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INDIAN GEOGRAPHY

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PREFACE

A highly skilled professional team of PW ONLY IAS works arduously to ensure that the students receive the best content for the UPSC exams. A plethora of UPSC Study Material is available in the market but PW ONLY IAS professionals are continuously working to provide supreme quality study material for our UPSC students.

From the beginning, the content team comprising Content Creators, Reviewers, DTP operators, Proofreaders, and others is involved in shaping the material to their best knowledge and experience to produce powerful content for the students.

Faculties have adopted a new style of presenting the content in easy-to-understand language and have provided the team with expert guidance and supervision throughout the creation of this book.

PW ONLY IAS strongly believes in conceptual and fun-based learning. PW ONLY IAS provides highly exam-oriented content to bring quality and clarity to the students.

This book adopts a multi-faceted approach to mastering and understanding the concepts by having a rich diversity of questions asked in the examination and equipping the students with the knowledge for this competitive exam.

The main objective of the study material is to provide short, crisp, concise, and high-quality content to our students.

- ❑ Holistic Coverage of 50+ NCERT Books
- ❑ Thinking Points in and as 'Points to Ponder'
- ❑ Intensive use of Maps, Diagrams and Flowcharts
- ❑ Subject-Specific Workbooks for Practice



Alakh Pandey

Every chapter consists of 'Points to Ponder', where our leaders raise thinking points for the students to go beyond the confines of the book. The students are expected to think about and find out possible answers to these points. The Caricatures used are inspired by Alakh Pandey Sir and Sumit Rewri Sir.



Sumit Rewri



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India - Location

Bibliography: This chapter encompasses the summary of Chapter 7 of Class VI NCERT (The Earth: Our Habitat), chapter 1 of Class IX NCERT (Contemporary India), and chapter 1 of Class XI NCERT (Indian Physical Environment).

Introduction

India is a country of vast geographical expanse. It covers an area of 3.28 million square kilometres, accounting for 2.4 per cent of the world's total area. In the north, it is bound by the lofty Himalayas, in the west lies the Arabian Sea, in the east lies the Bay of Bengal and in the south lies the Indian Ocean, washing the shores of the Indian peninsula.

India and the World

- ❖ The Indian landmass has a **central location between East and West Asia** (Refer Figure 1.1).
- ❖ The **trans-Indian Ocean routes**, which connect the countries of Europe in the West and the countries of East Asia, provide a **strategic central location** to India.
- ❖ The Deccan Peninsula protrudes into the Indian Ocean, thus helping India to establish close contact with **West Asia, Africa and Europe from the western coast and with Southeast and East Asia from the eastern coast**.
- ❖ India's strategic location at the head of the ocean since ancient times and its long coastline which is longer than any other country in the Indian Ocean rim, justifies the naming of an Ocean after it.

POINTS TO PONDER

Historically, India's location has helped her to maintain a central position in world trade throughout most of her history. On the other hand, It has hindered the growth of Indian Political Entities and restricted them within the confines of the Himalayas and the Indian Ocean. Do you think India's location in the world map is a double edged sword. If yes, find out the positives and negatives emanating due to the location of India.



Additional Information

Since the opening of the Suez Canal in 1869, India's distance from Europe, has been reduced by 7,000 km. The Suez Canal is an artificial sea level waterway connecting Red Sea in Indian Ocean to Mediterranean Sea.



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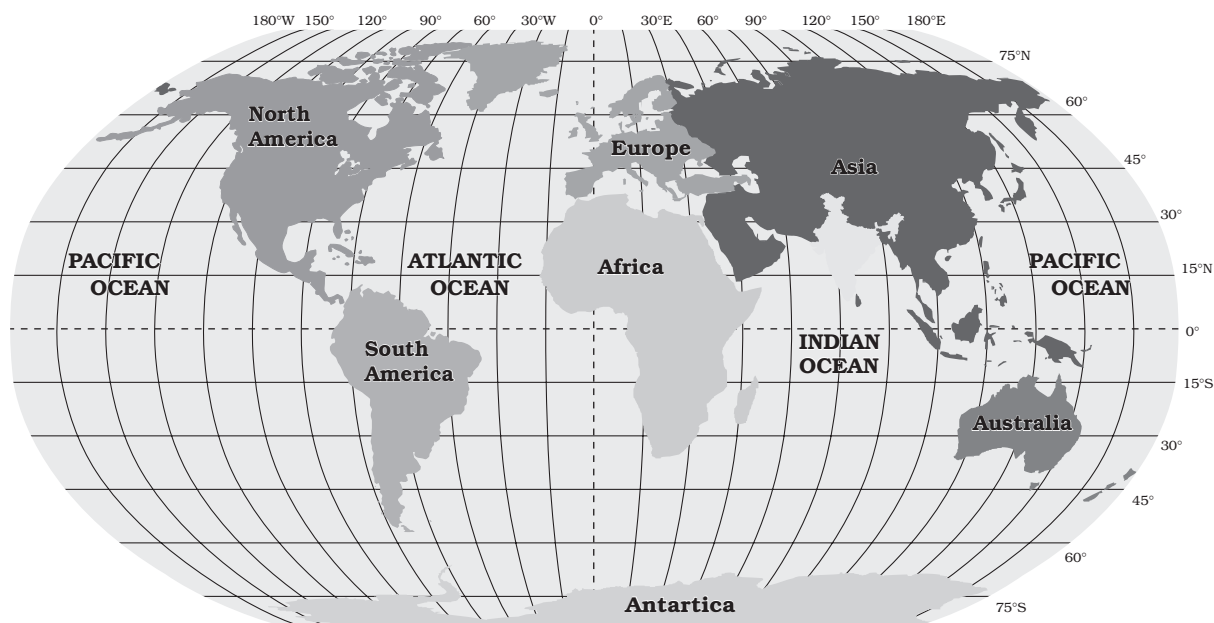


Figure 1.1: India and the World

India and its Neighbours

- ❖ India is located in the **south-central part of the continent of Asia**, bordering the **Indian Ocean** and its two arms extending in the form of the **Bay of Bengal and the Arabian Sea**.
- ❖ The maritime location of Peninsular India has provided links to its neighbouring regions through the **sea and air routes**.
- ❖ There are **seven countries** (Refer to Figure 1.2) that share land boundaries with India namely **Pakistan and Afghanistan in the Northwest, China, Nepal, and Bhutan in the North and Myanmar and Bangladesh in the east**.
- ❖ Among India's neighbours **Afghanistan, Nepal and Bhutan** do not have access to any ocean or sea.
- ❖ In the Indian Ocean, lie our island neighbours -**Sri Lanka and Maldives**. Sri Lanka is separated from India by the Gulf of Mannar and Palk Strait whereas Maldives Islands are situated to the south of the Lakshadweep Islands.
- ❖ India has had strong geographical and historical links with its neighbours.

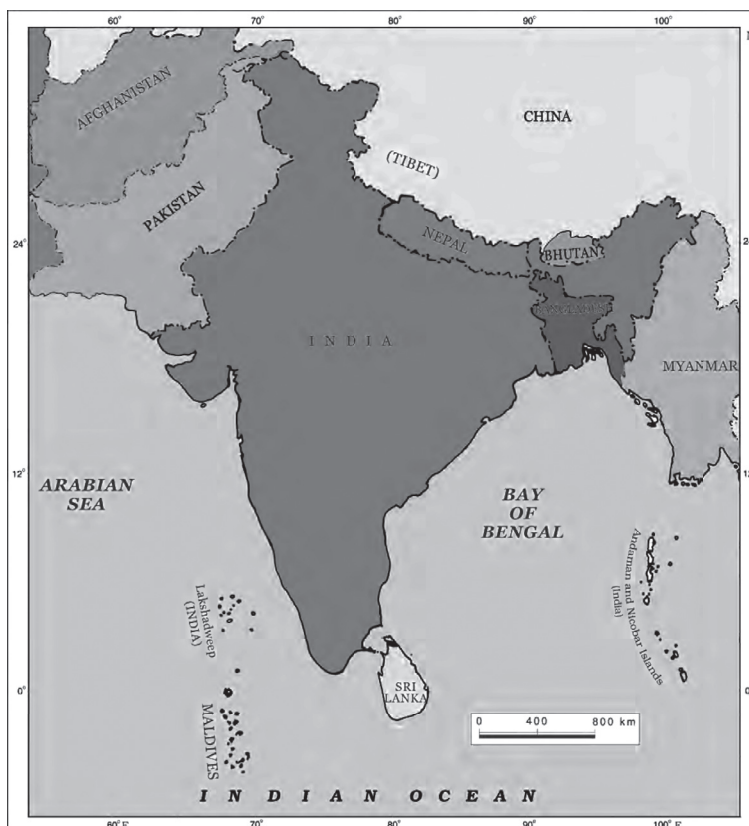


Figure 1.2: India and its Neighbours

India's geographical Extent

- ❖ India is located in the **northern hemisphere**. From south to north, the mainland of India extends between **8°4'N and 37°6'N latitudes** from **Kanyakumari to Karakoram** which is **about 3,200 km** and from east to west, India extends between **97°25'E to 68°7'E longitudes** from **Arunachal Pradesh to Kutch** which is **about 2,900 km** (Refer Figure 1.3).

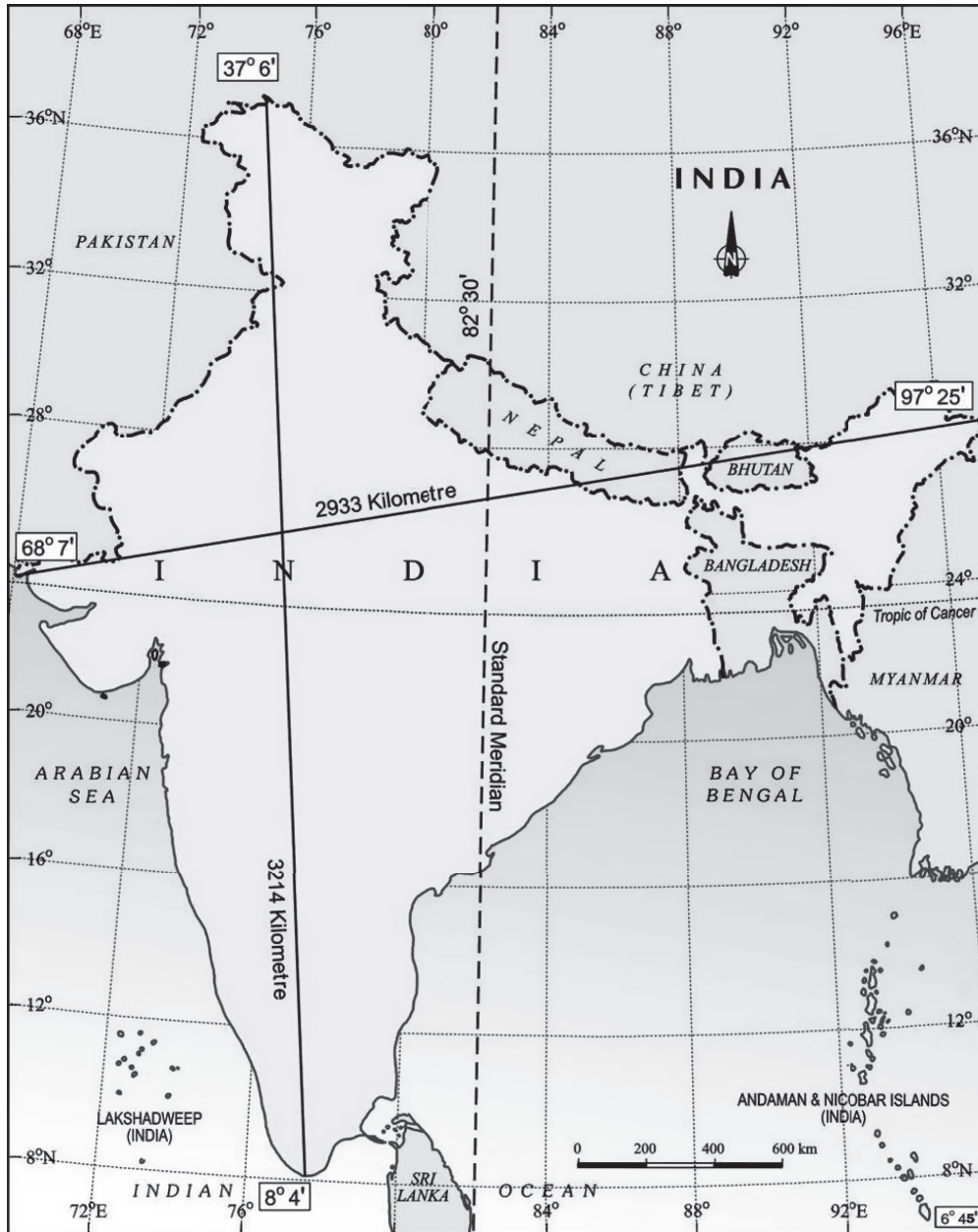


Figure 1.3: India: Longitudinal Extent and Standard Meridian

- ❖ To the southeast and southwest of the mainland lie the Andaman and Nicobar Islands and the Lakshadweep Islands in the Bay of Bengal and the Arabian Sea respectively.

Do You Know?

82°30'E has been selected as the Standard Meridian of India as it passes through the centre of India.

- ❖ Also, it has a land boundary of about 15,200 km and the total length of India's coastline (Including Andaman and Nicobar and Lakshadweep islands) is 7,516.6 km.
- ❖ India's territorial limit further extends towards the sea up to 12 nautical miles (about 22.2 km) from the coast.

Physical and Administrative Division of India

Physical Division

- ❖ India is marked by a diversity of physical features such as mountains, plateaus, plains, coasts and islands (Refer Figure 1.4).

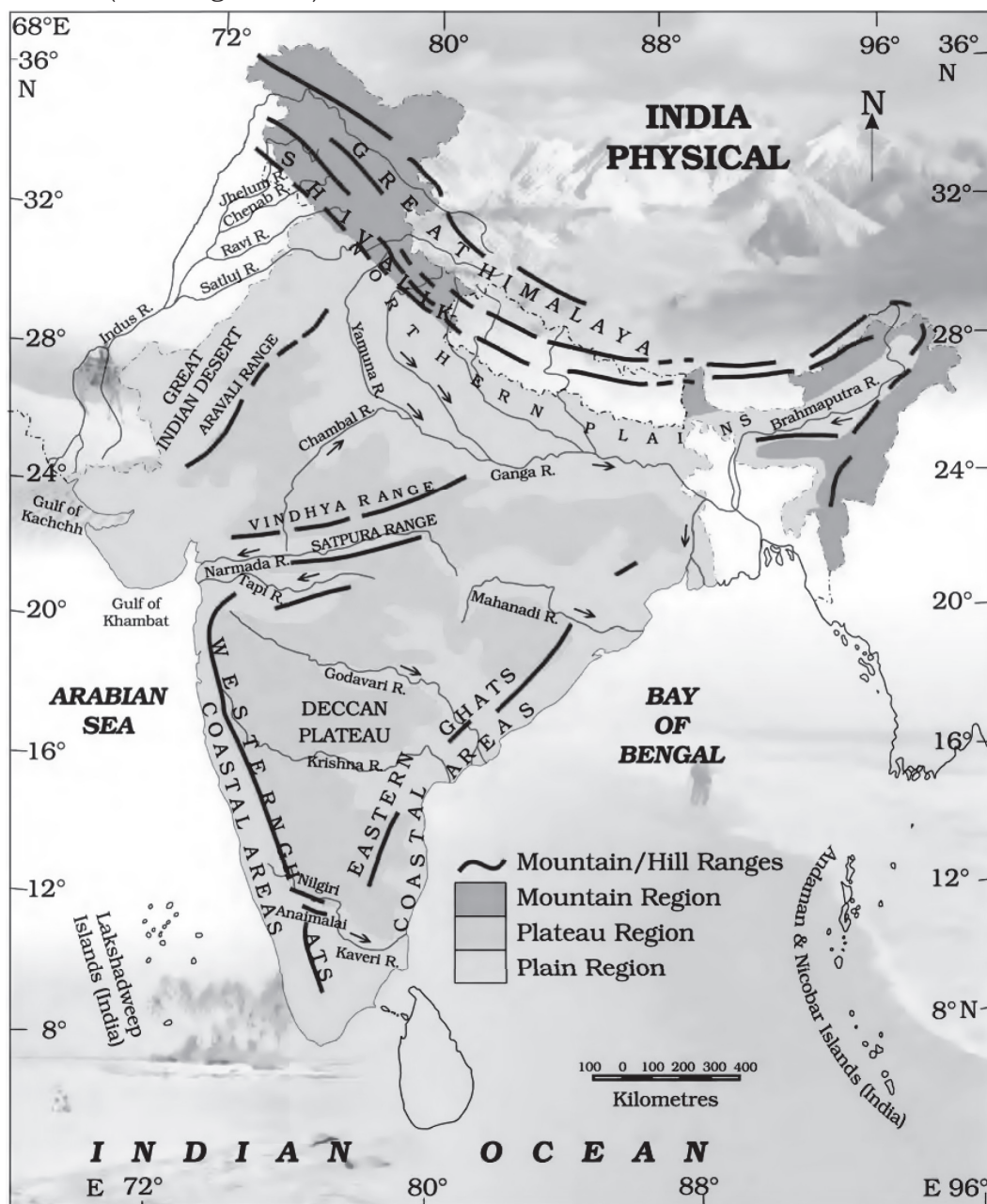


Figure 1.4: Physical Map of India

- ❖ Standing as sentinels in the north are the lofty snow-capped Himalayas. **Himalaya** mean ‘the abode of snow’.
- ❖ **The Himalayan mountains:** These are divided into three main parallel ranges. These are:
 - ❖ The northernmost is the **Great Himalayas or Himadri**. The world’s highest peaks are located in this range.
 - ❖ **The Middle Himalaya or Himachal lies to the south of Himadri**. Many popular hill stations are situated here.
 - ❖ The **Shiwalik is the southernmost range**.
- ❖ **Northern Indian Plain:** It lies to the south of the Himalayas. They are generally flat and formed by the alluvial deposits laid down by the rivers – the Indus, the Ganga, the Brahmaputra and their tributaries.
- ❖ **Great Indian desert:** It lies in the western part of India. It is a **dry, hot and sandy stretch of land**. It has very little vegetation.
- ❖ **Peninsular plateau:** It lies to the south of the northern plains. It is triangular in shape and the relief is highly uneven. This is a region with numerous hill ranges and valleys.
 - ❖ **Aravalli hills**, one of the oldest ranges of the world, border it on the northwest side.
 - ❖ The **Vindhyas and the Satpuras** are the important ranges. The rivers **Narmada and Tapi** flow through these ranges. These are west-flowing rivers that drain into the Arabian Sea.
 - ❖ **The Western Ghats or Sahyadris** border the plateau in the west and the Eastern Ghats provide the eastern boundary. While the Western Ghats are almost continuous, the **Eastern Ghats** are broken and uneven.
- ❖ **Coastal Plains:** To the West of the Western Ghats and the East of the Eastern Ghats lie the Coastal plains.
 - ❖ The **western coastal plains are very narrow** whereas **eastern Coastal plains are much broader**.
 - ❖ There are a number of east-flowing rivers. **The rivers Mahanadi, Godavari, Krishna and Kaveri** drain into the **Bay of Bengal**. These rivers have formed fertile deltas at their mouths.
 - ❖ **The Sunderban delta** is formed where the Ganga and Brahmaputra flow into the Bay of Bengal.
- ❖ **Islands:** *Two groups of islands also form part of India.*
 - ❖ **Lakshadweep Islands** are located in the Arabian Sea. These are **coral islands** located off the coast of Kerala.

Do You Know ?

The Ganga and the Brahmaputra form the world’s largest delta, the Sundarbans delta. The delta is triangular in shape. It is an area of land formed at the mouth of the river (Where rivers enter the sea, that point is called the mouth of the sea).

Do You Know ?

The southernmost point of the Indian Union– ‘Indira Point’ got submerged under the sea water in 2004 during the Tsunami.

Do You Know ?

- The Tropic of Cancer ($23^{\circ}30'N$) divides the country into two almost equal halves.
- The Southern half i.e. southern part of the country lies within the tropics
- The northern part lies in the subtropical zone or the warm temperate zone.

Do You Know ?

Corals are skeletons of tiny marine animals called Polyps. When the living polyps die, their skeletons are left. Other polyps grow on top of the hard skeleton which grows higher and higher, thus forming the coral islands.



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- ✧ **The Andaman and the Nicobar Islands** lie to the southeast of the Indian mainland in the Bay of Bengal.

Administrative division

- ✧ India is a vast country. For administrative purposes, the country is divided into **28 States and 8 Union Territories** (Refer Figure 1.5)
- ✧ New Delhi is the national capital.

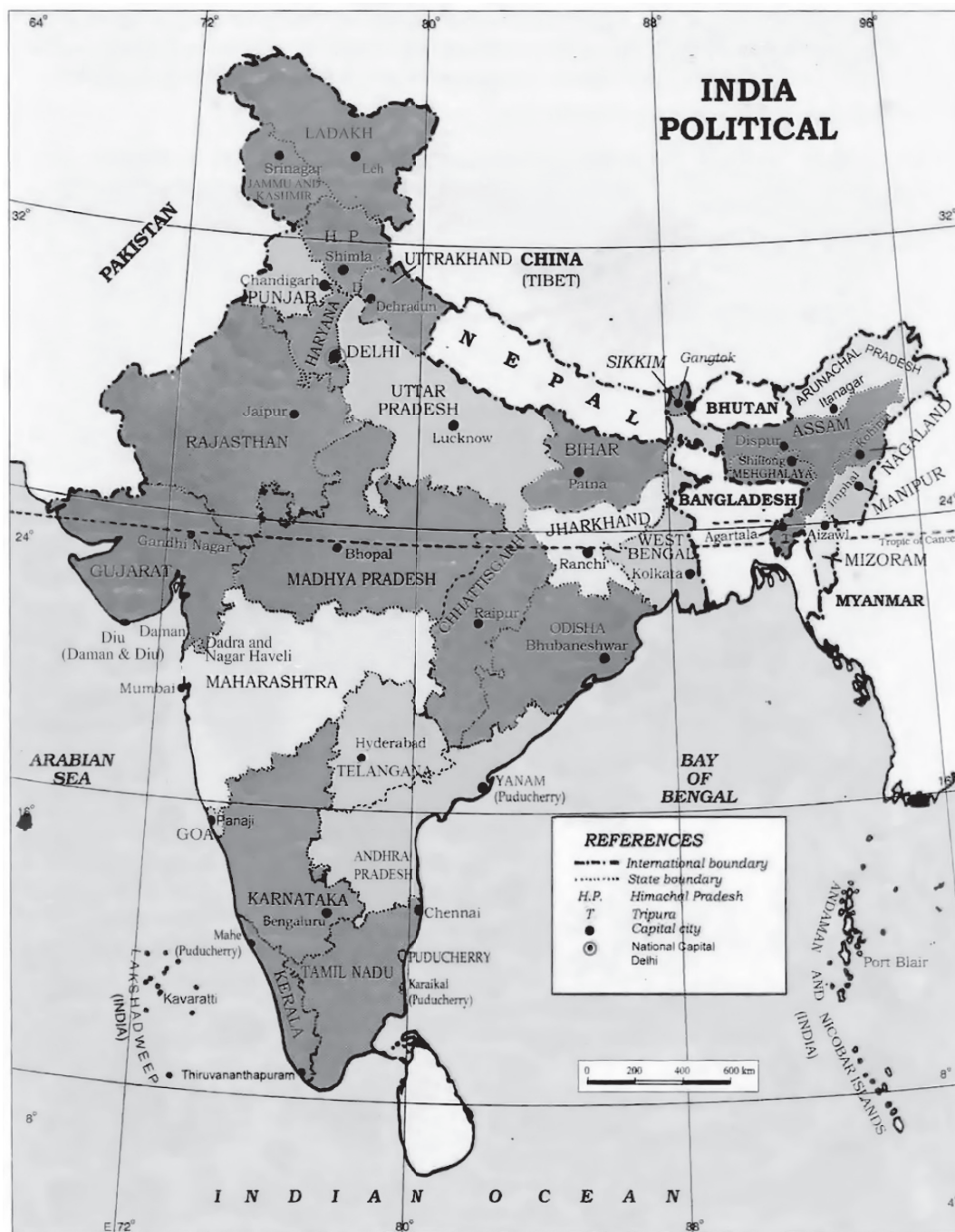


Figure 1.5: India Political Map

Conclusion

The geographical location of a country has a bearing on its climate, economic activities, culture as well as defence. In order to have a better understanding of one's own country, it is worthwhile to study the location and the advantages and disadvantages resulting from it. Further, major policies of India namely Economic policies, Energy policies, Foreign trade policies, and defence policies take into account the location of India.

Glossary:

- **Latitude:** Often called parallels or circles of latitude, latitudes are imaginary circles parallel to the equator.
- **Longitude:** Longitude specify the east-west position of a location on the globe.
- **Tropic of Cancer:** The Tropic of Cancer lies at $23^{\circ}30'$ north of the Equator and marks the most northerly latitude at which the sun can appear directly overhead at noon.
- **Indian Ocean littoral countries:** Countries having coastline in the Indian Ocean.
- **Standard Meridian:** It is a longitude that determines standard time for the country. Standard Meridian of India is 82 degrees 30 minutes and passes through Mirzapur (Uttar Pradesh)
- **Island:** It is a body of land that is surrounded by water.
- **Coastal Plain:** It is a flat, low-lying piece of land next to the ocean.
- **Plateau:** It is a flat, elevated landform that rises sharply above the surrounding area on at least one side.
- **Alluvial deposits:** These are very fine soils, brought by rivers and deposited in the river basins.
- **Tributary:** A river or stream which contributes its water to a main river by discharging it into the main river from either side.
- **Peninsula:** It is a piece of land that is surrounded by water on three sides.



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Structure and Physiography

Bibliography: This chapter encompasses the summary of **Chapter-2 - XI NCERT** (India Physical Environment), **Chapter 2 - IX NCERT** (Contemporary India.)

Introduction

The Earth has transformed over time due to endogenic and exogenic forces shaping its surface and subsurface features. For instance, The Indian plate, once located south of the equator and part of a larger entity including the Australian plate, fragmented over millions of years. The Australian plate moved southeastward, while the Indian plate moved northward, a movement that continues today. This resulted in the creation of the region's present geological features and divisions. In this chapter, we will study these geological and physiographic divisions of India.

Major Geological Division of India

India encompasses all major physical features found on Earth. The country's land exhibits remarkable **physical variations (Refer Figure 2.1)**. This northward shift of the Indian plate profoundly impacted the Indian subcontinent's physical environment, leading to the development of the following **geological divisions of India**.

- ❖ The Himalayas and other Peninsular Mountains,
- ❖ The Indo - Ganga - Brahmaputra Plain.
- ❖ The Peninsular Block

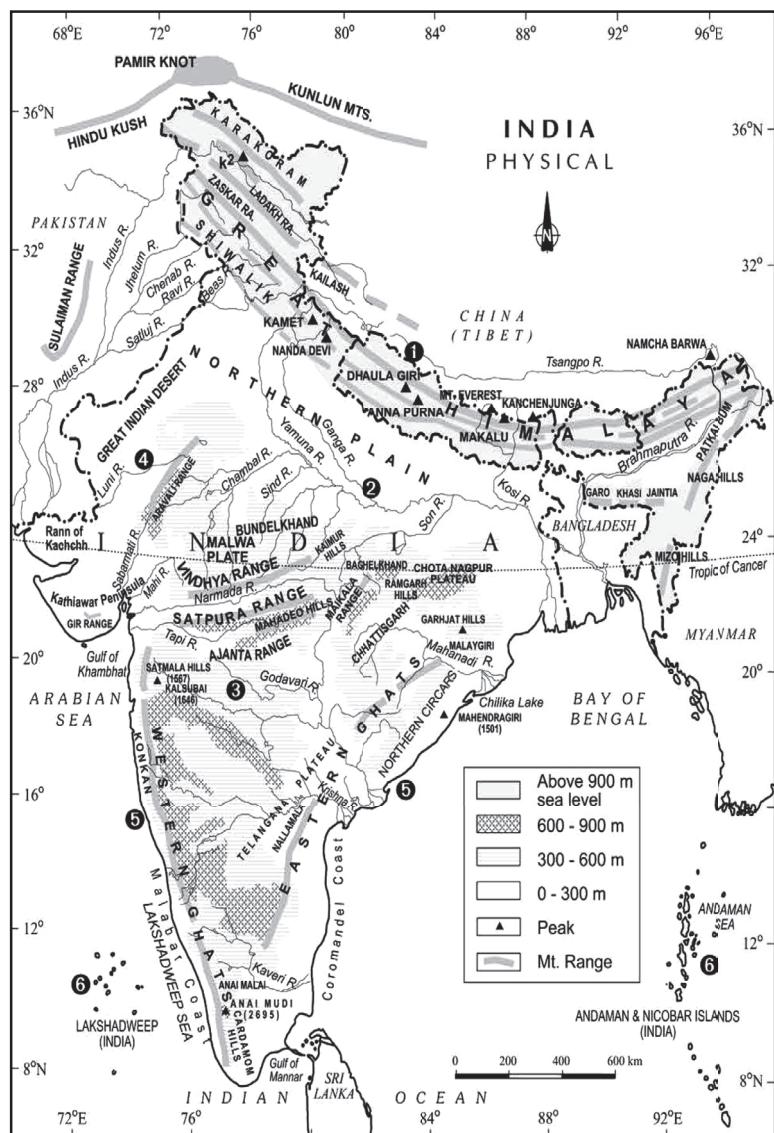


Figure 2.1: Physical Features of India



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The Himalayas and other Peninsular mountains

- ❖ **The Himalayas**, a geologically young and impressive fold mountain range, which stretches across India's northern borders.
- ❖ This mountain system extends from the Indus River in the west to the Brahmaputra River in the east, covering approximately 2,400 kilometers (**Refer Figure 2.2**).
- ❖ The Himalayas consist of **three main parallel ranges**: the Great Himalayas (**Himadri**), Lesser Himalayas (**Himachal**), and **Shiwaliks**, which we will study in subsequent sections.
- ❖ They are still subjected to the interplay of exogenic and endogenic forces, resulting in the development of faults, folds and the thrust plains.

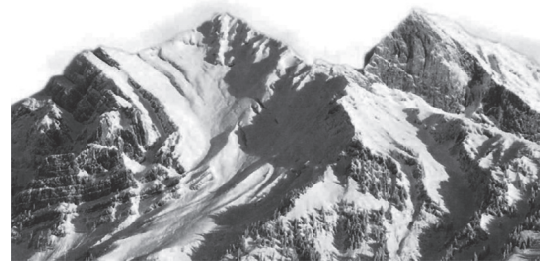


Figure 2.2: The Himalayas

Indo-Ganga-Brahmaputra Plain

- ❖ It is the third geological division of India consisting of vast plains formed by the Indus, Ganga, and Brahmaputra rivers.
- ❖ Originally, this area was a **geo-synclinal depression** that reached its peak development approximately 64 million years ago during the third phase of the Himalayan mountain formation.
- ❖ Over time, these plains have been gradually filled with sediments carried by the Himalayan and Peninsular rivers.
- ❖ The alluvial deposits in these plains have reached an average depth ranging from 1,000 to 2,000 meters.

