B.A./B. Sc.GE(N)-102

GEOGRAPHY OF INDIA AND LAB WORK

DEPARTMENT OF GEOGRAPHY AND NATURAL RESOURCE MANAGEMENT

SCHOOL OF EARTH AND ENVIRONMENTAL SCIENCES
UTTARAKHAND OPEN UNIVERSITY
(Teenpani Bypass, Behind Transport Nagar, Haldwani (Nainital), Uttarakhand, India)

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B.A./B.Sc. GE(N)-102
GEOGRAPHY OF INDIA AND WEATHER MAPS AND CLIMATE DATA (LAB/PRACTICAL)

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BLOCK-1 PHYSICAL ASPECTS

UNIT 1 - LOCATION AND EXTENT

1.1 OBJECTIVES

After reading this unit, you should be able:

- To highlight the historical, cultural, and strategic significance of India.
- To elaborate the location and extent of the country and its global situation.
- To explain the land and water frontiers of India.

1.2 INTRODUCTION

India is a land of great diversities, potentialities and is a rich country inhabited by the poors. Its culture and civilization are as old as man himself. It has great geographical extent. It belongs to south part of Asia continent. It has lofty Himalayas in the north representing the youngest mountain building epoch in the geological history, a part of which is permanently snow covered. On the south, it is washed by the Indian Ocean. It encompasses vast areas of diverse landmasses. It has vast fertile plains known as Great Plains of India. The western part of the plain is defined by Thar Desert. On the eastern part there is a big delta of Ganga-Brahmputra Rivers. On the south of the plain, the landmass is known as the Peninsular India, comprising a number of uneven plateaus carved out by rivers flowing in different directions. It is an event of earliest geological structure. This Indian peninsula has eastern coastal Plain on its east washed by Bay of Bengal, whereas the western coastal narrow plains on its west. Although climatically a typical monsoonal realm with all rhythmic characteristics, the country exhibits a wide range of climatic variation from the dry continental conditions to the humid littorals.

Its vastness, has given the pronoun of sub-continent, as it occupies most part of South-Asia. Prof. Chisholm has rightly said that there is no part of the world better demarcated by nature as a region by itself than the Indian sub-continent. G.B. Cressey has also strongly advocated that may be termed as sub-continent because it is distinct geographical unit with a number of physical and cultural diversities. A number of Indian Geographers are not in favour to use this term for our country. They are of the opinion that our motherland has vastness and a number of diversities in physical, human and cultural features. Such diversity may be rare in other parts of the world. It has basic differences in religions, customs, ideas, dresses, food habits, but all these seem to be having omnipresent unity. The unity in diversity is the main ornament of Indian culture. We have always faced the immigration of a number of races and tribes but with the time, these have been intermingled in India and have given the new outlook to a new Indian culture. We have incorporated foreign culture by developing it into our own culture. This is reason, that Indian culture has been coordinator- The diversities in Physical structure, climate, soil, animal life, agriculture, minerals and industries have generated the diversities in social and cultural landscape, but overall our landscape are tied together in harmony R.L. Singh has rightly said that India is, thus, a country of unity in diversity exhibiting manifold physical, cultural and economic contrasts which are the woof and wharf of the national panorama.

With all these natural contrasts and changing socio-economic and political pattern, India projects itself a single territorial unit on a national scale. The role of Great Plains is not ignorable, as it has developed Hindu culture which is a fusion of Dravidian and Aryan cultures, these cultures are diverse in origin in its territorial limits. The culture and national integration is reflected in the location of four Dhamas (Holy places) - Badri-Kedarnath in the north, Puri in the East, Rameshwaram in the South and Dwarka in the west. These are our four religious cardinal points within the dimensions of the country.

Nomenclature – This country has been variously named as India, Hindustan, Bharat and Aryavarta. The word India traces its origin in the Greek literature, meaning the land of India, the people living near the Indus [Latin, Indus]. Persians extended its name Sindhu-the river from the Indus .The people living near this river Sindhu were called as Hindu. As the Persians pronounce ‘S’ as ‘H’, and, thus the land to the east of Sindhu was called Hindustan.

The name ‘Bharat’ bears the testimony of geographical and historical significance. The concept of Bharat was developed after the name of Bharat, the sovereign King, who visualized the fundamental unity of the country. The Rigveda first mentions him as a leader of powerful Aryan tribe. The Bhagavata Purana calls him as Adhirat and Samarat, i.e. King of Kings, who accelerated the pace and process of Aryanisation of the then people. Bharat is ‘therefore’ another name for Aryanised India where Aryan culture developed and attained its fruition. At present only India and Bharat are mostly used, although Hindustan is also in common use.

1.3 LOCATION

India is the seventh largest country in the world, after Russia, Canada, China, U.S.A., Brazil and Australia. It has an area of 32,87,782 sq. km., thus accounts for about 2.4 Percent of the total surface area of the world . The distance between the northern most part and southern most part of India is approximately 3214 km. The east- west extent also measures about 2933 km.

India lies entirely in the Northern Hemisphere. It extends from 8o4´ North to 37o18´ N latitude. The tropic of cancer divides India into almost two equal halves. The Southern most point of India of the mainland is known as Kanya Kumari .The Bay of Bengal, the Indian Ocean, and the Arabian Sea meet here. Andaman and Nicobar group of Islands, lies in Bay of Bengal between 6oN and 14oN. Many of the islands are of volcanic origin. In Arabian Sea, Lakshadweep is a group of islands comprised by Laccadive, Minicoy, Amindivi and many smaller islands. Most of the islands are of Coral Origin. Indira Point is the most southern point of India, situated in Nicobar Island.

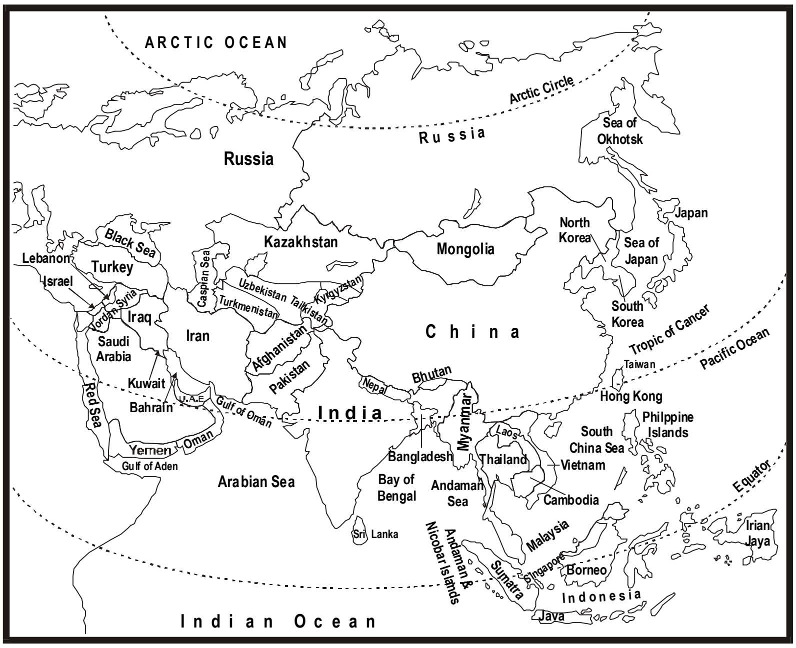

Fig. No. 1.1 Position of India in Asia and Indian Ocean

India extends the longitudes between 68o7′ East to 97o25′ E. The line of 82o30′ E longitude defined as standard Meridian line, which passes through the middle of India from Mirzapur near Allahabad. Our Indian Standard Time is determined by this longitude. The longitudinal difference between Saurashtra in the west and Arunachal Pradesh in the east is about 30o. Thus, it gives the difference of local time at both these places of 2 hours (30x4 = 120 minutes). Since Arunachal Pradesh is towards the east, it will have sunrise about two hours before the sunrise at Saurasthra. In the same way, the latitudinal difference gives the difference in the length of day of Kerala in the south and Laddakh in the North. This extent has given its impact on rainfall, temperature and vegetation.

Land of Potentialities

India is blessed with a large variety of natural resources in huge quantities. Many of these still await exploitation. The nature has been bountiful of India. The people have not yet been able to develop requisite technology, in the modern context, to harness these resources. India is known for her own huge minerals, forests, ground water, and good percentage of most fertile land. It is one of the leading agricultural countries of the world; still we are far behind in productivity of agricultural crops as compared to that in the advanced countries. As a whole, India is now self dependent in food production and is in a position to fulfill the food requirements of the increasing population of course; the greatest asset of India is its population which is second only to that of China. If it is properly channelized, could be converted into huge man power resource and could prove boon, rather than bane, for national development.

1.4 SITE AND SITUATION

India' situation is important from strategic and transport point of view. Our country stands at the head of the Indian Ocean at the very centre of Eastern Hemisphere commanding trade routes running in all directions. Its location, size and economic resources have made it the most dominating country among the littoral states. India is the only country in the world after which name of an ocean (Indian Ocean) has been named. It proves the great prominence enjoyed by India in early days. The trans-Indian ocean routes connecting the developed countries of Europe in the west and the developing countries of Asia in the east must skirt the shores of India. India is the only country, which has long coast line on this ocean. In real sense, Indian ocean is truly the ocean of India. Most of the air routes between Europe, West Asia and Africa in the west and East Asia, South-east Asia, Japan, China and Australia in the east also pass through India and its coasts. It is in direct touch of the countries of East Africa and Middle East Asia. The opening of Suez Canal has brought the countries of Southern Europe and North Africa very close to India. In the east, Malacca strait has brought her very close to Singapore, Vietnam, Cambodia, Hong Kong, Macau, Malaysia and Indonesia.

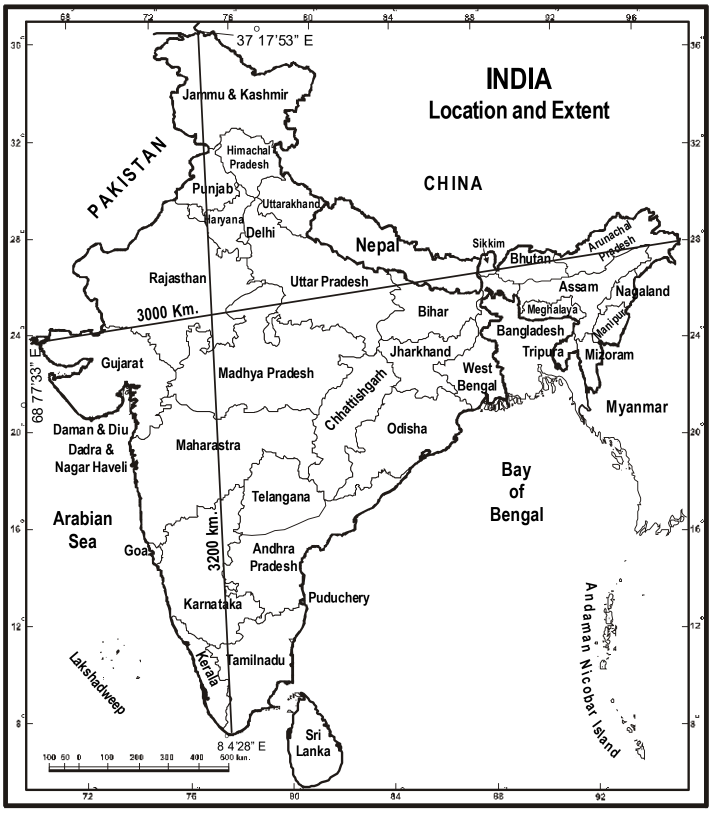

Fig. No. 1.2 India and States

India is a link between western developed countries and eastern developing countries. Indian traders and sailors had developed trade relations with eastern Asian countries and as well as with western Asian countries. The main items of trade were spices, precious stones, gold, cotton and silk textiles.

South Indian Rulers like Cholas, Pandeyas and Pallavi had developed their colonies on the islands of Eastern Asia, where Indian culture has its strong foot prints. There are a number of temples in Thailand, Indonesia with slokas from Ramayans engraved on the walls. Bali, Sumatra, Java of Indonesia are an evidence of Indian culture. These seem to derive their names from Ramayan. The Mauritius and Ceylon in the Indian Ocean are also true representative of Indian culture.

Therefore, such important strategic significant location of India accelerated European like France, Portugal, Britain, Holland etc. to establish their colonies at the important coastal location of India. Vasco, Puducherry, Kalikat, Deev and Daman, Mahi, Mumbai, Surat are the examples of this. It was Britain, who entered into India by establishing trade relations and in this context it developed East India Company. Britishers had recognized India as rich in resources, with the time. British made there control on administrative affairs, and thus ruled India nearby for three centuries. India has overhead position among SAARC countries-(Afghanistan, Pakistan, Bhutan, Nepal, Bangladesh, Shri Lanka, Maldives). We are also playing an important role among Asian countries, and have given the leadership in social and economic field. India is the birth place of religions, like Buddh, Jain, and Hindu. Buddhist religion and Hindu cultures spread to far off areas towards South and East Asia. Buddhism travelled from India to Tibet through land routes and further crossed over to China, Korea and even Japan. India has a number of such evidences, which show that our relations through land frontiers are much older than our maritime contacts. Passes, gorges and valleys in the Himalayan Mountain chains offered passages to travellers in ancient times. Waves of settlers from the North-west were lured by the riches of India in general and that of the Great Plains in particular. Greeks, Mongols, Turks, Arabs and Iranians entered India as conquerors and tried to be settling down here. They tried to assimilate themselves with the Indian culture. With the passage of time, they led to a mixture of races, cultures, people and ethnic groups. Some of the invaders brought architectural excellence to India, but they took back to their homelands, Indian spiritual knowledge. Thus, India is an integral part of the oriental world and holds a significant position in the region.

India, officially known as the 'Republic of India', is a union of 29 states and 7 union territories. In 2014, Telangana, a new state has been carved out from Andhra Pradesh. These states have 640 districts. These states are political divisions made on a number of factors like geography, population, local cultures, languages and administrative conveniences. Rajasthan with an area of 3,42,239 sq. km. is the largest state. In fact Rajasthan, Maharastra and Madhya Pradesh have area more than three lakh sq. km. On the other hand, Goa is the smallest state with an area of 3702 sq. km. only with an exception of Arunachal Pradesh and Assam; most of the north eastern states are of small size.

As per census of 2011, the population of India is 1,21,05,69,573, Uttar Pradesh is the largest state with 19,98,12,341 population, while Sikkim is the smallest state with 6,10,577 population only. The density of population is 382 persons per sq. km. Bihar is most densely populated state with 1106 persons per sq. km. Arunachal Pradesh with 17 persons per sq. km. is the least dense state. In all, the number of females per 1000 males is 943 in 2011. Kerala is the only state where, the number of females is more than the number of males (1084 females per 1000 males). The effective literacy rate is 73.0 percent. Kerala is the most literary state of India. Here the literacy ratio is 94.0 percent.

From the population point of view, the first four large states of the country after Uttar Pradesh are known as Maharastra 11.24 crore, Bihar 10.45 crore, West Bengal 9.13 crore, Andhra Pradesh (Telangana) also 8.46 crore. Among union territories, the first four are Delhi 167.88 lakh, Pudduchery 12.48 lakh, Chandigarh 10.55 lakh and Andaman–Nicobar Islands 3.81 lakh population. Lakshdweep is the smallest territory with 64473 populations only. Delhi is the most populous with 11320 persons per sq. km.

In 2011, India recorded the presence of 7933 towns and 640930 villages. The urban population is 377.1 million, 31.2 percent of the total. Utter Pradesh has the largest rural population of 155.3 million (18.6% of the country's rural population) whereas Maharastra has the highest urban population of 50.8 million (13.5% of country's urban population) in the country.

The growth rate of population in India is 17.7 percent (Rural 12.3% and urban 31.8%). During 2001-2011 decade there has been an increase of 3.4 percent in the proportion of urban population. As per census 2011, the child population in the age group of 0-6 years stands at 164.5 million, 13.6 percent of total population. There is a fall in child sex-ratio (0-6 years) from 927 to 919 (-8 points) during the last decade. Delhi (814) has recorded the lowest and Chhatisgarh (977) the highest child sex-ratio in rural areas.

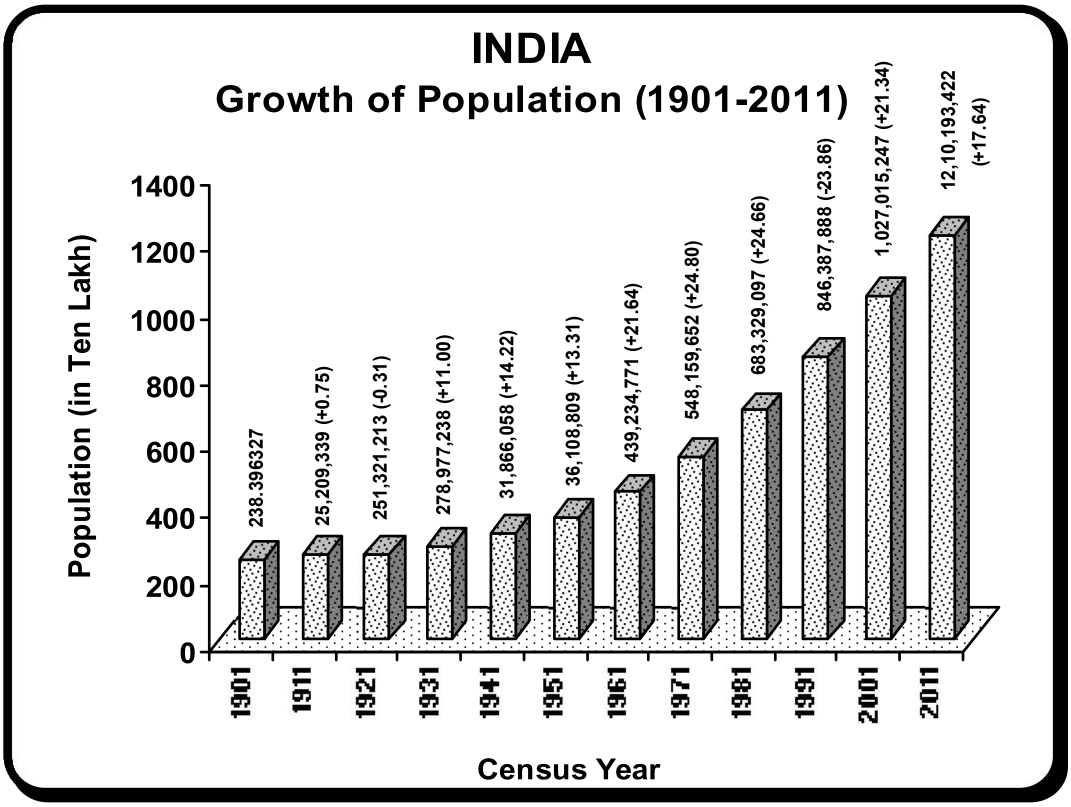

Fig. 1.3 Decadal Growth in Population (1901-2011)

The total scheduled caste population in census 2011 is 201.4 million, 16.6 percent of total population. The highest proportion of scheduled castes has been recorded in Punjab (31.9%) and the lowest in Mizoram (0.1%). The total scheduled tribe population is 104.3 million, 8.6% of the total population. The highest proportion of scheduled tribes has been recorded in Lakshadweep (94.8%) and the lowest in Uttar Pradesh (0.6%).

States/U. Territories- Population and Other Characteristics 2011

Sl. No.	State/Union Territory	Area in Sq. km.	Population	Density no. of P.P. km^2	Sex-ratio	Effective literacy %	Capital	Main language
1	Arunachal P.	83743	1383721	17	938	65.4	Ita Nagar	Monpa +13
2	Assam	78438	31205576	398	958	72.2	Dispur	Assamese
3	Andhra P.	275069	84580777	308	993	67.0	Hyderabad	Telgu
4	Bihar	94163	104499452	1106	918	61.8	Patna	Hindi
5	Chhatisgarh	136034	25545198	189	991	70.3	Raipur	Hindi
6	Gujarat	196024	60439692	308	919	78.0	Gandhi Nagar	Gujarati
7	Goa	3702	1458545	394	973	88.7	Panji	Konk & Mar.
8	Himachal P.	55673	6864602	123	972	82.8	Shimla	Hindi
9	Haryana	44212	25351462	573	879	75.6	Chandigarh	Hindi
10	Jammu & K.	222236*	12541302	124	889	67.2	Srinagar	Kas. +Dogri
11	Jharkhand	79714	32988134	414	949	66.4	Ranchi	Hindi
12	Karnataka	191791	61095297	319	973	75.4	Bengaluru	Kannada
13	Kerala	38863	33406061	860	1084	94.0	Thiruvananth P.	Malayalam

14	Manipur	22327	2570390	115	992	79.2	Imphal	Manipur
15	Mizoram	21081	1097206	52	976	91.3	Aizawal	Mizo
16	Meghalaya	22429	2966889	132	989	74.4	Shillong	Khasi, Garo
17	Madhya P.	308000	72626809	236	931	69.3	Bhopal	Hindi
18	Maharastra	307713	112374333	365	929	82.3	Mumbai	Marathi
19	Nagaland	16579	1978502	119	931	79.6	Kohima	Angami
20	Odisha	155707	41974218	270	979	72.9	Bhuvneshwar	Oriya
21	Punjab	50362	27743338	551	895	75.8	Chandigarh	Punjabi
22	Rajasthan	342239	68548437	200	928	66.1	Jaipur	Hindi
23	Sikkim	7096	610577	86	890	81.4	Gangtok	Lepcha, Bh
24	Tripura	10492	3673917	350	960	87.2	Agartala	Bengali
25	Tamilnadu	130058	72147030	555	996	80.1	Chennai	Tamil
26	Uttarakhand	53484	10086292	189	963	78.8	Dehradun	Hindi
27	Uttar Pradesh	238566	199812341	829	912	67.7	Lucknow	Hindi
28	West Bengal	88752	91276115	1028	950	76.3	Kolkata	Bengali
1	A & N Islands	8249	380581	46	876	86.6	Port Blair	
2	Chandigarh	114	1055450	9258	818	86.0	Chandigarh	
3	Delhi	1483	16787941	11320	868	86.2	Delhi	Hindi
4	Daman & Diu	112	243247	2191	618	87.1	Daman	Gujarati
5	D & N Hav.	491	343709	700	774	76.2	Silvassa	Gujarati
6	Lakshadweep	32	64473	2149	947	91.8	Kavartti	
7	Pudducherry	492	1247953	2547	1037	85.8	Puducherry	
	India	3287782	1210569573	382	943	73.0	New Delhi	

The number of literates in India is 763.5 million. Male literates are 434.7 million and female literates are 328.8 million. The effective literacy ratio is 73.0 percent. Among males it is 80.9 percent and among females, it is 64.6 percent. As per census 2011, the total number of workers is 481.7 million. Of this, 331.9 million workers are males and 149.9 million are females. The work participation rate is 39.8 percent. Nearly 55 percent of the workers are engaged in agricultural activities, while the remaining 45 percent workers are engaged in household activities and other non-agricultural activities.

1.5 INDIA & INTERNATIONAL BOUNDARIES & COUNTRIES

Encompassed between the Himalayas in the north, north-west and north-east, the Indian ocean in the South and Marshy Rann of Kutch, Thar desert of Rajasthan and fertile plain of Punjab-Haryana in the west, India has both land and water frontiers.

(i) Land Frontiers- India shares her 15,200 Km. long land frontier with Pakistan in the west and north-west, Afghanistan in the North-west, China, Nepal and Bhutan in the north, Bangladesh and Myanmar in the east. India's longest border is with Bangladesh 4096 Km. while the shortest border of 80 km. is with Afghanistan.

1. Border with China- India shares 3917 km. long border with China, which is one fourth of the total land border of the country. Five Indian states namely Jammu and Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh touch Indian boundary with China. It is very difficult to demarcate this boundary on the ground due to rugged terrain and harsh environment. Therefore, it was delimited on the maps in a rather imprecise form between British India and independent Tibet. China has never accepted this boundary legally. The attack on India by China in 1962 was a revenge of the so-called India interference in Tibet affairs. After all, India was compelled to accept the Chinese sovereignity over Tibet.

The boundary with China is generally divided into three sectors namely: (i) The Western Sector, (ii) The Middle Sector, (iii) The Eastern Sector.

(i) The Western Sector: This 2152 km. long sector of the Sino-India border separates Jammu and Kashmir State from Sinkiang province of China. The frontier between Sinkiang and Pakistan occupied Kashmir (POK) is about 480 Km. long. The rest of the boundary is between Laddakh and Tibet. Here Kunlun Mountain Range runs near the border. It forms a physical boundary between Gilgit area and Sinkiang, Kara Koram pass is situated on border. This part has the location of Aksai Chin district, the Changmo Valley, Pangog Tso and the Sponggar Tso area of north-east Ladakh as well as a strip of about 5000 sq. Km. down the entire length of eastern Laddakh.

(ii) The Middle Sector- This is nearly 625 km. long and runs along the watershed from Ladakh to Nepal. Himachal Pradesh and Uttarakhand have their location on this border. The boundary of Himachal Pradesh follows the water parting between the spiti and Para Chu rivers and continues along the watershed between the eastern and western tributaries of the Satlej. The Uttarakhand boundary is demarcated by the watershed between the Satluj on the one hand and the Kali, Alaknanda and the Bhagirathi on the other. This boundary crosses the Satluj near the Shipki La on the Himachal-Tibet border. Thereafter, it runs along the watershed passes of Mana, Niti, Kungri-Bingri, Darma and Lipu Ladakh. It finally joins trijunction of China, India and Nepal.

(iii) The Eastern Sector- This is nearly 1140 km. long. It runs from Sikkim to Arunachal Pradesh and follows the crest of the Himalayas between Bhutan and Myanmar. This line is usually referred to as the Mc Mohan line after Henry Mc Mohan. He was a Birtish representative, who signed the 1913-14 Shimla convention. India has always referred Mc Mohan Line as international boundary between Tibet and India. China has never accepted the validity of this line as international line.

2. The India-Nepal Boundary- India has 1752 km. long boundary along Nepal, which follows almost the foothill of the Shiwalik Range, Uttrakhand, Uttar Pradesh, Bihar, Sikkim and West Bengal states of India do touch, Nepalese border. Major portion of Indo-Nepalese border runs in the east-west direction.

Length of India's Border with the neighbouring countries.

Sl. No.	Name of the Country	Length of Border in Km.	Percentage of total Length of Border
1.	Bangladesh	4096	26.95
2.	China	3917	25.77
3.	Pakistan	3310	21.78
4.	Nepal	1752	11.53

5.	Myanmar	1458	9.59
6.	Bhutan	587	3.86
7.	Afghanistan	80	0.52
	Total	15200	100.00

3. The India–Bhutan Boundary- It is 587 km. long. Sikkim on West, Arunachal Pradesh on the east, and West Bengal, Assam on the south touch the border of this landlocked country. Bhutan's border with China follows the crest of the great Himalayas the watershed for the north part.

4. The India-Bangladesh Boundary- India has 4096 km. border along Bangladesh, the longest one among the neighbouring countries. It is 26.95 percent of the total land border of India. Five Indian states West-Bengal, Assam, Meghalaya, Tripura and Mizoram Share international boundary with Bangladesh. The boundary line between India and Bangladesh criss-crosses the vast Ganga-Brahmputra Delta. This boundary is purely man-made. The entire area is a flat one. It always become very difficult to identify the areas of either side even the people living on both sides have not much difference. This boundary is determined under Redcliffe award. West Bengal has longest border, 2272 km. long with Bangladesh, on the border, where Ganga enters into Bangladesh, Farrakka Barrage has been built, which is aimed at rejuvenating the river system of West-Bengal, flood control, efficient distribution of water in different parts of the state and desilting the Kolkata-Haldia harbour. After Farrakka Barrage, River Ganga in Bangladesh is known with the name of Padma. River Brahmputra after following along Garo hills enters Bangladesh where it is known by the name of Jamuna. This border has put into the pressure of the refugee influx of Bangladesh is nearly in all Indian states touching the Bangladesh border.

5. India-Myanmar Boundary- This boundary is 1458 km. long. It runs from India-China Myanmar trijunction in the north to the Southern tip of Mizoram. It touches the border of our Arunachal Pradesh, Nagaland, Manipur, and Mizoram. This boundary runs roughly along the watershed between the Brahmputra and Chindwin. It passes through thickly forest hills. Here Mizo and Naga hills are scattered.

6. India-Pakistan Boundary- This boundary is the result of partition of the country in 1947. This runs through varied relief features and is marked by a large number of incongruities, anomalies and irrationalities. It starts from the marshy Rann of Kutch in Gujarat and traverse through the sandy deserts of Rajasthan, fertile plain of Punjab, hills and mountains of Jammu and Kashmir and reaches upto the Karakoram Range in its northernmost reach. It is purely man-made boundary, and is based on communal considerations. This boundary is also known by the name of Radcliff line marked under the chairmanship of Sir Cyril Radcliff.

Rann of Kutch is a marshy salty lake. It had an area of 20720 sq. km. but now 19813.5sq. km. area is in our possession. The boundary along Jammu and Kashmir has been a matter of dispute between both the countries. It is an extremely important state from the strategic point of view, because of its contiguity to India, Pakistan, China, Afghanistan and proximity to Tajikistan. This state was sought by Pakistan on the basis of its Muslim Majority status on the appeal of Maharaja Hari Singh on October 26, 1947, Jammu and Kashmir became legally and constitutionally an integral part of Indian Union. Pakistan was not agreed on this merger and rushed its own troops in Kashmir. At that time India took the case of aggression from Pakistan to United Nations. United Nation Commission asked both the countries to agree on a ceasefire line. It was accepted as line of control by both Pakistan and India on January 1, 1949. The ceasefire line left India in possession of two thirds of the state. This ceasefire line adjusted under Shimla agreement has crystallized into defacto boundary between areas controlled by India and Pakistan respectively. At present, out of a total area of 2,22,236 sq. km. a territory of 78,114 sq. km. is under illegal occupation of Pakistan and 5180 sq. km. illegally handed over by Pakistan to China and 37,555 sq. km. under illegal occupation of China in Ladakh district.

