

GEOGRAPHY OF INDIA



“शिक्षा मानव को बन्धनों से मुक्त करती है और आज के युग में तो यह लोकतंत्र की भावना का आधार भी है। जन्म तथा अन्य कारणों से उत्पन्न जाति एवं वर्तमान विषमताओं को दूर करते हुए मनुष्य को इन सबसे ऊपर उठाती है।”

इन्दिरा गांधी



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“Education is a liberating force, and in our age it is also a democratising force, cutting across the barriers of caste and class, smoothing out inequalities imposed by birth and other circumstances.”

– Indira Gandhi

VOLUME – 1

BLOCK 1

PHYSICAL SETTING

BLOCK 2

RESOURCE BASE

Course Design Committee

Prof. H. Ramachandran
Department of Geography,
University of Delhi,
Delhi

Prof. Vijayshri
Former Director
School of Sciences,
IGNOU, New Delhi

Dr. Satya Raj
Discipline of Geography,
School of Sciences,
IGNOU, New Delhi

Prof. Sachidanand Sinha
Centre for the Study of
Regional Development,
Jawaharlal Nehru University,
New Delhi

Prof. Mahendra Singh
Nathawat
Discipline of Geography,
School of Sciences,
IGNOU, New Delhi

Dr. Koppiseti Nageswara Rao
Discipline of Geography,
School of Sciences,
IGNOU, New Delhi

Prof. N.R. Dash
Department of Geography,
The Maharaja Sayajirao
University of Baroda, Gujarat

Prof. Subhakanta Mohapatra
Discipline of Geography,
School of Sciences,
IGNOU, New Delhi

Dr. Vishal Warpa
Discipline of Geography,
School of Sciences,
IGNOU, New Delhi

Prof. Milap Chand Sharma
Centre for the Study of Regional
Development, Jawaharlal Nehru
University, New Delhi

Dr. Vijay Kumar Baraik
Discipline of Geography,
School of Sciences,
IGNOU, New Delhi

Block Preparation Team

Course Contributors

Dr. Uttam Lal (Units - 1, 2, 3, 4 and 5)
Department of Geography,
School of Human Sciences,
Sikkim University, Gangtok

Content Editor

Prof. Harjit Singh (Retd.)
Centre for the Study of Regional Development,
Jawaharlal Nehru University, New Delhi

Course Coordinators - Dr. Vishal Warpa & Dr. Koppiseti Nageswara Rao

Print Production

Sh. Rajiv Girdhar
A.R., MPDD, IGNOU

Sh. Hemant Parida
S.O., MPDD, IGNOU

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GEOGRAPHY OF INDIA: INTRODUCTION

Till now, you have studied the core courses in the first four semesters of your B.Sc. General Geography programme. The last two semesters are devoted for the study of Discipline Specific Elective Courses. We have taken up Geography of India in fifth semester and Economic Geography in sixth semester. This course is designed to give you an overall understanding of the multifarious physical and human characteristics of Geography of India. By now, you are well aware that Geography studies the plethora of human and physical themes along with their multitude of sub-themes to discern a pattern, interrelationship and associations etc., in a spatial and temporal dimension. You will be able to comprehend the strengths as well as weaknesses keeping in consideration the resource endowment, opportunities and myriad of constraints. Study of this course may help you to paint a broad geographical picture to understand the prevalent binaries in terms of developed and underdeveloped regions.

This course is printed in two volumes. Volume-1 consists of first two blocks and the other three blocks (3 to 5) are arranged in volume-2.

Geography examines the distribution, spatial variation, and relationships between physical and cultural characteristics in a spatial and temporal dimension. India is a multicultural nation. This course examines the physical environment, resource base, economics, population, and settlement of India. The course lays the groundwork for further study in regional or systematic geography in India. One of the primary goals of the course is to investigate India's physical environment, including its physiography, drainage, climate, soil, and vegetation. These critical qualities are thoroughly discussed in **Block 1** spread over five Units.

The availability of natural resources in an area, such as land, water, forest, mineral, and energy, is critical for a country's growth and development. **Block 2** is devoted to the study of India's resource base aimed for the economic development in five Units. The availability of resources and the economics of a place are inextricably linked. Land and water are used for agricultural products as well as other economic and cultural purposes. A region's forest resources not only provide livelihood opportunities for local inhabitants, but also provide energy and matter to all living species. Resources such as minerals and energy can be used to measure a country's economic development. In order to comprehend how a community or a country as a whole experiences economic progress, it is crucial to appreciate the significance of natural resources.

Block 3 describes India's economy. India has one of the world's fastest expanding economies. The Indian economy is mostly based on agriculture, which is regarded as the country's backbone due to the country's rich deltas and river valleys. The Green Revolution has enabled academicians/researchers to investigate the peculiarities of Indian agriculture, as well as agricultural land usage and cropping patterns. Aside from agriculture, industry and transportation growth in India have offered a plethora of opportunities for the betterment of the country's landscape. The placement of industries and industrial corridors in India is also influenced by the availability of raw materials, labour, climate, market, transportation, capital, and banking facilities, among other factors.

The study of population, including size and growth, distribution and density, age and gender ratio, religious and linguistic makeup, castes and tribes, and so on, helps you to understand the value of population as a human resource in India. The features of India's rural and urban settlements will also give information on the country's urbanisation process. **Block 4** introduces you about India's population, socioeconomic structure, and

settlement trends. Regional approaches to India's geography, with a focus on physiographic approaches, socio-cultural approaches, and economic approaches developed from a variety of aspects, which may include historical, regional, cultural, and demographic considerations. **Block 5** of this course goes into further detail.

Overall, this course will be beneficial to grasp India's geography in a broader context. We hope that after taking this Geography of India course, you will be able to describe geography as an interdisciplinary field of study that explores numerous aspects of both physical and human features.

In this quest, our warmest wishes are always with you. If you need assistance with this course, please contact us at: vishalwarpa@ignou.ac.in and knrao@ignou.ac.in



BGGET-141

GEOGRAPHY OF INDIA

BLOCK

1

PHYSICAL SETTING

UNIT 1

INDIA IN THE SUB-CONTINENTAL SETTING

UNIT 2

PHYSIOGRAPHY

UNIT 3

DRAINAGE

UNIT 4

CLIMATE

UNIT 5

SOIL AND VEGETATION

GLOSSARY

BGGET- 141

GEOGRAPHY OF INDIA

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Unit 16	Physiographic Approach
Unit 17	Socio-Cultural Approach
Unit 18	Economic Approach

BLOCK 1: PHYSICAL SETTING

Since antiquity, as you know that Geography is one of the oldest domains of knowledge. In simple words, it provides the description of the Earth. It is concerned with the study of physical and cultural features, their distribution, spatial variation and interrelationship with one another over the space and time. You are aware that first set of principal landforms are landmass and waterbodies. You further know that these two principal landforms are not homogeneously distributed over the range of geographic environments on planet Earth. Variations are quite evident to all of us across the different sub-features of these two like mountains, river valleys, plateau, coasts, islands and other water bodies etc. India has a peculiar physical setting in the sub-continent. The unique physical setting has given birth to simple to complex maze of intervening historical events including both domestic and foreign across the geographic ranges. It has deeply impacted the society, economy and nation altogether. India is dotted with a myriad type of physical landscapes coupled with climatic pluralities ranging from cold desert, dry alpine, temperate to that of tropical climatic conditions. All these together make possible the development of variety of soil on which human settlements are constructed and range of agricultural and its allied activities are carried out. Further, good soil cover also helps in the growth of plethora of vegetation cover with lots of shades characteristically differing from north to south and east to west. It is the physical setting which makes possible the availability of myriad of resources like land, water, forest, mineral and energy etc. In continuity, such natural resources provide the fundamental base for the interplay and trade-off of varied set of economic activities enacted by anthropogenic agents as a source of livelihood and prosperity.

In first Block, we will introduce you to the physical setting of India with particular focus on India in the sub-continental setting, its physiography, drainage and climate along with soil and vegetation elaboratively discussed in five units.

Unit 1: India in the Sub-Continental Setting

First unit is devoted to the study of India in the sub-continental setting. It will provide you a glimpse of its locational aspects in the Indian sub-continent. For centuries, Indian sub-continent has witnessed a series of domestic and foreign political upheaval, which you will study in historical set-up. As a result, a rich mosaic of socio-cultural practices has evolved over the period of time that has bestowed a unique personality to our country. Together historical set-up and socio-cultural personality have further helped to delineate a prosperous contour of unity in diversity, which you will learn towards the end of this unit.

Unit 2: Physiography

Second unit is devoted to the study of physiography. You are well aware of the meaning of physiography. It refers to the diverse types of physical units like mountains, valleys, plateaus, coasts and islands etc., which you will study and learn in this Unit. You will also learn about the physiographic characteristics. In addition, you will learn diverse concepts related to the evolution of landforms along with their significance for human settlements and their economic activities.

Unit 3: Drainage

Third unit is devoted to the study of drainage. You know that drainage system is very important for the society and economy of any geographical area on the planet Earth. You will get a detailed idea about the drainage system of India along with its classification. You

will learn about the Himalayan and Peninsular Drainage system and its evolution in an elaborative manner. Further, you will also learn about the major river basins of India.

Unit 4: Climate

Fourth unit is devoted to the study of climate. You are familiar about the climate and its several associated important features. You will learn about the same in detail along with characteristics of Indian climate and weather. Besides that, you will also come to know about the distribution of rainfall and temperature in India in spatial and temporal context. You know about the monsoon and its importance in the agricultural activities. You will learn about the mechanisms of precipitation with special reference to Indian monsoon along with agro-climatic regions. You will also get an idea about the climatic factors responsible for generating drought conditions across the geographic ranges of India. As a whole, this Unit will enable you to understand climate and also to comprehend climatic factors which are closely associated and governed by the physiographic set-up of the country.

Unit 5: Soil and Vegetation

Fifth unit is devoted to the study of soil and vegetation. You will learn about the characteristics of soil and vegetation that governs these two in any geographic region. You will know about the classification schemes of soil and vegetation of India. The distribution of soil and natural vegetation of India is also dealt in this Unit. Further, you will also learn about the major soil and vegetation regions of India in totality.

We hope that after studying this block, you will be able to comprehend the physical setting of India in a better and lucid manner.

Our best wishes are always with you in this endeavour.

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INDIA IN THE SUB-CONTINENTAL SETTING

Structure

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	Shape and Size	1.9	References and Suggested
1.3	Historical Setup		Further Reading
1.4	Socio-Cultural Personality		

1.1 INTRODUCTION

Block 1 begins with study and description of the physical setting in Unit 1. You will learn that India is very diverse in terms of its physical characteristics and its socio-cultural setting. It is quite varied due to its locational extent and is prominent owing to its large size. Besides its shape and size, its long history has further added a great degree of diversity to its social and cultural personality. India has the world's second-largest population with several religious and cultural groups that have remained in unity. Understanding the overall geography and its history along with its culture and socio-economic characteristics helps us in knowing India in a wider context. Considering unity in its population despite the existing diversities adds further uniqueness to its socio-cultural characteristics. Hence, the chapter introduces its Physical setting which helps in understanding the history and overall socio-cultural characteristics of the country.

Discussion on physical setting includes location along with shape and size in Section 1.2. Section 1.3 pertains to historical factors and forces those have shaped the historical set-up. This will help to understand and appreciate the socio-cultural personality of India as discussed in Section 1.4. To better comprehend the essence of all the above-mentioned things, you will gain insight related to unity in diversity after studying Section 1.5. The study of this Unit will highlight the physical setting in all its different dimensions and enable you to visualize the kind of other physical characteristics in terms of

physiography, climate, drainage, soil and natural vegetation etc., which have been dealing within subsequent Units of Block 1.

Expected Learning Outcomes

After studying this unit, you should be able to:

- explain the geographical setting of India and its advantage of having a favourable physical location;
- explain the history that has shaped its social, cultural and political outlook; and
- analyse different forms of diversity and explain the unity within the existing diversity.

1.2 PHYSICAL SETTING

India, that is Bharat, is drained by many important rivers of South Asia. Prominent and culturally sacred river The Ganges is among these, which occupies a prominent part of the South Asian realm. It is bounded by young fold mountain ranges in the north, northwest and northeast. The word 'India' owes its origin to the Greek word 'Indio' meaning the land near Indos (Lambert, 1960). The Romans pronounced the river Indus and the country beyond that as India. Similarly, Persians and Arabs referred to this river as Hindu (for Sindhu) and the land east of it as Hindustan. Hence, the nomenclature of the country itself has its origin from the pronunciation that was made in different periods in history.

1.2.1 Location

India lies in the northern and eastern hemispheres of the globe between 8°4'N to 37°6'N latitudes and 68°7' E and 97°26' E longitudes. It roughly occupies central part of the eastern hemisphere. The Tropic of Cancer passes through the middle of the country dividing India into almost two halves with the southern zone falling into hot tropical areas and the northern zone forming sub-tropical and temperate parts.

In terms of its location, it lies in the northern part of the Indian Ocean. The Indian Peninsula stretches into the ocean with two large water bodies surrounding it namely Arabian Sea in the west and Bay of Bengal in the east. Coastline around these two water bodies roughly covers the length of about 6083 kilometre and has played a significant role in international trade, commerce and cultural interaction with people of the Middle East, Southeast Asia and East Africa. Fig. 1.1 shows the location of India in the sub-continent.

In terms of its geopolitical location, Pakistan and Afghanistan lie in the northwest; China, Nepal, and Bhutan in the north; Bangladesh and Myanmar in the east and Sri Lanka in the south. Its total boundary of about 15,200 kilometre passes through deserts, rugged mountains, marshy lands and plains.

India's geographical location has created diverse climatic conditions resulting in a variety of flora and fauna. India has characteristics of tropical, sub-tropical

and temperate types of climate. This has helped in getting advantage of several cropping seasons round the year.

Owing to its central location in the world, India enjoys a geostrategic position that cannot be easily surpassed by any other country in the region. This advantage was used by Britain to colonise and have its stronghold over the other countries of Asia, Africa and Oceania.

1.2.2 Shape and Size

India has a total geographical area of about 32,87,263 square kilometre, which is roughly 0.57 percent of the total area of the Earth and 2.4 percent of the total land area. India is the seventh-largest country of the world after Russia, Canada, USA, China, Brazil and Australia. It had a population of about 1210.2 million persons in 2011. It stands second to China in terms of population in the world. This vast area and huge population present both physical and cultural diversities within the country.

India roughly has a quadrangular shape which roughly extends 3214 kilometre north to south and 2933 kilometre east to west. There exists a difference of just 281 kilometre between the north-south and east-west extensions of the country. Apart from it, India also has two groups of islands, Andaman-Nicobar in the Bay of Bengal and Lakshadweep-Minicoy in the Arabian Sea.

SAQ I

Write a note on the physical setting of India and the advantage it has with its neighbouring countries.

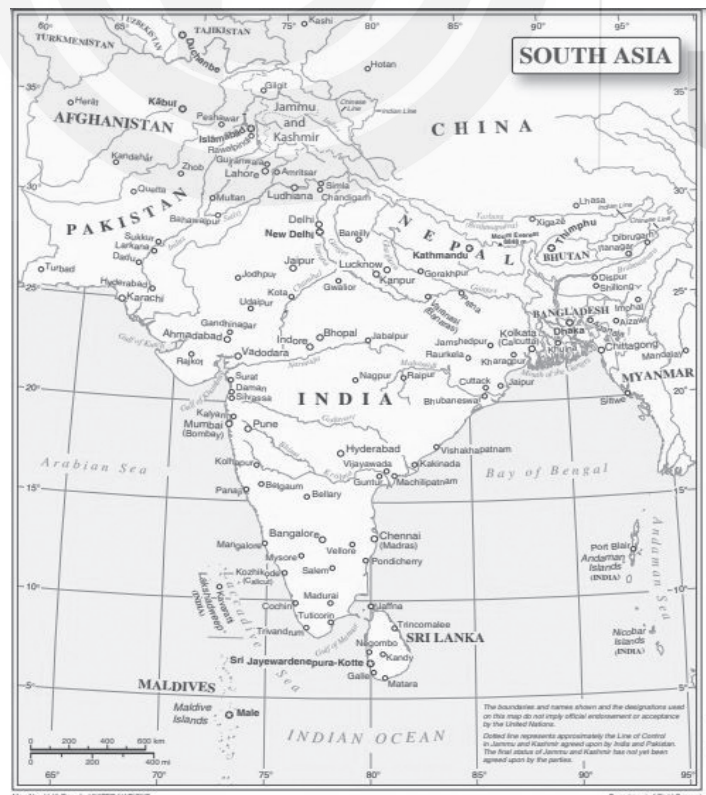


Fig. 1.1: Location of India.

(Source: <https://www.un.org/Depts/Cartographic/map/profile/SouthAsia.pdf>.)

1.3 HISTORICAL SETUP

Due to the lack of archaeological studies, very little is known about the political organization of India during pre-historic and proto-historic times. But there is sufficient evidence to prove the presence of Dravidians in the region before the Aryans (Tiwari, 2007) and of a flourishing civilization called Indus Valley Civilization whose traces have been found in Mohenjodaro and Harappa (presently in Pakistan) and several places of northwest India (Lothal and Kalibangan (presently around Gujarat and Rajasthan). The Aryans had their settlement in the region around Punjab. Slowly they started moving towards Ganga valley i.e., between the Himalayas and the Vindhyas.

The process of merger of small kingdoms and the concept of political unity started during Rig Vedic period. During the Vedic period, territorial jurisdiction of India extended from Afghanistan in the west to Myanmar in the east. North to south extension was from Nepal in the north to Tamil Nadu in the south (Tiwari, 2007). Some scholars believed that the territory of India during ancient times extended from China to Sindh and from Iraq to east of the Arabian Sea (Lewis, et.al., 1997). The country was divided into several smaller kingdoms called Janapadas. In the later stage (around 600 B.C.), a larger Kingdom namely Magadha was formed through annexation of many Janapadas. This was the first initiative to have political unity in the region.

South Indian territory was then governed by Cholas, Pandyas and Tamrapani. During the Mauryan period, the empire comprised the region around Afghanistan as far as Hindukush, Baluchistan, Sindh, Kutch and the whole of India except Assam and some parts of southern districts of Karnataka. Fig. 1.2 shows the expanse of Maurya Empire. However, Mauryan Empire disintegrated after the death of Ashoka. Several smaller kingdoms emerged including Sakhas and Kushans.

The period of Gupta Empire under the leadership of Chandragupta Vikramaditya became much more powerful in and around (A.D. 300-450). Under his reign, he was able to consolidate mostly Northern territory from Himalayas in the north to Narmada and Gujarat to Bengal. South India then had smaller independent kingdoms like Chalukyas, Pallava, Chola, Chera and Pandya etc. Huen Tsang visited India during this period and was able to document political, social, and economic conditions of the people of that time.

The Turks invaded during 11th and 12th Centuries. Mohammad Ghori defeated the last Rajput king of Delhi Prithvi Raj Chauhan and started the slave dynasty. This was followed by several other Dynasties like Khilji dynasty, Tughlaq dynasty, Sayyid dynasty and Lodhi dynasty. Again in 1526 A.D., Babur defeated the last Lodi Ruler, Ibrahim Lodi and laid foundation of the Mughal Empire in India. Mughal Empire flourished and Emperor Akbar consolidated whole of the sub-continent into a large empire extending from Odisha in the east to Kabul in the west and from Kashmir in the north to Ahmadnagar in the south.

With the discovery of sea routes to India by Vasco-da-Gama (AD. 1498), the Portuguese reached Calicut in 1500 AD. During the reign of Akbar, the English, the French and the Dutch got entry into India through several rivalries to carry

out their business. The French were the last European colonial powers to set foot in India. They were also keen on profiting from Asian trade (Bansal, et. al., 2019). Finally, India got independence on 15th August 1947 which ended British rule and India became Republic on 26th January 1950. India consisted of a large number of Princely States during the colonial era and it comprised 571 State units which were subsequently merged to form 27 States.

There was a further reorganization of States when it was found that the boundaries formed by the Princely States were not very logical economically, culturally, linguistically and administratively. Hence, States' Reorganisation Commission was constituted in 1953 for the reorganisation of the Indian States. Further need was felt for the organization of States on linguistic basis. Andhra Pradesh was the first state formed on linguistic basis in 1953. In 1960, new states of Maharashtra and Gujarat were formed from the erstwhile state of Bombay. Similarly, Punjab was divided into two states of Punjab and Haryana in 1966.

Further under the North East Area Reorganization Act in 1971, the northeast region was divided into five states (Assam, Manipur, Meghalaya, Nagaland and Tripura), and Arunachal Pradesh and Mizoram were separately given the statehood later on. Sikkim was integrated in 1975 from its protectorate status making it 22nd State of the Country. It was only in the year 2000 that the states of Chhattisgarh, Jharkhand, and Uttarakhand were carved out of Madhya Pradesh, Bihar and Uttar Pradesh respectively. More recently, the state of Telangana was carved out of Andhra Pradesh in 2014. Today, the Union of India comprises 28 States and 8 Union Territories after the formation of Ladakh and Jammu and Kashmir as separate Union Territories in 2019.

SAQ 2

Explain the historical events that have taken place before the formation of the proper political structure that exists today.

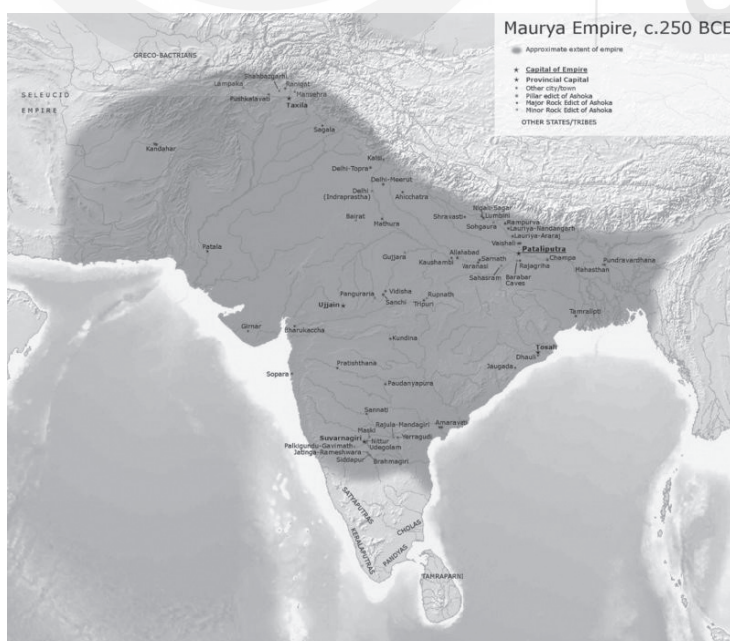


Fig. 1.2: Expanse of Mauryan Empire.

(Source: http://epgp.inflibnet.ac.in/epgpdata/uploads/epgp_content/indian_culture/01._outlines_of_indian_history/mauryan_empire/et/5193_et_et.pdf.)

1.4 SOCIO-CULTURAL PERSONALITY

India is home to over a billion people with incredible cultural diversity in terms of languages, geographic regions, social groups and religious groups etc. Indian culture possesses a rich blend of social norms, ethical values, traditional belief systems, artefacts, technologies and political systems. The cultural histories are strongly connected to India by the process of immigration and colonization particularly in South Asia and Southeast Asia. Indian culture is often labelled as a combination of several cultures that have been influenced by a history that is several millennia old, beginning with the Indus Valley Civilization. Many elements of culture, such as Indian religions, philosophy, languages, dance, music, and movies have had a great impact on the Indian rich cultural diversity that exists even today. Hence, Indians have a strong sense of pride in the distinctiveness of their rich cultural diversity.

India is one of the linguistically diverse nation and ranks 4th in terms of variety of languages spoken. The People's Linguistic Survey of India (2010-2012) reported the existence of 780 languages (including languages and dialects) in India. India is home to great ethnic diversity. Ethnicities can often be divided based on various linguistic groups in India. The two largest groups that can be divided on linguistic grounds are Indo-Aryan (78 percent) and Dravidian (20 percent). Indo-Aryan groups are commonly found in northern region and speak languages like Hindi, Gujarati, Urdu, Marathi, Punjabi, Odia and Bengali. The Dravidians on the other hand inhabit the southern territory and speak languages including Tamil, Kannada, Telugu, and Malayalam.

However, such categorization does not reflect people's identities in India. Within these broad language groups, there is significant linguistic diversity with people speaking hundreds of regional or local dialects. Constitution of India identifies 22 major languages with Hindi and English as official languages.

Indian origin religions mainly include Hinduism, Jainism, Buddhism and Sikhism that are mostly based on the concepts of karma (deeds). Religions which originated outside India, including Abrahamic religions, such as Judaism, Christianity, and Islam are also present in India. Along with these are present Zoroastrianism and Bahá'í Faith both escaping persecution in places of their origin have found shelter in India over the centuries.

India has 28 States and 8 Union Territories with different cultures. It is the second most populated country in the world after China. The Indian culture is often labelled as an amalgamation of several other cultures across Indian sub-continent and has been influenced and shaped by its history that dates back to several thousand years. Indian culture has been heavily influenced by locally originated customs and rituals throughout its history. Much of Indian philosophy, literature, architecture, art and music have been influenced by series of cultural evolution and exchanges that had taken place in the sub-continent. Over the centuries, there has been a significant fusion of various cultures in India between the Hindus, Muslims, Buddhists, Jains, Sikhs and various other beliefs of tribal populations.

Indian religions are important among world religions along with Abrahamic religions. Hinduism and Buddhism are the world's third and fourth-largest religions respectively. Followers of Indian origin religions – Hindus, Sikhs, Jains and Buddhists make up around 80–82 percent of India's population. India is one of the most religiously and ethnically diverse nations in the world, having society with some deep religious and cultural beliefs and practices. Religion plays a central and definitive role in the life of most of its people. Although, India is a secular country with Hindu majority, it also has large proportion of Muslim population. Except for Jammu and Kashmir, Ladakh, Punjab, Meghalaya, Nagaland, Mizoram and Lakshadweep, Hindu population forms majority. Muslims form majority in the Union Territory of Jammu and Kashmir and are also well distributed in rest of the country. They have significant proportion in Uttar Pradesh, Bihar, Maharashtra, Kerala, Telangana, Andhra Pradesh, West Bengal and Assam. Christians, Sikhs and Buddhists are other significant minorities of India.

Because of the diversity of different religious groups in India, at times it has led to turmoil and violence resulting in clashes between people of different religious groups. Some groups have founded various national-religious political parties, and despite government policies, minority religious groups are being subjected to prejudice from more dominant groups to maintain and control resources in many regions of India. Diversities in terms of ethnic, linguistic, regional, economic, religious, class and caste group's cross cut Indian society. Among Hindus, caste system based on the 'Varna' System classifies Indian society into four broad categories namely *Brahmin* (priestly class), *Kshatriya* (nobility and warrior class), *Vaishya* (traders/ merchants) and *Shudras* (artisan or labour class).

The 'Varna' based castes system has traditionally been associated with occupations such as priests, potters, barbers, carpenters, leather workers, butchers and launderers. The social order that existed in ancient times has still been carried forward in society. Members of castes ranking higher in the prevalent social order usually have been comparatively more prosperous than members of lower-ranking castes. Those in the lower niche of the caste hierarchy often endured poverty and social disadvantage.

Over a long period, the caste system became an important component of social hierarchy making many Shudras untouchables (Dalits) owing to the nature of work they performed in the society. The occupation then became an important aspect of the society leading it to *the Jati* system. Such differences in society today are however no longer enforced and discrimination based on caste is outlawed.

Castes are ranked, named, endogamous (in-marrying) groups, and membership which is achieved by birth. There are thousands of castes and sub-castes in India, involving hundreds of millions of people. These large kinship-based groups are fundamental to South Asian social structure. Many people feel that caste membership provides a sense of belonging to a recognized group from whom support can be expected in a variety of situations.

Hierarchies are found throughout India be it north India or south India, among Hindu or Muslim, urban or rural, and social groupings are ranked according to various essential qualities. Societal hierarchy is evident in caste groups, amongst individuals and in family and kinship groups. Castes are primarily associated with Hinduism; however, it also exists among Indian Muslims, Christians and some other religious communities which are not very distinctive as that of Hindus. Within most villages or towns, everyone knows the relative rankings of each locally represented caste which constantly shapes the behavioural system among different social groups.

