Introduction

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

2. India is a land of great variety of natural vegetation.
   1. Himalayan heights are marked with temperate vegetation;
   2. the Western Ghats and the Andaman Nicobar Islands have tropical rain forests,
   3. the deltaic regions have tropical forests and mangroves;
   4. the desert and semi desert areas of Rajasthan are known for cactii, a wide variety of bushes and thorny vegetation.

3. Depending upon the variations in the climate and the soil, the vegetation of India changes from one region to another.

Types Of Forests

(i) **Tropical Evergreen and Semi Evergreen forests**

(ii) **Tropical Deciduous forests**
(iii) Tropical Thorn forests

(iv) Montane forests

(v) Littoral and Swamp forests.
Tropical Evergreen and Semi Evergreen Forests

1. Tropical Evergreen:
   1. These forests are found in the western slope of the Western Ghats, hills of the northeastern region and the Andaman and Nicobar Islands in warm and humid areas with an annual precipitation of over 200 cm and mean annual temperature above 22°C.
   2. Tropical evergreen forests are well stratified, with layers
      1. closer to the ground and are covered with shrubs and creepers,
      2. with short structured trees.
      3. tall variety of trees, reach great heights up to 60 m or above.
   3. There is no definite time for trees to shed their leaves, flowering and fruition.
   4. As such these forests appear green all the year round.
   5. Species found in these forests include rosewood, mahogony, aini, ebony, etc.

2. Semi Evergreen:
   1. The semi evergreen forests are found in the less rainy parts of these regions.
   2. Such forests have a mixture of evergreen and moist deciduous trees.
   3. The undergrowing climbers provide an evergreen character to these forests.
   4. Main species are white cedar, hollock and kail.

3. Colonial Impact:
   1. The oak forests in Garhwal and Kumaon were replaced by pine (chirs) which was needed to lay railway lines. Forests were also cleared for introducing plantations of tea, rubber and coffee.
   2. The British also used timber for construction activities as it acts as an insulator of heat. The
protectional use of forests was, thus, replaced by commercial use.

**Tropical Deciduous Forests**

1. These are the most widespread forests in India also called the monsoon forests spread over regions which receive rainfall between 70-200 cm.
2. On the basis of the availability of water, these forests are further divided into moist and dry deciduous.
3. The **Moist deciduous forests**
   1. are more pronounced in the regions which record rainfall between 100-200 cm.
   2. These forests are found in the northeastern states along the foothills of Himalayas, eastern slopes of the Western Ghats and Odisha.
   3. Teak, sal, shisham, hurra, mahua, amla, semul, kusum, and sandalwood etc.

4. **Dry deciduous forest**
   1. covers vast areas of the country, where rainfall ranges between 70 -100 cm.
   2. These forests are found in rainier areas of the Peninsula and the plains of Uttar Pradesh and Bihar.
   3. In the higher rainfall regions of the Peninsular plateau and the northern Indian plain, these forests have a parkland landscape with open stretches in which teak and other trees interspersed with patches of grass are common.
   4. As the dry season begins, the trees shed their leaves completely and the forest appears like a vast grassland with naked trees all around.
   5. Tendu, palas, amaltas, bel, khair, axlewood, etc.
   6. western and southern part of Rajasthan, vegetation cover is very scanty due to low rainfall and
Tropical Thorn Forests

1. Tropical thorn forests occur in the areas which receive rainfall less than 50 cm.
2. These consist of a variety of grasses and shrubs.
3. It includes semi-arid areas of south west Punjab, Haryana, Rajasthan, Gujarat, Madhya Pradesh and Uttar Pradesh.
4. In these forests, plants remain leafless for most part of the year and give an expression of scrub vegetation.
5. Important species found are babool, ber, and wild date palm, khair, neem, khejri, palas, etc.
6. Tussocky grass grows up to a height of 2 m as the under growth.

Montane Forests

1. In mountainous areas, the decrease in temperature with increasing altitude leads to a corresponding change in natural vegetation.
2. Mountain forests can be classified into two types, the northern mountain forests and the southern mountain forests.
3. The Himalayan ranges
   1. show a succession of vegetation from the tropical to the tundra, which change in with the altitude.
   2. Deciduous forests are found in the foothills of the Himalayas.
   3. It is succeeded by the wet temperate type of forests between an altitude of 1,000-2,000 m.
4. In the higher hill ranges of northeastern India, hilly areas of West Bengal and Uttaranchal, evergreen broad leaf trees such as oak and chestnut are predominant.

5. Between 1,500-1,750 m, pine forests are also well-developed in this zone, with Chir Pine as a very useful commercial tree.

6. Deodar, a highly valued endemic species grows mainly in the western part of the Himalayan range.

7. Deodar is a durable wood mainly used in construction activity.

8. Similarly, the chinar and the walnut, which sustain the famous Kashmir handicrafts, belong to this zone.

9. Blue pine and spruce appear at altitudes of 2,225-3,048 m.

10. At many places in this zone, temperate grasslands are also found.

11. But in the higher reaches there is a transition to Alpine forests and pastures.

12. Silver firs, junipers, pines, birch and rhododendrons, etc. occur between 3,000-4,000 m.

13. However, these pastures are used extensively for transhumance by tribes like the Gujjars, the Bakarwals, the Bhotiyas and the Gaddis.

14. The southern slopes of the Himalayas carry a thicker vegetation cover because of relatively higher precipitation than the drier north-facing slopes.

15. At higher altitudes, mosses and lichens form part of the tundra vegetation.

16. The southern mountain forests include the forests found in three distinct areas of Peninsular India viz; the Western Ghats, the Vindhyas and the Nilgiris.

As they are closer to the tropics, and only 1,500
m above the sea level, vegetation is temperate in the higher regions, and subtropical on the lower regions of the Western Ghats, especially in Kerala, Tamil Nadu and Karnataka.

3. The temperate forests are called Sholas in the Nilgiris, Anaimalai and Palani hills.

4. Some of the other trees of this forest of economic significance include, magnolia, laurel, cinchona and wattle.

5. Such forests are also found in the Satpura and the Maikal ranges.

**Littoral and Swamp Forests**

1. India has a rich variety of wetland habitats, about 70 per cent of this comprises areas under paddy cultivation with total area is 3.9 million hectares.

2. Two sites – Chilika Lake (Odisha) and Keoladeo National Park (Bharatpur) are protected as water-fowl habitats under the Convention of Wetlands of International Importance (Ramsar Convention).

3. The country’s wetlands have been grouped into eight categories, viz.
   1. the reservoirs of the Deccan Plateau in the south together with the lagoons and other wetlands of the southern west coast;
   2. the vast saline expanses of Rajasthan, Gujarat and the Gulf of Kachchh;
   3. freshwater lakes and reservoirs from Gujarat eastwards through Rajasthan (Keoladeo National Park) and Madhya Pradesh;
   4. the delta wetlands and lagoons of India’s east coast (Chilika Lake);
5. the freshwater marshes of the Gangetic Plain;  
6. the floodplains of the Brahmaputra; the marshes and swamps in the hills of northeast India and the Himalayan foothills;  
7. the lakes and rivers of the montane region of Kashmir and Ladakh; and  
8. the mangrove forest and other wetlands of the island arcs of the Andaman and Nicobar Islands.

4. Mangroves grow along the coasts in the salt marshes, tidal creeks, mud flats and estuaries. They consist of a number of salt-tolerant species of plants.  
5. Crisscrossed by creeks of stagnant water and tidal flows, these forests give shelter to a wide variety of birds.

6. In India, the mangrove forests spread over 6,740 sq. km which is 7 per cent of the world's mangrove forests.  
7. Andaman and Nicobar Islands and the Sunderbans of West Bengal are mangroves.  
8. Other areas of significance are the Mahanadi, the Godavari and the Krishna deltas.

An international convention is an agreement among member states of the United Nations.

FOREST COVER IN INDIA

1. According to state records, the forest area covers 23.28 per cent of the total land area of the country.  
2. The forest area is the area notified and recorded as the forest land irrespective of the existence of trees is based on the records of the State Revenue Department  
3. the actual forest cover is the area occupied by forests with canopy is based on aerial photographs and satellite imageries.  
4. According to India State of Forest Report 2011, the actual forest cover in India is only 21.05 per cent.  
5. Of the forest cover, the share of dense and open forests are 12.29 and 8.75 per cent respectively.
6. Lakshadweep has zero per cent forest area; Andaman and Nicobar Islands have 86.93 per cent.
7. Most of the states with less than 10 per cent of the forest area lie in the north and northwestern part of the country, these are Rajasthan, Gujarat, Punjab, Haryana and Delhi. Most of the forests in Punjab and Haryana have been cleared for cultivation.
8. States with 10-20 per cent forest area are Tamil Nadu and West Bengal.
9. In Peninsular India, excluding Tamil Nadu, Dadra and Nagar Haveli and Goa, the area under forest cover is 20-30 per cent.
10. The north-eastern states have more than 30 per cent of the land under forest.
11. Hilly topography and heavy rainfall are good for forest growth.
12. There are 15 states where the forest cover is more than one-third of the total area, which is the basic requirement for maintaining the ecological balance.
13. On the basis of the percentage of the actual forest cover, the states have been grouped into four regions:

<table>
<thead>
<tr>
<th>The Region</th>
<th>Percentage Cover of the Forest</th>
</tr>
</thead>
<tbody>
<tr>
<td>(i) The region of high concentration</td>
<td>&gt; 40</td>
</tr>
<tr>
<td>(ii) The region of medium concentration</td>
<td>20-40</td>
</tr>
<tr>
<td>(iii) The region of low concentration</td>
<td>10-20</td>
</tr>
<tr>
<td>(iv) The region of very low concentration</td>
<td>&lt; 10</td>
</tr>
</tbody>
</table>

Forests and Life

1. To a vast number of tribal people, the forest is a home, a livelihood, their very existence.
2. It provides them **food, fruits of all kinds, edible leaves, honey, nourishing roots and wild game.**
3. It provides them with **material to build their houses and items for practising their arts.**
4. they are the source of sustenance and livelihood for **tribal communities.**
5. **tribal communities live in harmony with nature and protect forests.**
6. Out of a total of 593 districts 188 have been identified as tribal districts.
7. The **tribal districts account for about 59.61 per cent of the total forest cover of the country** which is only 33.63 per cent of the total geographical area of the country.
8. The age-old **knowledge of tribals regarding forestry can be used in the development of forests.**
9. Rather than treating tribals as minor forest produce collectors they should be made growers of minor forest produce and encouraged to **participate in conservation.**

**FOREST CONSERVATION**

- Forests have an intricate interrelationship with life and environment. These provide numerous direct and indirect advantages to our economy and society. Hence, conservation of forest is of vital importance to the survival and prosperity of humankind.
- Accordingly, the Government of India proposed to have a nation-wide forest conservation policy, and **adopted a forest policy in 1952, which was further modified in 1988.**
- According to the new forest policy, the **Government will emphasise sustainable forest management in order to conserve and expand forest reserve** and to meet the needs of local people.
- The forest policy aimed at :
  - (i) bringing 33 per cent of the geographical areas
under forest cover;

- (ii) maintaining environmental stability and to restore forests where ecological balance was disturbed;
- (iii) conserving the natural heritage of the country, its biological diversity and genetic pool;
- (iv) checks soil erosion, extension of the desert lands and reduction of floods and droughts;
- (v) increasing the forest cover through social forestry and afforestation on degraded land;
- (vi) increasing the productivity of forests to make timber, fuel, fodder and food available to rural population dependant on forests, and encourage the substitution of wood;
- (vii) creating of a massive peoples movement involving women to encourage planting of trees, stop felling of trees and thus, reduce pressure on the existing forest.

Based on the forest conservation policy the following steps were initiated:

- **Social Forestry**
  - Social forestry means the management and protection of forests and afforestation on barren lands with the purpose of helping in the environmental, social and rural development.
  - The National Commission on Agriculture (1976) has classified social forestry into three categories.

- **Urban forestry**
  - pertains to the raising and management of trees on public and privately-owned lands in and around urban centres such as green belts, parks, roadside avenues, industrial and commercial green belts, etc.

- **Rural forestry** lays emphasis on
- **Agro-forestry** is the raising of trees and agriculture crops on the same land inclusive of the waste patches. It combines forestry with agriculture, thus, altering the simultaneous production of food, fodder, fuel, timber and fruit.

- **Community forestry** involves the raising of trees on public or community land such as the village pasture and temple land, roadside, canal bank, strips along railway lines, and schools etc. , aims at providing benefits to the community as a whole and provides a means under which the people of landless classes can associate themselves in treeraising and thus, get those benefits which otherwise are restricted for landowners.

- **Farm Forestry**
  - Farm forestry is a term applied to the process under which farmers grow trees for commercial and non-commercial purposes on their farm lands.
  - Forest departments of various states distribute seedlings of trees free of cost to small and medium farmers.
  - Several lands such as the margins of agricultural fields, grasslands and pastures, land around homes and cow sheds may be used for raising trees under non-commercial farm forestry.

**WILDLIFE**

1. Wildlife of India is a great natural heritage.
2. It is estimated that about 4-5 per cent of all known
plant and animal species on the earth are found in India.

3. The main reason for this remarkable diversity of life forms is the great diversity of the ecosystem which this country has preserved and supported through the ages.

4. Some of the important reasons of the declining of wildlife are as follows:

1. **Industrial and technological advancement** brought about a rapid increase in the exploitation of forest resources.
2. More and more lands were cleared for agriculture, human settlement, roads, mining, reservoirs, etc.
3. Pressure on forests mounted due to lopping for fodder and fuelwood and removal of small timber by the local people.
4. Grazing by domestic cattle caused an adverse effect on wildlife and its habitat.
5. **Hunting was taken up as a sport by the elite and hundreds of wild animals were killed in a single hunt. Now commercial poaching is rampant.**
6. **Incidence of forest fire.**

5. It is being felt that conservation of wildlife is of great significance to the national as well as the world heritage along with the **promotion of ecotourism.**

**WILDLIFE CONSERVATION IN INDIA**

1. The protection of wildlife has a long tradition in India.
2. In 1972, a comprehensive Wildlife Act was enacted, which provides the main legal framework for conservation and protection of wildlife in India.
3. The two main objectives of the Act are:
   1. to provide **protection to the endangered species listed in the schedule of the Act** and
2. to provide legal support to the conservation areas of the country classified as National parks, sanctuaries and closed areas.

