Annual rainfall 100 to 200 cm. ➢ Mean annual temperature of about 27°C	➢ Trees shed their leaves during the spring and early summer when sufficient moisture is not available. ➢ Tropical moist deciduous forests present irregular top storey [25 to 60 m]. ➢ Heavily buttressed trees and fairly complete undergrowth. ➢ **Main species** - teak, sal, laurel, rosewood, amla, Mahua, Sandalwood, jamun, bamboo ➢ It is **comparatively easy to exploit these forests due to their high degree of gregariousness (more pure stands).**	➢ Belt running along the Western Ghats ➢ A strip along the Shiwalik range including terai and bhabar ➢ Manipur and Mizoram. ➢ Eastern Madhya Pradesh and Chhattisgarh. ➢ Chota Nagpur Plateau. ➢ Orissa and West Bengal ➢ Andaman and Nicobar islands.
Tropical Dry Deciduous Forest	➢ Annual Rainfall – around 100 cms	➢ Shed their leaves in dry season. ➢ They have closed but uneven canopy. ➢ **Undergrowth**: Enough light reaches the ground to permit the growth of grass and climbers. ➢ **Species** - teak, axlewood, rosewood, common bamboo, **red sanders**,	➢ They occur in an irregular wide strip running from the foot of the Himalayas to Kanniyakumari except in Rajasthan, Western Ghats and West

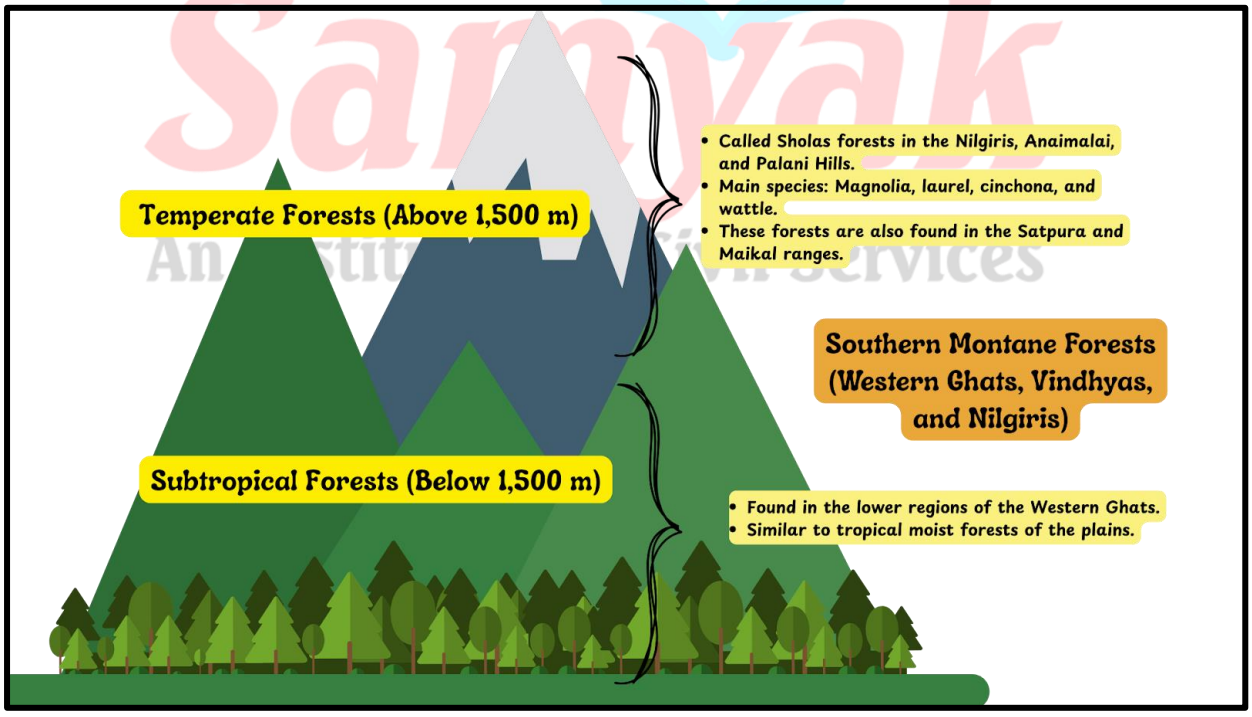
		laurel, palas, Ber	Bengal.
Tropical Thorn Forest	➢ Annual rainfall less than 75 cm. ➢ Mean temperature is 25°-30°C.	➢ The trees are low (6 to 10 metres maximum) and widely scattered. ➢ Acacias and Euphorbias are very prominent. ➢ The Indian wild date is common. Some grasses also grow in the rainy season. ➢ The important **species** are neem, babul, cacti.	➢ Rajasthan, south-western Punjab, western Haryana, Kachchh and neighbouring parts of Saurashtra. ➢ On the leeside of the Western Ghats covering large areas of Maharashtra, Karnataka, Telangana, Andhra Pradesh and Tamil Nadu.
Sub-tropical Broad-leaved Hill Forests	➢ Mean annual rainfall is 75 cm to 125 cm. ➢ Average annual temperature is 18°-21°C.	**Evergreen species**. ➢ Commonly found species are evergreen oaks, chestnuts, ash, beech, sals and pines. ➢ Climbers and epiphytes are common. ➢ It is a **"stunted rain-forest"** and is not so luxuriant as the true tropical evergreen.	➢ Eastern Himalayas to the east of 88°E longitude at altitudes varying from 1000 to 2000 m. ➢ These forests are not so distinct in the southern parts of the country. ➢ They occur only in the Nilgiri and Palni hills at 1070-1525 metres above sea level.
Sub-Tropical	➢ Annual rainfall is 50-	➢ Low scrub forest with small evergreen stunted	➢ Found in the Bhabar, the