One of the great themes pervading Indian life is social interdependence. People are born into groups-families, clans, castes, sub-castes and religious communities and feel a deep sense of inseparability from these groups. Social support from the family or the wider social groups forms an important component of individual life. There exists bonding within the family and within the community of which the people are part. Economic activities, too, are deeply embedded in social fabrics.

Social inequality exists throughout the world, but perhaps nowhere has inequality been as elaborately constructed as in the Indian institution of caste. Caste has existed for many centuries, but in the modern period, it has been severely criticized and is undergoing significant change.

The existence of differences in social hierarchy can even be seen in the spatial context. In rural areas, many low-caste people are still landless, unemployed and are often discriminated at different instances. However, such rigidity in caste-based discrimination has been decreasing in the urban spaces with increasing incidences of inter-caste marriages becoming acceptable. Correlations between caste and occupations are declining rapidly both in rural and urban areas.

Village Panchayat is often recognized as a council composed of important local men making important decisions on governance and maintain social order. The village headman usually settles the disputes with his unbiased decision by the virtue of trust and power that has been vested in him by society. Today, the government supports an elected Panchayat and headman system, which is distinct from the traditional system and in many cases, mandates the inclusion of members from different sections of the society to give them fair representation. Regulations of the state have increasingly intruded into villages and their social system and structural organizations have experienced diminishing traditional systems of authority. There has been a marked transformation in structural organization of the social system over time. Economic development and prosperity have been quite instrumental in bringing major changes in psychological and behavioural outlook of people. Overall progress that India has undergone over the period to some extent has been the result of its socio-cultural, economic and political transformation that it has adopted and progressed keeping in mind its social fabric.

SAQ 3

History of India has largely shaped India's socio-cultural characteristics. Explain.

1.5 UNITY IN DIVERSITY

India is the land of great diversities owing to its vast geographical extension. Diversities in various forms ranging from physical, social, and cultural can be seen across the country. For instance, talking about physical diversity, it can be seen that southern Peninsula is largely made up of a plateau which is one of the oldest landmasses on the Earth. Its rocks are mostly igneous and metamorphic which have never submerged under sea since their formation over about 3000 million years ago. In contrast, there are Himalayan mountain ranges in the north which form youngest mountains on Earth. Within these mountains, altitudinal differences are huge within a short distance of few kilometres. In between Indian Peninsula and Himalayas are situated the vast plains known as Indo-Gangetic plains, which are very young in age.

Even the river systems of Himalayas and Peninsula have contrasting characteristics. For instance, Himalayan rivers originate from the glaciers and snow-clad mountain peaks and are perennial in nature as opposed to Peninsular rivers, which are rain-fed and their volume and flow sharply decreases during dry months. Besides, there are sharp contrasts in terms of soil characteristics found in different regions, vegetation types and climate. For instance, place like Dras in Ladakh can experience temperature of -40°C , while temperature around Barmer in Rajasthan may go above 48°C . Similarly, Mawsynram near Cherrapunji receives an annual rainfall of over 1221 centimetre in contrast to places like Jaisalmer in Rajasthan receiving rainfall of only about 12 centimetre.

Such extremes and diversities in physical conditions have produced social and cultural heterogeneity in the country. Diversities in religions, languages, culture and racial heterogeneity to large extent have been due to its vast size and other areal/historical factors.

However, it must not be forgotten that despite the above-mentioned diversities there is an underlying unity as well. India has been able to stand as a single territorial unit. Despite having several physical, political, social and economic contrasts there is a bond of belongingness among people of the country. Great saints of our nation have been able to spread the message of universal brotherhood and it has helped in uniting the people belonging to different religions, cultural groups and economic strata who have been living in harmony. The climatic rhythm too has been able to bring unity and harmony among its people, for example, the onset of monsoon and its annual rhythm influences the whole country. In particular, it brings together northern plains, central India, and even the northeast region by bringing in uniformity of agricultural practices.

Religious composition and unity among its people show that Hinduism influences life of majority of Indians along with Islam intertwined in a complex matrix on Indian land. Hindus formed 79.8 percent of India's population while 14.2 percent were Muslim, 2.3 percent Christians, 1.7 percent Sikhs, 0.7 percent Buddhists and 0.37 percent Jains in 2011. Even with such significant religious differences; there exists a sense of brotherhood under the umbrella of being Indian. Despite having low proportion of religious minorities due to

huge population of India, the actual number of people of these groups is quite significant.

Similarly, economic progress and prosperity can be seen to be uniting India into a single entity. For instance, mineral resources belts of eastern India comprising Chhattisgarh, Jharkhand, Odisha and some other areas around Chotanagpur Plateau, have been able to bring economic prosperity in the region. Similarly, tea grown in Assam in the north-east region too has been able to contribute significantly towards prosperity in the country as a whole. Punjab, Haryana, West Bengal, Uttar Pradesh, Gujarat and many other states have been performing very well in agricultural productivity thereby making the country sufficient in meeting its food demand and also for exports of grains.

Indians generally value harmony and keeping unity with others. There exists strong nexus with the community and relatives within the society. The community on the other hand also provides social support to the family or the people of which they are part. The interdependence and social ties are much stronger in rural areas than in urban centres. It is the bonding and social network that provides support system and security to people in villages. The greatest asset of our nation today has been its rich cultural diversity, population size and its natural resources. The unity of its population of different religions, cultures and socio-economic fabrics further strengthens India to stand with the global powers. One cannot deny the fact that India is the land of potentialities provided there is unity, harmony and common brotherhood among its population.

SAQ 4

There is unity despite the varying degree of diversity in India. Explain.

1.6 SUMMARY

In this unit, you have learnt the following:

- India is unique in terms of its geographical location.
- It has been greatly influenced by its physical location that has significantly influenced its climate, rainfall, temperature and other socio-cultural characteristics.
- There exists a diversity of various forms owing to its large size and extension adding more to its diversity of various forms.
- India's history has a very close association with its culture.
- The existence of rich culture along with its amalgamation with various other cultures over the period and intermixing has given it a unique identity and social characteristics.
- Despite having differences and diversity in its population and cultural groups, there exists unity among its population and can stand united as a nation.

- This makes India distinct with varying degrees of socio-cultural and ethno-political differences.

1.7 TERMINAL QUESTIONS

1. Write a note on the physical setting of India highlighting the diversities in its physical setup.
2. Explain the historical progress and cultural transformation that India has undergone from the ancient to the modern period.
3. There exists a unity in diversity in India. Explain.

1.8 ANSWERS

Self Assessment Questions (SAQ)

1. The latitudinal extension makes it favourable for experiencing the tropical and temperate climate adding to the diversity in its agricultural production. Apart from its large area, presence of large seas i.e., Arabian Sea and Bay of Bengal have been advantageous for the trade and commerce.
2. India has experienced series of invasions and its history has been very different from most other nations. There have been several instances of restructuring and reorganizations of its territories under the reign of different rulers, before it finally became independent from colonial masters.
3. Different invaders and rulers not only brought their people but also came to India with their culture. There was intermixing of culture in different periods giving cultural distinctiveness that exists today.
4. Unity despite the existing differences has been its unique characteristic.

Terminal Questions

1. To answer this question, include the key features of physical setting of India and also highlight its diversities. Refer to Sections 1.1, 1.2 and 1.3.
2. While answering this question, highlight the main features of historical progress and cultural transformation that India has witnessed from ancient to the modern period. Refer to Section 1.4.
3. Highlight the essence of the dictum of unity in diversity in India to answer this question. Refer to Sections 1.5 and 1.6.

1.9 REFERENCES AND SUGGESTED FURTHER READING

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UNIT 2

PHYSIOGRAPHY |

Structure

2.1	Introduction		Peninsular Plateau
	Expected Learning Outcomes		Coastal Plains and Islands
2.2	Physiographic Characteristics	2.5	Summary
2.3	Evolution of Landforms	2.6	Terminal Questions
2.4	Major Physiographic Divisions	2.7	Answers
	Himalayas	2.8	References and Suggested
	Northern Plains		Further Reading

2.1 INTRODUCTION

In Unit 1, you have already studied and learned about the geographical position of India in the sub-continental setting. Along with this, you have also studied and learned about physical, historical, socio-cultural personality and aspects of unity in the diversity of India. We are sure that you must have understood the whole gist of the Unit that lends a unique character to the entire nation in its multifarious dimensions. You might have also observed that the study of these physical, historical and socio-cultural components related to the study of the sub-continental setting of India is highly influenced by its physiographic setting characterized by its rich variety in every dimension.

In this Unit, we will discuss the physical dimensions in terms of physiographic units and their several important components. Physiographic characteristics have been described in Section 2.2 and the evolution of landforms in Section 2.3. The purpose is to highlight diverse types of physiographic divisions encompassing the Himalayas, Northern Plains, Peninsular Plateau, Coastal Plains and Islands along with their significance in India's totality. Section 2.4 deals with major physiographic divisions of India and their significance for various purposes including human settlements and a range of economic activities.

Expected Learning Outcomes

After studying this unit, you should be able to:

- comprehend the physiographic division of India;
- know origin and significance of the Himalayas;

- know about the Peninsular plateau;
- understand about Northern plains and Islands of India; and
- explain the difference between the East and West coasts of India.

2.2 PHYSIOGRAPHIC CHARACTERISTICS

India is a land of diversity. Culture, economy and even the landscape of India have diverse elements. The wide variety of physical features of India makes the country an important unit for geomorphological study. India has every possible landscape that is found on planet Earth. The most important physiographic characteristics of India are:

- 1) North India is bounded by the mighty Himalayas which run for about 2400 kilometre from west to east and have widths varying between 160 to 400 kilometre. Himalayan mountains stretch from Jammu and Kashmir and Ladakh in the west to Arunachal Pradesh in the east covering an area of 5 lakh square kilometre.
- 2) The Great Northern plains are lying between the Himalayas in the north and Peninsular plateau in the south stretching from northern Rajasthan in the west to Ganga delta and Assam in the east covering an alluvium region of 7.8 lakh square kilometre.
- 3) Two lakh square kilometre of western India is characterized by a hot desert known as '*Thar desert*'. It largely covers a large part of Rajasthan state west of Aravalli hills and is bordered by the states of Punjab, Haryana, and Gujarat.
- 4) The triangular Peninsular plateau extends from south of the Great Indian plains and tapers to Kanyakumari in its southern extremity.
- 5) The topography of India has been dissected by numerous rivers. These include perennial Himalayan rivers flowing due to snow-melting and rain-fed Peninsular non-perennial rivers. Ganges, Indus and Brahmaputra along with their tributaries form major Himalayan river systems while Krishna, Kaveri, Godavari, Mahanadi, Narmada and Tapi are important Peninsular rivers.
- 6) India has wide and long coasts and many tropical islands.

A brief idea about physiographic characteristics will help you in understanding the evolution of landforms as discussed in the next Section.

SAQ I

Briefly discuss the gist of physiographic characteristics of India with suitable examples.

2.3 EVOLUTION OF LANDFORMS

The present relief features of India are the result of several geological/geomorphological events that occurred over millions of years. It is estimated

that the Earth is approximately 4.54 billion years old. The endogenic and exogenic forces have played a significant role in giving shape to various surface and sub-surface features of the Earth. The Continental Drift Theory and Theory of Plate Tectonics define the formation of physical aspects of the Earth's surface. Initially, all continents were united in the form of one landmass, known as '*Pangea*' or '*Super Continent*'. This landmass got fragmented and many parts drifted apart giving rise to continents as seen today. A large part of the supercontinent had its northern part named '*Angara Land*' or '*Laurasia*' and the southern part was named '*Gondwana Land*'. The area that now comprises the Himalayas and Northern plains of India was under a shallow sea, called '*Tethys*'. Over millions of years, rivers flowing on these two landmasses deposited a huge quantity of sediments in the sea of Tethys. These two colossal landmasses were gradually but progressively leading towards each other. This lateral compression force, particularly from the south, led to the folding of sediments deposited in the sea and the thrust pushed the deposits upward. Over millions of years, this process led to the formation of grand fold mountains called the Himalayas.

With the rise of mountains, a huge geosyncline emerged to the south of the Himalayas also called Foredeep. This depression got filled up with alluvium brought by rivers and it resulted in the formation of wonderfully even aggradational plains. These are called Indo-Gangetic plains or Northern plains.

Study of evolution of landforms will make you to appreciate the major physiographic divisions of India which are explained in detail in the next Section.

SAQ 2

What is the evolution of landforms? Discuss in brief.

2.4 MAJOR PHYSIOGRAPHIC DIVISIONS

Land surface of India is as complex as its making. It has all types of landforms such as mountains, hills, plateaus and plains. Nearly 11 percent of the total area is mountainous, 18 percent hilly, 28 percent plateau type, and the remaining 43 percent is having a plain surface.

Due to geological complexities and geomorphological diversities, the division of India into physiographic regions is a difficult task. It is normally divided into the following five physiographic divisions. These are:

- 1) The Northern Mountains (The Himalayas)
- 2) Northern Plains
- 3) Peninsular Plateau
- 4) Coastal Plains
- 5) Islands

2.4.1 The Himalayas

Himalayas run for 2400 kilometre extending from Jammu & Kashmir in the west to Arunachal Pradesh in the east with a width ranging from 160 kilometre to 400 kilometre. Its average height is 6000 metre. It is estimated that these young folded mountain ranges cover an area of 5 lakh square kilometre. These are the highest mountains in the world. Rocks of the Himalayas are folded and faulted. These have several over folds, recumbent folds, nappes and thrust faults. These are still in the stage of formation.

(1) From south to north, the classic boundary faults are as under:

Main Frontal Thrust (MFT); (2) Main Boundary Thrust (MBT); (3) Main Central Thrust (MCT); (4) South Tibetan Detachment System (STDS); and (5) Indus-Tsangpo Suture Zone (ITSZ).

(2) The Himalayan terrain from south to north has been conventionally divided into sub-parallel tectonic – stratigraphic sub-divisions as below:

- A. Sub-Himalaya or Outer Himalaya;
- B. Lower Himalaya or Lesser Himalaya;
- C. Higher Himalaya or Great Himalaya; and
- D. Trans-Himalaya (mountain ranges lying north of the Great Himalayan range).

The Outer Himalayas (The Shiwaliks)

Outermost range of the Himalayas is known as Shiwalik or the Outer Himalaya. It consists of foothills of the Himalayas with an altitude of 600-1500 metre and a width ranging from 15 to 50 kilometre. In between Siwalik and Himachal range is found flat bottomed longitudinal valleys termed as 'doons/dun'. Dehra Dun valley (75 kilometre long and 15-20 kilometre wide) is a typical example of this.

The Lesser Himalayas (The Himachal)

Situated in between Shiwaliks in the south and the Great Himalayas in the north in the Middle Himalayas runs almost parallel to both ranges. It has an average elevation of 3500 to 4500 metre, and an average width of 60 to 80 kilometre. Important mountain ranges included in this section of the Himalayas are Pirpanjal, Dhauladhar, Nag Tiba, Mahabharat-Lekh range and Mussoorie range. Pirpanjal range which lies in Jammu and Kashmir and partly in Himachal Pradesh is the longest and most important range extending from 300 to 400 kilometre. It rises to the elevation of 5000 metre. Famous Kashmir valley is situated in-between the Pirpanjal range and the Great Himalayan range. Pirpanjal range extends for some distance beyond Rohtang pass and then there is the Dhauladhar range which is the most prominent range of Himachal Pradesh. It rarely attains an elevation of higher than 4000 metre. Further east, the Middle Himalayas are marked by Mussoorie and Nagtiba ranges. The Mahabharat-Lekh range in southern Nepal is the continuation of the Mussoorie range.

The Great Himalayas (The Himadri)

This is also known as the inner or the central Himalayas. This is the northernmost or innermost of all the Himalayan ranges with an average elevation of 6000 metre above sea level and an average width of 25 kilometre. The core of these ranges is made up of Archaean rocks including granites and schists, etc. Its main range called the Great Himalayan range has some of the tallest peaks in the world, which mostly remain under perpetual snow. Some of the highest peaks are Mt. Everest (8848 metre), Kanchanjunga (8598 metre), Dhaulagiri (8172 metre), Annapurna, Nanga Parbat, Manaslu, Nandadevi, Kamet and Trisul etc. High mountain passes like Bara Lacha La, Shipki La, Thanga La, Niti Pass, Lipu Lekh Pass, Nathu La, Zelep La, Burjil Pass and Zoji La are found in this range.

The Trans-Himalayas

Ranges situated north of the Great Himalayan range are called Trans-Himalayas. Trans-Himalayas are sometimes also referred to as Tibetan Himalayas because a considerable part of it lies on the Tibetan side. These run parallel to the north of the Great Himalayan range for a distance of about 1000 kilometre in the east-west direction with an average width of 40 kilometre at the eastern and western extremities and about 225 kilometre in the central part. These rise up to more than 5000 metre. Zaskar, Ladakh, Karakoram and Kailash are main Trans-Himalayan ranges.

Regional Divisions of Himalayas

Himalayas have been divided based on regions from west to east. Sir Sidney Burrard divided the entire length of the Himalayas into the following four divisions based on the river valleys:

- A. The Western Himalayas (includes Jammu & Kashmir, Ladakh and Himachal Pradesh Himalayas)
- B. The Kumaun Himalayas
- C. The Nepal Himalayas
- D. The Assam Himalayas

S. P. Chatterjee (1973) divided the Himalayan region into 5 regions from west to east. These are discussed as under:

- A. Kashmir Himalayas
 - B. Himachal Himalayas
 - C. Kumaun Himalayas (Uttarakhand Himalaya)
 - D. The Central Himalayas
 - E. The Eastern Himalayas
- i. **Kashmir Himalaya** lies almost entirely in the Union Territories of Jammu and Kashmir and Ladakh with an average height nearly 3000 metre above mean sea level. It comprises a series of ranges such as Karakoram, Ladakh, Zaskar, Great Himalayan and Pirpanjal range. The north-eastern part of Kashmir Himalayas is a cold desert, which lies between the Great Himalayan range and the Karakoram range.

Karakoram range lies to the North of the river Indus having lofty peaks and a large number of big glaciers. Ladakh plateau, Kashmir valley and Jammu Himalayas are important features of this region.

- ii. **Himachal Pradesh Himalaya** mainly covers the state of Himachal Pradesh. This part lies approximately between the Ravi in the west and Yamuna (a tributary of Ganga) in the east. The northernmost part of the Himachal Himalayas is an extension of the cold desert of Ladakh. All zones of the Himalayas are present here. These include Greater Himalaya being represented by Great Himalayan range and Trans Himalaya by Zaskar range. Lesser Himalaya is represented by the Dhauladhar range while outer Himalaya is represented by the Shiwalik range. Rohtang, Baralacha La and Shipki La are important mountain passes of this part of the Himalayas.
- iii. **Uttarakhand Himalaya** lies in Uttarakhand state and is also known as Kumaun Himalayas. This part extends approximately between river Tons (Yamuna tributary) in the west and Kali river (a tributary of Ghaghara) in the east. Its main peaks are Nanda Devi (7817 metre), Kamet (7756 metre), Trishul (7140 metre), Chaukhamba I (7138 metre), Satopanth (7075 metre), Kedarnath (6968 metre) and Bhagirathi massif consisting of four peaks ranging between 6856 to 6193 metres. Lesser Himalaya in Kumaun is represented by Mussoorie and Nagtibba ranges. Shiwalik in this region runs south of the Mussoorie range between the Ganga and Yamuna rivers for a length of about 75 kilometre. Thaya La, Muling La, Mana, Niti and Marhi La are important mountain passes.
- iv. **Central Himalaya** stretches for a distance of about 800 kilometre, between river Kali in the west and river Teesta in the east. All the three ranges of the Himalayas are present here. Some of the world's highest and famous peaks like Mt. Everest, Kanchanjunga, Makalu, Annapurna and Dhaulagiri etc., are located here. Mahabharata-Lekh range represents Lesser Himalaya. Most of its part lies in Nepal.
- v. **Eastern Himalaya** lies between Teesta and the Brahmaputra rivers covering a distance of about 720 kilometre. Eastern Himalaya consists of three broad sub-regions namely Darjeeling-Sikkim Himalaya, Bhutan Himalaya and Arunachal Himalaya. Darjeeling and Sikkim represent the western flank of Eastern Himalaya while Bhutan is located in its central section. Arunachal Pradesh extends eastward from Bhutan Himalaya up to the Diphu pass. Eastern Himalayas exclude the Siliguri sub-division of Darjeeling as well as Tirap and part of the Lohit district which lies south of the Lohit river in Arunachal Pradesh.

Darjeeling-Sikkim Himalaya consists of four sub-divisions; Singalila range, Donkia range, Darjeeling hill region and Kalimpong hill region. While Bhutan Himalaya consists of the Chomolhari-Kulakangri region, Punakha-Thimpu region, Tongsa region, Dewangiri and Phuntsoling regions. Similarly, Dafla, Miri, Abor and Mishmi regions are the four sub-sections of Arunachal Himalaya.

Eastern Hills or Purvanchal Hills

After crossing Dihang gorge (Brahmaputra gorge), the Himalayas suddenly turn southward and form a series of comparatively low hills running in the shape of a crescent with its convex side pointing towards the west. These hills are collectively called the Purvanchal because these are located in the eastern part of the country. These hills extend from Arunachal Pradesh in the north to Mizoram in the south and form a boundary between India and Myanmar.

These comprise the following hills – Mishmi hills, Patkai Bum range, Naga hills, Manipur hills and Mizo hills (Lushai hills). All these ranges are generally 2,000 metre, or lesser in elevation but are rather forbidding because of dense forests, very rough terrain and inhospitable living conditions.

Origin of the Himalayas

Geologically speaking, the Himalayas are a young fold mountain system. These contain highly metamorphosed rocks belonging to various geological periods. These rocks abound in fossils of different periods. According to geologists, there existed a large continent, called '*Pangaea*' surrounded by a vast ocean called '*Panthalassa*'. Around 200 million years ago, a geo-syncline called the Tethys existed at the center of Pangaea roughly dividing it into the northern continent known as *Angaraland* and the southern continent called *Gondwanaland*. Towards the end of the Mesozoic period, great changes occurred. Sediments of the Tethys began crumpling due to compression which was contained for a long period.

Gondwanaland was disrupted and its different parts began to drift apart. Thus, the Indian Ocean was formed in the process. Deposition and subsidence continued for a longer period. Towards the end of the cretaceous period, there was an uplift in the bed of the Tethys and large-scale warping gave birth to the Himalayas. Scholars believe that the Himalayas are still restless and continue to rise. The Plate tectonic theory advocates that the origin of the Himalayas is result of the plate movements.

Significance of the Himalayas for India

Strategic Significance: It acts as a natural frontier of India with other countries (China, Afghanistan and Pakistan).

Climatic Significance: It prevents further northward movement of the summer monsoon and also prevents cold northern winds from Siberia to enter India.

Physical Significance: Glaciers of the Himalayas feed the perennial rivers of North India. The rivers erode the mountain ranges and deposit alluvial soils which are highly productive.

Agricultural Significance: Rivers from the Himalayas deposit lot of sediments at the foothold, from which are formed India's most fertile agricultural grounds known as Northern plains. Water of mighty rivers arising out of the Himalayas is utilized for generating hydroelectric power, irrigation, along with industrial and domestic purposes.

Economic Significance: It can be seen in terms of the huge hydroelectric power potential of Himalayan Rivers, Himalayan Timber, Himalayan Herbs and Medicinal Plants. River sediments are used as a great source of minerals and building materials.

Tourism Significance: It has large ecological biodiversity, natural scenery and hill stations. The Himalayas is the abode of numerous tribes and has rich cultural heritage. The Himalayas are also rich in flora and fauna.

SAQ 3

Write a brief note on the longitudinal divisions of the Himalaya.

2.4.2 Northern Plains

Great Northern plains are situated between the Himalayas in the north and Peninsular plateau in the south. These plains stretch from northern Rajasthan in the west to the Ganga delta in the east and further east to Assam. These plains are also known as Indo–Gangetic–Brahmaputra plain.

The Indo–Gangetic –Brahmaputra plain forms an alluvium region covering an area of 7.8 lakh square kilometre. The plain extends for a length of 3200 kilometre from the mouth of Indus to the mouth of the Ganga, of which the Indian sector alone accounts for 2,400 kilometre consisting of the greater part of northern India. From east to west with an average, width varies between 150 to 300 kilometre. The plain is formed by the basins of Ganga, Indus and Brahmaputra with their tributaries. It contains more than 40 percent of the total population of India. It is an extremely flat and level plain, with an average slope of 25 centimetre per square kilometre.

Significance of the Northern Plains

The deep fertile alluvial soils of the plain, perennial rivers and favourable climate have rendered the plains agriculturally most prosperous. Various food crops, as well as non-food crops are grown here. The region is rightly termed as the 'Granary of the Country'. The plains contain about 1/3rd area of the country which supports 40 percent population of the country. The plains have witnessed several political, religious and cultural movements since the dawn of history. The Northern plains have been the principal theatre of Indian history and culture.

Origin of the Great Plains

Process of origin of the plains is still debatable as several scholars have postulated contrasting viewpoints.

(1) General Concept

Origin of the Great plains of India should be considered as the outcome of several interconnected processes and mechanisms e.g., sedimentation, subsidence, upliftment and recession of sea, etc. It is believed that an extensive trench (which is known as geosynclines) was formed in front of the Himalayas due to Himalayan orogeny. Rivers flowing from the Himalayas and the Peninsula started depositing sediments in the trench.

The ever-increasing weight of continuous sedimentation of an enormous volume of eroded materials (alluvia) caused gradual subsidence of the trench. Thus, the repetition of twin processes of sedimentation and subsidence over a long period resulted in the deposition of sediments up to great thickness (hundreds of metres).

The trench was ultimately filled with sediments and the 'Great plains' were formed. The Arabian Sea continued to withdraw, as a result, new land areas were freed from the sea and added to plains.

(2) Concept of E. Suess

According to E. Suess, an extensive foredeep was formed between the Himalayas and Peninsular India due to Himalayan *orogeny*. The foredeep was in the form of an extensive syncline, the bed of which being irregular and undulating was a broad synclinorium (consisting of numerous small anticlines and synclines).

The rivers coming from the Himalayas started to deposit sediments into the foredeep. The sediments were derived through erosion of the Himalayas by southward flowing rivers. In due course of time, the foredeep was filled with the sediments and thus the 'Great plains' were formed.

(3) Concept of S. Burrard

According to S. Burrard, an extensive rift valley measuring 2400 kilometre in length and 500 metre in depth formed due to the origin and upliftment of the Himalayas. The northern and the southern blocks of this rift valley were formed by the southern ranges of the Himalayas and the foreland of the Indian Peninsula respectively. According to him, this rift was formed due to the formation of two normal faults. The rift valley was filled up with sediments brought by the rivers coming from the Himalayas and Peninsula plateau. Thus, the Great plains were formed due to gradual sedimentation in due course of time.

Scholars like Hayden and R. D. Oldham have not accepted Burrard's view of the Indo-Gangetic Depression. Burrard's views of rift valley formation in front of the Himalayas are not tenable as no evidence could be found which can validate the idea of the formation of rift valley along the northern foreland of the Indian Peninsula.

Topography

The Great plains exhibit a remarkably homogeneous surface with little relief. It is a featureless alluvial fertile plain formed by the rivers' deposits.