On this boundary Siachin Glacier has been under dispute. It is 75 km. long and 2 to 8 km. wide. It covers an area of 450 sq. km. at an altitude of 5800 metre above sea level in Ladakh region near Kara- Koram Range. India occupies about two-third area of the glacier in its south-eastern part. Here Nubra River, which has its origin from Karakoram Glacier proved the way to Indian troops. Nubra joins Shyok river, a tributary of the Indus. The glacier has Gasherbrum. Saltore and Vilafondala passes in India.

Sir Creek forms the boundary between Gujarat state of India and Sind province of Pakistan. This creek is extremely rich in marine life. Pakistan has claimed its possession on the eastern bank of the Creek, as the border between India and Pakistan

7. India-Afghanistan Border- India has 80 km. long border with this country. It is a mountains area. Hindukush mountain area is extended on this line.

Water Frontiers

India has the length of 7517 km. coast line, out of which 6100 km. long coast line is of mainland, while the remaining 1417 km. coasts are added by Andaman and Nicobar Islands in the Bay of Bengal and Lakshadweep Islands in the Arabian Sea. The mainland of India is washed on three sides by the Indian ocean with its two arms namely the Arabian sea in the west and the Bay of Bengal in the east. Next to the Himalayas, the Indian ocean is the most dominant factor which has influenced the destiny of India. It is the ocean through which India could establish her trade and spiritual contacts with the neighbouring countries in the historic past.

India is the only country in the world after which the an ocean has been named. It has great strategic importance for India. It serves as a great linkage between the countries lying on its coasts and even further beyond. It has made in direct approach with west Asia, Africa and Europe from the west coast and south-east Asia, Far East and oceania from the eastern coast. The Indian Ocean has bridges a gap between east and west. This ocean is endowed with a rich variety of natural resources like sea minerals, petrol, fishes, and natural gas. This ocean had been a powerful medium of trade, defense, colonization and diffusion of Indian culture particularly in south-east Asia.

Obviously, the riches of the Indian ocean have attracted geo-political maneuvers. The island like Diego Garcia, and the narrow straits like the channels of Maldives, Hormuz, Malacca, and Sunda Command great geo-strategic significance. The Indian Ocean has remained a battle ground of super powers of the world. U.S.A., China, Russia have always made their interest to develop naval base in various islands of the ocean. The growing rivalries among the countries of East Africa, South West Asia, the growing menace of terrorism in the Muslim countries of the region, the Indian ocean has assumed paramount importance in the world politics.

Indian and Sri Lanka Boundary

Pak Strait, a narrow and shallow sea separates India with Sri Lanka. Dhanush Kodi on the Tamilnadu coast in India is only 32 km. away from Talaimanar in Jaffna peninsula of Sri Lanka. Both these points are joined by a group of islets forming Adam's Bridge. This nearness has invited peninsular Indian culture into half of Ceylon island. It is because of that the northern and north-eastern parts of the island have large number of Tamilians, who are the migrants of Tamilnadu.

1.6 CONCLUSION

Even with all these natural contrasts and changing socio-economic and political patterns. India projects itself as a single territorial unit on a national scale. Though India is a country of many religions and the people worship different deities, but all the Hindus believe in the doctorines of Karma, Dharma, and rebirth, immortality of soul, renunciation and Moksha. They are free to visit any piligrimage without any restriction. Hinduism has naturally been a way of life rather than a monolithic culture.

The unifying role of the Great plains which constitute a link between two diverse structural units which together have contributed to its making. So, signifying is the role of the Ganga that rightly it is regarded as the 'Mother Ganga', the pivot of our culture, providing perennial vitality to the society and acting as the strongest bond. The cultural heritage of the Ganga has been all pervasive. Its dominance is still reflected in the traditional variation attached to several rivers within different regions of the country, such as the Kaveri, and the Godavari, the Ganga of the south, thus leading to 'Gangaisation' of the Indian culture. This cultural unity shall continue to prevail against all odds. The ties of this cultural unity is very strong. Even the great physical scarps could not disrupt the nation, inspite of a number of barriers evolved by the foreigners.

India is a multi-lingual nation. These languages have always worked as a bridge in our social and cultural intercourse. The Ramayan Mahabharat, Vedas, Puranas, Upanishads still provide themes even for music, dance style, way of life. The sages and prophets like the Buddha, Kabir, Tulsi, Shankaracharya and Ramanujam have all paid their homage to various cultural and religious places. Forests, plentiful in the past, have been abode of the forest culture. These have been the shelter place of great thinkers, saints, meditators and yogis. It is a well known fact that Muslim and British rulers failed to disrupt our cultural unity. Anyhow, there is no doubt that the Britishers put the foundation of industrial development and thus gave an opportunity to develop urban and industrial culture. It is our belief and firm determination, the edifice of political unity will ever derive strength from our strong cultural base. India is committed to make a strong powerful and prosperous country.

1.7 SUMMARY

India is a Well-Knit geographical unit. It is a great country where old culture and civilizations have developed. Its vastness has given the pronoun of sub-continent. India has a number of diversities in physical, human and cultural features, but the unity in diversity is the main ornament of our Indian culture, which has proved as a coordinator of number of races and tribes who have immigrated here.

This country has been variously named as India, Hindustan, Bharat and Aryavarta. India is the seventh largest country. It lies mainly in Northern Hemisphere. It has 30o longitudinal extent, and because of that India has determined 82o30′ E longitude as the standard meridian. India is blessed with a large variety of natural resources. Its situation is important from strategic and transport point of view. It has nodal situation in Indian Ocean, and is in direct approach to African, European and Asian countries. Its nodal situation inspired we people to develop their residential colonies in Eastern Asia. These Asian countries have the resemblance of Indian culture in their social life. It is the birth place of Buddha, Jain and Hindu Religions. Buddhism has crossed outside India. The country has proved itself as an integral part of the oriental world.

India is an union of 29 states and 7 union territories. Its population is 1210 million in 2011. The density of population is 382 persons per sq. km. The effective literacy is 73 percent. Our population is male dominated. Nearly 31.2 percent population is urban, living in 7933 towns. The growth rate is 17.7 percent. Uttar Pradesh is the largest populated state of India. Great Plains have played a unifying role between two diverse structural units. River Ganga is the pivot of our culture. India is a multi-lingual nation. These have worked as a bridge in our social and cultural intercourse.

India has both land and water frontiers. It shares here 15,200 km. long land frontiers with Pakistan, Afghanistan, China, Nepal, Bhutan, Bangladesh and Myanmar. Our longest border of 4096 km is with Bangladesh. The boundary with China seems to follow the rugged terrain. Mc Mohan line was considered as an international boundary between Tibet and India. Nepal border follows the Siwalik foothills. The boundary with Bangladesh is purely man-made. India-Pakistan Boundary is the result of partition of our country. This is known as Radcliff boundary. Jammu and Kashmir State on which Pakistan shows her controversy had legally become our state on 26 October 1947.

Our water frontiers are 7517 km. long. Its coastal line is 6100 km. long on the mainland; the remaining coasts are added by our Islands of Arabian Sea and Bay of Bengal. The presence of Indian Ocean on its south has made India strategically an important nation. It has given us petrol and fish resources. India and Sri Lanka is separated by Pak strait, which is a narrow and shallow sea. The nearness of Sri Lanka had invited peninsular Indian culture into half of its area.

1.8 GLOSSARY

- Lofty - High (Himalayas)
- Peninsular India – A plateau of plateaus
- Sub-Continent – One geographical unit
- Littorals – Coastal
- Rymthic – Cycle of seasons
- Bharat – A Sovereign Aryan King
- India – Land of Indoi (Greek literature)
- Hindustan – Sindh River (Persian literature)
- Land frontier – Land boundary
- POK – Pakistan Occupied Kashmir

- Myanmar – Old name is Burma
- Rann of Kachchh (Kutch) – A marshy salty lake
- Coral Origin islands- Lakshadweep
- Volnanic Origin islands – Andaman & Nicobar
- Kanya Kumari – Known as Cape Comorian, associated with Goddess Kumari
- Palk Strait – Seperates India with Sri Lanka
- Lakshadweep – Laccadive, Minicoy and Amindivi islands
- Local time : The time of place by Mid-day sun
- Standard time : The local time of the place reckoned by the country as standard time.
- Sir Creek – forms boundary between Gujarat and Sind
- Siachin Glacier – 75 Km. long and 2 to 8 km. wide.

1.9 ANSWER TO CHECK YOUR PROGRESS

1. Seventh largest in area and second largest in population.
2. Areal extent is 32.87 Lakh sq. km., 2.4% of the total surface area.
3. Latitudinal extent is 804´ N to 37o18´ North.
4. Longitudinal extent is 68o7´ E to 97o25´ East.
5. Standard Meridian Line is 82o30´ East, passes from Mirzapur Near Allahabad.
6. India is south part of Asia continent.
7. India is washed by Indian ocean on its south.
8. Because of its natural demarcation, it is called sub-continent.
9. India has diversities in physical , human and cultural features.
10. India is a single territorial unit on a national scale.
11. Hindu culture, is a fusion of Dravidian and Aryan cultures,
12. The north-south extent is 3214 km.
13. The east-west extent is 2933 km.
14. Indira point is the last point on Nicobar island.
15. Cape Comorian (Kanaya Kumari) is the last south point of India's mainland.
16. India is quite rich in natural resources.
17. Huge man power of India, if properly Channelized, is a boon for national development.
18. Trans Indian Ocean routes Connect India with Europe and Africa in west and east Asia, Australia in the east.
19. Malacca Strait has brought Singapore and other islands closer to India.

20. Suez Canal opening has brought South European countries closer to India.
21. Indian culture has its strong foot prints in eastern Asia.
22. Bali, Java, Sumatra are typical names originated from India.
23. France, Portugal, Britain, Holland developed their colonies in India.
24. East India Company was established by British.
25. SAARC is a group of eight nations.
26. India is the birth place of Buddha, Jain and Hindu religions.
27. India's relations through land frontiers are much older than water frontiers.
28. India is an integral part of the oriental world.
29. India's land frontier is 15200 km. long.
30. India shares 3917 km. long border with China.
31. Five Indian states Jammu & Kashmir, Himachal Pradesh, Uttarakhand, Sikkim and Arunachal Pradesh touch Indian boundary with China.
32. The international line along Arunachal Pradesh is known as Mc Mohan Line.
33. India has the longest international boundary with Bangladesh.
34. India has always referred Mc Mohan Line as an international line between Tibet and India.
35. India's border with Nepal follows foothills of the Siwalik Range.
36. India – Bhutan boundary is 587 km. long.
37. India touches Nepal by Uttarakhand, Uttar Pradesh, Bihar, Sikkim and West Bengal.
38. Bhutan has West Bengal and Assam on its Indian border.
39. India's border with Bangladesh is touched by west Bengal, Meghalaya, Assam, Tripura, and Mizoram states.
40. India's boundary with Bangladesh is purely flat and man-made.
41. River Ganga in Bangladesh is known as Padma.
42. Bangladesh border has the pressure of the influx of refugees.
43. Nagaland, Arunachal Pradesh, Manipur and Mizoram states are situated along Mynamar border.
44. River Brahmputra is called Jamuna in Bangladesh.
45. The boundary between India and Pakistan is known as Redcliffe line.
46. Jammu and Kashmir state has strategic significance for India, as its touches Pakistan, Afghanistan, China and has proximity to Tajakistan.
47. Sir Creek is rich in marine life.
48. India's Coastal line in all is 7517 km. long.
49. Indian Ocean has helped in the establishment of trade and spiritual contacts with neighbouring countries.
50. Pak strait separates India with Sri Lanka.
51. Indian Ocean has remained a battleground of super powers.

52. India officially is known as Republic of India.
53. India has 29 states and 7 union territories.
54. Telangana is the 29th state of India, carved out in 2014.
55. Rajasthan is the largest state in area.
56. Uttar Pradesh is the largest state in population.
57. The density of population is 382 persons per sq. km. in 2011.
58. India's population in 2011 is 1216 million.
59. Bihar is the most densely populated state with 1106 persons per sq. km.
60. The number of females per 1000 males is 943 females in 2011.
61. India has recorded 7933 towns and 640930 villages in 2011.
62. The growth rate of population is 17.7 percent during 2001-2011 decade.
63. The percentage of effective literacy is 73.0 percent.
64. India still have 55 percent of its workers engaged in agricultural activities.
65. Great plains are the unifying force between the plateau and mountain regions.
66. India is a multi-lingual nation.
67. India is a land of sages and prophets.
68. India is committed to make a strong, powerful and prosperous nation.

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1.12 TERMINAL QUESTIONS

Long Answer

1. Elaborate the importance of geographical significance of India.
2. Write an essay on the vastness and diversities of India
3. India is rich country inhabited by the poors. Examine this statement.
4. India is a land of unity in diversity. Elaborate this statement.
5. Discuss in the detail the characteristics of Indian land and water frontiers.

Short Answer

1. India is a land of potentialities.
2. Discuss the size and extent of India.
3. Explain the political map of India.
4. Examine the strategic importance of India
5. Describe the natural diversities of India.
6. Indian culture has its own imprints on the countries of world.
7. Discuss the nomenclature of India.
8. India is a sub-continent. Elaborate it.
9. Discuss location and extent of India.
10. Discuss land frontiers of India.
11. Discuss water frontiers of India.
12. Examine the strategic importance of Indian Ocean for India.
13. Explain the chief characteristics of Indian border with China.
14. Describe the border of India with Pakistan.

Objective Questions:

1. The Standard Meridian of India is:

(a) 82o30′ East (b) 88o10′ East

(c) 85o0′ East (d) 80o30′

2. The frontier between India and China is:

(a) Mac Mohan (b) Red Cliff

(c) Indira Point (d) 30o North latitude

3. What is the density of Population of India is as per census of 2011. (No. of persons per sq. km.)

(a) 327 (b) 382(c) 367 (d) 310

4. How many states are in India:

(a) 25 (b) 27 (c) 29 (d) 28

5. Which country does not touch the border of India on its three sides:

(a) Nepal (b) Bhutan (c) Bangladesh (d) Pakistan

6. Which state is the largest in population:

(a) Andhra Pradesh (b) Maharastra

(c) Uttar Pradesh (d) Bihar

Answer– 1 (a), 2 (a), 3 (b), 4 (c), 5(d), 6(c)

UNIT 2 - GEOLOGY AND PHYSIOGRAPHIC REGION

2.1 OBJECTIVES

After reading this unit, you should be able:

1. To discuss important inter-related physical attributes of India's land surface.

2. To study geological, structure, rock types and their economic importance.

2.2 INTRODUCTION

Geological structure is a controlling factor in the determination of relief and physiographic features, and also in the formation of rocks and minerals. Such study is quite fundamental to various economic activities including mining and agriculture. Sedimentary rocks have helped in the formation of alluvial soils, which are excellent in agricultural production. These rocks are also known for fossiliferous marine deposits containing petroleum and are found near Ankleshwar and Khambhat area. Igneous and metamorphic rocks produce soils of low fertility, but these are rich in the deposits of metallic and other useful minerals. The old Archaean Rocks are to be proved rich for the reserves of gold and iron ore. Rocks of Carboniferous epoch are known for coal reserves. Iron ore and coal are the foundation of industrial development. Petrol is main base of transport industry, whereas agriculture depends on soil quality. Thus, the knowledge of geological structure and relief of the country is essential to study all of these above facts. This is quite fundamental to its economic development.

The present relief in the country is a consequence of the upheavals in its geological history. The rock structure is the creation of the process. After these internal processes, the exogenetic processes worked upon them. Running water is the chief among these. It has also given its important effect on the natural drainage.

2.3 GEOLOGY

The geological history of India is just similar to human history. It is both complex and varied. It has gone through the various stages of geological formations ranging from the Pre-Cambrian to the recent times. These Pre-Cambrian Rocks are as old as India itself, while recent rocks of quaternary Period are found in the form of sedimentary deposits of alluvial soils.

The Peninsular massif is made up by old to oldest rocks. It is the part of Gondwanaland. The Himalayan Mountain and related new folded mountain ranges have new rocks, younger than Peninsular India. These are the formation of sea sediments. These mountains have given the birth to Great Plains of India, which is the result of the deposits brought by the rivers of Himalayas. Thus, it clearly depicts that all the three physiographic regions have emerged out one after one and thus all of these have most striking geological contrasts.

Geologically, India represents a monumental assemblage of rocks of different character belonging to Pre-Cambrian to the recent times. These rocks of India have four important groups, which are as follows:

1. Pre-Cambrian (Archaean) group of Rocks
2. Purana group of Rocks
3. Dravidian group of Rocks
4. Aryan group of Rocks

1. Pre-Cambrian or Archaean Group of Rocks–

In 1915, **W.C.F. Smith** and **R. Bruce Foote** had firstly studied these rocks. The word Archaean was used by **J.D. Dana** for rock structure prior to the Cambrian system. These are classified into two systems:

(a) Rocks of Archaean System– These are the oldest rocks in the world even than man himself. These were the first to be formed at the time of cooling and solidification of the upper crust of the earth' surface in the Pre-Cambrian era about 4000 million years ago. These are highly metamorphosed rocks, and have lost their original form. These are crystalline and have the absence of fossils. These have been under the influence of internal forces. These are of gneiss, granite and schist type.

These are extended on 187,500 sq.km area. They occupy the Karnataka, Tamilnadu, Andhra Pradesh, Telangana, Madhya Pradesh, Chhatisgarh, Odisha, Jharkhand, western Part of West Bengal and south Rajasthan. In the extra-peninsula, these rocks are exposed in the core areas of main Himalayas.

(b) The Dharwar System– These rocks have derived its name from the rocks first studied in the Dharwar district of Karnataka. These are found in abundance here, and occupy just half of the state. These have derived their materials from Archaean system and are highly metamorphosed. These have the absence of fossils. These are the most ancient metamorphosed sedimentary rock system of India. These are very old one. The weathering of the Archaean gneisses and schists yielded the earliest sediments which were deposited on the bed of the sea, and formed the oldest sedimentary strata known an Dharwar system. At few places, these are highly metamorphosed, and are not easily distinguished from their primitive formations. These are not found in horizontal layers or in their original form.

These are extended in most part of Karnataka, Rajasthan and some parts of Gujarat, Jharkhand, Chhattisgarh, Odisha states of peninsular India. In the extra-Peninsular region, these are extended in lower valleys of western Himalayas, in east Meghalaya and Arunachal Pradesh.

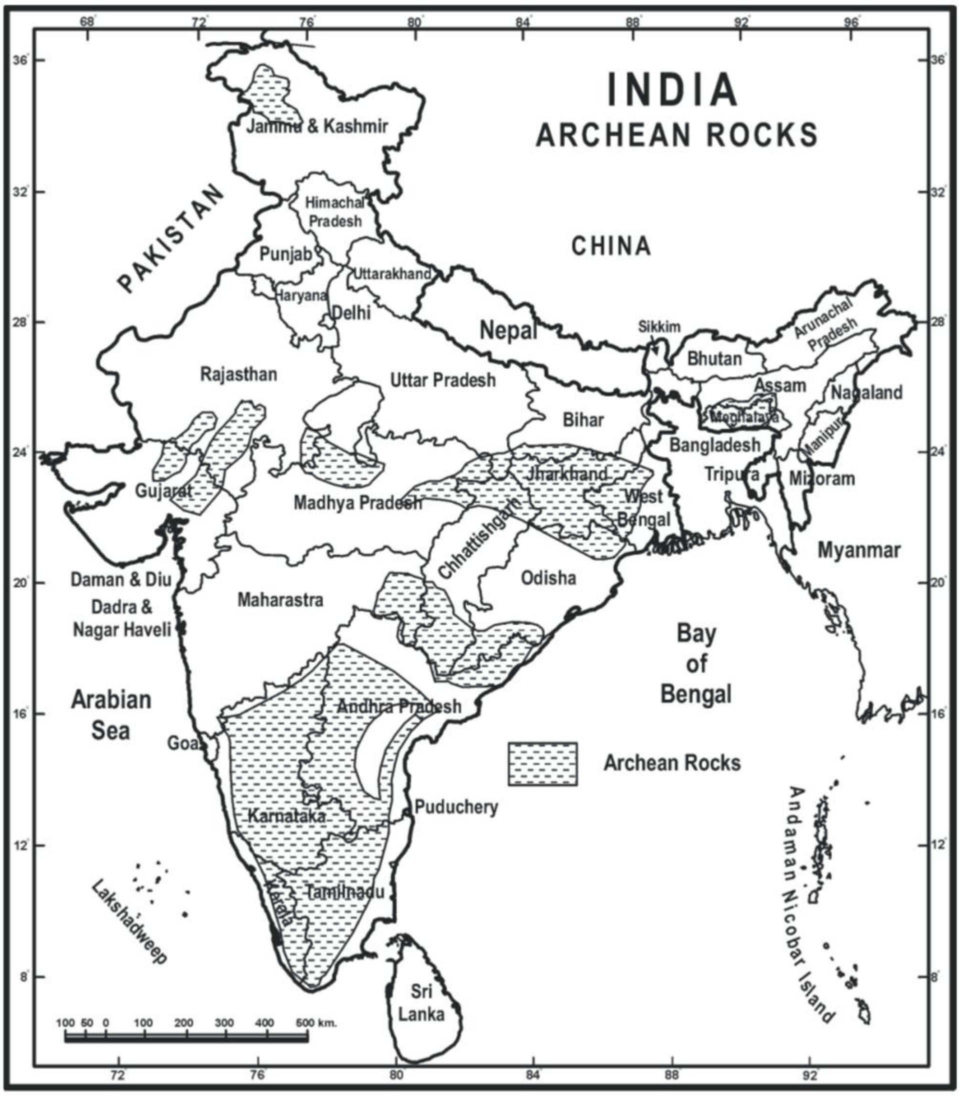

Fig. No. 2.1 Distribution of Archean Rocks in India

The Dharwars are most important rocks of economic value. They possess valuable minerals like high grade iron ore, manganese, mica, cobalt, asbestos, garnet, marble, lead, quartzite, gold and copper. Kolar and Dharwar Valleys are known for gold, while iron ore is found in Jharkhand, Odisha, Goa, Madhya Pradesh, Chhatisgarh and Karnataka.

Aravalli Hills, the oldest folded mountains were formed in Dharwar Period. These hills possess the most diverse lithological characters, being a complex of all kinds of rocks-plastic sediments, chemically precipitated rocks, volcanic and plutonic rocks all of which generally show an intense degree of metamorphism.

2. Rocks of Purana Group

These rocks were formed after a long gap of the formations of Dharwar Rocks. This term Purana is also known as Proterozoic. The geological movements in this period gave the formation to Kuddapah and Vindhyan system rocks.

(a) Rocks of Cuddapah System– These rocks have been formed in Eparchean Period after a long interval of time elapsed after the formation of Dharwar system. These are named after Kuddapah, a District of Andhra Pradesh, where these rocks are found in irregular crescent shape on an extensive area. Naturally, Kuddapah system is separated from the Dharwar system by a great unconformity. These rocks have a 6000 m. thickness in southern India. The outcrops of cuddapah rocks suggest that these were subjected to compressive forces directed from the concave side near which stood high mountains which supplied materials forming the rocks of the basin. In due course of time, these deposits took the form of sedimentary rocks, which are known as Cuddapah system of rocks. Shale, quartzite, slate and limestone rocks were the parent rocks, which were highly metamorphosed. This metamorphism was comparatively low than the Dharwar Rocks. These have not evidence of fossils, inspite of the proof of existence of life on the earth.

These rocks cover an area of 22000 sq. km. and are found in Andhra Pradesh, Chhatisgarh, Rajasthan, Maharastra, Tamilnadu and in some areas of Himalayas. Krishna River valley, Nallamalai Hills, Cheyar River valley and Papaghani River valley have the extension of these rocks in peninsular India. These are also found in scattered form in Belgam of Karnataka and mid-valley of Godavari. In Rajasthan, these are extended in its south-east part and also near Delhi Hills. In Extra-Peninsular Region the rocks are extended in Kashmir and Himachal Pradesh.

These rocks are less significant economically than Dharwar Rocks. These are having the minerals in less quantity. These rocks contain mainly iron ore and Manganese. Asbestos and talc are obtained from Cuddapah and Karnool districts. Marble stone and colourful stones are also found. These also contain large deposits of building purpose. Quartzites and cement grade limestones, Copper, Cobalt, nickel are obtained in East Rajasthan.

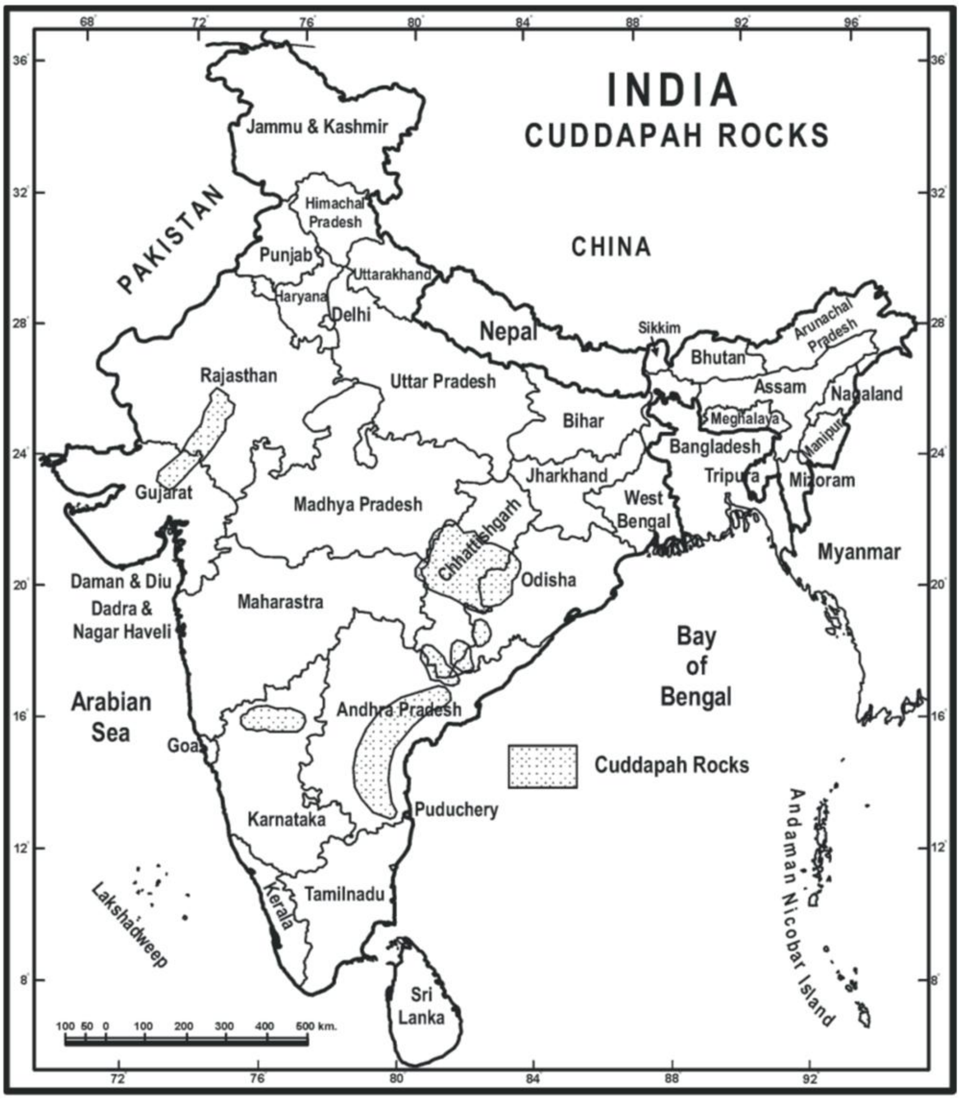

Fig. No. 2.2 Distribution of Cuddapah Rocks in India

(b) Rocks of Vindhyan System– This system derives its name from the great vindhyan mountains. The rocks are studied by a number of scholars. Among them **E. Braden Burg, R.D. Oldham, Medlicott, F.R. Mellot, W.King, A.M. Heron** and **J.B. Odem** are most important. **O.H.K. spate** has tried to distinguish between the Vindhyan rocks and the Vindhyan hills.

These rocks are made after Cuddapah Rocks. These are ancient sedimentary rocks, superimposed on the Archean base. Sandstones of Vindhyan Rocks are the evidence of those deposits which took place in shallow seas, and river valleys.

The rocks of the vindhyan system comprise two distinct but unequal sets of deposits:-

(a) The Lower Vindhyan Rocks– These are 1300-1100 million years old and are marine in origin, mostly calcareous in nature and shows tectonic deformation by folding movements. These rocks possess quartzite in lower parts, shale in the mid and lime stone in the upper part of rocks. Their distribution is as follows:

(i) In son valley, these are known as Semri Series.

(ii) Kurnool series in south west part of Andhra Pradesh.

(iii) Bhima series of Bhima River valley in Karnataka.

(iv) Palni series of Chittorgarh and Jodhpur in Rajasthan.

(v) Upper Godavari valley, Malwa region in the north of Narmada Valley and Bundelkhand region have few specialized areas of these rocks.

(b) The Upper Vindhyan Rocks– These are 1000-600 million years old, and are fluviatile in origin. These are found in undisturbed horizontal strata. Sandstone, shale and conglomerate are the main rocks. In Aravalli Region, these rocks are found on the upper surface of Dharwar system of rocks. These are widely distributed in the following peninsular and extra-peninsular areas.

(i) Mander, Rewa and Kaimur Series in the north of River Narmada.

(ii) Central Railway rail route between Katni to Allahabad.

(iii) Areas lying near Dehri-on-son of Jharkhand.

(iv) Aravalli Hills and nearby areas.

(v) Nearby areas of Pir Panjal and Dholadhar Ranges, spiti valley and Shimla. These are known for slate stone.