The Peninsular Block

- ❖ It is defined by its northern boundary as an irregular line extending from Kachchh along the western flank of the Aravali Range near Delhi, and continuing roughly parallel to the Yamuna and the Ganga until reaching the Rajmahal Hills and the Ganga delta, also encompasses extensions like Karbi Anglong, Meghalaya, and Rajasthan.
- ❖ It is mainly composed of **ancient gneisses and granites**, this region has remained stable since the Cambrian period despite tectonic activity.
- ❖ As part of the larger Indo-Australian Plate, it has experienced various vertical movements and block faulting. Notable geological features include **rift valleys** like the Narmada, Tapi, and Mahanadi, along with the presence of Satpura block mountains and various **mountain ranges** such as Aravalli, Nallamala, Javadi, Velikonda, Pallikonda, and Mahendragiri.
- ❖ Additionally, the area's **east-flowing rivers** create shallow valleys and form significant deltas, such as those of the Mahanadi, Krishna, Kaveri, and Godavari. Tectonic activity has led to coastal changes, submerging parts of the western coast while sparing the original basement.

These geological variations significantly impact the physiography and relief of different regions in India, as geological and geomorphological processes shape the subcontinent's landscape.

Physiography of India

- ❖ Physiography, the **result of geological structure**, ongoing processes, and developmental stages, showcases India's diverse physical features.
- ❖ In the north, an expansive rugged landscape unfolds with a series of mountain ranges, diverse peaks, picturesque valleys, and deep gorges.
- ❖ Contrasting this, the south comprises stable table lands characterized by dissected plateaus, exposed rocks, and prominent scarps.
- ❖ Between these regions lies the extensive North Indian Plain, highlighting India's rich physiographic diversity.



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- ❖ Based on these macro variations, India can be divided into the **following physiographic divisions**:
 - ❖ The Northern and North-eastern Mountains
 - ❖ The Northern Plain
 - ❖ The Peninsular Plateau
 - ❖ The Indian Desert
 - ❖ The Coastal Plains
 - ❖ The Islands.

Northern and Northeastern Mountains

- ❖ The North and Northeastern Mountains encompass the Himalayas, a series of parallel mountain ranges. Notable among these are the Greater Himalayan range, including the **Great Himalayas** and the **Shiwalik**.

- ❖ These ranges generally run from northwest to southeast in northwestern India, while Darjeeling and Sikkim's Himalayas stretch east to west. In Arunachal Pradesh, they extend southwest to northwest, and in Nagaland, Manipur, and Mizoram, they align north-south.

- ❖ The Great Himalayan range, at approximately **2,500 km in length from east to west** and varying from **160-400 km in width from north to south**, acts as a formidable natural barrier separating the Indian subcontinent from Central and East Asian countries.

- ❖ The Himalayas along with other Peninsular mountains 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.

- ❖ The **Great Himalayas** are the loftiest, with peaks averaging around 6,000 meters and composed of granite. Prominent peaks are found here.

- ❖ **Lesser Himalayas**, rugged and composed of highly compressed rocks, include ranges like Pir Panjal, Dhauladhar, and Mahabharat. They encompass well-known valleys like Kashmir Valley in U.T of Jammu and Kashmir and Kullu Valley Himachal Pradesh.

- ❖ The outermost range, the **Shiwaliks**, has an altitude ranging from 900 to 1100 meters and is composed of sediments brought by rivers from the main Himalayan ranges to the north. These valleys are covered in thick gravel and alluvium.

- ❖ **Longitudinal valleys** situated between the Lesser Himalayas and Shiwaliks are known as **Duns**. Examples include Dehradun, Kotli Dun, and Patli Dun.

- ❖ The Himalayas are divided into regions based on river valleys, including **Punjab Himalaya, Kumaon Himalayas, Nepal Himalayas, and Assam Himalayas**.

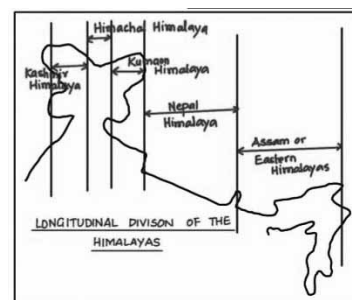
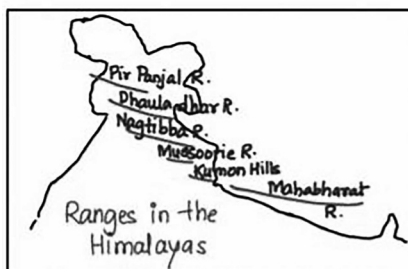
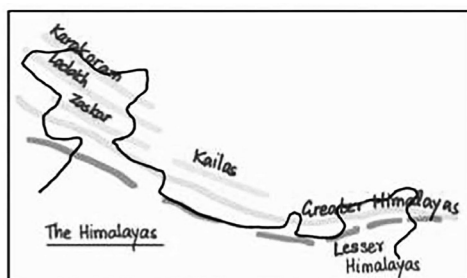
Peak	Country	Height in metres
Mt. Everest	Nepal	8848
Kanchenjunga	India	8598
Makalu	Nepal	8481
Dhaulagiri	Nepal	8172
Nanga Parbat	India	8126
Annapurna	Nepal	8078
Nanda Devi	India	7817
Kamet	India	7756
Namcha Barwa	India	7756
Gurla Mandhata	Nepal	7728

Figure 2.3: Some of the Highest Peaks of the Himalayas

POINTS TO PONDER

The Himalayas exhibit a pattern when we move from west to east. The peaks start getting higher and the horizontal distance between the three Himalayan ranges i.e. Upper, middle and lower start diminishing and the distinction among the three starts fading away. Can you find out the reason for the same?





- ❖ The eastern boundary of the Himalayas is marked by the Brahmaputra River, from where these extend further as the **Purvanchal or Eastern hills**.
- ❖ Beyond its physical presence, the Himalayas also influence climate, drainage, and cultural distinctions.

The Northern Plains

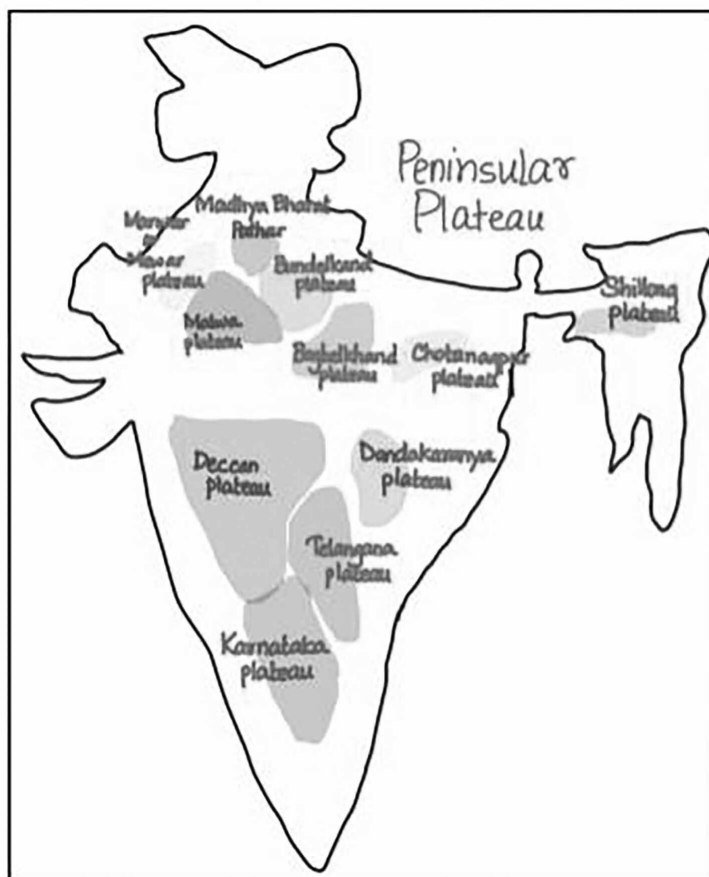
- ❖ The Northern Plain, a vast alluvial region, results from the convergence **of three major river systems**: the Indus, the Ganga, and the Brahmaputra, along with their tributaries.
- ❖ Stretching around 3,200 kilometres from east to west and varying in width from 150-300 kilometres, this fertile plain is rich in **alluvial soil**. (Refer Figure 2.4)
- ❖ Over millions of years, sediment deposition at the base of the Himalayas created this highly productive agricultural area, covering approximately 7 lakh sq. km and supporting a dense population.
- ❖ The Northern Plain features diverse zones, including **Bhabar** (along the Shiwalik foothills), **Tarai** (marshy and swampy), and **the alluvial plains**.
- ❖ Within the alluvial plains, two categories are notable: **Khadar** (younger floodplain deposits) and **Bhangar** (older alluvium deposits).
- ❖ The region exhibits various relief features, such as sandbars, meanders, oxbow lakes, and braided channels formed by the rivers.
- ❖ A distinctive geographical feature is the '**Doab**,' representing fertile land between two rivers. The 'Punjab' region, derived from '**Punj**' (five) and '**ab**' (water), signifies the presence of five major rivers.
- ❖ **Majuli**, located in the Brahmaputra River, stands as the world's largest inhabited riverine island.
- ❖ **Dudhwa National Park** is situated in the Terai region, a swampy area characterized by rich natural vegetation and diverse wildlife.
- ❖ **Dhubri**, located in Assam, marks a significant point in the course of the Brahmaputra River. Here, the river takes a nearly 90° southward turn before entering Bangladesh.
- ❖ The Brahmaputra plains exhibit riverine islands, sandbars, and periodic floods, forming braided streams and deltas.
- ❖ Haryana and Delhi serve as a **water divide** between the Indus and Ganga river systems.
- ❖ The Brahmaputra River flows from northeast to southwest, impacting the geography of the Northern Plain.
- ❖ These fertile alluvial plains support a large population due to their agricultural productivity.



Figure 2.4: The Northern Plains

Peninsular Plateau

- ❖ The Peninsular Plateau is **an ancient tableland** composed of crystalline, igneous, and metamorphic rocks.
- ❖ Rising from the height of 150 m above the river plains up to an elevation of 600-900 m is the irregular triangle known as the Peninsular Plateau.
- ❖ It is one of the oldest and the most stable landmass of India with a general elevation of the plateau from the west to the east, which can be seen in the pattern of the flow of rivers.
- ❖ It was formed due to the breaking and drifting of the **Gondwanaland**, making it one of the oldest land masses.
- ❖ 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 along with an extension of this seen in the northeast, in the form of Shillong and Karbi-Anglong plateau.



- ❖ It is made up of a series of **patland plateaus** like the **Hazaribagh plateau**, the **Palamu plateau**, the **Ranchi plateau**, the **Malwa plateau**, the **Coimbatore plateau** and the **Karnataka plateau**, etc.
- ❖ A few notable features of this region are tors, block mountains, rift valleys, spurs, bare rocky structures, series of hummocky hills and wall-like quartzite dykes which are natural sites for water storage.
- ❖ The western and northwestern part of the plateau is marked by the presence of black soil. It has gone through recurrent phases of upliftment and submergence along with crustal faulting and fractures. For example, Bhima fault which experiences recurrent seismic activity.
- ❖ These features have diversified the relief of the plateau. Some of them, like the northwest complex reliefs, gorges and 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: **Deccan Plateau**, **Central Highland**, and **N-E Plateau**.

The Deccan Plateau

The Deccan Plateau is surrounded by **geographical features**:

- ❖ Western Ghats in the west
- ❖ Eastern Ghats in the east
- ❖ Satpura, Maikal range, and Mahadeo hills in the north.

- ❖ The **Western Ghats** are known by various local names, including **Sahyadri** in Maharashtra, **Nilgiri Hills** in Karnataka and Tamil Nadu, and **Anaimalai Hills** and **Cardamom Hills** in Kerala.
- ❖ The Western Ghats **are higher in elevation and more continuous** compared to the Eastern Ghats, with an average elevation of about 1,500 meters, increasing from north to south.
- ❖ Notable peaks in the Western Ghats include **Anamudi** (2,695 meters) on the Anaimalai Hills and **Dodabetta** (2,637 meters) on the Nilgiri Hills. Anamudi is the highest peak on the Peninsular plateau.
- ❖ Many of the major Peninsular rivers originate in the Western Ghats including Godavari, Krishna, Kaveri, Mahanadi etc.
- ❖ The **Eastern Ghats** consist of discontinuous and low hills, which have been significantly eroded by above mentioned rivers.
- ❖ Some important hill ranges within the Eastern Ghats include the Javadi Hills, Palconda Range, Nallamala Hills, and **Mahendragiri Hills** (the highest peak in the Eastern Ghats). Shevroy Hills and the Javadi Hills are located to the southeast of the Eastern Ghats.
- ❖ The **Eastern and Western Ghats converge** at the **Nilgiri Hills**.

POINTS TO PONDER

The Deccan Traps are a distinct landscape found in and around Maharashtra region. Find out the unique characteristics of the Traps and the reason for its formation. Can you link the reason with the resources available in this area, particularly, the Black soil.



The Central Highlands

- ❖ They are bounded by the **Aravalli range** to the west.
- ❖ **Satpura range**, with plateaus at 600-900 m elevation, forms the northern boundary of the Deccan plateau.
- ❖ These highlands are relict mountains, highly denuded, and exist as disjointed ranges.
- ❖ The Peninsular plateau extends to Jaisalmer in the west, covered by sand ridges and crescent-shaped sand dunes (**barchans**).
- ❖ Metamorphic processes have shaped the region, evidenced by rocks like marble, slate, and gneiss.
- ❖ Elevation generally ranges from 700-1,000 m above sea level, sloping north and northeast.
- ❖ Many tributaries of the **Yamuna River** originate in the **Vindhyan and Kaimur ranges**.
- ❖ The Aravalli range in the west gives rise to the Banas, a significant tributary of the Chambal River.
- ❖ An eastern extension, the **Rajmahal Hills**, is followed by the mineral-rich **Chotanagpur plateau** to the south.

The Northeastern Plateau

- ❖ It is an **extension of the main Peninsular plateau**.
- ❖ It was formed due to the north-eastward movement of the Indian plate during the Himalayan formation, resulting in a significant fault between the Rajmahal hills and the Meghalaya plateau.
- ❖ This depression(fault) was later filled by river deposition, leading to the detachment of the Meghalaya and **Karbi Anglong plateau** from the main Peninsular Block.
- ❖ The Meghalaya plateau is subdivided into three regions: The **Garo Hills, the Khasi Hills, and the Jaintia Hills** are all named after local tribal groups.
- ❖ An extension of this plateau is observed in the Karbi Anglong hills of Assam.



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- ❖ Similar to the Chotanagpur plateau, the Meghalaya plateau is rich in mineral resources, including coal, iron ore, sillimanite, limestone, and uranium.
- ❖ This region receives maximum rainfall from the southwest monsoon, resulting in a highly eroded surface.
- ❖ **Cherrapunji**, in the Meghalaya plateau, is known for its bare rocky surface without a permanent vegetation cover due to heavy rainfall.

The Indian Desert

- ❖ Located northwest of the Aravalli hills, it is characterized by undulating topography with longitudinal dunes, barchans and sandy plains. **Barchans**, which are crescent-shaped dunes, cover extensive areas.
- ❖ The desert area receives minimal rainfall, averaging below 150 mm per year, resulting in an arid climate and sparse vegetation. (Refer **Figure 2.5**)



Figure 2.5: The Indian Desert

- ❖ Also known as **Marusthali** due to its distinctive features.
- ❖ It is believed to have been underwater during the **Mesozoic** era, evidence of which has been found in wood fossils in **Akal** and marine deposits near **Brahmsar** (estimated to be 180 million years old).
- ❖ While the underlying rock structure is an extension of the Peninsular plateau, surface features have been shaped by physical weathering and wind actions.
- ❖ Some of the prominent desert features include **mushroom rocks**, shifting dunes, and oases (primarily in the southern part).
- ❖ The desert can be divided into northern and southern parts based on their orientation, sloping towards Sindh and the Rann of Kachchh, respectively.
- ❖ Streams briefly appear during the rainy season but often disappear into the desert sands as they lack sufficient water to reach the sea. Rivers in the region are mostly **ephemeral**, with the **Luni** River being the largest in the region.
- ❖ Low precipitation and high evaporation create a water deficit region.
- ❖ Some streams vanish into the sand and exhibit inland drainage by joining lakes or playas.
- ❖ Lakes and **playas** have brackish water, a major source of salt production.

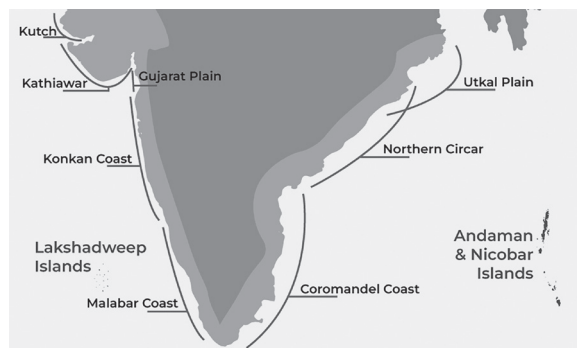
Coastal Plains

India's extensive coastline can be broadly divided into **two main regions**: the western coastal plains and the eastern coastal plains.

Western Coastal Plains

- ❖ These plains are submerged coastal areas and have natural conditions favorable for port development. The western coastal plains consist of the **Konkan, Kannad Plain, and Malabar** coast.
- ❖ Notably, the ancient city of **Dwarka** on the west coast is submerged.

- ❖ Key **natural ports** along this coast include Kandla, Mazagaon, JLN Port, Nhava Sheva, Marmagao, Mangalore, and Cochin.
- ❖ Geographically, it extends from the Gujarat coast in the north to the Kerala coast in the south.
- ❖ Divisions include the **Kachchh and Kathiawar** coasts in Gujarat, **the Konkan** coast in Maharashtra, the **Goan** coast, and the **Malabar** coast in Karnataka and Kerala.
- ❖ The western coastal plains are narrow in the middle and broaden up towards the north and south.
- ❖ Rivers in this region do not form deltas, but the Malabar coast is known for its "**Kayals**" (backwaters) used for fishing and tourism.
- ❖ The Nehru Trophy Vallamkali (boat race) is a famous event held in Punnamada Kayal in Kerala.



Eastern Coastal Plains

- ❖ These plains are an example of an **emergent coast** and are broader than their western counterparts. The eastern coastal plains include the **Northern Circar and Coromandel Coast** regions.
- ❖ Well-developed deltas are formed by rivers flowing eastward into the Bay of Bengal, including the **Mahanadi, Godavari, Krishna, and Kaveri** deltas.
- ❖ **Lake Chilika** is a significant feature along the eastern coast.
- ❖ Due to its emergent nature, there are fewer ports and harbours along this coast. The continental shelf here extends up to 500 km into the sea, making it challenging for the development of major **ports and harbours**.

Do You Know?

Chilika Lake is the largest salt water lake in India. It lies in the state of Odisha, to the south of the Mahanadi delta.

The Islands

India has **two major island groups**, one in the Bay of Bengal and the other in the Arabian Sea.

Bay of Bengal Islands

- ❖ Comprising approximately 572 islands/islets, located between 6°N-14°N and 92°E -94°E.
- ❖ Divided into the **Andaman Islands in the north and the Nicobar Islands in the south**, separated by the **Ten Degree Channel**.
- ❖ These islands are believed to be an elevated portion of submarine mountains, with some smaller islands being volcanic. (Refer Figure 2.6)
- ❖ Notable features include **Barren Island**, the only active volcano in India, and various mountain peaks like **Saddle Peak** (738 m, North Andaman), **Mount Diavolo** (515 m, Middle Andaman), **Mount Koyob** (460 m, South Andaman), and **Mount Thuiller** (642 m, Great Nicobar).
- ❖ The coastal areas have coral deposits and beautiful beaches.
- ❖ These islands experience convectional rainfall and have equatorial vegetation.



Figure 2.6: The Islands

- ❖ The **2004 Indian Ocean tsunami** was a devastating natural calamity that affected these islands, among other areas, causing significant damage.

Arabian Sea Islands

- ❖ Includes **Lakshadweep and Minicoy** islands, located between 8°N-12°N and 71°E -74°E, situated 280 km-480 km off the Kerala coast.
- ❖ Formerly known as **Laccadive, Minicoy, and Amindive**, these islands were renamed Lakshadweep in 1973.
- ❖ These islands are built entirely from **coral deposits**, with about 36 islands, of which 11 are inhabited. Among these, Minicoy is the largest island.
- ❖ These are divided into northern islands like **Amini Island** and southern islands like **Canannore Island**.
- ❖ The eastern seaboard has storm beaches with pebbles, shingles, cobbles, and boulders.
- ❖ These islands play a significant role in India's geography, with unique flora and fauna and strategic importance. They have diverse ecosystems and equatorial climates.

Coral polyps are short-lived microscopic organisms, which live in colonies. They flourish in shallow, mud-free and warm waters. They secrete calcium carbonate and their skeletons form coral deposits in the form of reefs. They are mainly of three kinds: barrier reefs, fringing reefs and atolls. The Great Barrier Reef of Australia is a good example of the first kind of coral reef. Atolls are circular or horseshoe-shaped coral reefs.

Significance of India's Physical Features

- ❖ India's diverse physiographic units, each with its unique characteristics, contribute to the nation's natural wealth.
- ❖ The **mountains** serve as primary sources of water and forest resources, vital for the country's well-being.
- ❖ The **northern plains**, with their fertile soil, have long been the granaries of India and the foundation of early civilizations.
- ❖ The **plateau**, rich in minerals, has played a pivotal role in the nation's industrialization.
- ❖ **Coastal regions** and island groups offer opportunities for fishing and port activities, enhancing India's maritime potential.

Conclusion

A detailed account of the different physiographic units we studied above highlights the unique features of each region. These regions complement one another, enriching India's abundant resources. India's multifaceted physical features hold immense potential for future development, encompassing agriculture, industry, and maritime endeavours.

Glossary:

- **Mushroom rocks:** They are the erosional landforms of the arid or desert region. The erosive power of wind becomes very high at a certain height from the ground level. The resistant rocks take the shape of mushrooms having a large top and a small neck.
- **Ephemeral:** An ephemeral stream is that which only exists following precipitation. They mostly receive water in the rainy season.





Drainage System

Bibliography: This chapter encompasses the summary of **Chapter 3** of Class XI (India Physical Environment) **Chapter 3** of Class IX (Contemporary India) of NCERT.

Introduction

The term "drainage" refers to the **movement of water through well-defined channels**, and the collective system of these channels is referred to as a **"drainage system"**. The specific pattern of drainage in a given area is a result of various factors, including the geological history of the region, the type and composition of rocks, the topographical features, the slope of the land, the volume of water flowing through, and the regularity of the flow over time.

Difference Between River Basin and Watershed

- ❖ A river serves as the drainage outlet for water collected from a specific region known as its **"catchment area"**.
- ❖ An area encompassing a river and its tributaries, which collectively contribute to the river's water flow, is termed a **"drainage basin"**.
- ❖ The demarcation line that separates one drainage basin from another is referred to as the **"watershed"**.
- ❖ In practice, catchments of larger rivers are commonly referred to as **"river basins"**, whereas those of smaller rivulets and rills are often termed **"watersheds"**.
- ❖ Any elevated area, such as a mountain or an upland, separates two drainage basins. Such an upland is known as a **water divide** (Refer Figure 3.1).
- ❖ River basins generally cover larger geographic areas compared to watersheds, which are relatively smaller.
- ❖ Both river basins and watersheds share a fundamental characteristic: they exhibit unity within themselves. What occurs in one part of a river basin or watershed has a direct impact on other parts and on the entire unit.
- ❖ This interconnectedness makes them **ideal units for micro, meso, or macro-level planning and management**, as actions in one area can have far-reaching consequences throughout the entire basin or watershed.

Do you know?

The world's largest drainage basin is the Amazon river.

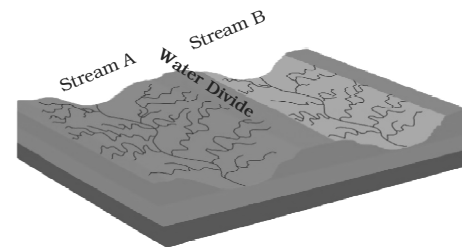


Figure 3.1: Water Divide



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Important Drainage Patterns

- **Dendritic:** The drainage pattern resembling the branches of a tree is known as “dendritic”, the examples of which are the rivers of the northern plain.
- **Radial:** When the rivers originate from a hill and flow in all directions, the drainage pattern is known as ‘radial’. The rivers originating from the Amarkantak range present a good example of it.
- **Trellis:** 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’.
- **Centripetal:** When the rivers discharge their waters from all directions in a lake or depression, the pattern is known as ‘centripetal’.

The Indian Drainage System

The Indian drainage system can be distinguished on the basis of discharge of water, size of watershed and on the basis of origin i.e. Himalayan or Peninsular (Refer Figure 3.2).

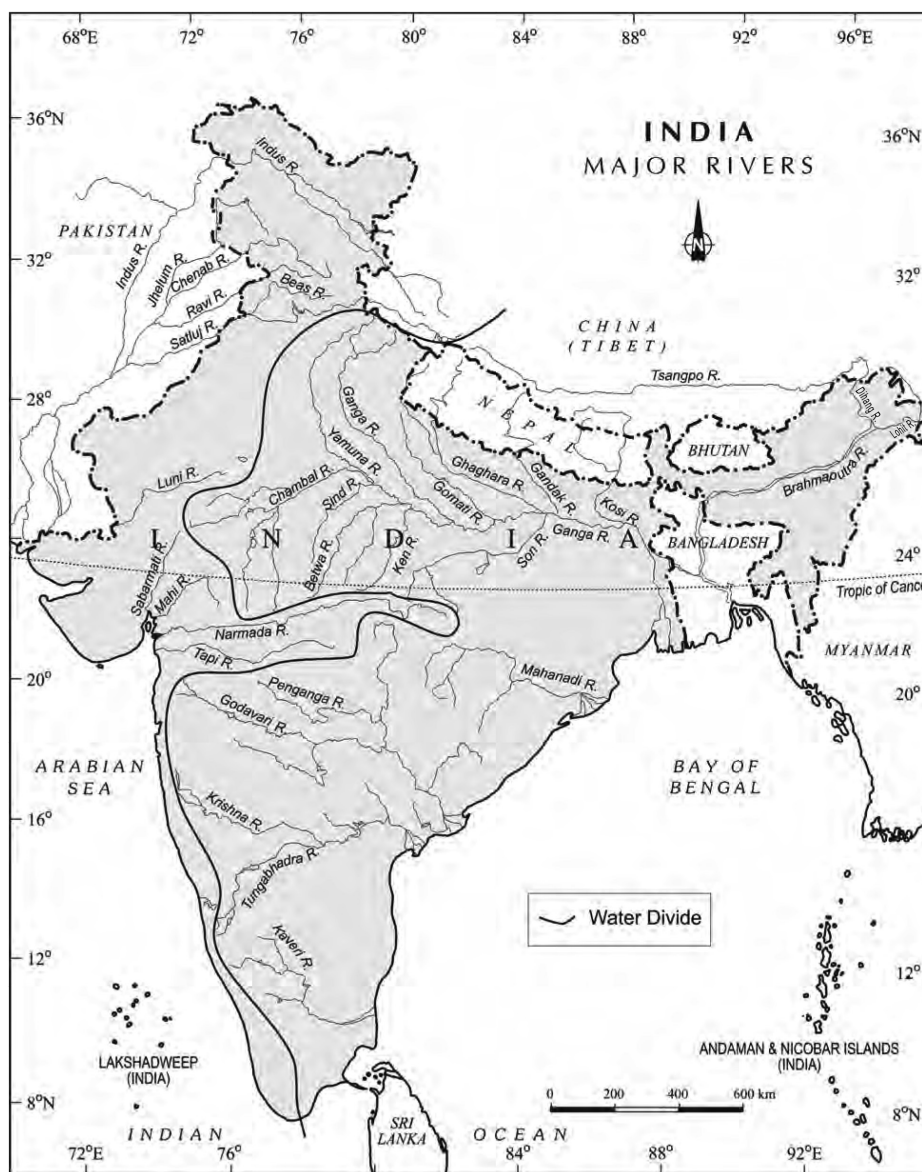


Figure 3.2: Major River of India

On the Basis of Discharge of Water (Orientations to the Sea)

The Indian drainage system can be grouped into two, the Arabian Sea drainage and the Bay of Bengal drainage. Both the drainage systems are separated through the Delhi ridge, the Aravallis and the Sahyadris.

- ❖ **The Arabian Sea drainage:** Nearly **23 percent**, comprising the **Indus**, the **Narmada**, the **Tapi**, the **Mahi** and the **Periyar** systems, and discharging their waters in the Arabian Sea.
- ❖ **The Bay of Bengal drainage:** **77 percent** of the drainage area, consisting of the **Ganga**, the **Brahmaputra**, the **Mahanadi**, the **Krishna**, etc. and is oriented towards the Bay of Bengal.

Do you know?

- Many rivers have their sources in the Himalayas and discharge their waters either in the Bay of Bengal or in the Arabian Sea.
- Large rivers flowing on the Peninsular plateau have their origin in the Western Ghats and discharge their waters in the Bay of Bengal.
- The Narmada and Tapi are two large rivers which are exceptions. They along with many small rivers discharge their waters in the Arabian Sea.

On the Basis of the Size of the Watershed

On the basis of the size of the watershed, the drainage basins of India are grouped into three categories:

- ❖ **Major river basins:** These are 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:** These are river basins with catchment areas between 2,000-20,000 sq. km incorporating 44 river basins such as the Kalindi, the Periyar, the Meghna, etc.
- ❖ **Minor river basins:** These are river basins with catchment areas of less than 2,000 sq. km including a fairly good number of rivers flowing in the area of low rainfall.

On the Basis of the Mode of Origin

On the basis of the mode of origin, nature and characteristics, the Indian drainage may also be classified into the Himalayan drainage and the Peninsular drainage.

Let us first understand the Himalayan drainage system.

The Himalayan Drainage

Characteristics of the Himalayan drainage system

- ❖ The Himalayan drainage system primarily comprises the basins of three major rivers: the **Ganga**, the **Indus**, and the **Brahmaputra**.
- ❖ These rivers exhibit a **perennial flow** as they are **nourished by both melting of snow and precipitation**.
- ❖ Their journey through the Himalayas is marked by the **creation of gorges**, carved out through the simultaneous processes of **erosion** and the **Himalayan uplift (Refer Figure 3.3)**.
- ❖ Alongside the deep gorges, these rivers also form **V-shaped valleys**, **turbulent rapids**, and **waterfalls** during their course through the mountainous terrain.
- ❖ As they transition into the plains, they undergo further transformations, resulting in **depositional features** like **flat valleys**, **ox-bow lakes**, **flood plains**, **braided channels**, and **deltas** formed near their respective river mouths. (Refer Figure 3.4)



Figure 3.3: A Gorge

- ❖ **In the Himalayan reaches**, the course of these rivers is highly **winding and tortuous**, but as they flow over the plains, they exhibit a **pronounced tendency to meander and frequently shift their courses**. This dynamic interaction with the landscape characterises the **ever-changing nature of the Himalayan drainage system**.
- ❖ **River Kosi**, also known as the '**sorrow of Bihar**', has been notorious for frequently changing its course. The Kosi **brings a huge quantity of sediments** from its upper reaches and **deposits it in the plains**. The course gets blocked, and consequently, the **river changes its course**.