The plain may be divided into the following belts-

- a) Bhabar belt
- b) Terai belt
- c) Bhangar belt
- d) Khadar belt
- e) Delta Plains

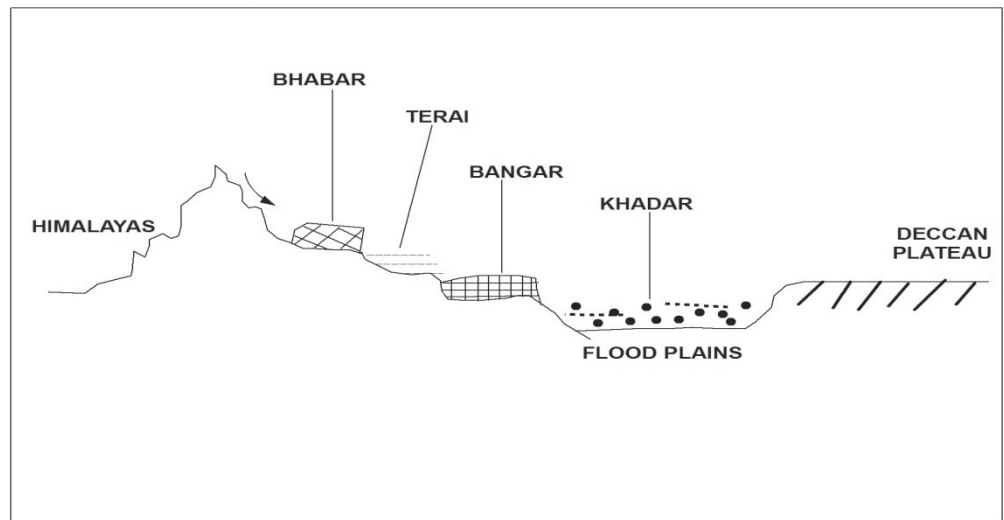


Fig. 2.1: Schematic Representation of Indian Plains depicting Bhabar Belt.

Bhabar Belt

Bhabar belt is about 7-15 kilometre wide narrow belt adjacent to foothills of Himalayas. It is made up of porous, rocky soils, and pebbles that get deposited at the foot of the Himalayas due to the breakoff slope. This material is made of debris washed down from higher ranges. Due to the very high porosity of this belt, water seeps down and the streams are lost and start flowing underground.

Terai Belt

The Terai belt is 15-30 kilometre wide marshy tract that lies next to Bhabar running parallel to it. Due to bedrock, the streams lost in Bhabar reappear in Terai. Thus, the water table is very high making the land marshy. Consequently, Terai belt is moist and thickly forested and is home to a variety of wildlife.

Bhangar Belt

This is the largest part of the Northern plains made up of old alluvium and forms an alluvial terrace above flood plains. The soil is made up of old alluvium and in the drier parts, it has calcareous deposits called *kankar*.

Khadar Belt

Khadar belt is found along all rivers in the flood plains. Soil is made up of new alluvium which gets deposited every year due to floods.

Delta Plain

The deltaic plain has a huge amount of new alluvium and is mostly in the form of Khadar. It covers about 1.9 lakh square kilometre of area in the lower reaches of the Ganga river. It is an area of deposition as the river flows in this tract sluggishly. The deltaic plain mainly consists of old mud, new mud and marsh.

Regional Division of Great Plains of India

The Great plains of North India is considered monotonous and characterized by its extreme horizontality and low elevation. This vast area exhibits distinctive fluvial patterns, directions of flow, and geomorphology. The Great plain of India is divided into the following four regions:

- 1) **The Rajasthan Plain**
- 2) **The Punjab–Haryana Plain**
- 3) **The Ganga Plain**
- 4) **The Brahmaputra Plain**

1. The Rajasthan Plain

The western extreme of the Great plains of India consists of the Thar or Great Indian desert which covers western Rajasthan and the adjoining parts of Pakistan. The Thar desert (also known as the Great Indian desert) is a hot desert that forms a significant portion of western India. It is spread over four states in India viz., Punjab, Haryana, Rajasthan, and Gujarat. It covers an area of 2 lakh square kilometre. The desert continues into Pakistan as the Cholistan desert. Most of the Thar desert is situated in Rajasthan, covering 61 percent of its geographic area. The area is characterized by extreme temperatures of above 45°C in summer to below freezing in winters with low rainfall.

Some of the peculiar features are:

- Covers a total area of 2.0 lakh square kilometre, out of which 1.75 lakh square kilometre lie in India.
- 2/3rd of the Indian desert lies on the western part of Aravali range in Rajasthan.
- 1/3rd of the Indian desert lies in Haryana, Punjab and Gujarat.

Rajasthan plain is sub-divided as follows -

1. Western Sandy Plains
 - a. Sandy Arid Plains
 - i. Marusthali
 - ii. Dune Free Tract
 - b. Semi-Arid Transitional Plains (Rajasthan Bagar)
 - i. Luni Basin (Godwar Tract)
 - ii. Plain of Interior Drainage (Shekhawati Tract)
2. Eastern Plains
 - a. Banas Basin
 - b. Chappan Plains

2. Punjab–Haryana Plain

Part of the plain shows flat to slightly convex surface controlled by sub-surface Delhi–Aravali ridge. Its eastern boundary in Haryana is formed by the river Yamuna. Rest of Haryana doesn't have any perennial river. It is called the Indo-Gangetic Divide and has reversal of slope. Punjab state is a part of

the plain formed as a result of alluvial deposits by five rivers viz., Satluj, Beas, Ravi, Chenab and Jhelum.

The plain-

- It covers an area of approximately 95,000 square kilometre.
- Elevation of its northern part is 300 metre (above MSL), while in the south-eastern part, it is 200 metre (above MSL).

Mass of alluvium has been broken by the river courses which have carved broad flood plains of khaddar flanked by *bluffs* locally known as *dhayas*. These bluffs, as high as 3 metre, or more have been heavily gullied. The land between rivers here is called *Doab*.

The northern part of this plain adjoining Shiwalik hills has been intensively eroded by numerous seasonal streams called *chos*.

The area between the Ghaggar and the Yamuna rivers lies in Haryana and is often termed as "*Haryana Tract*". It acts as a water divide between the Yamuna and the Satluj rivers.

3. Ganga Plain

This is the largest unit of the Great plains of India stretching from Delhi to Kolkata in the states of Uttar Pradesh, Bihar, and West Bengal covering an area of about 3.75 lakh square kilometre. It is named after the name of the great river the Ganges. Geomorphologically, the entire Ganga plain is featureless and monotonous. Extensive flood plains, natural levees, sharp meanders, ox-box lakes, gullied riparian tracts, braided channels, and bluffs etc., are the only morphological features of the Ganga plain.

The entire Ganga plain exhibits geomorphological homogeneity. It is divided into three geographical regions following R.L. Singh (1971) based on cultural and economic factors.

- a) Upper Ganga Plain
- b) Middle Ganga Plain
- c) Lower Ganga Plain

Upper Ganga Plain

Upper Ganga Plain lies between the Yamuna valley in the west and 100 metre contour in the east covers an area of 1.49 lakh square kilometre of Uttar Pradesh. The plain is about 550 kilometre long in the east-west direction and nearly 380 kilometre wide in the north-south direction. Its elevation varies from 100 to 300 metre, above the mean sea level (MSL).

The micro-level topographic facets and their regional characteristics render possible delineation of as many as four physiographic units. These are:

- a. The Sub-Montane Belt
- b. The Ganga-Ghaghra Doab Region
- c. The Ganga-Yamuna Doab
- d. Yamunapar Ravine Tract

Middle Ganga Plain

Middle Ganga plain covering an area of 1.44 square kilometre is spread over eastern Uttar Pradesh and the whole of Bihar plains. It stretches for about 600 kilometre in the east-west and nearly 300 kilometre in a north-south direction. Most accepted boundaries of it are made by 100 metre contour in the west, 75 metre contour in the northeast, and 30 metre contour in the southeast. This is a very low plain and no part of it exceeds 150 metre elevation.

The north Middle Ganga plain is characterized by the presence of numerous paleo-channels, ox-bow lakes, tanks and ponds locally known as *tal/s* (formed due to shifting in river courses). Other morphological features include natural levees, ravines, and badlands in the riparian tracts of the rivers, flood plains, meander loops, eroded but unstable riverbanks and sandy features like dhus, etc.

Following the scheme of R.L. Singh (1971), the Middle Ganga plain is divided into two broad sub-regions and their micro level further divisions. These are:

a. The Ganga Plain North

- i. The Ganga-Ghaghra Doab
- ii. The Saryupar Plain (the Ghaghra-Gandak interfluve)
- iii. The Mithila Plain (the Gandak-Kosi interfluve) and
- iv. The Kosi Plain (the Kosi-Mahananda interfluve)

b. The Ganga Plain South

- i. The Ganga-Son divide
- ii. The Magadh Plain and
- iii. The Anga Plain

Lower Ganga Plain

The Lower Ganga plain, in the real sense of the term, includes the Kishanganj tehsil of Purnea district (Bihar), whole of the West Bengal state (excluding the Purulia district and the mountainous parts of Darjeeling and Kalimpong districts) and most of Bangladesh as well. The total geographical area under this plain is 81 thousand square kilometre. Two third of this area is below 30 metre, above mean sea level (MSL).

R.L. Singh (1971) divided the Lower Ganga Plain, based on micro-order diversities within the homogenous surface configuration into the following physiographic sub-divisions -

- a. The Northern plain is characterized by duars (Terai) tal, diara and Barind tract.
- b. The Delta proper comprises:
 - i. Moribund delta
 - ii. The mature delta
 - iii. The active Delta

The western margin of the delta is called the Rarh plain.

The Brahmaputra Plain

This is also known as Brahmaputra valley of Assam plains, most of its part is situated in Assam state. This plain is about 720 kilometre long and its average width is 60 to 100 kilometre. The entire plain covers an area of 56 thousand square kilometre. It is an aggradational plain built up by the depositional work of the river Brahmaputra and its tributaries. The general elevation of the plain varies from 130 metre in the east to 30 metre in the west.

SAQ 4

Discuss the major topographic features of the Northern plains of India.

2.4.3 Peninsular Plateau

The plateau region situated in the south of the Great plains and surrounded by seas on three sides is known as Peninsular India. It is a triangular plateau with its base in the north which coincides with the southern edge of the Great plains and its apex is formed by Kanyakumari. It extends over south-eastern Rajasthan, Madhya Pradesh, Chhattisgarh, Telangana and parts of Andhra Pradesh, Karnataka, Odisha, Tamil Nadu as well as Jharkhand. It has an outlier in Meghalaya in the east. It is surrounded by the hill range on all three sides. To its north are the Aravalli, the Vindhyan, the Satpura and the Rajmahal hills. Along with its western and eastern edges are the Western Ghats and the Eastern Ghats respectively. The entire plateau measures about 1600 kilometre in the north to south and 1400 kilometre in the west to east directions.

The Peninsular plateau forms part of an ancient tabular block stretching over an area of 16 lakh square kilometre. It is divided into several large and small plateaus, hill ranges, basins and valleys.

Origin of the Peninsular Plateau

The age of the Peninsular plateau has been estimated at 500 million years. According to Geologists, this plateau forms a part of ancient Gondwanaland. It has remained unaffected by mountain-building forces. However, it has experienced block faulting and displacement of rocks as evidenced/witnessed by fault valleys of Narmada and Tapti rivers during Carboniferous period. During the Cretaceous period, large-scale volcanicity produced the Deccan trap comprising thick lava sheets of several thousand metres in depth.

The following rock systems are found here.

- Archaean Group
- Dharwar System
- Cuddapah System
- Vindhyan System
- Gondwana System

Physical Divisions of the Peninsular Plateau

It has following sub-divisions:

East Rajasthan Uplands

It lies east of the Aravalli ranges also known as Marwar upland with an elevation ranging between 250-500 metres. It slopes eastwards.

The Central Uplands

The Central uplands are also known as Madhya Bharat Pathar located in the east of Marwar uplands. Most of it comprises the basin of Chambal river. The area is famous for ravines and badlands.

Malwa Plateau

Malwa plateau roughly forms a triangle based on Vindhyan hills, bounded by the Aravalli range in the west and sharply defined scarp overlooking Bundelkhand in the east. In the north, the plateau is marked by Chambal Ravines. The plateau is highly broken having rolling plains separated by flat-topped forested hill ranges.

Bundelkhand Uplands

Lying between the Yamuna river and Vindhyan plateau, these have an average elevation ranging from 300-600 metre.

- Covers an area of about 54 thousand square kilometre.
- It is characterized by snail topography, mesas, buttes, long and narrow ridges, and many artificial lakes.

Baghelkhand Plateau

It lies to the east of Maikal range and south of Son river. It covers an area of 1.4 lakh square kilometre. The plateau has a general elevation of 150 to 1200 metre and has an uneven surface.

Chhota Nagpur Plateau

Lying to the west of the Bengal basin and east of Baghelkhand, Chhotanagpur plateau covers mostly Jharkhand, northern Chhattisgarh and the Purulia district of West Bengal.

- It covers an area of 87 thousand square kilometre.
- The average elevation of this plateau is 700 metre. The highest elevation of about 1100 metre is found in the mid-western portion, generally known as *pat* lands.
- Chhota Nagpur plateau virtually consists of a series of plateaus standing at various levels of elevation like Hazaribag plateau, Ranchi plateau and Rajmahal hills, etc.

Meghalaya Plateau

It is an outlier of the Peninsular plateau. The Garo Rajmahal gap separates Meghalaya plateau from the main block of the Peninsular plateau.

- The plateau is flanked by Garo hills (900 metre), in the west and Khasi–Jaintia hills (1500 metre) in the east.
- Shillong peak (1961 metre) is the highest point.

Deccan Plateau

This is the largest unit of the Peninsular plateau of India covering an area of about 5 lakh square kilometre. This triangular plateau lies between Eastern and the Western Ghats and Satpuras and Vindhyan hills in the northwest, Mahadev and Maikal hills in the north.

- Its elevation ranges from 600 to 1000 metre.
- It was formed by the volcanic activity. The lava deposits are more than 200 metre thick.

The Deccan plateau is further sub-divided into several smaller plateaus. These are as under:

1. Maharashtra Plateau

- Forms the northern part of the Deccan plateau.
- Much of the region is underlined by basaltic rocks of lava origin.
- Horizontal lava sheets have led to the formation of the typical Deccan Trap.
- The entire area is covered by the black cotton soil known as regur.

2. Karnataka Plateau

- Popularly known as Mysore plateau lies to the south of the Maharashtra plateau.
- The plateau is divided into two parts called Malnad and Maidan.

3. Telangana Plateau

- The southern part is higher than its northern part.
- The entire plateau is divided into two major physiographic regions namely Ghats and the peneplains.

Hill Ranges of Peninsular Plateau

It has following sub-divisions:

Aravalli Ranges

One of the major physiographic elements of Peninsular India is Aravalli range which extends from Gujarat through Rajasthan up to Delhi for about 800 kilometre in a south-west to north-east direction.

- It is a relic of the world's oldest mountain chain formed during the Pre-Cambrian period.

- Its average elevation ranges between 400-600 metre, but near Mount Abu, the highest peak known as Guru Shikhar rises to 1722 metre.

Vindhyan Ranges

From the southern edge of the Malwa plateau, the Vindhyan range stretches for a distance of about 1200 kilometre, with an average elevation ranging from 300 to 650 metre. It rises abruptly from the bed of the Narmada river.

Satpura Ranges

It lies between the valley of Narmada in the north and Tapi in the south. Satpura range attains its maximum height near Panchmarhi (1350 metre). The Eastern part of the range is known as Maikal plateau. Maikal range runs in the north-south direction and reaches its maximum height near Amarkantak (1,127 metre).

Western Ghats (The Sahyadris)

The Western Ghats form the eastern edge of the Deccan plateau. Western Ghats run in the north-south direction from Tapi valley (21°N) in Maharashtra to Kanyakumari (11°N). These Ghats run parallel to the west coast for about 1600 kilometre. A steep wall-like slope facing the Arabian Sea indicates extensive submergence. Anaimudi (2695 metre), Doda Betta (2637 metre), Makurti (2554 metre), Vavul Mala (2339 metre), Mahabaleswar (1438 metre), Kalasubai (1646 metre) and Kudremukh (1892 metre) are some of the highest peaks in the Western Ghats. The Ghats present a stair-like topography due to denudation. The Ghats are crossed by three gaps known as *Thalghat* (583 metre), *Bhorphat* (630 metre) and *Palghat* (305 metre).

Eastern Ghats

Bordering the eastern edge of the Deccan plateau, Eastern Ghats run almost parallel to the east coast of India leaving broad plains between their base and the coast. Unlike the Western Ghats, Eastern Ghats form a discontinuous and low belt, lying parallel to the east coast, stretching from the south of Mahanadi valley to Vaigai in Tamil Nadu, for a distance of about 800 kilometre.

Depending upon relief and structure, Eastern Ghats can be divided into northern and southern parts. In the northern part in-between Mahanadi and Godavari, Eastern Ghats bears a true character of hills with a width of 200 kilometre in the north which narrows down to 100 kilometre in the south. Mahendra Giri (1,501 metre) is tallest peak.

Significance of the Peninsular Plateau

1. The plateau is rich in useful minerals like manganese, iron ore, bauxite, gold, copper, coal and diamond etc.
2. Black cotton soils of the Deccan plateau are favourable to growing cotton and sugarcane.
3. The Western Ghats and other hills are thickly forested providing valuable varieties of woods including teak, ebony, mahogany, cane, bamboo and sal, etc.

4. The Western Ghats provide a natural habitat for many wild animals and birds.
5. Rivers flowing through Peninsular plateau make several waterfalls in their courses which have been harnessed for generating hydroelectricity.
6. Several hill resorts like Ooty, Panchmarhi and Mahabaleshwar etc. attract tourists from all over India and abroad.

2.4.4 Coastal Plains and Islands

A narrow coastal strip between the edges of the Peninsular plateau and the coastline of India running for a distance of about 7,516 kilometre is called the Coastal plain.

The area between the Western Ghats and the Arabian Sea coast is called West Coastal plain and the area between the Eastern Ghats and the Bay of Bengal is called East Coastal plain.

East Coastal Plain

East Coastal plain begins from the north with the plains formed by Subarnarekha river extending to the south till Kanyakumari. It thus stretches for nearly 1500 kilometre, with nearly a width of 100 kilometre. Compared to Western Coastal plain, the East Coastal plain is wider. The deltas of Mahanadi, Godavari, Krishna, and Kaveri rivers cover nearly 25 percent area of this plain.

East Coastal plain can be physiographically sub-divided into:

- a) Coromandel coast (the Tamil Nadu coast and parts of Andhra Pradesh coast together known as Coromandal coast).
- b) North Sircar coast (between the Mahanadi and the Krishna rivers and Carnatic between the Krishna and the Cauvery rivers).

While according to states, it can be divided into:

Utkal Plain

- The Utkal plain comprises coastal areas of Odisha, about 400 kilometre long.
- It includes the Mahanadi delta.

Andhra Plain

- Located to the south of Utkal plain and extends up to Pulicat lake. This lake has been barred by a long sand spit known as Sriharikota Island.
- The most significant feature of this plain is the delta formed by Godavari and Krishna rivers.

Tamil Nadu Plain

- The Tamil Nadu plain stretches for 675 kilometre, from Pulicat lake to Kanyakumari along the coast of Tamil Nadu. Its average width is 100 kilometre.
- The most important feature of this plain is the Cauvery delta where the plain is 130 kilometre wide.
- Fertile soil and large-scale irrigation facilities have made the Cauvery delta the granary of south India.

Dunes and Lagoons in East Coastal Plain

East Coastal plains have presence of many sand dunes, lagoons, and varieties of marshland. The sand dunes vary between 1 to 4 kilometre in length and 60-65 metre in height. Between the sand dunes and the coast lie the lagoons. Slightly these are connected to the sea e.g., Chilka lake on Utkal coast, Kolleru and Pulicat lakes on the Andhra coast.

West Coastal Plain

It stretches from Rann of Kachchh in the north to Kanyakumari in the south. To the east, it is bounded by steep slopes of Western Ghats, and to the west lies the Arabian Sea. Compared to East Coastal plain, the West Coastal plain is narrower. West Coastal plain becomes narrower gradually from Kachchh coast to Kanyakumari, where it is narrower. The average width of the West Coastal plain is 65 kilometre.

Kachchh and Kathiawar Region

Kachchh/Kutch and Kathiawar, though an extension of the Peninsular plateau (because Kathiawar is made of Deccan lava and there are tertiary rocks in the Kutch area) are still treated as an integral part of Western Coastal plains as these are now levelled down. Kutch Peninsula was an island surrounded by seas and lagoons. These seas and lagoons were later got filled by sediment brought by the Indus river which used to flow through this area. Lack of rainfall in recent times has turned it into an arid and semi-arid landscape. Salt-soaked plain to the north of Kutch is the 'Great Rann'. Its southern continuation is known as 'Little Rann'.

Gujarat Plain

This forms the northern portion of the west coast. It is quite wide. The plain area lies in the east of Kathiawar and Kutch Peninsula towards the west and southwest including the southern part of Gujarat and the coastal areas of the Gulf of Khambhat are called Gujarat plains.

- Formed by the rivers Narmada, Tapi, Mahi and Sabarmati.
- The eastern part of this plain is fertile enough to support agriculture, but the greater part near the coast is covered by windblown loess (heaps of sand).

Konkan Plain

- Konkan plain south of Gujarat plain extends from Daman to Goa (50 to 80 kilometre wide).
- It has some features of marine erosion including cliffs, shoals, reefs and islands in the Arabian Sea.

Karnataka Coastal Plain

- South of the Konkan coast starts the Coastal plains of Karnataka between Goa in the north and Mangalore in the south, for 225 kilometre. It is a narrow plain with an average width of 30-50 kilometre, the maximum being 70 kilometre near Mangalore.
- The Sharavati while descending over such a steep slope makes an impressive waterfall known as Gersoppa (Jog) Falls which is 271 metre high.
- Marine topography is quite marked on the coast.

Kerala Plain

- Situated between Mangalore and Kanyakumari, it is also known as the Malabar plain.
- The existence of lakes, lagoons, backwaters and spits etc., are significant characteristics.
- The backwaters, locally known as kayals (famous for tourism) are shallow lagoons or inlets of the sea, lying parallel to the coastline.

Importance of Coastal Plains of India

1. The coastline of India is uniform and regular, little indented by large inlets. West coast has small inlets which contain a few natural harbours like Mumbai, Marmora, Cochin, and New Mangalore. The east coast, except Vishakhapatnam, does not have natural harbours.
2. Western Coastal plains are noted for growing spices and on the other hand east coast is known for growing rice, palm, areca nut and coconut.
3. Backwaters, lakes, and lagoons are ideal for fishing.
4. The Coastal plains have been centers of international trade and commerce since ancient times.
5. Mudgaon beach in Goa, Juhu beach in Mumbai, Gopalpur on the sea, and Puri in Odisha, Ramakrishna Beach in Vishakhapatnam (A.P.), and Chennai beach have attracted tourists for a long time.
6. Kerala coast has abundant deposits of monazite and offshore areas of Mumbai have petroleum deposits in abundance.

Indian Islands

India possesses 247 islands scattered in the Bay of Bengal (204 islands) and the Arabian Sea (43 islands). Both groups of islands differ from each other in their geological structure. The Bay of Bengal islands is associated with Tertiary orogeny while those of the Arabian Sea have a coral origin.

Apart from large numbers of islands near of Indian coasts, there are two other main groups.

Arabian Sea Islands

The offshore islands situated within a distance of 5 kilometre from the coast include Piram, Bhainsla near Kathiawar (Gujarat), Henery, Kainery, Butcher, Elephanta, Arnala (in Bassein region), Bhatkal and Pigeoncock, etc. (north of Mangalore), Diu, Vaid, Nora, Pirtan, Khariabet and Aliabet etc. (in Gujarat).

The distant islands include the Lakshadweep, Minicoy, and Amindive. The Lakshadweep islands are situated at a distance of 200-300 kilometre off the mainland with an area of 108.78 square kilometre. The Minicoy Island (4.3 square kilometre) lies southwards.

Bay of Bengal Islands

The Andaman Islands are situated between 6°45'N and 13°45'N latitudes and 92°10'E and 93°15'E longitudes covering an area of about 8300 square kilometre. The North and the Middle Andamans are highly dissected and densely forested and rise to 730 metre in height. The South Andamans are largely flat lowlands.

The Nicobar group of islands containing 19 islands is situated between 6°3'N and 9°3'N latitudes. The Great Nicobar with an area of 862 square kilometre is the largest island in the group. The little Nicobar, Katchall, Comerta, Trinket, Nankowry, Teressa and Tillanchag are other important islands. The Barren and Narcondam islands situated north of port Blair are volcanic islands.

Thus, you have got a detailed knowledge of the major physiographic divisions of India and its significance.

SAQ 5

Highlight the main features of the Indian islands with suitable examples.

2.5 SUMMARY

In this unit, you have learnt the following:

- Learned that physiography is that branch of geomorphology and geology that deals with the development of the existing shape of the land.

- The present surface features of India owe its formation to the various geological periods and geo-climatic processes.
- The mountain region belongs to the great orogeny of the tertiary period while Peninsular India has not been subject to crustal deformation for long age. Consequently, the topography of Peninsular India has been subjected to sub-aerial denudation or external forces.
- The Great plains of India owe their formation to sedimentary deposition and aggradation work of the rivers of the Indo-Ganges and Brahmaputra river system.
- The relief of India is marked by a great variety due to the differences in geological structure and history.

2.6 TERMINAL QUESTIONS

1. Write a brief note on the longitudinal division of the Himalaya.
2. Describe briefly the formation of the Northern plains.
3. Write a short note on Indo–Gangetic plain.
4. Name the major physiographic divisions of India. Write a brief account of the Coastal plains and Islands group of India.
5. Give an account of the Deccan plateau.

2.7 ANSWERS

Self-Assessment Questions (SAQ)

1. India has a unique physiographic personality. It is bounded by Great Himalayan mountains in the north, large Northern plain, Thar desert in the west, Peninsular Plateau in the south, large rivers and Coastal plains. All these settings give India a blend of different outlook in its physiographic characteristics.
2. Landform evolution is the process in which landform evolves. It deals with the major forces that are responsible for landform development and its past and present geological characteristics. The endogenic and exogenic forces have played a significant role in giving shape to various surface and sub-surface features of the Earth. The Continental Drift Theory and Theory of Plate Tectonics define the formation of physical aspects of the Earth's surface and landform evolution.
3. S. P. Chatterjee (1973) divided the Himalayan region into 5 regions from west to east. These are Kashmir Himalaya, Himachal Himalaya, Kumaun Himalaya (Uttarakhand Himalaya), Central Himalaya and Eastern Himalaya.
4. The Great plains of north India are considered monotonous and characterized by its extreme horizontality and low elevation. This vast area exhibits distinctive fluvial patterns, directions of flow and

geomorphology. These are known as Rajasthan plain, Punjab–Haryana plain, Ganga plain and Brahmaputra plain. All these plains have different evolutionary processes and have been subjected to different processes of formation.

5. India possesses 247 islands scattered in the Bay of Bengal (204 islands) and the Arabian sea (43 islands). Both groups of islands differ from each other in their geological structure. The Bay of Bengal islands is associated with tertiary orogeny while those of the Arabian Sea are of coral origin.

Terminal Questions

1. While answering this question, you should cover the longitudinal divisions of the Himalayas spanning from western to eastern portions. You may refer to Sub-Section 2.2.2.
2. Your answer should briefly cover the essence of formation of the Northern plains of India and its significance. You may refer to Sub-Section 2.2.3.
3. You should be discussing the major features of Indo–Gangetic plain. You may refer to Sub-Section 2.2.4.
4. You should write the major physiographic divisions of India and briefly provide an account of the Coastal plains and Islands group of India. You may refer to Sub-Section 2.2.5.
5. Your answer should throw light on the key characteristics of the Deccan plateau. You may refer to Sub-Section 2.2.5.

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UNIT 3

DRAINAGE |

Structure

3.1	Introduction Expected Learning Outcomes	3.8	The Peninsular Drainage Systems and its Evolution
3.2	Drainage Systems of India	3.9	The Major River Systems of the Peninsular Drainage
3.3	The Himalayan Drainage Systems	3.10	The Major River Basins of India
3.4	The Evolution of Himalayan Drainage System	3.11	Summary
3.5	The Indus River System	3.12	Terminal Questions
3.6	The Ganga River System	3.13	Answers
3.7	The Brahmaputra River System	3.14	References and Suggested Further Reading

3.1 INTRODUCTION

Indian sub-continent consists of a great diversity of physical features comprising numerous large and small rivers. Rivers in India are one of the important natural resources that provide water for agriculture, industrial activities, domestic use, aquaculture, inland water transport, and production of hydroelectricity etc. Indian rivers carve various forms of geomorphic features such as waterfalls, cliffs, gorges, valleys, flood plains, and deltas etc., along their courses. India receives an average annual rainfall of 120 centimetre. The annual yield of water in Indian rivers is 1,858,100 million cubic metre. Out of the total yield of water, more than one third (33.8 percent) is contributed by the Brahmaputra, followed by Ganga (25.2 percent), Godavari (6.4 percent), Indus (4.3 percent), Mahanadi (3.6 percent), Krishna (3.4 percent), and Narmada (2.9 percent).