4. This Act has been comprehensively amended in 1991, making punishments more stringent and has also made provisions for the protection of specified plant species and conservation of endangered species of wild animals.

5. There are 103 National parks and 535 wildlife sanctuaries in the country (Appendix V of ncert).

6. For the purpose of effective conservation of flora and fauna, special steps have been initiated by the Government of India in collaboration with UNESCO’s ‘Man and Biosphere Programme’.

7. Special schemes like Project Tiger (1973) and Project Elephant (1992) have been launched to conserve these species and their habitat in a sustainable manner.

8. Project Tiger: main objective of the scheme is to ensure maintenance of viable population of tigers in India for scientific, aesthetic, cultural and ecological values, and to preserve areas of biological importance as natural heritage for the benefit, education and enjoyment of the people. Initially, the Project Tiger was launched in nine tiger reserves, covering an area of 16,339 sq. km, which has now increased to 44 tiger reserves, encompassing 36,988.28 sq. km of core tiger habitats distributed in 17 states. The tiger population in the country has registered an increase from 1,411 in 2006 to 1,706 in 2010.

9. Project Elephant was launched in 1992 to assist states having free ranging population of wild elephants. It was aimed at ensuring long-term survival of identified viable population of elephants in their natural habitat. The project is being implemented in 17 states.

10. Apart from this, some other projects such as Crocodile Breeding Project, Project Hangul and conservation of Himalayan Musk deer have also been launched by the Government of India.
1. A Biosphere Reserve is a unique and representative ecosystem of terrestrial and coastal areas which are internationally recognised within the framework of UNESCO’s Man and Biosphere (MAB) Programme. The Biosphere Reserve aims at achieving the three objectives
as depicted in Figure 5.8.

Figure 5.8: Objectives of a Biosphere Reserve

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Name of the Biosphere Reserve and Total Geographical Area (km²)</th>
<th>Date of Designation</th>
<th>Location in the States/UT</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>Nilgiri (5520)</td>
<td>01.08.1986</td>
<td>Part of Wynad, Nagarhole, Bandipur and Madumalai, Nilambur, Silent Valley and Siruvani Hills (Tamil Nadu, Kerala and Karnataka).</td>
</tr>
<tr>
<td></td>
<td>Name</td>
<td>Designation</td>
<td>Date</td>
</tr>
<tr>
<td>---</td>
<td>--------------------</td>
<td>-------------------</td>
<td>----------</td>
</tr>
<tr>
<td>3.</td>
<td>Nokrek (820)</td>
<td></td>
<td>01.09.1988</td>
</tr>
<tr>
<td>4.</td>
<td>Manas (2837)</td>
<td></td>
<td>14.03.1989</td>
</tr>
<tr>
<td>5.</td>
<td>Sunderban (9630)</td>
<td></td>
<td>29.03.1989</td>
</tr>
<tr>
<td>6.</td>
<td>Gulf of Mannar (10500)</td>
<td></td>
<td>18.02.1989</td>
</tr>
<tr>
<td>7.</td>
<td>Great Nicobar (885)</td>
<td></td>
<td>06.01.1989</td>
</tr>
<tr>
<td>8.</td>
<td>Similipal (4374)</td>
<td></td>
<td>21.06.1994</td>
</tr>
<tr>
<td>10</td>
<td>Dehang Debang (5111.5)</td>
<td></td>
<td>02.09.1998</td>
</tr>
<tr>
<td>No.</td>
<td>Name</td>
<td>Area</td>
<td>Date</td>
</tr>
<tr>
<td>-----</td>
<td>-------------------------</td>
<td>--------</td>
<td>------------</td>
</tr>
<tr>
<td>11</td>
<td>Pachmarhi (4981.72)</td>
<td></td>
<td>03.03.1999</td>
</tr>
<tr>
<td>12</td>
<td>Khangchendzonga (2619.92)</td>
<td></td>
<td>07.02.2000</td>
</tr>
<tr>
<td>13</td>
<td>Agasthyamalai (3500.36)</td>
<td></td>
<td>12.11.2001</td>
</tr>
<tr>
<td>14</td>
<td>Achanakmar-Amarkantak</td>
<td>(3835.51)</td>
<td>30.03.2005</td>
</tr>
<tr>
<td>15</td>
<td>Kachchh (12,454)</td>
<td></td>
<td>29.01.2008</td>
</tr>
<tr>
<td>16</td>
<td>Cold Desert (7770)</td>
<td></td>
<td>28.08.2009</td>
</tr>
</tbody>
</table>
There are 18 Biosphere Reserves in India (Table 5.1, Figure 5.9). Ten Biosphere Reserves have been recognised by the UNESCO on World Network of Biosphere Reserves.

1. **Nilgiri Biosphere Reserve**

   1. The Nilgiri Biosphere Reserve (NBR), the first of the fourteen biosphere reserves of India, was established in September 1986.
   2. It embraces the sanctuary complex of Wyanad, Nagarhole, Bandipur and Mudumalai, the entire forested hill slopes of Nilambur, the Upper Nilgiri plateau, Silent Valley and the Siruvani hills.
   3. The total area of the biosphere reserve is around 5,520 sq.km.
   4. The Nilgiri Biosphere Reserve possesses different habitat types, unspoilt areas of natural vegetation types with several dry scrubs, dry and moist deciduous, semievergreen and wet evergreen forests, evergreen sholas, grasslands and swamps.
   5. It includes the largest known population of two endangered animal species, namely the Nilgiri Tahr
and the Lion-tailed macaque.

6. The largest south Indian population of elephant, tiger, gaur, sambar and chital as well as a good number of endemic and endangered plants are also found in this reserve.

7. The habitat of a number of tribal groups remarkable for their traditional modes of harmonious use of the environment are also found here.

8. About 80 per cent of the flowering plants reported from the Western Ghats occur in the Nilgiri Biosphere Reserve.

2. Nanda Devi Biosphere Reserve

1. The Nanda Devi Biosphere Reserve situated in Uttarakhand includes parts of Chamoli, Almora, Pithoragarh and Bageshwar districts.

2. The major forest types of the reserve are temperate.

3. A few important species are silver weed and orchids like latifolie and rhododendron.

4. The biosphere reserve has a rich fauna, for example the snow leopard, black bear, brown bear, musk deer, snowcock, golden eagle and black eagle.

5. Major threats to the ecosystem are the collection of endangered plants for medicinal use, forest fires and poaching.

3. Sunderbans Biosphere Reserve

1. It extends over a vast area of 9,630 sq.km and consists of mangrove forests, swamps and forested islands is located in delta of the river Ganga in West Bengal.

2. Sunderbans is the home of nearly 200 Royal Bengal tigers.
3. The tangled mass of roots of mangrove trees provide safe homes for a large number of species, from fish to shrimp.
4. More than 170 birds species are known to inhabit these mangrove forests.
5. Adapting itself to the saline and fresh water environment, the tigers at the park are good swimmers, and they hunt scarce preys such as chital deer, barking deer, wild pig and even macaques.
6. In the Sunderbans, the mangrove forests are characterised by Heritiera fomes, a species valued for its timber.

4. Gulf of Mannar Biosphere Reserve
1. The Gulf of Mannar Biosphere Reserve covers an area of 105,000 hectares on the southeast coast of India.
2. It is one of the world’s richest regions from a marine biodiversity perspective.
3. The biosphere reserve comprises 21 islands with estuaries, beaches, forests of the nearshore environment, sea grasses, coral reefs, salt marshes and mangroves.
4. Among the Gulf’s 3,600 plant and animal species are the globally endangered e.g. sea cow (Dugong dugon).
5. Besides six mangrove species, endemic to Peninsular India are also endangered.
Introduction

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

2. There are variations in weather conditions during different seasons. These changes occur due to the changes in the elements of weather (temperature, pressure, wind direction and velocity, humidity and precipitation, etc.).

Unity And Diversity In The Monsoon Climate

1. **Monsoon** connotes the climate associated with seasonal reversal in the direction of winds. India has hot monsoonal climate which is the prevalent climate in south and southeast Asia.

2. The monsoon regime emphasises the unity of India with the rest of southeast Asian region.

3. But its regional variations which differentiate the weather and climate of different regions of India.

4. Eg: the climate of Kerala and Tamil Nadu in the south are so different from that of Uttar Pradesh and Bihar in the north, and yet all of these have a monsoon type of climate.
5. The climate of India has many regional variations expressed in the pattern of winds, temperature and rainfall, rhythm of seasons and the degree of wetness or dryness.

6. Regional variation can be described as subtype of the monsoon.

1. Regional Variations in Temperature:
   1. While in the summer the mercury occasionally touches 55°C in the western Rajasthan, it drops down to as low as minus 45°C in winter around Leh.
   2. Churu in Rajasthan may record a temperature of 50°C or more on a June day while the mercury hardly touches 19°C in Tawang (Arunachal Pradesh) on the same day.
   3. In Kerala and in the Andaman Islands, the difference between day and night temperatures may be hardly seven or eight degree Celsius. But in the Thar desert, if the day temperature is around 50°C, at night, it may drop down considerably up to 15°C-20°C.

2. Regional variations in precipitation:
   1. While snowfall occurs in the Himalayas, it only rains over the rest of the country.
   2. While Cherrapunji and Mawsynram in the Khasi Hills of Meghalaya receive rainfall over 1,080 cm in a year, Jaisalmer in Rajasthan rarely gets more than 9 cm of rainfall during the same period.
   3. The Ganga delta and the coastal plains of Orissa are hit by strong rain-bearing storms almost every third or fifth day in July and August while the Coromandal coast, a thousand km to the south, goes generally dry during these months.
   4. Most parts of the country get rainfall
during June-September, but on the coastal areas of Tamil Nadu, it rains in the beginning of the winter season.

Factors Determining The Climate Of India

1. Factors related to Location and Relief

   1. Latitude:

      1. Northern part of the India lies in subtropical and temperate zone and the part lying south of the Tropic of Cancer falls in the tropical zone.
      2. The tropical zone being nearer to the equator, experiences high temperatures throughout the year with small daily and annual range.
      3. Area north of the Tropic of Cancer being away from the equator, experiences extreme climate with high daily and annual range of temperature.

   2. The Himalayan Mountains:

      1. The towering mountain chain provides an invincible shield to protect the subcontinent from the cold northern winds. These cold and chilly winds originate near the Arctic circle and blow across central and eastern Asia.
      2. The Himalayas also trap the monsoon winds, forcing them to shed their moisture within the subcontinent.

   3. Distribution of Land and Water:

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

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

5. Altitude:
   1. Temperature decreases with height.
   2. Due to thin air, places in the mountains are cooler than places on the plains.

6. Relief:
   1. The physiography or relief of India also affects the temperature, air pressure, direction and speed of wind and the amount and distribution of rainfall.
   2. The windward sides of Western Ghats and Assam receive high rainfall during June-September whereas the southern plateau remains dry due to its leeward situation along the Western Ghats.

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

2. Mechanism of Weather in the Winter Season

1. Surface Pressure and Winds:
   1. In winter, the weather conditions over India are generally influenced by the distribution of pressure in Central and Western Asia.
   2. A high pressure centre in the region lying to the north of the Himalayas gives rise to the flow of air at the low level from the north towards the Indian subcontinent, south of the mountain range.
   3. The surface winds blowing are in the form of a dry continental air mass comes in contact with trade winds over north-western India.
   4. The position of this contact zone is not, however, stable. Occasionally, it may shift its position as far east as the middle Ganga valley with the result that northwestern and northern India up to the middle Ganga valley comes under the influence of dry northwestern winds.

2. Jet Stream and Upper Air Circulation:
   1. The pattern discussed above is only at the lower level of the atmosphere.
   2. Higher up about three km above the
surface of the earth -> upper air circulation -> All of Western and Central Asia remains under the influence of westerly winds along the altitude of 9-13 km from west to east.

3. These winds blow across the Asian continent at latitudes north of the Himalayas roughly parallel to the Tibetan highlands. These are known as jet streams.

4. Tibetan highlands act as a barrier in the path of these jet streams -> get bifurcated -> one blows to the north of the Tibetan highlands while the southern branch blows in an eastward direction, south of the Himalayas.

5. It has its mean position at 25°N in February at 200-300 mb level. The southern branch influence the winter weather in India.

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

1. Western Cyclonic Disturbance and Tropical Cyclones:
1. These disturbances enter the Indian subcontinent from the west and the northwest during the winter originate over the Mediterranean Sea and are brought into India by the westerly jet stream.

2. Prevailing night temperature increases means the arrival of these cyclones disturbances.

3. Tropical cyclones originate over the Bay of Bengal and the Indian ocean which have very high wind velocity and heavy rainfall and hit the Tamil Nadu, Andhra Pradesh and Orissa coast mostly are very destructive due to high wind velocity and torrential rain that accompanies it.

1. Mechanism of Weather in the Summer Season

   1. Surface Pressure and Winds:

   1. As summer sets in -> sun shifts northwards, the wind circulation over the subcontinent undergoes a complete reversal at both, the lower as well as the upper levels.

   2. By the middle of July, the ITCZ (explained below) shifts northwards, roughly parallel to the Himalayas between 20° N and 25° N.

   3. The westerly jet stream withdraws from the Indian region.

   4. The ITCZ being a zone of low pressure, attracts inflow of winds from different directions.

   5. The maritime tropical airmass (mT)
from the southern hemisphere, after crossing the equator, rushes to the low pressure area in the general southwesterly direction.

6. It is this moist air current which is popularly known as the **southwest monsoon**.

Figure 4.2 : Summer Monsoon Winds : Surface Circulation

1. **Jet Streams and Upper Air Circulation**:
   1. An easterly jet stream flows over the southern part of the Peninsula in June, and has a maximum speed of 90 km per hour.

2. **Inter Tropical Convergence Zone (ITCZ)**
   1. The Inter Tropical Convergence Zone (ITCZ) is a low pressure zone located at the equator where trade winds converge, and so, it is a zone where air tends to ascend.
   2. In July, the ITCZ is located around 20°N-25°N latitudes (over the Gangetic plain), sometimes called the **monsoon trough**.
   3. Due to the shift of ITCZ, the trade winds of the southern hemisphere cross the equator between 40° and 60°E longitudes and start blowing from southwest to northeast due to the Coriolis force. It becomes southwest monsoon.
   4. In winter, the ITCZ moves southward, and so the reversal of winds from northeast to south and southwest, takes
place. They are called northeast monsoons.