Evolution of the Himalayan Drainage

- ❖ The evolution of the Himalayan rivers has been a subject of debate, but geologists have put forward a theory that suggests a **significant ancient river known as the Shiwalik or Indo-Brahma** once flowed along the entire longitudinal extent of the Himalayas, stretching **from Assam to Punjab and then onward to Sindh**.
- ❖ This massive river is believed to have **discharged into the Gulf of Sind near lower Punjab** during the Miocene period, which occurred approximately **5-24 million years ago**.
- ❖ Evidence supporting this theory includes the remarkable **continuity of the Shiwalik and its deposits**, which consist of sands, silt, clay, boulders, its lacustrine origin and alluvial nature.
- ❖ Over time, it is postulated that the Indo-Brahma river underwent a process of dismemberment, resulting in the formation of three distinct drainage systems:
 - ❖ The **Indus and its five tributaries** in the western part;
 - ❖ The **Ganga and its Himalayan tributaries** in the central part; and
 - ❖ The stretch of the **Brahmaputra in Assam and its Himalayan tributaries** in the eastern part.
- ❖ This dismemberment is thought to have occurred due to geological events during the Pleistocene epoch. The **uplift of the Potwar Plateau (Delhi Ridge)** in the western Himalayas is believed to have **acted as a water divide, dividing the Indus and Ganga drainage systems**.
- ❖ Likewise, the **mid-Pleistocene downthrusting of the Malda gap** area, situated between the Rajmahal hills and the Meghalaya plateau, **diverted the Ganga and Brahmaputra systems toward the Bay of Bengal**.

The Indus River System

- ❖ The Indus River basin is one of the largest river basins of the world, encompassing an area of **11,65,000 square km**, with **321,289 square km falling within the boundaries of India**.
- ❖ This river stretches over a **total length of 2,880 km**, of which **1,114 km are located in India**.
- ❖ It is also known as the **Sindhu**, represents the westernmost of the Himalayan rivers in India.

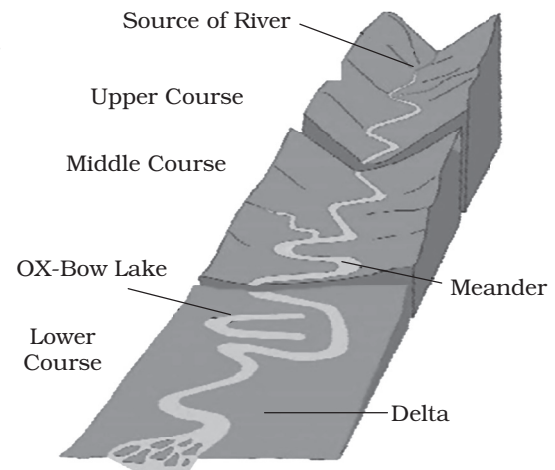


Figure 3.4: Some features made by rivers



- ❖ The Indus River **originates from a glacier near Bokhar Chu**, located at approximately **31°15' N latitude and 81°40' E longitude**, in the Tibetan region.

Course of the Indus river

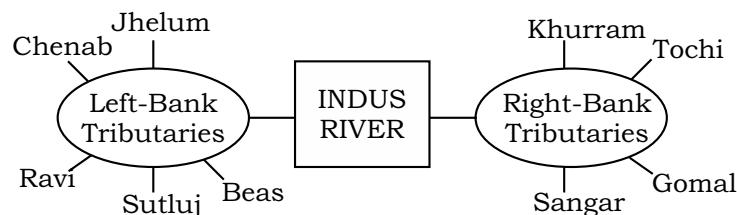
- ❖ Its **source lies at an altitude of 4,164 metres** within the Kailash Mountain range. In the Tibetan region, it is referred to as '**Singi Khamban**' or **Lion's mouth**.
- ❖ After commencing its journey in the northwest direction, situated between the Ladakh and Zaskar ranges, it passes through regions like Ladakh and Baltistan.
- ❖ The river courses through the Ladakh range, forming a **dramatic gorge near Gilgit** in the union territory of Jammu and Kashmir, India.
- ❖ Eventually, it **crosses into Pakistan near Chilas**, within the **Dardistan region**.
- ❖ This river's remarkable journey through diverse landscapes is a significant aspect of the geography and hydrology of the region.
- ❖ The river flows southward and receives '**Panjnad**' a little above Mithankot. The Panjnad is the name given to the five rivers of Punjab, namely the **Satluj, the Beas, the Ravi, the Chenab and the Jhelum**.
- ❖ It finally discharges into the Arabian Sea, east of Karachi. The Indus flows in India only through **Jammu and Kashmir**.

Do you know?

According to the regulations of the Indus Water Treaty (1960), India can use only 20 percent of the total water carried by the Indus river system. This water is used for irrigation in Punjab, Haryana and the southern and the western parts of Rajasthan

Tributaries of the Indus river

- ❖ The Indus River system is characterised by several significant tributaries, each with its unique origin and course.
- ❖ It receives a number of Himalayan tributaries such as the **Shyok, the Gilgit, the Zaskar, the Hunza, the Nubra, the Shigar, the Gasting and the Dras**.
- ❖ It finally emerges from the hills near Attock where it receives the **Kabul river** on its right bank.
- ❖ The other important tributaries joining the right bank of the Indus are the **Khurram, the Tochi, the Gomai, and the Sangar**. They all **originate in the Sulaiman ranges**.



Some of the major **left bank tributaries** are:

Jhelum

- ❖ The Jhelum, a crucial tributary of the Indus, **begins at a spring in Verinag**, located at the southeastern part of the Kashmir Valley, near the foot of the **Pir Panjal mountain range**.
- ❖ It **traverses through Srinagar** and the **Wular Lake** before **crossing into Pakistan** through a deep, narrow gorge.
- ❖ Ultimately, it **meets the Chenab near Jhang in Pakistan**.

Chenab

- ❖ The Chenab is the **largest tributary of the Indus**.
- ❖ It is formed by the confluence of two streams, the **Chandra** and the **Bhaga**, near Tandi, situated close to Keylong in Himachal Pradesh. It is also referred to as **Chandrabhaga**.
- ❖ This river flows for approximately 1,180 kilometres before entering Pakistan.

Ravi

- ❖ The Ravi **originates in the Kullu hills** of Himachal Pradesh, west of the Rohtang Pass.
- ❖ It **flows through the Chamba valley** before crossing into Pakistan, where it **joins the Chenab near Sarai Sidhu**.
- ❖ During its course, the Ravi drains the region between the southeastern part of the Pir Panjal and the Dhauladhar ranges.

Beas

- ❖ The Beas river is yet another important tributary **originating from the Beas Kund near the Rohtang Pass**, at an elevation of 4,000 metres above sea level.
- ❖ It **flows through the Kullu valley**, forming gorges at Kati and Largi within the Dhauladhar range.
- ❖ Upon entering the Punjab plains, it **merges with the Satluj River near Harike**.

Satluj

- ❖ The Satluj River has its source in the '**Raksas Tal**' near **Mansarovar, Tibet**, at an altitude of 4,555 metres. It is known as **Langchen Khambab in Tibet**.
- ❖ The river **flows nearly parallel to the Indus for around 400 kilometres before entering India**.
- ❖ Then it **emerges from a gorge at Rupar, passes through the Shipki La** in the Himalayan ranges, and subsequently enters the Punjab plains.

The Ganga River System

- ❖ The Ganga is a very significant river in India, both in terms of its **vast river basin** and its **cultural importance** as well.
- ❖ The river has a length of **2,525 km**. It is shared by **Uttarakhand** (110 km) and **Uttar Pradesh** (1,450 km), **Bihar** (445 km) and **West Bengal** (520 km).
- ❖ The **Ganga basin covers about 8.6 lakh sq. km area in India** alone.

Do you know?

The Sundarban Delta derived its name from the Sundari tree, which grows well in marshland. It is the world's largest and fastest growing delta. It is also the home of Royal Bengal tiger.

Course of the Ganga River

- ❖ It **risers in the Gangotri glacier near Gaumukh**, situated at an elevation of 3,900 metres in the Uttarkashi district of Uttarakhand. At this point, it is referred to as the **Bhagirathi**.
- ❖ As the river progresses, it navigates through the Central and Lesser Himalayas, carving its way through narrow gorges.

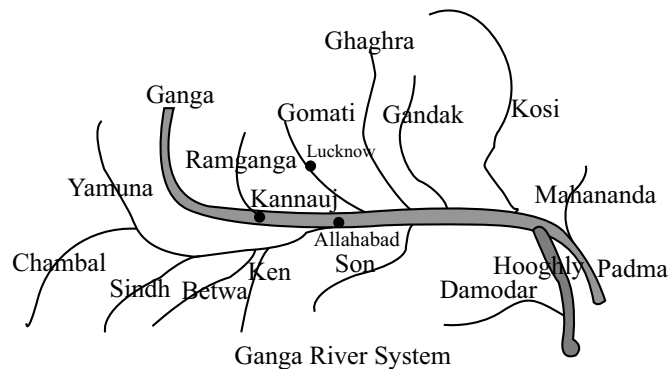
- ❖ A pivotal moment in its course occurs at **Devprayag**, where the **Bhagirathi** meets the **Alaknanda**, and from this juncture onwards, it takes on the name **Ganga** (Refer Figure 3.5).
- ❖ The **Alaknanda** itself originates from the **Satopanth glacier**, located above **Badrinath**.
- ❖ Alaknanda river is formed by the **convergence of the Dhaulī and the Vishnu Ganga**, which come together at **Joshimath**, also known as **Vishnu Prayag**. This meeting marks a significant merging of waters in the upper reaches of the Ganga's journey.
- ❖ The other tributaries of Alaknanda such as the **Pindar** joins it at **Karna Prayag** while **Mandakini** or **Kali Ganga** meet it at **Rudra Prayag**.



Figure 3.5: Confluence of Bhagirathi and Alaknanda at Devprayag

Important Tributaries of the River Ganga

- ❖ The Ganga **enters the plains at Haridwar**. From here, it flows first to the south, then to the south-east and east before splitting into two distributaries, namely the **Bhagirathi** and the **Padma**.
- ❖ The Ganga river system is the largest in India having a number of **perennial and non-perennial tributaries** originating in the Himalayas in the north and the Peninsula in the south, respectively.
- ❖ The **Son** is its **major right bank tributary**.
- ❖ 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 Ganga river system is characterised by several other tributaries, each with its unique origin and course as follows:

Left Bank Tributaries of Ganga

Gandak

- ❖ The Gandak comprises two streams, namely **Kaligandak** and **Trishulganga**.
- ❖ It **rises in the Nepal Himalayas** between the **Dhaulagiri** and **Mount Everest** and drains the central part of Nepal.
- ❖ It **enters the Ganga plain in Champaran** district of Bihar and **joins the Ganga at Sonpur near Patna**.

Namami Gange Programme

The 'Namami Gange Programme', is an **Integrated Conservation Mission**, approved as "**Flagship Programme**" by the Union Government in June 2014 with the **twin objectives of effective abatement of pollution, conservation and rejuvenation of the National River Ganga**. Main pillars of the Namami Gange Programme are: Sewerage Treatment Infrastructure, River-Front Development, River-Surface Cleaning, Biodiversity, Afforestation, Public Awareness, Industrial Effluent Monitoring, and Ganga Gram.

Ghaghara

- ❖ The Ghaghara River **originates from the glaciers of Mapchachungo**.
- ❖ As it flows, it collects water from its tributaries, including the **Tila, Seti, and Beri** rivers.
- ❖ Emerging from the mountains, it creates a **deep gorge at Shishapani**.
- ❖ Before meeting the Ganga at **Chhapra**, the **Ghaghara is joined by the Sarda River**, also known as Kali or **Kali Ganga**, in the plains.

Kosi

- ❖ The Kosi River is an antecedent river, with its source located north of Mount Everest in Tibet.
- ❖ Its primary stream, the **Arun**, originates in this region.
- ❖ After traversing the Central Himalayas within **Nepal**, it is joined by the **West-flowing Son Kosi** and the **East-flowing Tamur Kosi**, forming the **Sapta Kosi**.

Ramganga

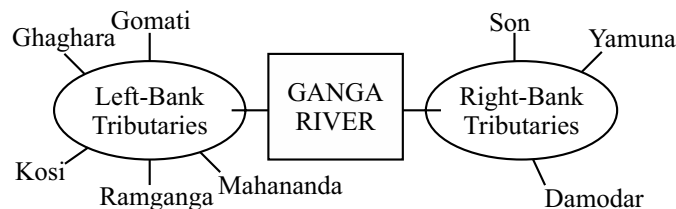
- ❖ The Ramganga River is relatively smaller in size, starting its journey in the **Garhwal hills near Gairsain**.
- ❖ After crossing the **Shivalik** region, it changes its course to the southwest and **enters the plains of Uttar Pradesh** near Najibabad.
- ❖ Eventually, it **merges with the Ganga River near Kannauj**.

Sarda

- ❖ **The Sarda or Saryu River** originates from the **Milam glacier** in the Nepal Himalayas, initially known as the **Goriganga**.
- ❖ Along the India-Nepal border, it takes on the names **Kali** or **Chauk** and eventually **joins the Ghaghara River**.

Mahananda

- ❖ The Mahananda River, a significant tributary of the Ganga, **originates in the Darjeeling hills**.
- ❖ It is the final left bank tributary of the Ganga and joins the river in West Bengal.



Right Bank Tributaries of Ganga

Yamuna

- ❖ The Yamuna is the **westernmost and longest tributary** of the Ganga.
- ❖ It originates from the **Yamunotri glacier** on the western slopes of the **Banderpunch** range, with an elevation of 6,316 meters.
- ❖ It **merges with the Ganga at Prayag (Prayagraj)**.
- ❖ The Yamuna is joined by several rivers on its right bank, including **the Chambal, the Sind, the Betwa, and the Ken**, all of which originate from the **Peninsular plateau**.

- ❖ On its left bank, the Yamuna receives contributions from rivers such as **the Hindon, the Rind, the Sengar, and the Varuna.**

Chambal

- ❖ The Chambal River, one of the **major contributors to the Yamuna, originates near Mhow in the Malwa plateau** of Madhya Pradesh.
- ❖ It flows northwards through a gorge up wards of Kota in Rajasthan, where the **Gandhi Sagar dam** has been constructed.
- ❖ Continuing its course, it moves through areas like **Bundi, Sawai Madhopur, and Dholpur** before eventually joining the Yamuna.
- ❖ The Chambal is renowned for its **unique badland topography**, known as the **Chambal ravines.**

Son

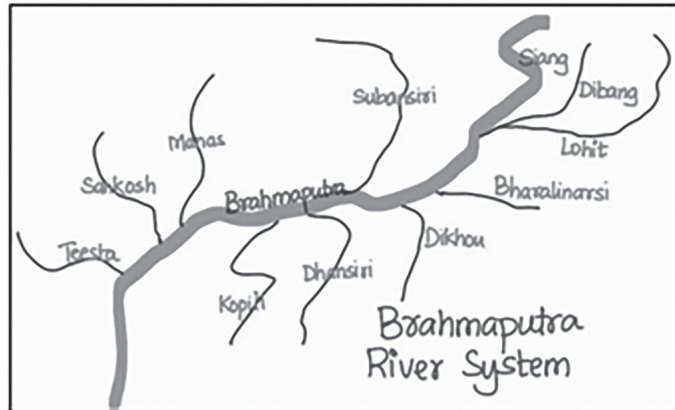
- ❖ The Son River, on the other hand, is a major tributary situated on the south bank of the Ganga.
- ❖ Its source lies in the **Amarkantak plateau**, and it forms a series of waterfalls at the plateau's edge.
- ❖ The Son River proceeds westward, passing **Arrah**, located to the west of Patna, before finally merging with the Ganga.

Damodar

- ❖ The Damodar River flows along the eastern margins of the **Chotanagpur Plateau**, meandering through a rift valley before eventually merging with the **Hugli River.**
- ❖ Its primary tributary is the **Barakar River.**
- ❖ Once notorious as the "**sorrow of Bengal**" due to its **frequent flooding**, the Damodar River has been effectively managed and controlled by the Damodar Valley Corporation, which oversees a multipurpose project in the region.

The Brahmaputra System

- ❖ The Brahmaputra River, **one of the largest rivers globally**, originates from the **Chemayungdung glacier** in the Kailash range **near Mansarovar Lake.**
- ❖ The Brahmaputra River is notorious for its frequent floods, channel shifts, and bank erosion.
- ❖ This phenomenon is primarily a **result of its large tributaries**, which carry substantial sediment loads due to heavy rainfall in the river's catchment area.



Course of the Brahmaputra River

- ❖ Initially, it flows eastward longitudinally for approximately **1,200 km** in a dry and flat region of **southern Tibet**, where it is known as the **Tsangpo**, meaning "**the purifier.**"
- ❖ In Tibet, the **Rango Tsangpo** serves as the **major right-bank tributary** of this river.
- ❖ The Brahmaputra transforms into a turbulent and dynamic river after carving a deep gorge in the Central Himalayas, particularly near **Namcha Barwa**, which stands at an elevation of 7,755 metres.
- ❖ As it exits the foothills of the Himalayas, the river adopts the name **Siang** or **Dihang.**

- ❖ It **enters India to the west of Sadiya town in Arunachal Pradesh.**
- ❖ As it flows south-westward, the Brahmaputra receives its main **left bank tributaries**, including the **Dibang** or **Sikang** and **Lohit** rivers. Following these confluences, it is recognized as the **Brahmaputra River.**
- ❖ As the Brahmaputra River **enters Bangladesh near Dhubri**, it flows southward. In Bangladesh, it is **joined on its right bank by the Tista River**, after which it is referred to as the **Jamuna River.**
- ❖ Eventually, it merges with the **Padma River**, which ultimately falls into the **Bay of Bengal.**

Other Tributaries of the Brahmaputra River

- ❖ The Brahmaputra River, during its journey through the Assam valley, receives numerous tributaries. Among its **major left-bank tributaries** are the **Burhi Dihing and Dhansari (South)**, while important **right-bank tributaries** include the **Subansiri, Kameng, Manas, and Sankosh rivers.**
- ❖ The **Subansiri River**, originating in Tibet, is characterised as an **antecedent river.**

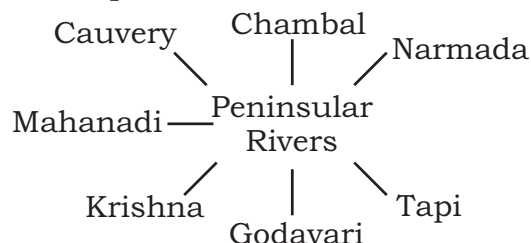
The Peninsular Drainage System

Characteristics of the Peninsular Drainage System

- ❖ The Peninsular drainage system is older than the Himalayan one, which is evident from the characteristics of the rivers and the landscape.
- ❖ The Peninsular drainage system features **broad, mostly graded shallow valleys**, and the **rivers exhibit maturity in their courses.**
- ❖ The **Western Ghats**, which run parallel to the western coast, **serve as the watershed between the major Peninsular rivers**, which ultimately discharge their waters into the Bay of Bengal, and the smaller rivulets that flow into the Arabian Sea.
- ❖ Most of the significant Peninsular rivers except Narmada and Tapi, flow from west to east.
- ❖ The **Chambal, Sind, Betwa, Ken, and Son**, originating in the northern part of the Peninsula, are part of the Ganga river system. Other major river systems in the Peninsular drainage include the **Mahanadi, Godavari, Krishna, and Kaveri (Cauvery).**
- ❖ Peninsular rivers are **characterised by their fixed courses, the absence of meanders, and the non-perennial flow of water**, although the **Narmada and Tapi**, which flow through rift valleys, **are exceptions to this pattern.**

POINTS TO PONDER

Prominent rivers of Peninsular India like Godavari, Krishna and Kaveri flow towards the East into the Bay of Bengal. What do you think are the reasons behind this? However, there is also a paradox of some west flowing rivers, prominent amongst which are Narmada, Tapi etc. Can you figure out the reason for this?



The Evolution of Peninsular Drainage System

Three major geological events in the distant past have played a crucial role in shaping the present drainage systems of Peninsular India:



- ❖ **Subsidence of the Western Flank:** During the early Tertiary period, the western flank of the Peninsula subsided below sea level. This event disrupted the symmetrical plan of the rivers on either side of the original watershed.
- ❖ **Upheaval of the Himalayas:** The uplift of the Himalayas caused subsidence on the northern flank of the Peninsular block, leading to trough faulting. The Narmada and Tapi rivers flow in these trough faults and have filled the original cracks with their detritus materials. Consequently, there is a lack of alluvial and deltaic deposits in these rivers.
- ❖ **Tilting of the Peninsular Block:** The Peninsular block experienced a slight tilting from northwest to southeast during the same period. This tilting gave the entire drainage system an orientation towards the Bay of Bengal.

These geological events have had a profound impact on the flow patterns and characteristics of the rivers in Peninsular India.

River Systems of the Peninsular Drainage:

Mahanadi:

- ❖ **Origin:** The Mahanadi River originates near **Sihawa** in the Raipur district of Chhattisgarh.
- ❖ **Course:** It flows through the state of **Odisha, Chhattisgarh** and **river does not flow in MP, but the river drainage basin included areas of MP** traversing a total length of 851 kilometres.
- ❖ **Catchment Area:** The Mahanadi River has a vast catchment area that covers approximately **1.42 lakh square kilometres**.
- ❖ **Navigation:** Some navigation activities are carried out in the lower course of the river.
- ❖ **Drainage Basin:** The drainage basin of the Mahanadi is distributed as follows: **53 percent** of it lies in the states of **Madhya Pradesh** and **Chhattisgarh**, while the remaining **47 percent** is located in **Odisha**. The Mahanadi River ultimately discharges its waters into the Bay of Bengal.

Godavari:

- ❖ **Origin:** The Godavari River originates in the Nasik district of Maharashtra. It is the **largest river system in the Peninsular drainage**.
- ❖ **Course:** It flows through several states, including **Maharashtra, Madhya Pradesh, Chhattisgarh, Odisha, Telangana and Andhra Pradesh**, before finally discharging its water into the Bay of Bengal.
- ❖ **Length:** The Godavari is a lengthy river, stretching for about **1,465 kilometres**.
- ❖ **Catchment Area:** Its catchment area is extensive, covering approximately **3.13 lakh square kilometres**.
- ❖ **Distribution:** The distribution of the Godavari's catchment area is as follows: **49 percent** lies in Maharashtra, 20 percent in **Madhya Pradesh and Chhattisgarh**, and the rest in **Andhra Pradesh, Telangana, Odisha and Yanam (Puducherry)**.
- ❖ **Tributaries:** The river has several significant tributaries, including the **Penganga**, the **Indravati**, the **Pranhita**, and the **Manjra**.
- ❖ **Delta:** After Rajamundri, the river splits into several branches, forming a large delta before it enters the Bay of Bengal.

POINTS TO PONDER

The Indian landscape is rich and blessed with adequate water resources. Despite this India has continued to be a water stressed Nation for about a decade now. What can be the causes of this? Is the regional variation in water distribution the cause or is low water use efficiency the determinant factor? To what extent do you think that inter-linking of Rivers can prove to be a solution?



Krishna:

- ❖ **Origin:** The Krishna river **originates near Mahabaleshwar** in the Sahyadri (Western Ghats).
- ❖ **Length:** The total length of the Krishna river is approximately **1,401 kilometres**.
- ❖ **Tributaries:** It receives water from several major tributaries, including the **Koyna**, the **Tungabhadra**, and the **Bhima**.
- ❖ **Catchment Area:** The Krishna river's catchment area is quite extensive, with **27 percent** of it in Maharashtra, **44 percent** in Karnataka, and **29 percent** in Andhra Pradesh and Telangana.

Kaveri:

- ❖ **Origin:** The Kaveri river originates in the **Brahmagiri hills**, specifically in the Kodagu district of Karnataka.
- ❖ **Length:** It has a total length of approximately **800 kilometres**.
- ❖ **Catchment Area:** The Kaveri river basin covers an area of **81,155 square kilometres**. It spans across multiple states, with around **3 percent in Kerala**, **41 percent in Karnataka**, and **56 percent in Tamil Nadu**.
- ❖ **Tributaries:** The Kaveri has several important tributaries, including the **Kabini**, the **Bhavani**, and the **Amravati**.

Do You Know?

The river Kaveri makes the second biggest waterfall in India, known as **Shivasamudram Falls**. The hydroelectric power generated from the falls is supplied to Mysuru, Bengaluru and the Kolar Gold Field.

Narmada:

- ❖ **Origin:** The Narmada river originates on the western flank of the **Amarkantak plateau** at an altitude of approximately 1,057 metres.
- ❖ **Course:** It flows in a rift valley between the **Satpura Range** in the south and the **Vindhyan Range** in the north.
- ❖ **Length:** The Narmada river has a total length of about **1,312 kilometres**.
- ❖ **Catchment Area:** The catchment area of the Narmada river covers approximately **98,796 square kilometres**.
- ❖ **Estuary:** The Narmada **river empties into the Arabian Sea** south of Bharuch, forming a broad **27-kilometre-long estuary**.
- ❖ **Sardar Sarovar Project:** It is a major **multipurpose river valley project** constructed on the Narmada River. This project serves various purposes, including **irrigation**, **hydroelectric power generation**, and **water supply**.

Tapi:

- ❖ **Origin:** The Tapi river originates from **Multai** in the Betul district of Madhya Pradesh.
- ❖ **Length:** The Tapi river has a total length of approximately **724 km**.
- ❖ **Catchment Area:** It drains an area of about **65,145 square km**.
- ❖ **Distribution:** Approximately **79 percent** of its basin lies in the state of **Maharashtra**, **15 percent** in **Madhya Pradesh**, and the remaining **6 percent** in **Gujarat**.

Luni:

- ❖ **Origin:** The Luni River originates near **Pushkar in Rajasthan**. It has two main branches, the **Saraswati** and the **Sabarmati**, which join together at **Govindgarh**.
- ❖ **Course:** Initially, the river flows westward, and after reaching **Telwara**, it takes a southwest direction.
- ❖ **Endpoint:** The Luni River eventually **drains into the Rann of Kachchh in Gujarat**.



- ❖ **Nature:** The entire river system of the Luni is **ephemeral**, meaning **it experiences seasonal flow** and is not a perennial river.

Lakes

- ❖ India boasts a diverse array of lakes, each distinct in terms of size and characteristics. Many of these lakes are permanent, while others only contain water during the rainy season, particularly in semi-arid regions with inland drainage basins.
- ❖ Some lakes have **formed due to the actions of glaciers and ice sheets**, while others owe their existence to processes like **wind and river action**, as well as **human activities**.
- ❖ **Oxbow lakes**, for instance, **develop when meandering rivers create cut-offs in floodplains over time**.
- ❖ Coastal areas give rise to lagoons through the **formation of spits and bars**, exemplified by lakes like **Chilika, Pulicat, and Kolleru**.
- ❖ **Inland drainage lakes**, such as **Sambhar Lake** in Rajasthan, are often seasonal and **may contain saltwater**, with their primary use being salt production.
- ❖ **Freshwater Lakes:** The Himalayan region hosts a majority of **freshwater lakes**, predominantly of glacial origin. These lakes were **carved out by glaciers and subsequently filled with snowmelt**.
 - ❖ Notable examples include **Wular Lake in Jammu and Kashmir**, which **owes its existence to tectonic activity** and stands as the **largest freshwater lake in India**.
 - ❖ Additional significant freshwater lakes encompass **Dal Lake, Bhimtal, Nainital, Loktak** (Refer Figure 3.6), and **Barapani**.
- ❖ Apart from natural lakes, the damming of the rivers for the generation of hydel power has also led to the formation of lakes, such as **Guru Gobind Sagar (Bhakra Nangal Project)**.
- ❖ During heavy rains, a lake **prevents flooding** and during the dry season, it helps to **maintain an even flow of water**.
- ❖ Lakes can also be used for **developing hydel power**. They moderate the climate of the surroundings; maintain the aquatic ecosystem, enhance natural beauty, help develop tourism and provide recreation.

Do You Know?

71 percent of the world's surface is covered with water, but 97 per cent of that is salt water. Of the 3 percent that is available as freshwater, three quarters of it is trapped as ice.



Figure 3.6: Loktak Lake

Role of Rivers in the Economy

- ❖ Throughout human history, rivers have held profound significance. They provide a foundational natural resource, crucial for a wide range of human endeavours. As a result, the banks of rivers have historically drawn settlers, leading to the growth of thriving cities.
- ❖ Leveraging rivers for purposes such as **irrigation, navigation, and hydroelectric power generation** holds particular importance, especially in countries like India where **agriculture is the primary livelihood** for the majority of the population.

POINTS TO PONDER

River and Water bodies are the lifelines of a Nation. In this context, there have been issues over water sharing between countries for the trans-national rivers. Find out some of these trans-national water bodies across the world. Do you think the country possessing the origin of rivers has a natural advantage or extra rights over it? Find out the principles established for the division of water resources amongst countries for such rivers.



River Pollution

- ❖ The growing domestic, municipal, industrial and agricultural demand for water from rivers naturally affects the quality of water. As a result, more and more water is being drained out of the rivers reducing their volume.
- ❖ On the other hand, a heavy load of untreated sewage and industrial effluents are emptied into the rivers.
- ❖ This affects not only the quality of water but also the self-cleansing capacity of the river.
- ❖ The increasing urbanisation and industrialisation do not allow the rivers to assimilate and dilute pollution and the pollution level of many rivers has been rising.
- ❖ Concern over rising pollution in our rivers led to the launching of various action plans to clean the rivers. The National River Conservation Plan (NCRP) is one such initiative.

Conclusion

India's rivers carry substantial water volumes annually, but this distribution is marked by disparities both temporally and spatially. Some rivers flow perennially, maintain consistent water levels throughout the year, whereas others, classified as non-perennial, experience significantly reduced water flow during dry seasons. The monsoon season sees excessive water, leading to wasteful floods that ultimately drain into the sea. Conversely, regions affected by floods may see drought conditions elsewhere in the country.

- **Catchment area:** A catchment area is an area of land that collects water after rainfall, typically bounded by hills. Water flows down into these areas and collects into rivers and streams.
- **Drainage basin:** A drainage basin is an area of land where water from rain or snow melt drains downhill into a body of water such as a river, lake, wetland or ocean. The drainage basin includes both the streams and rivers that convey the water as well as the land surface from which water drains into those channels.
- **Tributary:** A tributary, or affluent, is a stream or river that flows into a larger stream or main stem river or a lake. A tributary does not flow directly into a sea or ocean.
- **Watershed:** A watershed is an area of land that drains all the streams and rainfall to a common outlet such as the outflow of a reservoir, mouth of a bay, or any point along a stream channel.
- **Water divide:** A mountain or an upland separates two drainage basins in an elevated area. Such an upland is known as a water divide.
- **Perennial:** A stream or a river that flows continuously through its river bed for a year is known as a perennial river. They have water in their river bed for the whole year.
- **Gorge:** A canyon, or chasm, is a deep cleft between escarpments or cliffs resulting from weathering and the erosive activity of a river over geologic time scales. Rivers have a natural tendency to cut through underlying surfaces, eventually wearing away rock layers as sediments are removed downstream.
- **Antecedent river:** An antecedent river is a river that existed before the landscape around it was formed.





Climate

Bibliography: This chapter encompasses the summary of Chapter 4 of Class IX (Contemporary India-1), and Chapter 4 of Class XI (India Physical Environment).

Introduction

India is a vast subcontinent and experiences a diverse range of climatic variations influenced by the distinctive **monsoon patterns** with changing seasons, habits and attire change, reflecting the profound impact of weather on our daily lives. In India, summer requires light attire, and winter requires woollens. These variations arise from the ever-fluctuating elements of weather, such as **temperature, pressure, and wind direction**. Central to this part is the monsoon, characterised by its **unique seasonal reversal of wind**, which bestows India with its hot and humid monsoonal climate, a characteristic shared with other regions of south and southeast Asia.

Climate

- ❖ **Definition:** Climate refers to the sum total of weather conditions and variations over a large area for a long period of time (more than thirty years).
- ❖ **Factors Influencing Climate:** The six major factors influencing climate are latitude, altitude, pressure and wind systems, distance from the sea (continentality), ocean currents, and relief features.

Do You Know?

- Weather is the momentary state of the atmosphere while climate refers to the average of the weather conditions over a longer period of time.
- Weather changes quickly, may be within a day or week but climate changes imperceptively and may be noted after 50 years or even more.