Economic Importance: These have large quantities of excellent and durable limestone, sandstone, Chinese clay, flagstones, fire clay, pure glass making sand. Limestone is the base of cement industry. Sandstone is of red colour and is being used in the construction of buildings. Red fort and Jama Masjid of Delhi, Stup of Sanchi, Fatehpur Sikri, Red fort, and Sikandara of Agra are made up by these stones. These are also known for Panna and Golcunda Diamonds.

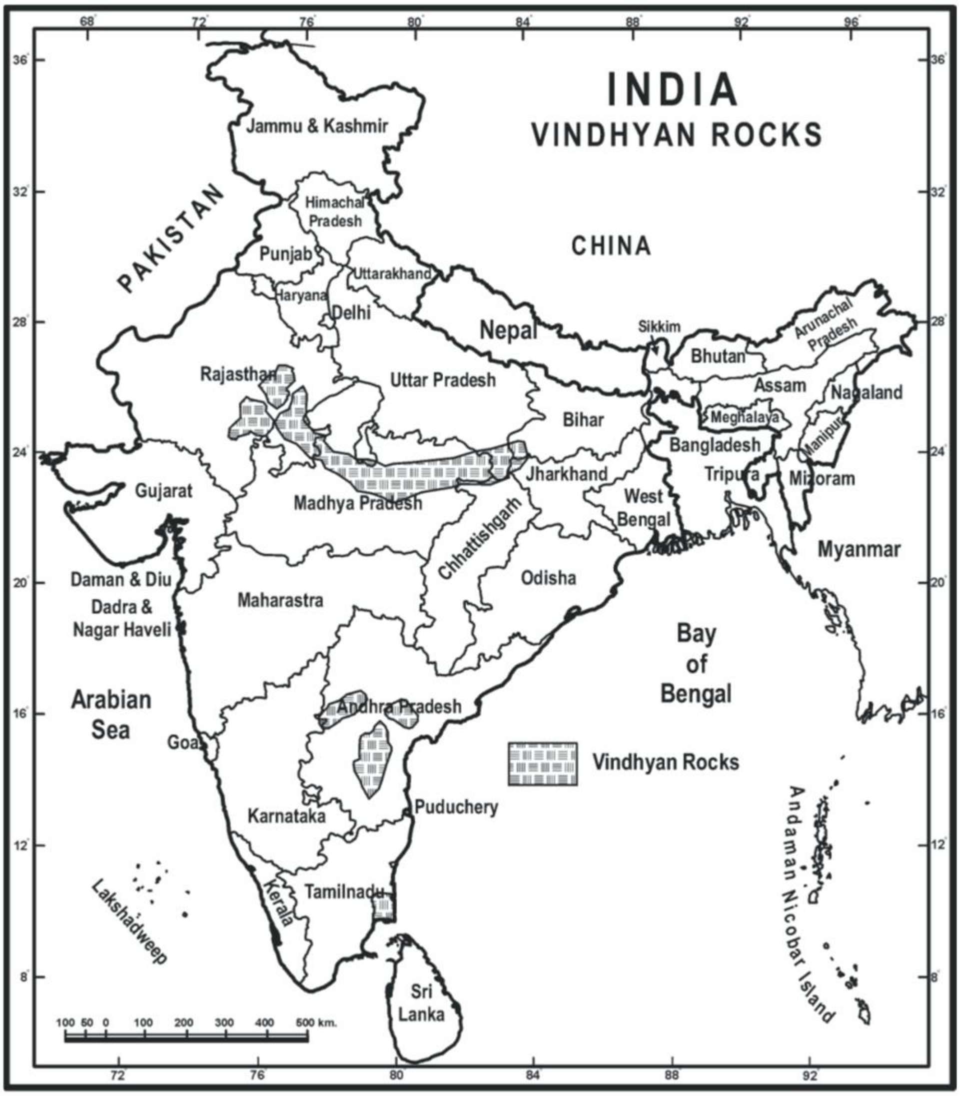

Fig. No. 2.3 Distribution of Vindhyan Rocks in India

3. The Dravidian Rock System

The rocks of the Dravidian system came into existence between 600-300 million years ago. These are mainly found in extra-Peninsular Region. Peninsular Region does not have the presence of such rocks. The Dravidian Era is marked with the beginning of life on the earth, and because of that, this rock system contains abundant fossils. The rocks of Cambrian, Ordovician, Silurian, Devonian and carboniferous periods are the rocks of Dravidian System.

(a) Cambrian Rocks– This name is derived after Cambria the latin name for Wales in Great Britain. These occur in Baramula, Anantnag districts and Pir Panjal areas of Kashmir and Spiti valley of Himachal Pradesh. They consist of the deposits of states, quartzites, sandstones, clay, salt and dolomites. It has Salt Range on India-Pak Border.

(b) Ordovician Rocks– This name is after the ordovices, former inhabitants of wales. These are mainly found in the Lidar valley in Kashmir spiti valley of Himachal Pradesh and Kumaon Region of Uttarakhand. Quartzites, sandstones and limestones are the main deposits.

(c) The Silurian Rocks– This name is also after the Silures, former inhabitants of wales. Spiti and Kullu valleys of Himachal Pradesh, Handwara and Lidar valley in Anantnag of Kashmir have the extension of these rocks. Limestone and Shales are the main deposits.

(d) The Devonian Rocks– This name is also after Devonshire of England. These rocks are quite thick with quartzite reaching thickness 900m. at certain places. They are devoid of any fossile remains. Such deposits do exist in Lidar valley, Pir Panjal area, Spiti valley.

(e) The Carboniferous Rocks– These are 350 million years old, and are divided into Upper, Middle and Lower Carboniferous System, which are also included in the Rocks of Aryan Group. Coal formation got start in Carboniferous, which in geology means coal bearing. These were known afterwards by the name of Gondwana system.

Upper Carboniferous Rocks are made of limestone and dolomite. Mount Everest is composed of these rocks. Middle carboniferous is the age of Himalayan upheavals. Lower Carboniferous has slates of different type. Western and eastern Himalayas do have these deposits.

4. The Rocks of Aryan Group

The Aryan group comprises the rock formations ranging from the upper Carboniferous to Recent Period. These are fairly preserved in the Peninsular India and are found in perfect sequence in extra-Peninsular Region. During this period, the map of India has noted heavy changes.

Himalayan mountains and Great Plains were formed during these periods. It is not wrong to say that Indian sub-continent assumed its present shape. The rocks of Aryan Group belong to the systems of Gondwana, Deccan Traps, Tertiary and Quaternary.

(I) Rocks of Gondwana System

The use of term Gondwana was made by **H.B. Medlicott** in 1872. After him **O. Feast Mantle** had used this term in 1876. This system has derived its name from the Kingdom of Gond region of Madhya Pradesh, from where the presence of these rocks was noted for the first time. Afterwards, this name was frequently used for those lands, where such rock deposits were found.

Origin of Rocks– According to Geologists, the formations of these rocks had taken place during the Jurassic period and Upper Carboniferous period. It is assumed that earth movements couldn't take place for a long time after the formation of the rocks of vindhyan system. Hercynian Movement in Upper Carboniferous period left its effect on the entire globe. The distribution of water and land was changed in most parts of the earth. A sea known as Tethys was developed from west

Mediterranean Sea to China. In the north of this sea, was Angaraland and in the south, India, Africa, South America, Australia and Antarctica were developed in the form of Gondwanaland. By this time Kara-Koram, Kunlun and a number of central Asian Mountain ranges were emerged out on the south flanks of Angaraland.

This system has experienced several climatic changes during the process of deposition of sediments. The Ice age, made active to glaciers which accelerated the rate of erosion in high mountain areas. This eroded material began to accumulate in the river valleys and shallow water areas. River valleys were become fertile. These lower areas were having hot and wet climate which gave the luxurious growth to terrestrial plants. These terrestrial plants were named as Glossopteris flora. These plants were subsided in the shallow water areas and this change in the form of vegetation is now known as coal deposits. These rocks are still found in the form of horizontal layers, and are free from all disturbances. The remnants of fishes and creep animals are also found in these rocks. Their deposition in the river valleys gave protection to their original status. Their formation took a long time from Upper Carboniferous to the Jurassic period, which noted a number of climatic changes.

Distribution of Gondwana Rocks– These rocks are observed in narrow valleys of South India. Its triangular shape has noted their presence on the flank of its both sides. On the eastern coast, these are found in the upper layers. These are found in peninsular and extra-peninsular areas.

(a) Rocks of Peninsular Areas- (i) In Damodar Valley extended upto Rajmahal Hills, (ii) In Mahanadi Valley, (iii) In Godavari valley and in its tributaries-Venganga, and Wardha Valleys, (iv) In Kutch, Kathiawar, west Rajasthan, north-east Andhra Pradesh and east Tamilnadu.

Thus, these rocks are distributed mainly in Jharkhand, Madhya Pradesh, Chhatisgarh, Andhra Pradesh and Odisha.

(b) Rocks of Extra-Peninsular Areas- Here, their identification is quite typical, due to their high metamorphism, and thus are quite different from Gondwana rocks of peninsular India. Their presence can be marked in Kashmir, Sikkim, North West Bengal and Assam.

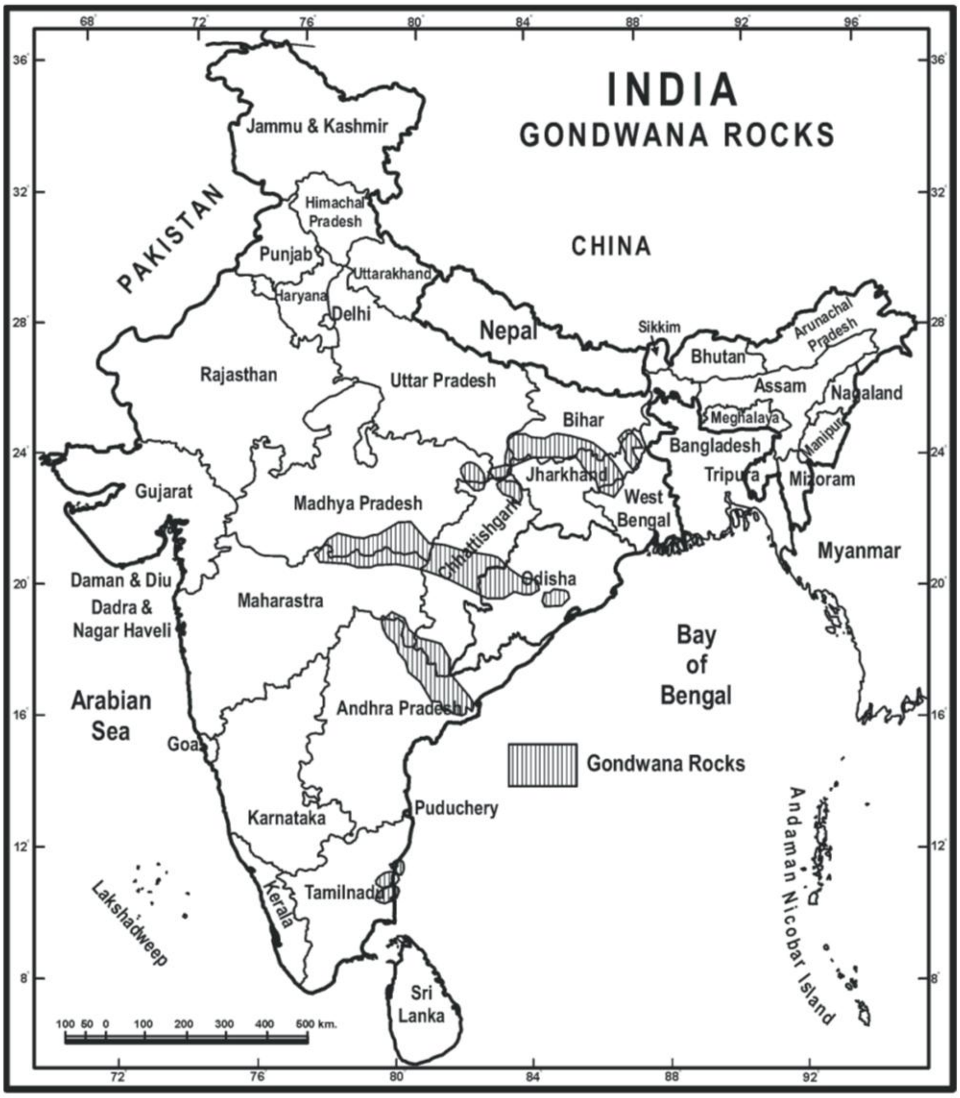

Fig. No. 2.4 Distribution of Gondwana Rocks in India

Economic Importance- These rocks contain above 98 percent of our coal reserves. Sandstones, slates and conglomerates are used as building materials. Chinese clay is used in brick and ceramic making. These have their importance for cement, chemical fertilizer industries.

(II) Deccan Traps

It covers over an area of 5 lakh sq. km. of peninsular India. The period of their formation is from the end of cretaceous period till the beginning of Eocene period. During the last Mesozoic period, a vast area was flooded by the outpourings of extremely mobile basalt lava from fissures and cracks. It covered fully the pre-existing topography. These volcanic deposits have flat top, and thus executed a shape of plateau, known as Deccan Plateau. It has horizontal lava layers, with steep sides. Because of these sides it is called trap, the name derived from the Swedish word meaning a stair or step. **Spate** has preferred to use the term 'Deccan Lava'. It has great variation in thickness of lava layers. It varies from 1-2 to 35 m. The thickness is declined towards the east, but it reaches to 2134m in the west side.

Deccan trap mainly has the nature of Basalt and Dolerite. These rocks are very hard. The weathering of these rocks for a long time has given birth to black cotton soil known as regur. This trap has also given birth to laterite soil, which is the creation of Monsoon climate. It has the contents of Aluminium, iron and manganese. The colour is dark brown, brown and purple. The relative density of Basalt and dolorite is 2.9. It has uniformity in chemical composition. The content of silica is 50 percent. The other chemicals are iron, calcium and magnesium. The Deccan trap has been divided into three groups:-

(i) **Upper Traps-** It is extended mainly in Maharastra. It has numerous inter-trappean beds and layers of volcanic ash. The average thickness is 460 metre.

(ii) **Middle Traps-** These are 1200m thick and are spread mainly in Madhya Pradesh. It has numerous ash beds in the upper portion and is practically devoid of inter-trappeans.

(iii) **Lower Traps-** These are found in east side. It is only 152m thick. It has inter-trappean beds with rare ash beds.

Economic Importance of Deccan Traps– These rocks are a great source of building stones and road building material. These have quartz, agate, calcite and Pyrite, mainly near Rajpipla, Khambhat and Ratnagiri. Bauxite deposits are found in Maharastra, Madhya Pradesh, and Jharkhand. It is used as ore aluminium, also in petroleum refining.

(III) Rocks of Tertiary System

These rocks were formed from Eocene to Pliocene period about 60 to 7 million years ago. This period is known as tertiary Era. It is the most significant period in India's geological history, because the Himalayas were born and India's present form came into being in this period. It gave us two physiographic regions-Himalayan Mountains and Coastal lands of peninsular plateau. The Tertiary has been called as the Age of the Mammals because of the abundance of the fossil remains of these animals in the deposits of this period.

Origin of Himalayas– Tethys Sea, during this period noted revolutionary changes. It was extended between Gondwanaland and Angaraland. This sea was a long, narrow and shallow. It was filled up with sediments, brought by rives from both these landmasses. These sediments were subjected to powerful compression. This compression, due to the movement of both the land masses towards each other attributed the orogenic movements on the basis of Tethys Sea. These movements gave birth to Himalayas, Iranian, Cacasus, Carpathian, Alps, pyrenese mountains. The upheaval of Himalayas is a sum of four or five stages. These stages belong to upper cretaceous, upper Eocene, middle Miocene, Pliocene, and lastly to Pleistocene.

Primary tertiary rocks are sea rocks, which have deposits of shallow and deep water. In the north-west Eocene rocks are marine rocks, Whereas Murrie rocks are the rocks formed on the confluence of sea and river. Siwalik rocks are fluviatile rocks.

Distribution– These are found mainly in extra-peninsular region. In peninsular India, their distribution is limited upto coastal areas. The Tertiary system is generally divided into the following three system of rocks:-

(a) Eocene System Rocks– It comprises three series- (a) Marine facies- These are found in Jammu and Kashmir, and north part of Himalayas. These rocks are made by the lime. (b) Coastal facies- These are found in Jammu, near Shimla and Garhwal Himalayas. These have shrinked towards the east. (c) Fresh water facies- Such rocks are found in eastern states and Myanmar.

In north-eastern parts of the country, the Eocene is represented by limestones and coal bearing sandstones in Meghalaya. The Barail series has a wide distribution in Surma valley and Naga Hills. It has also tertiary coal deposits. The middle parts of these rocks do contain the reserves of petrol. In Rajasthan, Palna deposits of Bikaner district are known for Tertiary coal. Surat, Broach and Kutch districts have deposits of the Eocene system.

(b) Oligocene and Lower Miocene System Rocks– These are 40 to 25 millions year old. It was a period of inter-mountain formations process. The tertiary outcrops suffered considerable denudation which resulted in the removal of rocks belonging to this system. These rocks are found in Jammu & Kashmir, Assam and other eastern states of India.

(c) Mio-Pliocene System– It is fully developed in India. It gave the birth to third upheaval of Himalayas and by this time, the sediments of Mio-Pliocene rose up and gave the birth to Siwaliks. These are found all along the foothills of the Himalayas. These contain sandstones, grits, conglomerates, clays and silts, which give an evidence of their deposition in lagoons and fresh water lakes made by rivers at that time. At some places Shiwaliks are highly fossiliferous. It has a variety of fossils showing wide range of environment from humid forest conditions to aridity.

In Andhra Pradesh Cuddalore and Rajahmundry rocks are of such type. These are sandstone rocks. Such rocks are also found in the area lying between Rameshwaram and Puduchery in an elongated and wide belt, and also in Nellore and Godawari districts of Andhra Pradesh. These have mammalian fossils. The sea coast near Kollam in Kerala state has also deposits of limestone rocks. These rocks are famous for clays of different varieties and sandstone, is used in the construction of buildings.

(IV) Rocks of Quaternary System

It is a brief period of nearly one million years and is said to have just begun. It has two divisions without a clear-cut boundary between them. The older is Pleistocene and the younger is called Recent.

(1) Pleistocene Rocks– It is marked by cold climate and glaciation. **De Terra and Patterson** have divided this period into four glacial and three inter-glacial periods. At this time sea level was lowered by about 100 metres than it is now. Himalayan glaciers were also much larger during the glacier period. The evidences of such incidents can be marked by moraines, boulder fans and thick fluvo-glacial materials. These moraines left their impact on the drainage system, which resulted at some places in the form of lakes.

The Karewas of Kashmir are such rocks, which were deposited in Karewa Sarovar during second glacial and inter-glacial periods. The flat topped terraces of Kashmir valley, and on the flanks of the Pir Panjal consisting of clays, sands, silt together with conglomerates are known as Karewas in Kashmiri Language. Karewa Rocks are spread over an area of 7500 sq.km. These are 1600 m thick and are in the form of horizontal layers. These rocks were uplifted in the form of Pir Panjal on the south flank of Kashmir valley. This valley is an evidence of the emergence of the surface of Karewa Sarovar.

Karewa Rocks are riverine. These have the remnants of Chir, Oak, Beach, Cinnamon, which proves, that the climate was temperate at that time. Fresh water mammals, fishes, remains are also found in these rocks.

Older Alluvium– The alluvial deposits of Sutlej valley, Narmada and Tapi valley, and in the upper valleys of Godawari and Krishna rivers are also of the Pleistocene Period. Here fossiferous clays, sands and gravels are also of this period.

Indo-Gangetic Alluvium– These are the most important deposits, brought by Indus, Sutlej, Ganga and Brahmputra Rivers. They were \able to fill up the great depression lying between the foot of the Himalayas and the northern edge of the Peninsula. These deposits have a great variation in depth. This depth is assumed nearly 1800 to 2100m. In upper Assam these alluvial deposits have high depth. These deposits are made by sand and clay. These are of two types:

(i) **Older Alluvium**– It is called Bhangar. The colour is dark and has also composition of nodules. It is of Middle or upper Pleistocene age.

(ii) **New Alluvium**– It is called Khadar. The colour is light and contains nodules and sand. It is good reservoir of underground water. It is of upper Pleistocene age.

The coastal areas of Peninsular India have also alluvial deposits of Pleistocene age. The coasts of Odisha, Andhra Pradesh, Tamilnadu and Gujarat have these deposits in a broader area. It is marked by deltas of great river like of Mahanadi, Godavari, Krishna and Cauvery. There are several lagoons. Chilka lake and Pulicut lakes are outstanding lagoons. Rann of Kutch has an evidence of both submergence and emergence. It was a part of sea in Pleistocene age, but now it is filled up with the deposits of Pleistocene and recent age. The Thar Desert of western Rajasthan has also an evidence of deposits of these ages.

(2) Recent Rocks– These are still today in the process of formation. This age is responsible for the formation of mouth of rivers, and coastal sand dunes. Narmada, Tapi, Mahandi, Godavari, Krishna, Cauvery, Periyar Rivers have deposited alluvium in large quantity on their mouth.

In brief, it can be ascertained that Peninsular India has the Rocks of oldest period to recent period. Here are such old rocks, which have changed their original form. On the contrary, Himalayan and Great Plain Regions both are decorated by the rocks of Tertiary and Recent age.

2.4 PHYSIOGRAPHIC DIVISIONS OF INDIA

The surface of the country is as complex as its making. It has great physiographic diversity on account of the differences in geological structure, history and involved denudational processes. It has all type of landscape such as mountains, hills, plateaus and plains. Nearly 11 percent of total area is mountainous, 18 percent hilly, 28 percent plateau type and remaining 43 percent is having plain surface. It has more extension of plain surface than the world's average.

Determination of Physiographic Regions

Due to geological complexities and geomorphological diversities, division of India into physiographic regions is a difficult task. Some geographers have divided into three physiographic divisions, and some scholars have determined coastal plains as a separate region. The question is not of three or four physiographic regions, but it is very ascertain that all these regions are quite different from each other due to physiographic and geological point of view. Thus, to be more realistic, it is preferred to divide India into following five physiographic divisions:

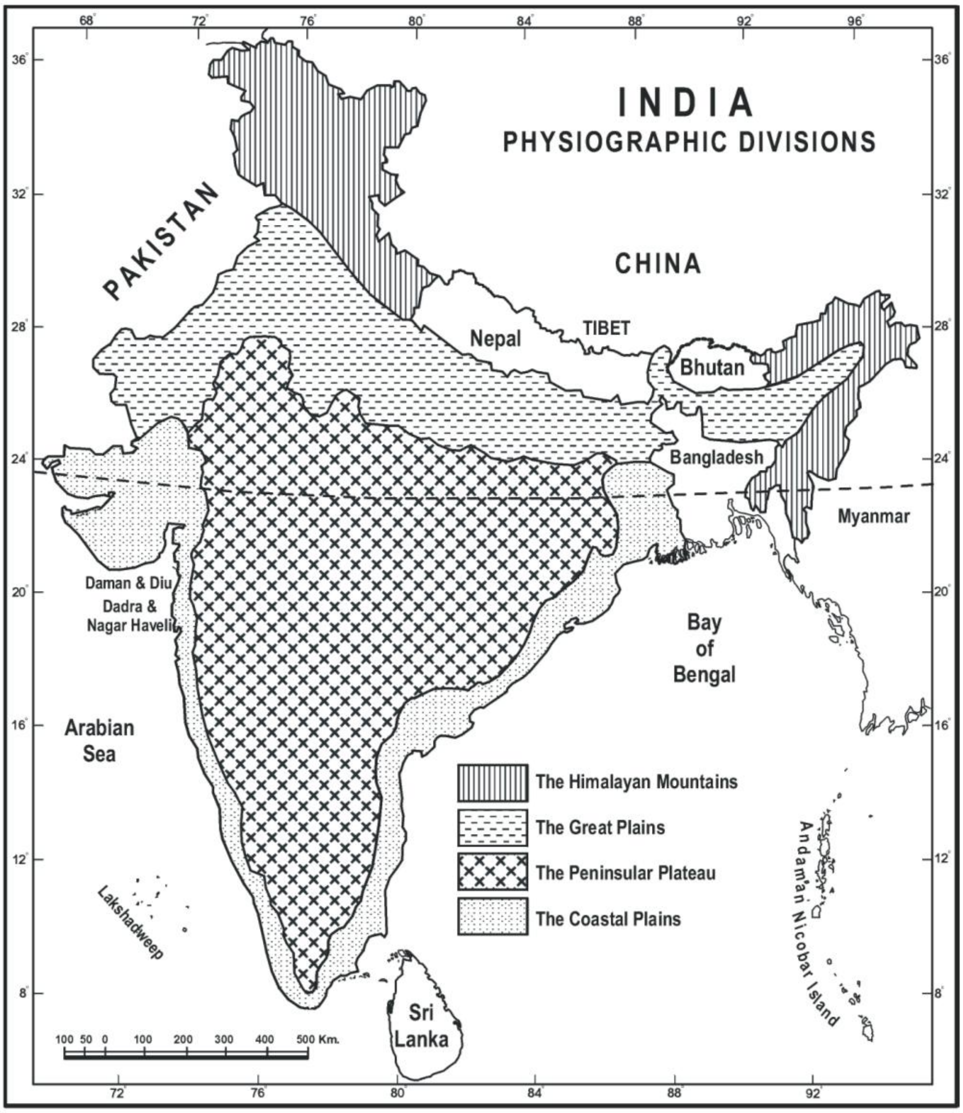

Fig. No. 2.5 India : Physiographic Divisions

1. The Himalayan Mountains, 2. The Great Plains, 3. The Peninsular Plateau, 4. The Indian Coasts and 5. Islands.

2.4.1 Himalayan Mountains

High relief, snow capped summits, deeply dissected topography, antecedent drainage, complex geological structure and rich temperate flora in sub-tropical latitudes give a very distinctive character to the well-defined mountains of India– the Himalayas. It is extended in between the gorges of the Indus and Brahmputra. The Himalayas form India’s northern frontier from Jammu & Kashmir to Arunachal Pradesh.

Himalayas run in 2400 km. length with a width of 160 km. to 400 km. Their extension is between 22 longitudes. The average height is 6000m. It is estimated that they cover an area of 5 lakh sq. km. Their slope towards south is convex. These are young folded mountains. They have loftiest peaks of the world. The sedimentary rocks of Himalayas are folded and faulted. They have a number of over folds, recumbent folds, nappes, and thrust faults. These are still in the stage of formation. It has sedimentary rocks deposited in the sea, of various age. These are limited also by Nanga Parbat in the west and Namcha Warba in the east.

Classification of Himalayas

Himalayas have been divided on geographical, regional and geological basis.

(i) Geographical Division

Himalayas are a series of several ranges. These ranges are separated by deep valleys; and have a steep gradient towards the south, much gentle slope towards the north. These mountains comprise almost four parallel ranges, which are as follows;

(1) Inner or Great Himalayas- This is the innermost, the loftiest and the most continuous of the Himalayan ranges. It is defined as Himadri in ancient Indian literature. These are extended from Nanga Parbat (8126m) in the north-west over looking the Indus to Namcha Barva (7756m) in the north-east over looking the Brahmputra. It is 2500 km. long and 25 km. wide on an average. The average height of the range is 6100m. It has eight peaks of more than 8000m height. Highest peak is Mt. Everest also known as Queen of mountains. It is also named as Gauri Shanker also.

The Himadri Range is snowbound throughout the year and a number of glaciers descend from it up to 2440m above mean sea level in Kashmir and 3960m in the central and eastern Himalayas. Glaciation is the most important/denudational process accounting jagged topography of this lofty range. Most of the Himalayan glaciers are 3-5km in length but there are some giant streams exceeding 20km such as Milam and the Gangotri in Kumaon and Zemu in Sikkim. These glaciers have given birth to a number of important rivers like Ganga, Yamuna and so on.

This range has a number of passes. The Burzil pass and the zoji La in Kashmir ; the Bara Lacha La and shipki La in Himachal Pradesh ; the thag La, Niti pass and Lipu Lekh pass in Uttarakhand ; and the Nathu La and Jelop La in Sikkim are important passes through the Himadri. The Hindustan – Tibet Road connecting Shimla with Gartok passes through shipki La in Sutlej valley. Another important trade route connects Kalimpong in west Bengal with Lhasa, the capital city of Tibet through Jelop La, the chumbi valley in Sikkim.

(2) Lesser or Middle Himalayas- This range runs in the south of Great Himalayas parallel to it. It is also called Himachal or Lower Himalaya. It forms a most intricate and rugged mountain system 60-80km wide and 1800-3000m an average height. Several peaks rising to 1500m height. The northern slopes are gentle and covered with dense forests in the east. Many peaks are snow covered throughout the year. These Himalayas include a number of ranges like Pir Panjal, the Dhaola Dhar, the Mussoorie Range, the Nag Tib.

The Pir Panjal is its western extension, and occupies its Position in Kashmir. It is the longest and most important range. It extends from Jhelum river to the upper Beas river for 300-400 km. Zaskar range separates it from valley of Kashmir. It rises to 4000m. Pir Panjal (3494m) and Banihal (2832m) are two main passes. The Banihal pass is used by Jammu-Kashmir highway. To the southeast of this Dhaola Dhar Range is extended, on which Shimla (2205m) is situated. Chakrota, Mussoorie, Nanital, Ranikhet hill stations have developed on Nag Tibba Mussoorie Range. Their height is between 1500-2000m.

These mountains are composed of Pre-Cambrian and Paleozoic Rocks. These have slate, limestone, quartz rocks in abundance. It has noted reverse faults and folds. From tectonic point, these have been remained stable and less hostile. These are more friendly to human contact.

Valleys- Two open valleys are found between middle and Great Himalayas. In west, Kashmir valley is extended between Pir Panjal and Great Himalayas. It is 150km. long and 89km. broad. Its total area is 4900sq.km. and has an elevation of 1700m. In east, Kathmandu valley is situated in Nepal.