3. **Easterly Jet Stream and Tropical Cyclones:**
   1. The easterly jet stream steers the tropical depressions into India.
   2. The tracks of these depressions are the areas of highest rainfall in India.
   3. The frequency at which these depressions visit India, their direction and intensity, all go a long way in determining the rainfall pattern during the southwest monsoon period.

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**The Nature Of Indian Monsoon**

Systematic studies of the causes of rainfall in the South Asian region help to understand the causes and salient features of the monsoon, particularly some of its important aspects, such as:

1. The onset of the monsoon.
2. Rain-bearing systems (e.g. tropical cyclones) and the relationship between their frequency and distribution of monsoon rainfall.

**1. Onset of the Monsoon**

1. In nineteenth century, it was believed that the differential heating of land and sea during the summer months is the mechanism which sets the stage for the monsoon winds to drift towards the subcontinent.
2. During April and May when the sun shines vertically over the Tropic of Cancer, the large landmass in the north of Indian ocean gets
intensely heated due to which formation of an intense low pressure in the north-western part of the subcontinent.

3. Since the pressure in the Indian Ocean in the south of the landmass is high as water gets heated slowly, the low pressure cell attracts the southeast trades across the Equator.

4. These conditions help in the northward shift in the position of the ITCZ.

5. The southwest monsoon may thus, be seen as a continuation of the southeast trades deflected towards the Indian subcontinent after crossing the Equator.

6. These winds cross the Equator between 40°E and 60°E longitudes.

7. The shift in the position of the ITCZ is also related to the phenomenon of the withdrawal of the westerly jet stream from its position over the north Indian plain, south of the Himalayas.

8. The easterly jet stream sets in along 15°N latitude only after the western jet stream has withdrawn itself from the region.

9. This easterly jet stream is held responsible for the burst of the monsoon in India.

10. Entry of Monsoon into India: The southwest monsoon sets in over the Kerala coast by 1st June and moves swiftly to reach Mumbai and Kolkata between 10th and 13th June.

11. By mid July, southwest monsoon engulfs the entire subcontinent.

2. **Rain-bearing Systems and Rainfall Distribution**

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

3. The intensity of rainfall over the west coast of India is, however, related to two factors:
   1. The offshore meteorological conditions.
   2. **EI-Nino and the Indian Monsoon**
      1. EI-Nino is a complex weather system that appears once every three to seven years, bringing drought, floods and other weather extremes to different parts of the world.
      2. The system involves oceanic and atmospheric phenomena with the appearance of warm currents off the coast of Peru in the Eastern Pacific and affects weather in many places including India.
      3. EI-Nino is merely an extension of the warm equatorial current which gets replaced temporarily by cold Peruvian current or Humbolt current (locate these currents in your atlas).
      4. This current increases the temperature of water on the Peruvian coast by 10°C.
      5. This results in:
         1. the distortion of equatorial atmospheric circulation;
         2. irregularities in the evaporation of sea water;
         3. reduction in the amount of planktons which further reduces the number of fish in the sea.
         4. The word EI-Nino means ‘Child Christ’ because this current appears around Christmas in
December. December is a summer month in Peru (Southern Hemisphere).

5. EI-Nino is used in India for forecasting long range monsoon rainfall.

4. The position of the equatorial jet stream along the eastern coast of Africa.
India: Normal Dates of Onset of the Southwest Monsoon

1. The frequency of the tropical depressions originating from the Bay of Bengal varies from year to year.
2. As the axis of the monsoon trough oscillates, there are fluctuations in the track and direction.
of these depressions, and the intensity and the amount of rainfall vary from year to year.

3. The rain which comes in spells, displays a declining trend from west to east over the west coast, and from the southeast towards the northwest over the North Indian Plain and the northern part of the Peninsula.

1. **Break in the Monsoon**
   1. It is break of one or two week during the continues spell of rain in south west monsoon which are quite common.
   2. These breaks in the different regions are due to different reasons:
      1. In northern India rains are likely to fail if the rain-bearing storms are not very frequent along the monsoon trough or the ITCZ over this region.
      2. Over the west coast the dry spells are associated with days when winds blow parallel to the coast.

**The Rhythm Of Seasons**

Climatic the following four seasons:

1. **The Cold Weather Season**
   - **Temperature:**
     - Usually, the cold weather season sets in by mid-November in northern India. December and January are the coldest months in the northern plain.
     - The mean daily temperature remains below 21°C over most parts of northern India. The night
temperature may be quite low, sometimes going below freezing point in Punjab and Rajasthan.

- There are three main reasons for the excessive cold in north India during this season:
  - States like Punjab, Haryana and Rajasthan being far away from the moderating influence of sea experience continental climate.
  - The snowfall in the nearby Himalayan ranges creates cold wave situation; and
  - Around February, the cold winds coming from the Caspian Sea and Turkmenistan bring cold wave along with frost and fog over the northwestern parts of India.
- The Peninsular region of India, however, does not have any well-defined cold weather season because of moderating influence of the sea and the proximity to equator.

- **Pressure and Winds**:
  - By the end of December (22nd December), the sun shines vertically over the Tropic of Capricorn in the southern hemisphere. The weather in this season is characterised by feeble high pressure conditions over the northern plain.
  - In south India, the air pressure is slightly lower. The isobars of 1019 mb and 1013 mb pass through northwest India and far south, respectively.
  - As a result, winds start blowing from northwestern to South due to low pressure gradient, the light winds with a low velocity of about 3-5 km per hour begin to blow outwards.
  - They are westerly or northwesterly down the Ganga Valley. They become northerly in the Ganga-Brahmaputra delta.
• Free from the influence of topography, they are clearly northeasterly over the Bay of Bengal.
• During the winters, the weather in India is pleasant.
• However there are some shallow cyclonic depressions originating over the east Mediterranean Sea and travelling eastwards across West Asia, Iran, Afghanistan and Pakistan before they reach the northwestern parts of India.
• On their way, the moisture content gets augmented from the Caspian Sea in the north and the Persian Gulf in the south.

**Rainfall:**

• Winter monsoons do not cause rainfall as they move from land to the sea.
• There are some exceptions to it:
  • In northwestern India, some weak temperate cyclones from the Mediterranean sea cause rainfall in Punjab, Haryana, Delhi and western Uttar Pradesh. Although the amount is meagre, it is highly beneficial for rabi crops. The precipitation is in the form of snowfall in the lower Himalayas. It is this snow that sustains the flow of water in the Himalayan rivers during the summer months. The precipitation goes on decreasing from west to east in the plains and from north to south in the mountains. The average winter rainfall in Delhi is around 53 mm.
  • Central parts of India and northern parts of southern Peninsula also get winter rainfall occasionally.
  • Arunachal Pradesh and Assam in the
northeastern parts of India also have rains between 25 mm and 50 mm during these winter months.

- During October and November, northeast monsoon while crossing over the Bay of Bengal, picks up moisture and causes torrential rainfall over the Tamil Nadu coast, southern Andhra Pradesh, southeast Karnataka and southeast Kerala.

1. The Hot Weather Season

- Temperature:
  - With the apparent northward movement of the sun towards the Tropic of Cancer in March, temperatures start rising in north India.
  - April, May and June are the months of summer in north India. In most part temperatures recorded are between 30°-32°C.
  - In March, the highest day temperature of about 38°C occurs in the Deccan Plateau while in April, temperature ranging between 38°C and 43°C are found in Gujarat and Madhya Pradesh.
  - The Peninsular situation of south India with moderating effect of the oceans keeps the temperatures lower than that prevailing in north India. So, temperatures remain between 26°C and 32°C.
  - Due to altitude, the temperatures in the hills of Western Ghats remain below 25°C.
  - In the coastal regions, the north-south extent of isotherms parallel to the coast confirms that temperature does not decrease from north to south rather it increases from the coast to
the interior.

- **Pressure and Winds:**
  - Because of the heating of the subcontinent, the ITCZ moves northwards occupying a position centred at 25°N in July.
  - The location of the ITCZ attracts a surface circulation of the winds which are southwesterly on the west coast as well as along the coast of West Bengal and Bangladesh.
  - They are easterly or **southeasterly** over north Bengal and Bihar.
  - It has been discussed earlier that these currents of **southeasterly** monsoon are in reality ‘displaced’ equatorial westerlies.
  - The influx of these winds by mid-June brings about a change in the weather towards the rainy season.
  - In the heart of the ITCZ in the northwest, the dry and hot winds known as ‘**Loo**’, blow in the afternoon, and very often, they continue to well into midnight.
  - Dust storms in the evening are very common during May in Punjab, Haryana, Eastern Rajasthan and Uttar Pradesh.
  - These temporary storms bring a welcome respite from the oppressing heat since they bring with them light rains and a pleasant cool breeze.
  - Occasionally, the moisture-laden winds are attracted towards the periphery of the trough.
  - A sudden contact between dry and moist air masses gives rise to local storms of great intensity.
  - These local storms are associated with violent winds, torrential rains and even hailstorms.
  - **Some Famous Local Storms of Hot Weather Season**
    - **Mango Shower** : Towards the end of summer, there are pre-monsoon showers
which are a common phenomena in Kerala and coastal areas of Karnataka. Locally, they are known as mango showers since they help in the early ripening of mangoes.

- **Blossom Shower**: With this shower, coffee flowers blossom in Kerala and nearby areas.
- **Nor Westers**: These are dreaded evening thunderstorms in Bengal and Assam. Their notorious nature can be understood from the local nomenclature of ‘Kalbaisakhi’, a calamity of the month of Baisakh. These showers are useful for tea, jute and rice cultivation. In Assam, these storms are known as “Bardoli Chheerha”.
- **Loo**: Hot, dry and oppressing winds blowing in the Northern plains from Punjab to Bihar with higher intensity between Delhi and Patna.

1. **The Southwest Monsoon Season**
   1. low pressure conditions over northern plains get intensified as temp increases.
   2. By early June, they are powerful enough to attract the trade winds of Southern Hemisphere coming from the Indian Ocean.
   3. These southeast trade winds cross the equator and enter the Bay of Bengal and the Arabian Sea, only to be caught up in the air circulation over India.
   4. Passing over the equatorial warm currents, they bring with them moisture in abundance.
   5. After crossing the equator, they follow a
southwesterly direction. That is why they are known as southwest monsoons.

6. The rain in the southwest monsoon season begins rather abruptly.

7. One result of the first rain is that it brings down the temperature substantially.

8. This sudden onset of the moisture-laden winds associated with violent thunder and lightening, is often termed as the “break” or “burst” of the monsoons.

9. The monsoon may burst in the first week of June in the coastal areas of Kerala, Karnataka, Goa and Maharashtra while in the interior parts of the country, it may be delayed to the first week of July.

10. As these winds approach the land, their southwesterly direction is modified by the relief and thermal low pressure over the northwest India.

11. The monsoon approaches the landmass in two branches: (i) The Arabian Sea branch (ii) The Bay of Bengal branch.


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

         1. Its one branch is obstructed by the Western Ghats. These winds climb the slopes of the Western Ghats from 900-1200 m. Soon, they become cool, and as a result, the windward side of the Sahyadris and Western Coastal Plain receive very heavy rainfall ranging between 250 cm and 400 cm. After crossing the Western Ghats, these winds descend and get heated up. This
reduces humidity in the winds. As a result, these winds cause little rainfall east of the Western Ghats. This region of low rainfall is known as the rain-shadow area.

2. Another branch of the Arabian sea monsoon strikes the coast north of Mumbai. Moving along the Narmada and Tapi river valleys, these winds cause rainfall in extensive areas of central India. The Chotanagpur plateau gets 15 cm rainfall from this part of the branch. Thereafter, they enter the Ganga plains and mingle with the Bay of Bengal branch.

3. (iA third branch of this monsoon wind strikes the Saurashtra Peninsula and the Kachchh. It then passes over west Rajasthan and along the Aravalis, causing only a scanty rainfall. In Punjab and Haryana, it too joins the Bay of Bengal branch. These two branches, reinforced by each other, cause rains in the western Himalayas,

2. Monsoon Winds of the Bay of Bengal

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

2. The monsoon, therefore, enters West
Bengal and Bangladesh from south and southeast instead of from the south-westerly direction. From here, this branch splits into two under the influence of the Himalayas and the thermal low is northwest India.

1. Its one branch moves westward along the Ganga plains reaching as far as the Punjab plains.
2. The other branch moves up the Brahmaputra valley in the north and the northeast, causing widespread rains. Its sub-branch strikes the Garo and Khasi hills of Meghalaya. Mawsynram, located on the crest of Khasi hills, receives the highest average annual rainfall in the world.
3. Two factors responsible for Tamil Nadu coast remains dry during this season:
   1. The Tamil Nadu coast is situated parallel to the Bay of Bengal branch of southwest monsoon.
   2. It lies in the rainshadow area of the Arabian Sea branch of the south-west monsoon.

12. Characteristics of Monsoonal Rainfall:

1. **seasonal in character**, which occurs between June and September.
2. largely **governed by relief or topography**.
3. The **monsoon rainfall has a declining trend with increasing distance from the sea**
4. The monsoon **rains occur in wet spells of few days duration at a time**. The wet spells are interspersed with rainless interval known as ‘breaks’. These breaks in rainfall are related to the **cyclonic depressions** mainly
formed at the head of the Bay of Bengal, and their crossing into the mainland. Besides the frequency and intensity of these depressions, the passage followed by them determines the spatial distribution of rainfall.

5. The summer rainfall comes in a heavy downpour leading to considerable run off and soil erosion.

6. Monsoons play a pivotal role in the agrarian economy of India because over three-fourths of the total rain in the country is received during the southwest monsoon season.

7. Its spatial distribution is also uneven which ranges from 12 cm to more than 250 cm.

8. The beginning of the rains sometimes is considerably delayed over the whole or a part of the country.

9. The rains sometimes end considerably earlier than usual, causing great damage to standing crops and making the sowing of winter crops difficult.