Indian Climate

- ❖ The Climate of India is “**monsoon**” type, which is found mainly in **South Asia and South-East Asia**.
- ❖ The word “monsoon” is derived from the Arabic word “mausim” which means seasons.

Factors Related to Location and Relief:

- ❖ **Latitude:** The **Tropic of Cancer** divides India, placing the northern part in the sub-tropical and temperate zones, and the southern part in the tropical zone. Consequently, the south experiences constant high temperatures, while the north sees more extreme seasonal variations.
- ❖ **The Himalayas:** They act as a protective barrier that shields India from **cold northern winds** originating near the Arctic. They also help trap **the monsoon winds**, which release their moisture within the subcontinent.

POINTS TO PONDER

The **Monsoon Winds**, in their genesis, have a South Eastern pattern. However, after crossing the Equator, a sudden change in the direction i.e. South-West winds are witnessed which brings a significant amount of rainfall in the Indian Subcontinent. Can you find out the reason for this change in direction of the winds?



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- ❖ **Land-Water Distribution:** India's land and sea experience differential heating, leading to **varying air pressure zones**. This causes the **reversal of monsoon winds** based on seasons.
- ❖ **Proximity to the Sea:** The coastal areas, due to their closeness to the sea, have a balanced climate. However, interiors like **Delhi and Kanpur**, which are distant from the sea, experience more pronounced seasonal contrasts.
- ❖ **Altitude:** Elevated regions are cooler due to the decline in temperature with height. Thus, places like Darjeeling are cooler than plains regions on the same latitude, like Agra.
- ❖ **Relief:** India's topography influences temperature, rainfall, and wind patterns. For instance, the windward side of the Western Ghats receives high rainfall, while the leeward side remains relatively dry.

Factors Related to Air Pressure and Wind:

- ❖ **Surface Air Pressure and Winds:** This involves understanding how air pressure and winds are distributed across the earth's surface.
- ❖ **Upper-Air Circulation:** This factor encompasses the global weather controllers, including the movement of different air masses and the role of jet streams.
- ❖ **Weather Disturbances:** 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.
- ❖ These mechanisms and their effects vary and can be best understood by studying them in the context of India's winter and summer seasons.

Mechanisms of Weather in the Winter Season

Surface Pressure and Winds:

- ❖ In winter, weather patterns in India are influenced by pressure distributions in **Central and Western Asia**.
- ❖ A high-pressure zone forms north of the Himalayas, causing **dry continental winds** to flow 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, extending to the middle Ganga valley, making **the region dry**.

Jet Stream and Upper Air Circulation:

- ❖ At higher altitudes, **roughly 3 km above the surface** (Refer to Figure 4.1), a distinct air circulation pattern emerges, unaffected by surface atmospheric pressure variations.
- ❖ Westerly winds over Western and central Asia flow across the Asian continent at latitudes north of the Himalayas, near the **Tibetan highlands**, known as **jet streams**.

POINTS TO PONDER

Surface winds and upper tropospheric winds have their own distinctions. They do affect each other but are not necessarily mirror images. Can you find out the reason and factors which affect upper tropospheric circulations and distinguish it with surface winds in the Indian context?



Western Cyclonic Disturbance and Tropical Cyclones

The winter months see the entry of western cyclonic disturbances from the Mediterranean Sea, ushered in by the westerly jet stream. Their approach typically leads to a rise in night temperatures.

Tropical cyclones originating from the Bay of Bengal and the Indian Ocean strike the coasts of Tamil Nadu, Andhra Pradesh, and Orissa. Characterized by high wind speeds and heavy rainfall, these cyclones often cause significant destruction.

- ❖ These streams **bifurcate due to the Tibetan highlands**, with the southern branch influencing India's winter weather.

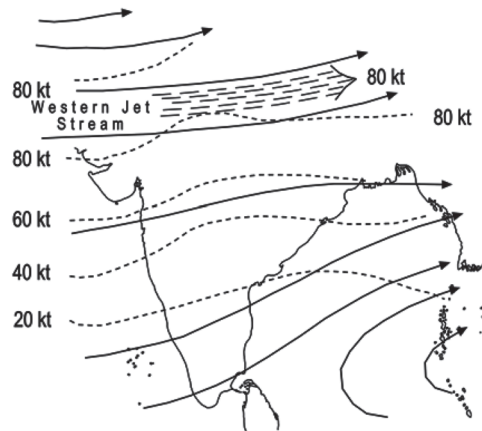


Figure 4.1: Direction of Winds in India in Winter at the Height of 9-13 km

Mechanisms of Weather in the Summer Season

Surface Pressure and Winds:

- ❖ With the onset of summer and the sun's northward movement, India's wind circulation sees a reversal at both lower and upper levels. (Refer to Figure 4.2.)
- ❖ By mid-July, the Intertropical Convergence Zone (ITCZ) shifts northward, aligning approximately with the Himalayas between 20° N and 25° N.
- ❖ By this time, the westerly jet stream has receded from India, and its withdrawal is interlinked with the northward shift of the ITCZ.
- ❖ As the ITCZ shifts northward, it attracts low pressure winds from various directions. The maritime tropical air mass from the southern hemisphere approaches this zone, leading to the **southwest monsoon**.

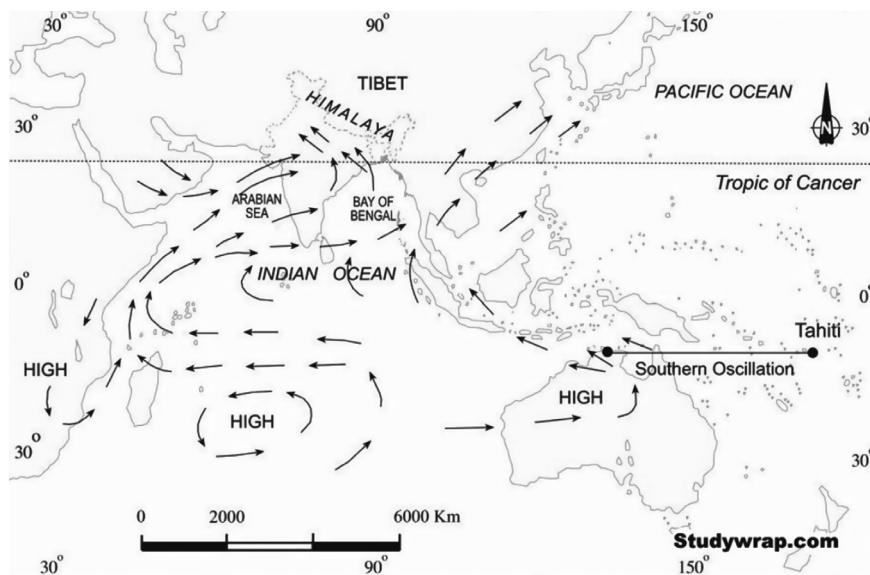


Figure 4.2: Summer Monsoon Winds: Surface Circulation

Jet Streams and Upper Air Circulation:

- ❖ The described pressure and wind patterns are specific to the troposphere.
- ❖ In June, an easterly jet stream flows over the southern part of the Peninsula, reaching speeds up to 90 km per hour. By September, its influence extends up to 22° N latitude but usually doesn't surpass 30° N latitude.

Easterly Jet Stream and Tropical Cyclones:

- ❖ The easterly jet stream guides tropical depressions into India, significantly influencing monsoon rainfall distribution.
- ❖ The paths of these depressions are high rainfall zones. Their frequency, direction, and intensity play crucial roles in shaping India's monsoon rainfall pattern. (Refer to Figure 4.3.)

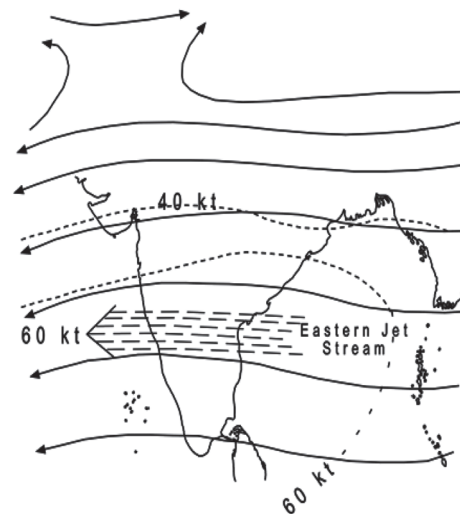


Figure 4.3: The Direction of Winds at 13 km Altitude in Summer Season

Monsoon

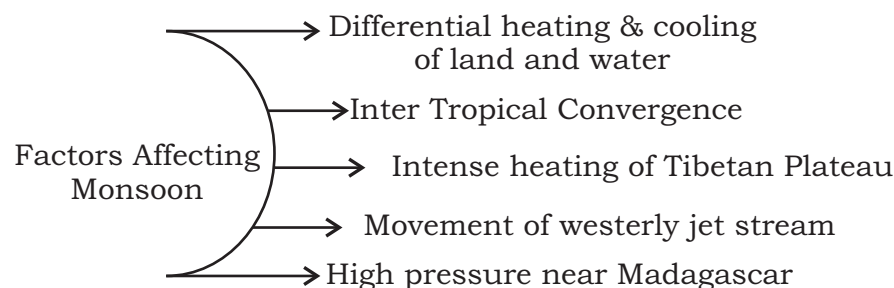
It refers to a climate characterised by seasonal reversals of the wind system. The sailors who came to India in historic times were among the first to notice the phenomenon of the monsoon.

Factors Affecting Monsoon Climate:

- ❖ The differential heating and cooling of land and water creates low pressure on the landmass of India, while the sea around experience comparatively high pressure.
- ❖ The shift of the position of **Inter Tropical Convergence Zone (ITCZ)** in summer, over the Ganga plain (this is the equatorial trough normally positioned about 5°N of the equator).
- ❖ The **presence of the high-pressure area, east of Madagascar**, approximately at 20°S over the Indian Ocean.
- ❖ The **Tibetan plateau** gets intensely heated during the summer, which results in strong vertical air currents and the formation of low pressure over the plateau at about 9 km above sea level.
- ❖ The movement of the **westerly jet stream** to the north of the Himalayas and the presence of the tropical easterly jet stream over the Indian peninsula during summer.

POINTS TO PONDER

Monsoon Winds play a deterministic role in the Indian climate system. However, the Monsoon weather system is not confined only to the Indian Subcontinent. Find out the other parts of the world where they have a role to play. Also, assess the impact they have in such regions.



The Onset of the Monsoon

- ❖ The onset of the monsoon was attributed to the **differential heating of land and sea** during the summer.
- ❖ By **April and May**, the northern landmass heats up, creating a significant **low-pressure area**. Meanwhile, the slower-heating Indian Ocean **retains high pressure**.
- ❖ This contrast draws the southeast trade winds towards the subcontinent, leading to **the northward movement of the Intertropical Convergence Zone (ITCZ)**. After crossing the Equator between 40°E and 60°E longitudes, these winds become the southwest monsoon.
- ❖ The withdrawal of the westerly jet stream from northern India and the subsequent setting of the easterly jet stream are crucial for the monsoon's onset.
- ❖ **Entry of the Monsoon into India:** The southwest monsoon sets in over the Kerala coast by 1st June and moves swiftly to reach Mumbai and Kolkata between 10th and 13th June. By mid-July, the southwest monsoon covers the entire subcontinent. (Refer Figure 4.4)

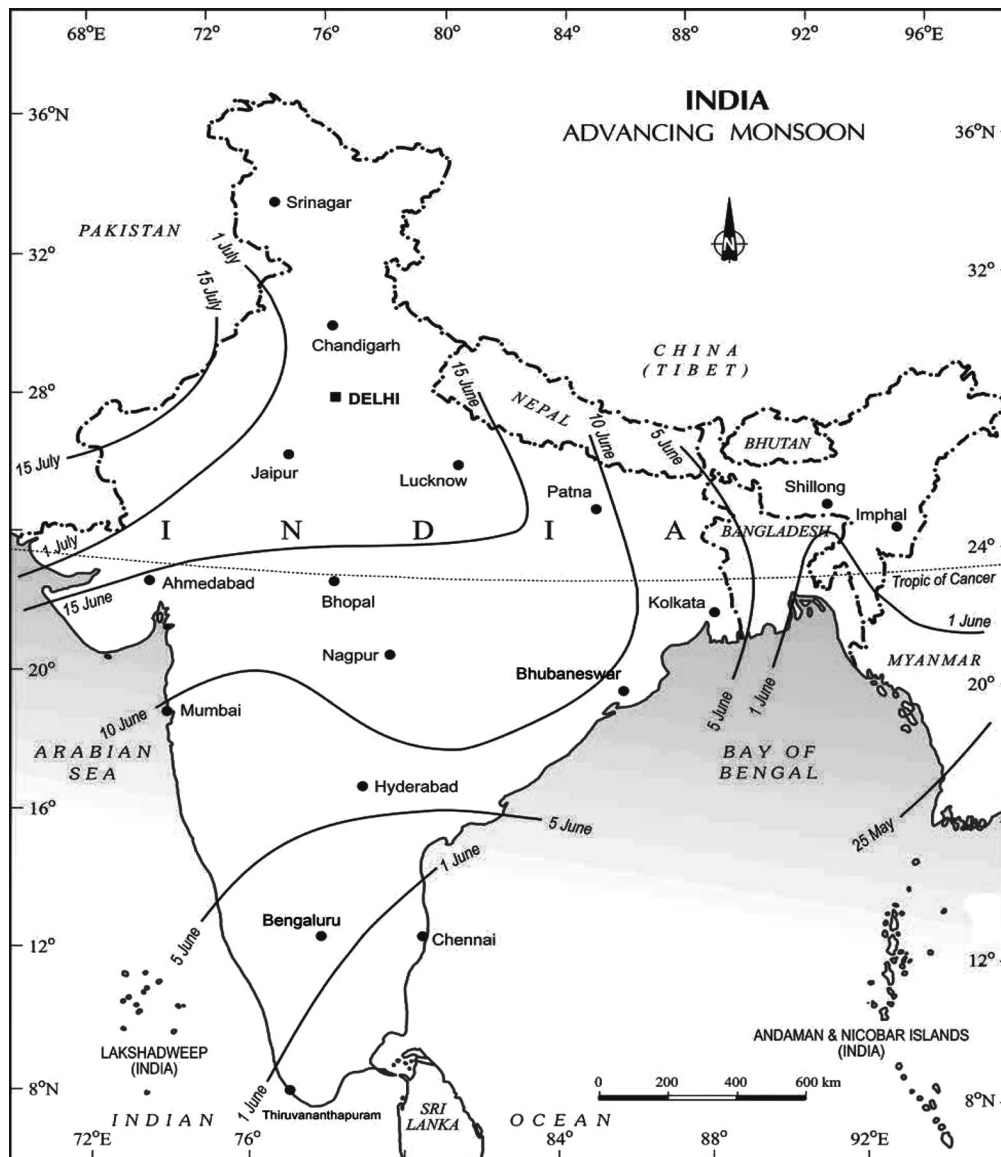


Figure 4.4: India: Normal Dates of onset of the Southwest Monsoon

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 India. El-Nino is merely an extension of the warm equatorial current which gets replaced temporarily by cold Peruvian current or Humbolt current (locate these currents in your atlas).

This current increases the temperature of water on the Peruvian coast by 10° C. This results in:

- The distortion of equatorial atmospheric circulation;
- Irregularities in the evaporation of sea water;
- 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).
- El-Nino is used in India for forecasting long range monsoon rainfall. In 1990-91, there was a wild El-Nino event and the onset of southwest monsoon was delayed over most parts of the country ranging from five to twelve days.

Unity and Diversity in the Monsoon Climate:

- ❖ India's monsoon climate emphasises its unity with the larger southeast Asian region, characterised by rich regional variations.
- ❖ For instance, states like **Kerala and Tamil Nadu** in the south differ climatically from northern states like **Uttar Pradesh and Bihar**, even though all experience the monsoon pattern. These variations manifest in **winds, temperature, rainfall, and seasonal rhythms**.
- ❖ Extreme temperature contrasts are evident: While Rajasthan's western parts might sizzle at 55°C in summer, Leh can plummet to minus 45°C in winter.
- ❖ Similarly, places like Cherrapunji in Meghalaya might receive a staggering 1,080 cm of annual rainfall, whereas **Jaisalmer in Rajasthan** might get a meagre 9 cm.
- ❖ **Precipitation** forms also vary, from Himalayan snowfalls to widespread rains in the north-east. Yet, despite these stark differences, India's climate is undeniably monsoonal in its essence and rhythm.

The Indian Weather Season

India experiences a rhythmic annual climate cycle with four distinct seasons: cold weather, hot weather, southwest monsoon, and retreating monsoon.

The Cold Weather Season:

Temperature Dynamics:

- ❖ Usually, the cold weather season sets in by **mid-November in northern India**. The **mean daily temperature remains below 21°C** over most parts of northern India (Refer Figure 4.5).
- ❖ **Winter in northern India**, especially in regions like **Punjab, Haryana, and Rajasthan**, can be very cold, with temperatures sometimes dropping below freezing.
- ❖ This cold is attributed to **three reasons**:
 - ❖ States like **Punjab, Haryana, and Rajasthan** are far away from the moderating influence of sea and experience **continental climate**.
 - ❖ The **snowfall** in the nearby Himalayan ranges creates a cold wave situation; and

- ✧ Around **February**, the **cold winds coming from the Caspian Sea and Turkmenistan** bring cold waves along with **frost and fog** over the **north-western parts of India**.
- ❖ In contrast, the Peninsular region does not experience a sharp cold season due to the sea's moderating influence and its equatorial proximity.
- ❖ Thus, coastal regions, like Thiruvananthapuram, maintain a mild temperature range throughout the year.

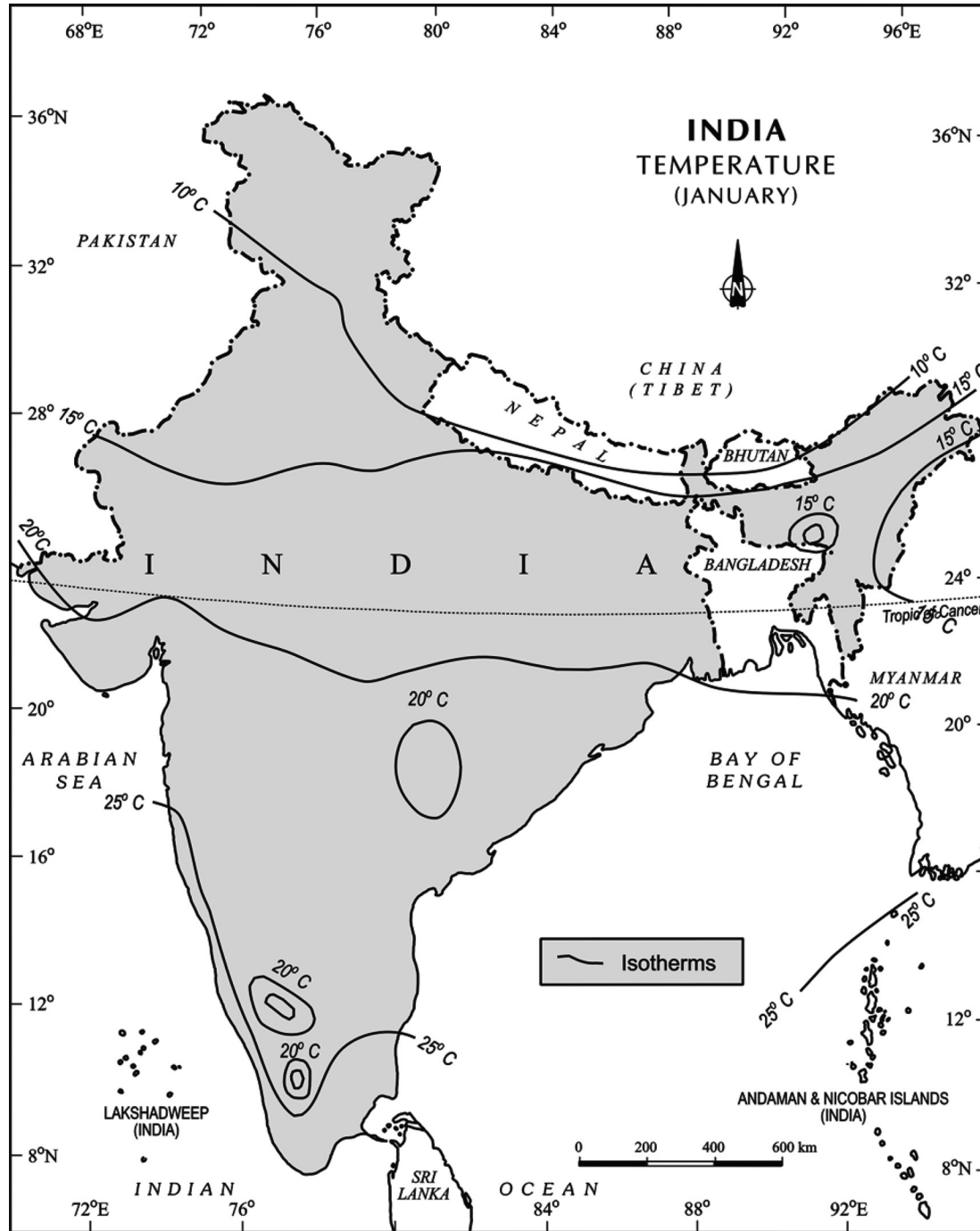


Figure 4.5: India: Mean Monthly Temperatures of the Day in January

Pressure and Wind Patterns:

- ❖ By the end of December (22nd December), the sun shines vertically over the **Tropic of Capricorn** in the southern hemisphere.
- ❖ During winter, high-pressure conditions dominate northern India, while the south has slightly lower pressure.
- ❖ The isobars of 1019 mb and 1013 mb pass through northwest India and the far south, respectively. Winds, driven by these pressure differences, move from the northwestern high-pressure zone to the southern low-pressure areas. **(Refer Figure 4.6)**

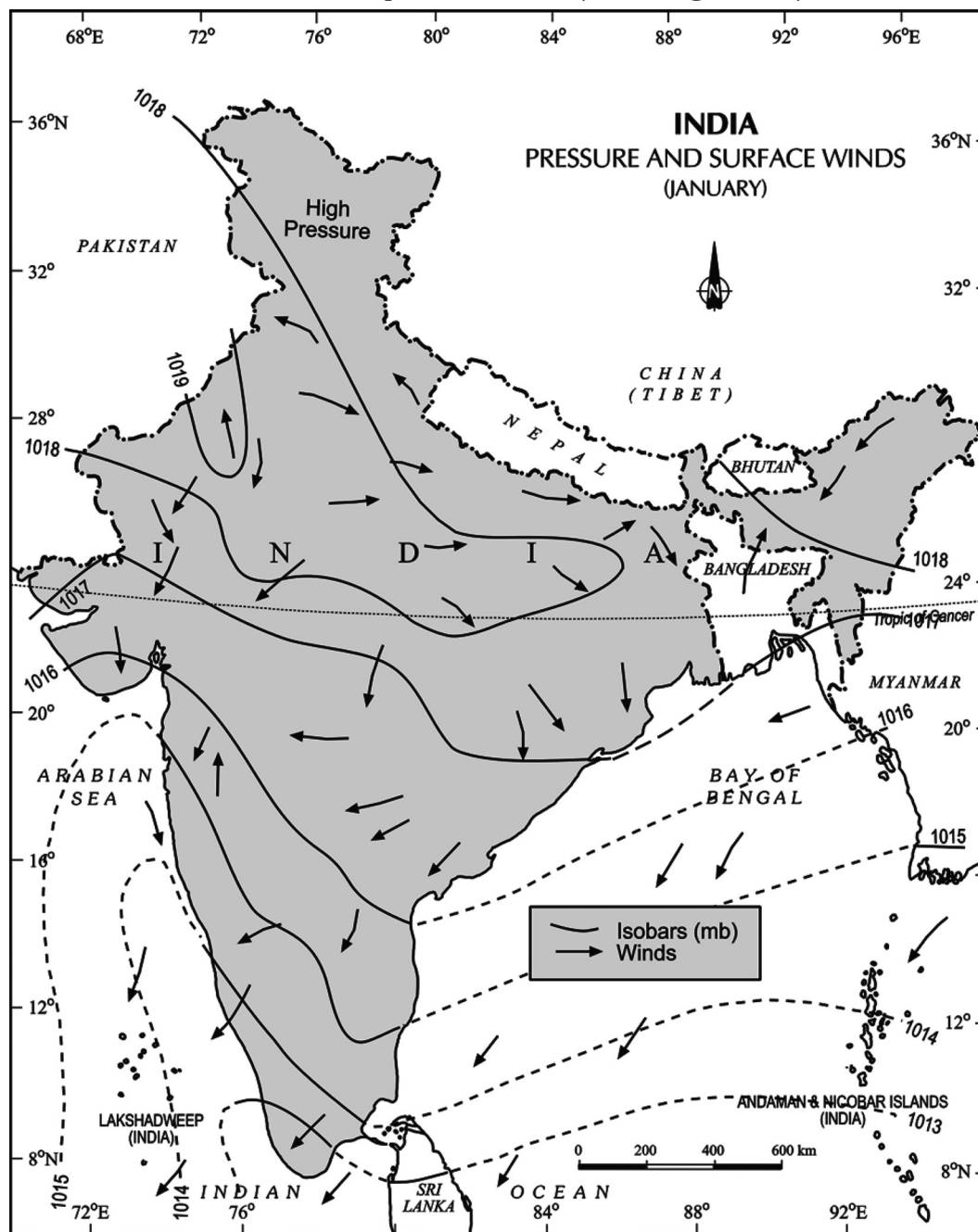


Figure 4.6: India: Pressure and Surface Winds (January)

Rainfall Variations:

- ❖ Generally, winter monsoons do not bring rain to India, primarily because of their **low humidity and the land's anti-cyclonic circulation**. However, there are exceptions:
- ❖ **Weak temperate cyclones from the Mediterranean** can cause rainfall in northwestern India,
- ❖ North-eastern regions like **Arunachal Pradesh and Assam** experience 25-50 mm of rain during the winter.
- ❖ The northeast monsoon, after **collecting moisture over the Bay of Bengal**, results in **heavy rainfall along the Tamil Nadu coast** and nearby south-eastern regions in **October and November**.

The Hot Weather Season:**Temperature:**

- ❖ As the sun moves **northward from March**, **northern India witnesses rising temperatures**, marking the onset of summer, which spans **April, May, and June**. (Refer Figure 4.7.)

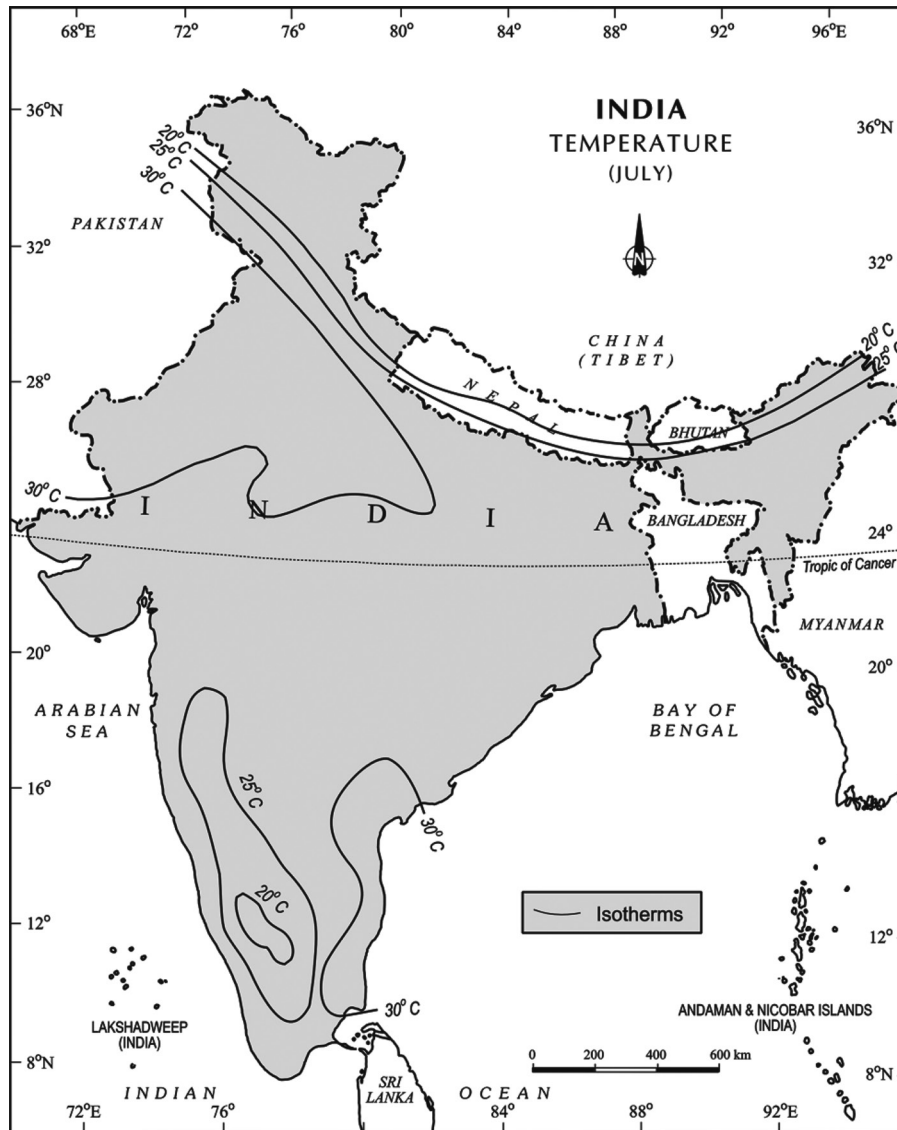


Figure 4.7: India: Mean Monthly Temperature of the Day in July

- ❖ Temperatures typically range between **30°C to 32°C**. By May, northwestern regions like **Gujarat and Madhya Pradesh** often experience scorching temperatures up to 48°C.
- ❖ In contrast, southern India enjoys a milder summer, with temperatures maintained between 26°C and 32°C, due to its peninsular location and the oceans' moderating effects.
- ❖ Coastal regions see minimal temperature variation from north to south, and the mean daily minimum during these summer months rarely falls below 26°C.

Pressure and Wind Patterns:

- ❖ Summer brings intense heat and falling air pressure to northern India. The ITCZ, influenced by the subcontinent's heat, shifts northward by July, centering around 25°N. This change creates a low-pressure monsoon trough stretching from the Thar desert to the Chotanagpur plateau.
- ❖ Also during summer afternoons, hot winds called '**Loo**' blow, especially in the ITCZ's heart. Dust storms are frequent in May across regions like Punjab, Haryana, and Uttar Pradesh, offering brief relief from the intense heat with their accompanying light rains.
- ❖ Occasionally, the clash between dry and moist air masses results in intense **local storms**, characterised by **strong winds, heavy rains, and even hailstorms**.

Local Storms	Region	Feature
Mango Shower	Kerala and coastal Karnataka	Pre-monsoon showers at the end of summer Aids in the early ripening of mangoes
Blossom Shower	Kerala	Results in the blossoming of coffee flowers
Nor Westers (Kalbaisakhi)	Bengal and Assam	Dreaded evening thunderstorms Beneficial for tea, jute, and rice cultivation In Assam, known as "Bardoli Chheerha"

The southwest monsoon season

Initiation of Monsoons:

- ❖ By **May**, the **intensifying low-pressure** conditions over the northwestern plains of India had become pronounced enough to attract the **southeast trade winds from the Southern Hemisphere**.
- ❖ Originating from the Indian Ocean, these winds are laden with **moisture** from the **warm equatorial currents**. Upon crossing the equator, they take a southwesterly turn, earning them the name "**southwest monsoon**".