This Unit contains discussion on the drainage system of India and its classification as given in Section 3.2. Himalayan drainage system and its evolution have been discussed in Sections 3.3 and 3.4. Elaborate discussion of major river system of Himalayas has been presented in the next Sections of 3.5, 3.6 and 3.7. Further, the Peninsular drainage system and its evolution have been described in Section 3.8 followed by the detailed illustration of major river systems of Peninsular drainage in Section 3.9. Major river basins of India have been identified and discussed in Section 3.10.

Expected Learning Outcomes

After studying this unit, you should be able to:

- identify major river systems of India;
- explain the evolution of Himalayan and Peninsular drainage systems;
- describe the distribution and pattern of Himalayan and Peninsular drainage systems; and
- identify the size and distribution of major river basins of India.

3.2 DRAINAGE SYSTEMS OF INDIA

All of you are familiar with rivers of India which are revered by us since time immemorial and act as lifeline for economic activities. In this Unit, you will learn about these river systems in detail. Drainage systems of India can be broadly divided on many bases. Major classifications can be done based on the following:

1. **Origin:** Based on the origin, Indian rivers are classified into two broad categories (i) The **Himalayan river systems** which include rivers like Ganga, Indus, Brahmaputra and their tributaries. (ii) **The Peninsular river systems** include rivers of India including Narmada, Tapi, Krishna, Mahanadi, Cauvery, Godavari and their tributaries.

2. **Orientation towards the Sea:** The second classification of drainage system of India is based on the rivers' orientation towards the sea i.e., (i) rivers flowing into Bay of Bengal, and (ii) those flowing into Arabian Sea.

Most of drainage of India is oriented towards Bay of Bengal amounting to 77 percent. These comprise large number of rivers such as Ganga, Brahmaputra, Godavari, Krishna, Cauvery, Mahanadi and Penner etc. Whereas, 23 percent of drainage area in India is oriented towards the Arabian Sea. This drainage area is drained by rivers like Indus, Sabarmati, Mahi, Narmada, and Tapi etc.

3. **Size of Catchment Area:** Based on the size of catchment area, Indian rivers are divided into three categories (i) river basins with catchment area of less than 2,000 square kilometre are known as 'Minor river basins', (ii) river basins with catchment area between 2,000 and 20,000 square kilometre are known as 'Medium river basins' and (iii) river basins with catchment area of 20,000 square kilometre and above are known as 'Major river basins'.

Below given Fig. 3.1 depicts the drainage system of India. After studying the classification of drainage systems of India, you will learn about the two major river systems of India in detail in the next Sections.

SAQ I

What are two categories of Indian drainage systems based on orientation towards the sea?

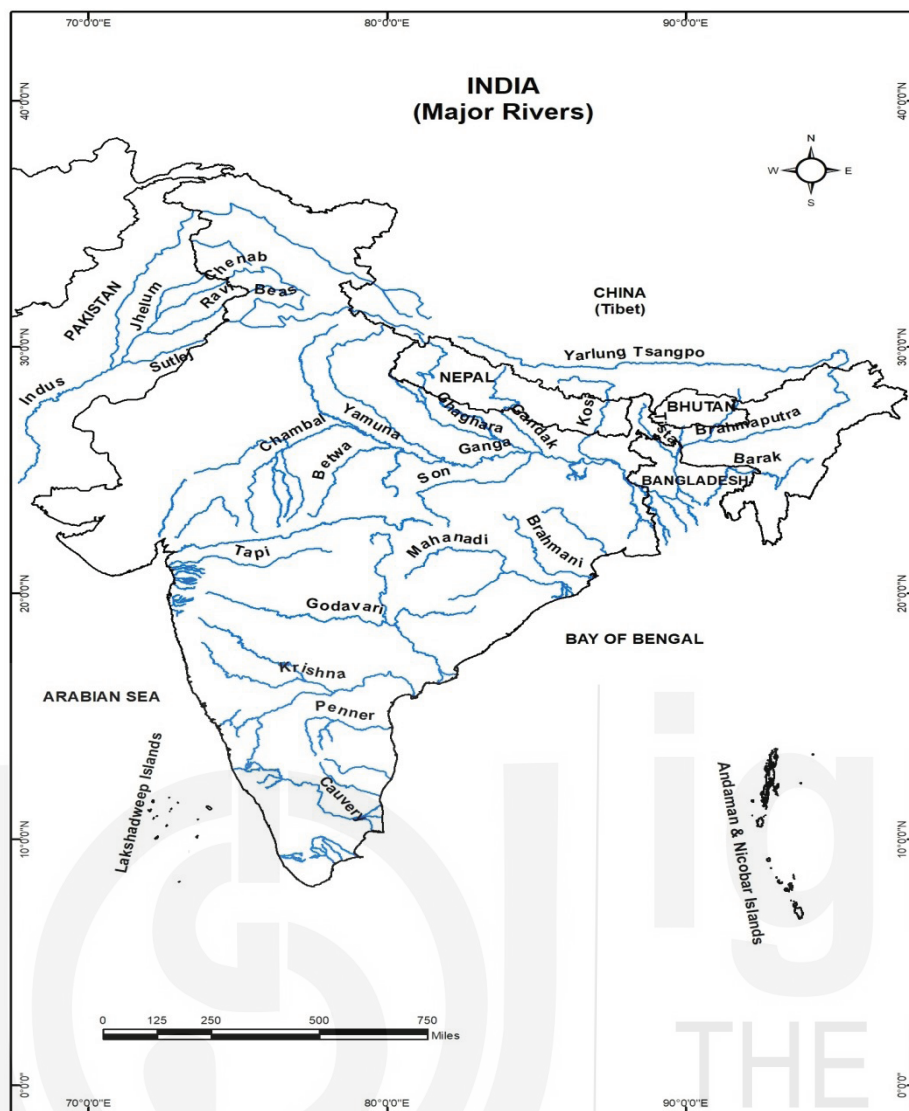


Fig 3.1: Drainage System of India.

(Source: Adapted from Survey of India (2019). Second Edition, *Physical Map of India*)

3.3 THE HIMALAYAN DRAINAGE SYSTEMS

Himalayan river system comprises of Indus, Ganges, and Brahmaputra river systems. As a result of erosional activity carried out in their courses, some of these rivers form rapids, waterfalls, V-shaped valleys, and deep gorges in their upper courses lying in mountains. After entering the plains, these rivers form depositional features like flood plains, oxbow lakes, flat valleys and deltas. These rivers are perennial in character as these get water through snow-melt from glaciers and also from seasonal rainfall. Fig. 3.2 depicts the Himalayan drainage system.

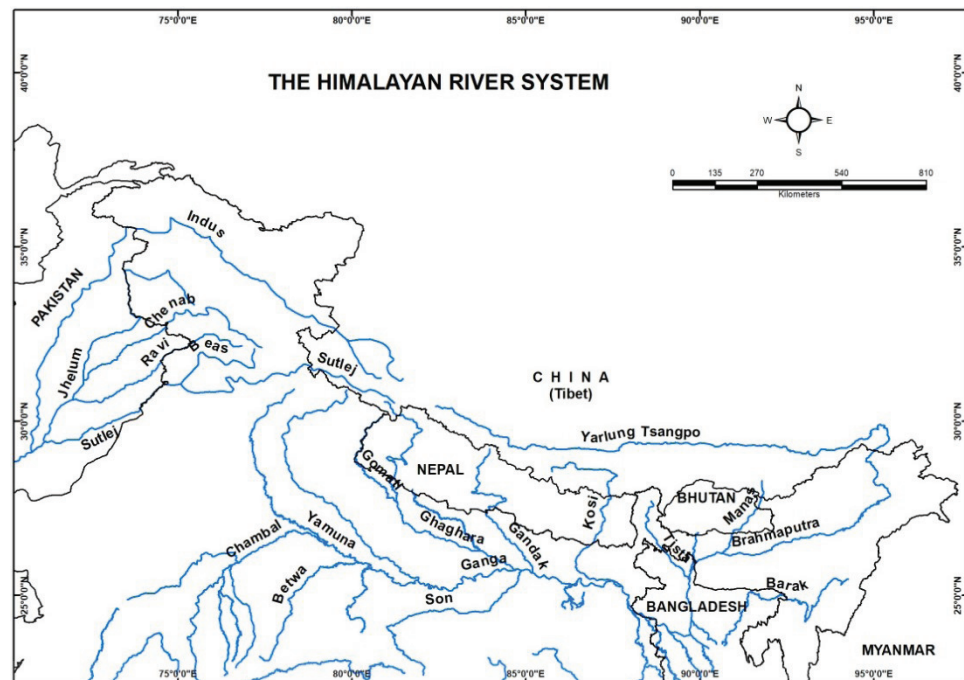


Fig. 3.2: Himalayan Drainage System.

(Source: Adapted from Survey of India (2019). Second Edition, *Physical Map of India*)

3.4 EVOLUTION OF HIMALAYAN DRAINAGE SYSTEM

There are various views about the evolution of Himalayan rivers. Many geologists believe that during Miocene Period a mighty river whom they call *Shiwalik* or *Indo-Braham* flowed along the entire length of Himalayas from Assam to Punjab, and finally it discharged into Gulf of Sind. It is believed that over the time the river got disjointed into three drainage systems namely: (i) in central part, it formed Ganga and its tributaries (ii) in the eastern part of India, it got disjointed and formed Brahmaputra river system and its tributaries whereas, (iii) in the western part, it disjointed into the Indus with its tributaries. The process of disjoining is ascribed to the upheaval of Himalayas including Potwar plateau during Pleistocene period. The water-divide between rivers Ganga and Indus got formed due to upliftment of Potwar plateau. Whereas, the diverged system of river Brahmaputra and Ganges flow towards Bay of Bengal which is attributed to down thrusting of Malda gap area between Meghalaya plateau and Rajmahal hills during mid-Pleistocene period.

3.5 INDUS RIVER SYSTEM

Indus river rises from glaciers situated on southern flanks of Kailash range in Tibetan plateau at an altitude of 5,182 metre. The total length of Indus river from source to mouth is 2,897 kilometre. Indus is also known as Sindhu and is the westernmost river system of India. It is regarded as the cradle of the Indus valley civilization. You all know that Indus is one of the largest river systems in the world. Entering India at an elevation of 4,206 metre, it continues to flow in the northwest direction between Zaskar range and Ladakh range. Shyok river joins it at an elevation of about 2,700 metre. Dras, Zaskar, Hunza, Shiger and Gorthang are important Himalayan tributaries of Indus which join

the river. Indus is joined by 'Panchnad' which is the name of five rivers namely: Jhelum, Chenab, Ravi, Satluj and Beas after entering the plains. The right bank tributaries of Indus which rise from the Sulaiman range are Sangar, Gomai, Khurramand and Tochi. The Indus finally flows into Arabian Sea after forming a delta in south of Karachi. Its important tributaries are as under:

1. **Jhelum** river originates from Verinag located at the south-eastern part of Kashmir. The total length of Jhelum is 724 kilometre. Catchment area of Jhelum river up to Indo-Pakistan border is 34,775 square kilometre. Jhelum flows from its source to Wular lake and flows further in south-westerly direction to enter Pakistan through a deep narrow gorge forming 170 kilometre of the India-Pakistan boundary. It joins river Chenab at Trimmu in Pakistan.
2. **Chenab** river acquires its name after the confluence of two streams namely Chandra and Bhagga. Chandra originates from Chander Tal and Bhagga from Suraj Tal situated near Bara Lacha Pass from the Great Himalayan range in Lahaul-Spiti district. After the confluence of Chandra and Bhagga at place called Tandi, the river comes to be known as Chandrabhaga and subsequently Chenab. The catchment area of Chenab up to Indo-Pakistan border is 26,155 square kilometre and its total length is 1,180 kilometre. Chandrabhaga the united stream flows in northwest direction parallel to Pir Panjal range through Pangi Valley and enters Jammu and Kashmir at an elevation of 1,838 metre as Chenab river. It cuts a deep gorge of about 1000 metre deep near Kistwar and flows for 290 kilometre. After flowing for a distance of about 330 kilometre, it travels westward to enter the plains near Akhnur in Jammu and Kashmir. It joins Panchnad after traversing to southwest through Pakistan Punjab plains for a distance of 664 kilometre and consequently meets Satluj after joining of Jhelum and Ravi.
3. **Ravi** river is an important tributary of Indus river and originates from Bara Bhangal in Kangra district in Himachal Pradesh. The total catchment area of river Ravi is 14,442 square kilometre, of which only 5,957 square kilometre falls in India. From the source, it flows in northwest direction and drains the area between Pir Panjal and Dhauladhar ranges. It cuts a deep gorge in Dhauladhar range after turning in the south-westerly direction. It enters Punjab plains near Madhopur and later enters Pakistan. It flows for 725 kilometre and joins river Chenab near Sarai Sidhu.
4. **Beas** river is a sub-tributary of Indus that originates from Beas Kund on Rohtang Pass at an elevation of about 4,000 metre. Total catchment area of Beas is 20,303 square kilometre. River Beas having a steep upper course crosses Dhauladhar range and cuts a deep gorge of about 900 metre deep from Lorji to Talwara. It turns in south-westerly direction and meets Satluj river in Punjab. It is comparatively small river that flows for a distance of 460 kilometre and lies entirely in India.
5. **Satluj** river originates near Mansarovar and Rakshastal in Tibetan plateau at a height of 4,570 metre. It drains an area of about 25,900 square kilometre and length of course of Satluj is 1,450 kilometre, out of

which 1,050 kilometre lie in Indian territory. Satluj river is the longest tributary of Indus river in India. It flows parallel to Indus river for about 400 kilometre, before entering Punjab plains and it pierces a deep gorge at Naina Devi Dhar. Entering Ropar and after flowing westward river Beas joins it at Harike. Bhakra Nangal project has been built on this river.

SAQ 2

Identify the 'Panchnad' of Indus river system.

3.6 GANGA RIVER SYSTEM

Ganga is one of the most important sacred river systems of India. It has large number of perennial and non-perennial tributaries. Left bank major tributaries of Ganga are Gomati, Ghaghara, Ramganga, Gandak, Kosi, and Mahananda. Whereas, river Yamuna, Son and Damodar are its right-bank tributaries. Its water is extensively utilized for irrigation, industries, hydel power generation and for domestic use. Flood plains of Ganga are identified as granary house of India that support enormous population of the country. Total length of river Ganga is 2,525 square kilometre, that run across the states of Uttarakhand and Uttar Pradesh (1,450 kilometre), Bihar (445 kilometre), and West Bengal (520 kilometre) and remaining 110 kilometre forms boundary between Uttar Pradesh and Bihar. It covers about 8.6 lakh square kilometre basin area in India. Ganga acquires its name after the confluence of Bhagirathi river and Alaknanda river at Devprayag. River Bhagirathi has its origin from Gangotri glacier at Gaumukh (3900 metre), whereas Alaknanda originates from confluence of Satopanth glacier and Bhagirathi Kharak glacier. Ganga upon reaching Haridwar enters the plains, after travelling for a distance of 280 kilometre from its source. It flows south and southeast for a distance of about 770 kilometre and reaches Allahabad where it meets Yamuna river. Yamuna is one of the most important tributaries of Ganga. River Ganga and Brahmaputra forms the largest delta before entering Bay of Bengal as *Sundarban delta* which is characterized by dense forest cover.

1. River **Yamuna** with its length of about 1,384 kilometre, rises from Yamunotri glacier on the western slope of Bandarpunch range at an elevation of 6313 metre. Its water is important for eastern and western Yamuna canals and Agra canal for irrigation. It runs parallel to river Ganga and joins it at Prayag in Allahabad. Its main southern tributaries are Ken, Betwa, Sind, and Chambal, whereas Sasur Khaderi, Sengar, Hindon, Tons, Baruna and Rind are its northern tributaries.
2. River **Chambal** originates from Signar Chauri peak (843 metre), near Mhow in Madhya Pradesh. It flows for a length of 965 kilometre covering total drainage area of 143,219 square kilometre. It drains through the states of Uttar Pradesh, Madhya Pradesh and Rajasthan to join Yamuna river near Etawah. Its tributaries are Shipra, Prajawati, Banasand and Kali Sindh. There are numerous important dams built along the river namely Jawahar Sagar dam, Rana Pratap Sagar dam and Gandhi

Sagar dam which immensely contribute in the generation of hydroelectricity and also provides irrigation facilities.

3. **Ramganga** river originates near Gairsain in the Lesser Himalayas and flows for a distance of 600 kilometre, forming total catchment area of 32,800 square kilometre. Deoha, Gangan, Kosi, Khoh and Aril are its important tributaries. It drains through Jim Corbett National Park and joins Ganga near Forrukhabad.
4. River **Ghaghara** originates from the glaciers of Mapchachungo. Its catchment area is 127,950 square kilometre, out of which only 45 percent lies in India. After joining the waters of Beri, Tila and Seti rivers, Ghaghara carves out deep gorge of about 600 metre deep at Shishapani. It is joined by river Sarda in the plain and further flows in south eastwardly direction before finally merging into the Ganga at Chhapra.
5. **Gandak** river rises near the Nepal Tibet border. Its main tributaries are Bari, Mayangadi, Trishuli, and Kali Gandak. Its total length is 425 kilometre, and joins Ganga near Patna. The total catchment area of Gandak is 48,500 square kilometre, out of which 9,540 square kilometre lies in India.
6. River **Kosi** consists of seven streams of which Arun is the mainstream. It rises to the north of Gosainthan. It has a total length of 730 kilometre, with drainage area of 86,900 square kilometre, out of which 21,500 square kilometre falls in India. It is joined by Tamur Kosi from the east and Sunkosi from the west after crossing Central Himalayas in Nepal. River Kosi forms depositional landforms like alluvial fans while entering plains near Jianagar from Shivalik. Kosi is called 'Sorrow of Bihar' because of frequent floods and shifting of river courses.
7. River **Son** originates from Amarkantak plateau and flows for a length of 780 kilometre, and drains an area of about 71,900 square kilometre. Initially, it flows in northern direction and then bends to north-easterly course and joins Ganga near Ara west of Patna. Son is south bank tributary of Ganga, and important tributaries of Son are Kanhar, North Koel, Gopat, Johilla and Rihand.
8. **Damodar** river originates from the hills of Chotanagpur plateau. It has total length of 541 kilometre. It drains an area of about 22,000 square kilometre. It is known as 'sorrow of Bengal' as it causes disastrous floods during monsoon season. It joins river Hugli 48 kilometre to the south of Kolkatta.

SAQ 3

Name right bank tributaries and left bank tributaries of Ganga river.

3.7 BRAHMAPUTRA RIVER SYSTEM

Brahmaputra river is also known as *Tsangpo* in Tibet. It is one of the important rivers of India. It has a total length of 2480 kilometre, out of which 1,346 kilometre falls in India. It covers a total drainage area of 5,80,000 square kilometre, out of which 2,58,008 square kilometre lies in India. Brahmaputra has its source in Chemayungdung glacier of Kailash range. The river flows eastward for nearly 1,200 kilometre, almost parallel to the Great Himalayan range and makes sharp southward bend and creates deep gorge at Namcha Barwa. It is known by the name Siang or Dihang here, flowing further southwest, it is joined by left bank tributaries, i.e., Lohit and Dibang or Sikang near Sadiya in Arunachal Pradesh, making it to be known as the Brahmaputra. River Brahmaputra flows in Assam for a distance of 720 kilometre. A large number of tributaries from north and south join the major river here. The streams that merge with Brahmaputra from north are Raidak, Nyera Ama, Kameng, Tista, Dhansiri (north), Champaman, Subansiri, Gangadhar, Dharla and Belsiri. Streams joining in from south are Dikshu, Kalang, Dhansiri (south), Burhi Dihing, Noa Dihing, and Dibru. Brahmaputra carries enormous silt and is characterized by excessive meandering. It is 13 to 16 kilometre wide in Dibrugarh forming many riverine islands. The most famous one being Majuli island covering an area of about 1,250 square kilometre. Enormous water quantity of Brahmaputra results in disastrous floods during monsoon season almost every year. Brahmaputra river enters Bangladesh near Dhubri after traversing Garo hills in Meghalaya.

3.8 PENINSULAR DRAINAGE SYSTEMS

Peninsular drainage systems are much older and comprise numerous important rivers such as Krishna, Cauvery, Subarnarekha, Mahanadi, Godavari, Brahmani, Penner, and Tambraparni, which are oriented towards Bay of Bengal forming deltas. Rivers such as Chambal, Ken, Sind, Betwa, and Son have their origin in northern part of Peninsular India and are part of Ganga river system. Peninsular rivers except Narmada and Tapi mostly flow from west to east direction. Peninsular rivers possess low gradients which results in low water velocity and sediment carrying capacity. Therefore, these rivers are characterized by large deltas at their mouth. However, river course of Peninsular rivers remains devoid of meanders. These rivers dry out during summer or carry lesser amount of water due to lack of perennial sources.

Evolution of Peninsular Drainage System

Past geological events have been responsible for shaping drainage system of Indian Peninsula. Geologists suggest that (i) The subsidence of western side of Peninsula during early tertiary period led to subsidence below sea, disturbing symmetrical form of rivers on both sides of the original watershed. (ii) The upheaval of Himalayas took place when northern side of peninsular block underwent subsidence and resulted in trough faulting through which now main west-flowing rivers Narmada and Tapi flow and fill the original cracks with their residual materials. Therefore, there is a lack of presence of alluvial and delta formation on the western coast. (iii) Tilting of Peninsular

block towards southeastern direction resulted in the alignment of its rivers towards Bay of Bengal.

3.9 RIVERS OF PENINSULAR DRAINAGE

Important rivers of Peninsular India are:

1. **Godavari** is the largest Peninsular river and originates near Trimbak plateau in Nasik district of Maharashtra. It flows for a total length of 1,465 kilometre. It runs through states of Maharashtra, Chattisgarh, Odisha, Madhya Pradesh, Telangana and Andhra Pradesh. Its important tributaries are Pranhita, Purna, Penganga, Manjra, Wainganga, Pravara, Wardha, Maner, Indravati Sabari and Pench. It has total catchment area of 3,12,812 square kilometre.
2. **Narmada** originates from Amarkantak plateau in Madhya Pradesh which lies at an elevation of about 1057 metre, above mean sea level (MSL). Total length of the river is 1,312 kilometre, with a catchment area of about 98,795 square kilometre. It flows in a rift valley with Satpura in the south and Vindhyan range in the north. The river cascades into marble rock gorge and forms Dhuandhar waterfalls near Jabalpur. It meets Arabian Sea after traversing for 1,312 kilometre and forms 27 kilometre long estuary. Sardar Sarovar Project for irrigation, drinking water, hydropower generation and canal network purposes has been built on this river.
3. River **Tapi** originates from a place called Multai situated in Satpura range in Betul district of Madhya Pradesh. It is one of the important westward flowing rivers. Its length is 700 kilometre, and catchment area is about 65,145 square kilometre. Around 6 percent of its basin area lies in Gujarat, 15 percent in Madhya Pradesh, whereas a large part of 75 percent lies in Maharashtra.
4. **Sabarmati** river originates from Dhebar lake (Mewar hills) and flows to Gulf of Khambat. Its important tributaries are Harnav, Vatrak, Wakul, Sedhi and Meshwa. It has a total length of 371 kilometre and is the third-largest westward flowing river of Peninsular India. It has a catchment area of 21,895 square kilometre.
5. **Mahanadi** has its source near Sihawa at an elevation of 442 metre in Raipur district of Chattisgarh. It flows for a distance of 858 kilometre. Its left bank tributaries are Ib, Mand, Hasdeo, and Seonath. Its right bank tributaries include Tel, Ung and Jonk. It covers catchment area of about 1,41,589 square kilometre.
6. River **Brahmani** with a length of 800 kilometre is formed due to the confluence of Sankh and Koel rivers near Rourkela in Odisha. Its drainage area is 39,033 square kilometre. Its tributaries are Tikra, Kura and Sankhad and it flows through districts of Balasore, Talcher and ultimately drains into Bay of Bengal.
7. River **Subarnarekha** originates from Piska near Ranchi. It is 470 kilometre long and drains an area of 19,296 square kilometre. It flows in an easterly direction through Singhbhum, Mayurbhanj and Medinipur districts.

8. River **Krishna** is the second largest of Peninsular India. It is 1300 kilometre long with a drainage basin of 2,58,948 square kilometre, which is shared by Andhra Pradesh, Telangana, Karnataka and Maharashtra. Major tributaries of Krishna are Yerla, Koyna, Panchaganga, Varna, Ghatprabha, Dudhganga, Bhima, Tungabhadra, Malprabha and Musi.
9. **Penner** river originates from Nandi hills in Chikballapur district of Karnataka. Its total length is 560 kilometre, and occupies a catchment area of 55,213 square kilometre between Krishna and Cauvery. Its main tributaries are Kendura, Sagileru, Jayamangali, Chitravati, Cheyyeru and Papaghni. It forms a gorge near Gandikota Cuddapah district and merges into sea near Nellore town.
10. **Cauvery** river originates from Brahmagiri range in Kodagu district at an elevation of 1,342 metre. It flows for 805 kilometre. Srimsha, Lokpavani, Herangi, Arkavati, and Hemaati are its northern tributaries and Amravati, Suvarnavati, Lakshmatirtha, Bhawani and Kabana are its southern tributaries. Cauvery drains a catchment area of 81,155 square kilometre, out of which 55 percent lies in Tamil Nadu, 41 percent in Karnataka and 3 percent lies in Kerala. River Cauvery carries plenty of water throughout the year as it receives rainfall during both northeast and southwest monsoon seasons. Finally, it joins sea at a place named Kaveripatnam in Tamil Nadu.
11. **Luni** originates at Pushkar valley of Aravallis at an elevation of 550 metre. Its total length is 495 kilometre, and covers a drainage area of 37,363 square kilometre. In its upper course, the river is known as Sagarmati. It runs west of Aravallis and ends in marshes near north of Rann of Kachchh. Its tributaries are Bundi, Sarsuti, Sukri and Jawai etc.

The river system of Peninsular drainage can also be studied on the basis of its direction of flow as East flowing river system and West flowing river system. The East flowing rivers of Peninsular river system drains into Bay of Bengal while the West flowing river drains into Arabian Sea as shown in Fig. 3.1. On the basis of their direction of flow, following are the major east flowing rivers:

1. Godavari
2. Krishna
3. Kaveri
4. Mahanadi
5. Pennar
6. Damodar
7. Subarnarekha

The west flowing rivers that drains itself into Arabian Sea are:

1. Narmada
2. Tapi
3. Sabramati

4. Luni
5. Mahi
6. Sharavati

So far, you have learnt about the major river systems of both Himalayas and Indian peninsula along with their tributaries. Now, you will study about major river basin of India in brief.

SAQ 4

Identify the east flowing rivers and west flowing rivers of Peninsular drainage system.

3.10 MAJOR RIVER BASINS OF INDIA

A river basin is defined as the land area drained by main river and its tributaries. Based on the size of their catchment area, some of the major river basins of India are Brahmaputra, Indus, Ganga, Cauvery, Sabarmati, Tapi, Mahi, Mahanadi, Krishna, Narmada, Luni, Brahmani, Penner and Godavari etc.

Major river system of India can be divided into following two major types as Himalayan river basin and Peninsular river basin. Indus, Ganga, and Brahmaputra river basin has been discussed as Himalayan river basin and Mahanadi, Krishna, Kaveri, Godavari, Narmada, Tapi and Luni has been detailed below as Peninsular river basin.