Views on the origin of these valleys–

- **D.N. Wadia** says that Kashmir valley is an exaggerated instance of a Dun or longitudinal valley.
- According to **De Terra** that it is a recently depressed intermost basin, pointing to marked evidence of faulting on the Himalayan flank.
- It is generally believed that this basin was occupied by a lake in the Pleistocene age. This was filled up with sediment and uplifted to form Kashmir valley. The synclinal basin of the valley is floored with a variety of alluvial deposits. Jhelum River flows through it, which has its deep gorge in Pir Panjal.

Other Valleys– In Himachel Pradesh, there is Kangra valley. It is a strike valley. It extends from the foot of Dhaola Dhar Range to the south of Beas. Kullu valley is a transverse valley. It is extended in the upper course of Ravi River.

(3) Sub- Himalayas or Siwalik- This comprises the outermost range of the Himalayas. It is also known as outer Himalayas. This chain of hills runs almost Parallel to the lesser Himalayas for a distance of 2400km. from the Potwar Plateau in Punjab to the Brahmputra valley in Arunachal Pradesh. The average width is between 15to30km. It varies from 50km in Himachal Pradesh to less than 15km in Arunachal Pradesh. The altitude varies from 600 to 1500m. These are known by different names, such as Jammu hills in Jammu, Dafla, Miri, Abor and Mishmi hills in Arunachal Pradesh.

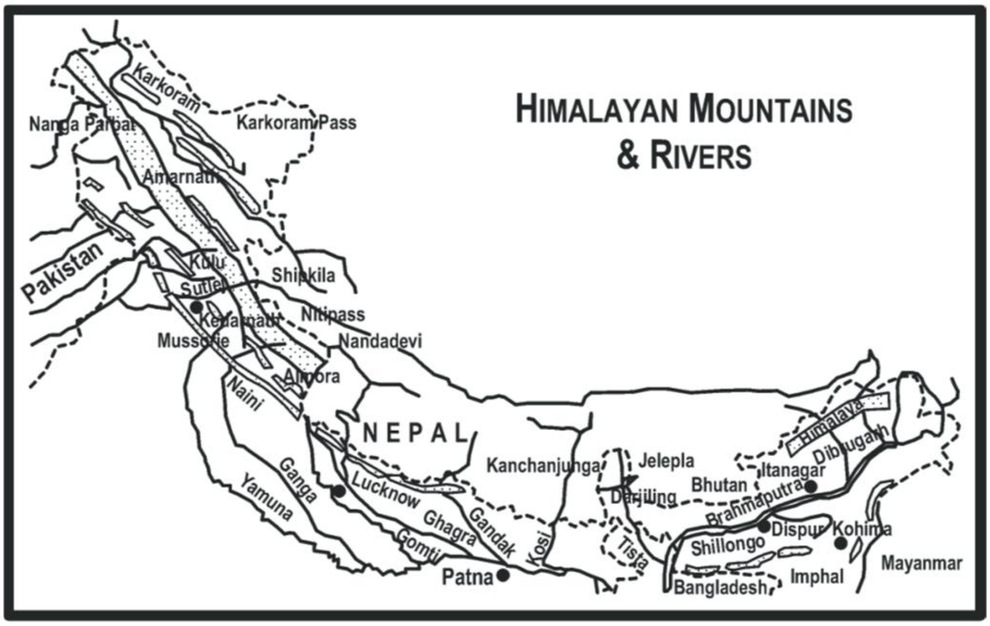

Fig. 2.6 Himalayan Mountains

The Shivaliks are formed of great thickness of Mio-Pleistocene sands, gravels and conglomerates which have been brought by the rivers flowing from the higher ranges of the Himalayas. These have been folded, faulted and indunated by the earth movements. Obviously the Shiwaliks were formed last of all the ranges. These have very high uneven surface. The slopes are steep. Deep valleys have formed due to high erosion and landslide. Himalayan Rivers cut their course through the Shiwalik Range. These rivers crossing Shiwaliks have given the formation to wide and at some places gorge like valleys. In west Bengal Shiwaliks have totally disappeared between River Tista and Raydok and thus form a 90km wide valley.

Valleys–There are found a number of valleys between, Shiwaliks and Middle Himalayas. These are like plains called 'duns' or 'Doons' in the west and 'Duars' in the east. The Duns are the discontinuous series of longitudinal vales. Dehradun in Uttarakhand is the best example of such plain which is 75 km. long and 15-20 km. wide. It is covered with boulder and clay deposits. It is a flat bottomed strike valley. The other Dun valleys are- Udhampur and Kotli in Jammu, Kotah, Patli, Chumbi, Kyarda, Chaukhamba and Kothri in Uttarakhand and Himachal Pradesh. These are also quite typical.

The range is covered with thick, tropical west deciduous forests in the east upto Nepal; the vegetation becomes thinner further west. The southern slopes of the range are barren, and highly dissected by several seasonal streams locally called 'Chaos'.

4. The Trans-Himalayas

These are extended immediately north of Great Himalayas. These were explained, by **Sven Hyden** in 1906 for the first time. He defined Kara-Koram Range as the 'backbone of High Asia'. The Zaskar, Kailesh, Laddakh and Kara-Koram are the main ranges of these Himalayas. It extends for a distance of about 1000 km in east-west direction and its average elevation is 3100m. The average width is about 225 km. in the central part and it remains 40 km. at the eastern and western extremities.

These are formed of sedimentary deposits. They have the rocks of Cambrian to Tertiary Period. There is an absence of vegetation. This range gives birth to Sutlej, Sindh and Brahmaputra Rivers.

In the north of main range, Zaskar Range runs parallel to it. Its average height is 6000m. Beyond the Zaskar Range lies the gorge of the Indus, about 560km. long, 10km. wide and 5200m deep near Bunji, where the river cuts Laddakh Range. The river turns towards south-west and cuts through the Himalayas entering Pakistan about 90 km. west of the Nanga Parbat. Further north, between the Indus and its tributary Shyok, runs Laddakh Range, which is 5800m high and more than 300 km. long. It runs parallel to Zaskar Range.

Kailash Range is an offshoot of the Laddakh Range. It is extended mainly in Tibbet. North of the Indus is the great Kara-Koram a region of lofty peaks and vast glaciers. Here India's frontier is joined with China and Afghanistan. The main peaks are Mt K^2 (8611m), the second highest peak in the world, and the highest peak in India, also named as **Godwin Austen** by the Britishers; Hidden Peak (8068m), Broad Peak (8047m) and Gasherbrum II (8035m). The largest glaciers are Hispar and Batura of the Hunza Valley over 57 km. long and Biafo and Baltoro of the Shigar Valley, a tributary of the Indus, 60 km. long. The Siachin glacier of the Nubra Valley is the longest one with a length of over 72 km. The Kara-Koram Range merge into Pamir Knot towards west. It is merged in Kailash Range of Tibet towards south-east.

The Ladakh Plateau occupies the north-eastern portion of Kashmir. It has an average elevation of 5300m. The plateau has been dissected into a number of plains and mountains. These are designated from north to south. Among these Lingzi Tang Plains, Lokzhung Mountains, Aksai Chin and Soda Plains are more prominent.

(5) The Eastern Hills or the Purvanchal

Himalayas have taken a sudden southward turn after crossing the Dihang gorge. They form a series of low hills, forming crescent shape. Their west side towards India is convex. These are extended from Arunachal Pradesh in the north to Mizoram in the south. They form India's frontier with Myanmar. These hills are known for their same origin as of the Himalayas. Patkoi are the northern hills with an elevation of 2000m to 3000m. These are merged with Naga Hills in the south. Saramati (3826m) is the highest peak of Naga Hills. Barail range separates Naga Hills from Manipur Hills, which are extended in the south of Naga Hills. The elevation of eastern hills decreases from north to south.

2.4.2 Great Plain of India

This plain lies between the Himalayas in the north and Peninsular Plateau in the south. It is an aggradational plain. It is a part of Indus-Ganga-Brahmputra Plain. It is known as most densely populated and most fertile plain of the world. It covers a total area of 7.8 lakh sq. km. Its average width varies from 150 to 300km. It is widest in the west where it stretches for about 500km. Its width decreases in the east and reaches to 145 km.

It is a monotonous plain. The average elevation is about 200m above mean sea level. Its highest elevation is 291m between Ambala and Saharanpur. It is a watershed area, separating the drainage system of the Ganga from the Indus. Politically, it extends as the lands of Rajasthan, Haryana, Punjab, Delhi, Uttar Pradesh, Bihar, West Bengal and Assam.

Origin and Formation of the Plain

It is almost universally accepted that this vast plain is the result of great depositions of deep depression lying between the Peninsular and the Himalayas. It is formed after the Himalayan Orogeny. The alluvial deposits are so deep, that it is very difficult to ascertain its actual depth. According to some experiments, the average thickness of alluvium is 1300 to 1400m. This thickness is higher between Delhi hills and Rajmahal hills. These have lesser thickness on its western and eastern margins. Thus, it is very difficult to ascertain the depth of the foredeep, on which, the depositional work took place.

Origin of Foredeep

Divergent views have been expressed regarding the origin of this great depression and the process of filling it. One of the group of scholars is of the view that this foredeep is in the form of geosyncline. It was a remnant part of Tethys Sea. The eastern part of this geosyncline has been named as Eastern gulf and the western part, as Gulf of Sind **Edward Suess**, the famous Austrian geologist is of such opinion. He suggested that a foredeep was formed in front of the Himalayas. It couldn’t further extend in south due to inflexible solid landmass of the Peninsula. It was like a syncline, which was filled up by the Himalayan Rivers mainly.

The another group of scholars is of the view that this foredeep is just like a great deep rift or fracture, which was formed at the time of the elevation of the Himalayas. **Sir Sydney Burrard** has concealed that a fracture in the earth's sub-crust, several thousand metres deep and 2400 km. long took place at the time of elevation of Himalayan chain. He has supported his view by giving examples of some other rift valleys of the Himalayas as well as the rift valleys of Narmada and Tapi in the Peninsular India.

Most of geologists do not agree with this view. They are of the opinion that there are no evidences of a rift valley at the northern edge of the Peninsula. Any how, there is no doubt that the Great Plains represent the infilling of a foredeep warped down between Peninsular Block and the advancing Himalayas. These have been formed by the deposition detritus of the mountains by the numerous rivers emerging from them during a period of great gradational activity.

Geomorphic Divisions of the Plain

This plain is so monotonous, feat and featureless; it is very difficult to put the plain into a number of divisions. Its surface is not more than 300m high from the mean sea level. The average gradient of slope between Saharanpur and Kolkata is 20cm per km. It declines towards the middle and lower valley of River Ganga. After Varanasi upto Ganga delta, the average slope is 15 cm. per Km. On the basis of nature of relief and soil structure the following divisions can be marked in this Great Plain.

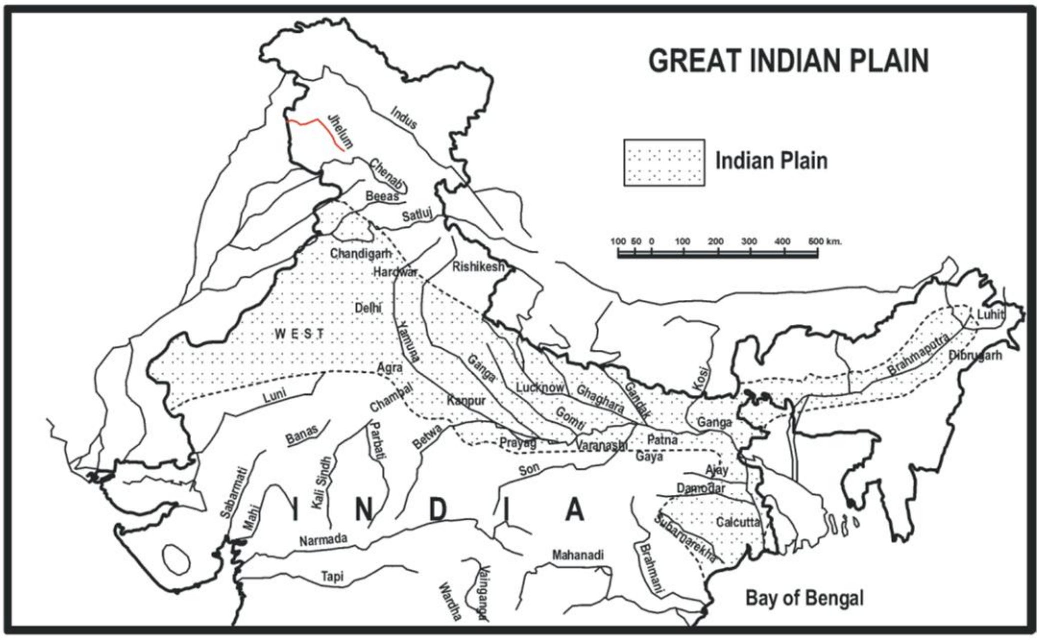

Fig. 2.7 Extent of Great Indian Plain

(i) The Bhabhar Region- The Bhabhar is a piedmont plain. It is composed of unsorted debris from the Himalayas. It forms the northern boundary of the Great Plain. The porosity of the pebble studded rock beds is so high that most of the streams sink and flow underground. Therefore, the area is marked by dry river courses except in the rainy season. Though, it is a narrow belt about 10 to 15 km. wide running in east-west direction but it is comparatively narrow in the east and extensive in the western.

(ii) The Terai Region- It is a 15-30 km. wide marsh tract in the south of Bhabhar running parallel to it. The water of underground streams of the Bhabhar belt is reemerged here. It is a low lying plain characterized by finer sediments, natural forest cover, emergent and ill defined water channels, low gradient and high water table resulting in swamps and marshes. Most of the Terai Region has been reclaimed and turned into the cultivation of rice, sugarcane and wheat.

(iii) Alluvial Region- The Great Plain is the product of alluvial soils. It is generally stiff clay with low sand content. This alluvium is of two types:-

(a) Bangar Alluvium- These are old alluvium, which were formed during the middle to upper Pleistocene age. These form the higher ground in the interfluve areas above the general flood limit. The colour is green. It is often composed with Calcareous concretions known as Kankar. These are highly fertile.

(b) Khadar Alluvium- It is composed of newer alluvium. It forms flood plains along the river banks. A new layer of alluvium is deposited by river flood every year. These deposits are of the age of upper Pleistocene and Recent period. The colour is light. These are good storage of underground water. The clays have Kankar and sand. These are quite fertile and are normally renewed every year, denoting the increase in fertility.

(iv) Reh- This is spread in those Bangar areas where the irrigation has the dominance. It is known as the white layer of saline efflorescences. It is widely extended in drier areas of Uttar Pradesh, and Haryana. It is also known as Kallar.

(v) Bhur- It denotes an elevated piece of land situated along the drain areas of Ganga and Ramganga Rivers. This has been formed due to accumulation of wind-blown winds during the hot dry months of the year. In real sense, these are dunes of sand.

(vi) Deltaic Region- These are formed on the mouth of rivers. Ganga-Brahmputra Delta is quite large and is extended on the lands of India and Bangladesh. The old delta is in India.

This Great Plain is badly eroded by the rivers on its southern margins especially between Chambal and Son Rivers and thus are known as 'Bad Land'.

Sub-divisions of Great Plains

On the basis of direction of flow of rivers and distinctive surface features in different parts, this plain can be divided into four major sub-divisions:

1. **Rajasthan Plain-** This is the western extremity of the Great Plain and is extended on an area of 1.75 Lakh sq. km. It covers western Rajasthan and is delimited by Aravalli Range in the east and Pakistan in the west. It is the part of Marusthali Marwar Plain. This desert is an undulating plain. The average elevation is about 350m. It's slope is towards south and west. It has vast stretch of sand with a few outcrops of bedrock of Gneiss, schists and granites. Such rocks prove the geologically that it is a part of the Peninsular Plateau, and gives an evidence of aggradational plain. Sand dunes cover a large area. The southern and western parts have mostly longitudinal plains. The eastern and southern parts, where ever the wind is strong, barkhans and transverse dumes are common. The steppe land of the Bagar runs, in a north-east to south-west direction from the north-eastern edge of the Aravalli to the 25 cm. isohyets in the west.

The main River is Luni. It has its basin in the south with a height of 150m. The topography is marked by a few hills of hard rocks. The Luni is a seasonal stream flowing towards south-west of the Rann of Kutch. The north area of Luni Basin has inland drainage with a number of lakes like Sambhar, Didwana, Lun Karansar, Kuchaman and Degna. The Sambhar lake is the largest. It covers 300 sq.km. area and is extended at a distance of 65 km. west of Jaipur.

2. **The Punjab-Haryana Plain-** It is also called Sutlej-Yamuna Divide. It is extended on Punjab, Haryana and Delhi states. Sutlej, Ravi and Beas are main rivers. Between Sutlej and the Yamuna, the Ghagghar a seasonal stream is important. River Saraswati was perhaps an important perennial river in the past, it disappeared with the change in climate.

This entire plain extends for a length of 640km. in north-west to south-east direction and is about 300 km. wide in east-west direction. The total area of this plain is above 1.75 lakh sq.km. It is bounded by River Yamuna on the east. On south-east Aravalli Ranges are ended near Delhi. The average height of the plain is 250m. It varies from 300m in the north to 200m in the south-west. The area has two regional slopes, westwards to the Indus Plain and southwards to the Rann of Kutch. The Ravi, the Beas and Satluj form Doabs the land between two rivers. The land between Ravi and Beas is called upper Bari Doab, the land between Beas and Sutlej as Bist Doab; and the land in the south of Sutlej is known as Ghagghar Plain. This Ghagghar Plain has developed as a fertile plain because of irrigation facilities.

3. The Ganga Plains- This Plain covers an area of 3.57 lakh sq. km. of Uttar Pradesh, Bihar and West Bengal. The slope is west to east and to south east. The Ganga is the main stream of the region. The important tributaries are the yamuna and Son on its right bank and the Ghaghra, Gandak and Kosi on the left bank. All through its course in the plains, the river is a braided stream by low-lying depressions which get flooded during rains. Bhangar and Khadar are its two main physiographic variations. Dead arms of rivers, filled up with water are called Beel. It has three main sub-divisions:-

(i) Upper Ganga Plain- It is bounded by Shiwalik Hills in the north, Peninsular Plateau in the south, River Yamuna in the west and 100 metre contour in the east. The average height is between 100 and 300m. The slope is steep in north as compared to south and east parts. Yamuna, Ganga, Ramganga, Sharda, Gomti, Ghaghra are the main rivers.

(ii) Middle Ganga Plain- It is extended on east U.P. and Bihar. It is bounded by 100m. coutour in the west, which follows Allahabad-Faizabad Rail Line, 75m contour on the east and 30m contour line on south-east. The plain is highly affected by the shifting of courses of rivers, causing floods. Kosi is a bad name, and called Borrow of Bihar.

Ghaghra, Gandak, Kosi and Ganga are main rivers. It has great occurrence of Khadar land. Kankar formation is less. It is highly fertile. It is decorated with ox-bow lakes and dead arms of rivers. Floods are the regular feature.

(iii) Lower Ganga Plain- It includes the whole of West Bengal excluding Purulia district in the west and the hilly parts in the north. It is extended from the foothills of Himalayas in the north upto Ganga Delta in the south. It is drained by Tista, Jaldhaka and Torsa rivers. The plain is narrowed down near Raj Mahal hills; it is formed in Pleistocene period and subsequently upwarped and eroded into terraces. Its most of the part is composed of recent alluvium. The level in the south is very low below 50m. The seaward face of the delta is strongly influenced by tidal estuaries resulting into a maze of sand banks, mud flats, mangrove swamps. It is covered with tidal forests called Sunderbans.

(iv) Brahmputra Plains- This is also known as Assam valley. It is low level narrow plain lying between Meghalaya Plateau and Himalaya Mountain. It is 80 Km. broad. The valley is built-up mostly by the aggradational work of the Brahmputra. The height is 130m in the east, and 30m in the west. The average slope is 12cm. per km. The direction of slope is towards south-west. Terai and semi-terai regions exist on the northern fringe of the Plains. These are covered with swampy soil and dense forests.

This Plain is the soul of India. It is most densely and prosperous part of the country. It plays a great role in the economy of India. This has high significance for agriculture, trade, industry and transport.

2.4.3 The Peninsular Plateau

These uplands are morphologically polygenetic and complex, relatively a stable landmass extends from the southern margin of the Great Plains upto the coastal margin of the country. The entire plateau measures about 1700 km. in north-south and 1400 km. in east-west direction. It covers a total area of about 16 lakh sq. km., and is the largest physiographic unit of India. The average height is 600-900m. The general slope of the plateau is from west to east with an exception of Narmada and Tapi rift valleys which slope westwards.

This Plateau occupies south-east Rajasthan, Madhya Pradesh, Chhatisgarh, Odisha, Maharastra, Gujarat, Karnataka, Telangana, Andhra Pradesh, Tamilnadu and Kerala. From the natural point, its north boundary is formed by Aravalli, Kaimur and Raj Mahal Hills, on its west western ghat and on its east Eastern ghat have its limitation. It is an ancient tabular block composed mostly of the Archean gneisses and schists. It has a number of evidences of structural changes. Some scholars are of the view that Meghalaya Plateau, Rajasthan Desert are the part of it, undoubtedly, the entire plateau is an aggradation of several small plateaus and hill ranges interspersed with river basins and valleys. A brief of all these features of the plateau will help us to understand the relief of this great plateau.

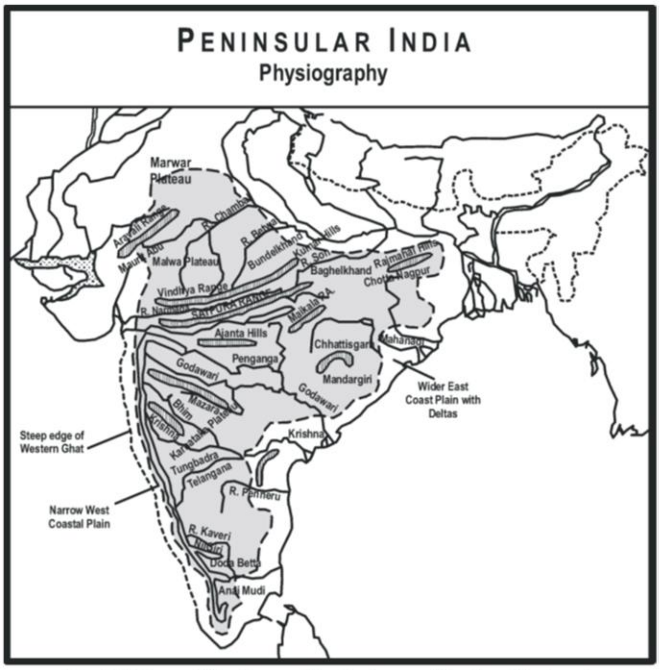

Fig. 2.8 Some Physiographic Features of Indian Peninsula

The Plateaus

Narmada and Son Rivers have dissected it in a number of plateaus. It has four main plateaus:-

(i) **Malwa Plateau-** This Plateau has complex geology. It is formed of lava and covered with black soils. The slope is towards north. Betwa, Parvati, Neewaj, Kali Sindh, and Chambal Rivers drain it. The general height decreases from 600 m in the south to less than 500m in the north. There are rolling plains and flat topped hills. The northern part of the plateau has been converted into ravines by River Chambal.

(ii) **Bundelkhand and Baghelkhand Plateaus-** The north-east part of Malwa Plateau is known by this name. It disappears near the Yamuna Plain in the north. It is extended between Gwalior Plateau and Vindhyachal Range. It is formed by old Bundelkhand gneiss. It has river terraces. The elevation is between 300 and 600m. The number of hills and dunes of sandstone and granite are found in scattered form.

Baghelkhand Plateau is extended in the east of Kaimur and Bharner hills. It is made up of limestones and sandstones on the west and granite in the east. The central part of the plateau acts as a water divide between the son drainage system in the north and the Mahanadi river system in the south.

(iii) **Chhotanagpur Plateau-** It is situated in the east of Baghelkhand, separated by River Son, flowing in north-west and joins the Ganga. Mahanadi, Swarn Rekha and Damodar are the other main rivers. Damodar River flows through the middle of this region in a rift valley from west to east. It has large deposits of Gondwana period. Mahanadi forms its southern limit, and flows in south-east direction. Raj Mahal Hills form the north eastern edge of the plateau. These are mostly made of basalt.

This Plateau virtually consists of a series of plateaus standing at different levels of elevation. Hazaribagh, Kodarma and Ranchi are the other main plateaus. The average elevation of Ranchi Plateau is 700m. Most of the surface is rolling where Ranchi city is located. At places it is interrupted by Monodnocks and conical hills. This plateau is known as storehouse of minerals. Bauxite, mica, and coal are the main minerals, found in abundance. It is also rich in forest wealth. Sal, teak, jamun, shisham, bamboo are the main trees. Hilly slopes and river valleys are known for rice cultivation.

(iv) Meghalaya Plateau- The rocks of the Peninsular plateaus are extended beyond the Rajmahal hills, and form a rectangular block known as Meghalaya or Shillong Plateau. Garo-Rajmahal gap has separated it. This gap is the result of down-faulting, which was filled by sediments deposited by the Ganga. This plateau is formed of the Garo hills (900m) in the west and Khasi-Jaintia Hills (1500m) in the east. These hills slope towards north to the Brahmputra valley and towards south to the Surma and Meghna Valleys. Cherapunji is situated in the south of Khasi Hills.

All the other Plateaus of the Peninsula are extended in the south of Narmada and Mahanadi Rivers. Among them Deccan Plateau is the main. Telangana and Karnataka Plateaus are extended in the southern part.

(v) Deccan Plateau- It is also known as Maharastra Plateau. Much of the region is underlain by basaltic rocks of lava origin. It covers an area of 5 lakh sq. km., and includes the parts of Madhya Pradesh, Chhatisgarh, Maharastra, and Gujarat. Thus, it is delimited by Amar Kantak and Sarguja in the east, Kutch in the west, Belgaum in the south and Rajmahindry in the south-east. River Tapi forms its north limit, the Western Ghats are found in the west.

The depth of lava is upto 2000m. This depth declines from west to east. The slope is from north-west to south-east. The broad and shallow valleys of the Godavari, the Bhima and Krishna are flanked by flat topped steep sided hills and ridges. Here, igneous rocks, sandstone limestone, and coal are the deposits of Gondwana Period. These rocks are rich in minerals. Iron ore, manganese, gold, mica, Magnesite, and Bauxite are the main minerals. The entire area is covered by black cotton soil known as regur.

(vi) **Telangana Plateau-** It covers most part of Telangana state. Godavari River has divided it into two regions, namely the ghats and rolling plains. The northern part is of hilly nature and is covered with forests. River Wardha has its flow on it. The southern part is peneplain in nature. It has given birth to a number of big towns like Hyderabad and Secundrabad.

(vii) **Karnataka Plateau-** It is extended in the south of Maharastra. The 600 m contour line divides it into two parts- (i) The Northern Part- It contains the head of the Tungbhadra and Kaveri river. Here Ghat Prabha and Mal Prabha Rivers join Krishna on its right bank. (ii) The Southern Part- It is known as Mysore Plateau. It is made up primarily of the Archean formations. It has rolling surface with an average elevation of 600-900m. It has its slope towards east.

This plateau is highly dissected. The plateau is divided into two parts called Malnad and Maidan. The Malnad in Kannada means hill country. It is dissected into deep valleys covered with dense forests. The Maidan is formed of rolling plain with low granite hills. The entire plateau tapers between the western ghats and eastern ghats in the south and merges with the Nilgiri Hills there.

Hills Ranges and Mountains of Peninsular Plateau:

The Plateaus of this peninsula are separated from one another by hill ranges and river valleys. Most of these hills are relict type. These are remnants of the original higher hills. The main hills are as follows:-

(i) **The Vindhyachal Mountain Range-** It extends more or less parallel to the Narmada valley in an east-west direction from Gujarat to Sasaram in Bihar. The total length in 1200 km. The general elevation is 300 to 750m. This range is a combination of Vindhyachal, Bharner, Kaimur and Parasnath Hills. It is composed of horizontally bedded sedimentary rocks of ancient age. Red sandstone is the most dominant rock. This range acts as a watershed between the Ganga system and the river systems of south India. It rather separates North India to South India. The northern slope of this range is rather gentle, but the southern slopes are marked with spurs, steep falls and valleys.

(ii) **Satpura Mountain Range-** It's name is derived from Sat (seven) and Pura (mountains). Therefore, it is a series of seven mountains. It runs in an east-west direction south of the Vindhyas and in between the Narmada and Tapi, roughly parallel to these rivers. It commences from Rajpipla Hills in the west and further in the east and north-east direction extended through Mahadev and Maikal Hills. In east, it is submerged in Rajmahal Hills. It is composed of mainly Basalt and Granite Rocks. The average height is 760m. The highest peak of this range is Dhupgarh (1350m) near Pachmarhi on Mahadev Hills. Amarkantak is the second highest peak with a height of 1066m. Narmada River takes it origin near to the peak. It has number of waterfalls. The main water fall is Dhuandhar on River Narmada near Jabalpur. Marble stone rocks are found here. Satpura Range is an escarpment on its north.

(iii) **Aravalli Hills-** It runs in north-east to south-west direction for a distance of 800 km. between Delhi and Palanpur (Gujarat). They represent the relict of the world's oldest fold mountain system.

The range is mostly composed of quartzites, gneisses, and schists of the Pre-Cambrian age. The average height is between 300 and 900m. In the north it is lower than 400m near Delhi. Here, these are known as Delhi Hills (304m). It is supposed to continue further north upto Hardwar buried under the alluvium of the Ganga Plains. In the south, it fans out into several ridges, most of them rising to above 900m. The highest point is reached at the Gurusikhar Peak (1722m) in the Abu Hills. Near Udaipur, these are known as Jarga Hills, and near Alwar as Harsh Nath Hills. This range functions as Water-divide. Mahi and Luni on its west, flows to Arabian sea. Banas, a tributary of Chambal, is on it’s east. All these are seasonal rivers. These are the oldest folded mountains of the world. A number of scholars have forwarded their views on its origin.