Burst of Monsoons:

- ❖ The commencement of the **rainy season in the southwest monsoon** period is marked by a sharp and abrupt onset. This sudden introduction of moisture-rich winds, accompanied by intense thunder and lightning, is termed the "**burst**" of the monsoons.
- ❖ **Coastal areas like Kerala, Karnataka, Goa, and Maharashtra typically experience this burst in the first week of June**, while interior regions might witness it by the first week of July. A significant drop in daytime temperature, ranging from 5°C to 8°C, is observed between mid-June and mid-July (**Refer Figure 4.8**).

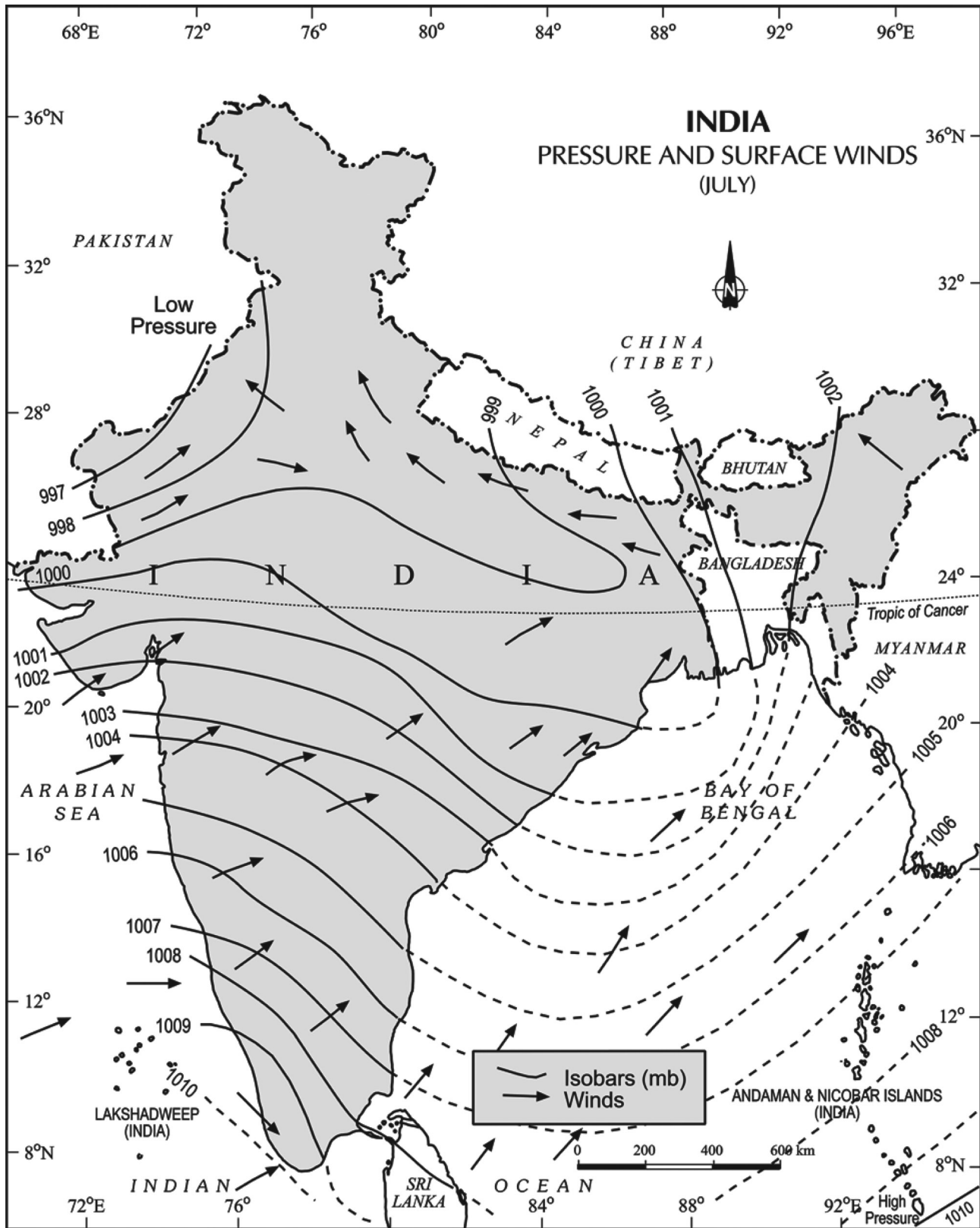


Figure 4.8: India: Pressure and Surface Winds (July)

Monsoon Branches

- ❖ The incoming monsoon winds are bifurcated by **India's topography** and the thermal **low-pressure system over northwestern India** into two primary branches: the Arabian Sea branch and the Bay of Bengal branch.

The Arabian Sea branch (Monsoon Winds of the Arabian Sea):

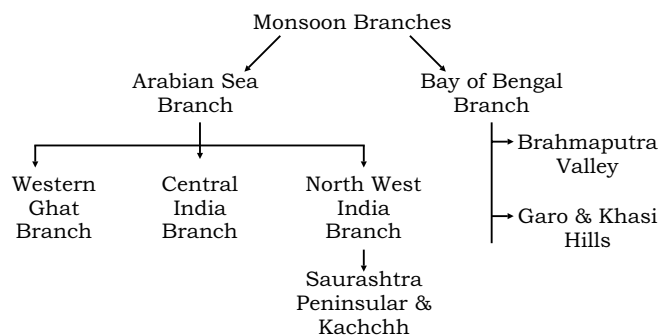
The monsoon winds originating over the Arabian Sea are further split into three branches:

1. Western Ghats and Rain-shadow Effect:

- ❖ The monsoon winds from the Arabian Sea, upon encountering the Western Ghats, **ascend its slopes**, cooling down in the process.
- ❖ This leads to heavy rainfall (between 250 cm and 400 cm) on the **windward side of the Sahyadris (Coastal Maharashtra)** and the Western Coastal Plain.
- ❖ After crossing the Ghats, the winds **descend**, warm up, and lose their moisture. This results in minimal rainfall to the east of the Western Ghats, creating a **rain-shadow region**. Notable differences in rainfall can be observed across places like **Kozhikode, Mangalore, Pune, and Bengaluru**.

2. Central India Impact:

- ❖ Another branch of the Arabian Sea monsoon impacts the region **north of Mumbai**.
- ❖ It moves through the **Narmada and Tapi river valleys**, bringing rainfall to vast areas of central India.
- ❖ The **Chotanagpur plateau** receives about **15 cm** of rainfall from this branch. Eventually, these winds reach the **Ganga plains** and merge with the monsoon winds of the Bay of Bengal.



3. Northwest India and Himalayan Influence:

- ❖ The **third branch** hits the **Saurashtra Peninsula and Kachchh**, then moves over **west Rajasthan and along the Aravallis**, producing limited rainfall.
- ❖ It continues to **Punjab and Haryana**, where it **converges with the Bay of Bengal monsoon branch**. Together, they deliver rain to the western Himalayas.

The Bay of Bengal Branch (Monsoon Winds of the Bay of Bengal):

- ❖ The monsoon winds of the Bay of Bengal **initially hit the Myanmar coast and parts of southeast Bangladesh**.
- ❖ However, due to the **Arakan Hills** along Myanmar's coast, a significant portion of this branch is **redirected towards the Indian subcontinent**.
- ❖ As a result, the monsoon enters **West Bengal and Bangladesh** from the south and southeast, rather than the typical southwesterly direction.
- ❖ Influenced by the Himalayas and the **thermal low in northwest India**, this monsoon branch divides into two major streams.
- ❖ One stream moves **westward** along the Ganga plains, extending to the **Punjab plains**.
- ❖ The other heads **north**, travelling up the **Brahmaputra valley**, leading to extensive rainfall in the **north and northeast**.

Do You Know?

The Tamil Nadu coast remains dry during the southwest monsoon season due to two main factors:

- It is situated parallel to the Bay of Bengal branch of the southwest monsoon, which brings less rainfall to this area.
- The Tamil Nadu coast lies in the rain shadow area of the Arabian Sea branch of the southwest monsoon, further reducing its rainfall.

- ❖ A sub-branch of the Bay of Bengal monsoon targets the Garo and Khasi hills in Meghalaya.
- ❖ **Mawsynram, situated on the Khasi Hills' crest**, holds the distinction of receiving the highest average annual rainfall globally.

The retreating monsoon season (The Transition Season):

- ❖ The months of **October and November** mark the phase of retreating monsoons.
- ❖ **By September's end**, the southwest monsoon weakens due to the southward shift of the low-pressure trough from the Ganga plain.
- ❖ The monsoon begins its retreat from western Rajasthan in early September.
- ❖ By September month-end it leaves areas like **Rajasthan, Gujarat, and the Western Ganga plain**.
- ❖ By early November, this low-pressure influence reaches Karnataka and Tamil Nadu, and by mid-December, it completely exits the Peninsula.
- ❖ During this retreat, **clear skies dominate, and temperatures rise**, leading to the '**October heat**'.
- ❖ However, by **late October**, north India remains dry, eastern parts of the Peninsula experience rain.
- ❖ **Cyclonic Influences:**
 - ✧ Rainfall in this season is primarily due to **cyclonic depressions** originating over the Andaman Sea.
 - ✧ These cyclones, especially potent when crossing the eastern coast of the southern Peninsula, frequently affect the deltas of rivers like the **Godavari, Krishna, and Kaveri**, causing significant damage.
 - ✧ While these cyclonic storms also impact West Bengal, Bangladesh, and Myanmar, they are **less prevalent in the Arabian Sea. The Coromondal coast mainly gets its rain from these cyclonic events.**

Traditional Indian Seasons

- ❖ In Indian tradition, the year is distinctively divided into **six seasons**, each lasting two months.
- ❖ This classification, deeply rooted in historical observations, is mainly followed in **northern and central India**.
- ❖ The traditional system of seasons doesn't align with the climatic patterns of **south India**, where seasonal variations are minimal.

Seasons	Months (According to the Indian Calendar)	Months (According to the Gregorian Calendar)
Vasanta	Chaitra-Vaisakha	March-April
Grishma	Jyaistha-Asadha	May-June
Varsha	Sravana-Bhadra	July-August
Sharada	Asvina-kartika	September-October
Hemanta	Margashirsa-Pausa	November-December
Shishira	Magha-Phalguna	January-February



Distribution of Rainfall

- ❖ The average annual rainfall in India is about **125 cm**, but it has great spatial variations (Refer Figure 4.9).
- ❖ **High Rainfall Zones:** Regions with **over 200 cm** of rainfall include the **west coast, Western Ghats, and the sub-Himalayan areas in the northeast, especially parts of the Khasi and Jaintia hills**, which receive more than 1,000 cm. The Brahmaputra valley and adjoining hills get slightly less, under 200 cm.
- ❖ **Medium Rainfall Zones:** Areas receiving between **100-200 cm** encompass southern Gujarat, east Tamil Nadu, northeastern Peninsula, and areas covering Odisha, Jharkhand, Bihar, eastern Madhya Pradesh, northern Ganga plain, and parts of the northeast.
- ❖ **Low Rainfall Zones:** Regions like western Uttar Pradesh, Delhi, Haryana, Punjab, Jammu and Kashmir, eastern Rajasthan, Gujarat, and the Deccan Plateau experience rainfall between 50-100 cm.
- ❖ **Inadequate Rainfall Zones:** Certain parts of the Peninsula, notably in Andhra Pradesh, Karnataka, Maharashtra, Ladakh, and most of western Rajasthan, receive less than 50 cm of rainfall.
- ❖ **Snowfall:** This phenomenon is limited to the Himalayan region.

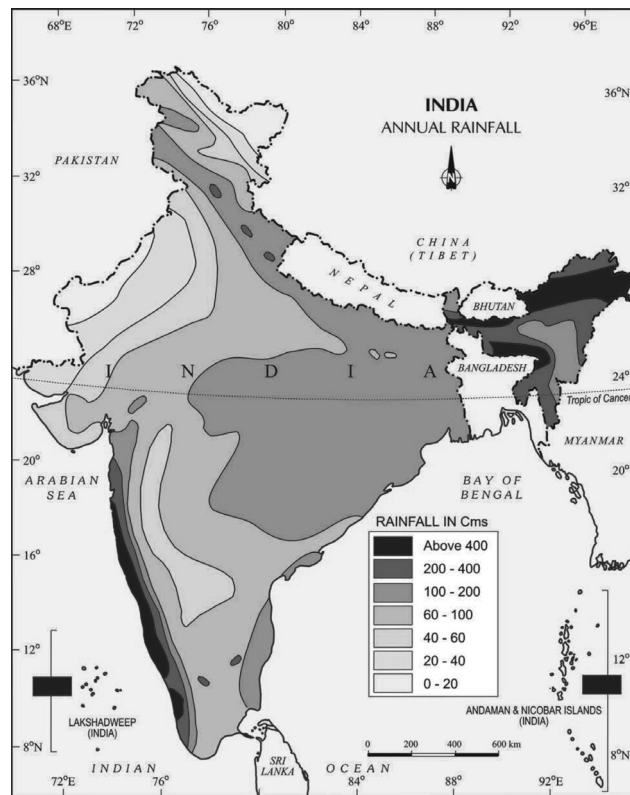


Figure 4.9: India: Annual Rainfall

Variability of Rainfall

- ❖ A characteristic feature of rainfall in India is its variability. The variability of rainfall is computed with the help of the following formula:

$$C.V = \frac{\text{Standard Deviation}}{\text{Mean}} \times 100, \text{ where C.V is the co-efficient of variation.}$$

- ❖ Areas with less than 25% variability include the western coasts, Western Ghats, north-eastern Peninsula, eastern Ganga plains, north-eastern India, Uttarakhand, Himachal Pradesh, and southwestern Jammu and Kashmir. These regions typically receive more than 100 cm of annual rainfall.
- ❖ On the other hand, regions like western Rajasthan, northern Jammu and Kashmir, and the interior Deccan plateau, which receive less than 50 cm of rainfall annually, experience a variability of over 50%.
- ❖ The remaining parts of India, receiving between 50-100 cm of rainfall, exhibit a variability ranging from 25% to 50% (Refer to Figure 4.10).

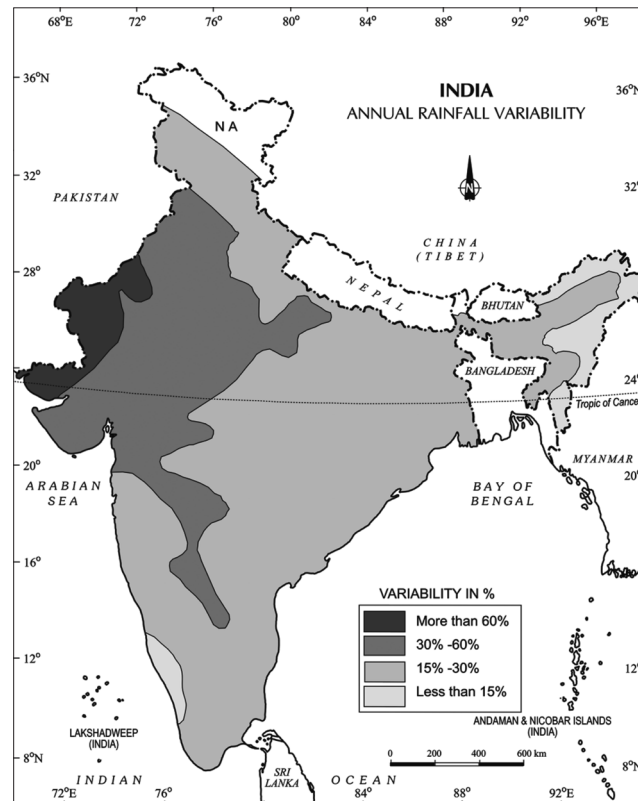


Figure 4.10: India: Variability of Annual Rainfall

Climatic Regions of India

- ❖ **Koeppen's classification:** It based upon specific letter symbols such as '**S**' for semi-arid regions and '**W**' for arid regions. Further sub-divisions were marked by additional lowercase letters like '**f**' for sufficient precipitation or '**m**' for rainforests despite a dry monsoon season.
- ❖ He delineated five primary climatic types:
 - ✧ **Tropical climates:** Mean monthly temperatures are consistently above 18°C throughout the year.
 - ✧ **Dry climates:** Precipitation is notably low relative to temperature. These are further categorised as semi-arid (S) or arid (W).
 - ✧ **Warm temperate climates:** The coldest month has a mean temperature ranging between 18°C and -3°C.
 - ✧ **Cool temperate climates:** The warmest month averages above 10°C, while the coldest month falls below -3°C.
 - ✧ **Ice climates:** The warmest month's mean temperature remains below 10°C.

- ❖ As per Koeppen's scheme, **India comprises eight distinct climatic regions** (Refer to Table 4.1 and Figure 4.11).

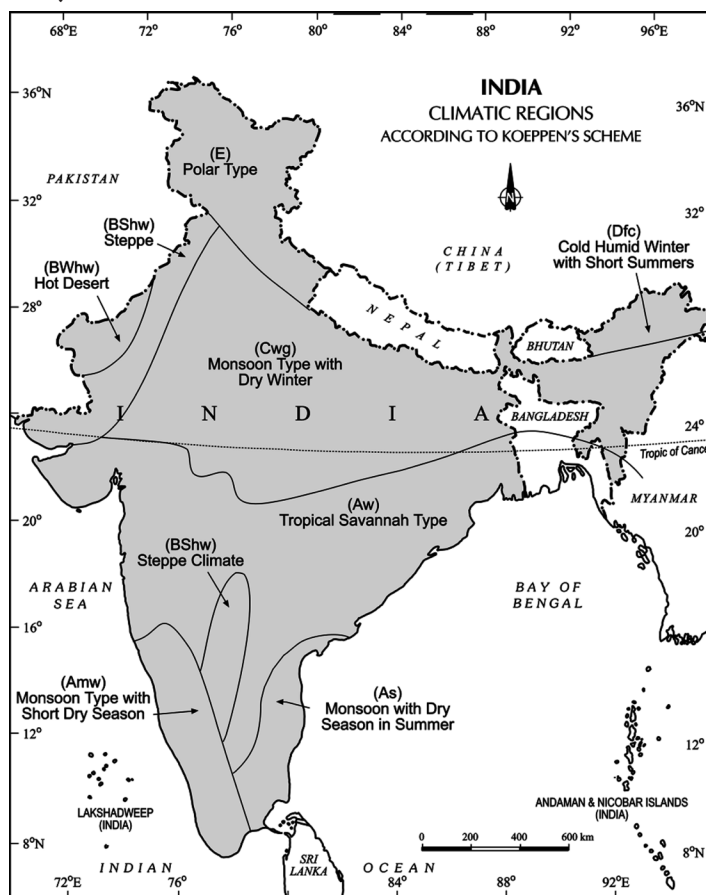


Figure 4.11: India: Climatic Regions According to Koeppen's Scheme

Table 4.1: Climatic Regions of India According to Koeppen's Scheme

Type of Climate	Areas
➤ Amw – Monsoon with short dry Season	➤ West coast of India south of Goa
➤ As – Monsoon with dry summer	➤ Coromandel coast of Tamil Nadu
➤ Aw – Tropical savannah	➤ Most of the Peninsular plateaus, south of the Tropic of Cancer
➤ BShw – Semi-arid steppe climate	➤ North-western Gujarat, some parts of western Rajasthan and Punjab
➤ BWhw – Hot desert	➤ Extreme western Rajasthan
➤ Cwg – Monsoon with dry winter	➤ Ganga plain, eastern Rajasthan, northern Madhya Pradesh, most of North-east India
➤ Dfc – Cold humid winter with short summer	➤ Arunachal Pradesh
➤ E – Polar type	➤ Jammu and Kashmir, Himachal Pradesh and Uttarakhand

Monsoons and Economic Life in India

- ❖ **Agriculture's Dependence on Monsoon:** The agricultural cycle in India heavily depends on the monsoon, as the majority of the population relies on farming. The majority of this agriculture is centred around the patterns of the southwest monsoon.
- ❖ **Temperature and Crop Growth:** Barring the Himalayas, India's temperature is conducive to year-round crop cultivation.

- ❖ **Diversity in Crops and Challenges from Rainfall Variability:** Inconsistent rainfall can lead to droughts or floods, affecting regions annually.
- ❖ **Prosperity Tied to Rainfall:** Timely and adequate rainfall is crucial for agriculture, especially in areas without developed irrigation. Any failure in monsoon patterns can severely impact agricultural output.
- ❖ **Soil Erosion Issues:** The sudden onset of the monsoon can cause widespread soil erosion.
- ❖ **Winter Rainfall Benefits:** In northern India, rainfall during winter, brought by **temperate cyclones**, aids the growth of rabi crops.
- ❖ **Lifestyle:** The regional climatic variations influence the diverse food habits, clothing preferences, and housing styles across India.

Global Warming

- ❖ It refers to the long-term warming of the planet's overall temperature.
- ❖ **The Greenhouse Effect:** An increase in gases such as **carbon dioxide, methane, chlorofluorocarbons, and nitrous oxide** termed "**greenhouse gases**" intensifies the greenhouse effect.

Consequences of Global Warming:

- ❖ **Melting Polar Regions:** Due to global warming, polar ice caps and mountain glaciers are melting, causing ocean levels to rise.
- ❖ **Projected Temperature Rise:** Over the past **150 years**, Earth's surface temperature has increased. Predictions indicate a further **2°C rise by 2100**.
- ❖ **Sea Level Concerns:** It is estimated that sea levels will rise by **48 cm by the end of the 21st century**, which would lead to more frequent flooding events.

Conclusion

India's weather is a mix of **complex patterns** primarily influenced by the monsoons. The oscillation between the **dry north-easterly winds and moisture-rich south-westerly winds** produces the subcontinent's different climatic zones, however, the **Himalayas** and the **oceans** also play important roles in regulating temperatures. India's climate is an excellent example of both **unity and diversity**, with severe temperatures in places like Rajasthan and Ladakh and a variety of precipitation patterns from Meghalaya to Tamil Nadu.

Glossary:

- **Climate:** It is the average weather conditions of a place over a period of years.
- **Precipitation:** It is any liquid or frozen water that falls from the sky and reaches the ground.
- **Frost:** The thin, white layer of ice that forms when the air temperature is below the freezing point of water, especially outside at night.
- **Isobars:** A line on a map or chart that connects places of equal barometric pressure.
- **Jet streams:** These are narrow bands of strong wind that generally blow from west to east all across the globe. The two most constant jet streams are the mid-latitude and subtropical jet streams.
- **The Intertropical Convergence Zone (ITCZ):** It is the region that circles the Earth, near the equator, where the trade winds of the Northern and Southern Hemispheres come together.
- **El Niño:** It is a climate pattern that describes the unusual warming of surface waters in the eastern Pacific Ocean.
- **La Niña:** It is a climate pattern that describes the cooling of surface-ocean water along the tropical west coast of South America.
- **Monsoon:** It is a seasonal change in the direction of the prevailing, or strongest, winds of a region.
- **Rainforest:** It is an area of tall, mostly evergreen trees with a high amount of rainfall.



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Natural Hazards and Disasters

Bibliography: This chapter encompasses the summary of chapter 6- XI NCERT (India Physical Environment) and Unit 11- XI CBSE (A Supplementary Textbook in Geography).

Introduction

Disasters are as old as human history but the dramatic increase and the damage caused by them in the recent past have become a cause of national and international concern. A Disaster is a serious disruption of the functioning of a community or a society involving widespread human, material, economic or environmental losses and impacts, which exceed the ability of the affected community or society to cope using its own resources. Disasters can be caused by naturally occurring events, such as earthquakes, hurricanes, flooding, or tornadoes, or they can be due to man-made events, either accidental (such as an accidental toxic spill or nuclear power plant event), or deliberately caused (such as various terrorist bombings and poisonings).

Meaning of Disaster

- ❖ Disaster can be **defined** as “A serious disruption in the functioning of the community or a society causing widespread material, economic, social or environmental losses which exceed the ability of the affected society to cope using its own resources”.
- ❖ It is a result of the combination of **hazard, vulnerability and insufficient capacity** to reduce the potential chances of risk (**Refer to Figure 5.1**).

Word Origin

The term disaster owes its origin to the French word “**Desastre**” which is a combination of two words ‘**des**’ meaning bad and ‘**aster**’ meaning star. Thus the term refers to ‘**Bad or Evil star**’.

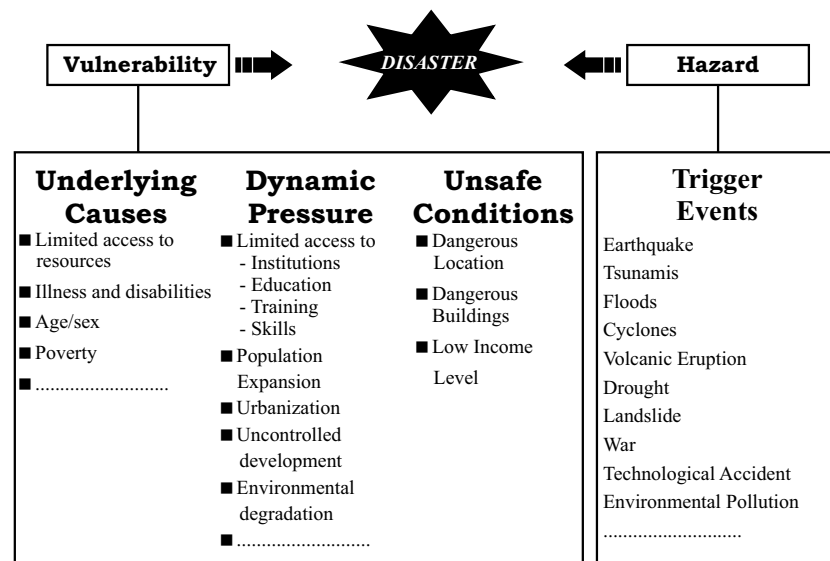


Figure 5.1: Meeting of Vulnerability and Hazard Causing Disaster



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- ❖ Drought and famine have proved to be the deadliest disasters globally, followed by floods, technological disasters, earthquakes, wind storms, extreme temperature, etc.
- ❖ Global economic loss related to disaster events averages around US \$880 billion per year. As per World Bank report of 2018 it is now US \$520 billion each year. Figure 5.2 shows the deadliest disasters of the decade (1992 – 2001).

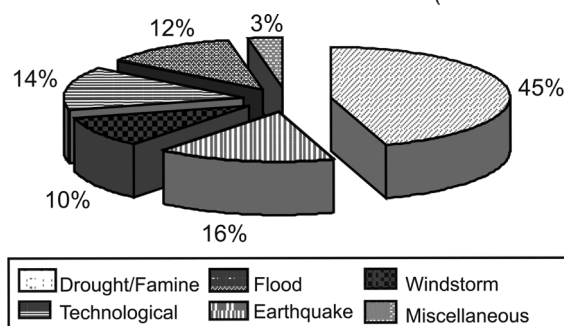


Figure 5.2: World Scenario: Reported Deaths from all Disasters (1992-2001)

Trend of Disaster in Recent Times

From 1994 to 1998, reported disasters average was 428 per year but from 1999 to 2003, this figure went up to an average of 707 disaster events per year showing an increase of about 60 per cent over the previous years.

The biggest rise was in countries of low human development, which suffered an increase of 142 percent.

Relationship between Hazard, Vulnerability and Disaster

- Any hazard – flood, earthquake or cyclone which is a triggering along with greater vulnerability would lead to disaster causing greater loss to life and property.
- However, with greater capacity of the individual/community and environment to face these disasters, the impact of a hazard reduces.
- Therefore, we need to understand the three major components namely hazard, vulnerability and capacity to have a basic understanding of disaster management.
- For example, an earthquake in an uninhabited desert isn't a disaster; it becomes one when it affects people and their assets. Hence, disasters occur when hazards and vulnerability intersect.

Hazard

- ❖ **Hazard** may be **defined** as “A dangerous condition or event that threatens or has the potential for causing injury to life or damage to property or the environment”.
- ❖ Hazards can be grouped into **two broad categories** namely **natural** and **manmade**.
- ❖ **Natural hazards:** These hazards have **natural origin** such as meteorological, geological or even biological origin.
 - ❖ Geological origins such as tsunamis, earthquakes, volcanoes etc.
 - ❖ Meteorological origins such as cyclones, cloudburst, etc.
 - ❖ Biological origins such as viral, fungal etc.

Additional Information

Hazards are always prevalent, but the hazard becomes a disaster only when there is greater vulnerability and inadequate capacity to cope with it.

Types	Hazards
Geological Hazards	Earthquake, Landslide, Tsunami, Dam burst, Volcanic eruption, and Mine Fire, Landslide.
Water & Climatic Hazards	Tropical Cyclone, Tornado and Hurricane, Cloudburst, Floods, Drought, Hailstorm, Heat & Coldwave, Snow Avalanche, Coastal Erosion.
Environmental Hazards	Environmental pollutions, Desertification, Deforestation, Pest Infection.
Biological	Human/Animal Epidemics, Pest attacks, Food poisoning, Weapons of Mass Destruction.

Chemical, Industrial and Nuclear Accidents	Chemical disasters, Oil spills/Fires Industrial disasters, Nuclear
Accident related	Boat/Road/Train accidents/air crash, Urban fires, Forest fires, Electric Accidents, Building collapse, Festival related disasters, Mine flooding

- ❖ **Manmade hazards:** These occur **due to human negligence** and are associated with industries or energy generation facilities and include explosions, leakage of toxic waste, pollution, dam failure, wars etc

Vulnerability

- ❖ **Vulnerability** may be **defined** as “the extent to which a geographic area is likely to be damaged or disrupted by the impact of a particular hazard, on account of their nature, construction and proximity to hazardous terrains or disaster-prone area”.
- ❖ Vulnerabilities can be categorised into **physical and socio-economic vulnerability**.

Physical Vulnerability:

- ❖ It includes notions of **who and what** may be damaged or destroyed by natural hazards.
- ❖ It is based on the physical condition of people and elements at risk, such as buildings, infrastructure etc.

Socio-economic Vulnerability:

- ❖ It refers to the degree to which individuals and communities are susceptible to harm from disasters due to their social and economic status. For example, people who are poor and living on the sea coast are generally at higher risk vis-a-vis rich people in case of cyclones and floods.

Risk

- ❖ Risk is a measure of the expected losses due to a hazard event occurring in a given area over a specific time period.
- ❖ It is a function of the probability of a particular hazardous event and the losses each would cause.
- ❖ A community is said to be at ‘risk’ when it is exposed to hazards and is likely to be adversely affected by its impact.

POINTS TO PONDER

Disasters cause large scale destruction and damage to life and property. However, the disaster's effect is amplified with increased vulnerability. Can you think of the factors that can make some people more vulnerable than others?



POINTS TO PONDER

Natural Hazards such as Floods, Tsunamis, Landslides etc. are known for wreaking havoc and leading to loss of life and property. Are natural hazards truly natural? Do humans play a significant role affecting their intensity and frequency?



Classification of Natural Disasters

Earthquakes

Earthquake refers to the sudden shaking of the earth's crust. It is highly destructive of all the natural disasters.

Causes of Earthquakes

- ❖ **Earthquakes due to Plate Tectonics:** 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.

Do You know?

An earthquake with a magnitude 7.5 on the Richter scale releases 30 times the energy than one with 6.5 magnitudes. An earthquake of magnitude 3 is the smallest normally felt by humans.

- ❖ **Earthquakes due to other causes:** It could also be triggered by volcanic eruption, rock falls, landslides, subsidence, particularly in the mining areas, impounding of dams and reservoirs, etc.

Measuring Earthquakes

- ❖ Earthquakes can be measured by the use of **two distinctively different scales of measurement** demonstrating magnitude and intensity.

Do You know?