Dry Evergreen Forest	100 cm	trees and shrubs. ➢ **Olive, acacia modesta and pistacia are the most predominant species.**	Shiwaliks and the western Himalayas up to about 1000 metres above sea level.
Montane Wet Temperate Forests	➢ Grows at a height of 1800 to 3000 m above sea level ➢ Mean annual rainfall is 150 cm to 300 cm ➢ Mean annual temperature is about 11°C to 14°C	➢ These are closed evergreen forests. Trunks have large girth. ➢ Branches are clothed with mosses, ferns and other epiphytes. ➢ The trees rarely achieve a height of more than 6 metres. ➢ Deodar, Chilauni, Indian chestnut, birch, plum, machilus, cinnamomum, litsea, magnolia, blue pine, oak, hemlock, etc. are important species. ➢ Champa variety of ground flora	➢ Higher hills of Tamil Nadu and Kerala, in the Eastern Himalayan region.
Himalayan Moist Temperate Forests	➢ Annual rainfall varies from 150 cm to 250 cm	➢ Mainly composed of **coniferous species.** ➢ Species occur in mostly pure strands. ➢ Trees are 30 to 50 m high. ➢ **Chir(Pines), cedars, silver firs, spruce, etc. are most important trees.** ➢ They form high but fairly open forest with shrubby undergrowth including oaks, rhododendrons and some bamboos.	➢ Occurs in the temperate zone of the Himalayas between 1500 and 3300 metres. ➢ Cover the entire length of this mountain range in Kashmir, Himachal Pradesh, Uttarakhand, Darjeeling and Sikkim.
Himalayan Dry Temperate Forests	➢ Precipitation is below 100 cm and is mostly in the	➢ Coniferous forests with xerophytic shrubs in which deodar, oak, ash, olive, chilgoza, maple are the	➢ Such forests are found in the inner dry ranges of the

	form of snow.	main trees.	Himalayas where south-west monsoon is very feeble. ➢ Such areas are in Ladakh, Lahul, Chamba, Kinnaur, Garhwal and Sikkim.
Alpine & Subalpine Forest	➢ In the higher reaches, there is a transition to Alpine forests and pastures occurring at altitudes of 2,500-4,000 m.	➢ In the Western Himalayas, the vegetation consists mainly of juniper, rhododendron, willow, and black currant. ➢ In the eastern parts, red fir, black juniper, birch, and larch are the common trees.	➢ Subalpine forests extend from Kashmir to Arunachal Pradesh between 2900 to 3500 metres.
Littoral & Swamp Forest	➢ They have roots that consist of soft tissue so that the plant can breathe in the water.	➢ It consists mainly of whistling pines, mangrove dates, palms, and bullet wood.	➢ Found along the Andaman and Nicobar Islands and the delta area of the Ganga and the Brahmaputra. ➢ Other areas of significance are the Mahanadi, the Godavari and the Krishna deltas.