1. **According to Most of Geologists-** These are the oldest and are extended part of the high mountains. These have their origin in the form of fold mountains during Vindhyan Period. These mountains are highly affected by the processes of denudation. So, these are called mountains of circum-denudations.

2. **A.M. Heron-** These Hills are probably the oldest hills of the world, which still exist today.

3. **Fermor-** This is a horst type of mountain.

4. **D.N. Wadia-** The Aravallis extended as a continuous chain of lofty mountains from Deccan to possibly beyond. Present Aravallis are eroded remnants.

5. **M.S. Krishnan-** Aravallis were extended upto Lakshadweep Archipelago.

Aravallis are made by hard quartz rocks. These are known for lead, Copper, Zinc, Manganese, Asbestos, Marble stone and Mica Minerals.

(iv) **Western Ghats-** These are also called Sahayadris. These form the western edge of the Deccan tableland. They run in north-south direction, parallel and close to the Arabian sea Coast from Tapi Valley (21ºN) to a little north of Kanyakumari (11ºN) for a distance of 1600km. The western Ghats abruptly rise as a sheer wall to an average elevation of 1100m from the Western Coastal Plain and appear to be a imposing mountain. They slope gently on their eastern flank. They are composed of horizontally bedded lavas. These ghats have high surface variations.

The north Sahyadri extends from Tapi River to the origin of Malprabha River, with a length of 650km. Gadavari, Bhima, Krishna and Ura Rivers are originated from this area. Thalghat and Bhorghat are two main passes. Thalghat is at 581m height and provide passage to Kolkata, while Bhorghat is at 630m height connect Pune with Mumbai.

Middle Sahyadri runs between Malprabha River origin and Palghat pass. It is 650km. long. This part is made of granites and gneisses and present rougher topography. It is covered with dense forests. The average height is 1220m. The main peaks are Kudra Mukh (1892m) and Pushpagiri (1714m). Tungbhadra and Kaveri Rivers drain this area. Here, Nilgiri Hills mark the junction of the Western ghats with Eastern ghats. Doada Betta (2637m) is an important peak of the area.

South Sahyadri is extended from Nilgiri Hills to Kanyakumari upto a distance of 290km. Here, Palghat Gap is a prominent break in its continuity. The gap is only 24km. wide at its narrowest point and 144m high. It gives passage to Tamilnadu from Kerala. In the south of Palghat gap, there is an intricate system of steep and rugged slopes on both sides of the ghats. Anai Mudi (2695m) is the highest peak of South India. Palni Hills are in north east and Cardamom Hills are in south.

Western Ghats present a very youthful topography. The rivers flowing eastward have broad valleys.

(v) **Eastern Ghats-** These form the eastern boundary of the Deccan Plateau. They are extended from the south of River Mahanadi upto Nilgiri Hills in a length of 1300km. in North-east to south-west direction. They have lost their own existence after Nilgiri Hills. The average height is 615m. In north, the width is 190 km, while in south it reaches to 70 km. These Hills have been badly eroded by rivers. They exhibit a true mountain character between the Mahanadi and Godavari. The average height in this section is 920m. The highest point (1680m) is in the Visakhapatnam district. Mahendragiri (1501m),the second height, is in the Ganjam district of odisha. The ranges are principally composed of Khondalites and Charnokites and covered with dense forests.

These hills have been quite disappeared between Godavari and Krishna Rivers deltas. They appear again as continuous ranges in only the Cuddapah and Kurnool districts of Andhra Pradesh. These ranges, here are known as Nallamalai Hills, 900-100m high, composed of quartzites and slates,the southern part of these hills is called Pal Konda Range.

Further south in Tamilnadu, these hills become confusing, and have number of ranges in west and south-west direction. They are called Javadi Hills in North Arcot district, Gingee Hills in South Arcot district, Kollaimalai and Pachaimalai in Tiruchirapalli district, Shevroys and Gondumalai in Salem district and Biligiri Rangan Hills in Coimbatore district, which join Nilgiri Hills. Here the height is 1279m, composed mostly of Charnockites. Melagiri Range between Kaveri and Pinar Rivers is famous for the sandalwood and teak forests. Here, Kaveri River forms Hozekal waterfall.

Other Geomorphic Features:

(i) **Narmada Valley-** It is a rift valley. It lies between Vindhyachal Range in the north and Satpura Range in the south. This valley plain is 322 km. long and 35 to 56 km. wide. It is 152 m high from mean sea level. It is in the form of structural depression.

(ii) Tapi Valley- It is extended in the south of Satpura Ragne. It's plain is 240km. long and 50km. wide. It is 304m high from mean sea level and is also in the form of rift valley.

(iii) Kathiawar and Kutch Peninsulas- It is a bag type peninsula, which has been separated by alluviums of Gujarat from Peninsular Plateau. It is mostly composed of Deccan lavas, while tertiary rocks predominate in the Kutch peninsula, which is characterized by small folds, dissected plateaus and scarp lands. The northern most part of Kutch peninsula is known as Rann of Kutch. It is a subsided surfaced covered with mud flats and salt marshes flooded during the rains. The most part of Kathiawar Peninsula is composed by sand dunes. The midpoint of this peninsula has Girnar and Gir Hills. The Girnar peak is the highest peak with a height of 1117m.

In conclusion, it may be said that there is a great variety of physical features in peninsular India. Though, this plateau is poor in forest resources, yet it is rich in minerals and is regarded as the 'storehouse of minerals'.

2.4.4 Coastal Regions

The coastal line of India is 5686km. long. If we add to this coastline of our islands, the total coastline stretches to 7515km. The Coastal Plains run from Rann of Kutch in the west to the Ganga-Brahmputra delta in the east. The area between the Western Ghats and the Arabian Sea Cost is known as West Coastal Plain and that between the Eastern Ghats and the Bay of Bengal Sea Coast is called the East Coastal Plain. These two Coastal Plains may be put as follows:

1. Western Coastal Plains:

This is a narrow coastal plain. It is extended from Rann of Kutch to Cape Camorin. It has an average width of 64 km. Here, the rivers are small and swift. It can be divided into four sub-divisions:-

(i) **Kutch Peninsular Coastal Plain-** Kutch is an island. Rann of Kutch is a shallow bay that is joined with the mainland in dry season, but in rainy season, it has its own identity. It is a salty sandy plain interspersed with rocky hills. The Rann gets flooded during the rains.

(ii) **Gujarat Plains-** It is formed by the Sabarmati, Mahi, Narmada and Tapi Rivers. The Plain includes the southern part of Gujarat and the Coastal areas of the Gulf of Khambhat. This is a low plain. It is 12m high only near the mouth of Sabarmati. A chain of saline marshes near the coast is prone to floods during high tide.

(iii) **Konkan Plains-** This extends from Daman to Goa in a length of 500 km. The width varies from 50 to 80 km. It has some features of marine erosion. The Thana creek of the Ulhas around Mumbai island is an important embayment, which provides an excellent natural harbour on the southern side of the island. The slopes of western coast of Konkan have black soils, which are known for Sal and Teak foests. It has a series of small bays and coves lying between jutting head lands containing beaches of sand. The coconut trees are found near the coast of these small bays. It is known for Rice and Mango because of heavy rains.

(iv) **Malabar Coastal Plains-** This plain is extended from Goa to Manglore in a length of 225km. It is a low undulating plain. It is composed by old metamorphic rocks. It is more open and level than in the north. It has lateritic hills. The Mandovi-Zuari creek in Goa is an important embayment in the Coastline. Marine topography is quite marked on the coast. It is known for the luxurious growth of banana, mango, coconut, rice, betel nut, and spices.

(v) South Coastal Plains- This is mainly of Kerala Coast, which is extended between Manglore and Kanyakumari in 500km. length. This is much wider coastal plain. It is a low lying plain with the height of not more than 30m. the existence of lakes, lagoons, backwaters, spits etc. is main characteristic of this coast. The backwaters locally known as Kayals are the shallow lagoons or inlets of the sea, lying parallel to the coastline. These lagoons or lakes have been joined together by the canals, which are used for travel and trade. Kochchi port is also Located on one of such lake. This coast is very popular for fishing, coconut, rice, betelnut, banana and spices are grown on the lands of this coast.

2. East Coastal Plains

These are extended from mouth of Subarna Rekha to Kanya Kumari and are much wider and contain many prominent deltas. A major part of the plains is formed as a result of alluvial fillings. It is also known for the long series of sand deposits on the coastal areas, which are brought by sea waves. These sand deposits are responsible for the formation of Chilka and Palicut lakes. The inner part of the coastal area is the residual plain of alluvium, which is the product of denudation of upper areas. This coast is also known as Coromandal and North Circar Coast, which has its three main sub-divisions:

(i) The Utkal Plain- It comprises coastal areas of Odisha, and is 400 km long. This costal line is straight and smooth. Most important physiographic features are Mahanadi delta and Chilka lake. The coasts are much wider near Mahanadi delta. Chilka lake is in the South of the delta, which is 75 km. long. It is cut off from the Bay by a long spit of sand, hills enclosing it on the south and west. Here, Visakhapatnam port is a safe port in the back of Dolphin Rock. It has good facilities of shipping because of deep water. This plain has also the presence of a number of small rivers. Their mouth have a number of ports, which play an important role in coastal trade and fishing. The coastal and deltaic lands are known for jute and rice cultivation.

(ii) **The Andhra Plain-** It is extended along coast of Andhra Pradesh. The combined delta of the Krishna and Godavari is situated here. The Kolleru Lake is situated between the deltas of the two rivers. It marks the coast line of the past indicating the seaward advance of the deltas. The plains extend upto about 100 km. inland along the Krishna. Pulicat Lake, 40 km north of Chennai is a typical lagoon. It is separated from the sea by Sriharikota Island, an old beach ridge. This island is known for satellite launching station of ISRO.

(iii) **The Tamilnadu Plain-** It is extended in a length of 675 km. from Lake Pulicat to Kanyakumari along the coast of Tamilnadu and Puddudery. It's average width is 100 km. Near Kaveri delta, the width is 130 km. This delta is very fertile and is known as granary of South India. In the Gulf of Mannar, between Tamilnadu and Sri Lanka, there are several tiny coral islands.

2.4.5 Indian Islands

Apart from the large number of islands in the near proximity of the Indian coast, there are 247 distant islands, of which 222 islands are situated in Bay of Bengal and the remaining in Arabian sea. The islands of both of these differ to each other. The Arabian Sea Islands are the founder remnants of the old landmass and subsequent coral formations. The Bay of Bengal Islands represent surfaces of the Tertiary fold axis. All these islands have been put into two main categories on the basis of their location from the coast. The islands, which are at a distance of 1 to 5 km from the coast are defined as off-shore Islands, whereas those islands which are away from the coast i.e. more than 5 km are defined as Distant Islands.

1. Arabian Sea Islands

These extend from gulf of cambay to cape Comorian. They have Coral origin and are surrounded by fringing reefs. Here off-shore islands are mostly found near Kathiwar of Gujarat, gulf of Khambhat, near the estuaries of Narmada and Tapi and along the coastal areas of Maharasrtra, Goa and Karnataka.

The distant islands are Lakshadweep Islands. Literally means one lakh islands. Actually it is a group of 25 islands. Previously, these were known as Lakkadiv, Minicoy and Amendivi Islands. These are situated at a distance of 200 to 300 km. from the western coast of India, and are extended between 80^o to 120^o N Latitudes and 71^o to 74^o E longitudes. The total area of these islands is 32 sq. km. Lakshadweep is the biggest island. Kavarpatti the capital of these islands is situated here. Amindivi is an small island. Minicoy is the island of extreme south, and is situated on 8^o latitude. The area is 4.5 sq. km. These islands are known for Coconut groves.

2. Bay of Bengal Islands

These are situated nearly at a distance of 220 km from the mainland. These (mainly andman group) are extended in crescent shape in length of 590 km and a maximum width of about 58 km. They are developed in group, and are separated to each other by narrow bays. The coasts are of teeth shape which provides safe harbour for the ships. There are two main groups of these islands.

(i) Off-shore Islands- Such islands are more in number near Gangetic Delta. These are the evidences of alluvium deposits. Ganga Sagar is the longest island on the mouth of Hooghly. It is 20 km. long. New Moore island is recently formed. Mahanadi Brahmini Delta has also the presence of such islands. Pamban Island is situated between India and Srilanka. It is an extension of the peninsular surface in the Ramanathapuram district of Tamilnadu. A bridge carrying a railway line between Ramnathanpuram and Dhanushkoti connects it to the mainland. Sri Hari Kota island is situated near Nellore.

(ii) Distant Islands- These include Andaman and Nicobar group of islands, which are as follows-

(a) Andaman Islands- These are extended in a length of nearly 300 km between 92°20' E to 93°20' E longitude and 10°20' N to 14° N latitudes. It includes north, middle south and little Andamans. These form a group of 203 islands. These are separated by Ten Degree channel from the Nicobar group in the south. Andaman Islands are spread in an area of 8300 sq. km. These are formed by sandstone, limestone and shale of Tertiary period. These islands have rugged topography, with dense vegetation.

(b) Nicobar Islands- This group consists of 19 islands extended between 6°30' N to 9°30' N latitudes. They are scattered over a length of 262 km. with a maximum width of 58 km covering an area of 1653 sq. km. The great Nicobar of north is the largest island having an area of 168 sq. km., while the south nicobar has an area of 200 sq. km. The Southern most island is only 147 km. away from Sumatra island of Indonesia. The south most point of Nicobar is known as Indira point.

It is assumed that these distant islands are the remnant peaks of submerged mountains which were extended at the time between Arakan Yoma and mid-mountain range of Sumatra Island. The Barren and Narcondam islands, north of port Blair, are volcanic islands. Some of the islands are fringed with coral reefs. Many of them are covered with thick forests and some are highly dissected. Most of the islands are mountainous and reach to considerable height. Saddle Peak (773m) in North Andaman is the highest peak.

2.5 CONCLUSION

It is revealed that India has the rocks of all the ages since the origin of earth. Achaean Rocks are the oldest rocks, whereas Pleistocene rocks are the newest rocks. Peninsular India is decorated mainly with

Archean, Dharwar, Cuddapah, Vindhyan, Gondwana, Deccan trap, rocks. Archean Rocks are found in the core areas of Himalayas and Great plains. These have been the basic rocks. Himalayas are made up of Tertiary rocks, which are made up between Eocene and pliocene age. Our Great plains are made by the deposits of Pleistocene and recent rocks. These are still in formation.

The surface of the country is quite complex. Physical diversity is caused also due to difference in geological structure. It is very difficult to determine the number of physiographic regions. Hence, Himalayan Mountains, Great Plains, Peninsular Plateau, Indian Coasts and Islands are main five physiographic regions. The Indian Desert are also part of physiographic region. These have high surface variations.

2.6 SUMMARY

Geology of India is quite ancient, complex and varied. It has the rocks of Pre-Cambrian to the recent times. Peninsular India is made by old to oldest rocks. Himalayas rocks are younger than peninsular rocks and great plains have most young rocks. Indian rocks are put into four groups. These groups are composed by various systems. Pre-cambian rocks have Archean and Dharwar systems. Archean system is the system of oldest rocks. Dharwar Rocks are the dust of Archean system and are known for the deposits of valuable minerals. Purana group of rocks is formed by Cuddapah and Vindhyan system. Cuddapah system is very economically significant than Vindhayan rocks. These have the deposits of limestone, red sandstone, and fine clay. These rocks are basic materials for cement industry and building construction. Dravidian rocks system gives an evidence of beginning of life on the earth.

Rocks of Aryan group belong to the systems of Gondwana, Deccan traps, tertiary and quaternary. Gondwana system is known for coal deposits of India. These possess 98 percent of our coal reserves. This system experienced the luxurious growth of vegetation due to hot and wet climate. Deccan traps are hard rocks and their weathering has produced black fertile soil. These traps have variations in their thickness. Tertiary system is responsible for Himalaya's formation. This system has the rocks of Eocene, Oligocene, lower Miocene and mio-pliocene system. All these systems have helped in the formation of Himalayan ranges. Rocks of quaternary system include Pleistocene and recent rocks. Flanks of Pir-Panjal and Kashmir valley have riverine deposits. Indo-gangetic alluvium is the deposition made by rivers. The coastal alluvial deposits are also of Pleistocene age.

Indian physiography is of diverse nature. There are five main physiographic regions. The Himalayan mountains, the great plains, the peninsular plateau, the Indian coasts and the islands.

Himalayan mountains are extended between the gorges of Indus and Brahmputra. It forms our northern frontier. It has 2400 km. length. The average height is 6000 m. These are young folded mountains. It in made up by sedimentary rocks. It has three geographical divisions. Great Himalayas are the loftiest. These are snow-bound throughout the year. It has the origin of a number of important rivers like Ganga, Yamuna, Jhelum, Chenab, Ravi, Beas, Kosi. It has also a number of passes and glaciers. Lessar Himalayas form the parallel range of great Himalayas. It has a number of ranges. Pir Panjal is its western extension. It has open valley of Kashmir. It is the longest and most important range. Pir Panjal and Banihal are two important passes. Siwaliks are the outer most range of the Himalayas. The altitude varies from 600 to 1500m. These are made by sands, gravels and conglomerates. These are disappeared at several places by the erosion of rivers. Dun valleys are developed between Siwaliks and lesser Himalayas. Trans-Himalayas are extended north of great Himalayas. These have parallel ranges of Zaskar, Laddakh, Kara-Koram and Kailash. The K^2, the second highest peak is situated on Kara-Koram ram. Purvanchal hills form the north-east frontier with Myanmar.

Great plains are an aggradational plain. It is monotonous in nature. Sutlej Yamuna divide is a watershed area. This plain is the result of the deposition of alluvium in the depression brought by rivers from the Himalayas. The alluvium has a great depth. On the basis of nature of relief and soil structure it is divided into Bhavar, Terai, Bhangar and Khadar alluvium, reh, bhur and deltaic alluvium. Bhangar is an old alluvium, and is highly fertile on the basis of flow of rivers and distinctive surface features, it is divided into Rajasthan plain, Punjab-Haryana plain, Ganga plain and Brahmputra plain. Ganga plain is the most extensive. Here, Ganga is the main river. It is most fertile and densely populated. It has three sub divisions upper, middle and lower. There plains are the soul of India.

The Peninsular plateau, a stable landmass is extended from the southern margins of the great plains upto the coastal margins of east and west. It is aggradations of several small plateaus, and hill ranges interspersed with river basins and valleys. Malwa Plateau is covered with black soils. Bundelkhand and Baghelkhand Pleateau make the north limit of the plateau. Bundelkhand pleateau has number of hills and dunes of sand. Baghelkhand Plateau is made up of limestones and sandstones. It acts as a water divide. Chhota Nagpur Plateau is a series of Plateaus. It is the store house of minerals and forest resources. Meghalaya Plateau is formed by Garo, Khasi and Jaintia hills. Deccan plateau is known as Maharastra Plateau. It is made by lava. It has shallow valleys of the Godavari, Bhima and Krishna. Telangana plateau and Karnataka plateau are extended in the south part of the peninsula and have rolling plains and deep valleys.

The Vindhyachal Mountain Range is a combination of Vindhyahal, Bharner, Kaimur and Parasnath Hills. It is known for red sandstone. It is an escarpment of Narmada valley. Satpura mountain range is a combination of Mahadev, Maikal and Rajmahal hills. Amarkantak peak of the range is known for Dhuandhar waterfall. Aravalli hills are the oldest mountains. Western ghats, are just like a wall of western edge of the Plateau. It is crossed by three passes. Eastern ghats forming the eastern edge have been badly eroded by the rivers. These ghats join Western Ghats through Nilgiri hills. Narmada and Tapi River valleys are rift valley and form estuaries.

The mainland coastal plain is 5686 km. long. It is known as western coastal plain in the west. It is a quite narrow plain and has steep slope towards Arabian Sea. Eastern coastal plains are much wider and contain many prominent deltas. India has 247 distant islands. Out of which 222 islands are situated in Bay of Bengal and the remaining in Arabian Sea. Arabian sea islands are coral islands. Bay of Bengal islands are remanants of tertiary folds. In Arabian Sea, Lakshdweep islands is a group of 25 islands. These distant islands are at a distance of 200 to 300 km. from the western coast of India. Bay of Bengal islands are off shore and distant islands both. Andaman Islands are 203 in number. These have rugged topography with dense vegetation. Nicobar islands are 19 in number. The Great Nicobar is the largest island. The south most point is known as Indira point, which is now washed away by Tsunami waves. These are covered with thick forests.

2.7 GLOSSARY

- Pre-cambrian - Archean Rocks
- Group of Rocks - Divided into systems of Rocks
- Gondwana land - A landmass in the south of Tethys Sea
- Terrestrial plants - Glossopteris flora
- Deccan Traps - Deccan Lava Plateau
- Vindhyan Stone - Red Sandstone
- Angaraland - A landmass in the north of Tethys Sea
- Lagoons - Circular or ring coral lakes
- Bhangar - Old Alluvium
- Khadar - New Alluvium

- Himadri - Snow land
- Pass - A narrow gap between two hills
- Lesser Himalayas - Middle Himalayas
- Outer Himalayas - Shiwalik or sub-Himalayas
- Duns and Duars - Valleys between Shiwaliks and middle Himalayas longitudinal vales
- Glacier - River of ice and snow
- Aggradational Plain - Depositional plain
- Monotonous Plain - Uniform in topography
- Watershed - Water divide are between two Regular River Flow
- Foredeep - A great depression or geosynclines
- Bhavar - A piedmont plain of unassorted debris
- Terai - Low lying plain
- Reh - Saline land
- Bhur - Dunes of sand
- Beel - Dead arms of rivers
- Back water - Shallow lagoons
- Kosi - Sorrow of river
- Rolling plain - A plain at certain height with considerable slope
- Escarpment - An elevated wall side of a hill
- Cope Comorin - Kanya Kumari
- Sahyadri - Western ghats
- Rift valley - A submerged valley between two high landmasses
- Distant islands - Situated nearly 5 km away from the main land
- Off shore islands - Situated near or along the coastal line of mainland
- Rann of Kutch - Sandy and saline plain

2.8 ANSWER TO CHECK YOUR PROGRESS

1. The present relief is the product of long geological history.
2. Geological history of India is identical to human history.
3. India has geological formations from Precambrian to the Recent times.
4. Indian Rocks belong to four main groups – Archean, Purana, Dravidian and Aryan.
5. Archean Rocks are the oldest rocks, and highly metamorphosed.
6. Archean rocks are of two systems- Archean and Dhawar.
7. Dharwar Rocks are rich in minerals like iron ore, manganese, mica.
8. Aravalli hills were formed in Dharwar period.
9. Purana group of rocks is composed by cuddapah and Vindhyan System
10. Cuddpah Rocks are less significant than Vindhyan Rocks.
11. Vindhyan Rocks are known for excellent and durable limestone and Red sandstone.
12. Dravidian Rocks are mainly found in extra-peninsular region.
13. Aryan system of rocks belong upper Carboniferous to recent times.
14. Gondwana Rocks of river valleys are rich in coal reserves.
15. The weathering of Deccan Trap rocks has given birth to black cotton soil.
16. Eocene to Pliocene period is known for tertiary system of rocks.
17. Tertiary system of Rocks gave us two physiographic regions Himalayas and Great Plains.
18. The orogenic movements on the Tethys Sea basins gave birth to Himalayas.
19. Pleistocene Rocks are marked by cold climate and glaciations.

20. Karewa Sarovar Rocks of Kashmir gave the birth to Kashmir valley.
21. Indo-Gangetic Alluvium deposits are brought by Indus, Sutlej, Ganga and Brahmputra Rivers.
22. The coastal areas of peninsular India have alluvial deposits of Pleistocene age.
23. Peninsular India has rocks of oldest period to recent period.
24. Himalyas and Great Plains have rocks of tertiary to recent age.
25. Indian physiography is complex due to long geological history.
26. To determine the number of physical divisions of India, it is a difficult task due to geomorphological diversities.
27. India may be put into five physiographic divisions on the basis of nature of surface.
28. The Himalayas of India are well defined and are extended between the gorges of Indus and Brahmputra.
29. Himalayas are young folded mountains.
30. Himalayas are still in the stage of formation.
31. Great Himalayas are the loftiest and continuous rangers.
32. It is snow bound throughout the year.
33. Middle Himalayas are also known as lesser Himalayas.
34. Banihal pass connects Jammu with Srinagar.
35. Kashmir valley is extended between Pir-Panjal and Great Himalayas.
36. Kashmir valley was a lake in the Pleistocene age.
37. Outer Himalayas are known as Siwaliks.
38. Siwaliks are composed of sands, gravels and conglomerates.
39. Valleys scattered between Siwaliks and middle Himalayas are known as Duns and Duars.

40. Trans-Himalyas are extended immediately north of Great Himalayas.
41. Trans-Himalayas include Zaskar, Kailash, Laddakh and Karakoram.
42. Kara-Koram Range is a region of lofty peaks and vast glaciers.
43. The highest peak of Kara-Koram Range is MT. K^2 (8611m)
44. Siachin glacier of Nubra valley, is the longest glacier of the Kara-Koram area.
45. Eastern hills are known as Patkoi, Naga and Manipurm hills.
46. The great plains are aggradational plains.
47. The Great Plains is a result of great depositions of a deep depression.
48. To division of Great Plains is quite typical due to its monotony in nature.
49. The plain is marked by Bhavar on its north as a piedmont plain.
50. Terai Region is a low lying plain, with finer sediments.
51. Bhangar and Khadar are the main alluviums.
52. The western extremity of the Great Plains is known as Rajasthan plain.
53. Punjab Haryana plain is also known as Sutlej-Yamuna Divide.
54. Ganga plains has three sub-divisions upper, middle and lower.
55. Peninsular plateau is the combination of a number of small plateaus hills ranges, inspersed with river basins and valleys.
56. Malwa plateau is formed of lava and covered with black soils.
57. North-east part of Malwa plateau is known as Bundelkhand and Baghelkhand plateau.
58. Chhota Nagpur plateau is the store-house of minerals.
59. Deccan plateau is underlain by basaltic rocks of lava origin.
60. Vindhyachal Mountain range runs parallel to Narmada valley.

61. Vindhyahal mountain range is an escarpment of Narmada Rift valley.
62. Satpura mountain runs in east-west direction between Narmada and Tapi.
63. Satpura mountain Range is a combination of Satpura, Mahadev, Maikal and Rajmahal Hills.
64. Vindhyachal mountain Range is known as Vindhyachal, Bharner, Kaimur and Parasnath Hills.
65. Aravalli Hills are the oldest folded mountains.
66. The highest peak of Aravalli Hills is Gurusikhar Peak with 1722m height on Abu Hills.
67. Western Ghats run parallel and close to Arabian Sea coast.
68. Western ghats have three main passes-Thalghat, Bhorghat and Palghat.
69. Eastern ghats have been broken at many places by the rivers.
70. Eastern ghats join western ghats near Nilgiri Hills.
71. Narmada and Tapi Rivers form their estuaries and flow in rift valley.
72. Peninsular India conclusively has a great variety of physical features.
73. The length of our total coast line (with islands) is 7515 km.
74. Western coastal plains are narrow coastal plain.
75. Konkan and Malabar coastal plains are main part of western coastal plains.
76. Eastern coastal plains are much wider and contain prominent deltas.
77. Eastern coastal plain is also known as North circar coast and coromandal coast.
78. India has 247 distant islands.

79. Arabian sea islands are the remanents of old landmass.
80. Bay of Bengal Islands represent surfaces of the tertiary fold axis.
81. The distant islands of Arabian Sea are known as Lakshdweep Islands.
82. Bay of Bengal Islands as distant islands are defined as Andaman and Nicobar islands.
83. Pamban Island, an off-shore island connects India with Srilanka.
84. Sri Hari kota Island is a centre of ISRO and is situated near Nellore of Andhra Pradesh.

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2.11 TERMINAL QUESTIONS

1. Geological History of India is full of diversities. Examine this statement.
2. Archean group of rocks are basic rocks of India. Explain it in the context of their distribution.
3. Gondwana Rocks are known for their economic importance. Explain the distribution of these rocks.
4. Examine the geological structure of Peninsular India.
5. Tertiary Rocks have played a great role in the make of present map of India. How much do you agree with this statement? Explain.
6. Explain in detail the relief surface of Himalayan Mountain Region.
7. Elaborate the orogeny of Himalayas.
8. Give a geographical classification of Himalayas.
9. The Great Plains of India is a contribution of Himalayan Rivers. Justify this statement.
10. Explain the surface features of Indian Great Plains.
11. Discuss the physical characteristics of Gangetic Plain.
12. Discuss the social and economic importance of the Great Plains of India.
13. Peninsular India has a great variety of physical features. How do you agree with this statement? Examine it.

14. Divide India into physiographic regions and explain the physical features of any one of the Region.
15. India Plateau is an association of a number of plateaus, river valleys and hills. Examine this statement.
16. Write an essay on the relief of Southern Peninsula.
17. Discuss in detail main plateaus of peninsular India.
18. Discuss in detail main hills and mountains of peninsular India.
19. Western coastal plains and East coastal plains are not identical. Examine this statement in reference of their surface variations.
20. East coastal plains are broad coast plains. Discuss.
21. Describe the geographical structure of Western Coastal Plain.
22. Write an essay on the physical structure of Indian islands.