The largest earthquake that has been recorded with Richter Scale is 9.25 (Alaska, 1969 and Chile, 1960).

1. Richter Scale

- ❖ Earthquake **magnitude** is determined by the use of a **seismograph**, which is an instrument that continuously records ground vibration. The scale was developed by a seismologist named **Charles Richter**, so-called the Richter Scale.

List of Significant Earthquakes in India		
Year	Location	Magnitude of 6+
1950	Arunachal Pradesh - China Border	8.5
1956	Anjar, Gujarat	7.0
1967	Koyna, Maharashtra	6.5
1975	Kinnaur, Himachal Pradesh	6.2
1988	Manipur - Myanmar Boarder	6.6
1988	Bihar - Nepal Border	6.4
1991	Uttarkashi - Uttar Pradesh Hills	6.0
1993	Latur - Maharashtra	6.3
1997	Jabalpur, Madhya Pradesh	6.0
1997	Chamoli, Uttar Pradesh	6.8
2001	Bhuj, Gujarat	6.9
2005	Muzaffarabad (Pakistan) Impact in Jammu & Kashmir	7.4

2. Mercalli Scale

- ❖ The second type of scale, **the earthquake intensity scale** measures the **effects** of an earthquake where it occurs and was developed in **1902** by **Mercalli**, an Italian seismologist. Hence this scale is called the **Mercalli scale**.
- ❖ Mercalli Scale expresses the intensity of an earthquake's effect on people, structure and the earth's surface in values from I to XII.
 - ✧ Intensity of VI and below: People can feel the shake and there are cracks in the walls.
 - ✧ Intensity of XII: General panic with buildings collapsing totally and there is a total disruption in normal life.

Distribution Pattern of Earthquakes in India

- ❖ The **seismic zoning map** of India (Refer Figure 5.3) is divided into the following five earthquake zones:
 - ✧ Very high damage risk zone
 - ✧ High damage risk zone
 - ✧ Moderate damage risk zone
 - ✧ Low damage risk zone
 - ✧ Very low damage risk zone



Additional Information

- The Indian plate is slowly moving northwards at a rate of one centimeter per year, encountering resistance from the Eurasian plate to the north.
- This ongoing pressure buildup eventually results in the sudden release of energy, leading to earthquakes along the Himalayan region.
- Areas most susceptible to these earthquakes include Jammu and Kashmir, Ladakh, Himachal Pradesh, Uttarakhand, Sikkim, Darjeeling in West Bengal, and all seven northeastern states.

- ❖ **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) and Kashmir Valley in the Himalayan region and the Kachchh (Gujarat) are included in the **Very High Damage Risk Zone**.
- ❖ **High damage risk zone:** Parts of Jammu and Kashmir, Ladakh, Himachal Pradesh, Northern parts of Punjab, Eastern parts of Haryana, Delhi, Western Uttar Pradesh, and Northern Bihar fall under the High Damage Risk Zone.
- ❖ Remaining parts of the country fall under **Moderate to very Low Damage Risk Zone**. Most of the areas of the Deccan plateau are considered safe as far as earthquakes are concerned.

Do You Know ?

New Delhi lie in very high damage risk zone whereas big cities like Mumbai and Chennai are in moderate damage risk zone.

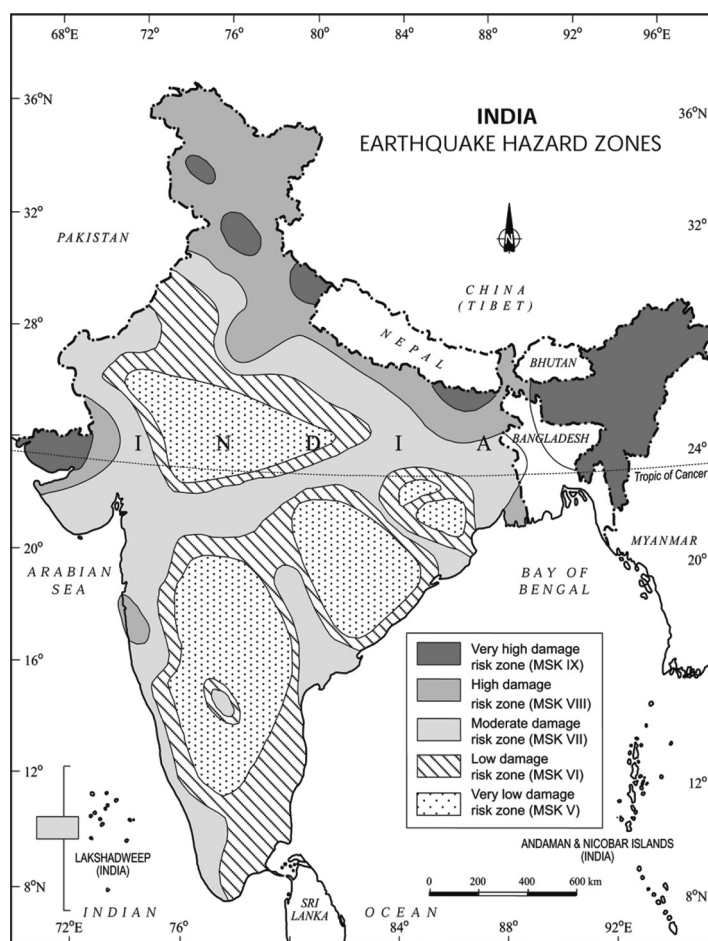


Figure 5.3: Earquake Hazard Zones in India

Consequences of Earthquakes

- ❖ Earthquakes are often associated with fear and horror due to the **scale, magnitude and suddenness** at which it spreads disasters on the surface of the earth.
- ❖ It becomes a **calamity** when it strikes the areas of high density of population.
- ❖ It damages and destroys the **settlements, infrastructure, transport and communication network, industries and other developmental activities.**
- ❖ It robs the population of the **material and socio-cultural gains** that they have preserved over generations.
- ❖ It renders people homeless, which puts pressure and stress, particularly on the weak economy of developing countries.
- ❖ It also causes **fires, dam failure and landslides** which may block waterways and also cause **flooding.**
- ❖ It may damage manufacturing industries and break down communication facilities.
- ❖ There is also a huge loss to the public health system, transport, communication and water supply in the affected areas.
- ❖ Surface seismic waves produce fissures on the upper layers of the earth's crust through which water and other volatile materials gush out, inundating the neighbouring areas.

Earthquake Hazard Mitigation

- ❖ It is not possible to prevent **the occurrence of an earthquake.** Hence, the next best option is to emphasise disaster preparedness and mitigation rather than curative measures. such as:
- ❖ 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.
- ❖ Preparing a **vulnerability map** of the country and dissemination of vulnerability risk information among the people.
- ❖ Educating people about the ways and means of minimising the adverse impacts of disasters.
- ❖ Modifying the house types and building designs in the vulnerable areas and discouraging the construction of highrise buildings, large industrial establishments and big urban centres in such areas.
- ❖ Making it mandatory to adopt earthquake-resistant designs and use of light materials in major construction activities in vulnerable areas.

Tsunami

- ❖ The term Tsunami has been derived from the Japanese term Tsu meaning '**harbour**' and tsunami meaning '**waves**'.
- ❖ A tsunami refers to a series of large waves usually noticed on sea or ocean surfaces that can lead to a considerable amount of loss of life and property. It is a sudden displacement of water that can take place in any waterbody if underlying causes are present there.
- ❖ Phenomena such as Earthquakes, landslides, volcanic eruptions or large meteoroid impacts result in sudden displacement of ocean water.

Do You Know?

Sometimes, Tsunami wave height can go upto 15m or more, which causes large-scale destructions along the shores. Thus, these are also called Shallow Water Waves.



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Causes of a Tsunami

- ❖ The geological movements that cause tsunamis are produced in **three major ways**:
 - ❖ **Fault movements** on the seafloor, accompanied by an earthquake cause tsunamis.
 - ❖ **Landslides** either occurring underwater or originating above the sea.
 - ❖ **Volcanic** activity near the shore or underwater such as in 1883, the violent explosion of the Krakatoa in Indonesia, produced a tsunami measuring 40 meters which crushed Java and Sumatra.

General Characteristics of Tsunami

- ❖ The speed of waves in the ocean depends upon the depth of the water. It is more in the shallow water than in the deep ocean. When a tsunami enters shallow water, its wavelength gets reduced and the period remains unchanged, which increases the wave height.
- ❖ The impact of tsunamis is **less over the ocean and more near the coast**.
- ❖ Tsunamis are frequently observed along the **Pacific Ring of Fire**, particularly along the coast of Alaska, Japan, the Philippines and other islands of Southeast Asia, Indonesia, Malaysia, Myanmar, Sri Lanka, and India.
- ❖ After reaching the coast, the tsunami waves release enormous energy and water flows turbulently onto the land destroying port cities, structures, buildings and other settlements.
- ❖ The mitigation of hazards created by tsunamis is difficult, it is beyond the capacity of individual states or governments to mitigate the damage. Hence, combined efforts at the international level are the possible ways of dealing with these disasters.

Do You Know?

India has volunteered to join the International Tsunami Warning System after the December 2004 tsunami disaster

Adverse Effects of Tsunami

- ❖ Local tsunami events or those less than 30 minutes from the source cause the majority of damage.
- ❖ **Flooding** during tsunamis causes major destruction to the human settlements, roads and infrastructure.
- ❖ Waves withdrawing back to the ocean, sweep out the foundations of the buildings, and houses carried out to sea.
- ❖ Damage to **ports and airports** may prevent the importation of needed food and medical supplies.
- ❖ Drowning deaths occur as people are either washed away or crushed by giant waves and debris during tsunamis.
- ❖ Basic civic facilities get hampered such as unavailability of drinking water, damaged sewage pipe etc.
- ❖ It may lead to crop loss, loss of livelihood like boats and nets, environmental degradation, etc.

Risk Reduction Measures

- ❖ **Tsunami walls** such as Japan tsunami walls of up to 4.5m (13.5 ft) high in front of populated coastal areas.
- ❖ **Flood gates and channels** to redirect the water from incoming tsunamis.
- ❖ **Site Planning and Land Management** is an important tool in reducing tsunami risk.



- ❖ **Educate the community** about good construction practices such as
 - ✧ Avoid building or living in buildings within several hundred feet of the coastline.
 - ✧ Construct the structure on a higher ground level with respect to mean sea level.
 - ✧ Elevate coastal homes
 - ✧ Construction water breakers to reduce the velocity of waves.
 - ✧ Use of water and corrosion-resistant materials for construction.
 - ✧ Construction of community halls at higher locations, which can act as shelters at the time of a disaster.
- ✧ **Flood management** to mitigate flooding resulting from a tsunami.

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 the surface to 12-14 km.
- ❖ It 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.

Cyclone Type	Region
Typhoons	Northwest Pacific Ocean (west of dateline)
Hurricanes	North Atlantic Ocean
	Northeast Pacific Ocean (east of dateline)
	South Pacific Ocean
Tropical Cyclones	Southwest Pacific Ocean
	Southeast Indian Ocean
Severe Cyclonic Storms	North Indian Ocean
Willie-Willie (Cyclone)	Australia
Tornadoes	South America

Condition for tropical cyclone

- ❖ **Warm sea surface** temperature **above 27 degrees Celsius**.
- ❖ Large and continuous **supply of warm and moist air** that can release enormous **latent heat**.
- ❖ Strong **Coriolis force** that can prevent the filling of low pressure at the centre (absence of Coriolis force near the equator prohibits the formation of tropical cyclones between 0° - 5° latitude).
- ❖ **Unstable condition through the troposphere** that creates local disturbances around which a cyclone develops.
- ❖ **Absence of strong vertical wind wedge**, which disturbs the vertical transport of latent heat.

POINTS TO PONDER

Indian Coasts are frequently hit by Tropical Cyclones causing large scale destruction. However, the frequency as well as the intensity of the Cyclones in the Bay of Bengal are much higher than those in the Arabian sea. What do you think might be the reasons behind this? Recently an increasing trend has been noticed in the Arabian sea. Find out the reasons for such a change.



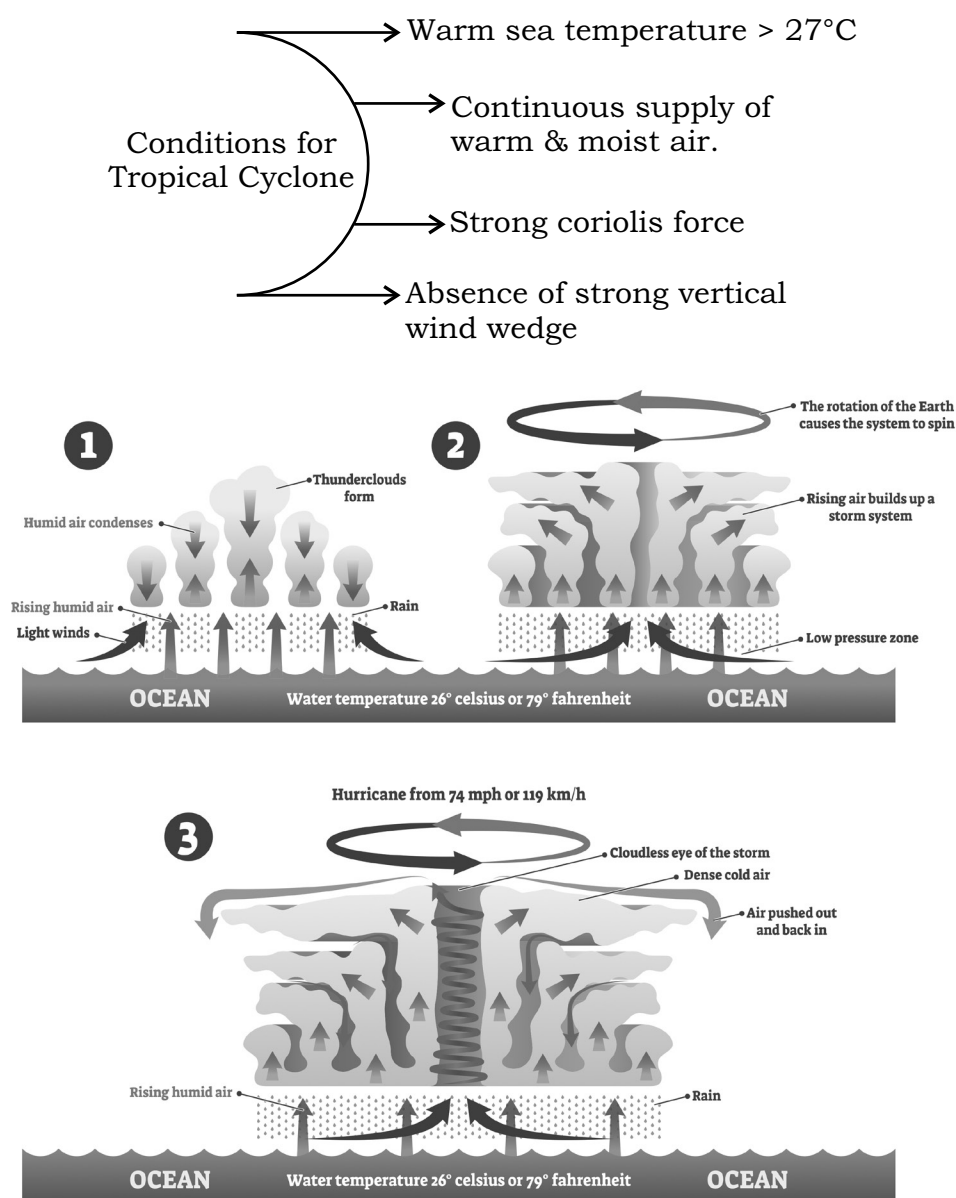


Figure 5.4: Stages of Cyclone Formation

Spatio-temporal Distribution of Tropical Cyclones 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 originate in these two important locations.
- ❖ The coastal areas are often struck by severe cyclonic storms with an average velocity of 180 km/h.
- ❖ Most of the cyclones originate between **10° - 15° north latitudes** during the monsoon season.
- ❖ However, in the case of the Bay of Bengal, cyclones mostly develop during the months of October and November. Here, they originate between 16° - 20° 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.

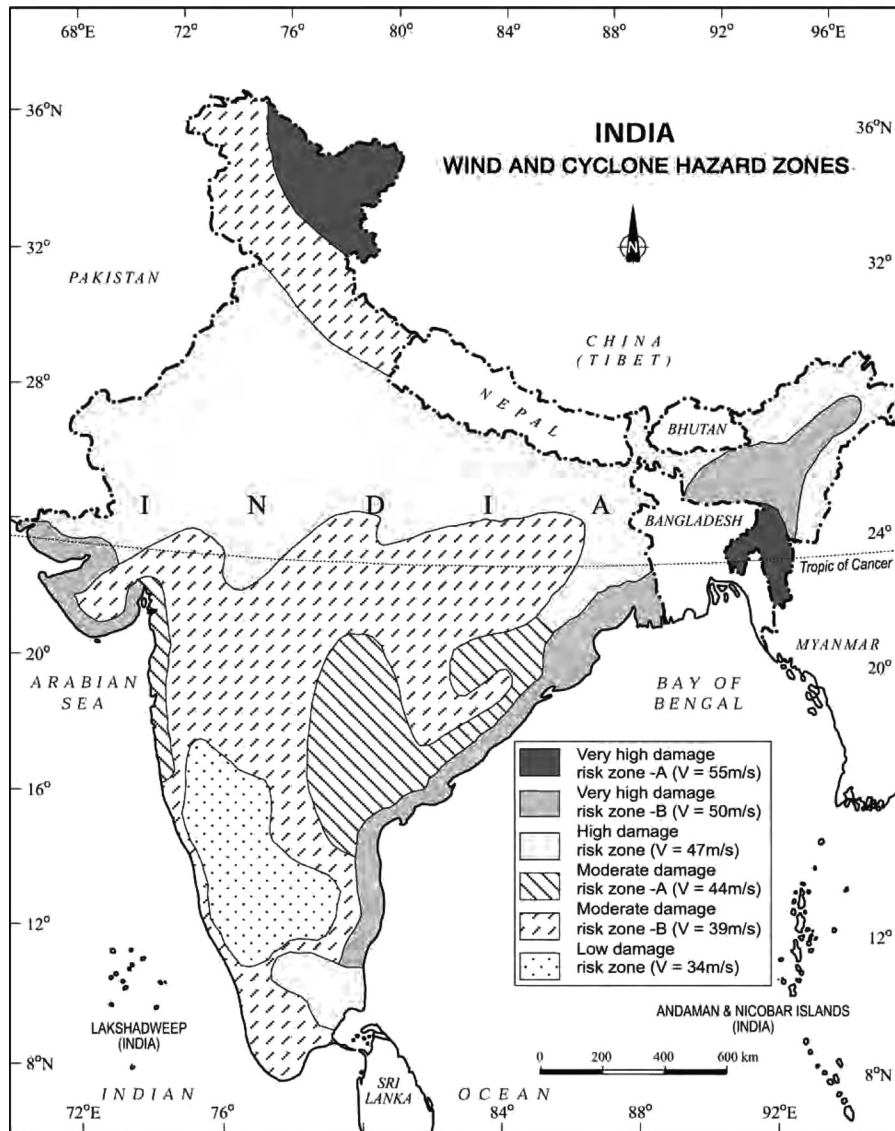


Figure 5.5: Wind and Cyclone Hazard Zones

Consequences of Tropical Cyclones

- ❖ Sudden, brief onslaught, high winds cause major damage to infrastructure and housing.
- ❖ Abnormal rise in the sea level known as **Storm Surge** resulting in inundation of human settlements, and agricultural fields.
- ❖ **Ground and pipe water supply** may get contaminated by flood waters.
- ❖ High winds and rains **ruin the standing crops and food stock** lying in low-lying areas.
- ❖ Salt from the seawater may get deposited on the agricultural land and increase the salinity.
- ❖ The loss of the crop may lead to acute food shortage.
- ❖ Disruption in the **communication links** as the wind may bring down the electricity and communication towers.
- ❖ Transport lines (road and rail) may be curtailed, lack of proper communication affects the effective distribution of relief materials.

Risk Reduction Measures

- ❖ **Coastal belt Plantation:** It act as a wide buffer zone against strong winds and flash floods.
- ❖ **Hazard Mapping:** A hazard map will show areas vulnerable to cyclones. It will be useful for disaster risk preparedness.
- ❖ **Good Construction Practices** (Refer Figure 5.6) should be adopted such as:
 - ❖ House design: All elements holding the structures need to be properly anchored to resist the uplift or flying off of the objects.
 - ❖ A row of planted trees will act as a shield. It reduces the energy.
 - ❖ Buildings should be wind and water-resistant.
 - ❖ Buildings storing food supplies must be protected against the winds and water.
 - ❖ Communication lines should be installed underground.
 - ❖ Provide strong halls for community shelter in vulnerable locations.

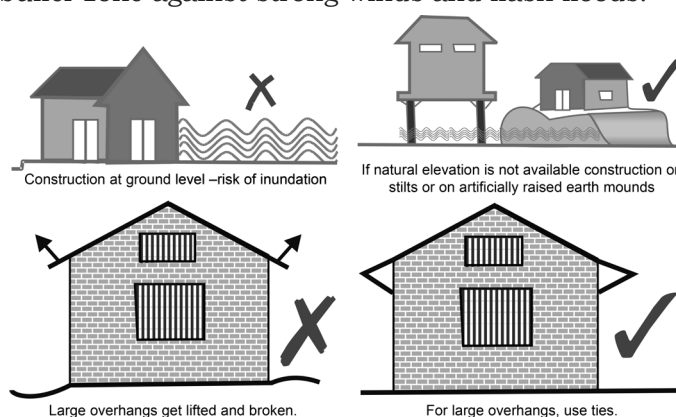


Figure 5.6: Safe Construction Practices

Floods

- ❖ A flood is an overflow of water that submerges land which is usually meant to be dry. While it may occur along river banks, lakes and sea coasts, river flooding is the most common of all around the world.
- ❖ Inundation of land and human settlements by the rise of water in the channels and its spill-over presents the condition of flooding.
- ❖ Floods are relatively slow in occurrence and often occur in well-identified regions and within the expected time in a year.

Causes of Floods

- ❖ Floods can **result from various factors**, including storm surges in coastal regions, prolonged high-intensity rainfall, ice and snowmelt, reduced infiltration rates, and the presence of eroded materials in water due to increased soil erosion.
- ❖ Indiscriminate deforestation, unscientific agricultural practices, disturbances along natural drainage channels, and the colonization of floodplains and riverbeds collectively increase the intensity, magnitude, and gravity of floods.

Distributional Pattern of Floods in India

- ❖ **Rashtriya Barh Ayog (National Flood Commission)** identified 40 million hectares of land as flood-prone in India. Most flood-affected states are Assam, West Bengal and Bihar (Refer to figure 5.7)
- ❖ Most of the rivers in the northern states like Punjab and Uttar Pradesh are also vulnerable to occasional floods.
- ❖ Sometimes, **Tamil Nadu** experiences flooding during **November-January** due to the retreating monsoon.

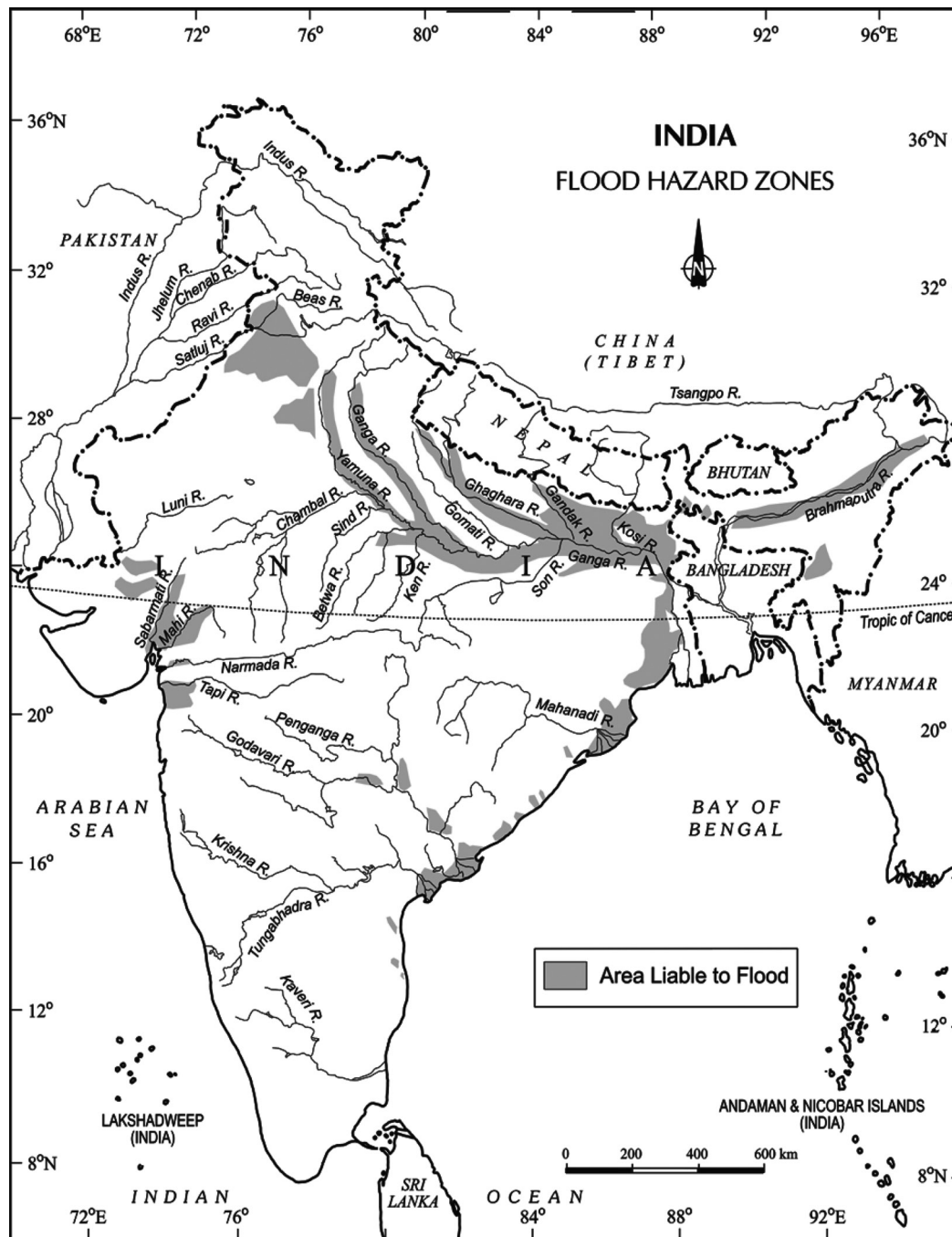


Figure 5.7: Flood Hazard Zones

Negative Consequences of Floods

- ❖ Floods destroy valuable crops every year.
- ❖ It damages **physical infrastructure** such as roads, rails, bridges and human settlements.
- ❖ Millions of people are rendered homeless and are also washed down along with their cattle in the floods.
- ❖ It also spreads diseases like cholera, gastro-enteritis, hepatitis and other waterborne diseases.

Positive Consequences of Floods

- ❖ Every year, floods deposit **fertile silt** over agricultural fields which is good for the crops.
- ❖ **Majuli** (Assam), the largest riverine island in the world, is the best example of good paddy crops after the annual floods in Brahmaputra.

Flood Mitigation

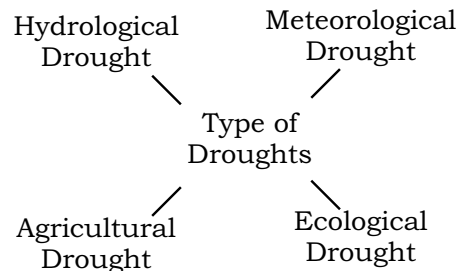
- ❖ Construction of flood protection embankments in flood-prone areas.
- ❖ Construction of dams, afforestation.
- ❖ Discouraging major construction activities in the upper reaches of most of the flood-creating rivers.
- ❖ Removal of human encroachment from the river channels and depopulating the flood plains. This is particularly true in western and northern parts of the country which experience flash floods.
- ❖ Cyclone centres may provide relief in coastal areas which are hit by a storm surge.

Droughts

- ❖ It refers to the absence of water for a long period of time, at a place.

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. Moreover, if an area has more than 30 per cent of its gross cropped area under irrigation, the area is excluded from the drought-prone category.
- ❖ **Hydrological Drought:** 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 a shortage of water and as a consequence of ecological distress, damages are induced in the ecosystem.



Drought Areas in India

- ❖ Nearly 19 per cent of the total geographical area of the country and 12 per cent of its total population suffer due to drought every year.
- ❖ On the basis of the severity of droughts, India can be divided into the following regions:
 - ✧ **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 Odisha 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.

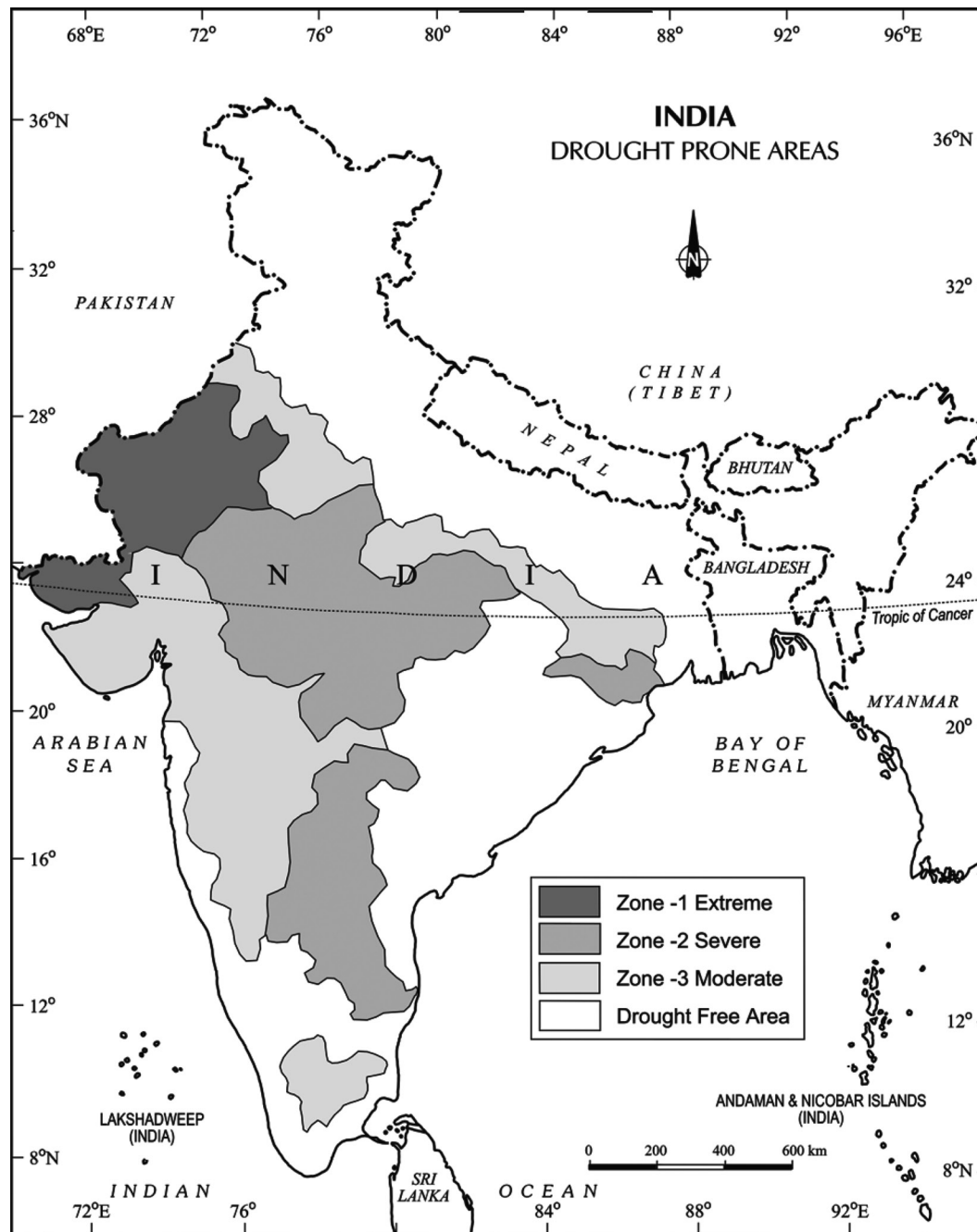


Figure 5.8: Drought Prone Areas

Consequences of Drought

- ❖ **Crop failure** leads to scarcity of food grains (akal), and fodder (trinkal).
- ❖ **Large-scale death of cattle** and other animals.
- ❖ Migration of humans and livestock.
- ❖ Scarcity of water compels people to consume **contaminated water** resulting in the spread of many waterborne diseases like gastroenteritis, cholera, hepatitis, etc.