1. Season of Retreating Monsoon
   1. The months of October and November are known for retreating monsoons.
   2. By the end of September, the southwest monsoon becomes weak as the low pressure trough of the Ganga plain starts moving southward in response to the southward march of the sun.
   3. The monsoon retreats from the western Rajasthan by the first week of September.
   4. It withdraws from Rajasthan, Gujarat, Western Ganga plain and the Central Highlands by the end
of the month.
5. By the beginning of October, the low pressure covers northern parts of the Bay of Bengal and by early November, it moves over Karnataka and Tamil Nadu.
6. By the middle of December, the centre of low pressure is completely removed from the Peninsula. The retreating southwest monsoon season is marked by clear skies and rise in temperature.
7. The land is still moist.
8. Owing to the conditions of high temperature and humidity, the weather becomes rather oppressive. This is commonly known as the ‘October heat’.
9. In the second half of October, the mercury begins to fall rapidly, particularly in northern India.
10. eastern part of the Peninsula: Here, October and November are the rainiest months of the year. The widespread rain in this season is associated with the passage of cyclonic depressions which originate over the Andaman Sea and manage to cross the eastern coast of the southern Peninsula. These tropical cyclones are very destructive. The thickly populated deltas of the Godavari, Krishna and Kaveri are their preferred targets.
11. A few cyclonic storms also strike the coast of West Bengal, Bangladesh and Myanmar.
12. A bulk of the rainfall of the Coromandel coast is derived from these depressions and cyclones.
13. Such cyclonic storms are less frequent in the Arabian Sea.

TRADITIONAL INDIAN SEASONS

In the Indian tradition, a year is divided into six two-
monthly seasons. This cycle of seasons, which the common people in north and central India follow is based on their practical experience and age-old perception of weather phenomena. However, this system does not match with the seasons of south India where there is little variation in the seasons.

<table>
<thead>
<tr>
<th>Seasons</th>
<th>Months (According to the Indian Calendar)</th>
<th>Months (According to the Gregorian Calendar)</th>
</tr>
</thead>
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<tr>
<td>Vasanta</td>
<td>Chaitra-Vaisakha</td>
<td>March-April</td>
</tr>
<tr>
<td>Grishma</td>
<td>Jyaistha-Asadha</td>
<td>May-June</td>
</tr>
<tr>
<td>Varsha</td>
<td>Sravana-Bhadra</td>
<td>July-August</td>
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<td>Sharada</td>
<td>Asvina-Kartika</td>
<td>September-October</td>
</tr>
<tr>
<td>Hemanta</td>
<td>Margashirsa-Pausa</td>
<td>November-December</td>
</tr>
<tr>
<td>Shishira</td>
<td>Magha-Phalguna</td>
<td>January-February</td>
</tr>
</tbody>
</table>
Distribution of Rainfall

1. The average annual rainfall in India is about 125 cm, but it has great spatial variations

2. **Areas of High Rainfall**: The highest rainfall occurs along the west
coast, on the Western Ghats, as well as in the sub-Himalayan areas is the northeast and the hills of Meghalaya. Here the rainfall exceeds 200 cm. In some parts of Khasi and Jaintia hills, the rainfall exceeds 1,000 cm. In the Brahmaputra valley and the adjoining hills, the rainfall is less then 200 cm.

3. Areas of Medium Rainfall: Rainfall between 100-200 cm is received in the southern parts of Gujarat, east Tamil Nadu, northeastern Peninsula covering Odisha, Jharkhand, Bihar, eastern Madhya Pradesh, northern Ganga plain along the sub-Himalayas and the Cachar Valley and Manipur.

4. Areas of Low Rainfall: Western Uttar Pradesh, Delhi, Haryana, Punjab, Jammu and Kashmir, eastern Rajasthan, Gujarat and Deccan Plateau receive rainfall between 50-100 cm.

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

6. Snowfall is restricted to the Himalayan region.

Variability of Rainfall

1. A characteristic feature of rainfall in India is its variability. The variability of rainfall is computed with the help of the following formula:
2. where C.V. is the coefficient of variation.
3. The values of coefficient of variation show the change from the mean values of rainfall. The actual rainfall in some places deviates from 20-50 per cent. The values of coefficient of variation show variability of rainfall in India.
5. These areas have an annual rainfall of over 100 cm. A variability of over 50 per cent exists in the western part of Rajasthan, northern part of Jammu and Kashmir and interior parts of the Deccan plateau. These areas have an annual rainfall of less than 50 cm. Rest of India have a variability of 25-50 per cent and these areas receive an annual rainfall between 50 -100 cm.

India : Variability of Annual Rainfall
Monsoons and the Economic Life in India

1. Monsoon is that axis around which revolves the entire agricultural cycle of India. It is because about 64 percent people of India depend on agriculture for their
livelihood and agriculture itself is based on southwest monsoon.

2. Except Himalayas all the parts of the country have temperature above the threshold level to grow the crops or plants throughout the year.

3. Regional variations in monsoon climate help in growing various types of crops.

4. Agricultural prosperity of India depends very much on timely and adequately distributed rainfall. If it fails, agriculture is adversely affected particularly in those regions where means of irrigation are not developed.

5. Sudden monsoon burst creates problem of soil erosion over large areas in India.

**Climatic Regions of India**

1. The whole of India has a monsoon type of climate. But the combination of elements of the weather, however, reveal many regional variations. These variations represent the subtypes of the monsoon climate.

2. A climatic region has a homogeneous climatic condition which is the result of a combination of factors.

3. Temperature and rainfall are two important elements which are considered to be decisive in all the schemes of climatic classification.

4. Koeppen based his scheme of Climatic classification on monthly values of temperature and precipitation. He identified five major climatic types, namely:

   - **Tropical climates**, where mean monthly temperature throughout the year is **over 18°C**.
   - **Dry climates**, where precipitation is very low in comparison to temperature, and hence, dry.
   - **Warm temperate climates**, where mean temperature of the coldest month is between **18°C and minus 3°C**.
   - **Cool temperate climates**, where mean temperature of the warmest month is over **10°C**, and mean temperature
of the coldest month is under minus 3°C.

- Ice
  climates, where mean temperature of the warmest month is under 10°C.
- Koeppen used letter symbols to denote climatic types as given above.
- He used
  - S for semi-arid if dryness is less.
  - W for arid and if it is more
  - the following small letters to define sub-types:
    - f (sufficient precipitation),
    - m (rain forest despite a dry monsoon season),
    - w (dry season in winter),
    - h (dry and hot),
    - c (less than four months with mean temperature over 10°C),
    - and g (Gangetic plain).
- Accordingly, India can be divided into eight climatic regions

<table>
<thead>
<tr>
<th>Type of Climate</th>
<th>Areas</th>
</tr>
</thead>
<tbody>
<tr>
<td>Amw Monsoon with short dry season</td>
<td>West coast of India south of Goa</td>
</tr>
<tr>
<td>As – Monsoon with dry summer</td>
<td>Coromandel coast of Tamil Nadu</td>
</tr>
<tr>
<td>Aw – Tripical savannah</td>
<td>Most of the Peninsular plateaus, south of the Tropic of Cancer</td>
</tr>
<tr>
<td>Bwhw – Semi-arid steppe climate</td>
<td>North-western Gujarat, some parts of western Rajasthan and Punjab</td>
</tr>
<tr>
<td>Bwhw – Hot desert</td>
<td>Extreme western Rajasthan</td>
</tr>
<tr>
<td>Cwg – Monsoon with dry winter</td>
<td>Ganga plain, eastern Rajasthan, northern Madhya Pradesh, most of North-east India</td>
</tr>
</tbody>
</table>
GLOBAL WARMING

1. You know that change is the law of nature. Climate has also witnessed change in the past at the global as well as at local levels.

2. It is changing even now but the change is imperceptible.

3. A number of geological evidences suggest that once upon a time, large part of the earth was under ice cover.

4. Besides the natural causes, human activities such as large scale industrialisation and presence of polluting gas in the atmosphere are also important factors responsible for global warming.

5. The temperature of the world is significantly increasing.

6. Carbon dioxide produced by human activities is a major source of concern. This gas, released to the atmosphere in large quantities by burning of fossil fuel, is increasing gradually. Other gases like methane, chlorofluorocarbons, and nitrous oxide which are present in much smaller concentrations in the atmosphere, together with carbon dioxide are known as green house gases.

7. These gases are better absorbers of long wave radiations than carbon dioxide, and so, are more effective at enhancing the green house effect. These gases have been contributing to global warming.

8. It is said that due to global warming the polar ice caps and mountain glaciers would melt and the amount of water in the oceans would increase.
9. The mean annual surface temperature of the earth in the past 150 years has increased.
10. It is projected that by the year 2100, global temperature will increase by about 2°C.
11. This rise in temperature will cause many other changes: one of these is a rise in sea level, as a result of melting of glaciers and sea-ice due to warming.
12. According to the current prediction, on an average, the sea level will rise 48 cm by the end of twenty first century. This would increase the incidence of annual flooding.
13. Climatic change would promote insect borne diseases like malaria, and lead to shift in climatic boundaries, making some regions wetter and others drier.
14. Agricultural pattern would shift and human population as well as the ecosystem would experience change.

3. Drainage System | India Physical Environment | Chapter 3 | Class 11 | Ncert Notes | Study Material | Pdf | Download | CBSE

Introduction

1. The flow of water through well-defined channels is known as ‘drainage’ and the network of such channels is called
a ‘drainage system’.
2. The drainage pattern of an area is the outcome of the
gеological time period, nature and structure of rocks,
tопography, slope, amount of water flowing and the
periodicity of the flow.
3. Perennial (always with water)
4. Ephemeral (water during rainy season, and dry,
otherwise).
5. A river drains the water collected from a specific area,
which is called its ‘catchment area’.
6. An area drained by a river and its tributaries is called
a drainage basin.
7. The boundary line separating one drainage basin from the
other is known as the watershed.
8. The catchments of large rivers are called river basins
while those of small rivulets and rills are often
referred to as watersheds.
9. There is, however, a slight difference between a river
basin and a watershed. Watersheds are small in area
while the basins cover larger areas.
10. River basins and watersheds are marked by unity. What
happens in one part of the basin or watershed directly
affects the other parts and the unit as a whole. That is
why, they are accepted as the most appropriate micro,
meso or macro planning regions.

11. Indian drainage system may be divided on various bases.
    1. On the basis of discharge of water (orientations
to the sea), it may be grouped into: (i) the
Arabian Sea drainage; and (ii) the Bay of Bengal
drainage.
        1. They are separated from each other through
the Delhi ridge, the Aravalis and the
Sahyadris
        2. Nearly 77 per cent the Ganga, the
Brahmaputra, the Mahanadi, the Krishna, etc. is oriented towards the Bay of Bengal. 3. 23 per cent comprising the Indus, the Narmada, the Tapi, the Mahi and the Periyar systems discharge their waters in the Arabian Sea.

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

   1. Major river basins with more than 20,000 sq.km of catchment area. It includes 14 drainage basins such as the Ganga, the Brahmaputra, the Krishna, the Tapi, the Narmada, the Mahi, the Pennar, the Sabarmati, the Barak, etc.
   2. Medium river basins with catchment area between 2,000-20,000 sq. km incorporating 44 river basins such as the Kalindi, the Periyar, the Meghna, etc.
   3. Minor river basins with catchment area of less than 2,000 sq.km include fairly good number of rivers flowing in the area of low rainfall.

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

   1. the Himalayan drainage and
   2. the Peninsular drainage.
   3. Although it has the problem of including the Chambal, the Betwa, the Son, etc. which are much older in age and origin than other rivers that have their origin in the Himalayas, it is the most accepted basis of classification.

Rivers which have their sources in the **Himalayas** and
discharge their waters either in the Bay of Bengal or in the Arabian Sea.

13. Large rivers flowing on the Peninsular plateau have their origin in the Western Ghats and discharge their waters in the Bay of Bengal.

14. The Narmada and Tapi are two large rivers which are exceptions. They along with many small rivers discharge their waters in the Arabian Sea.

15. Hence, this scheme has been followed in this book.

**Important Drainage Patterns**

1. The drainage pattern resembling the branches of a tree is known as “dendritic” the examples of which are the rivers of northern plain.

2. When the rivers originate from a hill and flow in all directions, the drainage pattern is known as ‘radial’. The rivers originating from the Amarkantak range present a good example of it.

3. When the primary tributaries of rivers flow parallel to each other and secondary tributaries join them at right angles, the pattern is known as ‘trellis’.

4. When the rivers discharge their waters from all directions in a lake or depression, the pattern is known as ‘centripetal’.

Major Rivers of India
DRAINAGE SYSTEMS OF INDIA

1. THE HIMALAYAN DRAINAGE
2. It mainly includes the Ganga, the Indus and the Brahmaputra river basins.
3. Since these are fed both by melting of snow and precipitation, rivers of this system are perennial.
4. These rivers pass through the giant gorges carved out by the erosional activity carried on simultaneously with the uplift of the Himalayas.
5. These rivers also form V-shaped valleys, rapids and waterfalls in their mountainous course.
6. While entering the plains, they form depositional
features like flat valleys, ox-bow lakes, flood plains, braided channels, and deltas near the river mouth.

7. River Kosi, also known as the ‘sorrow of Bihar’, has been notorious for frequently changing its course.
8. The Kosi brings huge quantity of sediments from its upper reaches and deposits it in the plains. The course gets blocked, and consequently, the river changes its course.

1. Evolution Of The Himalayan Drainage
2. There are difference of opinion about the evolution of the Himalayan rivers.
3. Geologists believe that a mighty river called Shiwalik or Indo-Brahma traversed the entire longitudinal extent of the Himalaya from Assam to Punjab and onwards to Sind, and finally discharged into the Gulf of Sind near lower Punjab during the Miocene period some 5-24 million years ago.
4. The remarkable continuity of the Shiwalik and its lacustrine origin and alluvial deposits consisting of sands, silt, clay, boulders and conglomerates support this viewpoint.
5. It is opined that in due course of time Indo–Brahma river was dismembered into three main drainage systems:
   1. The Indus and its five tributaries in the western part;
   2. The Ganga and its Himalayan tributaries in the central part; and
   3. The stretch of the Brahmaputra in Assam and its Himalayan tributaries in the eastern part.
6. The dismemberment was probably due to the Pleistocene upheaval in the western Himalayas, including the uplift of the Potwar Plateau (Delhi Ridge), which acted as the water divide between the Indus and Ganga drainage systems.
7. Likewise, the downthrusting of the Malda gap area between the Rajmahal hills and the Meghalaya plateau
during the **mid-pleistocene period**, diverted the Ganga and the Brahmaputra systems to flow towards the Bay of Bengal.