Objection Questions

1. Which is not included in Archean Rocks-
   (a) Gneiss (b) Schist (c) Granite (d) Sedimentary
2. Which mineral is not found in Cuddapah Rocks-
   (a) Iron ore (b) Manganese (c) Coal (d) Copper
3. Vindhyan Rocks are not found in which state-
   (a) Meghalaya (b) Karnataka (c) Madhya Pradesh (d) Rajasthan
4. Gondwana Rocks are found in which River valley-
   (a) Ganga (b) Mahanadi (c) Sutlej (d) Brahmputra
5. Which rocks are important for coal-
   (a) Gondwana (b) Vindhyan (c) Deccan Trap (d) Cuddapah
6. Which has the main contribution in the formation of Deccan Traps-
   (a) Granite (b) Lava (c) Clay soil (d) Sedimentary rock
7. Tertiary Rocks have helped in the formation of which physiographic region-
   (a) Himalayas (b) Great Plains (c) Chhota Nagpur Plateau (d) Aravalli Hills
8. Which pass provide way to Srinagar-
   (a) Banihal (b) Pir Panjal (c) Zipla (d) Rohtang

9. Indus River forms deep George at which depth near Nanga Parbat-
   (a) 5280m (b) 5100m (c) 5180m (d)5150m
10. Which glacier is the longest one of Trans-Himalaya-
    (a) Baltora (b) Siyachin (c) Wichafo (d) Hisspar
11. K^2 mountain peak is situated on which mountain range-
    (a) Zaskar (b) Laddakh (c) Kara-Koram (d) Hindukush
12. Sutlej-Yamuna Divide is not extended on which state-
    (a)Punjab (b) Haryana (c) Delhi (d) Himachal Pradesh
13. Which part of Great plains has least slope gradient-
    (a) Upper (b) Middle (c) Lower (d) not any one
14. Alluvial deposits have taken place on the bed of which rocks-
    (a) Tertiary (b) Godwana (c) Archean (d) Vindhyan
15. Which lake is the biggest one-
    (a) Sambhar (b) Didwana (c) Kuchaman (d) Degna
16. Which hills are the oldest-
    (a) Vindhyachal (b) Satpura (c) Aravalli (d) Garo
17. Which river divides peninsular India into two divisions-
    (a) Chambal (b) Narmada (c) Tapi (d) Damodar
18. Oatacmond (ooty) is situated on which hills-
    (a) Palni (b) Nallamalai (c) Nilgiri (d) Rajmahal
19. Western and Eastern ghats meet at which place-
    (a) Annamalai (b) Palni (c) Nilgiri (d) Aravalli
20. Which is the highest peak of peninsular India-
    (a) Dodabeta (b) Annaimudi (c) Gurushikhar (d) Dhupgarh
21. Which river does not form its own delta-
    (a) Mahanadi (b) Godavari (c) Kaveri (d) Narmada
22. Dhuaondhar waterfall is situated on which river-
    (a) Tapi (b) Narmada (c) Sabarmati (d) Mahanadi
23. Rann of Kutch does not have which feature-
    (a) Salty (b) Sandy (c) Infertile (d) Fertile
24. Mandvi-Zuari narrow valley is located in which state-
    (a) Karnataka (b) Kerala (c) Goa (d) Maharastra
25. India has how many Islands-
    (a) 251 (b) 247 (c) 222 (d) 210

26. Which island is not located in Arabian Sea-
    (a) Laccadiv (b) Minicoy (c) Amindivi (d) Pamvan
27. Which island is coral made-
    (a) Laccadiv (b) Nicobar (c) North Andaman (d) Harikota

Answer

1 (d), 2 (c), 3 (a), 4 (b), 5 (a), 6 (b), 7 (a), 8 (a), 9 (c), 10 (b), 11 (c), 12 (d), 13 (c), 14 (c), 15 (a), 16 (c), 17 (b), 18 (c), 19 (c), 20 (b), 21 (d), 22 (b), 23 (d), 24 (c), 25 (b), 26 (d), 27 (a)

UNIT 3 - DRAINAGE

3.1 OBJECTIVES

After reading this unit, you should be able:

1. To highlight all the major drainage systems of India.
2. To understand drainage patterns of India in different physiographic regions.
3. To acquaints us with the nature of flow of water on the surface.
4. To assess the amount of water in the rivers, season and amount of rainfall, nature of slope, pattern of river system in the area.
5. To examine various aspects of drainage of the country.

3.2 INTRODUCTION

Importance of Rivers- Rivers have played a great role in the economic development of India. These have been the means of economic and social activities of man since pre-historic time. Indus and Ganga river valleys are the birth place of Harappa, Mohan-jo-daro and Aryan civilization. Rivers constitute the most useful natural resource. They are the source of water for irrigation, domestic and industrial water supply, and hydro power generation. They serve as arteries of internal water transport. They provide us sand for building construction, glass industry. They play a great role in agricultural production, as they bring fertile soil, which give more production. They are the source of fishing activities. A number of ancient towns were developed along river banks, and most of them have emerged out as big towns of today. These rivers have their religious significance. This running water is a source of electricity generation, water for irrigation and drinking, and means of transportation.

3.3 MEANING OF DRAINAGE

Drainage implies the surface flow of water through streams and rivers. On one hand, it is an indication of amount of rainfall, and as well as the nature of surface in the regions. Rivers, as a running water play an important role in shaping the landscape. Great plains are the best example of it. Drainage system depends on number of factors-such as geological structure, nature of slope, amount of water, size and speed of water flow.

Evolution of Drainage system and changes in course of rivers

Indian rivers have noted the changes in their course of flow since the ancient times. The diastrophic movements, which helped in the formation of the Himalayas, have been responsible for these changes. These movements are responsible for the emergence of Himalayas out of the Tethys Sea. This sea was filled up by sediments brought by the rivers, flowing from two land masses- Gondwana land and Angaraland. During the first Himalayan upheaval in Oligocene period, part of Tethysian geosyncline was uplifted. This incidence is marked as an initiation of the Himalayan drainage. It is the view of a number of geologists that there was a mighty river which flowed from Assam to Punjab and even beyond upto Sindh. This hypothetical ancient river was called **Indo-Brahm** by **E.H. Pascoe**. He defined it as a great river. The Indus and Brahmaputra are the severed part of this original river. **E.G. Pilgrim** has named it as the Shiwalik River. He was of the opinion that the course of the primitive river is occupied by the present day Shiwalik hills. **Pascoe** and **Pilgrim** forwarded this assumption that Shiwalik deposition occurred along this great river. The earth movements of Tertiary period were responsible for the origin of this river and are believed to be successor of the Himalayan sea.

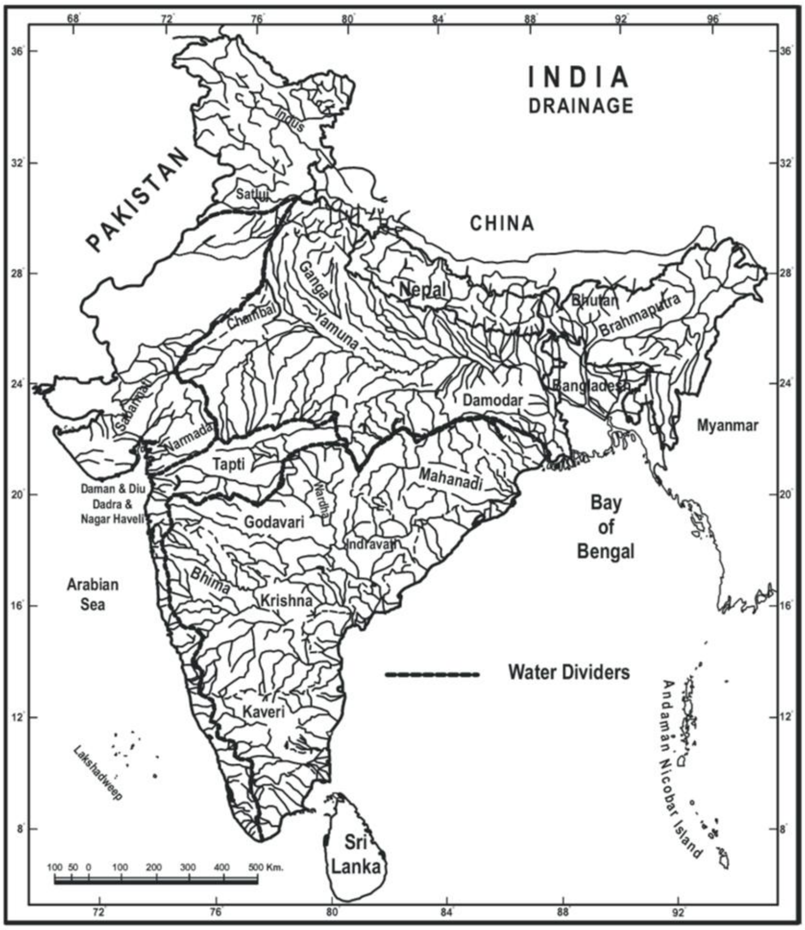

Fig. No. 3.1 Pattern of Drainage

It is the assumption that the upheavals of Himalayas have been responsible for the changes in the river system of Punjab and Sindh. After the formation of the Shiwaliks, an earth movement took place in Punjab, which disrupted the drainage system of this Great River. The uplift of the Shiwalik Range gave the origin and development of three river system, which are known as the Indus system, Punjab Rivers system and Ganga system. After the developments of these systems, a number of changes took place.

The dismemberment of the Indo-Brahma River, the Indus and its tributaries, the Ganga and its tributaries and the Brahmaputra and its tributaries came into being. It is supposed that the Yamuna was first a tributary of the Indus. During the late Pleistocene period, it joined with Sarswati somewhere in Suratgarh and continued to flow as Ghaghar, finally joining the Indus.

Some other scholars believe that Saraswati River reached upto Rann of Kutch as an independent river. Later on, it changed its course due to tectonic disturbance and it moved with the time towards the east, and was annexed by the Ganga to become its tributary and was called a Yamuna.

Geologists have forwarded this view also that in historical epoch, Sutlej and Yamuna were having their course of flow through Rajasthan. Saraswati River, which is now disappeared, was having its course near Nahan. River Yamuna, in the north of Delhi was having its course in the west of Karnal. In the early Christian era, Sutlej was an independent river. It emptied itself into the sea, but now it joins Indus River. Beas River, had its flow upto River Indus, but now it empties its water in Sutlej River near Ferozpur.

Changes in the course of River Ganga and its tributaries

Ganga and its tributaries have made important changes in their courses. During the fourth and sixth centuries Paliputra (Patna) was the capital city of Mauryan and Gupta's dynasty. This Patna was situated at the meeting point of son, Ghaghra, Gandak and Punpur rivers to Ganga. It was an important river port and trade centre. But it lost its prosperity with the time. Kosi River in the early of 18th century had its flow in the lower part of Purnea but now it flows in 80 km. west of Purnea. Tista River, firstly was tributary of River Ganga, but at the moment it falls its water into River Brahmputra. Brahmputra River previously had its flow in the east of Dacca, but at present it flows in the west of Dacca. It denotes that this river has made notable changes in its course.

Changes in the course of Rivers of Assam and its adjoining areas

Pascoe envisaged a great Tibbatean River flowing north-west wards along Tsangpo-Indus trough. This river might have empties itself into the oxus lake. In the support of his view, he has mentioned the Kei, Rong, Niang, Shabki rivers as tributaries of Tsangpo. The direction of their flow is towards the west, just opposite to the direction of present flow. **Pascoe** has assumed that this Tibbetean River is captured by Attock River of Punjab. He also argued that Sutlej captured a part of Tibbetean River and then lost again to the rejuvenated Tsangpo after the Dihing had cut back into the furrow. **De Terra** has argued that the Rivers of east Kara-Koram and Laddakh Region might have flown south eastward or eastward in the early of Pleistocene ice age. Its capture in the east might have executed by Dihang, a tributary of the Brahmputra. Both those views are controversial.

Distribution and Types of Drainage System in India

Main rivers and their tributaries are the base of drainage system. The direction of the flow of these rivers depend on nature of surface, degree of slope, structure of rocks, amount of water supply and size of catchment area. On the basis of river system in different physiographic regions, all Indian rivers along with their tributaries can be put into four groups:

(1) Himalayan River System

(2) Peninsular River System

(3) Coastal River System

(4) Inland River System

3.3.1 Himalayan River System

Three major river systems i.e. the Indus, the Ganga and the Brahmputra comprise the Himalayan River System. Many of the Himalayan rivers existed even before the Himalayan ranges were uplifted. The Gorges of the Indus, the Sutlej, the Alaknanda, the Gandak, the Kosi and the Brahmaputra clearly indicate that these rivers are older than the mountains themselves. It is believed that they continued to flow all through the building phase of the Himalayas; their banks rising steeply while the beds went lower and lower thus cutting deep Georges through the rising Himalayan Ranges. The gorge of river Sindh near Gilgit is 5180m. deep is an evidence. This river valley is the product of vertical erosion and has river terraces at different heights. Himalayan Rivers are typical example of antecedent drainage. All the Himalayan Rivers have deposited the eroded material on the plains, and thus, have played an active role in giving the present shape to these plains.

Indian River system of extra-peninsular India was divided into three parts with the formation of Shiwalik Hills. Two systems of these are situated in North India.

I Indus River System

This is one of the world's largest river systems. The Indus, Jhelum, Chenab, Ravi and Sutlej are the main rivers.

The **Indus**- This is the main stream. It rises near Mansarovar Lake from the glaciers of the Kailash Range at an elevation of 5000m. The river flows for 709 km. in India, through Jammu and Kashmir. The Shyok, the Shigar and the Gilgit join the Indus in this state. This River makes a steep turn near Nanga Parbat and thus enters in Pakistan having south-west flow. Zaskar River rising from Zaskar Range joins Indus near Leh. Five eastern tributaries of Indus are; Jhelum, Chenab, Ravi, Beas and Satluj. The river after its flow in dry Sindh lands finally empties itself into Arabian Sea. The total length of this river is 2880 km. It flows in India with a length of 1270 km. The total drainage area in India is 3.2 lakh sq. km. It contains huge amount of water. Nearly 60 percent of its water is used by India in a year under the Indus water Treaty.

The **Jhelum-** This river rises at verinag in Kashmir and flows through the Kashmir valley and Wular Lake before entering Pakistan through a narrow gorge across the Pir Panjal Range. It has formed Kashmir valley prosperous and fertile. At Muzaffarabad, it takes a sharp turn southward. Thereafter, it enters in Pakistan after Baramula and forms a deep valley. The total length of the river is 400 km. and the drainage area is 28490 sq. km. in India. Several power and irrigation projects have been developed on the river in Jammu and Kashmir. This river is navigable in the Kashmir state.

The **Chenab-** It is the largest of all the Indus tributaries. It is formed by two streams-Chandra and Bhaga. It originates from near the Bara Lacha pass in the Lahul-Spiti part of Zaskar Range. The united stream called the Chandrabhaga flows in the north-west direction and enters Jammu and Kashmir as the Chenab River at an elevation of 1838m. Near Kistwar it cuts a deep gorge. The river flows 1180 km. and its drainage spreads over 26755 sq. km.

The **Ravi-** It originates in Kullu Hills near Rohtang pass of Himachal Pradesh. It drains the area between the Pir Panjal and the Dhaola Dhar Ranges. It enters Punjab plain near Pathankot and later enters Pakistan 26 km. below Amritsar. Upper Bari Doab Canal is taken out from this river at Madhopur. It joins the combined flow of Jhelum and Chenab near Multan in Pakistan. It flows for 725 km. and drains 5957 sq. km. area in India.

The **Beas-** It originates near Rohtang Pass, at a height of 4062 m. This pass is 5 metre wide and 180m long. After flowing in Kullu, Mandi, and Kangra districts, it enters in the plains east of Pathankot. Thereafter, it takes a south-westerly direction and meets Sutlej River near Kapurthala or Harike. It is only 470 km. long. It’s catchment area is 25900 sq. km.

The **Sutlej-** It rises near Darma pass of Mansarovar lake at a height of 4570 m. It cuts deep gorges in the Great Himalayas. It has created an extra-ordinary canyon here, where the channel is 900 m deep. It’s tributaries in Himalahal Pradesh are short in length. Before entering Punjab plain, it cuts a gorge in Naina Devi Dhar, where the famous Bhakra Dam has been constructed. It is joined by the Beas at Harike. From near Ferozpur to Fazilka it forms the boundary between India and Pakistan for nearly 120 km. It receives the collective drainage of the Ravi, Chenab and Jhelum Rivers in Pakistan. It has its 1050 km flow in

India. It drains on area of 25900 sq. km. It's most of water potentiality has been used by the canal systems of Bhakra Nagal Project, and of the Harike and Sirhind barrages.

The waters of the Indus system are shared by India and Pakistan according to the Indo-Pakistan Indus Water Treaty signed by the two countries in 1960. According to this Treaty, India can utilize the water of Sutlej, Beas and Ravi without any restriction, while the water of Indus, Jhelum and Chenab can be used by India with certain restrictions.

II The Ganga River System

This is the most important river system. It provides the water to one fourth part of the country. It supports 40 percent population of India. The area also produces bulk of India's agricultural output. The total hydro-power potential of the Ganga system is estimated 13 million kw. This basin is shared by ten states. The total area of the Ganga basin in India is 8.61 lakh sq. km. This system includes the rivers of two different areas, firstly Rivers originating from Himalayas and secondly, originating from peninsular region. Main and most important rivers of the system are as follows-

The Ganga River- This is the master stream of the system. It is formed by two head streams, namely the Alaknanda and Bhagirathi. The Alaknanda rises near Garhwal-Tibet border at an elevation of 7800 m and the Bhagirathi originates from Gangotri Glacier in Uttarkashi district. Both of these rivers meet at Dev Prayag and then afterwards is known as Ganga. This river enters the Great Plains at Hardwar from where it flows towards south and south-east to Allahabad. According to **Trabou** this river is the biggest river in three continents and it is nearly 3000 km. long. This is the most sacred river of Hindus. Because of it, a number of holy places have developed on its bank from Gangotri to Delta. Hardwar, Prayag and Varanasi are most important. It has also developed large industrial and commercial centres of north India. Among these Kanpur, Varanasi, Patna, Kolkata are most famous. It's flow in the plains has been helpful in the ejection of canals in the area."

The main source of Ganga River is Gangotri glacier, which has its location at Gomukh near Kedarnath at an elevation of 6600m. Here, it is called as Bhagirathi. Janhavi River, a river of Great Himalaya, joins Bhagirathi near Gangotri. Both these rivers form a deep valley of 4870 m between Bandarpooch and Shrikant peaks. It is the view of geologists that the drainage of Ganga is antecedent. It means that it is older than the Himalayas. Alaknanda is the main tributary of Bhagirathi.

Pindar, Mandakini, Dhauliganga and Bishanganga pour their water into Alaknanda as the main tributaries. The Pindar River rising from Nanda Devi and East Trisul (6803m) joins Alaknanda near Karan Prayag, Mandakini or Kali Ganga near Rudra Prayag, Dhauliganga near Vishnuprayag and Bishanganga near Nandprayag.

River Ganga is joined by Ramganga, Ghaghra, Gandak, Burhi Gandak, Baghmati and Kosi on its left bank, while Yamuna, son, and Damodar join it on its right bank. Son and Damodar are the only peninsular rivers. After traversing 770 km upto Allahabad, it further flows another 300 km. eastwards to reach Bihar plain. Near Rajmahal Hills it turns to the south-east and south of Farakka, it ceases to be known as Ganga. It is bifurcated here, and thus enters, into Bangladesh known there as Padma Meghna. In India it is bifurcated into Bhagirathi and Hooghly Rivers.

The total length of the river is 2515 km. and drains 8.61 lakh sq. km. area. Ganga delta is extended between Hooghly and Meghna Rivers. It is considered as the largest delta of the world. It's total area is 51306 sq. km. It is covered with dense forests called as sunder vans. Hooghly is perhaps the most heavily navigated river of India, it acts as a link between Koklata and Haldia ports and the sea. Farraka Barrage ensures the flow of water for the navigation in these rivers.

The Yamuna River- The Yamuna is one of the most important tributaries of the Ganga. Its source is Yamunotri glacier in Uttarkashi district of Uttarakhand. It has an elevation of 6330m and is very close to that of the Ganga itself. After cutting across the Nag Tibba, the Mussoorie and Shiwalik ranges, it emerges out of the hilly area and enters plains near Tajewala, and then it flows parallel to the Ganga upto Allahabad, where it meets the latter. The total length of the river is 1385 km and drains 3.6 lakh sq. km. area.

Yamuna receives the water of Rishiganga, the Uma and Hanuman Ganga in the hilly region. Here, Tons is its main affluent. It rises from the Bandarpunch glacier. It joins Yamuna below Kalsi in Uttarakhand.

After the joining of River Hindon, it takes the south-east turn from Mathura and Keeps onward journey upto Allahabad, where it is merged into River Ganga. Between Agra and Allahabad, it receives the water of the tributaries originating from the Peninsular Plateau. These are the chambal, the Sind, the Betwa and the Ken. Its water is used by western Yamuna canal, Eastern Yamuna canal and Agra Canal. Delhi, Mathura and Agra are large and important urban centres, situated on the river. The Yamuna carried a substantial amount of transport during the medieval times but it declined in recent times due to competition with the railways.

The Ramganga River- This river originated near Nainital of the eastern Garhwal at an elevation of 3110m, and enters the Ganga plain near Kalagarh. It joins the Ganga at Kannauj after a flow in south-east direction. It traverses a distance of 600km. It drains the districts of Bijnor, Amroha, Moradabad and Bareilly. The Khoh, the Gangan, the Aril, the Kosi and the Deoha (Gorra) are its important tributaries.

The Ghaghra or Karnali River- This river is called Karnali in hilly area and Ghaghra in the plains. It originates from Mopcha chungo glacier of Tibtean Plateau. It enters India from south of Rajapur (Nepal) and flows south-east parallel to the Ganga and joins it near Chhapra in Bihar.

This river gets divided into many branches of which Koriyab and Garwa are important. They join the main stream in Bahraich district. Its important tributaries are the Sarda, the Sarju or Saryu on the bank of which Ayodhya is located. The river bed is sandy in east U.P. and it has sudden bends. It has high flood frequency and has shifted its coarse several times.

The Kali River- It originates from Milam glacier of north-east Kumaon. Here, it is known as Gauri Ganga. It is known as the Sarda after it reaches the plains near Pachmeshwar of Tanakpur. After flowing in south-easterly direction, it joins River Ghaghra near Barhampur. Sharda canal takes off from it near Brahmdev.

The Rapti River- It originates in Nepal and then flows first towards south and then westward. It joins river Ghaghra near Barhaj. Gorakhpur is an important urban centre. It brings foodgrains and timber from Nepal.

The Gandak River- This river originates near Tibet-Nepal border at a height of 7620m. It is known Saligrami in Nepal and Narayani in plains. The main tributaries are Kali Gandak and Trishuli Ganga. It joins Ganga at Hajipur near Patna. It is famous for the changes in its course.

The Kosi River- It originates in East Nepal, and is an important tributary of River Ganga. Its main stream is Arun which rises to the north of Gosainthan. All the sources of seven streams of Kosi are located in snow covered areas which also receive heavy rainfall and thus, receive huge volume of water. In plains, it forms a large alluvial fan and is braided in a number of streams. The Kosi flows for a distance of 730 km. in India and joins the Ganga near Kursela. It's total drainage area in India in 21500 sq. km. This river becomes a sluggish in the plains where it deposits eroded material on a large scale. It has shifting of its course frequently and thus result in frequent devastating floods. It has converted cultivated land into waste land in Bihar. Thus, the river is often termed as the 'sorrow of Bihar'

Rivers of Ganga System originating from the plateau

Chambal, Betwa, Benas, Ken, Kali Sindh, South Tons, Son and Damodar River are those rivers which empty their water into Ganga River System. All of these have their flow in south to north or north-east direction. These have their origin mainly from Vindhyan Mountain Range and adjoining hills. The detail of important rivers is as follows:

Chambal River- The Chambal rises from Mhow from the hills of the Vindhyan Range. It takes a north-westerly course through Malwa Plateau. It flows through Bundi, Kota and Dhaulpur districts. It passes through a gorge near Chaurasigarh, 312 km. from its source. The gorge is 96 km. long and stretches upto Kota city. After this, it takes turn to north-east upto Pinhat. Then, it takes turn to the east and runs nearly parallel to the Yamuna before joining it in Etawah district. The river flows much below its banks due to severe erosion because of poor rainfall. It has given birth to numerous deep ravines in Chambal valley, which has given rise to badland topography. The total length of the river is 1050 km. Kali Sindh, Parvati and Banas are its main tributaries.

Betwa River- It is also known as Vetravati River. It rises at an elevation of 470 m in the south west of Bhopal. It joins Yamuna near Hamirpur after its flow through Bhopal, Gwalior, Jhansi, Auiraya and Jalaun districts. It has a number of falls in its upper course. The total length is 590 km. Betwa canal is taken off from 23 km. west of Jhansi. The Dhasan is its an important tributary.

Banas River- It is the main tributary of Chambal. It originates in the southern part of the Aravali Range and takes a north-eastern course to join the Chambal near Sawai Madhopur.

Ken River- It rises from Kaimur Mountain and then flows through Bundelkhand, and joins Yamuna near Chila. Sonar and Berma Rivers are main tributaries. It is 360 km long.

Kali Sindh River- It originates from Nainvas of Tonk district in Rajasthan and joins Yamuna in the north of Jagmanpur. Its total length is 416 km.

South Tons or Tamsa River- It has its origin from Tamshakund reservoir situated in Kaimur Range. It flows in north-east direction and joins Satna River. It forms many waterfalls. Vihar waterfall is 113m high. Belan is its tributary. It fall its water in River Ganga at a distance of Allahabad.

Son River- Son River springs from the Amarkantak plateau. It flows in north-east direction. It joins Ganga about 16 km. upstream of Danapur in Patna district of Bihar. It is 780 km long. The important tributaries are Johila, Rihand, Kanhar, Gopet and the North koel. Almost all the tributaries join it on its right bank. This river assumes a large size in rainy season. A hydro-electric power project is developed on the Rihand in Sonbhadra district of Uttar Pradesh.

Damodar River- This river rises in the hills of Chhota Nagpur plateau at an elevation of 1366 m and flows through a rift valley. It joins Hooghly 48 km. above Kolkata. It is 541 km. long and drains 25820 sq. km. area. It was once known as sorrow of Bengal, but now it has been changed into a boon to west Bengal because of Damodar Valley Project. It’s direction of flow is north and north-east. It takes a turn in south-east direction near Asansol. Ajai, Rupnarayan and more rivers as small in size also follow it and empty their water in Hooghly.

III Brahmputra River System

This is also an important river system of India. It spreads over 5.80 lakh sq. km. area, of which 1.87 lakh sq. km. is in India. The main river of this system is Brahmputra.

Brahmputra River is called son of Brahma. It rises in the Kailash Range at a height of 5150m. After a west-east flow with a distance of 129 km. it enters India through Siang sub-division of Arunahal Pradesh, where it is called Dihang. In Tibet, it is known by the name of Tsangpo, which means a purifier. It takes an acute turn near Namcha Barwa Mountain (7756 m) to enter in India. From here it flows towards west through Assam valley for 725 km. This river has steep slope. It's altitude near Namcha Barwa is 2150m which falls to 135m at Sadiya. Here, it is joined by Dihang (or Sikang) in the north and Lohit from the south.

In Assam, it is called Brahmputra. It receives the water of a number of tributaries both from north and from the south- Tista Subansiri, Barali, Manas, North Dhansiri on the right bank, while joining it on the left bank are Buri, Dibang and South Dhansiri.

It carries a lot of sediments and there is excessive meandering. The deposition of loads in its river channel form many islands, and thus, river is known as braided river. Its channel is very wide near Dibrugarh nearly 16km. In rainy season, it brings disastrous floods and thus, becomes a River of Sorrow. However, it is navigable for a distance of 1280 km. from the north to Dibrugarh, and serves as an excellent island water transport route.

Brahmputra bends southwards due to Garo Hills and enters Bangladesh near Dhubri. It flows for a distance of 270 km. in the name of Jamuna River. It is known as Meghna with the joining of Surma River. Padma joins it on left bank near Chandpur. The combination of Padma and Meghna is known as Meghna, which makes a broad estuary before pouring into the Bay of Bengal. Here it has several islands.

3.3.2 Peninsular River System

The Indian Peninsula is traversed by a large number of rivers, small in size than North India. The amount of water depends on rainfall. The water remains more in rainy season, but it is reduced in dry period. The surface is entirely rocky and plateau, which does not absorb the water. This characteristic, make them flooded in the rainy season. These rivers are broad, shallow and largely graded valleys. These are not navigable. Most of these rivers pour their water into Bay of Bengal and form deltas on the east coast. These rivers have lost their erosive power. The rivers, which pour their water into Arabian sea generally form estuaries.

Although the general direction of flow of the Peninsular Rivers is from west to east, but these may be divided into three groups on the basis of main directions of flow:

(i) **East flowing Rivers-** Mahanadi, Godavari, Krishna and Kaveri.

(ii) **West flowing Rivers-** Narmada, Tapi and several small streams.

(iii) **North-east flowing Rivers-** These are the rivers of Ganga River system as they are the tributaries of the Ganga and the Yamuna.

(i) East Flowing Rivers:- These are mainly those rivers which pour their water into Bay of Bengal.

Mahanadi River- It literally means big river. It is an important river of the Peninsular India. It has its origin in the foothills or Danda Karanya near Sihawa in Raipur district of Chhatisgarh at an elevation of 442m. It is 858 km. long and its catchment area spreads over 1.41 lakh sq. km. The Seonath, its most important tributary, Hasdeo, Mand and ib join it from the north and the Tel joins it from the south. The Mahanadi flows through a series of rapids from Bandraj to Mundali.

It branches into many distributaries and forms its Delta near Cuttack. This fertile delta spreads over an area of 9500 sq. km. and is over 150 km. broad. The river has been harnessed to provide irrigation and hydro-power with the Mahanadi Multi purpose project with dams at Hirakund, Tikarpara and Naraj.