Measures

Droughts have both immediate as well as long-term disastrous consequences on the social and physical environments. Thus, planning for drought has to take both aspects into consideration.

Immediate measures:

- ❖ Provision for the distribution of safe drinking water.
- ❖ Medicines for the victims.
- ❖ Availability of fodder and water for the cattle.
- ❖ Shifting of the people and their livestock to safer places.

Long-term measures:

- ❖ Identification of groundwater potential in the form of aquifers.
- ❖ Transfer of river water from the surplus to the deficit areas.
- ❖ Planning for inter-linking of rivers.
- ❖ Construction of reservoirs and dams.
- ❖ Remote sensing and satellite imageries can be useful in identifying the possible river basins that can be interlinked and in identifying the groundwater potential.
- ❖ Dissemination of knowledge about drought-resistant crops and proper training to farmers.
- ❖ Rainwater harvesting can be an effective method in minimising the effects of drought.

Landslides

- ❖ A **sudden movement of rock, boulders, earth or debris down a slope** is termed a landslide.
- ❖ Landslides are **natural disasters occurring mainly in mountainous terrains** where there are conducive conditions of soil, rock, geology and slope.
- ❖ Landslides are sudden, unpredictable and are largely controlled by macro or regional factors, landslides are largely controlled by highly localised factors.

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**,
 - ❖ Areas that experience frequent **ground-shaking due to earthquakes**.
 - ❖ Areas of **intense human activities**, particularly those related to the construction of roads, dams, etc. are included in this zone.
- ❖ **High Vulnerability Zone:** All the Himalayan states and the states from the northeastern 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**.
 - ❖ **The Deccan plateau also** experiences occasional landslides.



- ❖ Landslides due to mining and subsidence are most common in states like Jharkhand, Odisha, Chhattisgarh, Madhya Pradesh, Maharashtra, Andhra Pradesh, Karnataka, Tamil Nadu, Goa and Kerala.
- ❖ **Other Areas:** The remaining parts of India, particularly states like Rajasthan, Haryana, Uttar Pradesh, Bihar, West Bengal (except district Darjeeling), Assam (except district Karbi Anglong) and Coastal regions of the southern States are safe as far as landslides are concerned.

Consequences of Landslides

- ❖ Landslides have a relatively small and localised area of direct influence.
- ❖ Roadblocks, destruction of railway lines and channel-blocking due to rock falls.
- ❖ Diversion of river courses due to landslides can also lead to flood and loss of life and property.
- ❖ It also makes spatial interaction difficult, risky as well as a costly affair, which, adversely affects the developmental activities in these areas.

Mitigation

- ❖ **Adoption of area-specific measures** to deal with landslides.
- ❖ In the high vulnerability zones, there should be restrictions on the construction and other developmental activities such as roads and dams.
- ❖ **Limiting agriculture to valleys** and areas with moderate slopes.
- ❖ Control on the development of large settlements should be enforced.
- ❖ **Promoting large-scale afforestation programmes.**
- ❖ **Construction of bunds** to reduce the flow of water.
- ❖ **Terrace farming should be encouraged in the northeastern hill states** where Jhumming (Slash and Burn/Shifting Cultivation) is still prevalent.

Disaster Management

- ❖ It is mainly a disaster Risk Reduction strategy involved in a continuous and integrated process of planning, organising, coordinating and implementing measures.
- ❖ It includes all measures which reduce disaster-related losses of life, property or assets by either reducing the hazard or vulnerability of the elements at risk.
- ❖ Disaster Risk Reduction initiatives are generally based on two-pronged strategies of Preparedness and Mitigation.

Disaster Risk Reduction

1. Preparedness:

- Measures taken before the occurrence of disaster aimed at minimising loss of life, disruption of critical services, and damage when the disaster occurs.
- **Preparedness includes the formulation** of viable emergency plans, development of warning systems, maintenance of inventories, training of personnel, search and rescue measures, and evacuation plans for areas at risk from a recurring disaster.

2. Mitigation:

- Measures taken to reduce both the effect of the hazard and the vulnerability in order to reduce the scale of a future disaster.
- **Examples of mitigation measures:** Water management in drought-prone areas, relocating people away from the hazard-prone areas, strengthening structures to reduce damage when a hazard occurs, and reducing the economic and social vulnerabilities of potential disasters.

Disaster Management Cycle

- ❖ Disaster Management includes the sum total of all activities, programmes and measures which can be taken up **before, during** and **after** a disaster with the purpose of avoiding a disaster, reducing its impact or recovering from its losses.

The three key stages of disaster risk management are:

1. Before a disaster (Pre-disaster)

- ❖ Activities taken to reduce human and property losses caused by a potential hazard.
- ❖ For example carrying out awareness campaigns, strengthening the existing weak points structures, preparation of the disaster management plans at household and community level etc.

2. During a disaster (Disaster occurrence): Initiatives are taken to ensure that the needs of victims are met and suffering is minimised. Activities taken under this stage are called emergency response activities.

3. After a disaster (Post-disaster): Initiatives taken in response to a disaster with the purpose to achieve early recovery and rehabilitation of affected communities, immediately after a disaster strikes. These are called response and recovery activities.

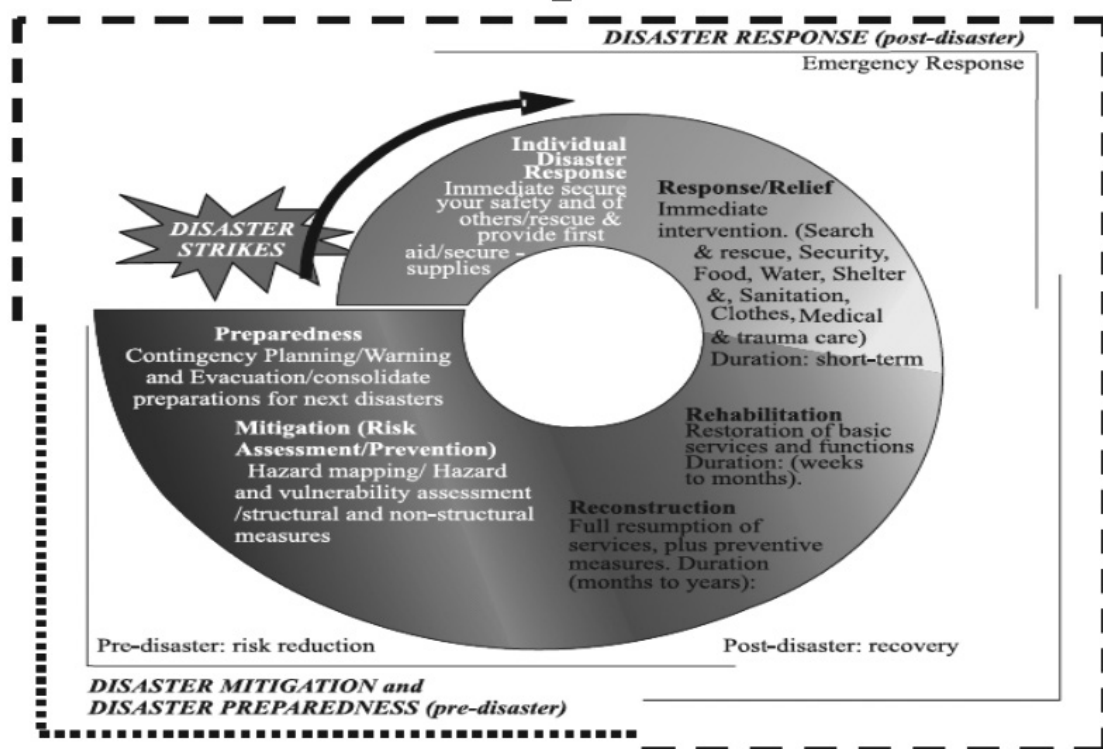


Figure 5.9: Disaster Management

Yokohama Strategy and International Decade for Natural Disaster Reduction (IDNDR) Yokohama Strategy and Plan of Action for a Safer World

- All the member states of the United Nations and other states met at the World Conference on Natural Disaster Reduction in the city of Yokohama from May 23rd-27th, 1994.
- It acknowledged that the impact of natural disasters in terms of human and economic losses has risen in recent years, and society, in general, has become vulnerable to natural disasters.

- It also accepted that these disasters affected the poor and disadvantaged groups the worst, particularly in the developing countries, which are ill-equipped to cope with them.
- The conference adopted the **Yokohama strategy** as a guide to the rest of the decade and beyond, to mitigate the losses due to these disasters.
- The resolution of the World Conference on Natural Disasters Reduction is as mentioned below:
 - ✧ Priority attention to the developing countries, particularly the least developed, land-locked countries and small-island developing states.
 - ✧ Developing and strengthening national capabilities and, where appropriate, national legislation for natural and other disaster prevention, mitigation and preparedness, including the mobilisation of non-governmental organisations and participation of local communities.
 - ✧ Promoting and strengthening sub-regional, regional and international cooperation in activities to prevent, reduce and mitigate natural and other disasters, with particular emphasis on
 - ❑ Human and institutional capacity-building and strengthening.
 - ❑ Technology sharing: the collection, dissemination and utilisation of information.
 - ❑ Mobilisation of resources.
- It also declared the decade 1990-2000 as the International Decade for Natural Disaster Reduction (IDNDR).

Conclusion

On the basis of the above discussion, it can be concluded that disasters can be natural or the results of human activities, and all hazards need not turn into disasters. Since it is difficult to eliminate disasters, particularly natural disasters, the next best option is mitigation and preparedness. The passing of the **Disaster Management Act, of 2005** and the establishment of the **National Institute of Disaster Management** are some examples of the positive steps taken by the Government of India.

Glossary

- **Disaster:** A serious disruption in the functioning of the community or society.
- **Hazard:** A dangerous condition or event that threatens or has the potential to cause injury to life or damage to property.
- **Famine:** A lack of food over a long period of time in a large area that can cause the death of many people.
- **Technological Disaster:** A technological disaster is an event caused by a malfunction of a technological structure or some human error in controlling or handling the technology.
- **Wind Storm:** A wind that is strong enough to cause light damage to trees and buildings and may or may not be accompanied by precipitation. Wind speeds during a windstorm typically exceed 55 km per hour.
- **Meteorology:** Meteorology is the study of the atmosphere, atmospheric phenomena, and atmospheric effects on our weather.
- **Meteorological Disaster:** Disaster caused by extreme weather produced by the earth's atmosphere.
- **Geological Disaster:** Natural disasters caused by a geological process are called geological disasters. These are earthquakes, tsunamis, volcanic eruptions, and landslides.
- **Epidemic:** An epidemic is a sudden disease outbreak that affects a large number of people in a particular region, community, or population.
- **Tectonic Plate:** A tectonic plate is a massive, irregularly shaped slab of solid rock, generally composed of both continental and oceanic lithosphere.
- **Disaster Management Act, 2005:** The act aims to establish an efficient disaster management system for the country in the event of natural and man-made calamities.





Soils

Bibliography: This chapter encompasses the summary of Chapter 2 of Class VII NCERT and Chapter 6 of Class XI NCERT.

Introduction

Soil, which is crucial for sustaining various life forms, evolves from the weathering of parent rock material over millennia. It is a major source of our food and some clothing materials. Soil formation is determined by multiple factors, including **climate, vegetation, and human activity**, which comprise components like **minerals, humus, water, and air**. Also, the various agents of weathering and gradation have acted upon the parent rock material to produce a thin layer of soil. Understanding and classifying soil through scientific study is vital for sustainable utilisation and enhancing its productivity.

Soil

- ❖ Soil is a mixture of rock debris and organic materials that develop on the earth's surface.
- ❖ The arrangement of layers of soil is known as the soil profile. It has **three layers**:
 - ❖ Horizon A with organic and mineral matter,
 - ❖ Horizon B as a transitional zone,
 - ❖ Horizon C with loose parent material

POINTS TO PONDER

Have you ever wondered how soil is formed and how lack of rain or excess of rain can affect the characteristics of soil? Can you think of other factors that affect the formation of soil and contribute to variation of its characteristics? And how variation in characteristics contributes to variation in crop pattern, culture, food choices etc?

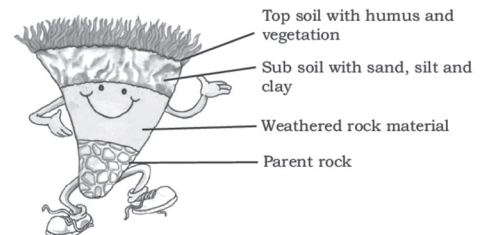
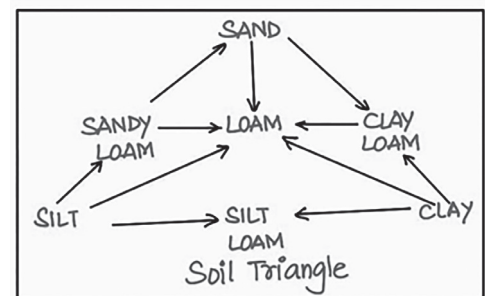


Figure 6.1: Soil Profile

Classification of Soils

- ❖ The **diverse relief and climatic conditions of India** have led to a variety of soils in the region.
- ❖ Historically, the soil was initially categorised simply as **fertile (Urvara) or sterile (Usara)**.
- ❖ In the 16th century, classification evolved to consider various factors like **texture, colour, land slope, and moisture content**, leading to the identification of main soil types such as **sandy, clayey, silty, and loam**, along with colour-based classifications like **red, yellow, and black**.



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ICAR has classified the soils of the India into the following order as per the USDA soil taxonomy

S.I. No.	Order	Area (in Thousand Hectares)	Percentage
(i)	Inceptisols	130372.90	39.74
(ii)	Entisols	92131.71	28.08
(iii)	Alfisols	44448.68	13.55
(iv)	Vertisols	27960.00	8.52
(v)	Aridisols	14069.00	4.28
(vi)	Ultisols	8250.00	2.51
(vii)	Mollisols	1320.00	0.40
(viii)	Others	9503.10	2.92
	Total		100

- Post-independence, scientific examinations greatly expanded with the establishment of the **Soil Survey of India in 1956** and contributions from the **National Bureau of Soil Survey** under the **Indian Council of Agricultural Research (ICAR)**
- Significant studies were undertaken in areas like **Damodar Valley**.
- ICAR, aligning with international standards, has based recent soil classifications on the **United States Department of Agriculture (USDA) Soil Taxonomy**, furthering the understanding and standardization of Indian soil types.

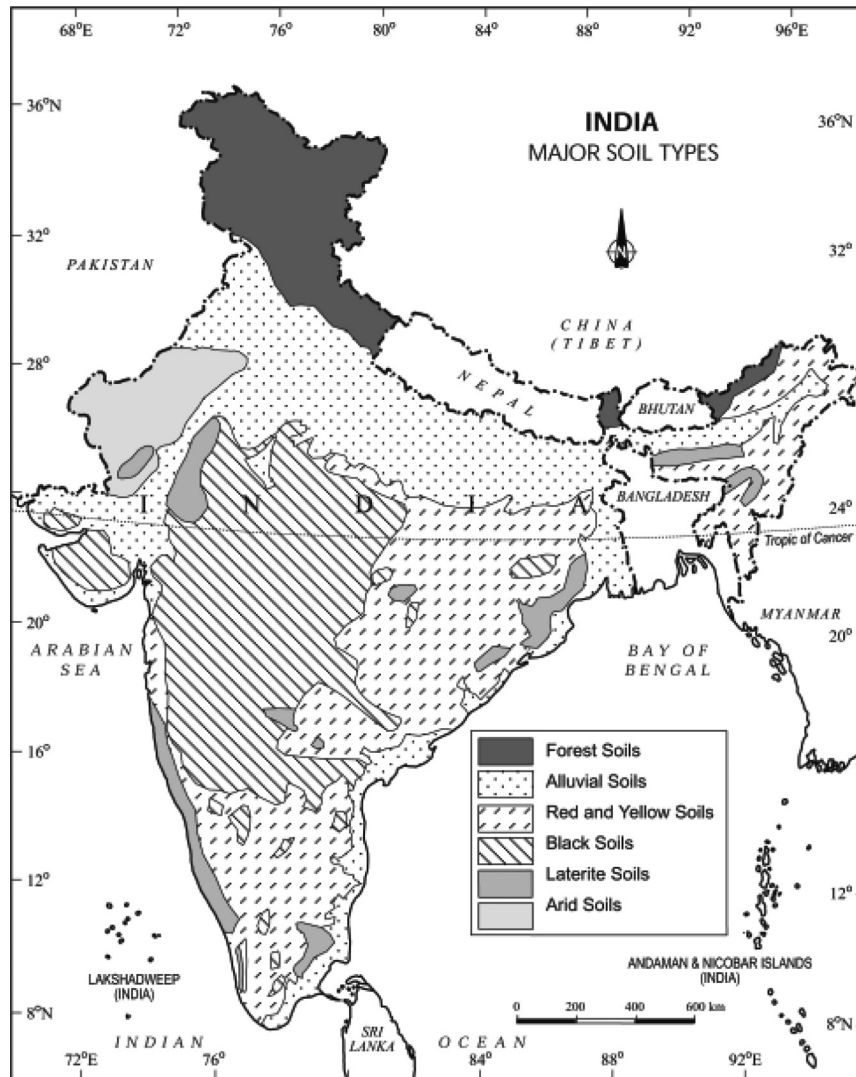


Figure 6.2: Major Soil Types of India

Alluvial Soils

Area

- ❖ These soils, prevalent in northern plains and river valleys, covering about 40% of India's terrain, are majorly transported and deposited by rivers, extend through **Rajasthan to Gujarat's plains**, and are also seen in **eastern deltas** and river valleys of the Peninsular region (Refer to Figure 6.2).

Characteristics

- ❖ Notably, in the **Upper and Middle Ganga plains**, two distinct types, **Khadar (new alluvium)** and **Bhangar (older alluvium)**, are found.
 - ❖ **Khadar** is enriched annually by flood deposits.
 - ❖ **Bhangar** is located away from flood plains.
 - ❖ Both types bear calcareous concretions known as **Kankars**.
- ❖ These soils become more loamy and clayey, moving from the lower Ganga plain to the Brahmaputra valley, with sand content **reducing from west to east**.
- ❖ Alluvial soils exhibit a colour spectrum from light grey to ash grey, with shades depending on deposition depth, material texture, and maturity time.
- ❖ Due to their fertility, alluvial soils are heavily cultivated.

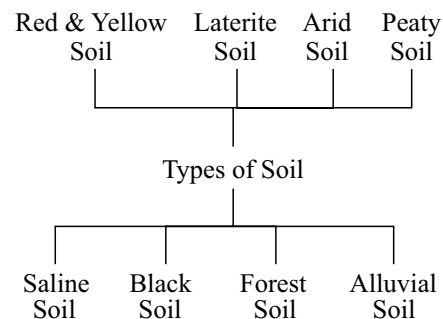


Figure 6.3: Alluvial Soil

Mineral composition

- ❖ Their texture ranges from sandy loam to clay, generally rich in potash but lacking in phosphorus.

Black Soil

Area

- ❖ It predominantly covers the Deccan Plateau and is found in parts of Maharashtra, Madhya Pradesh, Gujarat, Andhra Pradesh, and Tamil Nadu, with significant depth in the upper reaches of the Godavari and Krishna rivers and the north-western Deccan Plateau. (Refer to Figure 6.4)



Figure 6.4: Black Soil during Dry Season

Characteristics

- ❖ It is also referred to as '**Regur Soil**' or '**Black Cotton Soil**', these soils are characterised by their **clayey, deep, and impermeable nature**.
- ❖ They exhibit a unique behaviour of **swelling** and becoming **sticky** when wet and shrinking upon drying, leading to wide cracks during dry seasons, a phenomenon referred to as '**self-ploughing**'.
- ❖ This characteristic enables slow **moisture absorption and retention**, benefiting crops, especially rain-fed ones, by providing moisture during dry periods.

Mineral Composition

- ❖ On a chemical level, **black soils are rich in lime, iron, magnesia, and alumina, with a good content of potash, but are deficient in phosphorus, nitrogen, and organic matter.**
- ❖ Their colour spectrum ranges from deep black to grey, embodying fertile and cultivable properties favourable for agricultural activities.

Red and Yellow Soil

Area

- ❖ These are predominantly found on **crystalline igneous rocks** in the eastern and southern regions of the Deccan Plateau under low rainfall conditions and extend along the piedmont zone of the Western Ghat, showcasing a stretch of red loamy soil.
- ❖ These soils are also present in parts of Odisha, Chattisgarh, and southern areas of the Middle Ganga Plain.

Characteristics

- ❖ They exhibit a reddish hue due to iron diffusion in crystalline and metamorphic rocks, turning yellow when hydrated. While the fine-grained red and yellow soils are typically fertile, the coarse-grained variants in dry upland areas lack fertility.

Mineral Composition

- ❖ These soils are generally deficient in **nitrogen, phosphorous**, and **humus**, delineating a crucial understanding of their utilisation and management.

Laterite Soil

- ❖ Derived from the Latin word '**Later**' meaning brick, laterite soils form in high temperature and rainfall areas, undergoing intense leaching due to tropical rains, which wash away lime and silica, leaving behind soils rich in iron oxide and aluminium compounds.

Area

- ❖ Being widely used as bricks for construction, laterite soils predominantly occupy higher areas of the Peninsular plateau, notably found in Karnataka, Kerala, Tamil Nadu, Madhya Pradesh, and the hilly regions of Odisha and Assam.

Characteristics

- ❖ In regions of Tamil Nadu, Andhra Pradesh, and Kerala, red laterite soils are favourable for tree crops like cashew nuts.
- ❖ This distribution and character of laterite soils are crucial for understanding their agricultural and constructional utility in these regions.
- ❖ The high temperature aids bacteria in rapidly decomposing the humus content.

Mineral Composition

- ❖ Because they lack organic matter, nitrogen, phosphate, and calcium but are abundant in iron oxide and potash, these soils are initially unsuitable for cultivation, requiring manures and fertilisers to enhance fertility.

Arid Soil

Area

These soils are chiefly found in **western Rajasthan**, showcasing the region's arid topography. (Refer to Figure 6.5)



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Characteristics

- ❖ They are characterised by a colour range from **red to brown**, predominantly having a **sandy structure and a saline nature**, with salt content so high in certain areas that common salt can be extracted through evaporation.
- ❖ Due to the arid climate, high temperatures, and rapid evaporation, these soils lack moisture and humus, with nitrogen being insufficient, though phosphate content remains normal.

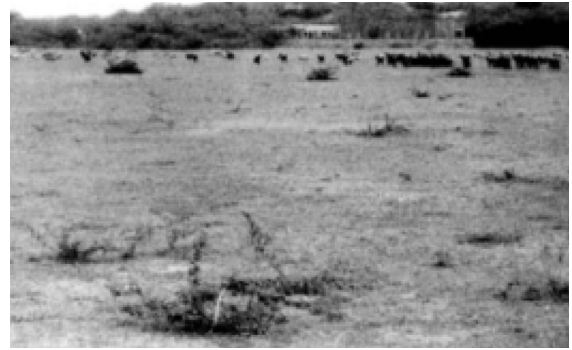


Figure 6.5: Arid Soil

Mineral Composition

- ❖ A notable feature is the '**kankar**' layers in the lower horizons due to increasing calcium content, which restricts water infiltration but ensures soil moisture retention when irrigation is introduced, aiding sustainable plant growth.
- ❖ Their fertility is hindered by the low humus and organic matter content, highlighting a need for substantial soil management for productive agricultural usage.

Saline Soils

Area

- ❖ Predominantly found in arid, **semi-arid, waterlogged**, and swampy regions due to the dry climate and poor drainage, their texture varies from sandy to loamy.
- ❖ Major occurrences are noted in **western Gujarat, the eastern coast deltas, and the northern Sundarban areas of West Bengal. The Rann of Kachchh** sees salt depositing crusts brought by the Southwest Monsoon, while seawater intrusion in deltas further contributes to soil salinity.

Characteristics

- ❖ Also known as **Usara soils**, saline soils are marked by a high proportion of sodium, potassium, and magnesium, rendering them infertile and unsupportive of vegetative growth.
- ❖ Intensive cultivation zones, especially **Green Revolution areas** with excessive irrigation, witness fertile alluvial soils turning saline.
- ❖ **The capillary action**, encouraged by excessive irrigation in dry climates, deposits salt on the soil's top layer.
- ❖ This scenario, particularly seen in Punjab and Haryana, prompts advice for farmers to **add gypsum as a remedial measure against soil salinity**, emphasising a balance between irrigation practices and soil management to maintain soil fertility and agricultural productivity.

Mineral Composition

- ❖ Saline soils are deficient in **nitrogen and calcium**.

Peaty Soils

Area

- ❖ Geographically, peaty soils are widely distributed in **northern Bihar and southern Uttarakhand**, along with coastal stretches of **West Bengal, Orissa, and Tamil Nadu**.

Characteristics

- ❖ These soils are typically **heavy, black in colour**, and, in many locales, exhibit alkaline properties.
- ❖ Peaty soils are prominently found in regions with heavy **rainfall and high humidity**, conducive to lush vegetation growth that, upon decomposition, contributes to the soil's **rich humus and organic content**, often reaching **40-50%**.
- ❖ The substantial organic matter within these soils reflects the region's dense vegetative cover, which in turn is significantly influenced by the local climatic conditions.

Mineral Composition

- ❖ Peaty soils have a low proportion of minerals compared to organic matter, with the exact mineral content varying depending on the specific location and conditions in which the soil has formed.

Forest Soils

Area

- ❖ Forest soils, inherent to regions with **ample rainfall**, exhibit varied structure and texture based on the specific mountainous environment such as in Arunachal Pradesh, and Himachal Pradesh.

Characteristics

- ❖ They are categorised as **loamy and silty** on valley sides and coarse-grained on upper slopes. Particularly in the **snow-clad regions of the Himalayas**, these soils undergo denudation, becoming acidic with a low humus content.
- ❖ However, the soils in the lower valleys are notably fertile.

Soil Degradation

- ❖ It is defined as a decline in **soil fertility**, marked by a reduction in nutritional status and soil depth due to erosion and misuse.
- ❖ This degradation is identified as a key factor driving the depletion of the country's soil resource base.
- ❖ The extent of soil degradation varies across different regions, influenced by local topography, wind velocity, and rainfall levels.

Soil Erosion

- ❖ Soil erosion, described as the destruction of soil cover, results from an imbalance between soil-forming and erosional processes, intensified by natural or human factors such as deforestation and overuse of land for settlement, cultivation, and grazing.
- ❖ The dynamics of erosion vary with regional conditions; **wind plays a significant role in arid areas, while water erosion, manifested as sheet and gully erosion** (Refer Figure 6.6), prevails in regions with heavy rainfall and steep slopes.
 - ✧ **Sheet erosion:** It discreetly removes the fertile topsoil.

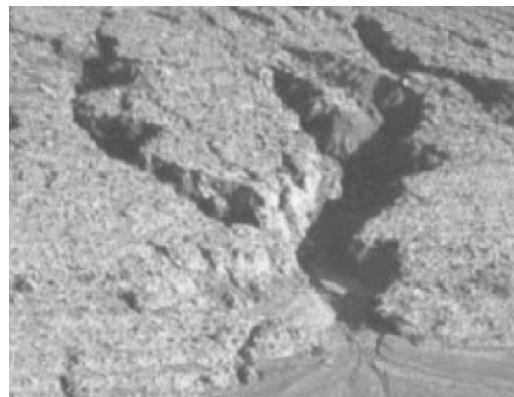


Figure 6.6: Soil Erosion

- ✧ **Gully erosion:** It visibly fragments agricultural lands, forming '**badland topography**' with ravines, notably in the **Chambal basin, Tamil Nadu, and West Bengal**, costing India around 8,000 hectares of land annually.

Implications of Soil Erosion

- ❖ Soil erosion not only jeopardizes agriculture but also escalates issues like **river siltation**, leading to reduced carrying capacity of rivers and **frequent floods**.
- ❖ **Deforestation** exacerbates soil erosion, especially in hilly regions, by removing the root-bound protection and humus supply to the soil.
- ❖ **Over-irrigation** in arable lands induces soil salinity as salt from lower profiles resurfaces, diminishing soil fertility.
- ❖ Moreover, reliance on **chemical fertilisers** without organic manures hardens the soil and declines its fertility over time, a challenge observed in command areas of river valley projects post the Green Revolution.
- ❖ With **nearly half of India's total land facing degradation**, the nation confronts a loss of millions of tonnes of soil and nutrients annually, adversely impacting national productivity.
- ❖ The stark data necessitates immediate initiatives for soil reclamation and conservation to abate the detrimental cycle of soil degradation and ensure sustainable agricultural productivity.

POINTS TO PONDER

Have you ever thought about the inter relationship between soil erosion and food crisis, water crisis and livelihood crisis? Can millet cultivation be the panacea for mitigating these problems? Can you think of other such measures?



Soil Conservation

- ❖ **Soil conservation** is a process of maintaining soil fertility and preventing erosion and emerges as a human-centric remedy to the degradation induced by human activities.
- ❖ The initial step entails restricting cultivation on sloped lands with a gradient of 15-25 per cent, instead of encouraging **terrace farming** (Refer Figure 6.7).
- ❖ **Over-grazing and shifting cultivation** have led to erosion, necessitating education for villagers on sustainable practices.



Figure 6.7: Terrace Farming

Remedial measures

- ❖ Several remedial measures, like **contour bunding, contour terracing, regulated forestry, controlled grazing, cover cropping, mixed farming, and crop rotation**, are advocated to mitigate soil erosion.
- ❖ To address gully erosion, terracing and the construction of check dams are suggested, along with efforts to control the extension of gullies through plugging, terracing, or cover vegetation planting.
- ❖ In arid regions, shielding cultivable lands from sand dunes through shelterbelts of trees, agro-forestry, and converting non-arable lands into pastures are recommended.
- ❖ Exemplifying this, the **Central Arid Zone Research Institute (CAZRI)** has experimented with stabilising sand dunes in western Rajasthan.

The Central Soil Conservation Board

- It was established by the Government of India and has devised numerous soil conservation plans tailored to the diverse climatic and social conditions across regions.
- However, these plans are considered fragmental. Integrated land-use planning, entailing land classification according to capability and the right utilisation of lands as per prepared maps, is endorsed as a holistic approach for soil conservation.
- The execution and success of these conservation measures fundamentally lie with the individuals who manage the lands and reap the benefits, underscoring the human-centric essence of soil conservation in India.

Conclusion

Soil, a pivotal entity, nurtures diverse life forms and significantly contributes to our daily sustenance. Its formation, influenced by natural and human-induced factors, reveals a complex structure that varies across regions. Unveiling the intricacies of soil through careful study and classification paves the way for sustainable practices, ensuring its preservation and continued fertility for future generations. Hence, a profound understanding of soil is imperative for harmonising human activities with nature's delicate balance.