1. **THE RIVER SYSTEMS OF THE HIMALAYAN DRAINAGE**

![Map of the Himalayan drainage systems](https://via.placeholder.com/150)

- The Himalayan drainage consists of several river systems but the following are the major river systems:

1. **The Indus System**
   1. It is one of the largest river basins of the world, covering an area of 11,65,000 sq. km (in India it is 321,289 sq. km and a total length of 2,880 km (in India 1,114 km).
   2. The Indus also known as the **Sindhu**, is the westernmost of the Himalayan rivers in India.
   3. It originates from a glacier near **Bokhar Chu** (31°15′ N latitude and 81°40′ E longitude) in the **Tibetan region** at an altitude of **4,164** m in the Kailash Mountain range.
   4. In Tibet, it is known as ‘**Singi Khamban**; or **Lion’s mouth**.
   5. After flowing in the northwest direction between
the Ladakh and Zaskar ranges, it passes through Ladakh and Baltistan.


7. It enters into Pakistan near Chilas in the Dardistan region.

8. The Indus receives a number of Himalayan tributaries such as the Shyok, the Gilgit, the Zaskar, the Hunza, the Nubra, the Shigar, the Gasting and the Dras. It finally emerges out of the hills near Attock where it receives the Kabul river on its right bank. The other important tributaries joining the right bank of the Indus are the Khurram, the Tochi, the Gomal, the Viboa and the Sangar. They all originate in the Sulaiman ranges.

9. The river flows southward and receives ‘Panjnad’ a little above Mithankot.

10. The Panjnad is the name given to the five rivers of Punjab, namely the Satluj, the Beas, the Ravi, the Chenab and the Jhelum.

11. It finally discharges into the Arabian Sea, east of Karachi.

12. The Indus flows in India only through Jammu and Kashmir.

13. The Jhelum, an important tributary of the Indus, rises from a spring at Verinag situated at the foot of the Pir Panjal.

14. It flows through Srinagar and the Wular lake before entering Pakistan.

15. It joins the Chenab near Jhang in Pakistan. The Chenab is the largest tributary of the Indus. It is formed by two streams, the Chandra and the
Bhaga, which join at Tandi near Keylong in Himachal Pradesh. Hence, it is also known as Chandrabhaga. The river flows for 1,180 km before entering into Pakistan.

16. The Ravi is another important tributary of the Indus. It rises west of the Rohtang pass in the Kullu hills of Himachal Pradesh and flows through the Chamba valley. Join the Chenab near Sarai Sidhu.

17. The Beas is another important tributary of the Indus, originating from the Beas Kund near the Rohtang Pass at an elevation of 4,000 m above the mean sea level. The river flows through the Kullu valley and forms gorges at Kati and Largi in the Dhaoladhar range. It enters the Punjab plains where it meets the Satluj near Harike.

18. The Satluj originates in the ‘Raksas tal’ near Mansarovar at an altitude of 4,555 m in Tibet where it is known as Langchen Khambab. It flows almost parallel to the Indus for about 400 km before entering India, and comes out of a gorge at Rupar. It passes through the Shipki La on the Himalayan ranges and enters the Punjab plains. It is an antecedent river. It is a very important tributary as it feeds the canal system of the Bhakra Nangal project.

2. The Ganga System

1. The Ganga is the most important river of India both from the point of view of its basin and cultural significance.

2. It rises in the Gangotri glacier near Gaumukh (3,900 m) in the Uttarkashi district of Uttarakhand. (Here, it is known as the Bhagirathi.)

3. It cuts through the Central and the Lesser Himalayas in narrow gorges.

4. At Devprayag, the Bhagirathi meets the Alaknanda;
hereafter, it is known as the Ganga. The Alaknanda has its source in the Satopanth glacier above Badrinath. The Alaknanda consists of the Dhauli and the Vishnu Ganga which meet at Joshimath or Vishnu Prayag. The other tributaries of Alaknanda such as the Pindar joins it at Karna Prayag while Mandakini or Kali Ganga meets it at Rudra Prayag.

5. The Ganga enters the plains at Haridwar. Splitting into two distributaries, namely the Bhagirathi and the Padma.

6. The river has a length of 2,525 km. It is shared by Uttarakhand (110 km) and Uttar Pradesh (1,450 km), Bihar (445 km) and West Bengal (520 km).

7. The Ganga basin covers about 8.6 lakh sq.km area in India alone. The Ganga river system is the largest in India having a number of perennial and non-perennial rivers originating in the Himalayas in the north and the Peninsula in the south, respectively.

8. The Son is its major right bank tributary. The important left bank tributaries are the Ramganga, the Gomati, the Ghaghara, the Gandak, the Kosi and the Mahananda.

9. The river finally discharges itself into the Bay of Bengal near the Sagar Island.

10. The Yamuna, the western most and the longest tributary of the Ganga, has its source in the Yamunotri glacier on the western slopes of Banderpunch range (6,316 km). It joins the Ganga at Prayag (Allahabad). It is joined by the Chambal, the Sind, the Betwa and the Ken on its right bank which originates from the Peninsular plateau while the Hindan, the Rind, the Sengar, the Varuna, etc. join it on its left bank.

11. The Chambal rises near Mhow in the Malwa plateau of Madhya Pradesh and flows northwards through a gorge up wards of Kota in Rajasthan, where the
Gandhisagar dam has been constructed. From Kota, it traverses down to Bundi, Sawai Madhopur and Dholpur, and finally joins the Yamuna. The Chambal is famous for its badland topography called the Chambal ravines.

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

13. The Ghaghara originates in the glaciers of Mapchachungo. After collecting the waters of its tributaries – Tila, Seti and Beri, it comes out of the mountain, cutting a deep gorge at Shishapani. The river Sarda (Kali or Kali Ganga) joins it in the plain before it finally meets the Ganga at Chhapra.

14. The Kosi is an antecedent river with its source to the north of Mount Everest in Tibet, where its main stream Arun rises. After crossing the Central Himalayas in Nepal, it is joined by the Son Kosi from the West and the Tamur Kosi from the east. It forms Sapt Kosi after uniting with the river Arun.

15. The Ramganga is comparatively a small river rising in the Garhwal hills near Gairsain. It changes its course to the southwest direction after crossing the Shiwalik and enters into the plains of Uttar Pradesh near Najibabad. Finally, it joins the Ganga near Kannauj.

16. The Damodar occupies the eastern margins of the Chotanagpur Plateau where it flows through a rift valley and finally joins the Hugli. The Barakar is its main tributary.

17. Once known as the ‘sorrow of Bengal’, the Damodar has been now tamed by the Damodar Valley
18. The **Sarda or Saryu** river rises in the **Milam glacier** in the **Nepal Himalayas** where it is known as the **Goriganga**. Along the Indo-Nepal border, it is called **Kali** or **Chauk**, where it joins the **Ghaghara**.

19. The **Mahananda** is another important tributary of the Ganga rising in the **Darjiling hills**. It joins the Ganga as its last left bank tributary in West Bengal.

20. **The Son** is a large south bank tributary of the Ganga, originating in the **Amarkantak** plateau. After forming a series of waterfalls at the edge of the plateau, it reaches **Arrah**, west of Patna, to join the Ganga.

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‘**Namami Gange Programme**’, is an Integrated Conservation Mission, approved as “Flagship Programme” by the Union Government in June 2014 with the twin objectives of effective abatement of pollution, conservation and rejuvenation of the National River Ganga.

<table>
<thead>
<tr>
<th>Main pillars of the Namami Gange Programme are:</th>
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<tbody>
<tr>
<td>• Sewerage Treatment Infrastructure</td>
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<tr>
<td>• River-Front Development</td>
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<td>• River-Surface Cleaning</td>
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<td>• Bio-Diversity</td>
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<td>• Afforestation</td>
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<td>• Public Awareness</td>
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<tr>
<td>• Industrial Effluent Monitoring</td>
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<tr>
<td>• Ganga Gram</td>
</tr>
</tbody>
</table>
The Brahmaputra System

1. The Brahmaputra, one of the largest rivers of the world, has its origin in the Chemayungdung glacier of the Kailash range near the Mansarovar lake.
2. From here, it traverses eastward longitudinally for a distance of nearly 1,200 km in a dry and flat region of southern Tibet, where it is known as the Tsangpo, which means ‘the purifier.’ The Rango Tsangpo is the major right bank tributary of this river in Tibet.
3. It emerges as a turbulent and dynamic river after carving out a deep gorge in the Central Himalayas near Namcha Barwa (7,755 m).
4. The river emerges from the foothills under the name of Siang or Dihang.
5. It enters India west of Sadiya town in Arunachal Pradesh.
6. Flowing southwest, it receives its main left bank tributaries, viz., Dibang or Sikang and Lohit; thereafter, it is known as the Brahmaputra.
7. The Brahmaputra receives numerous tributaries in its 750 km long journey through the Assam valley.
8. Its major left bank tributaries are the Burhi Dihing and Dhansari (South) whereas the important right bank tributaries are the Subansiri, Kameng, Manas and Sankosh. The Subansiri which has its origin in Tibet, is an antecedent river.
9. The Brahmaputra enters into Bangladesh near Dhubri and flows southward. In Bangladesh, the Tista joins it on its right bank from where the river is known as the Jamuna. It finally merges with the river Padma, which falls in the Bay of Bengal.
10. The Brahmaputra is well-known for floods, channel shifting and bank erosion. This is due to the fact that most of its tributaries are large and bring
large quantity of sediments owing to heavy rainfall in its catchment area.

THE PENINSULAR DRAINAGE SYSTEM

1. The **Peninsular** drainage system is **older** than the **Himalayan** one. This is evident from the **broad**, largely-graded **shallow valleys**, and the maturity of the rivers.

2. Most of the **major Peninsular rivers except Narmada and Tapi flow from west to east.**

3. The **Chambal**, the **Sind**, the **Betwa**, the **Ken**, the **Son**, originating in the **northern** part of the **Peninsula** belong to the **Ganga river system**.

4. The other major river systems of the Peninsular drainage are – the **Mahanadi** the **Godavari**, the **Krishna** and the **Kaveri**.

5. Peninsular rivers are **characterised** by **fixed course, absence**
of meanders and nonperennial flow of water.

6. The Narmada and the Tapi which flow through the rift valley are, however, exceptions.

The Evolution of Peninsular Drainage System

1. Three major geological events in the distant past have shaped the present drainage systems of Peninsular India:
   1. Subsidence of the western flank of the Peninsula leading to its submergence below the sea during the early tertiary period. Generally, it has disturbed the symmetrical plan of the river on either side of the original watershed.
   2. Upheaval of the Himalayas when the northern flank of the Peninsular block was subjected to subsidence and the consequent trough faulting.
   3. The Narmada and The Tapi flow in trough faults and fill the original cracks with their detritus materials. Hence, there is a lack of alluvial and deltaic deposits in these rivers.
   4. Slight tilting of the Peninsular block from northwest to the south-eastern direction gave orientation to the entire drainage system towards the Bay of Bengal during the same period.

River Systems of the Peninsular Drainage

There are a large number of river systems in the Peninsular drainage. A brief account of the major Peninsular river systems is given below:

1. The Mahanadi rises near Sihawa in Raipur district of Chhattisgarh and runs through Odisha to discharge its water into the Bay of Bengal. It is 851 km long and its catchment area spreads over 1.42 lakh sq.km. Some navigation is carried on in the lower course of this river. Fifty three per cent of the drainage basin of this
The Godavari is the largest Peninsular river system. It is also called the Dakshin Ganga. It rises in the Nasik district of Maharashtra and discharges its water into the Bay of Bengal. Its tributaries run through the states of Maharashtra, Madhya Pradesh, Chhattisgarh, Odisha and Andhra Pradesh. It is 1,465 km long with a catchment area spreading over 3.13 lakh sq. km. 49 per cent of this lies in Maharashtra, 20 per cent in Madhya Pradesh and Chhattisgarh, and the rest in Andhra Pradesh. The Penganga, the Indravati, the Pranhita, and the Manjra are its principal tributaries. In its lower reaches to the south of Polavaram, where it forms a picturesque gorge. The river after Rajamundri splits into several branches forming a large delta.

The Krishna is the second largest east flowing Peninsular river which rises near Mahabaleshwar in Sahyadri. Its total length is 1,401 km. The Koyna, the Tungbhadra and the Bhima are its major tributaries. Of the total catchment area of the Krishna, 27 per cent lies in Maharashtra, 44 per cent in Karnataka and 29 per cent in Andhra Pradesh and Telangana.

The Kaveri rises in Brahmagiri hills (1,341m) of Kogadu district in Karnataka. Its length is 800 km and it drains an area of 81,155 sq. km. Since the upper catchment area receives rainfall during the southwest monsoon season (summer) and the lower part during the northeast monsoon season (winter), the river carries water throughout the year with comparatively less fluctuation than the other Peninsular rivers. About 3 per cent of the Kaveri basin falls in Kerala, 41 per cent in Karnataka and 56 per cent in Tamil Nadu.
Nadu. Its important tributaries are the Kabini, the Bhavani and the Amravati.

5. The Narmada originates on the western flank of the Amarkantak plateau at a height of about 1,057 m. Flowing in a rift valley between the Satpura in the south and the Vindhyan range in the north, it forms a picturesque gorge in marble rocks and Dhuandhar waterfall near Jabalpur. After flowing a distance of about 1,312 km, it meets the Arabian sea south of Bharuch, forming a broad 27 km long estuary. Its catchment area is about 98,796 sq. km. The Sardar Sarovar Project has been constructed on this river. Narmada river conservation mission named “Namami Devi Narmade”.

6. The Tapi is the other important westward flowing river. It originates from Multai in the Betul district of Madhya Pradesh. It is 724 km long and drains an area of 65,145 sq. km. Nearly 79 per cent of its basin lies in Maharashtra, 15 per cent in Madhya Pradesh and the remaining 6 per cent in Gujarat.

7. Luni is the largest river system of Rajasthan, west of Aravali. It originates near Pushkar in two branches, i.e. the Saraswati and the Sabarmati, which join with each other at Govindgarh. From here, the river comes out of Aravali and is known as Luni. It flows towards the west till Telwara and then takes a southwest direction to join the Rann of Kuchchh. The entire river system is ephemeral.