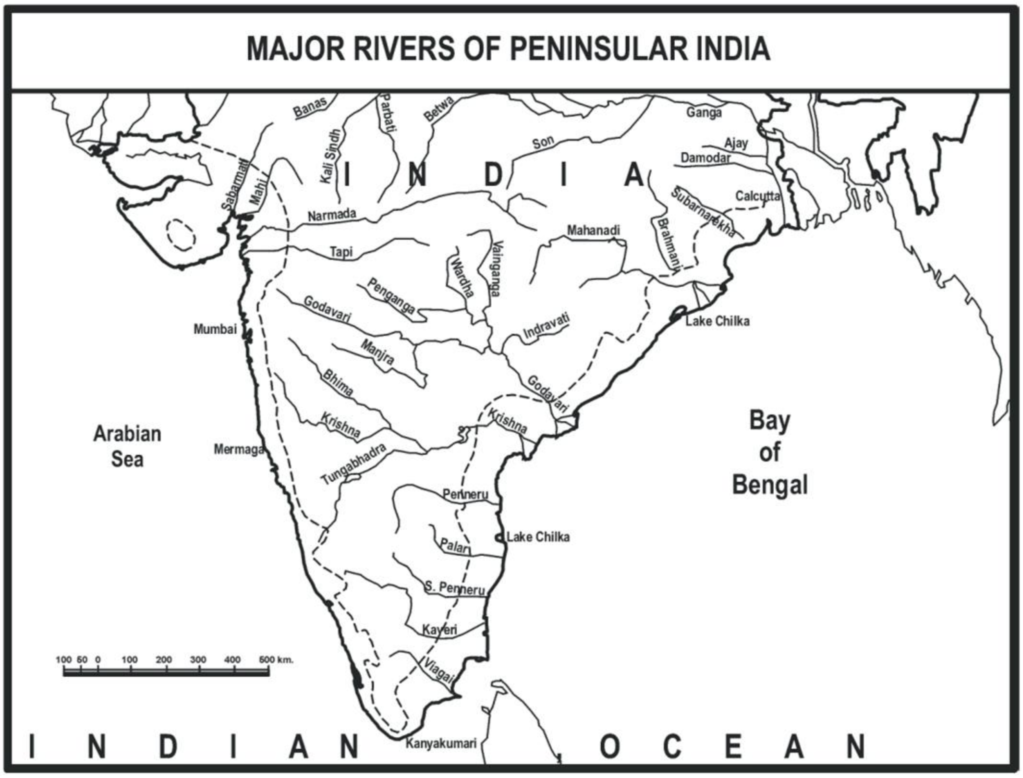

Fig. 3.2 Main Peninsular Rivers

Brahmani, Vatrani and Subarnarekha Rivers- Brahmani and Subernrekha originate from Chhota Nagpur Plateau in the south-west of Ranchi at an elevation of 600m and flows in south-east direction. Vatrani River has its origin from Keonjhar Plateau of Odisha. The Brahmani is 800 km. long and is formed by the confluence of Koel and Sankh Rivers near Brahmani alongwith Vatrani falls in Bay of Bengal. Subarnarekha River is 395 km. long and has a catchment area of 19300 sq. km.

Godavari River- This is the largest river system of the Peninsular India and is next only to the Ganga. It is also called Dakshina Ganga. It's total length is 1465 km. The source of the river is North Sahyadri hills near Nasik. It flows in south-east direction and receives water of a large number of tributaries from both banks. It is also to be noted that left bank tributaries are more in number and larger in size than the right bank tributaries. In north Pranhita, Penganga, Wardha, Wainganga and Indravati are main tributaries, while in south Manjra is the main tributary, which join Godavari near Hyderabad. The river causes heavy floods in its lower course, and here it is navigable. A number of development projects have been taken up in the Godavari basin. These are mainly hydro power and irrigation projects. After flowing through Maharastra, the Godavari flows through Telegana. It forms a large delta at its mouth.

Krishna River- The Krishna is the second largest east flowing Peninsular river. It rises in Mahabaleshwar hills and flows eastwards towards the south and into Bay of Bengal. Bhima is the largest tributary. The other tributaries are Koyna, Tungbhadra, Musi Varna, Panchganga and Dudhaganga. These rivers like the main stream flow in deep channels and swell into brimming torrents during the rainy season. They become streams of insignificant flow. It is important for hydro power generation. It's length is 1400 km. It's delta is merged with Godavari Delta.

Kaveri River- It is known as 'Ganga of the South'. It rises in the Coorg district of Karnataka at an elevation of 1341m. It has several waterfalls and rapids in its course. It flows with a length of 805 km. in south-east direction. It's principal tributaries are Hemavathi, Lokpavani, Shimsa, Arkavati in the north and the Lakshmanatirtha, Kabini, Suvarnavati, Bhawani and Amravati in the south. It descends from south Karnataka Plateau to the Tamilnadu plains. Sivasamudram is an important and famous waterfall. Its delta is extended on an area of 3200 sq. km. It extends from a point of 16 km. below Tiruchirapalli and the river divides into two channels at Srirangam. The Kaveri basin is one of the most developed regions of India from the point of view of power and irrigation. It has also religious significance. Nearly 90-95 percent of hydro power potential is already exploited.

Other Main Rivers- Among the other east flowing rivers of Peninsular India are the Penneru, the Ponnaiyar and the Vaigai, Penneru River springs from Nandi Durg peak in Karnataka and flows in northward direction. It forms estuary before it joins the Bay of Bengal. The Ponnaiyar is a small stream, which is confirmed to the coastal area.

Vaigai is in the south of Kaveri. It flows through a dry channel. It joins Bay of Bengal near Rameshwaram.

West Flowing Rivers

These are fewer and smaller as compared to east flowing rivers. Narmada, Tapi, Sabarmati, Mahi and Luni are important rivers. Hundreds of small streams originating in the Western Ghats flow stiffly westwards and join the Arabian sea. It is also interesting to note that these rivers do not form deltas, but only estuaries. Most of these rivers flow through hard rocks and are not able to form distributaries before they enter the sea.

Sabarmati River- Sabarmati river is 320 km. long. This rises in the Aravallis and flows to the gulf of Khambhat. This is the third largest west flowing peninsular river. The name Sabarmati is a combination of Sabar and Hathmati. The important tributaries of this river are Wakul, Harnav, Hathmati, Sedhi, Meshwa and Vatrak. Gandhinagar and Ahmedabad are situated along this river.

Mahi River- The river rises in the Vindhyas at an elevation of 500m and empties, itself into the gulf of Khambhat. It flows for a distance of 533 km. Its drain area is shared by Madhya Pradesh, Rajasthan and Gujarat. The main tributaries are the Som, Anas and Panam. It has also irrigation projects.

Luni River- Luni is a salt river. Its water is brackish. Its source lies to the west of Ajmer in the Aravali at on elevation of 550m and it flows in south-west direction. It is a small stream. It traverses for a distance of 482 km.

Narmada River- This is the largest of all the west flowing rivers of the Peninsular India. It rises from the western Amarkantak plateau at an elevation of 1057m in Shahdol district of Madhya Pradesh. It flows westwards through rift valley between the Vindhyan Range on the north and the Satpura Range on the south. Its total length is 1312 km. It's drainage area is 93180 sq. km. It forms the most spectacular and world famous Dhuan Dhar (cloud of Mist) falls below Jabalpur. Here, the water falls at a height of 22m and flows into a gorge. This gorge is composed of marble. Here the slope gradient is 7-9m per km. Below Jabalpur; it flows in a narrow elongated form and forms few rapids. It has two waterfalls of 12m each at Mandhar and Dardi. Kapildhara fall (23m) is also important.

Thus, the valley is a gorge like and full of rapids and waterfalls especially between Handia and Mandhata. The river makes an estuary before entering the gulf of Khambhat. It has several islands in the estuary. Among these Aliabet is the largest. The mouth of the river is 28 km wide. The Narmada is navigable upto 112 km from its month.

The Burhner, Banjar, Tawa and Chhota Tawa join the Narmada from the south, whereas the Hiran and Orsang join it from the north. A large number of irrigation and power projects have been proposed on the rivers of the basin. Sardar Sarovar is the largest project on this river. It is a sacred river. Nasik, situated on this river is known for the celebration of Kumbh fair.

Tapi River- It is also called Tapti. This second largest west flowing river has its origin from the sacred tank of multai on Satpura Hills in Betul district of Madhya Pradesh at an elevation of 730 m. It is 724 km. long and drains an area of 65145 sq km Most of its basin lies in Maharastra, Madhya Pradesh, and Gujarat also have the extension of its basin. It first traverses on open plain and then plunges into a rock gorge of Satpura Hills.

The main tributary of Tapi is Purna, which comes from Gawilgarh Hills and joins Tapi from above Bhusawal. River Girna, the another tributary is navigable for 32 km. from the sea. The Kakarpara and Ukai Projects on the river provide substantial power and irrigation potential.

Other West Flowing Rivers- These are the small streams of western ghat. Their number is about 600 and they fall their water into Arabian sea. The western slope of the ghats receives heavy rainfall from south-west monsoon and is able to feed such a large number of streams. These slopes are quite steep, and the coastal plains are narrow, which have made stream short and turbulent. The basin of these rivers is 3% of total area of the country, but it contains 18% of total water resources.

The important rivers are the Mandovi, Zuari and Rachol in Goa; Kalindi, Gangavalli-Bedti, Sharavati, Tadri and Netravati in Karnataka; and Beypore, Pannam, Bharatapuzha, Periyar and Pampa in Kerala. All those rivers are known for their narrow valleys and waterfalls. Most of these rivers form wide creeks, which have developed sea ports. Their irrigation potential is less, but hydel power potential in very high. A number of power projects have been developed in the area.

Here, Sharavati River has famous Jog falls at an elevation of 289m. Along with it, Kalinadi, Sabarigiri, Idduki and Vaitarna are known for their power projects.

IV Inland Drainage

Those rivers of India which do not reach to the sea constitute Inland drainage. Large parts of Thar Desert and Cold desert of Aksai Chin in Ladakh have inland drainage. The Ghaggar is the most important river of inland drainage. It is a seasonal stream. It rises on the lower slopes of the Himalayas and forms boundary between Haryana and Punjab. It is lost in the dry sands of Rajasthan near Hanumangarh. Its total length is 465 km. This river is said to be an affluent of either Sutlej river or Saraswati River. The dry bed of this channel can be marked at various places. Its main tributaries are Tangri, Markanda, Saraswati and Chaitanya. It contains a lot of water during rains. At that time its bed becomes 10 km wide at some places. Aravalli Range has the origin of small stream up immediately after the rains.

River Basins of India

River Basin is that territorial limit where run-off is contributed in the river system. These basins have three broad groups on the basis of their catchment areas:-

(1) **Major River Basin-** The catchment area is more than 2000 sq. km.

(2) **Medium River Basin-** The catchment area is between 2000 and 20000 sq.km.

(3) **Minor River Basin-** The catchment area is less than 2000 sq.km.

(1) **Major River Basin-** These are 13 in number. These basins serve 80 percent of our total population. The total flow of river water in these basins is 85 percent of total river flow. Ganga, Brahmputra and Indus are three major river basins of Himalayan system. The basins of peninsular plateau are such as Narmada basin, Tapi basin, extended in Madhya Pradesh and Gujarat. Mahanadi Basin is extended in Chhatisgarh and Odisha. The other basins are Godavari and Krishna basin in Maharastra; Kaveri and Pennar basin in Karnataka; Brahmni basin in Jharkhand and Odisha; Mahi basin and Sabarmati basin in Rajasthan and Gujarat.

(2) **Medium River Basin-** These are 45 in number. Four of these have their extension also on the lands of neighouring countries, and eleven basins are extended in two or more states. Seventeen river basins are extended on an area of 63500 sq. km. and these rivers empty their water in Arabian sea. The remaining 14 basins are related with Bay of Bengal. These basins occupy on an area of 210596 sq. km. As a whole all these medium river basins have their extension on 8 percent of total area of river basins and drain nearly12 lakh cubic metre water.

(3) **Minor River Basin-** These are in all 55 in number, and occupy nearly 2 lakh sq. km. area. Most of these have their extension on Western and Eastern Ghats. The remaining is occupying the desert

lands. These basins share 9 percent area of all River basins. These carry nearly 13 lakh cubic meter water.

Difference between the Himalayan and the Peninsular River System

The Himalayan rivers are quite different from the Peninsular India from the point of view of the drainage features and hydrological characteristics. These differences can be put as follows:

Himalayan Rivers & River System	Peninsular Rivers & River System
1. These are perennial rivers	1. These are non- perennial rivers.
2. These are fed by the melting of the snow.	2. The water is provided by the monsoons.
3. These are prone to floods.	3. These are not prone to floods
4. They are suitable for navigation as they flow slowly in the plains.	4. They are not unsuitable for navigation as they have swift flowing.
5. These are Himalayan Rivers as they originate from Himalayas.	5. These are peninsular rivers as they originate from peninsular plateau.
6. These rivers have their basins of large size.	6. Most of the River basins are small in size.
7. These rivers flow through deep I shape valley called gorges in hilly areas.	7. The peninsular rivers flow comparatively in shallow valleys.
8. These rivers, when enter into the plains, form meanders due to sudden reduction in the speed of flow of water.	8. The hard rock surface of the plateau does not permit these rivers to form meanders. They flow more or less in straight courses.
9. Himalayan Rivers form big deltas at their mouths.	9. Here, the rivers of east flowing form deltas, while the west flowing rivers form the estuaries.
10. These rivers are still in the youthful stage	10. These rivers have reached to mature stage.

3.4 CONCLUSION

Rivers are the backbone of economic and social development of a country. These are the drain lines to supply water for drinking. irrigation, navigation and power generation. Indian Rivers are known for their changes in courses, and this action is responsible for the formation of fertile Great Plains. In early periods, Indo-Brahm River had its flow just parallel to the Himalayas. The uplift of Himalayas and dismemberment of Indo-Brahm River have given birth to all north India Rivers. Himalayan River System in incorporated by the Indus System, Ganga system and Brahmputra system. The rivers of these systems are perennial in nature. River Ganga receives the water of those peninsular rivers, which flow towards the plains. Peninsular River System is composed by east flowing and west flowing rivers. Rivers flowing towards Bay of Bengal form deltas, whereas river flowing towards Arabian sea are small streams and form estuaries. The western dry lands of the country are known for inland drainage. The River basins of India are of three Groups, major, medium and minor. Himalayan River System is more useful than, as they flow throughout the year and have sufficient amount of water. On the otherhand, the Peninsular Rivers depend on Rainfall water.

3.5 SUMMARY

The drainage explains the surface flow of water in the form of rivers. Rivers are known for social and economic development of an area, and are birth place of civilization. These are means of navigation. The present system of rivers is not of today. It is the product of those past events which are responsible for the hanging pattern of the surface. The formation of Himalayas has affected the drainage system of its own region and also of the Great Plains. Indo-Brahm was the ancient river and the present Indus and Brahamputra rivers are the part of it. The earth movements of Tertiary period are responsible for their origin.

The rivers of this vast plain have an evidence of the changes in their courses. Saraswati River is the best example of it. Sutlej also, which was an independent river, now is the tributary of Indus. River Ganga has also made changes in its course.

Major rivers with their tributaries are the base of drainage system. India, thus has noted four drainage systems. Himalayan River System is incorporated by Indus, Ganga and Brahmputra Rivers. Indus River System is the world's large river system. The Indus, Jhelum, Chenab, Ravi and Sutlej are the main rivers. Indus has its origin beyond the main Himalayan Range i.e. from Kailash Range. It takes steep turn near Nanga Parbat and thus enters into Pakistan. Jhelum River rises at Verinag, it has formed Kashmir Valley. This river is 400 km long. It is known for power and irrigation projects. It is navigable in Kashmir. Chenab is the largest tributary of Indus River. It has its origin from Zaskar Range. It has its flow for 1180 km Ravi originates from Kullu Hills. It joins the combined flow of Jhelum and Chenab near Multan. The beas has its origin near Rohtang Pass. Sutlej has the origin from Dharma Pass located near Rohtang pass. It forms a canyon, Bhakra Dam is developed on it. The water of the Indus system is stored by India and Pakistan both.

Ganga River System occupies the mostly densely populated part of India. It has the vast plain very fertile and granary of India. Ganga is the main stream of this system. It includes the rivers having their origin from two distinguished region- Peninsular and Himalayas. River Ganga is a combination of Bhagrathi and Alaknanda. Both these meet together at Dev Prayag. It has antecedant drainage. This river is 2515 km. long. It is joined by Ram Ganga, Ghaghra, Gandak, and Kosi on its left bank; while Yamuna, son and Damodar on the right bank. It forms huge delta on its mouth.

Yamuna rises from Yamunotri glacier. It receives the water of number of hilly torrents. It joins Ganga in Allahabad. Chambal, Sind, Ken, Betwa, Banas, empty their water in it. They have their origin in peninsular region.

Brahmputra River System is dominated by Brahmputra River. It is known by different names, and flows in Assam through a ramp valley. It receives the water of a number of tributaries on its both sides. It forms also meanders and is known as braided river. Such condition has developed a number of islands in the bed of this river. It enters in Bangladesh with the name of Jamuna.

Peninsular India has rivers more in number than the Great Plains but these are small in size; depend for the flow on monsoon rainfall. These form broad, shallow and largely graded valleys. Rivers flow towards, Bay of Bengal form their own deltas. Mahanadi, Godavari & Krishna, and Kaveri deltas are most important. Rivers falling into Arabian Sea are known for their estuaries. Sabarmati, Narmada and Tapi are important. Godavari-Krishna Delta is the most wide spread delta of Peninsular India. The river flowing from Western Ghats are small, steep. Rivers of this area also form waterfalls, useful for hydel generation.

Inland drainage is the feature of hot desert of Rajasthan and cold desert of Aksai chin in Laddakh. There are three groups of drainage basins in India-major, medium and minor river basins. There is a vast difference between Himalayan and Peninsular Rivers.

3.6 GLOSSARY

- Drainage - Flow of water on the surface
- Diastrophic - Tectonic
- Tethys Sea - Extended between Angaraland and Gondwana land
- Indo-Brahm - Indus + Brahmputra

- Geosyncline - A subsided sediments between two landmasses
- Upheavels - Rising
- Tsangpo - Indus
- Gorge - Narrow & deep valley
- Distributaries - Split of main river into a number of channels
- Tributaries - River joining the main river
- Devprayag - Meeting point of Bhagirathi and Alknanda Rivers
- Synonyms of Ganga - Bhagirathi, Alaknanda, Hooghly
- River system - A group of rivers, which are inter connected
- Brahmputra - Son of Brahma
- Brahmputra - It is called Jamuna in Bangladesh
- Ganga - Called Padma and Meghna in Bangladesh
- Barrage - A reservoir of water constructed for the purpose to have regular flow of water in the river
- Dam - Reservoir with the purpose to generate power and water for irrigation
- Delta - Rivers is splited into a number of channels before joining the sea
- Estuary - River as a main river directly join the sea
- Godavari - Dakishna Ganga
- Kaveri - Ganga of the south
- Dhuandhar - Waterfall on Narmada, with full mist
- Inland drainage - Rivers do not empty their water into sea, dis appear in sands
- Perennial - Flow of water throughout the year
- Canyon - I-shaped valleys with vertical walls on either side of river
- Water-divide - Higher ground separating two adjoining drainage basins
- Pass - Gap in mountain providing a natural route across

- Meander - Leisurely flow of river or big loops of river.

3.7 ANSWERS TO CHECK YOUR PROGRESS

1. Drainage-Nature of flow of water in the rivers.
2. Rivers- cradle of civilization, and as a running water.
3. Ancient and religious towns have developed along rivers.
4. Indian Rivers have made changes in their flow since ancient times.
5. Indo-Brahm was an ancient river.
6. E.G. Pilgrim gave the name of Shiwalik river to Indo-Brahm River.
7. Formation of Himalayas have affected the courses of Indian Rivers.
8. Saraswati, Sutlej and Yamuna Rivers once were having their flow in Rajasthan.
9. Brahmputra is known Tsangpo in Tibet.
10. Flow of rivers has an effect of nature of surface, degree of slope, amount of water.
11. Himalayan River System is formed by Indus, Ganga and Brahmputra.
12. Indus River rises near Mansarovar lake in Tibet.
13. Indus makes a deep gorge of 5180 m deep near Gilgit.
14. Shigar, Shyok and Gilgit are the main tributaries in Indus in Kashmir state.
15. Indus river is 2880 km long
16. Jhelum, Chenab, Ravi, Beas and Sutlej are its main tributaries in the plain.
17. Jhelum rises at Verinag in Kashmir.
18. Jhelum river flows from Kashmir valley. Srinagar is on its bank.
19. Chenab River is the name of two rivers-Chandra and Bhaga.
20. Ravi and Beas have their origin from the hills of Himachal Pradesh.
21. Sutlej has its origin beyond the Great Himalayas.
22. Ganga River System is the most important river system.
23. The confluence of Bhagirathi and Alaknanda gives birth to Ganga.
24. Ganga River is 2515 km. long.

25. Yamuna is the main tributary of River Ganga, and joins it at Allahabad.
26. Ramganga, Ghaghra, Rapti, Gandak and Kosi are main tributaries of Ganga.
27. Chambal, Betwa, Ken, Kalisindh are peninsular rivers and join Yamuna in Great plains.
28. South Tons, Son and Damodar Rivers are as a peninsular rivers and join ganga.
29. Chambal River is known for Ravines.
30. Damodar River, a river of Chhota Nagpur Plateau, is known for Damodar valley project.
31. Brahmputra River rises near Mansarover Lake and flows in Tibet as Tsangpo.
32. Brahmputra is a braided river as it forms many islands in its channel.
33. Peninsular Rivers, which flow towards Bay of Bengal form wide deltas.
34. Mahanadi, Godavari, Krishna and Kaveri are the rivers which form deltas.
35. Narmada and Tapi Rivers form estuaries in Arabia sea.
36. Sabaramati and Mahi Rivers after flowing in Gujarat fall in Arabian sea.
37. Rivers originating from western state are small steep and form waterfalls.
38. Jog falls of Shrawati River is known for power project.
39. Thar desert and cold desert of Aksai chin are known for inland drainage.
40. Major River Basins are 13 in number. All the main rivers are of this category.
41. Medium River Basins are 45 in number. Mostly, these are in Peninsular India.
42. Minor River Basins are 55 in number and are extended on the western ghats.
43. Himalayan Rivers are perennial, while peninsular rivers are non-perennial.

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3.10 TERMINAL QUESTIONS

Long answer questions:

1. Give a description of drainage system of India and compare the north and south rivers.
2. Examine the development and characteristics of Himalayan drainage system.
3. Examine the development and characteristics of Peninsular drainage system.
4. Discuss in detail Indus River System.
5. Elaborate the Ganga River System and give a brief account of its main rivers.
6. How the rivers flowing to Arabian Sea are different from the rivers flowing to Bay of Bengal. Discuss it.
7. Discuss the main rivers of Peninsular India.

Short answer questions:

1. How the drainage basin is delimited.
2. Rivers are the birth place of civilization. Comment.
3. Discuss the Indus River and its tributaries.
4. Explain River Ganga and its main tributaries.
5. Discuss those peninsular rivers which fall into Ganga River System.
6. Give an account of Arabian Sea Rivers.
7. Explain the peninsular rivers of Bay of Bangal.
8. Discuss Brahimputra drainage system.
9. Discuss the classification of Indian River Basins.
10. Write an essay on Inland drainage of India.
11. Discuss various names of River Ganga and their importance.
12. Write in detail the characteristics of Narmada and Tapi River Basins.
13. Give a comparison of Western Ghat and Eastern Ghat rivers.

Objective Questions

1. Bagirathi and Alaknanda join together at which place-

(a) Deo Prayag (b) Vishnu Prayag (c) Nand Prayag
(d) Rudra Prayag

2. Which of the following river does not have its origin near mansarovar lake-

   (a) Sutlej (b) Indus (c) Brahmputra (d) Chenab

3. Which of the following river forms deep gorge in Himalayas-

   (a) Chenab (b) Jhelum (c) Ravi (d) Indus

4. Which of the following pair of rivers do not form the delta-

   (a) Krishna and Kaveri (b) Mahanadi and Godavari

   (c) Narmada and Tapi (d) Kaveri and Perriyar

5. Shivasamudram waterfall is situated at which of the river-

   (a) Krishna (b) Periyar (c) Kaveri (d) Mandavi

6. Dhuandhar waterfall is situated on which of the river-

   (a) Tapi (b) Narmada (c) Sharavati (d) Godavari

7. Which of the following river is different in its direction of flow-

   (a) Chambal (b) Banas (c) Betwa (d) Mahi

8. Which of the following river is not the tributary of River Godavari-

   (a) Penganga (b) Wainganga (c) Panch ganga (d) Indravati

9. Which of the follow river does not flow in Goa state-

   (a) Kalindi (b) Mandavi (c) Zuari (d) Rachol

10. What is the total length of River Indus-

    (a) 2880 km (b) 2800 km (c) 2810 km (d) 2850 km

11. Which of the following town is not located on the bank of Ganga River-

    (a) Prayag (b) Varanasi (c) Mirzapur (d) Mathura

12. Ganga is known by which name in Bangladesh-

    (a) Meghna (b) Padma (c) Tista (d) Bhagirathi

13. Which of the following river has the largest river basin-

    (a) Godavari (b) Kaveri (c) Mahanadi (d) Krishna

14. Narmada River does not flow in which of the following state-

    (a) Odisha (b) Gujarat (c) Maharastra (d) Madhya Pradesh

15. Which of the following feature is not of Western Ghat rivers-

    (a) Small and swift flow (b) Narrow bays

    (c) Delta (d) Suitable harbour sites

16. Which of the following river does not form estuary-

(a) Narmada (b) Sabarmati (c) Tapi (d) Markanda

Answer: 1 (a), 2 (d), 3 (d), 4 (c), 5 (c), 6 (b), 7 (d), 8 (c), 9 (a), 10 (a), 11 (d), 12 (b), 13 (a), 14 (a), 15 (c), 16 (d)

UNIT 4 - CLIMATE, SOILS & NATURAL VEGETATION

4.1 OBJECTIVES

After reading this unit, you should be able:

- To understand the climate and dynamics of climate of India.
- To know about the climatic regions of the country.
- To understand soils, their types and spatial distribution of soil.
- To study types of natural vegetation and their distribution.

4.2 INTRODUCTION

The climate of a country includes the study of temperature, rainfall, atmospheric pressure, as well as the direction of velocity of winds over a long period of time. These elements of climate are largely influenced by the location, nature of surface, areal distribution of land and water. India is a large country which results in sharp climatic contrasts. The great extent and location have provided diversion in our climate. It is not very easy to study the climate of India very deeply, as because half of its part lies in the north of Tropic of cancer, which is virtually the part of temperate zone from the thermal point of view. But the presence of Himalayas in the north has made India a tropical country, as these have been proved as an effective meteorological barrier, and thus India shares the characteristics of Tropical Monsoon climate. This climate is a rhythm of seasons, originated by Monsoon seasonal winds. These winds have given unity to our climate, but the location, physiography, its vastness have given regional variations, expressed in the pattern of winds, temperature and rainfall, rhythm of seasons and the degree of wetness or dryness. The comment of **Blanford** on these climatic diversities seems to be correct that we may speak of the climates but not the climate of India, for the world itself affords, no greater contrast than is to be met with at one and the same time within its limits."

Marsden too believed that India possesses all type of climate found in the world.

Natural vegetation refers to a plant community unaffected by non- either directly or indirectly. The flora refers to plants of a particular region or period listed by species, and considered as a group. The term forest generally denotes a large tract of land covered by trees grasses and shrubs. Generally, the flora, forest and natural vegetation are used to explain the plant community. In India, this community is defined as forests or natural vegetation. Climate, soil and topography are the most important geographical factors, which influence our natural vegetation. Rainfall is the most dominant factor. In higher altitudes of the Himalayas and in the hills of the peninsula, temperature plays a more important role. Change in soil conditions have given birth to different types of vegetation in different parts of the country. India's natural vegetation has undergone a drastic biotic change. Large tracts of forests have been removed to meet the demand for settlement and cultivation. In total, a great variety of natural vegetation is found in India.

Soil is the loose surface material covering the earth's crust. It is composed of mineral particles, humus, water and air and serves as a medium for plant growth. The nature of soil mostly depends on its physical and chemical properties. Soil is an important natural resource of India. Our agricultural production basically depends on its fertility. The rich, deep fertile soils of the Great Plains, coastal plains, support high density of population through agricultural prosperity. On the other hand, the shallow and coarse texture soils of plateau region and Thar Desert support only a small population, as these are not so fertile. Because of varied conditions, India has a large variety of soil groups, distinctly different from one another.

4.3 FACTORS INFLUENCING THE CLIMATE OF INDIA

India's climate is characterized as 'Tropical Monsoon' clearly indicating upon it the dominant influence of the country's latitudes and the monsoon winds. Changes in the upper air circulation during the year and Himalaya Mountain relief are the other important factors affecting it.

Climatic Contrasts

1. The day temperature in the month of June in arid regions of Rajasthan occasionally shoots to 50^0C, while on a severe winter night at Dras near Kargil, the minimum temperature shoots upto 40^0C.

2. Cherrapunji receives the annual rainfall of 1080 cm., while at Jaisalmer in Rajasthan, the annual rainfall rarely exceeds 12 cm.

3. The coastal regions are known for their equable and moderate climate, whereas the great plains have the climate of contrast seasons- winter and summer.

4. North India gets rain from western disturbances in winter season, while Tamilnadu and Andhra Pradesh coasts receive rainfall from retreating monsoon in November and December.

5. Farmers of Jammu & Kashmir have to face severe cold in the months of December to February, while on the other hand farmers of Kerala coast do enjoy these months in their farms with only dhoti wearing as Lungi.

6. Brahmputra valley receives heavy rainfall in June, whereas the farmers of Bihar and Uttar Pradesh have to work in their farms in the scorching heat of the sun.

Inspite of all these diversities, Indian climate has been pronounced as Tropical Monsoon Climate. L.D. Stamp has said that 'we have always considered India, a tropical country; it is true because it is surrounded in the north by the mountain wall, in which one type of climate prevails i.e. Tropical Monsoon Climate'. This climate has contrast seasons especially south-west wind in summer and north-east winds in winter. Reversal of wind system is the basic principle of Monsoon climate. This climate is influenced by a number of geographical factors. It is also affected by those factors which lie much beyond its geographical limits. Some of the factors are briefly discussed as under.