Himalayan River Basin

1. **Indus River Basin:** The Indus river originates near glaciers situated on the southern flanks of Kailash range in Tibetan plateau at an altitude of 5,182 meter. The Indus basin covers an area of 3,21,289 square kilometre in India with a total length of 2,880 kilometre. The entire Jammu and Kashmir state except its northern and northeastern tips, the whole of Punjab, Himachal Pradesh, the northern part of Haryana, and the northern tip of Rajasthan forms the part of Indus river basin. Its major left bank tributaries are the Beas, Chenab, Ravi, Satluj and Jhelum. The total drainage area of Indus is 1,178,440 square kilometre.
2. **Ganga River Basin:** It has its source from the Gangotri glacier in the western Himalayas. It is the largest basin in India covering an area of about 861,404 square kilometre. It flows through the states of Uttar Pradesh, Uttarakhand, Bihar, Jharkhand, and West Bengal and turns southeast to merge into the Bay of Bengal. Its important tributaries are Kosi, Betwa, Gandak, Son, Yamuna, Ghaghra and Gomti etc. The Ganga basin is shared by several states such as Himachal Pradesh which covers 0.5 percent of its basin area, Haryana covers 4.1 percent, West Bengal covers 8.2 percent, Rajasthan with 13 percent, Bihar and Jharkhand with 16.7 percent, Madhya Pradesh and Chattisgarh with 23.1 percent and Uttarakhand and Uttar Pradesh each covering the largest share of its basin with 34.3 percent.

3. **Brahmaputra River Basin:** The river Brahmaputra has its source in the Chemayungdung glacier of the Kailash range. Its total drainage area is 2,58,008 square kilometre in India. The total length of Brahmaputra is 2900 kilometre, out of which 916 kilometre is part of India. The drainage area of the Brahmaputra basin lies in the northeastern states of Arunachal Pradesh, Assam and Sikkim including the northern flank of Meghalaya and Nagaland states. Its major tributaries are Tista, Dharla, Lohit, Dibang, Dhansiri, Subansiri, Manas, Sankosh, Gangadhar and Raidak etc. Manipur, Mizoram and Tripura states are in the barak sub-basin area which merges with the combined flow of the Brahmaputra-Ganges in Bangladesh.

Peninsular River Basin

1. **Mahanadi River Basin:** It has its origin from the Sihawa district of Dandakaranya in the state of Chhattisgarh. After traversing for 857 kilometre, the river joins the Bay of Bengal. Its major tributaries are Jonk, Tel, Org, Seomant, Hasdeo, Mand and Ib. The total basin area is 141,589 square kilometre (4.3 percent of the total basin area of India).
2. **Krishna River Basin:** It originates from the Western Ghats near Satara district of Maharashtra. It flows for 1,400 kilometre in the easterly direction and merges into the Bay of Bengal. Its total basin area is 2,58,948 square kilometre, which is the second largest in India (7.9 percent of all India). Its major tributaries are Tungabhadra, Yerala, Koyna, Panchaganga, Varna, Ghatprabha, Dudhganga, Bhima, Malprabha and Musi.
3. **Godavari River Basin:** It originates from the Trimbak plateau of northwestern Maharashtra. It has a total basin area of 3,12,812 square kilometre (9.5 percent of India). Its important tributaries are Purna, Pravara, Penganga, Manjra, Wainganga, Pranhita, Wardha, Maner, Indravati Sabari, and Pench etc. It runs through the states of Maharashtra, Chattisgarh, Odisha, Madhya Pradesh and Andhra Pradesh.
4. **Cauvery River Basin:** It originates from the Brahmagiri range of Kodagu district from the Western Ghats in the state of Karnataka. It has a basin area of 87,900 square kilometre (2.7 percent of India) shared by Karnataka and Tamilnadu. Its left bank tributaries are Lokpavani, Shimsa, Hemavati, Arkavati, and Herangi. Whereas, its right bank tributaries are Bhavani, Kabbani, Noyil, Lakshmana Tirtha, Suvarnavati and Amravati.
5. **Tapi River Basin:** It has its source from Multai located in Satpura plateau in the Betul district of Madhya Pradesh. It has a total basin area of 65,145 square kilometre (2.0 percent of India). Its tributaries are Panjara, Purna, Aner and Girna. It flows for a distance of 700 kilometre and merges into the Arabian Sea.
6. **Narmada River Basin:** It originates from the western flanks of the Amarkantak range in Madhya Pradesh. It has a total basin area of 98,795 square kilometre (3.0 percent of all India). Its total length from the source is 1,311 kilometre. Narmada river traverses in the westward direction and eventually enters into the Arabian Sea. It does not have

large tributaries like other river basins and a major part of its basin lies in the state of Madhya Pradesh.

- 7. Luni River Basin:** It originates to the west of Ajmer at an elevation of 550 metre, and flows through the Thar desert, and ends in the marshy area to the north of Rann of Kachchh/Kutch. Its drainage area covers 37,363 square kilometre, and spreads over the states of Gujarat and Rajasthan.

The river basin of India can be divided on the basis of size of their basin area in India from the largest to the smallest. Following are the rivers on the basis of size of their basin:

Rank	River Basin
1	Ganga
2	Indus
3	Godavari
4	Krishna
5	Brahmaputra
6	Mahanadi
7	Narmada
8	Kaveri
9	Tapi
10	Luni

SAQ 5

What is a river basin? Identify and describe the largest river basins of India.

3.11 SUMMARY

In this Unit, you have learnt the following:

- India with its diverse physical features possesses a diverse range of large and small rivers which are important natural resources for various developmental purposes.
- India receives an average annual rainfall of 120 centimetre. The annual yield of water in the Indian rivers is 1,858,100 million cubic metres.
- The drainage system of India is broadly classified based on its (i) origin (ii) orientation to the sea and, (iii) size of the catchment area.
- Himalayan and the Peninsular drainage systems are the most important drainage systems of India.
- The Himalayan drainage system comprises the largest rivers in India namely Brahmaputra, Indus and Ganga etc. These rivers are characterized by large tributaries.
- The Peninsular drainage system is much older than the Himalayan drainage system. However, the river course of the Peninsular drainage is devoid of meanders.

- River basin is part of the land area being drained by the main river and its tributaries.

3.12 TERMINAL QUESTIONS

1. Identify the drainage systems of India and give the broad classification of this system.
2. Describe the evolution of the Himalayan drainage system. Give a detailed account of any one river systems of the Himalayan drainage.
3. Explain the important features of the river system of Ganga.
4. Identify the major river basins of India and explain any five major basins in detail.
5. Describe the three factors identified by geologists in the formation of drainage systems of the Indian Peninsula.

3.13 ANSWERS

Self-Assessment Questions (SAQ)

1. Based on the orientation of the sea, the Indian drainage is broadly classified into two systems i.e., (i) the Bay of Bengal drainage system e.g., Ganga, Brahmaputra, Godavari, Krishna, Mahanadi, Cauvery and Penner etc., and (ii) the Arabian Sea drainage system e.g., Indus, Narmada, Tapi, Sabarmati and Mahi etc.
2. The 'Panchnad' of the river Indus are Ravi, Satluj, Beas, Chenab and Jhelum.
3. The left bank tributaries of the Ganga are Gomati, Ghaghara, Ramganga, Gandak, Kosi and Mahananda whereas, the river Son, Yamuna and Damodar are the right bank tributaries.
4. The major east flowing rivers of Peninsular drainage systems are Mahanadi, Godavari, Krishna, and the Cauvery whereas the west-flowing rivers are Narmada and Tapi.
5. A river basin is defined as a part of the land area drained by the main river and its tributaries. The Ganga basin with its catchment area of 861,404 square kilometer is the largest in India. Important rivers are Subarnarekha, Mahanadi, Godavari, Brahmani, Penner, Krishna, Cauvery and Tambraparni. These rivers flow into the Bay of Bengal forming a delta. Peninsular rivers except for Narmada and Tapi, mostly flow from west to east direction.

Terminal Question

1. To answer this question, you have to identify the drainage systems of India and include the broad classification. Refer to Sections 3.1 and 3.2.
2. Your answer should include description of the evolution of Himalayan drainage system and also a detailed account of any one river systems of the Himalayan drainage. Refer to Sections 3.3 to 3.7.

3. You have to include the explanation of the important features of the river system of Ganga. Refer to Section 3.6.
4. Your answer should incorporate the identification of the major river basins of India along with explanation of any five major basins. Refer to Section 3.10.
5. You should include description of three factors as identified by the geologists in the formation of drainage systems of the Indian Peninsula. Refer to Section 3.8.

3.14 REFERENCES AND SUGGESTED FURTHER READING

1. Khullar, D.R. (2005). *Geography of India*. New Delhi, Kalyani Publication.
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UNIT 4

CLIMATE |

Structure

4.1	Introduction		Indian Monsoon and Agro-
	Expected Learning Outcomes		Climatic Regions
4.2	Characteristics of Indian	4.5	Droughts
	Climate and Weather	4.6	Summary
4.3	Rainfall and Temperature	4.7	Terminal Questions
	Distribution	4.8	Answers
4.4	Precipitation Mechanisms	4.9	References and Suggested
	with Special Reference to		Further Reading

4.1 INTRODUCTION

In the first three Units i.e., 1, 2, and 3 of Block 1, you have studied the geographical setting of India as a sub-continent, physiographic components, and drainage etc. In this Unit 4, you will study and learn that India has large variations in its climate. It is largely due to its vast size, varied relief, and locational factors etc. You will explore that climate of India comprises a wide range of weather conditions due to its vast geographical scale and varied topography. You will be amazed to know that India's geography is climatically pivotal as Tropic of Cancer passes through middle of the country. Along with it, latitudinal extent of the country from 8°4'N to 37°6'N makes it occupy position just above the equator, and thus, it experiences mostly tropical type of climate. You will be able to appreciate the presence of mighty Himalayas in the north, Indian Ocean in the south, and Arabian Sea and Bay of Bengal in the west and the east of the Peninsula. All these together have contributed to the creation of the uniqueness of India's climate. All the factors that affect the climate of India have been discussed in the Section below with a special focus on the role of monsoon.

We will discuss climate and its several associated important features in this Unit. Section 4.2 deals with the characteristics of Indian climate and weather. Section 4.3 describes the distribution of rainfall and temperature in India. Section 4.4 highlights the mechanisms of precipitation with special reference to Indian monsoon and agro-climatic regions. Section 4.5 has been devoted to climatic factors which generate drought conditions in various parts of India.

In nutshell, study of this Unit should enable you to understand climate and also to comprehend climatic factors which are closely associated with and governed by the physiographic set-up of the country. Along with gaining knowledge of climate, you will also be able to comprehend the role and importance of climate in the lives of people, in economy and society of the nation.

Expected Learning Outcomes

After studying this unit, you will be able to:

- understand the important characteristics of Indian climate and weather systems;
- know the broad patterns of rainfall and temperature distribution in India;
- explain factors responsible for climatic variations in India; and
- assess the role of factors affecting the climate of India.

4.2 CHARACTERISTICS OF INDIAN CLIMATE AND WEATHER

You may recall Units 12 and 13 of third semester course on General Cartography, where you learnt about the elements of weather and climate along with representation methods of climatic data. You know the role and importance of various elements that together govern as well as determine the weather and climate of any region. Climate of any country includes study of temperature, rainfall, and atmospheric pressure as well as wind system over a period of time. Climate is greatly influenced by location in terms of latitudinal extent, relief and distribution of land and water along with some other factors. In order to acquaint you with these factors in Indian context, we are explaining the role and relevance of some major factors affecting climate of India as discussed below:

a. Geographical Location and Latitudinal Extension

India roughly extends between 8° 4' N to 37° 17' N with Tropic of Cancer passing almost through middle of the country. Area lying south of Tropic of Cancer, being closer to equator, experiences higher temperature compared to land situated to the North of Tropic of Cancer. But presence of Arabian Sea in the west and Bay of Bengal in the east makes temperature along coastal areas relatively milder due to maritime influence.

b. Presence of Mountain Ranges and Altitudinal Effect

As already learnt in Unit 2, Himalayas have also been very important in terms of its influence on climate of Indian sub-continent. It primarily acts as a boon for the country in two ways. Firstly, it forms the natural barriers for the possible entry of extremely cold and dry winds descending from Central Asia during winters. Secondly, these mountain ranges form barriers for moisture-bearing southwest monsoon winds, thereby, making the region rainfall sufficient during the four months (June to September) of monsoon season.

c. Physiography

In Unit 2, you learnt that physiography of India is largely responsible for generating differences in temperature values, wind direction, pattern and amount of rainfall and nature of atmospheric pressure. Overall, climate of the region gets influenced by the physiographic characteristic of the landscape. For instance, places located at higher altitudes generally experience cool climate even if these are located in Peninsular India. Even distribution of rainfall, duration and its intensity largely get affected by physiographic set-up.

For instance, south-west monsoon winds from the Arabian Sea (moisture-laden) after striking the Western Ghats at perpendicular direction cause good amount of rainfall in Western Coastal plains which are on the windward side while vast area of Western Ghats lying on leeward side falls in the rain-shadow zone, thus remains dry. Same goes with monsoon winds that strike Himalayan ranges where physiographic characteristics of mighty Himalaya's influence climate of the Northern plains.

d. Distance from the Coast

The coastal environment also largely modifies the weather conditions of its nearby areas because there is constant mixing of temperature of the coastal seas and coastal lands. Thus, the daily range of temperature near the coastal areas remains minimum which increases with the increasing distances from the sea coast. Therefore, there exist minimum differences in the daily range of temperature around the coastal areas while high daily range of temperature is found in the interior parts of the country.

e. Winds

Monsoon winds are the most important element of Indian Climate. The wind that blows in hot summer months and brings soothing rainfall for both humans and crops in most parts of the country itself forms the important component of climate of India. South-west monsoon blowing from Bay of Bengal and Arabian Sea during June till September months brings rainfall to most parts of the country. Similarly, North East Monsoon or Retreating Monsoon that travels from land to sea during winter also brings good amount of rainfall to Coromandel coast during winter months.

f. Tropical Cyclones and Western Disturbances

Tropical cyclones are rapidly rotating storm system characterized by low-pressure center and are often associated with heavy rainfall, strong winds and rough weather conditions. These usually develop over Arabian Sea and Bay of Bengal and greatly influence many parts of the Peninsular India. Tropical cyclones usually develop during the southwest monsoon season in the region around the Bay of Bengal. Some cyclones are even seen at the time of retreating monsoonal winds during winter months.

Similarly, Western Disturbances originate around eastern Mediterranean Sea and moves eastward under the influence of Westerly Jet Streams and brings about winter rainfall/snowfall in northern part of India especially in Western Himalayan region and in Punjab, Haryana, Delhi and Western Uttar Pradesh.

g. Upper-Air Circulation

Changes in upper air circulation over Indian landmass largely influence climate of the country to significant extent. Jet Stream in upper air circulation influences the climate through two ways, viz., i) Westerly Jet Stream influences climate of the country especially during winter. This fast circulation of air is also largely responsible for bringing winter rainfall through Western Disturbances and ii) Easterly Jet Stream i.e., the reversal in upper air occurs in summer which originates due to heating of Tibetan plateau and shifting of Sun's rays to northern hemisphere. This phenomenon helps in the onset of southwest monsoon.

Hence, all these factors stated above influences the overall climatic characteristics of India.

Major Seasons of India

Based on various associated factors and the elements of climate as discussed above like latitudinal extension, temperature and rainfall, the following four main seasons can be identified:

- a) Cold weather season (Mid December to March)
- b) Hot dry weather season (Mid March to May)
- c) Wet season (June to September)
- d) Season of retreating monsoon (October to Mid December)

a) Cold Weather Season

During this season, temperature in general increases from north to south. Winter usually starts from December till February. Coldest months of the year are December and January, when average temperature remains around 10–15°C in the northwest. A line of 20°C isotherm run almost from east to west through middle of the country connecting Kachchh in the west and Ganga delta in the east. During January, northwest India covering Punjab, Haryana, UP, and Northern Rajasthan experiences less than 15°C temperature on an average. While during these winter months, Jammu and Kashmir, Himachal Pradesh, Uttarakhand and Sikkim experience less than 10°C temperature on an average during cold weather season. It is mainly due to altitudinal factor in these mountainous states. Peninsular region of India, however, does not have any well-defined cold weather season. There is hardly any seasonal change in distribution pattern of temperature in coastal areas because of moderating influence of sea and proximity to the equator.

Winter season is usually dry in most parts of India. However, northern India mainly Punjab, Haryana, and western Uttar Pradesh receives some rainfall of less than 5 centimetre due to western disturbances. Jammu and Kashmir, Himachal Pradesh and Uttarakhand also experience precipitation but in the form of snowfall. Coromandel coast receives some amount of rainfall during October and November months from easterly depression that develops in Bay of Bengal due to the presence of Inter-Tropical Convergence Zone (ITCZ). When the retreating monsoon blows from the northeast across the Bay of Bengal, it picks up a significant amount of moisture, which is subsequently released after moving back onto the Peninsula. Thus, from October to

December, the coast of Tamil Nadu state receives at least half of its roughly 40 inches (1,000 millimetre) of annual precipitation.

b) Hot Dry Weather

April, May, and June are months of summer in north India. In most parts of India, temperature recorded is between 30°C-32°C. In March, the highest day temperature of about 38°C occurs in Deccan plateau while in April, temperature ranging between 38°C-43°C is found in Gujarat and Madhya Pradesh. In May, the heat belt moves further north, and in the north-western part of India, temperature of more than 45°C is also experienced in some parts.

This is a period of rapid temperature rise. Areas situated to the south of Satpura range heats up with a mean maximum temperature of 40°C by April. The mean maximum temperature in Rajasthan, Uttar Pradesh, Delhi, Punjab and Haryana are around 42°C in some parts of these states. Temperature in the hilly region and Eastern part of the country does not rise to 40°C but ranges between 30°C-35°C on an average.

Air remains very dry over the central part of India while relative humidity is about 30 percent or less during the summer season. Total amount of rainfall during this season is recorded as low as 2.5 centimetre in Rajasthan, Gujarat, Madhya Pradesh and Maharashtra.

c) The Wet Season

Temperature reaches its maximum in June before the onset of the monsoon. Some places even experience temperature of about 46°C. Average daily temperature in the month of June remains around 40°C at Jodhpur, 39°C at Delhi, 38°C at Ahmadabad and Chennai, 34°C at Bellary and around 33°C at Kolkata. Temperature falls soon after the onset of monsoon. Average temperature for the month of July remains above 30°C.

As a result of high temperature in May and June, a low-pressure system of about 997 milibar is developed over north western India and pressure of about 1,009 milibar is developed near Kerala.

During this season, most of Indian landmass experiences good cloud cover and receives bulk of rainfall (around 79 percent) from the southwest monsoon. Southwest monsoon bifurcates into two branches known as 'Arabian Sea Branch' and 'Bay of Bengal Branch' which causes rainfall. Arabian Sea Branch causes rainfall along the West Coast, Western Ghats, Maharashtra, Gujarat and parts of Madhya Pradesh and Rajasthan. Bay of Bengal Branch strikes against the eastern Himalayas and is deflected westward towards Ganga plain and part of it goes to northeast. This branch causes rainfall in the areas of West Coast, Sahyadris, Meghalaya, Arunachal Pradesh, Sikkim and Darjeeling hills, which receive more than 200 centimetre of rainfall.

d) Season of Retreating Monsoon

Months of October and November are known for retreating monsoons. By the middle of September, southwest monsoon becomes weak as low-pressure trough of Ganga plain starts moving southward in response to southward

march of Sun. Retreating monsoon season is marked by clear skies and rise in temperature. The land is still moist. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive. This is commonly known as 'October heat'. In the second half of October, the mercury begins to fall rapidly, particularly in northern India. In the first half of October, major parts of the country experience an average temperature ranging between 25°C to 28°C. Rajasthan, Gujarat, and the coastal plains of East coast experiences temperature of about 28°C. As the monsoon starts retreating towards the south, the pressure gradient becomes low. Local pressure conditions usually affect the wind flow during that time.

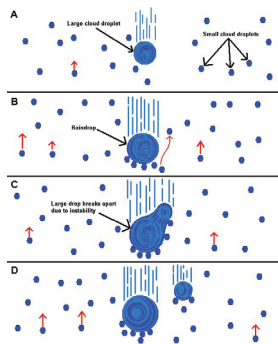
It is during the retreating monsoon season in India that the southeastern coast receives a lot of rainfall. Tropical cyclones also occur during this time. The state of Tamil Nadu receives almost half of its annual rainfall during this time. This is called the winter monsoon or the northeast monsoon.

SAQ I

- Discuss the role and importance of monsoon winds in the climate of India.
- Briefly highlight the main features of cold weather season with the help of suitable examples.

Process of Raindrop Formation (Collision-Coalescence Theory)

This theory explains that water droplets in a cloud collide against each other caused by convectional currents in the cloud. As other large water droplets (that are still suspended in the cloud) collide with small water droplets, they coalesce (join) causing them to become larger. The theory best explains the raindrop formation in warm clouds that suggests that the small droplets in clouds grow larger by collision and coalescence until they are sufficiently heavy to fall. The diagram below explains how the collision and coalescence take place in the atmosphere thereby eventually making the droplets heavier enough to fall as a rain.



4.3 RAINFALL AND TEMPERATURE DISTRIBUTION

India Meteorological Department (IMD) has classified India into four distinct seasons. Based on seasons, the temperature and rainfall distribution has been explained.

India is a vast country in geographical terms, with various regions experiencing very different climatic conditions. This is also reflected in the distribution of rainfall in India. Some regions experience very high rainfall and others receive very scanty rainfall. Difference between the recorded amount of highest and lowest rainfall in India is approximately 1,178 centimetre. In this section, we will discuss various zones of the country according to the average annual rainfall.

Rainfall Distribution in India

Precipitation in India is irregular over the course of a year, with a well-defined rainy season over most of the country starting in about June and ending in September. The average rainfall in India is 118 centimetre, according to annual data from the India Meteorological Department (IMD). The following is the distribution of rainfall in India as shown in Fig. 4.1.

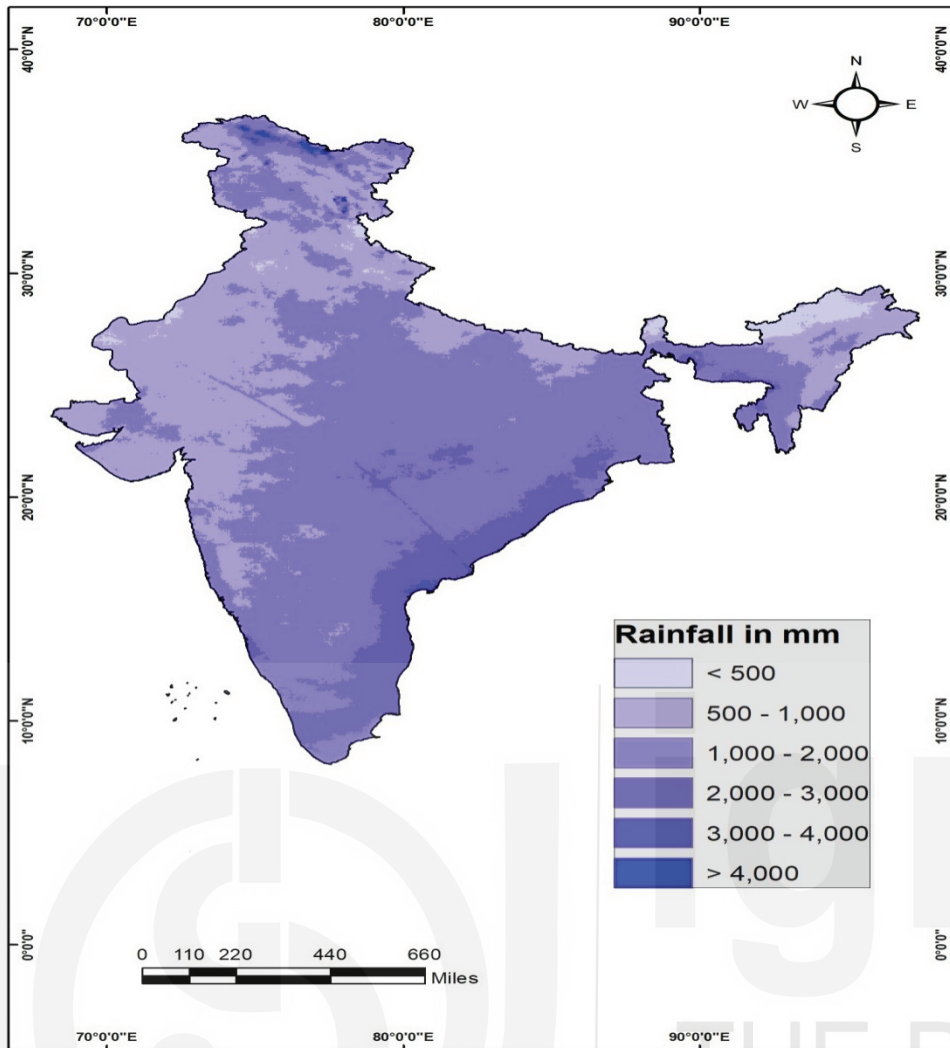


Fig. 4.1: Distribution of Annual Mean Rainfall in India.

(Source: Adapted, 2010. <http://chrsdata.eng.uci.edu>)

- **Extreme Precipitation Regions:** North-eastern states and the windward side of Western Ghats experience an average of 300-400 centimetre of annual rainfall. States like Assam, Meghalaya, Arunachal Pradesh, and hilly tracts of Western Ghats are host to tropical rainforests. However, the highest rainfall exceeding 400 centimetre in India and the world is recorded at Mawsynram village of Meghalaya. Cherrapunji and Mawsynram have often received average annual rainfall of about 450 and 467 inches respectively, which is notably higher than 400 centimetre.
- **Heavy Precipitation Regions:** Areas experiencing 200-300 centimetre rainfall belong to this zone. Most of eastern India is covered under this zone. These regions are also home to tropical rainforests. States such as West Bengal, Tripura, Nagaland, Manipur, Odisha and Bihar are included in this zone. Most of the areas in the sub-Himalayan belt also fall under this zone.
- **Moderate Precipitation Regions:** Areas which experience 100 to 200 centimetre of rainfall include parts of West Bengal, Bihar, Odisha, Madhya Pradesh, Andhra Pradesh and the leeward side of Western Ghats. Wet Deciduous forests comprise the most common natural vegetation of these regions.

- **Scanty Precipitation Regions:** Areas having 50 to 100 centimetre of rainfall consisting of parts of Maharashtra, Gujarat, Karnataka, Tamil Nadu, Andhra Pradesh, Madhya Pradesh, Punjab, Haryana and Western Uttar Pradesh. Tropical grasslands, savannah and dry deciduous forests are commonly found in these areas.
- **Desert and Semi-Desert Regions:** These are the areas that receive below 50 centimetre of rainfall. The states of Rajasthan, Gujarat and adjacent areas are classified as desert or semi-desert based on the amount of rainfall they receive. Some parts of Jammu and Kashmir such as Ladakh plateau are also included in this zone as cold deserts. The vegetation consists of hardy species which can withstand extended droughts. Some areas like parts of Gujarat have Savannah vegetation in the wetter regions. The lowest rainfall in India has been recorded in Ruyli village, Rajasthan.

Temperature Distribution of India

Temperature distribution across the globe is influenced by series of factors. Important among different factors include latitude, altitude, length of the day, wind and proximity to the sea. We shall discuss each of these factors in brief in the following paragraphs:

The main source of energy on the Earth is Sun (insolation) which comes in the form of electromagnetic radiation. Horizontally, it is varying widely. Since temperature is governed by insolation, temperature on Earth has wide variations. Variations in the distribution of temperature are controlled by several factors.

Latitude plays an important role because the angle of incidence of the Sun's rays and its effectiveness is determined.

Altitude also affects distribution of temperature because higher elevation has lower temperature and vice-versa. Both height and temperature are inversely related.

Length of the day is determined by other factors as well. But the thumb rule is that longer the day, greater is the received energy from the incoming solar radiation and hence, more temperature is recorded. However, the incidence of Sun's rays plays the most effective role. That is why the temperature is very low despite long duration of days in the polar region.

Winds transfer heat from one latitude to another. They also help in exchanging the heat between land and water bodies. The oceanic winds have the capacity to take the moderating influence of the sea to coastal areas as reflected in cool summers and mild winters. This effect is pronounced only on the windward side (the side facing the ocean). The leeward side or the interiors do not get the moderating effect of the sea, and therefore experience extremes of temperature.