UNDERSTANDING MONTANE FOREST





INDIA STATE OF FOREST REPORT (ISFR) 2023

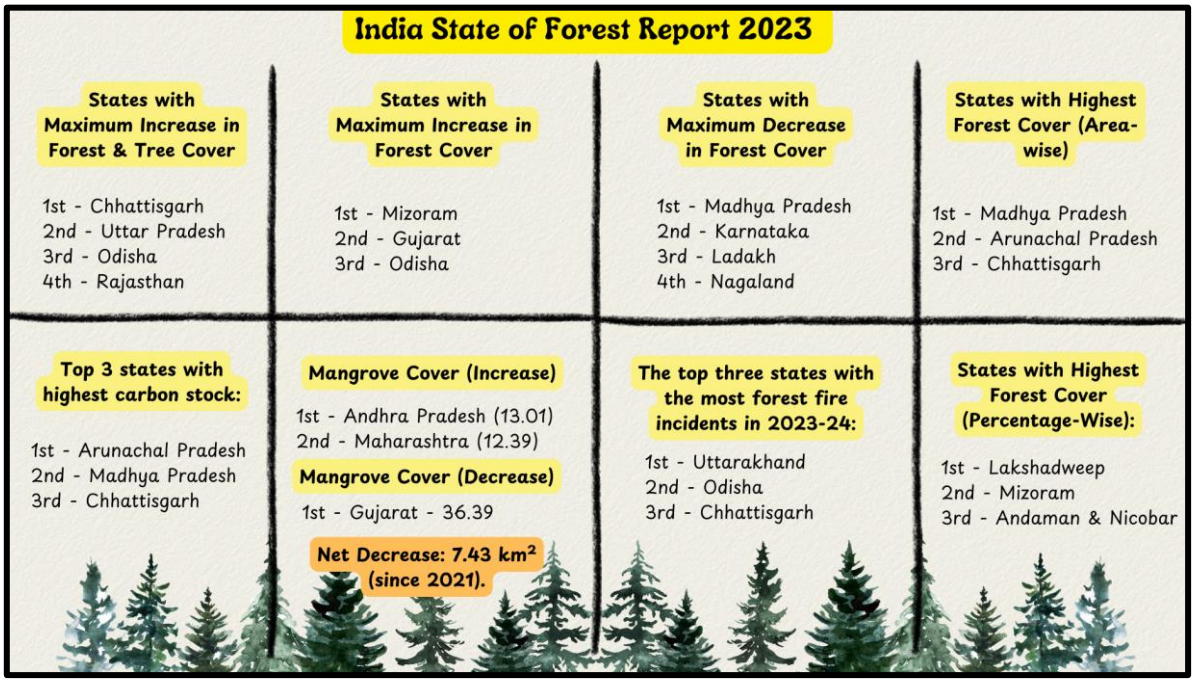
- The **18th India State of Forest Report (ISFR) 2023** was released by the **Ministry of Environment, Forest and Climate Change**.
- It is published biennially by the **Forest Survey of India (FSI)** to assess forest resources and trends.

Key Findings

- **Forest and Tree Cover**
  - Total Forest and Tree Cover: 8, 27,356.95 km² (25.17% of India's geographical area).
  - Forest Cover: 7, 15,342.61 km² (21.76% of India's geographical area).
  - Tree Cover: 1, 12,014.34 km² (3.41% of India's geographical area).

Trends in Forest Cover

- **Increase in Total Forest and Tree Cover:** 1,445.81 km² (2021-2023).
- **Increase in Forest Cover:** 156.41 km².



- **States/UTs with More than 33% Forest Cover:** 19 States/UTs, including Mizoram, Arunachal Pradesh, Nagaland, Meghalaya, Tripura, and Manipur, have forest cover above 75%.
- **India's Forest Carbon Stock:** 7,285.5 million tonnes (increased by 81.5 million tonnes since 2021).
- **India's CO_2 equivalent carbon stock**: **30.43 billion tonnes** (exceeded 2005 base year by **2.29 billion tonnes**).
- **Climate Targets:**
  - **Paris Agreement:** India aims to create 2.5-3.0 billion tonnes of CO_2 equivalent carbon sink by 2030.
  - **Bonn Challenge:** India has pledged to restore 26 million hectares of degraded land by 2030.
- **Mangrove Cover**
  - **Total Mangrove Cover:** 4,991.68 km² (0.15% of India's geographical area).
  - **Net Decrease:** 7.43 km² (2021-2023).

Long-Term Trends in Forestry (2013-2023)

- **Increase in Forest Cover:** 16,630.25 km².
- **Increase in Tree Cover:** 20,747.34 km².
- **Increase in Mangrove Cover:** 296.33 km².

- **Soil Health Improvement:**
  - Shallow to deep soil increased from 83.53% (2013) to 87.16% (2023).
  - Soil organic carbon increased from 55.85 t/ha to 56.08 t/ha.
- **Biotic Influences (Grazing, Felling, Fires) Reduced:**
  - **2013:** 31.28% of forests affected.
  - **2023:** 26.66% of forests affected (Improved floral & faunal biodiversity).

Global Standing of India's Forests

- India among the top 10 forest-rich countries globally **(FAO's Global Forest Resource Assessment, 2020).**
- India ranks 3rd in annual net gain of forest cover (2010-2020)**.**
- 17% of the world's human population and 18% of livestock depend on India's forests for livelihoods**.**