8. The rivers flowing towards the Arabian sea have short courses.
9. The **Shetruniji** is one such river which rises near Dalkahwa in Amreli district.
10. The **Bhadra** originates near Aniali village in Rajkot district.
11. The **Dhadhar** rises near Ghantar village in Panchmahal district.
12. **Sabarmati** and **Mahi** are the two famous rivers of **Gujarat**.
13. The **Vaitarna** rises from the Trimbak hills in Nasik district at an elevation of 670 m.
14. The **Kalinadi** rises from Belgaum district and falls in the Karwar Bay.
15. The source of **Bedti** river lies in Hubli Dharwar and traverses a course of 161 km.
16. The **Sharavati** is another important river in **Karnataka** flowing towards the west. The Sharavati originates in Shimoga district of Karnataka and drains a catchment area of 2,209 sq. km. on which the **Gersoppa (Jog)** fall is found.
17. Goa has two important rivers which can be mentioned here. One is **Mandovi** and the other is **Juari**.
18. Kerala has a narrow coastline. The longest river of Kerala, **Bharathapuzha** rises near **Annamalai** hills. It is also known as **Ponnani**. It drains an area of 5,397 sq. km.
19. The **Periyar** is the second largest river of **Kerala**. Its catchment area is 5,243 sq. km.
20. Another river of Kerala worth mentioning is the **Pamba river** which falls in the **Vemobanad lake** after traversing a course of 177 km.

<table>
<thead>
<tr>
<th>River</th>
<th>Catchment area sq. km</th>
</tr>
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<tbody>
<tr>
<td><strong>Sabarmati</strong></td>
<td></td>
</tr>
<tr>
<td><strong>Mahi</strong></td>
<td></td>
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<tr>
<td><strong>Vaitarna</strong></td>
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<tr>
<td><strong>Kalinadi</strong></td>
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<td><strong>Bedti</strong></td>
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<tr>
<td><strong>Sharavati</strong></td>
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<tr>
<td><strong>Mandovi</strong></td>
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<td><strong>Juari</strong></td>
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<tr>
<td><strong>Bharathapuzha</strong></td>
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<tr>
<td><strong>Periyar</strong></td>
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<tr>
<td><strong>Pamba river</strong></td>
<td></td>
</tr>
</tbody>
</table>
Small Rivers Flowing towards the East

1. There are small rivers which join the Bay of Bengal, though small, these are important in their own right.

2. The Subarnrekha, the Baitarni, the Brahmani, the Vamsadhara, the Penner, the Palar and the Vaigai are important rivers.

<table>
<thead>
<tr>
<th>River</th>
<th>Catchment area sq. km</th>
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</thead>
<tbody>
<tr>
<td>Subarnarekha</td>
<td>19,296</td>
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<tr>
<td>Baitarni</td>
<td>12,789</td>
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<tr>
<td>Brahmani</td>
<td>39,033</td>
</tr>
<tr>
<td>Penner</td>
<td>55,213</td>
</tr>
<tr>
<td>Palar</td>
<td>17,870</td>
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</table>

RIVER REGIMES

<table>
<thead>
<tr>
<th>Sl. No.</th>
<th>Aspects</th>
<th>Himalayan River</th>
<th>Peninsular River</th>
</tr>
</thead>
</table>
General Points:

1. The pattern of flow of water in a river channel over a year is known as its *regime*.

2. The **north Indian** rivers originating from the Himalayas are **perennial as they are fed by glaciers** and rainfall water.

3. The rivers of **South India** do not originate from glaciers and their **flow pattern witnesses fluctuations**. The flow **increases** considerably during **monsoon rains**. Thus, the regime of the rivers of South India is controlled by rainfall which also varies from one part of the Peninsular plateau to the other.

4. **The discharge is the volume of water flowing in a river**
measured over time. It is measured either in cusecs (cubic feet per second) or cumecs (cubic metres per second).

5. The Ganga has its minimum flow during the January-June period. The maximum flow is attained either in August or in September.

6. The mean maximum discharge of the Ganga at Farakka is about 55,000 cusecs while the mean minimum is only 1,300 cusecs.

7. The Narmada has a very low volume of discharge from January to July but it suddenly rises in August when the maximum flow is attained. The fall in October is as spectacular as the rise in August. The flow of water in the Narmada, as recorded at Garudeshwar, shows that the maximum flow is of the order of 2,300 cusecs, while the minimum flow is only 15 cusecs.

8. The Godavari has the minimum discharge in May, and the maximum in July-August. After August, there is a sharp fall in water flow although the volume of flow in October and November is higher than that in any of the months from January to May. The mean maximum discharge of the Godavari at Polavaram is 3,200 cusecs while the mean minimum flow is only 50 cusecs. These figures give an idea of the regime of the river.

EXTENT OF USABILITY OF RIVER WATER

1. There are perennial rivers carrying water throughout the year while the non-perennial rivers have very little water during the dry season.

2. During the rainy season, much of the water is wasted in floods and flows down to the sea.
3. Similarly, when there is a flood in one part of the country, the other area suffers from drought.

   1. Periyar Diversion Scheme
   2. Indira Gandhi Canal Project
   3. Kurnool-Cuddapah Canal
   4. Beas-Satluj Link Canal
   5. Ganga-Kaveri Link Canal

Organise a debate on the whole issue and prepare a write up. How do you rank the following problems in using river water?

(i) No availability in sufficient quantity
(ii) River water pollution
(iii) Load of silt in the river water
(iv) Uneven seasonal flow of water
(v) River water disputes between states
(vi) Shrinking of channels due to the extension of settlements towards the thalweg.

Pollution Causes of Rivers:

1. Most of the cremation grounds are on the banks of rivers and the dead bodies are sometimes thrown in the rivers.
2. On the occasion of some festivals, the flowers and statues are immersed in the rivers.
3. Large scale bathing and washing of clothes also pollute river waters.
2. Structure and Physiography
| India Physical Environment |
| Chapter 2 | Class 11 |
Ncert Notes | Study Material |
| Pdf | Download | CBSE

This chapter deals with:

1. Structure and Relief.
2. Physiographical divisions.
3. Drainage system: Concept of Water Sheds – The Himalayan and The peninsular

Introduction:

1. The earth and its landforms that we see today have evolved over a very long time (approximately 460 million years old).
2. Over these long years, it has undergone many changes brought about primarily by the endogenic and exogenic forces.
3. The Indian plate was to the south of the equator millions of years ago and it was much larger in size and the Australian plate was a part of it.
4. Over millions of years, this plate broke into many parts and the Australian plate moved towards the south-eastern direction and the Indian plate to the north.
5. Northward movement of the Indian plate is still continuing and it has significant consequences on the physical environment of the Indian subcontinent.
6. It is primarily through the interplay of these endogenic and exogenic forces and lateral movements of the plates that the present geological structure and geomorphologic processes active in the Indian subcontinent came into existence.

7. Based on the variations in its geological structure and formations, India can be divided into three geological divisions. These geological regions broadly follow the physical features:
   1. The Peninsular Block
   2. The Himalayas and other Peninsular Mountains
   3. Indo-Ganga-Brahmaputra Plain.

THE PENINSULAR BLOCK

1. The northern boundary of the Peninsular Block may be taken as an irregular line running from Kachchh along the western flank of the Aravali Range near Delhi and then roughly parallel to the Yamuna and the Ganga as far as the Rajmahal Hills and the Ganga delta.

2. Apart from these, the Karbi Anglong and the Meghalaya Plateau in the northeast and Rajasthan in the west are also extensions of this block.

3. The northeastern parts are separated by the Malda fault in West Bengal from the Chotanagpur plateau.

4. In Rajasthan, the desert and other desert-like features overlay this block.

5. The Peninsula is formed essentially by a great complex of very ancient gneisses and granites.

6. Some of its western coast which is submerged beneath the sea and some other parts changed due to tectonic activity without affecting the original basement.

7. The rift valleys of the Narmada, the Tapi and the Mahanadi and the Satpura block mountains are some examples of Vertical movements and block faulting.

8. The Peninsula mostly consists of relict and residual mountains like the Aravali hills, the Nallamala hills, the Javadi hills, the Veliconda hills, the Palkonda range and the Mahendragiri
hills, etc.

9. The river valleys here are **shallow with low gradients**.

10. Most of the east flowing rivers form deltas before entering into the Bay of Bengal. **The deltas** formed by the Mahanadi, the Krishna, the Kaveri and the Godavari are important examples.

**THE HIMALAYAS AND OTHER PENINSULAR MOUNTAINS**

1. The Himalayas along with other Peninsular mountains are young, weak and flexible in their geological structure unlike the rigid and stable Peninsular Block.

2. Consequently, they are still subjected to the interplay of exogenic and endogenic forces, resulting in the development of faults, folds and thrust plains.

3. These mountains are tectonic in origin, dissected by fast-flowing rivers which are in their youthful stage.

4. Various landforms like gorges, V-shaped valleys, rapids, waterfalls, etc. are indicative of this stage.

**INDO-GANGA-BRAHMAPUTRA PLAIN**

1. The plains formed by the river Indus, the Ganga and the Brahmaputra. Originally, it was a geo-synclinal depression which attained its maximum development during the third phase of the Himalayan mountain formation approximately about 64 million years ago.

2. Since then, it has been gradually filled by the sediments brought by the Himalayan and Peninsular rivers.

3. **Average depth of alluvial deposits in these plains ranges from 1,000-2,000 m.**

**PHYSIOGRAPHY**

1. ‘**Physiography**’ of an area is the outcome of structure, process and the stage of development.

2. The land of India is characterised by great diversity in its
physical features. Based on macro variations, India can be divided into the following physiographic divisions:

1. The Northern and North-eastern Mountains
2. The Northern Plain
3. The Peninsular Plateau
4. The Indian Desert
5. The Coastal Plains
6. The Islands

Map India Physical
The North and North-eastern Mountains

1. The North and Northeastern Mountains consist of the Himalayas and the Northeastern hills.
2. Some of the important ranges are the Greater Himalayan range, which includes the Great Himalayas and the Shiwalik.

3. The general orientation of these ranges is from northwest to the southeast direction in the northwestern part of India. Himalayas in the Darjiling and Sikkim regions lie in an eastwest direction, while in Arunachal Pradesh they are from southwest to the northwest direction. In Nagaland, Manipur and Mizoram, they are in the northsouth direction.

4. The approximate length of the Great Himalayan range, also known as the central axial range, is 2,500 km from east to west, and their width varies between 160-400 km from north to south.

5. The Himalayas stand almost like a strong and long wall between the Indian subcontinent and the Central and East Asian countries.

6. Himalayas are not only the physical barrier, they are also a climatic, drainage and cultural divide. There are large-scale regional variations within the Himalayas.

7. On the basis of relief, alignment of ranges and other geomorphological features, the Himalayas can be divided into the following sub-divisions:
   1. Kashmir or Northwestern Himalayas
   2. Himachal and Uttarakhand Himalayas
   3. Darjiling and Sikkim Himalayas
   4. Arunachal Himalayas
   5. Eastern Hills and Mountains.

8. Kashmir or Northwestern Himalayas:
   1. It comprise a series of ranges such as the Karakoram, Ladakh, Zaskar and Pir Panjal.
   2. The northeastern part of the Kashmir Himalayas is a cold desert which lies between the Greater Himalayas and the Karakoram ranges.
   3. Between the Great Himalayas and the Pir Panjal range, lies the world famous valley of Kashmir and the famous Dal Lake. Important glaciers of South
Asia such as the Baltoro and Siachen are also found in this region.

4. The Kashmir Himalayas are also famous for Karewa formations, which are useful for the cultivation of Zafran, a local variety of saffron.

5. Some of the important passes of the region are Zoji La on the Great Himalayas, Banihal on the Pir Panjal, Photu La on the Zaskar and Khardung La on the Ladakh range.

6. Some of the important fresh lakes such as Dal and Wular and salt water lakes such as Pangong Tso and Tso Moriri are also in this region.

7. This region is drained by the river Indus, and its tributaries such as the Jhelum and the Chenab.

8. The Kashmir and northwestern Himalayas are well-known for their scenic beauty and picturesque landscape.

9. The landscape of Himalayas is a major source of attraction for adventure tourists.

10. Some famous places of pilgrimage such as Vaishno Devi, Amarnath Cave, Charar-e-Sharif, etc. are also located here.

11. Srinagar, capital city of the state of Jammu and Kashmir is located on the banks of Jhelum river.

12. Jhelum in the valley of Kashmir is still in its youth stage and yet forms meanders – a typical feature associated with the mature stage in the evolution of fluvial land form.

13. Karewas: Karewas are the thick deposits of glacial clay and other materials embedded with moraines.

14. The southernmost part of this region consists of longitudinal valleys known as ‘duns’. Jammu dun and Pathankot dun are important examples.

9. The Himachal and Uttarakhand Himalayas:

1. This part lies approximately between the Ravi in the west and the Kali (a tributary of Ghaghara) in
the east.
2. It is drained by two major river systems of India, i.e. the Indus and the Ganga.
3. Tributaries of the Indus include the river Ravi, the Beas and the Satluj, and the tributaries of Ganga flowing through this region include the Yamuna and the Ghaghara.
4. The northernmost part of the Himachal Himalayas is an extension of the Ladakh cold desert, which lies in the Spiti subdivision of district Lahul and Spiti.
5. All the three ranges of Himalayas are prominent in this section also.
6. These are the Great Himalayan range, the Lesser Himalayas (which is locally known as Dhaoladhar in Himachal Pradesh and Nagtibha in Uttarakhand) and the Shiwalik range from the North to the South.
7. Some of the important hill stations such as Dharamshala, Mussoorie, Shimla, Kaosani and the cantonment towns and health resorts such as Shimla, Mussoorie, Kasauli, Almora, Lansdowne and Ranikhet, etc. were developed in this region.
8. The two distinguishing features of this are the ‘Shiwalik’ and ‘Dun formations’.
9. Some important duns located in this region are the Chandigarh-Kalka dun, Nalagarh dun, Dehra Dun, Harike dun and the Kota dun, etc.
10. **Dehra Dun** is the largest of all the duns with an approximate length of 35-45 km and a width of 22-25 km.
11. In the Great Himalayan range, the valleys are mostly inhabited by the Bhotia’s. These are nomadic groups who migrate to ‘Bugyals’ (the summer glasslands in the higher reaches) during summer months and return to the valleys during winters.
12. The famous ‘Valley of flowers’ is also situated in
this region.

13. The places of pilgrimage such as the Gangotri, Yamunotri, Kedarnath, Badrinath and Hemkund Sahib are also situated in this part.