Proximity to sea is a very great regulating force to determine temperature. The interior of the continents has extreme temperature records. In summer, they are very hot, but in winter, they are extremely cold. The prevailing winds redistribute temperature over the globe. The same is done by ocean currents.

Both of these modify the temperature in the areas of their influence. The slope and aspect also determine the amount of energy received from the Sun. The characteristics of land and its surface along with vegetation have good control over the distribution of temperature.

Overall, horizontal distribution of temperature keeps on declining from the equator. During July, when it is summer for the northern hemisphere and winter for the southern hemisphere, the Sun is directly shining over Tropics of Cancer and nearby areas, high temperature is recorded there. But in the southern hemisphere, temperature is low. Therefore, the highest temperature is over Tropic of Cancer and from here temperature keeps on reducing till poles. The temperature gradient is very strong in the polar areas as isotherms are very close. During July, it is severest in the southern polar areas. During January, summer condition prevails in the southern hemisphere, but for the northern hemisphere, it is winter. The case of July is completely reversed in January. The annual range of temperature is very low in equatorial regions as the Sun is almost vertical or near to vertical throughout the year. The areas in high latitudes experience very high annual range of temperature. In the equatorial region, it is just 30°C or less while in the polar continental region of Asian Siberia, annual range of temperature is over 60°C. It is caused by extreme low temperature in winter but in summer, temperature is moderate which makes the difference between two a big one.

4.4 PRECIPITATION MECHANISMS WITH SPECIAL REFERENCE TO INDIAN MONSOON AND AGRO-CLIMATIC REGIONS

Before discussing the different concepts and theories of Indian monsoon, you must first basically understand the basic phenomenon of differential heating of land mass and water bodies resulting into seasonal reversal of winds.

Indian monsoon is characterized by complete reversal of wind system with change of season in a year. During winter, dry winds blow from land to sea (from northeast to the south-west) in the direction of trade winds. These winds are characterized by low temperature and hence move from high-pressure area (landmass) to low-pressure area (sea). This phenomenon gets completely reversed during the summer season and winds blow from sea to land i.e., from southwest to north-east direction. The differences in pressure system owing to prevailing temperature over land and sea during summer and winter seasons, is largely responsible for the differences in pattern and intensity of rainfall over Indian land mass.

Formation of alternate low and a high-pressure system over land and sea during summer and winter seasons due to thermally induced factors that results into movement of wind from land to sea (during winter) and sea to land (during summer). During summer, intense heating of landmass leads to formation of thermally induced low pressure over northwestern parts of the country. This low-pressure area with opposite high-pressure conditions over neighboring seas influences direction, pattern, intensity and flow of the wind

system in respective seasons. This pattern gets reversed during winter season where high pressure areas are seen to be formed over north India while low pressure in the neighboring seas. The direction of the wind system during summer and winter season has been shown in Fig. 4.2.

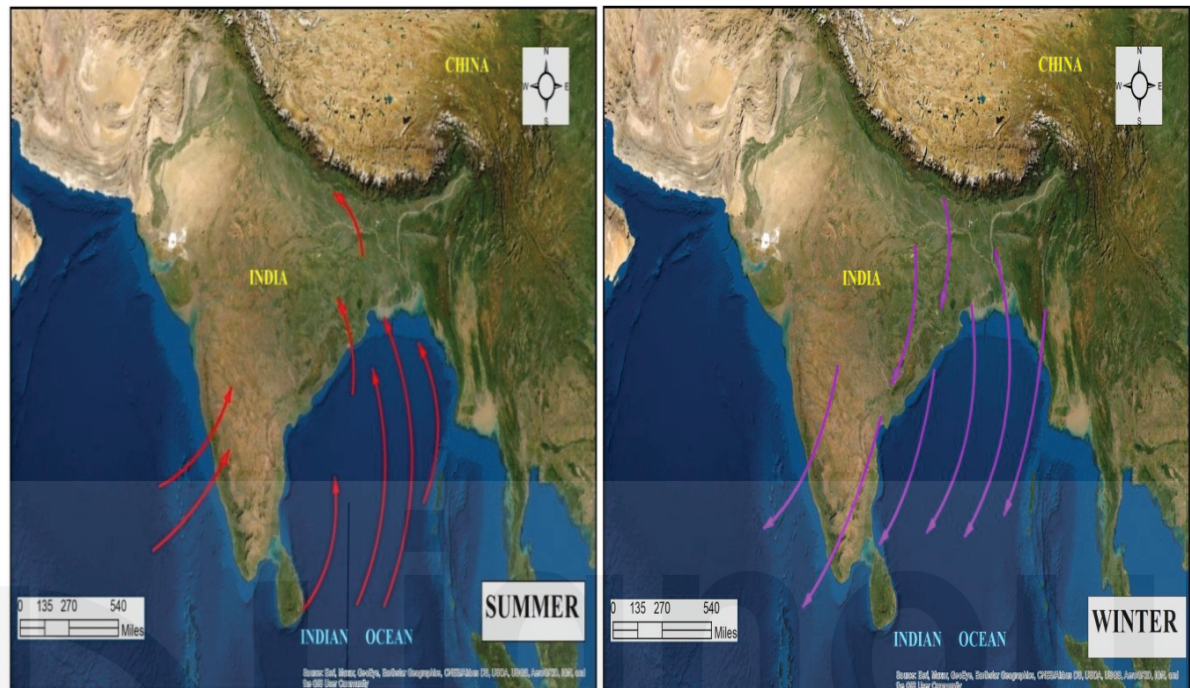


Fig. 4.2: Precipitation Mechanism with Special reference to Indian Monsoon.

Monsoonal rainfall plays a significant role in Indian landmass providing rainfall from the last week of May till the middle of September. It makes possible the Northern plains sufficient in rainfall availability and also rivers with sufficiency in the volume of flow. Besides this, Himalayan mountains in the north has also been very vital for acting as the barrier for moisture-laden winds thereby causing rainfall in most parts of the northern India. Thus, the location of India has been very favourable due to which a small portion of landmass falls under the category of extreme and severe drought prone while the majority of it experiences sufficient water in the form of rainfall or through different other sources.

The Indian Monsoon

The word monsoon is derived from Arabic word 'mausim' which means season. It is a general atmospheric circulation over a wide geographical area, in which there is seasonal reversal in dominant wind direction.

There are different views regarding the origin of the Indian monsoon. Following are the major theories regarding its origin:

a) Thermal Concept

This is also called 'Classical Theory' presented by Hally in 1686 to explain the origin of Asiatic monsoon. According to this concept, monsoons are land and sea breezes on larger scale produced by differential heating of continent and ocean. During summer, when the Sun's rays fall vertically on Tropic of Cancer, huge landmass of Asia is heated forming low pressure over land area

which gets reversed in winter when vertical rays of the Sun fall on Tropic of Capricorn in winter which results in cooling of Asian landmass.

Due to differential heating of land and sea, low pressure is developed over Indian landmass due to high temperature while high pressure is formed over ocean. The surface airflow is therefore from highs over ocean towards lows over heated land. The southeast trade wind while crossing equator is deflected towards right-hand side (Ferrel's law) and becomes southwest monsoon over Indian subcontinent. Since these are moisture-laden winds and therefore they produce rainfall.

However, the modern climatologist expresses their doubts over the thermal origin of high and low pressure over land and sea and has come up with a new concept called 'Dynamic Concept'.

b) Dynamic Concept

This Dynamic Concept was proposed by Flohn in 1951. According to Flohn, the monsoon is just seasonal migration of planetary winds and pressure belts following Sun's position in different latitudes in different months of the year. During summer solstice, the Sun's rays fall vertically over Tropic of Cancer, pressure belts shift towards the north. The zone of ITCZ or Doldrum moves northward and its northern boundary extend up to 30°N latitude. This process is further accelerated by intense heating of the subcontinent. Due to the shifting of pressure belts, Indian subcontinent comes under the impact of equatorial westerlies which are called the southwest monsoon. During the winter season, due to the southward shifting of pressure and wind belts, the planetary system of northeast trade wind gets re-established over the region. These are called northeast winter monsoon and are dry.

Fohn explains the origin of monsoon to thermal conditions of the tropical continental atmosphere to the variation of solar radiation. However, he seems to have ignored the upper atmospheric circulation which makes the Asiatic monsoon a complex system.

c) Recent Concepts about the Origin of Indian Monsoon

Findings of researchers conducted for the Indian monsoon after 1950s have revealed that its origin and mechanism are related to the following facts:

- The role of the position of the Himalayas and Tibetan plateau as a mechanical barrier or high-level heat source.
- The existence of upper air circumpolar whirls over north and south poles in the troposphere.
- The circulation of upper air jet streams in the troposphere.
- Differential heating and cooling of the huge landmass of Asia and the Indian Ocean.
- The El Nino-Southern Oscillation (ENSO) event.

There have been series of doubts regarding the heating mechanism and doubt that such heating cannot produce monsoon circulation. More recent theories have emphasized the circulation in the atmosphere over the

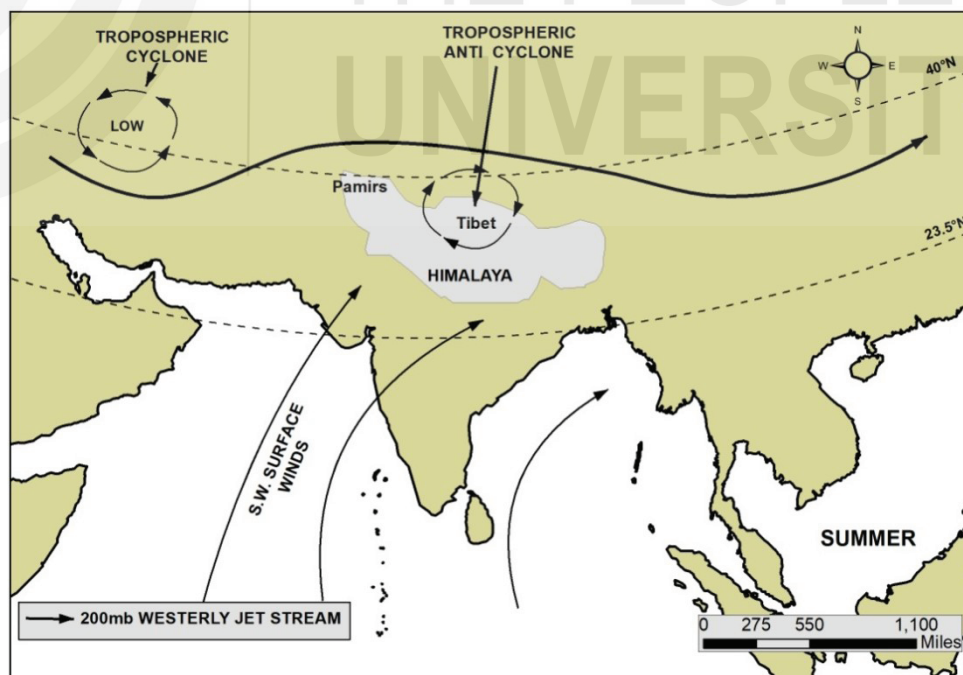
subcontinent and adjoining areas. Besides this, the recent concepts emphasize the role of the Tibetan plateau, Jet Streams, and the El Nino (Southern Oscillation) as causal factors for the origin of the monsoon.

Tibetan plateau plays an important role in initiating the monsoon circulation over the Indian subcontinent. The plateau of Tibet is more than 600 kilometre wide in the west and 1,000 kilometre in the East. Its length from west to east is about 2,000 kilometre. The average height of the plateau is about 4,000 metre.

Thus, it is an enormous block of high ground acting as a formidable barrier. It has 2°C to 3°C higher temperature than the neighbouring areas. This acts as a high-level heat source. This 'Heat Engine' produces a thermal anticyclone over the region. This anticyclone at Tibet weakens the western subtropical jet streams south of the Himalayas but produces tropical easterly jet on the southern side of the anticyclone. This tropical easterly jet stream first develops in longitudes east of India and then extends westward across India and the Arabian Sea to eastern Africa. These upper-level easterly jets create a flow of air on the southern side of the Tibetan plateau that reaches down to low levels over northern India.

During summer, the insolational heating of air over the Tibetan plateau weakens the western subtropical jet stream south of the Himalayas with the resultant reversal of pressure gradient and wind flow over northern India. All these conditions result in the burst of southwest monsoon over the Indian sub-continent.

Jet Streams during winter and summer and its pattern of flow have been shown in Fig. 4.3.



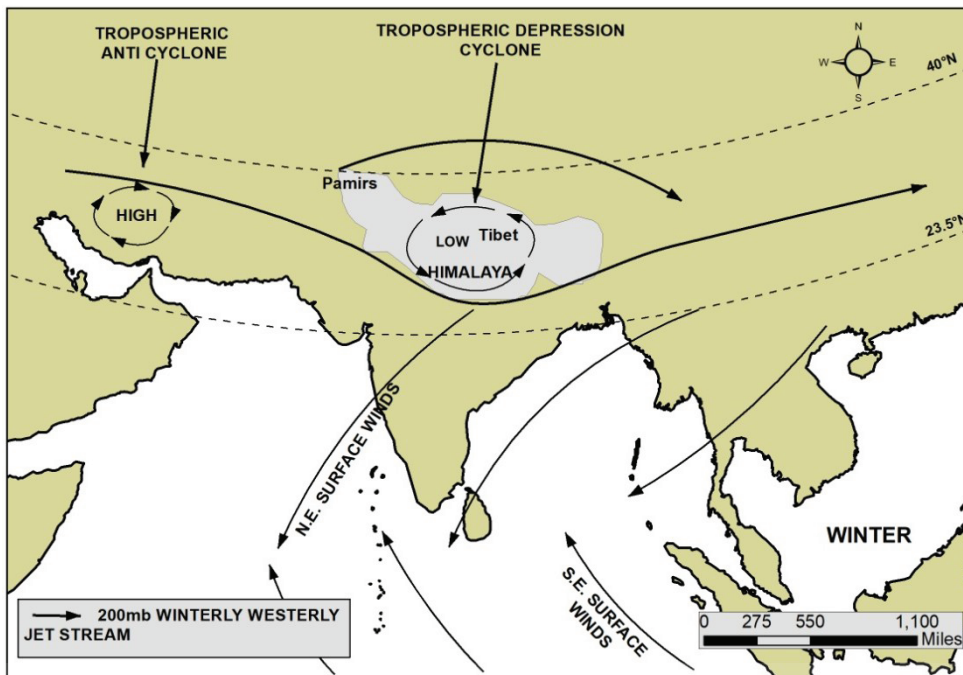


Fig. 4.3: Jet Steams and its Pattern of Flow

(Source: Adapted from Tiwari, R. C. (2007). *Geography of India*. Allahabad, Prayag Pustak Bhawan)

Agro-Climatic Regions of India

Based on the regional variation of rainfall, temperature conditions, the climatic pattern, and the soil types suitable for agriculture and cropping systems, there have been geographical divisions of agriculture based on the climatic patterns. These divisions are made in such a way that it demarcates the entire country into several region based on crops that are specific to a particular region.

Thus, an agro-climatic zone is a land unit categorised based on major climates suitable for certain varieties of crops. The basic objective of delineating the agricultural region is to make the production more sustainable and manage the regional resources to meet the food, fodder and fuel requirements in a more scientific way. Agro-climatic conditions mainly refer to soil types, rainfall, temperature and water availability which influences the type of vegetation.

The Planning Commission in its Seventh Plan has divided the country into fifteen major agro-climatic regions based on physiography, soil types, geological formation, climate, cropping patterns and development of irrigation and mineral resources (Fig. 4.4). Fourteen regions were on the mainland and the remaining one was in the islands of the Bay of Bengal and the Arabian Sea. Besides, this National Agricultural Research Project (NARP) launched by the Indian Council for Agricultural Research (ICAR) has divided the country into 127 agro-climatic zones based on the farming system, major crops, natural resources and production constraints.

Table 4.1: Agro-climatic Regions of India

Major Agricultural Regions	Geographical Area/ Location	Crops
North Western Mountain Region	Jammu and Kashmir, Himachal Pradesh and the hill region of Uttarakhand	Maize, saffron, barley, oats, wheat, peaches, apricot, almond, cherry and walnut, etc.
North Eastern Hill Region	Assam hills, Arunachal Pradesh, Sikkim, Manipur, Mizoram, Tripura and Darjeeling district of West Bengal	Rice, potato, maize and tea, oranges, pineapple and lime.
The Satluj Yamuna Plains Region	Haryana, Punjab, Delhi, parts of Rajasthan and western Uttar Pradesh	Rice, pulses, jute, potato and maize
The Upper Ganga Plains Region	Parts of Northern Uttar Pradesh and Bihar	Rice, millets, maize, gram, wheat, barley, potato and mustard
Middle Gangetic Plains Region	Central and western Uttar Pradesh, and Udham Nagar district of Uttarakhand	Wheat, sugarcane, rice, millets, gram, pulses, oilseeds and cotton
Lower Ganga Plains Region	Region around South Eastern Bihar and West Bengal	Rice, wheat, sugarcane and jute
South Eastern Plateau Region	Chhotanagpur plateau, parts of Jharkhand, Chhattisgarh and Odisha	Rice, maize, oilseeds, millets, ragi, gram, tur, groundnut, soyabean, urad and castor
The Aravali Malwa Upland Region	Bundelkhand, Bagelkhand, Malwa plateau and Vindhyan hills	Millets, wheat, gram, oilseeds, cotton and sunflower
The Maharashtra Plateau Region	Maharashtra and some parts of Deccan plateau region	Cotton, wheat, rice, jowar, bajra and pulses
The Deccan Interior Region	Deccan plateau, the greater parts of Karnataka, Maharashtra, Andhra Pradesh and uplands of Tamil Nadu	Wheat, gram, millets, cotton, pulses in rain-fed areas and sugarcane, rice, wheat in irrigated areas. Coffee, tea, cardamom and spices are also grown along the hilly slopes
The Eastern Coastal Region	The region falls along the Coromandel coast of Andhra Pradesh and Odisha	Rice, tobacco, tea, sugarcane, maize, millets, groundnut and oilseeds
The Western Coastal Region	Extends over Malabar and Konkan coastal plains and the Sahyadris	Coconut, oilseeds, rice, sugarcane, millets, pulses and cotton
The Gujarat	This region includes hills and	Rice, groundnut, cotton,

Region	plains of Kathiawar and the valleys of Mahi and Sabarmati rivers	millet, oilseeds, wheat and tobacco
The Western Rajasthan Regions	Rajasthan, West of Aravalli, and drier regions of Gujarat	Bajra, jowar, and moth are the main Kharif crops and wheat and gram are rabi crops.
Andaman and Nicobar Island Regions	Andaman-Nicobar and Lakshadweep area	Maize, millets, pulses, rice, turmeric and cassava

(Source: Khullar, D.R (2006). India: A Comprehensive Geography, Delhi, Kalyani Publisher)

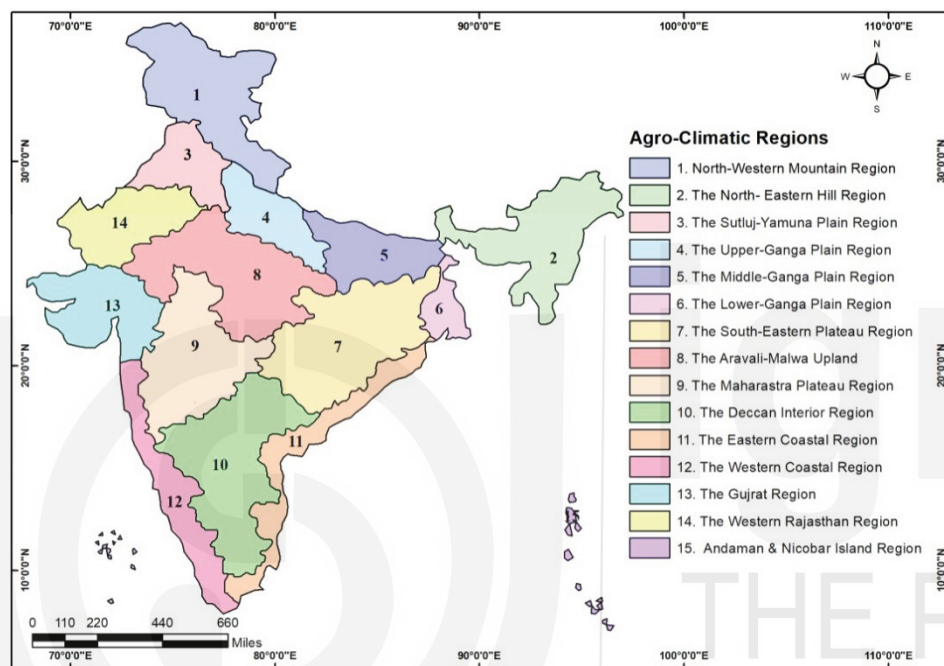


Fig 4.4: Major Agro-climatic Regions of India as per Planning Commission of India.

(Source: Adapted, http://apps.iasri.res.in/agridata/19data/chapter1/db2019tb1_2.pdf)

SAQ 2

What are agro-climatic regions? Discuss with examples in brief.

4.5 DROUGHTS

Drought is an extended period of unusually dry weather with no sufficient rainfall for the cultivation of crops. Droughts can last for months or years and can have a large-scale impact on human society as well as the ecosystem of the region. Lack of precipitation would therefore result in crop failure and shortages of food grains for the population which is also considered a disaster. According to High Powered Committee on Disaster Management Report, “any lack of water to satisfy the normal needs of agriculture, livestock, industry, or human population may be termed as drought.” The severity of droughts can have a large-scale impact on society, especially among agricultural communities. The inadequacy of water is concerning the prevailing agro-climatic conditions in any particular area. Drought is therefore

region and crop-specific phenomenon. It may result into a situation of distress caused by lack of rainfall. Drought has therefore been classified as:

- a) **Meteorological Drought:** A significant decline occurs from the mean precipitation resulting into dryness for a certain period. India Meteorological Department (IMD) has defined drought as a situation occurring in any area when the received amount of mean annual rainfall is less than 75 percent of the normal rainfall.
- b) **Hydrological Drought:** It refers to a deficit in the supply of surface and sub-surface water. Meteorological drought is associated with hydrological drought. Hydrological droughts are further classified as under:
 - i) **Surface Water Drought:** It is concerned with the drying up of surface water resources such as rivers, streams, lakes, ponds and other forms of surface reservoirs. Most of the surface droughts are caused due to anthropogenic activities like deforestation, construction of roads, buildings and mining activities etc.
 - ii) **Groundwater Drought:** It is associated with a decrease in groundwater content. Fall in the level of groundwater may be due to excessive pumping of groundwater by industries or for increasing agricultural production. When the rate of pumping far exceeds the rate of recharge from the surface water, the level of groundwater gradually falls resulting in groundwater drought conditions. The nature of soil largely affects the rate of groundwater recharge. For instance, the northern plain of India has porous soil which allows the groundwater to recharge at a faster rate than that of hard soil of the Peninsular region.
- c) **Agricultural Drought:** It indicates a deficit in soil moisture, driven by meteorological and hydrological drought, thereby substantially reducing the supply of moisture for vegetation. Agricultural drought affects crop production and the agricultural communities dependent on it. Introduction of High Yielding Variety (HYV) seeds with the onset of Green Revolution in 1960s have increased the demand for timely watering requirement for the crops and any delay in providing water may harm the crop production and result into crop failures. Such droughts that have a severe impact on crops due to deficiency of water are termed as 'agricultural droughts'.

Major Drought Prone Areas in India

A drought-prone area is defined as one in which the probability of a drought year is greater than 20 percent. A chronic drought-prone area is one in which the probability of drought in a year is greater than 40 percent. A drought year occurs when the rainfall of less than 75 percent of the normal is received. India can be categorized into four major zones based on the nature of drought conditions that prevails over the year. Four major drought-prone zones of India are shown in Fig. 4.5.

1. **Arid Zone:** This comprises states like Rajasthan, parts of Gujarat, and Jammu Kashmir region where the rainfall is very low with less than 50 centimetre throughout the year.

2. **Semi-Arid Zone:** It encompasses the states of Punjab, Haryana, Madhya Pradesh, parts of Telangana, Andhra Pradesh and Tamil Nadu.
3. **Sub-Humid Region:** The state of Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal and the North-Eastern states of India falls under this third zone.
4. **Others:** More than 40 percent of the Indian landmass falls under the category of drought-free area. This comprises regions around Northern plains, some parts of Odisha, West Bengal and Chhattisgarh do not have the characteristics of the above-mentioned categories but are rather mixed type and hence have been categorised separately.

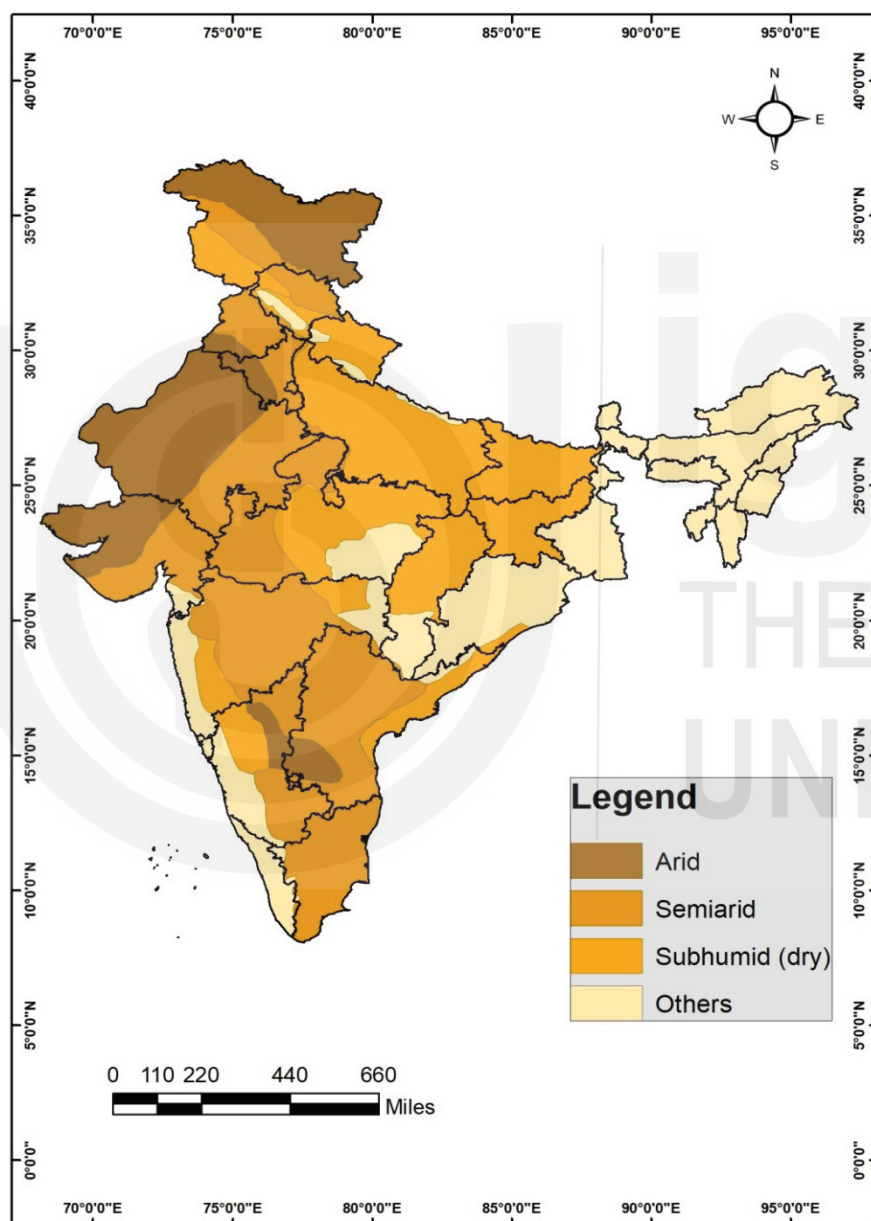


Fig. 4.5: Drought Prone Zones of India.

SAQ 3

What is agricultural drought? Discuss with examples in brief.