Glossary:

- **Humus:** It is a dark, organic material that forms in soil when plant and animal matter decays.
- **Delta:** It is a triangular area of low, flat land where a river splits into smaller rivers before flowing into the sea.
- **Hydrated:** It means having absorbed enough water or other liquid.
- **Evaporation:** It is the process of a liquid turning into a gas.
- **Capillary Action:** It is the movement of a liquid through a narrow space without the help of external forces, like gravity.
- **River Siltation:** It is the accumulation of fine sediments, such as silt or clay, in a river or lake.
- **Deforestation:** It is the large-scale removal of trees from forests or other lands for human activities.
- **Terrace Farming:** It is an agricultural practice farmers employ on steep slopes, hilly areas, and higher altitudes.
- **Agroforestry:** It is a land management practice that combines agriculture and trees.





Natural Vegetation

Bibliography: This chapter encompasses the summary of **Chapter 5-** XI NCERT (India Physical Environment) and **Chapter 5-** IX NCERT (Contemporary India).

Introduction

Natural vegetation denotes a plant community that remains undisturbed for an extended period, allowing its individual species to adapt fully to the local climate and soil conditions. India boasts diverse natural vegetation due to variations in climate and soil. It is recognized as **one of the world's 12 mega biodiversity countries**, a home to approximately 47,000 plant species, including 15,000 flowering plants (constituting 6 percent of the world's total). Additionally, India hosts numerous nonflowering plants like ferns, algae, and fungi, along with around 90,000 animal species and a rich diversity of fish in its freshwater and marine ecosystems.

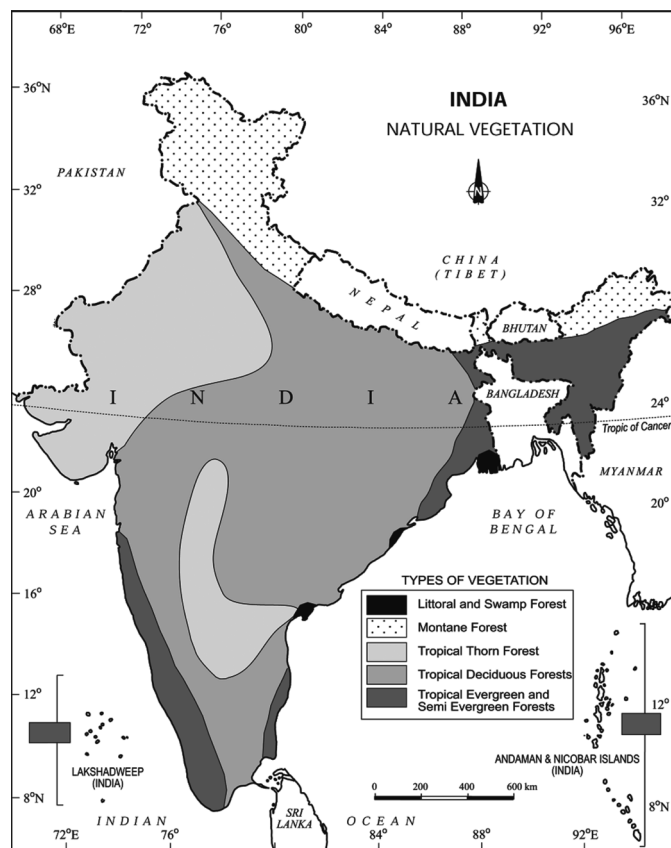


Figure 7.1: Natural Vegetation of India

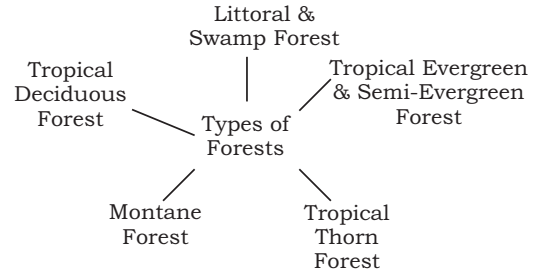


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Types of Forests

Indian forests can be categorized into distinct groups based on shared characteristics like the prevailing vegetation type and climatic regions:

- ❖ Tropical Evergreen and Semi-Evergreen Forests
- ❖ Tropical Deciduous Forests
- ❖ Tropical Thorn Forests
- ❖ Montane Forests
- ❖ Littoral and Swamp Forests



Tropical Evergreen

- ❖ **Location:** Tropical Evergreen forests are located along western slope of the Western Ghats, hills of the northeastern region and the Andaman and Nicobar Islands.
- ❖ **Climate and Rainfall:** Climate in these forests is warm and humid with an annual precipitation of over 200 cm and mean annual temperature above 22° C.
- ❖ **Characteristics**
 - ❖ These forests are **well-structured**, featuring layers near the ground covered in shrubs and creepers, followed by short and tall trees that can reach heights of 60 meters or more.
 - ❖ The region's warm and consistently wet climate fosters **lush vegetation**, including various types of trees, shrubs, and creepers, creating a **multi-layered forest**.
 - ❖ Leaves on the trees do not have a specific season for shedding, flowering, or fruiting, resulting in **year-round greenery**.
 - ❖ **Flora:** Notable commercially valuable trees in these forests include ebony, mahogany, rosewood, rubber, and cinchona.
 - ❖ **Fauna:** Common wildlife in these forests includes elephants, monkeys, lemurs, and deer. One-horned Rhinoceros are also found in Assam and West Bengal's forests. Additionally, these forests are home to numerous birds, bats, sloths, scorpions, and snails.

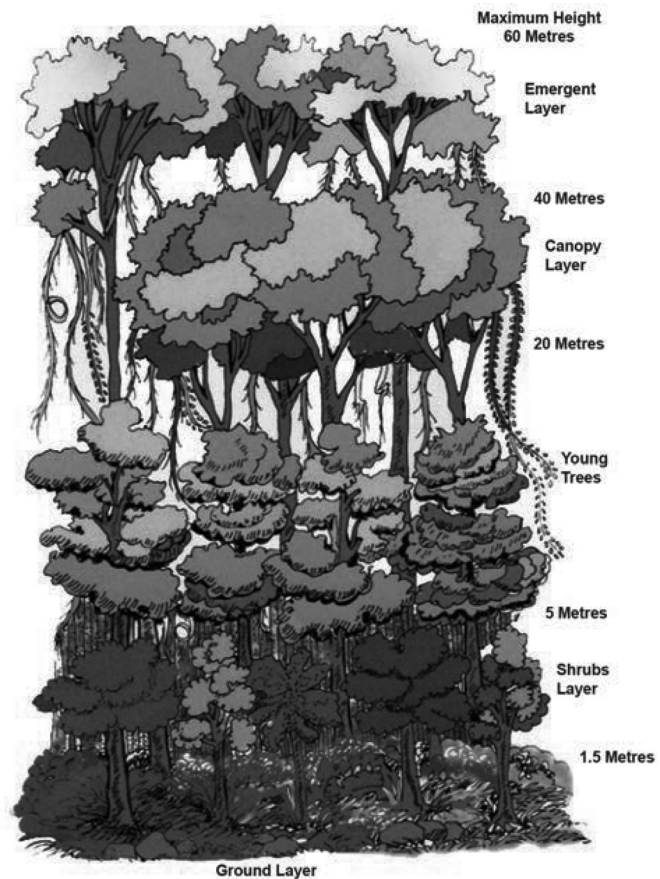


Figure 7.2: Tropical Evergreen Forest

Semi Evergreen Forests

- ❖ Semi-evergreen forests are **located in regions with lower rainfall**. These forests contain a combination of evergreen and moist deciduous trees, and the presence of undergrowth climbers contributes to their evergreen appearance.
- ❖ Key tree species in these forests include **white cedar, hollock, and kail**.

Tropical Deciduous Forests

These are the **most widespread forests** in India and are **also called the monsoon forests**.

- ❖ **Location:** They are spread over regions which receive rainfall between 70-200 cm.
- ❖ **Classification on the basis of the availability of water**
 - ✧ **Moist Deciduous Forests:** These forests are found in regions which record rainfall **between 100-200 cm**; in the northeastern states along the foothills of Himalayas, eastern slopes of the Western Ghats and Odisha.
 - ❑ **Flora:** **Teak** is the most dominant species of this forest, while Bamboos, sal, shisham, sandalwood, khair, kusum, arjun and mulberry are other commercially important species.
 - ✧ **Dry Deciduous Forests:** These forests are found in regions where rainfall ranges **between 70 -100 cm**. On the **wetter margins**, it has a **transition to the moist deciduous forest**; having a parkland landscape with open stretches in which teak and other trees interspersed with patches of grass.
 - ❑ Rainier areas of the Peninsula and regions of the northern Indian plain.
 - ❑ In **drier margins**, it has a **transition to thorn forests**; having a vast grassland with naked trees all around. Eg. western and southern part of Rajasthan. Tendu, palas, amaltas, bel, khair, axlewood, etc. are the common trees of these forests.
- ❖ In these forests, the common animals found are lion, tiger, pig, deer and elephant. A huge variety of birds, lizards, snakes and tortoises are also found here.

Tropical Thorn Forests

- ❖ **Location:** Tropical Thorn Forests occur in the areas which receive **rainfall less than 50 cm**.
 - ✧ In semi-arid areas of south west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh.
- ❖ **Characteristics**
 - ✧ These consist of a **variety of grasses and shrubs**.
 - ✧ Trees are **scattered and have long roots** penetrating deep into the soil in order to get moisture.
 - ✧ The **stems are succulent** to conserve water. Leaves are mostly thick and small to minimize evaporation.
 - ✧ In these forests, plants remain leafless for most part of the year and give an expression of **scrub vegetation**.
 - ✧ Important species found are babool, ber, and wild date palm, khair, neem, khejri, palas, Acacias, palms, euphorbias and cacti etc. Tussocky grass grows up to a height of 2 m as the undergrowth.
 - ✧ In these forests, the common animals are rats, mice, rabbits, fox, wolf, tiger, lion, wild ass, horses and camels.

Montane Forests

- ❖ These forests are characterized by the **decrease in temperature with increasing altitude that leads** to a corresponding change in natural vegetation (Figure 7.3).

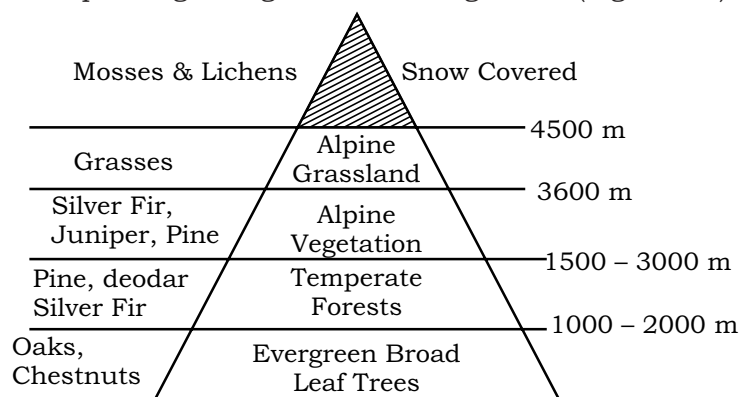
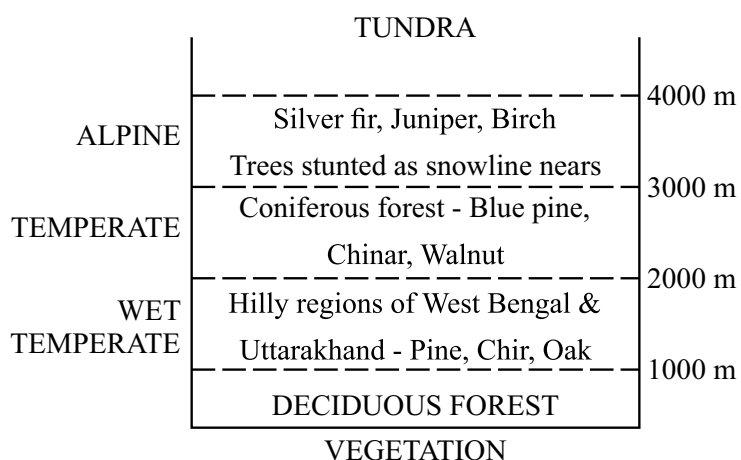


Figure 7.3: Montane Forest

❖ Types:

❖ Northern Mountain Forests:

- ❑ These ranges show a **succession of vegetation** from the tropical to the tundra, which change with the altitude.
- ❑ **Deciduous forests** are found in the foothills of the Himalayas, which is succeeded by the **wet temperate type of forests** between an altitude of 1,000-2,000 m. In the higher hill ranges of northeastern India, hilly areas of West Bengal and Uttaranchal, **evergreen broadleaf trees** such as oak and chestnut are predominant.
- ❑ Between 1500 and 3000 meters **temperate forests** containing coniferous trees, like pine, deodar, silver fir, spruce and cedar, are found. These forests cover mostly the **southern slopes of the Himalayas**, places having high altitude in southern and north-east India. At higher elevations, temperate grasslands are common.



- ❑ At elevations between 3,000 to 4,000 meters, there is a shift to Alpine forests and meadows. Predominant species in this region include **silver firs, junipers, pines, birch, and rhododendrons**. These meadows are widely used for seasonal nomadic grazing by tribes such as the **Gujjars, Bakarwals, Bhotiyas, and Gaddis**.

- ❑ At even higher altitudes surpassing 4,000 meters, the vegetation consists of **mosses and lichens** as part of the tundra landscape.
- ❖ **Southern Mountain Forests:**
 - ❑ Found in three distinct areas of Peninsular India i.e.; the **Western Ghats, the Vindhyas 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.
 - ❑ These temperate forests are also called **Sholas** in the Nilgiris, Anaimalai and Palani hills.
 - ❑ Some trees of **economic significance** found in these forests include, magnolia, laurel, cinchona and wattle.
- ❖ **Fauna:** The common animals found in these forests are Kashmir stag, spotted deer, wild sheep, jack rabbit, Tibetan antelope, yak, snow leopard, squirrels, Shaggy horned wild ibex, bear and rare red panda, sheep and goats with thick hair.

Littoral and Swamp Forests

- ❖ India has a rich variety of wetland habitats with a total area of **3.9 million hectares. 70 percent** of this comprises areas under paddy cultivation, indicating its importance.
- ❖ *India's wetlands are categorized into **eight groups** as follows:*
 - ❖ **Reservoirs in the Deccan Plateau** in the southern part of the country, along with lagoons and other wetlands along the southwestern coast.
 - ❖ **Extensive saline areas** in Rajasthan, Gujarat, and the Gulf of Kachchh.
 - ❖ **Freshwater lakes and reservoirs** stretch from Gujarat eastward through Rajasthan (including Keoladeo National Park) and into Madhya Pradesh.
 - ❖ **Delta wetlands and lagoons** along the eastern coast of India, exemplified by Chilika Lake.
 - ❖ **Freshwater marshes** in the Gangetic Plain.
 - ❖ **Floodplains** along the Brahmaputra River.
 - ❖ **Lakes and rivers** in the mountainous region of Kashmir and Ladakh.
 - ❖ **Mangrove forests** and other wetlands in the island chains of the Andaman and Nicobar Islands.

Mangroves

- ❖ The mangrove forests spread over 6,740 sq. km which is **7 percent of the world's mangrove forests**.
- ❖ According to India State of Forest Report 2021, the mangroves cover is now 4,992 sq km which is merely 3.3 percent of the world's mangrove forest.
- ❖ These **grow along the coasts** in the salt marshes, tidal creeks, mud flats and estuaries (Figure 7.4).
- ❖ They consist of a number of **salt-tolerant species of plants**.
- ❖ **The deltas** of the Ganga, the Mahanadi, the Krishna, the Godavari and the Kaveri are covered by such vegetation.



Figure 7.4: Mangrove Forests

- ❖ In the Ganga-Brahmaputra delta, **sundari trees** are found, which provide durable hard timber. Palm, coconut, keora, agar, etc., also grow in some parts of the delta.
- ❖ **The Royal Bengal Tiger** is a famous animal in these forests. Turtles, crocodiles, gharials and snakes are also found in these forests.

MEDICINAL PLANTS	
India is known for its herbs and spices from ancient times. Some 2,000 plants have been described in Ayurveda and at least 500 are in regular use. The World Conservation Union's Red List has named 352 medicinal plants of which 52 are critically threatened and 49 endangered. The commonly used plants in India are:	
Sarpagandha	➤ Used to treat blood pressure; it is found only in India.
Jamun	➤ The juice from ripe fruit is used to prepare vinegar, which is carminative and diuretic, and has digestive properties. The powder of the seed is used for controlling diabetes.
Arjun	➤ The fresh juice of leaves is a cure for earache. It is also used to regulate blood pressure.
Babool	➤ Leaves are used as a cure of eye sores. Its gum is used as a tonic.
Neem	➤ Has high antibiotic and antibacterial properties.
Tulsi	➤ Is used to cure cough and cold.
Kachnar	➤ Is used to cure asthma and ulcers. The buds and roots are good for digestive problems.
<i>Source: Medicinal Plants by Dr. S. K. Jain, 5th edition 1994, National Book Trust of India.</i>	

Forest Conservation

- ❖ Forests maintain a complex connection with life and the environment, offering various direct and indirect benefits to our economy and society. Therefore, the preservation of forests is crucial for the well-being and progress of humanity.
- ❖ Consequently, the Government of India introduced a **nationwide forest conservation policy**, implementing a forest policy in 1952 with the dual objectives of safeguarding and expanding forest reserves while also addressing the requirements of local communities.

National Forest Policy 1952

- ❖ Bringing **33 percent** of the geographical areas under forest cover;
- ❖ Maintaining **environmental stability** and to restore forests where ecological balance was disturbed;
- ❖ Conserving the **natural heritage** of the country, its biological diversity and genetic pool;
- ❖ Checks **soil erosion**, extension of the desert lands and reduction of floods and droughts;
- ❖ Increasing the **forest cover** through social forestry and afforestation on degraded land;
- ❖ **Increasing the productivity** of forests to make timber, fuel, fodder and food available to rural population dependent on forests, and encourage the substitution of wood;
- ❖ Creating a **massive people's movement** involving women to encourage planting of trees, stop felling of trees and thus, reduce pressure on the existing forest. Based on the forest conservation policy the many steps were initiated, few of which are discussed in following sections.

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.
- ❖ The **National Commission on Agriculture (1976)** has classified social forestry into three categories:
 - ❖ **Urban forestry:** It pertains to the raising and management of trees on public and privately owned lands in and around urban centers such as green belts, parks, roadside avenues, industrial and commercial green belts, etc.
 - ❖ **Rural forestry:** It lays emphasis on promotion of agroforestry and community-forestry.
 - ❑ **Agroforestry:** It 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: Raising of trees on public or community land** such as the village pasture and temple land, roadside, canal bank, strips along railway lines, and schools etc.
 - ❑ **Aim:** It aims at **providing benefits to the community as a whole**, under which the people of landless classes can associate themselves in tree raising and thus, get those benefits which otherwise are restricted for landowners.
 - ❖ **Farm Forestry: Farmers grow trees for commercial and non-commercial purposes on their farm lands**, the margins of agricultural fields, grasslands and pastures, land around homes and cow sheds may be used.

Wildlife

Statistics

- ❖ India possesses a rich natural heritage in its wildlife, with approximately 4-5% of all known plant and animal species worldwide being present in the country.
- ❖ India also boasts significant biodiversity, including 13% of the global bird population, 12% of Fish species, and 5-8% of amphibians, reptiles, and mammals.

Notable Wildlife in India

- ❖ It includes elephants in the hot, wet forests of Assam, Karnataka, and Kerala; one-horned rhinoceroses in the swampy lands of Assam and West Bengal; wild ass in the Rann of Kachchh; and camels in the Thar Desert.
- ❖ India is unique for having both tigers and lions, with Indian lions primarily residing in the Gir forest in Gujarat and tigers found in Madhya Pradesh, the Sundarbans of West Bengal, and the Himalayan region.
- ❖ In Ladakh's high-altitude regions, one can find yak, Tibetan antelope, bharal (blue sheep), wild sheep, and kiang (Tibetan wild ass).

POINTS TO PONDER

Have you ever visited thorn forests of Rajasthan, tropical rainforest of Kaziranga national park and sholas of Nilgiri? Did you observe that there exists huge variation in the type of plants and animals? Can you think of reasons behind such a megadiversity of flora and fauna?



Causes of Concern

- ❖ Despite this remarkable diversity, human activities have significantly disrupted these ecosystems.
- ❖ Factors like industrialization, land clearance for agriculture and settlements, deforestation for resources, grazing by domestic cattle, hunting, and forest fires have led to a decline in wildlife numbers.



- ❖ This exploitation has resulted in the endangerment and extinction of numerous plant and animal species, making conservation efforts imperative.

Wildlife Conservation in India

- ❖ India has a rich tradition of valuing wildlife, evident in timeless tales like Panchtantra and Jungle Books, which instill a deep love for wildlife, particularly in young minds.
- ❖ In **1972**, India introduced a comprehensive **Wildlife Act**, serving as the primary legal framework for wildlife conservation and protection. This legislation has two main objectives:
 - ❖ Safeguarding endangered species listed in the Act's schedule.
 - ❖ Providing legal support for the preservation of designated conservation areas such as National Parks, sanctuaries, and closed areas.
- ❖ The 1972 act underwent substantial amendments in 1991, resulting in stricter penalties and provisions for safeguarding specific plant species and the conservation of endangered wild animals (Figure 7.5).

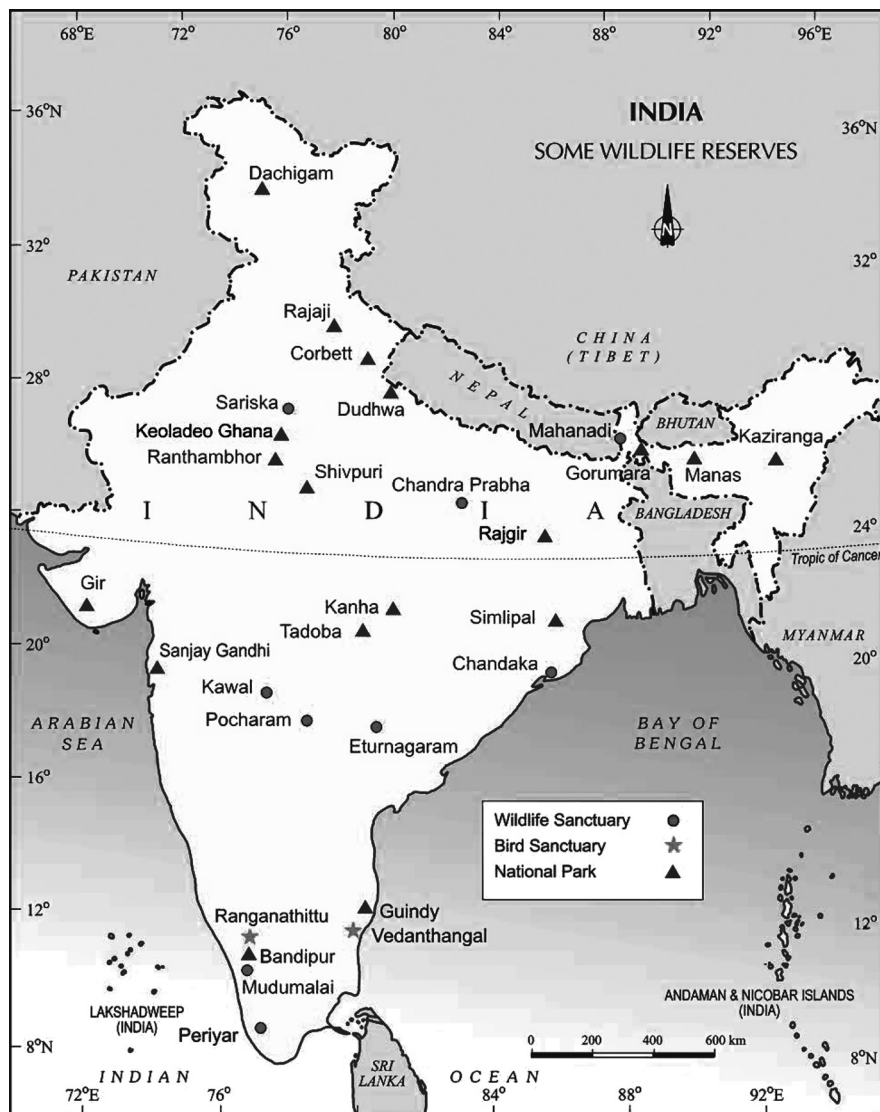


Figure 7.5: Wildlife Reserves

Project Tiger (1973)

- ❖ **Objective:** The primary goal of the initiative is to ensure the existence of a sustainable tiger population in India, valued for its scientific, aesthetic, cultural, and ecological significance.
 - ❖ Additionally, it aims to preserve areas of significant biological importance as natural treasures, accessible for the benefit, education, and enjoyment of the public.
- ❖ **Area under the Project:** Initially, Project Tiger was inaugurated in nine tiger reserves, covering a total area of 16,339 square kilometers. This initiative has since expanded to encompass 54 tiger reserves, encompassing a substantial 75,796.83 square kilometers of core tiger habitats distributed across 18 states.
- ❖ **Achievement:** Remarkably, India has witnessed a growth in its tiger population from 1,411 in 2006 to 2,967 in 2020, representing 70% of the global tiger population.

POINTS TO PONDER

Have you heard about Project Cheetah? Such projects incur huge amounts of money. Do you think such projects are necessary? Do these projects in any way contribute to conservation of the ecosystem? Can you think of its impact on the livelihood of tribals?

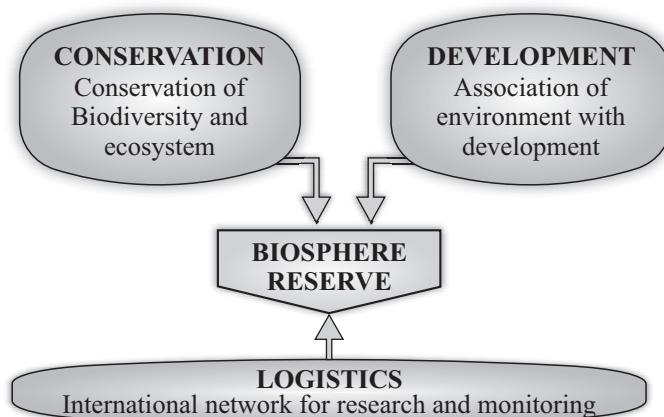


Project Elephant (1992)

- ❖ Initiated in 1992, this project was established to provide support to states with wild elephant populations roaming freely. The project is currently operational in 16 states.
- ❖ **Goal:** Its primary objective is to secure the enduring existence of recognized sustainable elephant populations within their native habitats.
- ❖ Additionally, the Government of India has undertaken several other initiatives, including the **Crocodile Breeding Project, Project Hangul, and the conservation of Himalayan Musk deer.**

Biosphere Reserves

- ❖ A Biosphere Reserve is a unique and representative ecosystem of terrestrial and coastal areas which are internationally recognised within the framework of **UNESCO's Man and Biosphere Programme (MAB)**.
- ❖ **Objective:**
 - ❖ There are 18 Biosphere Reserves in India (Figure 7.6 and Table 7.1), of which 12 Biosphere Reserves have been recognised by the UNESCO on World Network of Biosphere Reserves.



Objectives of a Biosphere Reserve

Table 7.1: List of Biosphere Reserves

SI. No.	Name of the Biosphere Reserve and Total Geographical Area (km ²)	Date of Designation	Location in the States/UT
1.	Nilgiri (5520)	01.08.1986	Part of Wayanad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani Hills (Tamil Nadu, Kerala and Karnataka).
2.	Nanda Devi (5860.69)	18.01.1988	Part of Chamoli, Pithoragarh and Almora Districts in Uttarakhand.
3.	Nokrek (820)	01.09.1988	Part of East, West and South Garo Hill Districts in Meghalaya.
4.	Manas (2837)	14.03.1989	Part of Kokrajhar, Bongaigaon, Barpeta, Nalbari, Kamrup and Darang Districts in Assam
5.	Sunderban (9630)	29.03.1989	Part of delta of Ganges and Brahmaputra river system in West Bengal.
6.	Gulf of Mannar (10500)	18.02.1989	Indian part of Gulf of Mannar extending from Rameswaram island in the North of Kanyakumari in the South of Tamil Nadu.
7.	Great Nicobar (885)	06.01.1989	Southern most island of Andaman and Nicobar Islands.
8.	Similipal (4374)	21.06.1994	Part of Mayurbhanj District in Odisha.
9.	Dibru-Saikhowa (765)	28.07.1997	Part of Dibrugarh and Tinsukia Districts in Assam.
10.	Dihang-Dibang (5111.5)	02.09.1998	Part of Upper Siang, West Siang and Dibang Valley Districts in Arunachal Pradesh.
11.	Pachmarhi (4981.72)	03.03.1999	Part of Betul, Hoshangabad and Chhindwara Districts in Madhya Pradesh.
12.	Khangchendzonga (2619.92)	07.02.2000	Part of North and West Districts in Sikkim
13.	Agasthyamalai (3500.36)	12.11.2001	Part of Thirunelveli and Kanyakumari Districts in Tamil Nadu and Thiruvananthapuram, Kollam and Pathanamthitta districts in Kerala.
14.	Achanakmar-Amarkantak (3835.51)	30.03.2005	Part of Anuppur and Dindori Districts of Madhya Pradesh and Bilaspur district of Chhattisgarh.
15.	Kachchh (12,454)	29.01.2008	Part of Kachchh, Rajkot, Surendranagar and Patan Districts in Gujarat.
16.	Cold Desert (7770)	28.08.2009	Pin Valley National Park and Surrounding; Chandratol and Sarchu and Kibber Wildlife sanctuary in Himachal Pradesh.
17.	Seshachalam (4755.997)	20.09.2010	Seshachalam hill ranges in Eastern Ghats encompassing part of Chittoor and Kadapa Districts in Andhra Pradesh.
18.	Panna (2998.98)	25.08.2011	Part of Panna and Chhattarpur Districts in Madhya Pradesh.

Sites with Bold Letters have been included in the World Network of BRs of UNESCO.



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Figure 7.6: Biosphere Reserves

Conclusion

India's natural vegetation is a testament to its incredible biodiversity. From the lush evergreen forests of the Western Ghats to the arid thorn forests of Rajasthan, the country's diverse landscapes support a wide array of plant and animal life. This rich tapestry of ecosystems not only contributes to India's ecological balance but also holds immense cultural and economic significance. However, these ecosystems face growing threats from deforestation, habitat loss, and climate change. It is imperative for India to continue its efforts in conserving and restoring its natural vegetation, not only for the sake of its unique biological heritage but also for the well-being of its people and the planet as a whole.

Glossary:

- **Fauna:** The animal life of a given area or time.
- **National Park:** A National park is an area which is strictly reserved for the protection of the wildlife and where activities such as forestry, grazing or cultivation are not allowed.
- **Protected Forest:** An area notified under the provisions of Indian Forest Act or the State Forest Acts having limited degree of protection. In Protected Forests, all activities are permitted unless prohibited.
- **Reserved Forest:** An area notified under the provisions of Indian Forest Act or the State Forest Acts having full degree of protection. In Reserved Forests, all activities are prohibited unless permitted.
- **Sanctuary:** A sanctuary is an area, which is reserved for the conservation of animals only and operations such as harvesting of timber, collection of minor forest products are allowed so long as they do not affect the animals adversely.
- **Virgin Vegetation:** Virgin vegetation refers to plant communities that have developed naturally without human interference and have remained untouched by human activities.