14. The region is also known to have five famous Prayags (river confluences).

10. The Darjiling and Sikkim Himalayas:

1. They are flanked by Nepal Himalayas in the west and Bhutan Himalayas in the east.
2. Known for its fast-flowing rivers such as Tista, it is a region of high mountain peaks like Kanchenjunga (Kanchengiri), and deep valleys.
3. The higher reaches of this region are inhabited by Lepcha tribes while the southern part, particularly the Darjiling Himalayas, has a mixed population of Nepalis, Bengalis and tribals from Central India.
4. The British, taking advantage of the physical conditions such as moderate slope, thick soil cover with high organic content, well distributed rainfall throughout the year and mild winters, introduced tea plantations in this region.
5. As compared to the other sections of the Himalayas, these along with the Arunachal Himalayas are conspicuous by the absence of the Shiwalik formations.
6. In place of the Shiwaliks here, the ‘duar formations’ are important, which have also been used for the development of tea gardens.

11. The Arunachal Himalayas:

1. These extend from the east of the Bhutan Himalayas up to the Diphu pass in the east.
2. Some of the important mountain peaks of the region are Kangtu and Namcha Barwa.
3. These ranges are dissected by fast-flowing rivers from the north to the south, forming deep gorges.
4. Bhramaputra flows through a deep gorge after
crossing Namcha Barwa.
5. Some of the important rivers are the Kameng, Subansiri, the Dihang, the Dibang and the Lohit.
6. These are perennial with the high rate of fall, thus, having the highest hydro-electric power potential in the country.
7. Some of the prominent tribes in this region from west to east are the Monpa, Abor, Mishmi, Nyishi and the Nagas. Most of these communities practise Jhumming.
8. This region is rich in biodiversity which has been preserved by the indigenous communities.
9. Most of the interactions are carried through the duar region along the Arunachal-Assam border.

12. The Eastern Hills and Mountains:
1. These are part of the Himalayan mountain system having their general alignment from the north to the south direction.
2. In the north, they are known as Patkai Bum, Naga hills, the Manipur Hills and in the south as Mizo or Lushai hills.
3. These are low hills, inhabited by numerous tribal groups practising Jhum cultivation.
4. The Barak is an important river in Manipur and Mizoram.
5. The physiography of Manipur is unique by the presence of a large lake known as ‘Loktak’ lake at the centre, surrounded by mountains from all sides.
6. Mizoram which is also known as the ‘Molassis basin’ which is made up of soft unconsolidated deposits.
7. Most of the rivers in Nagaland form the tributary of the Brahmaputra.
8. While two rivers of Mizoram and Manipur are the tributaries of the Barak river, which in turn is the tributary of Meghna;
9. The rivers in the eastern part of Manipur are the tributaries of Chindwin, which in turn is a tributary of the Irrawady of Myanmar.

The Northern Plains

1. The northern plains are formed by the alluvial deposits brought by the rivers – the Indus, the Ganga and the Brahmaputra.

2. These plains extend approximately 3,200 km from the east to the west. The average width of these plains varies between 150-300 km. The maximum depth of alluvium deposits varies between 1,000-2,000 m.

3. From the north to the south, these can be divided into three major zones: the Bhabar, the Tarai and the alluvial plains.

4. The alluvial plains can be further divided into the Khadar and the Bhangar.

5. Bhabar is a narrow belt ranging between 8-10 km parallel to the Shiwalik foothills at the break-up of the slope.

6. As a result of this, the streams and rivers coming from the mountains deposit heavy materials of rocks and boulders, and at times, disappear in this zone.

7. South of the Bhabar is the Tarai belt, with an approximate width of 10-20 km where most of the streams and rivers re-emerge without having any properly demarcated channel, thereby, creating marshy and swampy conditions known as the Tarai.

8. The south of Tarai is a belt consisting of old and new alluvial deposits known as the Bhangar and Khadar respectively.

9. These plains have characteristic features of mature stage of fluvial erosional and depositional landforms such as sand bars, meanders, oxbow lakes and braided channels.

10. The Brahmaputra plains are known for their riverine islands and sand bars.
11. The mouths of these mighty rivers also form some of the largest deltas of the world, for example, the famous **Sunderbans delta**.

12. This is a featureless plain with a general elevation of 50-150 m above the mean sea level.

13. The states of Haryana and Delhi form a water divide between the Indus and the Ganga river systems.

14. As opposed to this, the Brahmaputra river flows from the northeast to the southwest direction before it takes an 90° southward turn at **Dhubri** before it enters into Bangladesh.

15. These river valley plains have a fertile alluvial soil cover which supports a variety of crops like **wheat**, **rice**, **sugarcane** and **jute**, and hence, supports a large population.

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**The Peninsular Plateau**

1. Rising from the height of 150 m above the river plains up to an elevation of 600-900 m is the irregular triangle known as the Peninsular plateau.

2. Delhi ridge in the northwest, (extension of Aravalis), the **Rajmahal hills** in the east, **Gir range** in the west and the **Cardamom hills** in the south constitute the outer extent of the Peninsular plateau.

3. However, an extension of this is also seen in the northeast, in the form of Shillong and Karbi-Anglong plateau.

4. The Peninsular India is made up of a series of patland plateaus such as the Hazaribagh plateau, the Palamu plateau, the Ranchi plateau, the Malwa plateau, the Coimbatore Figure 2.10 : Northern Plain Figure 2.11 : A Part of Peninsular Plateau plateau and the Karnataka plateau, etc.
5. This is one of the oldest and the most stable landmass of India.
6. The general elevation of the plateau is from the west to the east, which is also proved by the pattern of the flow of rivers.
7. Name some rivers of the Peninsular plateau which have their confluence in the Bay of Bengal and the Arabian sea and mention some landforms which are typical to the east flowing rivers but are absent in the west flowing rivers.
8. Some of the important physiographic features of this region are tors, block mountains, rift valleys, spurs, bare rocky structures, series of hummocky hills and wall-like quartzite dykes offering natural sites for water storage.
9. The western and northwestern part of the plateau has an emphatic presence of black soil.
10. This Peninsular plateau has undergone recurrent phases of upliftment and submergence accompanied by crustal faulting and fractures.
11. (The Bhima fault needs special mention, because of its recurrent seismic activities).
12. These spatial variations have brought in elements of diversity in the relief of the Peninsular plateau.
13. The northwestern part of the plateau has a complex relief of ravines and gorges.
14. The ravines of Chambal, Bhind and Morena are some of the well-known examples.
15. On the basis of the prominent relief features, the Peninsular plateau can be divided into three broad groups: (i) The Deccan Plateau (ii) The Central Highlands (iii) The Northeastern Plateau.
16. The Deccan Plateau
   1. This is bordered by the Western Ghats in the west, Eastern Ghats in the east and the Satpura, Maikal range and Mahadeo hills in the north.
   2. Western Ghats are locally known by different names
such as Sahyadri in Maharashtra, Nilgiri hills in Karnataka and Tamil Nadu and Anaimalai hills and Cardamom hills in Kerala.

3. Western Ghats are comparatively higher in elevation and more continuous than the Eastern Ghats.

4. Their average elevation is about 1,500 m with the height increasing from north to south.

5. ‘Anaimudi’ (2,695 m), the highest peak of 2019-2020 STRUCTURE AND PHYSIOGRAPHY 17 Peninsular plateau is located on the Anaimalai hills of the Western Ghats followed by Dodabetta (2,637 m) on the Nilgiri hills.

6. Most of the Peninsular rivers have their origin in the Western Ghats.

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

8. Some of the important ranges include the Javadi hills, the Palconda range, the Nallamala hills, the Mahendragiri hills, etc.

9. The Eastern and the Western Ghats meet each other at the Nilgiri hills.

17. The Central Highlands

1. They are bounded to the west by the Aravali range.

2. The Satpura range is formed by a series of scarped plateaus on the south, generally at an elevation varying between 600-900 m above the mean sea level.

3. This forms the northernmost boundary of the Deccan plateau.

4. It is a classic example of the relict mountains which are highly denuded and form discontinuous ranges.

5. The extension of the Peninsular plateau can be seen as far as Jaisalmer in the West, where it has
been covered by the longitudinal sand ridges and crescent-shaped sand dunes called barchans.

6. This region has undergone metamorphic processes in its geological history, which can be corroborated by the presence of metamorphic rocks such as marble, slate, gneiss, etc.

7. The general elevation of the Central Highlands ranges between 700-1,000 m above the mean sea level and it slopes towards the north and northeastern directions.

8. Most of the tributaries of the river Yamuna have their origin in the Vindhyan and Kaimur ranges.

9. Banas is the only significant tributary of the river Chambal that originates from the Aravalli in the west.

10. An eastern extension of the Central Highland is formed by the Rajmahal hills, to the south of which lies a large reserve of mineral resources in the Chotanagpur plateau.

18. The Northeastern Plateau

1. In fact it is an extension of the main Peninsular plateau.

2. It is believed that due to the force exerted by the northeastward movement of the Indian plate at the time of the Himalayan origin, a huge fault was created between the Rajmahal hills and the Meghalaya plateau.

3. Later, this depression got filled up by the deposition activity of the numerous rivers.

4. Today, the Meghalaya and Karbi Anglong plateau stand detached from the main Peninsular Block.

5. The Meghalaya plateau is further sub-divided into three: (i) The Garo Hills; (ii) The Khasi Hills; (iii) The Jaintia Hills, named after the tribal groups inhabiting this region.

6. An extension of this is also seen in the Karbi Anglong hills of Assam.
7. Similar to the Chotanagpur plateau, the Meghalaya plateau is also rich in mineral resources like coal, iron ore, sillimanite, limestone and uranium.
8. This area receives maximum rainfall from the south west monsoon.
9. As a result, the Meghalaya plateau has a highly eroded surface.
10. Cherrapunji displays a bare rocky surface devoid of any permanent vegetation cover.

The Indian Desert

1. The Indian Desert To the northwest of the Aravali hills lies the Great Indian desert.
2. It is a land of undulating topography dotted with longitudinal dunes and barchans.
3. This region receives low rainfall below 150 mm per year; hence, it has arid climate with low vegetation cover.
4. It is because of these characteristic features that this is also known as Marusthali.
5. It is believed that during the Mesozoic era, this region was under the sea.
6. This can be corroborated by the evidence available at wood fossils park at Aakal and marine deposits around Brahmsar, near Jaisalmer (The approximate age of the woodfossils is estimated to be 180 million years).
7. Though the underlying rock structure of the desert is an extension of the Peninsular plateau, yet, due to extreme arid conditions, its surface features have been carved by physical weathering and wind actions.
8. Some of the well pronounced desert land features present here are mushroom rocks, shifting dunes and oasis (mostly in its southern part).
9. On the basis of the orientation, the desert can be divided into two parts: the northern part is sloping towards Sindh and the southern towards the Rann of
Kachchh.
10. Most of the rivers in this region are ephemeral.
11. The Luni river flowing in the southern part of the desert is of some significance.
12. Low precipitation and high evaporation makes it a water deficit region.
13. There are some streams which disappear after flowing for some distance and present a typical case of inland drainage by joining a lake or playa.
14. The lakes and the playas have brackish water which is the main source of obtaining salt.

The Coastal Plains

1. You have already read that India has a long coastline.
2. On the basis of the location and active geomorphological processes, it can be broadly divided into two:
   1. the western coastal plains
   2. the eastern coastal plains.
3. The western coastal plains are an example of submerged coastal plain. It is believed that the city of Dwaraka which was once a part of the Indian mainland situated along the west coast is submerged under water. Because of this submergence it is a narrow belt and provides natural conditions for the development of ports and harbours.
4. Kandla, Mazagaon, JLN port Navha Sheva, Marmagao, Mangalore, Cochin, etc. are some of the important natural ports located along the west coast.
5. Extending from the Gujarat coast in the north to the Kerala coast in the south, the western coast may be divided into following divisions – the Kachchh and Kathiawar coast in Gujarat, Konkan coast in Maharashtra, Goan coast and Malabar coast in Karnataka and Kerala respectively.
6. The western coastal plains are narrow in the middle and get broader towards north and south.
7. The rivers flowing through this coastal plain do not form any delta.
9. The Malabar coast has got certain distinguishing features in the form of ‘Kayals’ (backwaters), which are used for fishing, inland navigation and also due to its special attraction for tourists.

10. Every year the famous Nehru Trophy Vallamkali (boat race) is held in Punnamada Kayal in Kerala.

11. As compared to the western coastal plain, the eastern coastal plain is broader and is an example of an emergent coast.

12. There are well developed deltas here, formed by the rivers flowing eastward into the Bay of Bengal.

13. These include the deltas of the Mahanadi, the Godavari, the Krishna and the Kaveri.

14. Because of its emergent nature, it has less number of ports and harbours.

15. The continental shelf extends up to 500 km into the sea, which makes it difficult for the development of good ports and harbours.

The Islands

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

2. The Bay of Bengal island groups consist of about 572 islands/islets.

3. These are situated roughly between 6°N-14°N and 92°E -94°E.

4. The two principal groups of islets include the Ritchie’s archipelago and the Labrynth island.

5. The entire group of island is divided into two broad categories – the Andaman in the north and the Nicobar in the south.

6. They are separated by a waterbody which is called the Ten degree channel.

7. It is believed that these islands are an elevated portion of submarine mountains.

8. However, some smaller islands are volcanic in origin. Barren island, the only active volcano in India is also situated in the Nicobar islands.

9. Some important mountain peaks in Andaman and Nicobar Islands are Saddle peak (North Andaman – 738 m), Mount Diavolo (Middle Andaman – 515 m), Mount Koyob (South Andaman – 460 m) and Mount Thuiller (Great Nicobar – 642 m).
10. The coastal line has some coral deposits, and beautiful beaches.
11. These islands receive convectional rainfall and have an equatorial type of vegetation.
12. The islands of the Arabian sea include Lakshadweep and Minicoy.
13. These are scattered between 8°N-12°N and 71°E -74°E longitude.
14. These islands are located at a distance of 280 km-480 km off the Kerala coast.
15. The entire island group is built of coral deposits.
16. There are approximately 36 islands of which 11 are inhabited.
17. Minicoy is the largest island with an area of 453 sq.km.
18. The entire group of islands is broadly divided by the Ten degree channel, north of which is the Amini Island and to the south of the Canannore Island.
19. The Islands of this archipelago have storm beaches consisting of unconsolidated pebbles, shingles, cobbles and boulders on the eastern seaboard.