4.6 SUMMARY

In this unit, you have learnt the following:

- Characteristics of Indian climate and weather.
- Rainfall and temperature distribution across the geographical regions of India.
- Precipitation mechanisms with special reference to Indian monsoon and agro-climatic regions.
- Learnt about the various kinds of droughts in India.

4.7 TERMINAL QUESTIONS

1. Explain the mechanism of Indian Monsoon.
2. What do you mean by drought? Explain the types of droughts.
3. Explain major agro-climatic zones of India.
4. Explain the characteristics of the Indian climate and the factors affecting it.

4.8 ANSWERS

Self-Assessment Questions (SAQ)

1. a) Monsoon plays an important role in India in terms of modifying the overall climatic conditions. It also plays an important role in agricultural economy like that of India by providing the seasonal rainfall.
b) It is characterized by low temperature conditions with variability of temperature conditions in northern part of India and southern region. Winter rainfall in northern part of India due to western disturbances and rainfall due to retreating monsoon in the region around Tamil Nadu are also important characteristics.
2. Agro-climatic classification of a region is based on the suitability of climatic conditions. It has been divided into 15 major types.
3. Drought is an extended period of unusually dry weather with no sufficient rainfall for the cultivation of crops. It has been divided into four major types based on the nature and intensity of rainfall.

Terminal Questions

1. While answering this question, you should cover the key features that may help to highlight the mechanisms of monsoon succinctly. You may refer to Section 4.2.
2. Your answer should throw a light on the meaning of drought and its effects on the agriculture sector and farming households. You may refer to Section 4.5.
3. Your answer should highlight the major agro-climatic zones with suitable examples. You may refer to Section 4.4.

4. Your answer should cover the major characteristics of the Indian climate and the factors which affects it. You may refer to Section 4.2.

4.9 REFERENCES AND SUGGESTED FURTHER READING

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SOIL AND VEGETATION |

Structure

5.1	Introduction	5.5	Summary
	Expected Learning Outcomes	5.6	Terminal Questions
5.2	Characteristics of Soil and	5.7	Answers
	Natural Vegetation	5.8	References and Suggested
5.3	Classification and Distribution		Further Reading
5.4	Major Soil and Vegetation		
	Regions of India		

5.1 INTRODUCTION

In the previous Units of Block 1, you have learned about geographical position of India in the sub-continental setting, physiography, drainage, and climate.

By now, you must have understood the role and relevance of all these themes of physical setting in detail. Fifth Unit on soil and vegetation will help you to understand the broad characteristics of soil and vegetation and their relationship with the themes dealt within second, third, and fourth Units. Soil is thin surface layer of the Earth, comprising material particles formed by breakdown of rocks, decayed organic materials of living organisms, water, and air. Soil is formed under specific natural conditions and each element of natural environment contributes to this complex process, described by soil scientists as the process of 'Pedogenesis'. Pedology considers soil as a natural entity, biochemically weathered and synthesized product of nature.

In this Unit, we will discuss soil and natural vegetation. We will describe and highlight characteristics of soil and vegetation in Section 5.2. In Section 5.3, we will explain classification schemes and distribution concerning soil and natural vegetation of India. We will talk about major soil and vegetation regions of India in Section 5.4. This Unit will enable you to understand soil and natural vegetation of India in detail and also help in sensitizing you about the contemporary critical issues concerning these two precious and fundamental natural resources. These two are considered quintessential for the survival of human beings and the maintenance and well-being of diverse ecosystems of planet Earth.

Expected Learning Outcomes

After studying this unit, you should be able to:

- locate major soil regions on the map of India;
- recognize significance of soil as a resource;
- understand main characteristics of each major soil types of India;
- recognize main vegetation types and their characteristics in India; and
- locate main vegetation regions of India.

5.2 CHARACTERISTICS OF SOIL AND NATURAL VEGETATION

Soil

Before describing characteristics, we will provide a brief note on a few key definitions of soil and vegetation. According to Joffe and Marbut "soil is a natural body developed by natural forces acting on natural materials. It is usually differentiated into horizons from mineral and organic constituents of variable depth which differ from parent material below in morphology, physical properties and constituents, chemical properties and composition and biological characteristics". According to Raman "soil is uppermost weathered layer of Earth's crust. It consists of rocks that have been reduced to small fragments and have been more or less changed chemically together with the remains of plants and animals that live on it and in it".

Various characteristics of soil include parent material, mineral matter, organic matter and soil texture. We will describe each characteristic briefly to appreciate and make you learn the same in detail.

Parent Material: The material for soil formation is derived from rocks and is termed parent material. Parent material determines colouration of soil, its mineral composition along with texture. Parent material includes both hard resistant rocks such as granite, marble as well as slate and less resistant rocks such as recent volcanic lavas and ashes and metamorphic (schist, gneiss) and sedimentary rocks (sandstone, clay, silt and limestone), etc.

Mineral Matter: The volumetric composition of mineral matter accounts for 45 percent of soil. Mineral matters are extremely variable in size. Some are as large as smaller rock fragments while others such as clay particles are so small that they cannot be seen without the aid of microscope. Quartz and some other primary minerals (biotite and muscovite etc.) persist with little change in the composition of original rock. In general, primary minerals dominate coarser fractions of the soil. Secondary minerals (silicate, clay, limonite and hematite etc.) are prominent in fine materials, especially in clays. Mineral particle size does determine the properties of soil.

Organic Matter: It represents partially decayed and partially decomposed plant and animal waste. The volumetric composition of organic matter in soil accounts for around 5 percent. The end product of breakdown of dead organic material is known as 'humus'. It is structure less, dark brown or black coloured decayed soil material found within soil surface and is responsible for

making topsoil darker than subsoil. Micro-organisms continually break down such material. Consequently, organic matter is transitory soil constituent and is renewed constantly with addition of plant residues. Organic matter improves physical condition of the soil and also improves water holding capacity. It is also a major source of energy for soil micro-organisms. It forms a major source of plant nutrients such as nitrogen, phosphorus and sulphur.

Soil Texture: It is generally characterized by size of soil particles. Clayey soil may, thus, be described as fine and sandy as coarse, while silt is an intermediate type. The standard unit for measurement of soil particles is in millimetres, but a smaller unit is micron (1micron=0.001millimetre), which is applicable for the measurement of soil colloids. In sandy soil, the size of individual grain varies between 0.05 to 0.2 millimetre, which is visible to naked eye. Individual grains of clayey soil are 0.002 millimetre in diameter. Silty soil is finer than sand but coarser than clay. Therefore, its particles are found to have diameter between 0.02 to 0.002 millimetre.

Soil Air: Soil air is present in pore spaces (interstitial spaces) of soil which are not occupied by soil particles but are filled with water and partly with air. The volumetric composition of soil air in soil accounts for 25 percent. As the pore space is occupied by both water and air, the volume of air varies inversely with that of water. As moisture content increases, air content decreases and vice-versa. Soil air contains several gases such as nitrogen, oxygen, carbon dioxide and water vapour. Soil air contains greater proportion of carbon dioxide and lesser proportion of oxygen than atmospheric air. And, soil air has higher moisture content than that of atmosphere.

Natural Vegetation

Natural vegetation refers to vegetation cover that grows naturally in association with each other under geo-climatic variables without any human interference.

India with its diversified climate and physiography also possesses diversified natural vegetation. India is a land of great variety of natural vegetation. Himalayan heights are marked with temperate vegetation; Western Ghats and Andaman and Nicobar Islands have tropical rain forests, deltaic regions have tropical forests and mangroves; desert and semi-desert areas of Rajasthan are known for cacti, and a wide variety of bushes and thorny vegetation. Depending on variations in climate and soil, the vegetation of India changes from one region to another. The natural vegetation of India reflects a state of perfect harmony with relief and climatic conditions. Indo-Gangetic plains and Thar desert contains species that have been introduced from outside and are exotic and have migrated from Trans-Himalayan areas of Tibet and China. This natural vegetation of highlands is classified as boreal vegetation cover. Exotic plants which have come from Africa have influenced vegetation of arid and semi-arid regions such as Thar and also a considerable amount of vegetation of the Great plains of India. Those immigrating from Indo-Malaysia have influenced vegetation cover of hilly regions of North-East India. This process of immigration of uninvited plant species is not only continuous, but has become more marked and prominent with the increase in communication with other lands, both by sea and air. However, the introduction of some exotic species has been unfavorable for many of the endemic species in

India. The most striking example is of **Lantana bush** and **Hyacinth**, which invade the land and prevent the growth of economically important plants.

The total geographical area of India is 32,87,263 square kilometre, of which about 6,75,500 square kilometre area comes under forest cover. Forests in India stretch over the Himalayan mountains, Bhabhar and Terai, Western Ghats, Eastern Ghats, Bundelkhand, North-Eastern hills, Nilgiris, Chotanagpur plateau and other hills of Peninsular India. According to National Forest Policy, about 33 percent of the geographical area should be under forest cover. However, India accounts for nearly 22.50 percent of the area under forest cover making it much below in terms of percentage cover with many other countries of the world.

Factors Affecting Natural Vegetation of India

The geographical factors affecting the distribution of natural vegetation include climate, soil and topography. Seasonal variations in precipitation and temperature and climatic regime also bear important influences on natural vegetation. The amount of rainfall has an important bearing on the type of vegetation. Areas receiving 200 centimetre or more rainfall per annum have evergreen rain forests while monsoon deciduous forests are found in areas with rainfall between 100 and 200 centimetre. Areas with 50 to 100 centimetre of rainfall have drier deciduous or tropical savanna forests having open thorny scrub while those areas with less than 50 centimetre of rainfall have only dry thorny scrub and low open bushes merging into semi-desert. At an elevation of more than 900 metre, above the sea level, like in the Himalayas and hills of Peninsular India, temperature decreases with increasing altitude. As the temperature falls with increasing altitude, vegetal cover changes from tropical to sub-tropical to temperate and finally to alpine type. Changing and diverse soil conditions in India also give birth to a diverse range of vegetation such as mangrove forests, swamp forests, beach and sandy coastal forests, etc.

SAQ I

- Define organic matter and soil texture.
- Discuss the factors that affect natural vegetation of India.

5.3 CLASSIFICATION AND DISTRIBUTION

SOIL

Soil is one of the most important natural resources. Therefore, it is necessary to classify soil in systematic and orderly arrangements as given below:

- A. Geological Approach:** This is an old classificatory approach, where soils were divided into various groups depending on geological materials or rocks from which the soil originated. According to this system, soils can be divided into two broad groups: (1) sedentary and (2) transported. The classification was further improved to include other soil groups like red soil, black soil (regur), laterite and lateritic soils, delta soil, desert and terai soils.

B. Physical Classification: Soil is divided into several groups or classes such as sandy, clayey and loamy etc. It takes into account the mechanical composition of the upper 6 to 7 inches layer of soil. This classification is more useful for agricultural purposes.

C. Genetic Classification: It is based on the genesis or origin of soil and its subsequent development. This classification system is based upon the study of soil profile which is the ultimate product and reflection of all soil-forming factors and processes. Soils are classified into well-defined categories. Higher categories are put under orders, sub-orders, great soil groups, and sub-groups. At the order level, soils are classified into *zonal*, *azonal* and *intrazonal* groups.

(a) **Zonal soils** are more or less mature; they have well-developed horizon differentiation, colour and structure etc. Zonal soils are developed under the influence of climate and vegetation.

(b) **Azonal soils** are immature with no development of profile characteristics. Azonal soils are evident in steep rock slopes and on fresh alluvial deposits. These soils lack well developed horizons.

(c) **Interzonal soils** have a distinct profile and their characteristics are more influenced by local conditions of relief (topography) or parent material than by normal effects of climate and vegetation.

Table 5.1: Major Soil Groups

Order	Soil Groups
Zonal	1. Desert soil 2. Grey soil 3. Chestnut soil 4. Chernozem (black soil) 5. Laterite soil 6. Podsoles 7. Brown Earth 8. Tundra soil
Azonal	1. Lithosols 2. Regosols (dry sands) 3. Alluvium soil
Intrazonal	1. Saline and alkaline soil 2. Rendzina soil 3. Bog or marsh soil

(Source: Bryant, R.H (1986): *Physical Geography*. Made Simple Books, Oxford, Heinemann Professional Publishing Ltd.)

Table 5.2: Soil Types and Distribution in India

Sl. No	Soil Types	Locational Distribution
1.	Alluvial Soil	Northern Great plains (except Rajasthan) - West Bengal, Assam, Odisha, Haryana, Punjab and Terai area of Uttar Pradesh, Western Madhya Pradesh and Maharashtra - Konkan (as coastal alluvium)
2.	Black Soil	Deccan lava tract (Deccan Trap) including Maharashtra, Madhya Pradesh, Gujarat and

		Andhra Pradesh and Tamil Nadu, river valleys of Narmada, Tapi, Godavari and Krishna
3.	Red Soil	Chhotanagpur plateau, Malwa plateau, Telangana, Nilgiris, Tamil Nadu, Karnataka, Andhra Pradesh, south-eastern Maharashtra, eastern parts of Madhya Pradesh, parts of Odisha, Bundelkhand, and periphery areas of Deccan plateau, Jharkhand, Meghalaya, Mizoram, Manipur and Nagaland
4.	Laterite and Lateritic Soil	Karnataka, Kerala, Tamil Nadu and hilly regions of Assam, Rajmahal hills and Chhotanagpur plateau, (Birbhum, Bankura and Medinipur), West Bengal and Garo hills of Meghalaya
5.	Forest and Mountain Soil	Assam, Darjeeling, Uttarakhand, Himachal Pradesh and Kashmir
6.	Arid and Desert Soil	Rajasthan, Saurashtra, Kachchh, Haryana and south Punjab
7.	Saline and Alkaline Soil	Rajasthan, Uttar Pradesh, Bihar, Haryana, Punjab and Maharashtra
8.	Peat and Organic Soil	Western Kottayam and Alapuzha districts of Kerala, Odisha, West Bengal, central and north Bihar and Almora district of Uttarakhand

(Source: Khullar, D.R (2006). India: A comprehensive Geography. Delhi, Kalyani Publisher)

Natural Vegetation

H.G. Champion (1936) has identified 116 types of vegetation in India. Later on, several scholars attempted to simplify his detailed classification scheme of vegetation. Some notable scholars include G. S. Puri (in 1960), Legris (in 1963), Champion and K. Seth (in 1968) and S.S. Negi (in 1990). Therefore, based on their simplified scheme, India's vegetation has been divided into 5 major types and 16 sub-types (Fig. 5.1). These are discussed as below:

Table 5.3: Vegetation Types of India

Sr. No.	Major Types of Vegetation	Sub-Types
1	Moist Tropical	1) Tropical Wet-Evergreen 2) Tropical Semi-Evergreen 3) Tropical Moist Deciduous 4) Littoral and Swamp
2	Dry Tropical	1) Tropical Dry Evergreen 2) Tropical Dry Deciduous 3) Tropical Thorn
3	Montane Sub-Tropical	1) Sub-Tropical Broad Leaves Hill 2) Sub-Tropical Moist Hill (pine) 3) Sub-Tropical Dry Evergreen
4	Montane Temperate	1) Montane Wet Temperate 2) Himalayan Moist Temperate
5	Alpine	1) Sub-Alpine 2) Moist Alpine Scrub 3) Dry Alpine Scrub

(Source: Negi, S.S (1994). *India's Forest, Forestry and Wildlife*. Delhi, South Asia Publisher)

A. Moist Tropical Vegetation

1. Tropical Wet Evergreen: These grow in areas with an annual rainfall of about 250 centimetre, where annual temperature remains around about 25°-27°C and average relative humidity exceeds 77 percent. A distinctly short dry season is its main feature. Major characteristic of these vegetation type is that due to high heat and high humidity, trees do not shed their leaves together, in fact, form an evergreen forest. This vegetation comprises of lofty and very dense multi-layered forests with mesophytic evergreen which are adapted to neither too dry nor too wet type of climate. Trees of these forests are 45 metre in height which does not exceed 60 metre. These are characterized by thick canopy and appear like tropical rainforest with thick canopy of foliage from above. Undergrowth in this vegetation type is less as sunlight is unable to reach ground due to thick canopy. Undergrowth is mainly of ferns, climbers, bamboos and orchids.

These are found on the western side of Western Ghats at a height varying between 500 to 1370 metre, above sea level to the south of Mumbai, also across Purvanchal hills and Andaman and the Nicobar Islands.

The timber of the tropical wet evergreen vegetation is fine-grained, hard and durable. These hardwoods have high commercial value but it is highly challenging to exploit due to dense growth, absence of pure stands and lack of transport facilities. The important tree species include Mahogany, Mesua, White Cedar, Jamun, Canes, Dhup and Bamboo etc.

2. Tropical Semi-Evergreen: These are transitional vegetation cover found between tropical wet evergreen and tropical deciduous. These are comparatively less dry than wet tropical evergreen type. Annual rainfall ranges between 200-250 centimetre, with mean annual temperature varying from 24°C to 27°C and relative humidity is about 75 percent. These are mostly found in Assam, Western coast, lower slopes of Eastern Himalayas, Odisha and Andamans.

Semi-evergreen vegetation is less dense. These are more gregarious found in flocks and colonies and are characterized by many species. Trees usually have buttressed trunks with abundant epiphytes. These comprise rougher and thicker bark, heavy climbers and fewer bamboos.

The important tree species are Laurel, Rosewood, Mesua, thorny Bamboo, Kenju, Kusum, Mundani, Semul, Hopea, Kadam and Irul, etc., found on the Western Ghats. While in the Himalayan region, trees like white Cedar, Indian Chestnut and Champa etc., are found.

3. Tropical Moist Deciduous: These vegetation type represents the mixture of trees and grasses and are found in the region that receives an annual rainfall of about 100 to 200 centimetre per annum and mean annual temperature of about 27°C. The average relative humidity ranges from 60 to 75 percent.

Tropical moist deciduous vegetation presents an irregular story of trees which is about 25 to 60 metre in height. These have heavily buttressed trees and have fairly complete undergrowth. These occupy a much larger area than the evergreen type of vegetation, but large tracts have been cleared for

cultivation. These are mainly found over the belt running along the Western Ghats surrounding evergreen vegetation cover. These are also found along the Shivalik range including Terai and Bhabar regions. These are also present in the hills of eastern Madhya Pradesh and Chattisgarh, Chota Nagpur plateau, most parts of Odisha, parts of West Bengal and Andaman and Nicobar Islands. These provide valuable timber and other products like Teak, Sal, Laurel, Lendi, Semul, Irul, Rosewood, Amla, Kusum, Jamun and Bamboo etc.

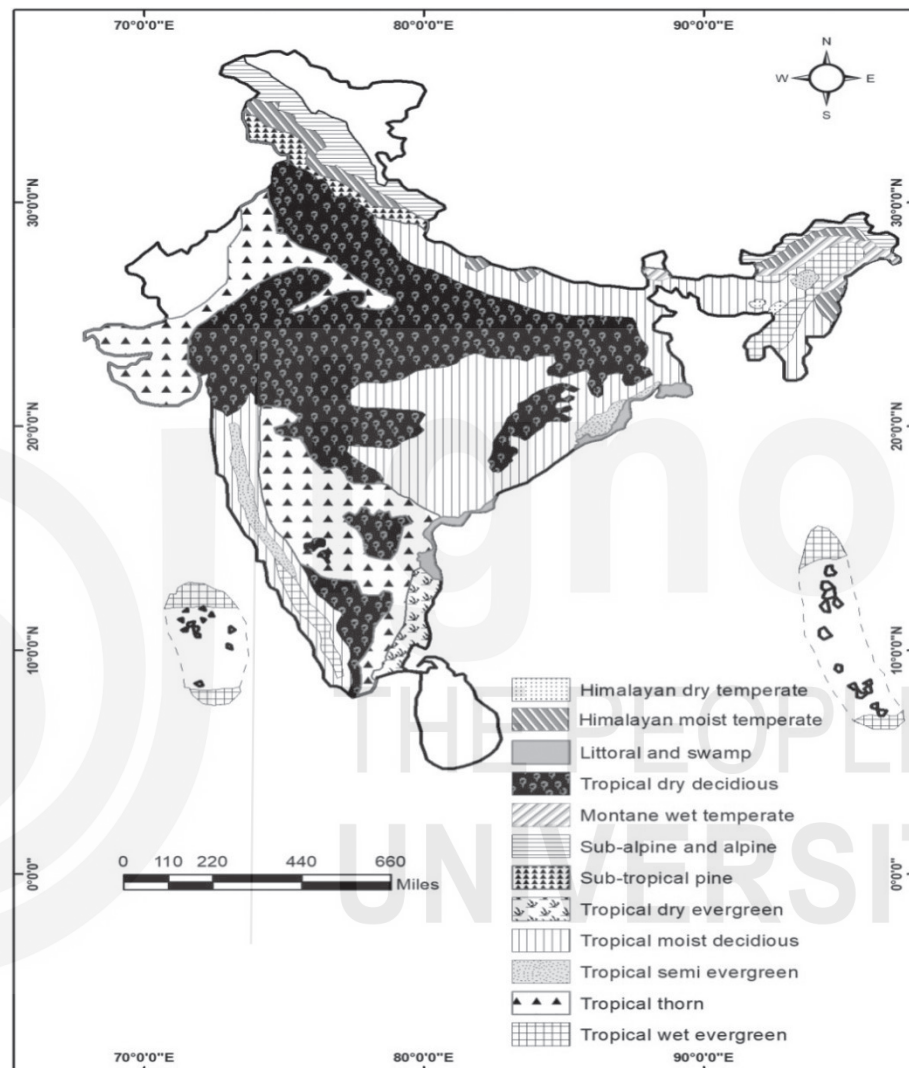


Fig. 5.1: Natural Vegetation of India.

(Source: Adapted from the Classification of Natural Vegetation after Champion and Seth, 1968)

4. Littoral and Swamps: This vegetation type thrives and flourishes in both fresh as well as brackish water which is a mixture of seawater and freshwater. The salinity ranges between 0.5 to 35 gram/kilogram. These mainly occur in and around deltas, estuaries and creeks which are prone to tidal influences. These are mainly found in the deltas of Ganga, Mahanadi, Godavari, Krishna and Cauvery along within Andaman and Nicobar.

These comprise mangrove trees of around 30 metre in height which are utilized for fuel purposes. Epiphytes are predominant in the entire forests, higher ground supports screw pines, while nippa fruticans (a palm) occupy marshes and creeks. Sundarbans delta of these forests is covered with Sundari (*Heriteira minor*) trees.

B. Dry Tropical Vegetation

1. Tropical Dry Deciduous: This is a transitional vegetation cover between moist deciduous and tropical thorn types. The amount of rainfall lies between 70 and 100 centimetre and average annual temperature ranges between 15°C to 22°C. The relative humidity varies between 63 to 77 percent. These cover a large area and run north-south from the foothills of the Himalayas to Kanyakumari except in Rajasthan and Western Ghats and Gujarat but covering Uttar Pradesh, Maharashtra, Tamil Nadu and Karnataka. Important tree species of tropical dry deciduous vegetation include Teak, Laurel, Khair, Harra, Bel, Rosewood, Satinwood, Anjeer, Palas, Amaltas and Bijsal, etc. Large tracts of these forests have been cleared for agriculture.

2. Tropical Thorn: This vegetation type is found over areas of very low rainfall of about 50 to 70 centimetre and the mean annual temperature ranging between 25°C to 27°C. The relative humidity is below 47 percent. Main areas where these are found include western Haryana, southwestern Punjab, central and eastern Rajasthan, western Uttar Pradesh, western Madhya Pradesh, Kachchh and neighbouring areas of Saurashtra and leeward slopes of Sahyadris. Trees found here are 6-9 metre in height and are stunted with large patches of coarse grasses. Vegetational cover species include Indian Date Palms, Acacias, Cacti, Palash, Wild Palms, Kokko, Kanju and Khejra etc.

3. Tropical Dry Evergreen: These occur in the area receiving about 100 centimetre of rainfall from October to December. They are mainly found along Coromandel coast. The annual mean temperature is 28°C and relative humidity is 74 percent. These vegetation cover have forests of low height exhibiting canopies of 9-12 metre. Important tree species of tropical dry evergreen vegetation are Toddy Palm, Kokko, Jamun, Ritha, Khirni, Tamarind and Neem etc.

C. Montane Sub-Tropical Vegetation

1. Sub-Tropical Moist (Pine): This type of vegetation is found in the north-western Himalayas (except in Kashmir), Khasi hills, Nagaland and Manipur. These occur at an altitude of 1000-1800 metre. Here, annual rainfall ranges between 100-200 centimetre, with an average temperature of 15°C to 22°C and relative humidity varying between 63 to 77 percent. Chir pine is the main tree found in the area of higher humidity. Other important tree species of sub-tropical moist vegetation are Jamun, Oak and Rhododendron with thick grass cover during the rainy season.

2. Sub-Tropical Dry Evergreen: It is found in the Bhabar, the Shiwaliks and the western Himalayas up to about 1,000 metre, above sea level. This vegetation type covers the piedmont area of the Himalayas in Punjab, Haryana and some parts of Kashmir hills. They occur at an elevation of 450 to 1,500 metre. The average annual temperature is 20°C with rainfall ranging between 50 to 100 centimetre and the number of rainy days of about 26-38 days. It includes various species of acacia with trees like Olive, Acacia, Modesta and Pistacia etc. Grass grows here during the rainy season.

3. Sub-Tropical Wet Hill: This vegetation occurs in relatively moist areas of lower altitudes on mountain ranges with a height of 900-1,050 metre, especially in the Eastern Himalayan region around Assam and Khasi hills.

They are also found in Pachmarhi, Nilgiri and Mahabaleshwar hills. Annual rainfall occurring here is more than 150 centimetre, with 78-146 rainy days. The average annual temperature ranges between 18°C to 24°C with a relative humidity of 51-81 percent. These are characterized by a mixture of tropical and temperate wet evergreen trees. The trees have an average height of 15 to 30 metre, with less dense canopy and scrubs. Major tree species found are Jamun, Machilus, Elaeocarpus, Colitis, Oak and Chestnut in the Eastern Himalaya.

D. Montane Temperate Vegetation

1. Wet Temperate: These are found at a height of 1,800 to 3,000 metre, above sea level. These occur along the slope of Nilgiris, Annamalai, Palni hills (above 1,500 metre), along the Himalayas and Assam hills (1800-2900 metre). The mean annual rainfall received in this vegetation type is 150-300 centimetre, with mean annual temperature ranging between 11-18°C with freezing point during winter months (December-February) and dense fog. The average relative humidity is over 80 percent. The heights of trees are 15-18 metre, which are called *Sholas* in south India. This vegetation type is characterized by dense undergrowth and numerous epiphytes, mosses and ferns. Important tree species found here are Magnolia, Laurel, Rhododendron, Elm, Prunus and Plum. Oak, Chestnut and Laurel are common species found in the northern part of India.

2. Himalayan Moist Temperate: These cover the entire length of the Himalayan mountain ranges from Kashmir along with Himachal Pradesh, Uttarakhand, Darjeeling, Sikkim, and Arunachal Pradesh. They occur at an altitude of 1,500-3,300 metre. The annual rainfall varies from 150 to 250 centimetre. The average annual temperature is 12°C to 13°C. The vegetation contains mixed species of broad-leaf evergreens and conifer species of Oak, Fir, Spruce (*Picea*), Deodar (*Cedrusdeodara*), Celtis, Chestnut, Cedar (*Chamaecyparis*), Maple, Silver Fir, Kail, Yew and Birch which are important species of trees. They form high but fairly open tree cover with shrubby undergrowth including Oaks, Rhododendrons, and some Bamboos.

3. Himalayan Dry Temperate. This vegetation type occurs in Ladakh, Chamba, Lahaul, Garhwal and Sikkim where precipitation is below 100 centimetre, and mostly in the form of snow. They are found at an altitude of above 1,500 metre. Such vegetation cover is found in the inner dry ranges of the Himalayas where the southwest monsoon loses its moisture content substantially. It is a kind of vegetation that supports xerophytic shrubs and trees. Some important and prominent tree species include Deodar, Juniper, Chilgozah (*Neoza*), Maple, Ash Celtis, Olive and Oak etc.

E. Alpine Vegetation

Alpine vegetation is found in the Himalayan ranges between 3,000 metre and 4,000 metre altitude in the form of dense vegetation cover. The Alpine vegetation degenerates into a low evergreen shrub on the southern slopes and dry xerophyte vegetation on the northern slopes of the Himalayas. Alpine pastures with stunted conifers below and snowfields above occur at an altitude of about 2250 metre and 2750 metre in the Pir Panjal range. These are used as grazing grounds by the Gujar nomads who practice transhumance. In the Western Himalaya, Alpine species with white flowers

called 'Brahmakamal' and the 'Kuth' are utilized in perfumery. Important tree varieties of alpine vegetation include Silver Fir, Juniper, Pine and Birch.

SAQ 2

Briefly highlight the classification scheme of natural vegetation of India.

5.4 SOIL AND VEGETATION REGIONS OF INDIA

India is a country of vast dimensions with varied conditions of geology, relief, climate and vegetation. Therefore, India has a large variety of soil groups, distinctly different from one another. Different criteria have been applied to classify Indian soils, the outstanding being geology, relief, fertility, chemical composition and physical structure etc. The Indian Council of Agricultural Research (ICAR) has divided the Indian soils into eight major groups. These are (1) Alluvial soils, (2) Black soils, (3) Red soils, (4) Laterite soils, (5) Forest and Mountain soils, (6) Arid and Desert soils, (7) Saline and Alkaline soils, and (8) Peat and Organic soils. Out of these eight groups, almost 80 percent of the total land surface and almost the entire cultivated area is located in the regions of alluvial, black, red and laterite soils.

Alluvial Soils: Alluvial soils are by far the largest and the most important soil group of India. Covering about 15 lakh square kilometre, or about 45.6 percent of the total geographical area of the country, these soils contribute the largest share of our agricultural wealth and support the bulk of India's population. Most of the alluvial soils are derived from the sediments deposited by the rivers as in the Indo-Gangetic plain. Although, some alluvial soils in the coastal areas has been formed by the sea waves. Thus, the parent materials of these soils are of transported origin.

Alluvial Soils are found in the Great Northern plains from Punjab in the west to West Bengal and Assam in the east. They also occur in the deltas of the Mahanadi, the Godavari, the Krishna and the Cauvery, where they are called deltaic alluvium. Along the coast, they are known as coastal alluvium. Some alluvium soils are also found in the Narmada and Tapi valleys. Along the west coast, alluvial soils occur in the Kerala coast and Gujarat plains. Large valleys on the Peninsular plateau also contain narrow patches of alluvial soils. Geologically, the alluvium of the Great plain of India is divided into newer or younger known as '*khadar*' and older known as '*bhangar*' soils.

The *khadar* soils are found in the low areas of valley bottom which are flooded almost every year. They occur in Eastern Uttar Pradesh and Bihar where floods are common phenomenon. They are pale brown, sandy clay and loamy, drier and leached, less calcareous, and carbonaceous. Whereas, *bhangar* are found on the higher reaches about 30 metre, above flood level. These soils are darker in color as they contain more clay. Due to their softness of the strata and fertility, the alluvial soils are best suited to irrigation and respond well to the canal and tube-well irrigation. When properly

irrigated, the alluvial soils yield splendid crops of rice, wheat, sugarcane, tobacco, cotton, jute, maize, oilseeds, vegetables and fruits.

Black Soils: The black soils are called *regur* and black cotton soils because cotton is the most important crop grown on these soils. Geographically, black soils are spread over 5.46 lakh square kilometre, i.e., 16.6 percent of the total geographical area of the country spanning from 15°N to 25°N latitudes and 72°E to 82°E longitudes. This is the region of high temperature and rainfall. It is, therefore, a soil group of the dry and hot regions of the Peninsula. These soils are mainly found in Maharashtra, Madhya Pradesh, parts of Karnataka, Andhra Pradesh, Gujarat and Tamil Nadu. The presence of a small proportion of titaniferous magnetite or even iron and black constituent of the parent rock, crystalline schists and basic gneisses contribute to the black color of these soils.

This soil group constitutes various tints of black soil such as deep black, shallow black, medium black and even a mixture of black and red. The typical black soils are highly argillaceous with a large clay factor of about 62 percent or more, without the presence of gravel and coarse sand. It also contains 10 percent of alumina, 9-10 percent of iron oxide, and 6-8 percent of lime and magnesium carbonate. This type of soil group is retentive of moisture. During the rainy season, it swells greatly and becomes sticky which makes it unfavorable for any cultivation. However, during dry season, the moisture evaporates and the soil particles shrink which develops cracks of about 10-15 centimetre wide and a metre deep. This permits the oxygenation of the soil to sufficient depths.

The black soils are of low fertility in the uplands whereas they are darker deeper and richer in the valleys. Because of their high fertility and moisture retentivity, this soil type has been used for growing a variety of crops for centuries without the utilization of fertilizer or manure. The important crops grown on the black soils are, the most important being cotton, wheat, jowar, linseed, sunflower, millets, castor and tobacco etc. When provided with efficient irrigation input, rice and sugarcane are also grown on such soils. Vegetables and fruits are also grown on black soils.

Red Soils: The Red soils are of the largest soil group in India occupying a vast area of about 3.5 lakh square kilometre, which is about 10.6 percent of the total geographical area of the country. These soils have come into existence due to weathering of ancient crystalline and metamorphic rocks. The main parent rock of this soil type is acid granite and gneisses, quartzitic and felspathic. The red soils are poor in lime, magnesia, phosphates, nitrogen and humus, but are rich in potash. In terms of their chemical composition, they are mainly siliceous and aluminous. The texture varies from sandy to clay, but the majority is loam.

These soil types are generally red but are also found in other tints of brown, chocolate, yellow, grey and even black. The red soils are found in almost the whole of Tamil Nadu, parts of Karnataka, southeast of Maharashtra, the eastern part of Andhra Pradesh, Madhya Pradesh, Chhattisgarh, Odisha and Chota Nagpur in Jharkhand. Whereas, in northern India, red soils extend in large parts of south Bihar, the Birbhum and Bankura districts of West Bengal,

Mirzapur, Jhansi, Banda and Hamirpur district of Uttar Pradesh, Aravallis and eastern half of Rajasthan, parts of Assam, Nagaland, Manipur, Mizoram, Tripura and Meghalaya. The red soils are poor, thin and gravelly, sandy or stony and porous on the uplands, but are rich, deep dark, and fertile on the lowlands. Under efficient irrigation and proper utilization of fertilizers, red soils give excellent yields of cotton, rice, millets, wheat, pulses, oilseeds, potatoes and tobacco along with fruits and vegetables.

Laterite and Lateritic Soils: The word laterite has been derived from Latin meaning brick and was first applied by Buchanan in 1810 to a clayey rock that hardens on exposure. Laterite soil is formed under conditions of high temperatures and heavy rainfall with alternate wet and dry periods. According to George Kuriyan, "it is probably the end product of decomposition found in regions of heavy rainfall, more than 200 centimetre". Such climatic condition facilitates leaching of soil whereby lime and silica are leached away leaving behind soil that is rich in oxides of iron and aluminum compounds. The laterite soils cover an area of about 2.48 lakh square kilometre, and are mainly evident on the summits of Western Ghats at 1000 to 1500 metre, above mean sea level. They are also found in the Eastern Ghats, Rajamahar hills, Malwa Plateau, Vindhya and Satpuras. The laterite soils are also developed in the southern patches of the country in some parts of Maharashtra, parts of Karnataka, Andhra Pradesh and Kerala. On the eastern side, it is found in Odisha, West Bengal, Meghalaya and Assam. The laterite soils are deficient in nitrogen and potash and are very poor in lime and magnesia. However, sometimes the phosphate content may be highly present in the form of iron phosphate. They may have a higher content of humus at some places. Due to intensive leaching, laterite soils generally lack fertility, but when put under efficient irrigation and manure facility they are suitable for growing plantation crops like tea, rubber, coffee, cinchona, areca nut and coconut etc. Laterite soils found in low lying areas are also favorable for the cultivation of paddy. Since laterite soils are the end product of weathering, they cannot be weathered further which makes the soil durable.

Forest and Mountain Soils: Such soils are spread across 2.85 lakh square kilometre, across India which is about 8.67 percent of the total land area of India. These soils are found over the slopes of hills covered by forests. These soils are formed mainly by the characteristic deposition of organic matter derived from the forest. These soils contain large quantities of decomposed leaves, flowers, and other organic matter called humus. However, these are deficient in potash, phosphorus and lime. Therefore, it requires a good amount of fertilizers for high crop yields. Such soils are heterogeneous whereby their character changes with parent rocks, ground configuration and climate. At higher elevations of the Himalayas, such soils are mainly found in valley basins, depressions and less steeply inclined slopes and are podzols. At lower levels such as the Sahyadris and the Eastern Ghats, brown Earth is common. Such types of forest soils are efficiently used for the plantations of tea, coffee, spices, and fruits in Karnataka, Tamil Nadu and Kerala. Whereas wheat, maize, barley and temperate fruits are grown in Jammu and Kashmir, Himachal Pradesh and Uttarakhand on such soil types.

Arid and Desert Soils: Such soils are spread across the large part of the arid and semi-arid regions of Rajasthan and adjoining areas of Punjab and

Haryana lying between the Indus and Aravalis. These cover an area of 1.42 lakh square kilometre, which accounts for 4.32 percent of total geographical area of the country. These areas receive less than 50 centimetre of annual rainfall and are affected by desert conditions. The Rann of Kachchh in Gujarat is an extension of this desert. These are predominantly sandy in texture and have salt content formed by evaporation of subsoil, such condition inhibits soil growth. The formation of sand is from the mechanical disintegration of the ground rocks or is blown from the Indus basin and the coast by the prevailing southwest monsoon winds. The desert soils comprise 90 to 95 percent of aeolian sand and 5 to 10 percent of clay. Such soils have high percentage of soluble soils, are alkaline with varying degrees of calcium carbonate, and are mainly poor in organic matter. The content of nitrogen is low in such soils. However, such deficiency is made up to some extent by the availability of nitrogen in the form of nitrates. The content of phosphorus is essentially high in such soils. Therefore, the presence of phosphorus and nitrates make it fertile wherever moisture is available. However, in large areas of desert soils, only drought resistant and salt tolerant crops can be cultivated such as barley, cotton, wheat, millets, maize and pulses etc.

Saline and Alkaline Soils: These soils are mainly spread across the arid and semi-arid tracts of Rajasthan, Punjab, Haryana, Uttar Pradesh and Bihar occupying 68,000 square kilometre of total geographical area. Such soils have sodium, calcium, and magnesium salt and encrustations on the surface. These soils are infertile and are also known by different names such as *Reh, Kallar, Usar, Thur, Rakar, Karl and Choppin*. The origin of such soils is mainly from decomposed rock and mineral fragments which on weathering liberate sodium, magnesium and calcium salts and sulfurous acid. These salts are transported to rivers by the process of solution and percolate on the sub-soils of the plains. In areas of canal irrigation and higher sub-soil water table, these harmful salts are transferred from below to top-soils through the process of evaporation, which makes the soil unfit for agriculture. About 1.25 million hectares of land in Uttar Pradesh and 1.21 hectares in Punjab have been affected by *Usar*. Gujarat has also been affected by such soil in the area around the Gulf of Khambhat.

Peat and Organic Soils: These soils are formed under humid conditions and contain large quantities of organic matter and soluble salts. Such soils occur in the western part of Kottayam and Alapuzha districts of Kerala. Marshy soils which contain a high percentage of humus occur in the coastal areas of West Bengal, Odisha and Tamil Nadu and the marshy Terai region of the Himalayas.

Natural Vegetation

Depending on the geo-climatic conditions, C.C. Calder in 1937 identified eight vegetation regions in India, namely:

1. The Eastern Himalayan Region
2. The North-Western Himalayan Region
3. The Assam Region
4. The Gangetic Plain
5. The Indus Plain
6. The Deccan Region

7. The Malabar Region
8. Andaman and Nicobar Islands

1. The Eastern Himalayan Region

This vegetation region stretches from the hilly regions of Sikkim, West Bengal, and Arunachal Pradesh. This undulating and mountainous region records an average annual rainfall of over 200 centimetre. This region comprises over 4000 species of plants which vary from tropical to temperate and alpine. The important species are Sal, Oak, Chestnut, Magnolia, Pyrus, Bamboo, Silver Fir, Pine, Birch, Rhododendron and Alpine grasses.

2. The North-Western Himalayan Region

This region stretches over Jammu and Kashmir, Himachal Pradesh and Uttarakhand. It is characterized by less rainfall and low temperature. The vegetation types are sub-tropical (up to 1,525 metre), temperate (1,525-3,650 metre) and alpine vegetation (3,650-4,575 metre). In the sub-montane region, the important vegetation species are Sal, Semul and Savanna types. Among the temperate vegetation, Pine, Oak, Deodar, Alder, Birch and Conifers are the main species. At higher alpine altitudes, the trees are replaced by alpine pastures and trees like Juniper, Silver Fir, Birch and Larch.

3. The Assam Region

The Assam region includes the whole of North-east India including Assam, Meghalaya, Nagaland, Manipur, Mizoram and Tripura. This region comprises vegetation that is rich in different species of bamboos and palms with Nilgiri type of grasslands at higher altitudes.

4. The Gangetic Plain

The vegetation type in this region ranges from the semi-arid shrubs of the Aravali region to evergreen mangroves of the Sundarbans delta. The vegetation of this region has been substantially transformed by human activities and the cultivation of crops. The vegetation of Uttar Pradesh is mainly dry deciduous type. In Bihar and West Bengal, it is a moist deciduous type. Sheesham, Neem, Mahuwa, Jamun, Acacia, Ber and Bel etc., are the main vegetation species of this region. Numerous types of grasses are also found in Gangetic plains.

5. The Indus Plain

This region stretches over Punjab, Haryana, Rajasthan, west of Aravali, Kachchh and the north-western part of Gujarat. This region receives scanty rainfall of less than 75 centimetre annually. Consequently, the vegetation of this region can bear arid and severe dry conditions. The important species are Acacias, Cacti, Wild Palms, Khejra and Palas etc. Numerous grasses develop during the rainy season, which withers away during the winter dry season.

6. The Deccan Region

This region covers the greater parts of Peninsular India. The xeric Deccan thorn forests lie to the west, south, and southeast, covering the drier portions of the plateau in the rain shadow zone of the Western Ghats. The more humid Eastern Highlands have more deciduous forests that lie to the northeast and

east. While in the Narmada valley, dry deciduous forests lie across the Satpuras to the northwest. The major vegetation of this region is Teak, Tendu, Sal, Palm and thorny shrubs.

7. The Malabar Region

The Malabar region stretches all along the western coast from the Gulf of Khambat to Cape Comorin (Kanyakumari). The vegetation of this region ranges from moist tropical evergreen to broadleaf mixed and monsoon deciduous type. The Nilgiri hills have temperate forests at higher altitudes.

8. Andaman and Nicobar

Andaman and Nicobar Islands experience a tropical climate without any extremes for the rains and thunderstorms. Rainfall is common. Therefore, it is highly favorable for the growth of evergreen forest. This region supports the growth of epiphyte vegetation. It mainly comprises ferns and orchids, woody climbers and the island is outlined with coconut trees.

SAQ 3

Discuss any three vegetation regions of India.

5.5 SUMMARY

In this unit, you have learned the following:

- Soil is the upper layer of the Earth composed of loose surface material. It is a mixture of many substances including an endless variety of minerals, remnants of plants and animals, water and air.
- It is the end product of continuing interaction between the parent material, local climate, plant and animal organisms and elevation of the land. Soil is an important segment of our ecosystem.
- Major forms of soil erosion are ravines, gullies, landslides and sheet erosion.
- The various characteristics of soil includes parent material of the soil, mineral matter, organic matter, soil texture, soil structure, soil acidity, soil air, soil water, soil horizon and soil profile.
- Six major types of soil found in India are alluvial, black, red, laterite, desert and mountain soil.
- Both physical and social factors cause soil erosion. The physical factors are the erosive power of rainfall, erodibility of soil, the severity of periodic floods and the length and steepness of the slope. The social factors are deforestation, overgrazing and the nature of land use and methods of cultivation.
- Natural vegetation refers to a plant community. The assemblage of plant species, e.g., trees, shrubs, grasses, creepers and climbers and the like living in association with one another in a given environment is known as natural vegetation.

- Contrary to this, a forest denotes a large tract covered by trees and shrubs which carries economic significance for human beings. Thus, a forest has a different connotation than what natural vegetation has.
- The geographical factors affecting the distribution of natural vegetation include climate, soil, topography, rainfall and temperature.
- The seasonal variation and regime also bear an important influence on the natural vegetation. The amount of rainfall has an important bearing on the type of vegetation.
- The natural vegetation of India reflects a state of perfect harmony with the relief and climatic conditions.
- The variations in climatic conditions in India have resulted in having various types of natural vegetation across the country.
- The vegetation of India changes from one region to another based on the actual variations in the climate and the soil.
- The different types of forests found in India are tropical evergreen rain forests, deciduous or monsoon types of forests, dry deciduous forests, mountain forests, tidal or mangrove forests, semi-desert and desert vegetation.
- A large proportion of vegetation cover of India in many regions has been substantially transformed by human activities and cultivation of crops owing to the rising population of the country.

5.6 TERMINAL QUESTIONS

1. Write two main characteristics of each soil type of India.
2. Divide India into major soil zones and give a detailed account of alluvial soil, and mention its agricultural potentials.
3. What are the factors controlling the formation and distribution of soil in India?
4. Distinguish between tidal vegetation and mountain vegetation.
5. Discuss the factors affecting the distribution of natural vegetation in India.
6. Discuss in detail the major vegetation regions of India.

5.7 ANSWERS

Self-Assessment Questions (SAQ)

1. a) Organic matter represents partially decayed and partially decomposed plant and animal waste whereas soil texture represents the size of soil particles. The volumetric composition of organic matter in soil accounts for around 5 percent. The end product of breakdown of dead organic material is known as 'humus'. It is structure less, dark brown or black coloured decayed soil material found within soil surface and is responsible for making topsoil darker than subsoil. Soil texture is generally characterized by size of soil particles. Clayey soil may, thus,

be described as fine and sandy as coarse, while silt is an intermediate type.

b) Factors affecting natural vegetation are climate, soil, and topography. Besides these, the amount and intensity of rainfall too affects the distribution of natural vegetation.

2. Champion and Seth's (1936) classification of vegetation with 116 types is the most well-known scheme. Vegetation of India has been classified into five types and 15 sub-types.
3. Any three vegetation regions of India are Assam, Gangetic and Indus regions, each being characterized by diverse vegetation species.

Terminal Questions

1. Briefly answer the two main characteristics of each soil type of India with suitable examples. Refer to Section 5.2.
2. While answering this question, you should be able to point out the major soil zones of India and also throw light on the alluvial soil along with its agricultural potentials. Refer to Section 5.4.
3. In your answer, you should aptly highlight the factors which control the formation as well as distribution of soil in India. Refer to Section 5.3.
4. By citing suitable examples, highlight the main differences between tidal vegetation and mountain vegetation types. Refer to Section 5.3.
5. Highlight the role of factors that affect the distribution of natural vegetation in India. Refer to Section 5.3.
6. Your answer should cover a brief description of the major vegetation regions of India. Refer to Section 5.4.

5.8 REFERENCES AND SUGGESTED FURTHER READING

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GLOSSARY

Aggradational Plain	: It refers to a depositional plain.
Angaraland	: The landmass to the north of Tethys Sea was called Angara land. The ancient continental mass consisted of the modern continents of Asia and Europe.
Aquaculture	: It refers to the farming and cultivation of freshwater and saltwater aquatic plants and animals under semi-natural and controlled conditions. The process includes breeding, growing and harvesting of aquatic plants and animals.
Bhabar	: A piedmont plain of unassorted debris.
Bhangar	: It refers to old alluvium.
Coastal Plains	: A plain adjacent to the coast is called a coastal plain. The southern part of the peninsula is bordered by narrow coastal strips along the Arabian Sea on the west and the Bay of Bengal on the east.
Colonization	: It refers to large-scale population movements where the migrants maintain strong links with their or their ancestors' former country, gaining significant privileges over other inhabitants of the territory by such links. For instance, India was once colonized by the British.
Confluence	: A confluence refers to the junction where two or more rivers join, merge and flow together.
Coral Reefs	: It signifies underwater structure made from calcium and carbonate secreted by corals. Corals are an animal that lives under the sea on the bed and live on a skeleton that it has created.
Coromandel Coast	: It is the south-eastern coastal region of the Indian sub-continent, bounded by the Utkal plains to the north, the Bay of Bengal to the east, the Kaveri delta to the south, and the Eastern Ghats to the west. Coromandel coast extends over an area of about 22,800 square kilometre.
Cultural Diversity	: The term cultural diversity can also be referred to as having different cultures within a given geographical territory. There exists mutual understanding and feelings for people of different cultural groups.
Deccan Traps	: It refers to Deccan lava plateau.
Delta	: A river delta is almost a triangular depositional landform formed by the deposition of sediments carried by the river which is deposited at mouth of the river.
Distant Islands	: Situated nearly 5 kilometre away from the mainland.
Drainage Basin	: A drainage basin refers to an area from which all precipitation flows to a set of streams or single stream and drains to a common outlet like rivers, streams and mouth

of a bay etc.

Dravidians	: The Dravidian peoples, or Dravidians, are an ethno-linguistic group originating in South Asia who predominantly speaks any of the Dravidian languages.
Drought	: It indicates a period when an area or region receives rainfall much lower than the normal precipitation. The lack of adequate precipitation, either rain or snow, can cause reduced soil moisture or groundwater, diminished stream flow, crop damage, and water shortage for the agriculture.
Duns	: The longitudinal valley lying between the Himalayas and the Shivalik is known as 'Duns'. Dehra Dun, Kothi Dun and Pathi Dun are some of the well-known Duns.
ENSO	: El Niño–Southern Oscillation is an irregular periodic variation in the winds and sea surface temperature over the tropical eastern Pacific Ocean.
Ethnic Group	: An ethnic group or ethnicity is a grouping of people who identify with each other based on shared attributes that distinguish them from other groups such as common set of traditions.
Foredeep	: It refers to a great depression or geosynclines.
Glacier	: It refers to river of ice and snow.
Gondwanaland	: The landmass to the south of Tethys sea was called Gondwanaland. The ancient continental mass consisted of South America, Africa, India, Australia and Antarctica.
Gorge	: A gorge refers to a narrow and steep valley that is formed by the erosive work of the rivers. It is characterized by very steep, narrow and rocky walls which are located between mountains or hills.
Himadri	: It refers to snow land.
ICAR	: The Indian Council of Agricultural Research (ICAR) is the apex body for coordinating, guiding and managing research and education in agriculture in the entire country under the Ministry of Agriculture and Farmers Welfare.
Immigration	: Large scale movement of people from one place to another in search of food, better living and sources of livelihood. Immigration in the past was often permanent and people moved in large groups to distant places changing the demographic characteristics of the population in the region.
Jet Stream	: It refers to a narrow, fast flowing and meandering air currents in the atmosphere. The main jet streams are located in the region around the tropopause and are westerly winds (flowing west to east). Jet streams may start, stop, split into two or more parts, combine into one stream, or flow in various directions.

Khadar	: It refers to new alluvium.
Lagoons	: It refers to circular or ring coral lakes.
Laurasia	: Laurasia was the northernmost of two continents that formed part of the Pangaea - supercontinent from approximately 200 million years ago. World landforms originated from two giant lands namely Angaraland (Laurasia) and Gondwanaland.
Leeward	: Towards the side sheltered from the wind is leeward.
Lesser Himalayas	: It refers to Middle Himalayas.
Linguistic Diversity	: Population diversity based on the language. It is an important component of the ethnic composition of any geographical territory.
Low Pressure System	: In the science of meteorology, a low-pressure area, bar low is a region where the atmospheric pressure is lower than that of surrounding locations. Low pressure systems form under the areas of wind divergence that occur in the upper levels of the atmosphere. A low pressure system is developed over Indian landmass during the hot summer season.
Mineral Matter	: Rock fragments of variable size that determines the properties of soil.
Moisture-laden Wind	: The winds that blow from the Arabian Sea and Bay of Bengal towards the land and carries moisture along with it. When these winds strike the mountain barriers, it causes rainfall in the region.
Monotonous Plain	: Uniform in topography.
Offshore Islands	: Situated near or along the coastal line of the mainland.
Organic Matter	: Organic matter in soil represents partially decayed and partially decomposed plant and animal waste.
Outer Himalayas	: It refers to Shivalik or sub-Himalayas.
Parent Material	: A material necessary for soil formation derived from the rocks.
Pass	: It refers to a narrow gap between two hills.
Peninsula	: A Peninsula refers to a stretch of land that is covered or surrounded by a water body on its three sides and connected to the mainland on one side.
Perennial Rivers	: The perennial rivers are those rivers that are fed by the melting glaciers and flow throughout the year irrespective of any season.

Perennial	: Continuing throughout the entire year as a stream.
Physiography	: The study of physical features of the Earth's surface. It is the sub-field of geography that studies physical patterns and processes of the Earth.
Precambrian	: It refers to the Archean rocks.
Purvanchal	: In Arunachal Pradesh beyond the Dihang valley, the Himalayas take a hairpin bend to the south and act as the eastern boundary of India and run through the north-eastern states. These divisions are known as 'Purvanchal'.
Rann of Kachchh/Kutch	: It refers to a sandy and saline plain.
Reh	: This is spread in those Bangar areas where irrigation has dominance. It is known as Kallar. It is widely extended in drier areas of Uttar Pradesh and Haryana.
Retreating Monsoon	: Retreating means withdrawal. So, the withdrawal of southwest monsoon winds from skies of north India during the months of October and November is known as 'retreating monsoon'. The process of withdrawal is gradual and takes about three months.
Rift Valley	: A submerged valley between two high landmasses.
Sahyadri	: It refers to Western Ghats.
Shiwalik	: The southernmost range of the Himalayas. It is a mountain range of the outer Himalayas.
Social Inequality	: It refers to a state of affairs in which all individuals within a specific society do not have equal rights, liberties, and status, possibly including civil rights, freedom of expression, autonomy, and equal access to certain public goods and social services. In simple terms, there exist hierarchies among the people in the society.
Soil Air	: Soil air is present in pore spaces (interstitial spaces) of the soil.
Soil Texture	: It is generally characterized by the size of its particles. A clayey soil may thus be described as fine, sandy and coarse, while silt is an intermediate category.
Soil Water	: It forms an important component for soil growth, held within the pores of the soil.
Southwest Monsoon	: Southwest monsoon period is the principal rainy season for the Indian subcontinent. The whole country receives nearly 75 percent of its rainfall during this period. Southwest monsoon sets in over the extreme southwestern tip of the peninsula by the end of May and causes rainfall from May-September especially in the Northern plains and the North-East region.
State	: The States Reorganisation Act, 1956 was a major reform

- Reorganization** : of the boundaries of India's states and territories, organising them along linguistic lines.
- Tropical Climate** : Climate that is experienced around the tropical belts i.e., in the region around Tropic of Cancer and Tropic of Capricorn. Tropical climate are characterized by monthly average temperature of 18°C or higher year-round and are characterized by hot temperature. The annual temperature range in tropical climate is normally very small.
- Tropical Cyclones** : A tropical cyclone is a rapidly rotating storm system characterized by a low-pressure at the center, a closed low-level atmospheric circulation, strong winds and a spiral arrangement of thunderstorms that produce heavy rain or squalls. Depending on its strength and location, a tropical cyclone is referred by different names, like hurricane, typhoon, tropical storm, tropical depression, cyclonic storm or simply cyclone.
- Vedic Period** : The Vedic Period, or Vedic Age, is the period between the late Bronze Age and early Iron Age in the history of India. It was the period when Vedic literature, including the Vedas (oldest scriptures of Hinduism), were composed. It is usually divided into early Vedic and later Vedic Periods.
- Vindhyan Stone** : It refers to red sandstone.
- Watershed** : It refers to a water-divide between two regular river flows.
- Westerlies** : The westerlies, anti-trades, or prevailing westerlies, are prevailing winds from the west toward the east in the middle latitudes between 30 and 60 degree latitude. They originate from the high-pressure areas in the horse latitudes and trend towards the poles and steer extra-tropical cyclones in this general manner.