2. People as Resource | Economics | Chapter 2 | Class 9 | Ncert Notes | Study Material | Pdf | Download | CBSE

Overview

- The chapter explains population as an asset for the economy rather than a liability (liability because as India has a large population
you need to provide more infrastructure to sustain them, provide Medicare, education, jobs etc)

- But, Population becomes human capital when there is investment in the form of education, training and medical care which in turn yields a return just like investment in physical capital (this can be seen directly in the form of higher incomes earned because of higher productivity, society also gains in the other indirect ways resulting in the growth of economy).

- Human capital is in one way superior to other resources like land and physical capital: human resource can make use of land and capital not the vice-versa.

- Therefore, ‘People as Resource’ is a way of referring to a country’s working people in terms of their existing productive skills and abilities.

- When the existing human resource is further developed by becoming more educated and healthier, we call it human capital formation.

Economic activities by Men and Women

- Economic activities have been classified into three main sectors:

  1. **Primary sector**— includes agriculture, forestry, animal husbandry, fishing, poultry farming, mining, quarrying
  2. **Secondary sector**— manufacturing
  3. **Tertiary sector**— trade, transport, communication, banking, education, health, tourism, services, insurance etc.

- Economic activities are also called market activities which are performed for pay or profit.

- Non-market activities are the production for self-
Based on the employment conditions these economic activities are further classified as:

1. **Organised Sector** is a sector where the employment terms are fixed and regular, and the employees get assured work, has basic facilities like maternity leave, childcare and other social securities.

   1. Women with high education and skill formation are paid at par with the men.

2. **Unorganised sector** is one where the employment terms are not fixed and regular.

   1. Here women are paid low compared to men because of their meagre education and low skill formation.

**Quality of Population**

The quality of population depends upon literacy rate, health of a person indicated by life expectancy and skill formation acquired by the people of the country.

- Illiterate and unhealthy population are a liability for the economy.
- Literate and healthy are asset.

- The literacy rates have increased in India from 18% in 1951 to 74% in 2010-11.
- Literacy among males is nearly 16.6% higher than females and it is nearly 16.1% higher in urban areas as compared to the rural areas.
- **Sarva Siksha Abhiyan**, Mid-day meal, bridge courses, back-to-school camps are some initiatives taken by central and state government to improve education in India.
Unemployment

- *Unemployment* is said to exist when people who are willing to work at the going wages cannot find jobs.

1. *Seasonal unemployment*: when people are not able to find jobs during some months of the year e.g. agriculture sector which is dependent on seasons.

2. *Disguised unemployment*: people appear to be employed e.g. work requiring five people but engages eight people, removal of three extra people won’t affect the productivity.

3. *Educated unemployment*: youth with graduation, post-graduation degrees are not able to find a job on a par with their qualification.

**Disadvantages:**

- Unemployment leads to wastage of manpower resource

- People do not have enough money to support their family

- Unemployment tends to increase economic overload

- It leads to a depressed economy

In case of India, statistically, the unemployment rate is low but this does not reduce the poverty because:

- Qualified persons take up jobs below their qualification with low income and productivity

- Disguised unemployment

- Poor people cannot afford to sit idle thus engage in any activity irrespective of its earning potential
Introduction

1. India has North South extremes at – Kashmir and Kanyakumari respectively.
2. West East extremes at – Gujarat and Arunachal Pradesh Respectively
3. India’s Teritorial Linmit further extends towards the sea upto 13 Nautical Miles (About 21.9km) from coast.
4. Our southern boundary extends upto 6°45′ N latitude in the Bay of Bengal.

Conversion Box

<table>
<thead>
<tr>
<th>Statute mile = 63,360 inches</th>
</tr>
</thead>
<tbody>
<tr>
<td>Nautical mile = 72,960 inches</td>
</tr>
</tbody>
</table>

1 Statute mile = about 1.6 km (1.584 km)
1 Nautical mile = about 1.8 km (1.852 km)

Important Implication

1. Implications of having such a vast longitudinal and latitudinal extent. If you work out the latitudinal and longitudinal extent of India, they are roughly about 30 degrees, whereas the actual distance measured from north to
south extremity is 3,214 km, and that from east to west is only 2,933 km.

2. This difference is based on the fact that the distance between two longitudes decreases towards the poles whereas the distance between two latitudes remains the same everywhere.

3. Southern part of the country lies within the tropics and the northern part lies in the sub-tropical zone or the warm temperate zone. This location is responsible for large variations in land forms, climate, soil types and natural vegetation in the country.

Implications on the Indian people
1. There is a variation of nearly 30 degrees, which causes a time difference of nearly two hours between the easternmost and the westernmost parts of our country.
2. The sun rises in the north-eastern states about two hours earlier as compared to Jaisalmer, the watches in Dibrugarh, Imphal in the east and Jaisalmer, Bhopal or Chennai in the other parts of India show the same time.
3. There is a general understanding among the countries of the world to select the standard meridian in multiples of 7°30′ of longitude. That is why 82°30′ E has been selected as the ‘standard meridian’ of India. Indian Standard Time is ahead of Greenwich Mean Time by 5 hours and 30 minutes.

Size

1. India with its area of 3.28 million sq. km accounts for 2.4 per cent of the world’s land surface area and stands as the seventh largest country in the world.
2. India has great physical diversity:
   1. Mountains in the North
   2. Larger rivers: Ganga, Bhramputra, Godavari, Krishna etc
   3. Green Forested Hills in Northeast and South India
   4. Marusthal – Wast sandy desert
3. Hindukush and Sulaiman ranges in the northwest, Purvachal hills in the north-east and by the large expanse of the Indian ocean in the south, it forms a great geographic entity known as the Indian subcontinent (Included – Pakistan, Nepal, Bhutan, Bangladesh And India).
4. Peninsular part of India extends towards the Indian Ocean.
5. The country has coastline of 6,100 km in the mainland and 7,517 km in the entire geographical coast of the mainland plus the island groups Andaman and Nicobar located in the Bay of Bengal and the Lakshadweep in the
Arabian Sea.

6. Thus India, as a country, is a physically diverse land providing occurrence of varied resources.

India and Its Neighbours

1. India is located in the south-central part of the continent of Asia, bordering the Indian ocean and its
two arms extending in the form of Bay of Bengal and the Arabian Sea.

2. This maritime location of Peninsular India has provided links to its neighbouring regions through the sea and air routes.

3. Sri Lanka and Maldives are the two island countries located in the Indian Ocean, which are our neighbours. Sri Lanka is separated from India by the Gulf of Mannar and Palk Strait. Differentiate between a Gulf and a Strait. Do you think that physical barrier is a hindrance in interaction with our neighbouring countries in modern times? Give some examples how we have overcome these difficulties in the present day.

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1. The Story of Village Palampur | Economics | Chapter 1 | Class 9 | Ncert Notes | Study Material | Pdf | Download | CBSE

Introduction

Palampur is a well-connected village with neighbouring villages and towns. Palampur has fairly well-developed system of roads, transport, electricity, irrigation, schools and health centre as compare to these facilities with those in nearby village Raiganj, and further on to the nearest small
town of Shahpur. This village has about 450 families. The 80 upper caste families own the majority of land in the village and owns quite a large houses. The SCs (dalits) comprise one third of the population and live in much smaller houses.

In villages across India, farming is the main production activity. The other production activities, referred to as non-farm activities include small manufacturing, transport, shopkeeping, etc.

Organisation of Production

The aim of production is to produce the goods and services that we want. There are four requirements for production of goods and services.

• Land and other natural resources such as water, forests, minerals.
• Labour, i.e. people who will do the work
• Physical capital, i.e. the variety of inputs required at every stage during production
Items that come under physical capital:
(a) Tools, machines, buildings, also called fixed capital
(b) Raw materials and money in hand, also called working capital
• Human capital, i.e. knowledge and business or company

Farming in Palampur

1. Land is fixed

75 per cent of the people are dependent on farming for their livelihood. Land area under cultivation is practically fixed which is around hectares 200 hectre. No scope of bringing new land under cultivation.
2. Is there a way one can grow more from the same land?
• Multiple cropping is a technique in which one or more crops can be grown on a piece of land.
  In rainy season farmers grow kharif crops (e.g. jowar and bajra).
  In autumn season farmers grow vegetable like potato.
  In winter season farmers grow rabi crops (e.g. wheat).
  In spring season farmers grow sugarcane on a part of the land.

A major factor helping multiple cropping is a well-developed irrigation system (i.e. electricity, tubewells, etc).

• Modern farming is another way to increase production from the same land (i.e. combination of high yielding varieties of (HYVs) seeds, chemical fertilisers, pesticides, irrigation, use of machinery for faster harvesting, etc).

3. Will the land sustain?
Scientific reports indicate that the modern farming methods have overused the natural resource base thus resulting in loss of soil fertility, reduced ground water level, pollute ground water, chemicals kill bacteria and other micro-organisms. Once destroyed it is very difficult to restore them. We must take care of the environment to ensure future development of agriculture.

4. How is land distributed between the farmers of Palampur?
150 families are landless, 240 families have small plots of land less than 2 hectares in size (not adequate for income) and 60 families have large plots of land more than 2 hectares.

5. Who will provide the labour?
Farm laborers come either from landless families or families cultivating small plots of land. It could be on a daily basis or for one particular farm activity or for the whole year.

6. The capital needed in farming
• Small farmers borrow from large farmers and rate of interest is very high.
• Large farmers have their own savings from farming.
7. Sale of surplus farm products
   • Small farmers kept them for their own family needs
   • Medium and Large farmers supply surplus farm products to the
     market, traders buy them to sell it further to shopkeepers in
     the towns and cities. A part of earnings is thus saved and kept
     for buying capital for the next season.

Non-farming activities in palampur

1. Dairy – the other activity
   Families having buffalos sell the milk in nearby villages and
   chilling centres from where the milk is transported to far
   towns and cities.

2. An example of small-scale manufacturing in palampur
   Manufacturing in palampur involves very simple producyion
   methods and are done on a small scale, mostly carried out at
   home. For example processing of sugarcane into jaggery.

3. The shopkeepers of palampur
   The traders of this village are shopkeepers who buy various
   goods from wholesale markets in the cities and sell them in
   the village.

4. Transport: a fast developing sector
   Variety of vehicles like rickshawalas, tongawalas, jeep,
   tractor, truck, bullock cart and bogey on road connecting
   palampur to other places. They ferry people and goods from one
   place to another.
1. THE EARTH IN THE SOLAR SYSTEM

CLASS 6 – GEOGRAPHY

CHAPTER 1

THE EARTH IN THE SOLAR SYSTEM

Figure 1.1 : Saptarishi and the North Star
While watching the night sky, you may notice various patterns formed by different groups of stars. These are called **constellations**.

**Ursa Major or Big Bear** is one such constellation.

One of the most easily recognisable constellation is the
**Saptarishi** (*Saptaseven, rishi*-sages). It is a group of seven stars (Figure 1.1) that forms a part of Ursa Major Constellation.

- In ancient times, people used to determine directions during the night with the help of stars. **The North star** indicates the north direction, also called the **Pole Star**. It always remains in the same position in the sky. We can locate the position of the Pole Star with the help of the Saptarishi.
- Some celestial bodies do not have their own heat and light. They are lit by the light of the stars. Such bodies are called **planets**.

- The word ‘planet’ comes from the Greek word “Planetai” which means ‘wanderers’. The earth is a planet. It gets all its heat and light from the sun, which is our nearest star.
- The moon that we see in the sky is a **satellite**. It is a companion of our earth and moves around it.

**THE SOLAR SYSTEM**

- The sun, eight planets, satellites and some other celestial bodies known as asteroids and meteoroids form the solar system.
**The Sun**

- The sun is in the centre of the solar system.
- It is huge and made up of extremely hot gases.
- It provides the pulling force that binds the solar system.
- The sun is the ultimate source of heat and light for the solar system.
- But that tremendous heat is not felt so much by us because despite being our nearest star, it is far away from us.
- The sun is about 150 million km away from the earth.

**Planets**

- There are eight planets in our solar system.
- In order of their distance from the sun, they are: Mercury, Venus, Earth, Mars, Jupiter, Saturn, Uranus and Neptune.
All the eight planets of the solar system move around the sun in fixed paths.

These paths are elongated. They are called orbits.

Mercury is nearest to the sun. It takes only about 88 days to complete one round along its orbit.

Venus is considered as ‘Earth’s-twin’ because its size and shape are very much similar to that of the earth.

Till recently (August 2006), Pluto was also considered a planet. However, in a meeting of the International Astronomical Union, a decision was taken that Pluto like other celestial objects (Ceres, 2003 UB313) discovered in recent past may be called ‘dwarf planets.”

The Earth

The earth is the third nearest planet to the sun.

- In size, it is the fifth largest
- It is slightly flattened at the poles. That is why, its shape is described as a Geoid. Geoid means an earth-like shape.
- Conditions favourable to support life are probably found only on the earth
- neither too hot nor too cold
- has water and air, which are very essential for our survival.
- The air has life-supporting gases like oxygen.

From the outer space, the earth appears blue because its two-thirds surface is covered by water. It is, therefore, called a blue planet.

The Moon

- Our earth has only one satellite, that is, the moon.
- Its diameter is only one-quarter that of the earth.
It appears so big because it is nearer to our planet than other celestial bodies.

- It is about 3,84,400 km away from us.
- The moon moves around the earth in about 27 days. It takes exactly the same time to complete one spin. As a result, only one side of the moon is visible to us on the earth.
  - The moon does not have conditions favourable for life. It has neither water nor air. It has mountains, plains and depressions on its surface. These cast shadows on the moon’s surface.

### Asteroids

- Apart from the stars, planets and satellites, there are numerous tiny bodies which also move around the sun. These bodies are called **asteroids**.
- They are found between the orbits of Mars and Jupiter (Figure 1.2).
- It is viewed as parts of a planet which exploded many years back.

### Meteoroids

- The small pieces of rocks which move around the sun are called **meteoroids**.
- Sometimes these meteoroids come near the earth and tend to drop upon it. During this process due to friction with the air they get heated up and burn. It causes a flash of light.
- Sometimes, a meteor without being completely burnt, falls on the earth and creates a hollow.
- Do you see a whitish broad band, like a white glowing path across the sky on a clear starry night? It is a cluster of millions of stars. This band is the **Milky Way galaxy** (Figure 1.6).
- Our solar system is a part of this galaxy. In ancient India, it was named **Akash Ganga**.
A galaxy is a huge system of billions of stars, and clouds of dust and gases.

There are millions of such galaxies that make the Universe.