1. **Location and Latitudinal Extent-** The mainland of India is extended between 8^0N and 37^0N. The tropic of cancer passes through the middle of the country. More than half of the area lies in the tropics and all the remaining in the sub-tropics. Areas south of tropic of cancer experience high temperature throughout the year. Areas north of this parallel enjoy warm sub-temperature climate, as because, these areas are surrounded by Himalayas in the north. Here, some places in the winter season record considerably low temperatures. The coastal areas have mild climate.

2. **Distance from the Sea-** With a long coast line, large coastal areas have an equable climate. On the contrary, interior locations are deprived of the moderating influence of the sea and experience extreme or continental climate. For example, the annual range of temperature at Thiruvanantpuram does not exceed 5^0C whereas it is as high as 25^0C at Delhi. Similarly, the amount of rainfall at Shillong is more than 250 cm which falls to a low of 25 cm at Jodhpur.

3. **Influence of Physiography-** Physiography of India has a great bearing on major elements of climate such as temperature, atmospheric pressure, direction of winds, and the amount of rainfall. In fact, the physical map of India is very closely related to our climatic conditions, Monsoon winds from Bay of Bengal are bifurcated into two branches by the physiographic features. One branch goes to Assam valley through the

Meghalaya Plateau and the other branch enters the plains through the Chhota Nagpur Plateau.

(a) Himalayan Mountain Range plays an important role in lending a sub-tropical touch, the climate of this region. The lofty mountains form a barrier that separates India from the rest of Asia. These ranges protect us from the bitterly cold and dry winds of central Asia during winter and thus make winter less cold than north and central Asia. Further, these mountain ranges act as an effective physical barrier. They trap the monsoon winds forcing them to shed their moisture within the country. As a result, the Great plains receive heavy rainfall, while central Asia lies in the 'rain shadow' of the Himalayas.

(b) The south west Monsoon winds from the Arabian Sea strike almost perpendicular to the Western Ghats and cause heavy rainfall in the western coastal plain and the western slopes of Western Ghats. On the contrary, vast areas of Maharastra, Karnataka, Talangana, Andhra Pradesh and Taimilnadu lie in rain shadow or leeward side of the Western Ghat and receive scanty rainfall. Here Manglore, along the coast gets the rain nearly 280 cm whereas Bengaluru receives only 50 cm rainfall.

(c) Aravalli Hills run parallel to the direction of the south-west monsoon winds. As such moisture laden winds pass through Rajasthan without shedding their moisture. This accounts for Rajasthan dry climate. Bay of Bengal monsoon also reaches here, when its moisture content becomes less or declines.

(d) The hills of Mehgalaya Plateau force the moisture laden winds coming from the Bay of Bengal to shed their moisture before proceeding northwards. As a result, the south of Assam gets heavy rainfall while the north is comparatively dry.

4. **Altitude-** Temperature decreases with the increase in height. For every 165 m ascent, the temperature falls by 1^0C. Hence places in the mountains are cooler than places on the plains. It is because that the

places located at higher altitudes even in Peninsular India have cool climate. Ooty and several other hill stations of Peninsular India and of the Himalayan Ranges like Mussoorrie, Shimla are much cooler than the places located in the Great Plains. Mount Abu of Aravalli Hills is much cooler than the adjoining desert plains of Rajasthan.

5. **Monsoon Winds-** The most dominant factor of the Indian climate is the monsoon winds as a result of which it is called as monsoon climate. These winds are the seasonal winds that in the sum of summer and winter winds. India remains in the influence of these winds throughout the year. They represent simply a land and sea breeze on a large scale, and that the annual period of the Monsoon corresponds to the diurnal period of the breezes. Monsoon are the strong wind stream, which blow on South Asian coasts from April to October and then flow in reversal form towards north-east direction with a slow speed.

6. **El-Nino Effect-** Recent studies have revealed that there are certain other factors in affecting the origin of monsoon, which happen at long distances and with large intervals of time. These are known as metrological tele-connections. The one is El-Nino. This is a warm ocean current of appearing along the Peru Coast in December. It affects the surface temperature of Southern Pacific Ocean. El-Nino is a Spanish Word and is defined as child chariot or child of crime. It is developed due to increase in temperature of South Pacific Ocean. The presence of this current was known for the first time in 1983. The increase in temperature of South Pacific Ocean helps in the deficiency of Monsoon rainfall in India. This current flows during the Christmas Season. It has its flow along western drift of cold Peru Current, and thus give birth to Pacific Equatorial Counter current. El Nina current affects the temperature of Indian Ocean. The increase in surface temperature of Indian Ocean Weakens South-west Monsoon and thus declines the probability of monsoon rains in India.

In recent times, there is a high increase in green house gases in the atmosphere. This incidence is related with global warming. This change has its bearing on the frequency of El-Nino. Every fourth or fifth year, this warm current tries to weak Indian Monsoon. Prof. **G.C. Chaudhary** has said that these currents flow at an interval of three to seven years, and they affect the climate of a vest area, extended upto 10^0 latitude on both sides of Equator. These currents also affect the coral's life and plankton of fishes in the ocean. These are responsible for long Monsoon gaps, drought conditions in India. Some times, their favourable conditions help in heavy monsoon rains.

7. **La-Nina-** After an El-Nino, weather conditions return to normal. However, sometimes trade winds become so strong that they cause abnormal accumulation of cold water in the central and eastern pacific region. This event is called La-Nina, which in effect is the complete opposition of El Nino. A La-Nina also moves an active Hurricane season. In India, its presence porteds exceptionally good news. It is the harbinger of heavy monsoon showers in India.

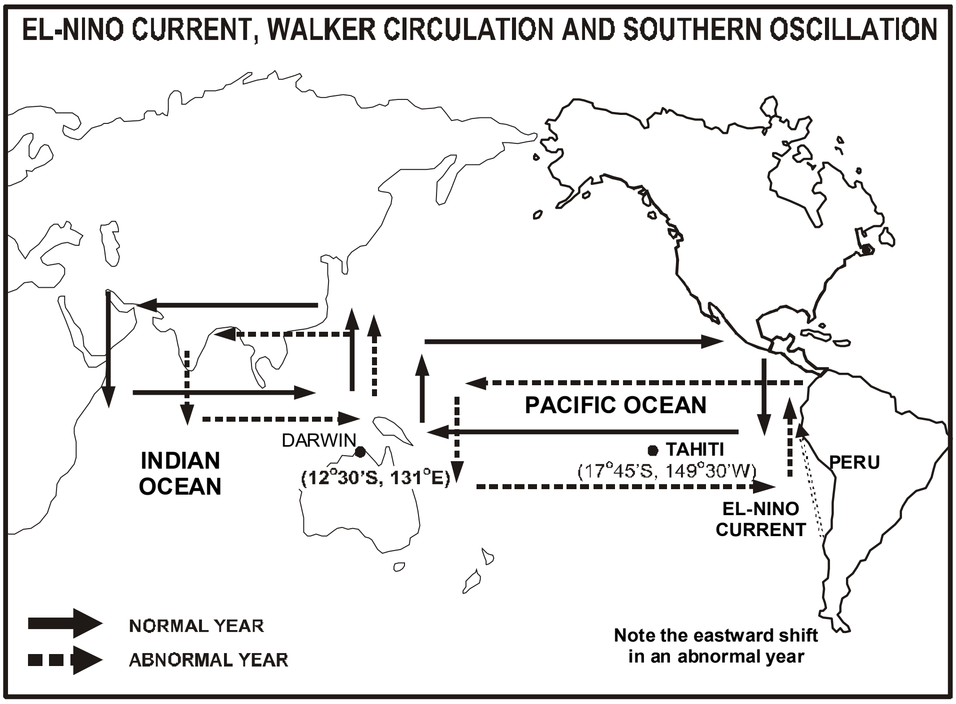

Fig.4.1 El-Nino, Walker Circulation and Southern Oscillation (By D.R. Khullar)

8. **Southern Oscillation-** It explains the linkages between the pacific and Indian oceans. These relations were discovered by **Sir Gilbort Walker** in 1920. It is observed that whenever the surface level pressure is high over the Indian Ocean, there will be low pressure over the pacific ocean and vice versa. This inter-relation at high and low

pressure over the pacific and the Indian Ocean is called **southern oscillation**. The low pressure conditions in Indian Ocean is observed in winter, indicate the conductive to good monsoon rainfall in India. This situation will help in good monsoon rainfall in India. On the other hand, if Indian ocean has high pressure, whereas pacific ocean has the low pressure, such condition will be conductive to weak monsoon rainfall. Such position is defined as El-Nino year. **Sir Gilbert Walker**, due to close association between change in pressure conditions of both the oceans, and the effect of El-Nino current has referred it as ENSO.

9. **Tropical Cyclones-** These originate in Bay of Bengal and Arabian Sea and influence primarily a larger area of south and central India. The number of such cyclones is more in Bay of Bengal. These cyclones become disastrous on the eastern coast. Their frequency is more during the onset and offset of monsoon seasons. During the months of June to September, their frequency is three to four, per month.

These cyclones are now called by different names. The list of these names was prepared by South Asian countries. These are named as Pyar, Fayan, Catrina, Laila, Iola and so on. The cyclone of 3-6 October 2014 was called by the name of Hud Hud, which affected Odisha and Andhra Pradesh on 31 October, 2014. Nilober cyclone of Arabian Sea effected Gujarat coastal area. These cyclones are quite violent and some times become highly destructive and cause the loss of life and property.

10. **Western Disturbances-** These are also known as temperate cyclones. These originate over the Mediterranean Sea and travel eastward under the influence of Westerly Jet Stream. They bring a small amount of rainfall which declines from west to east. They leave their effect on winter weather conditions of most of the Great Plains and Western Himalayan Region. The Westerly Jet Stream plays an impressive role in descending them towards North-West parts of India. Their frequency is observed four to five per month between November and April. They also cause rainfall in the hilly region and, thus, bring sudden

drops in the temperature. The rains are highly useful to Rabi crops. Some- times widespread frosts result in the damage of crops.

4.4 THE MONSOON

The term Monsoon has its origin from the Arabic word Mausim or Malayan word Monsoon, which means 'season.' In sixth and seventh century, Arabian navigators used this term for those winds which blow from north-east direction for six months and for remaining six months from south-west direction in Arabian Sea. These winds were noted in the area lying between India and East Africa. In the end of 15th century, Arabian people used south-west winds during the journey of Kalikut by Vasco-da-Gama. In 1686 Edmund Halley had forwarded has view on Asiatic Monsoon in Royal Society of England that the reversal in Monsoon winds is the result of the process of surface temperature. Monsoons are seasonal winds on a large scale, which change their direction according to seasons. These are the alternating thermal winds affecting the lower layer of the atmosphere. The term Monsoon has been used in singular and plural forms.

Forms and Meaning of Monsoon

(i) Singular Form- In India, the word Monsoon is used frequently for the rainy season and is defined in terms of rainfall alone. It is the opinion of few scholars that the winds blowing from south-west in summer season are called Monsoon winds. Thus, Monsoon is a westerly air flow of summer. In 1945, **Eaker** has said that, the whole airmass crossing the equator is deflected and will be called the monsoon- as distinct from the trade wind which is not deflected as it has not crossed the equator. In 1951, **A. Grims** has defined Monsoon as deflected trade winds. South-east trade winds are responsible for the origin of Monsoon. These winds change their direction at the time of crossing the Equator, due to Coriolis force of the earth.

(ii) Plural Form- Most of the scholars have used this term for two type of winds- i.e. one, Summer Monsoon winds, and second Winter Monsoon winds. Thus, the Monsoon is a double system of seasonal winds. **Koppon** (1923), **Hann** (1932) and **Angot** (1943) have said that the Monsoon represents simply a land and sea breeze on a large scale, and that the annual period of the Monsoon corresponds to the diurnal period of the breezes.

Conrad- A true thermal Monsoon demands a complete reversal of winds that is an angle of about 180^0 between the dominant winds at extreme season:

The origin of these seasonal winds is still shrouded in mystery, and a number of theories have been propounded by a number of scholars. Their views are flexible and dynamic. Monsoon has three main features:

(i) Reversal in the direction of Monsoon winds with the season.

(ii) Reversal in direction due to variation in temperatures of land and water.

(iii) Monsoon winds in summer season are rainy.

The views expressed, thus may be categorized into following three theories: (i) Classical Concept, (ii) Air mass concept, (iii) Perturbation concept.

(i) The Classical Concept- It is based on the variation in temperature of sea and land. Monsoon is a result of thermal contrasts. It is connected with thermal variations of the continents and oceans. This is a thermal concept. This concept is based on two essentials-

(a) Presence of land and water: If there was no variation of land and water on the surface, there was no possibility of its origin.

(b) Change in seasons: This is responsible for the change in wind directions.

During the summer season, these winds blow from Indian ocean to Indian landmass, and in winter season from the Indian landmass to Indian ocean. Their direction is affected by the rotation of the earth on its axis. It means that these winds take eastward turn after crossing the Equator, and thus south-east trade winds become south-east winds.

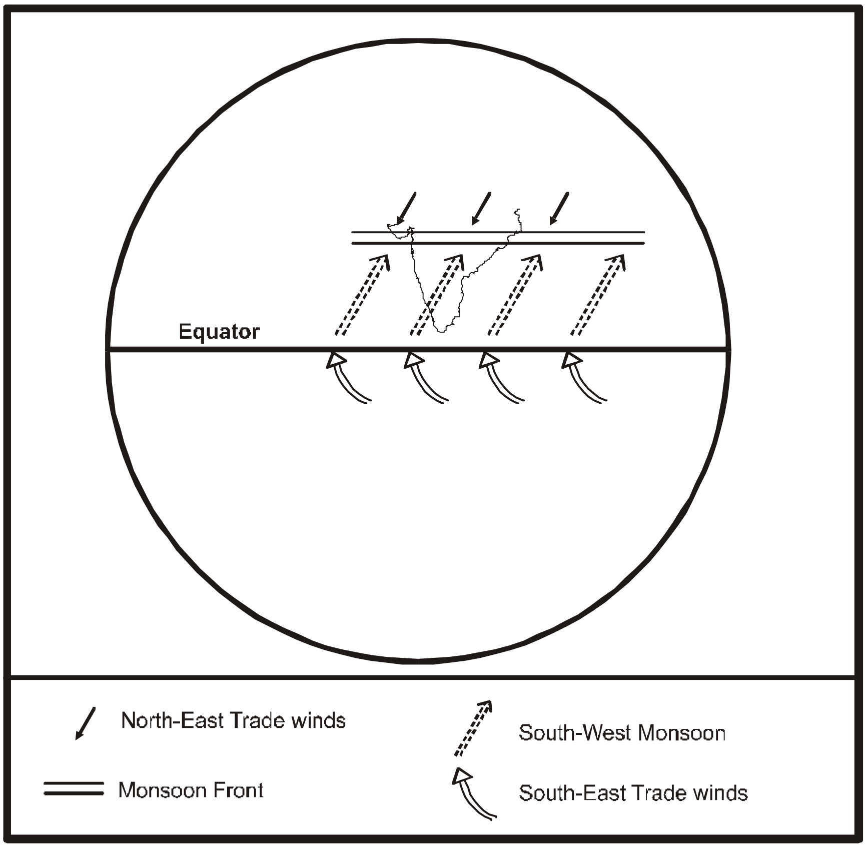

FIG.4.2 Origin of S.W. Monsoon in Northern Hemisphere

This concept is logical and acceptable, but it does not highlight the changing nature of Monsoon.

(ii) The Air Mass Concept- This concept is based on the contraction and expansion of Planetary Air Currents. This dynamic concept was developed by **Flohn** in 1951. He argued that Monsoon is only the seasonal migration of planetary winds and pressure belts following the position of sun. During the summer solstice, the sun's rays fall vertically over the Tropic of cancer. Consequently, all the pressure and wind belts of the globe shift northwards. At this time Inter-Tropical Convergence (ITC) moves northward, and major part of Indian landmass comes under the impact of equatorial westerlies, which are called south-west monsoon. During the winter season, the pressure and wind shift southward, thereby establishing the north-east monsoon (trade winds) over this region. Such systematic change in the direction of planetary winds is known as monsoon.

According to **spate**, the origin of monsoon is in accordance to the theory of the origin of cyclones. These monsoon cyclones originate due to accumulation of three fast moving Air currents- First-new humid monsoon Air currents, Second- old monsoon current of low temperature and more humid, Third- continental tropical Air Current, which is developed between old and new monsoon currents and, thus, a front or convergence is originated and a cyclonic air current is developed.

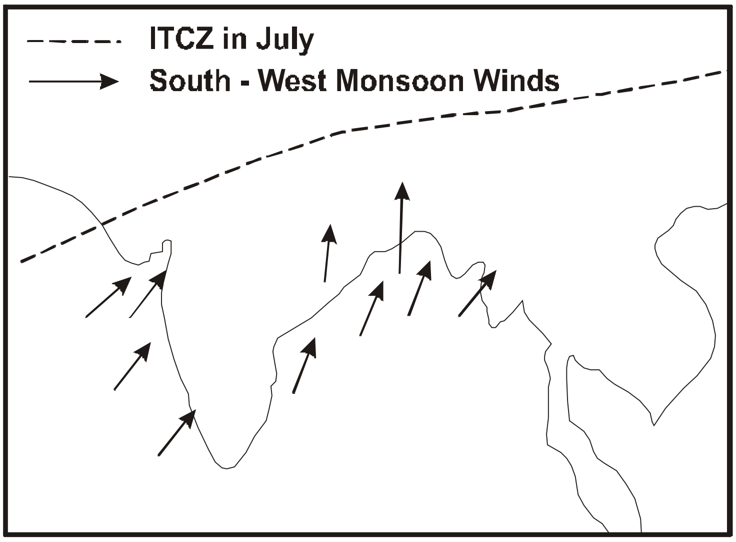

Fig. 4.3 Inter Tropical Front

A group of scholars has explained the origin of Inter-Tropical Convergence, and has related with the origin of monsoon. The north-ward migration of this ITC is an important factor influencing particularly the onset and intensity of south-west monsoons. The ITC shifts northward in summer season and has its position on north part of India. It's shifting towards north on the increase in temperature. This ITC is sometimes called as monsoon trough. It leaves its influence on the distribution of rainfall and also on the route of monsoon cyclones.

ITC changes its position in winter season. It is shifted towards the Equator. North India comes in the influence of North-East trade winds. When these winds cross Bay of Bengal gain moisture, and thus provide rains to Eastern Coastal areas. The ITC is contracted, when it reaches near to Equator. In real sense, this ITC is a zone of low pressure separating the north-east winds with the south-east trade winds. The position and presence of this zone affect the direction and amount of rainfall mainly in summer season. **Flohn** is of the view that reversal in Monsoon winds is not based on thermal changes; rather it is based on reinstallation of planetary trade winds.

(iii) The Perturbation School or Jet Stream Concept- It is a recent concept mainly developed after 1950. This concept is based on the role of Jet Streams, Tibet Plateau, and the ocean bodies in explaining the origin monsoon. The following shortcomings of monsoon attract us to study its origin:-

(a) The variability in summer rainfall
(b) Uncertainty in time of rains
(c) Number of rain days to be less in rainy months
(d) Uncertainty in the on set and off time of monsoon rains.

This concept is propounded by a number of Indian and foreign scholars among them **Koteswaram, M.T. Yin, Parthsarthy. Flohn, Raman** and **Ramnathan** are noteworthy. Here, it is important to know about the meaning of Jet Stream.

Meaning of Jet Stream- These are circum-polar air currents. These winds flow in both the hemispheres between winter 20^0N-35^0C in northern hemisphere and summer the surface. These are also Air Rivers, which were identified by American Pilots of aircrafts B-29 (Jet) during the Second World War. They were compelled to face these strong winds, which affected the speed and direction of their aircrafts.

These streams are named after Jet Aircraft, which is known for its speed and flight at high attitude. Thus are defined as follows-

Definitions

- Jet streams are upper air circulation winds and blow just like an ocean current. They blow in certain direction with definite width.
- The meandering narrow and strong speedy air current of Upper Troposphere are known as Jet Streams.
- **Kendrew-** Jet stream is a strong air belt found in both the hemispheres.
- **Trewartha-** Jet stream is a vast air current, which blow with a great velocity from west to east direction.

Characteristics

(i) Jet stream winds blow at an altitude of 6000-12000 m.

(ii) They change their location according to season. They shift towards near Equator in winter season and towards poles in summer season.

(iii) They blow from west to east in westerlies belt.

(iv) These have high variation in speed.

(v) Their speed is high in the central part than the sides.

(vi) The speed is 64 km per hour in winter and 24 km per hour in summer. Near axis the speed is very high.

Effect on Weather- There is intense relations between weather and Jet Stream. It affects on the activeness of Monsoon. It forces monsoon winds by putting pressure on the surface winds. These also leave their impact on the increase or decrease of rainfall and also on its uneven distribution. All these effects have been discussed by the scholars in different ways.

N.M.T. Yin presented his theory on the origin of Monsoon in 1949. He determined that burst of monsoon depends on-

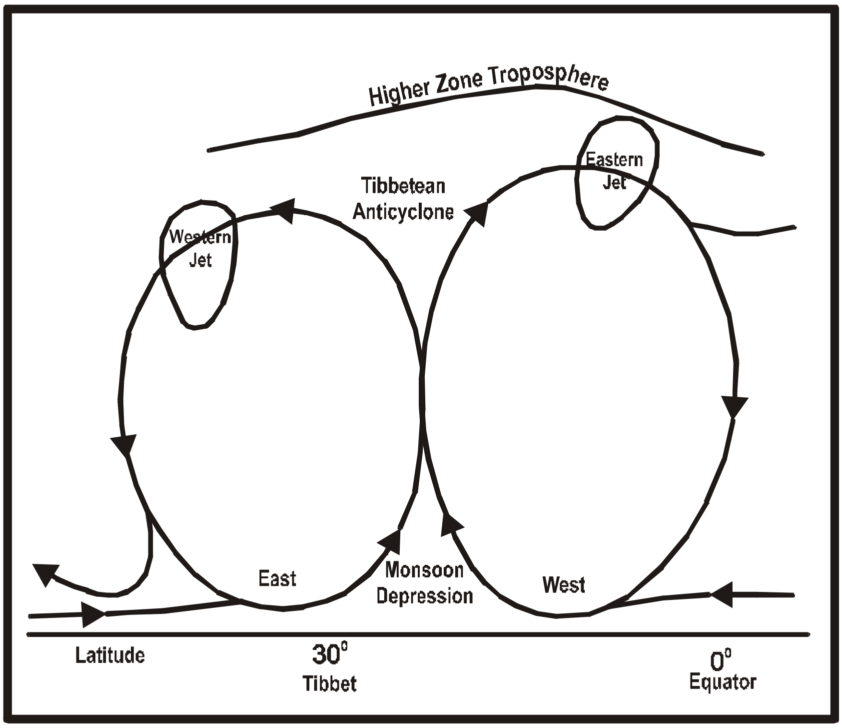

Fig. 4.4 Origin of Summer Monsoon Jet Stream

(i) The movement of upper air of monsoon trough of Bay of Bengal towards west means from 90°E to 80°E longitude.

(ii) The movement of low latitude western Jet Stream towards north.

(iii) The effect of the location of the pressure of North hemisphere winds.

He forwarded his views that burst of Monsoon depends upon upper atmosphere condition. The change in the position of low latitude axis trough from 90° E to 80° E, affects the movement of winds in Northern Hemisphere, and this situation invite the burst of monsoon. This is caused due to northward shift of western Jet Stream in north. In summer, this western Jet Stream has its effect in north. Its south branch, when it starts to proceed towards north, causes heavy rainfall by south west monsoons.

P. Koteswaram propounded a new hypothesis on the origin of monsoon in an article entitled, “The Easterly Jet Stream in the Tropics” in 1958.

He emphasized that Tibet Plateau affects the atmosphere in two ways: (a) as a meteorological barrier, and (b) as a high level heat sources.

He established the relationship between the monsoon and atmospheric conditions prevailing over Tibet Plateau. It becomes hot in summer and is 2°C to 3°C warmer than the air over the adjoining regions. It generates an area of rising air. During its ascent, the air spreads outwards and gradually sinks over the equatorial part of the Indian Ocean. At this stage, the ascending air is deflected to the right by the earth's rotation and moves in an anti-clockwise direction leading to anti-cyclonic conditions in the upper troposphere over Tibet. When these winds approach the west coast of India, they form south-west direction. After gaining the moisture from the Indian ocean causes heavy rainfall in India and adjoining countries.

Thus, it is revealed that intensity and heating of Tibet Plateau has a direct bearing on the amount of rainfall in India by the monsoons.

Monex means monsoon expedition. It has confirmed the views expressed by Koteswaram. A joint venture of Indian and Russia meteorologists carried out oceanographic and atmospheric studies with the help of modern techniques and instruments. They studied the irregularity of monsoon rainfall in summer season, and determined that Tibet Highland plays a dominant role in the origin of monsoon circulation over the Indian sub-continent. If the north-east winds are slow and weak, South-west monsoon also becomes weak otherwise not. More heating of Tibet Plateau makes monsoon more active. This plateau functions as a switch.

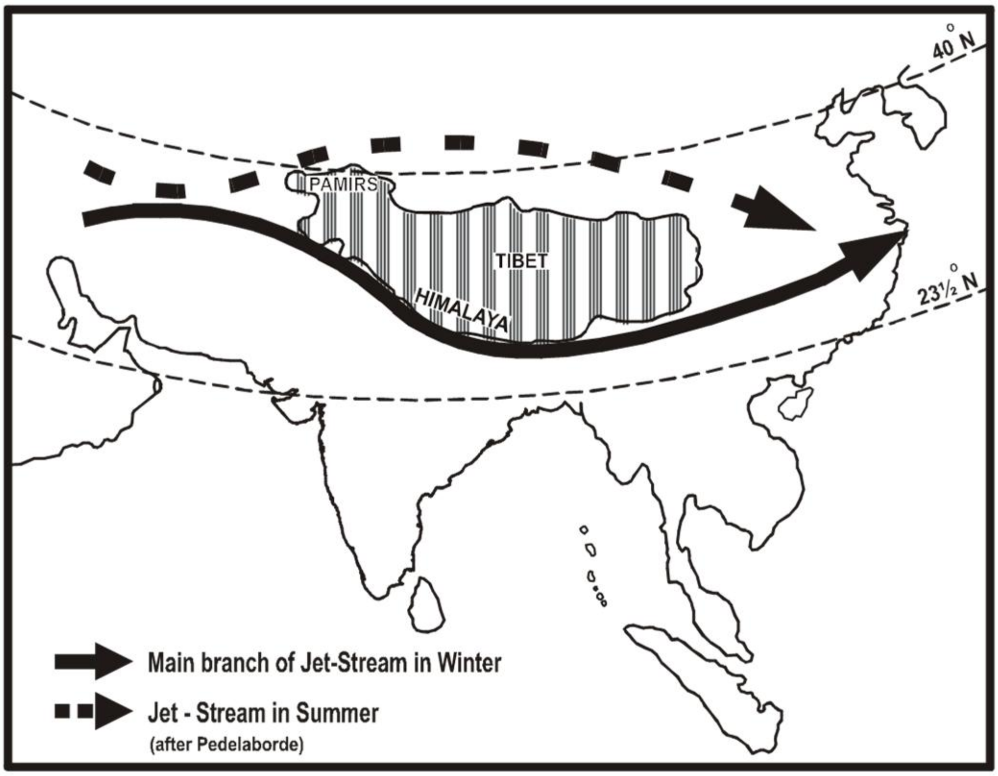

Fig. 4.5 Jet Stream (After Pedelaborde)

Flohn explained Tropical Jet Stream in 1968. According to him, Tibet Plateau is a steam engine for the origin of summer monsoon. It makes changes in the direction of winter winds, and thus, invites south west monsoon. At the time of south-west monsoon, the extension of tropical jet stream occupies more than half of the area of the northern hemisphere and thus, encourage heavy rainfall. The structure of Eastern Jet Stream is an important and incomparable structure of north hemisphere, which provides power and strength to rain providing winds.

Raman and Ramnathan highlighted on the structure of Tropical Easterly Jet Stream and suggested that Eastern Jet Stream becomes very active in the upper troposphere after the beginning of rainy season. The latent heat produced due to cloud cover results into inversion of temperature and causes rainfall.

S.Ram Rattan was of the opinion that the development of Monsoon winds is deeply connected with the air circulation in upper atmosphere in addition to the differential heating of land and sea. The air circulation is called **Jet Stream**. Jet Stream winds are sharp speed winds blowing in the upper limit of troposphere. This circulation creates anti-cyclonic pattern between 20°S and 40°N latitudes in summer, whereas cyclonic monsoon winds prevail at the surface. The upper atmospheric cyclone activates westerly jet winds in north of Himalayas while easterly jet winds in the south of Himalayas. These easterlies jet becomes powerful near 15° N latitude. This situation makes monsoon more active and thus, compel them for heavy rains.

A. Parthasarthy wrote an essay on 'Trying to solve the Monsoon Riddle' and explained that the monsoons are influenced by the north-east trade winds. Weak north-east trade winds result in the weak monsoon, and thus lead to drought conditions.

Thus it is revealed that the origin of monsoons does not depend only land and sea thermal contrasts but it is also affected by the circulation of upper air.

4.5 CLIMATE REGIONS OF INDIA

India is a so vast country that, it is quite natural to note here large variations in climate. The variation in height from mean sea level has given diversity to the climate. The climatic elements temperature and rainfall provide the base to divide India into climatic regions. Amount and variation of rainfall are much marked than those to temperature. Hence, most of scholars have given more importance than to temperature. The first attempt to divide India into climatic regions was made by **Blanford**. He said that the different parts of India exhibit a great diversity. Among the subsequent attempts to divide into climatic regions, the scholars who have forwarded their views on this issue are **Stamp, Kendrew, Thornthwaite, Koppen, Trewartha** and **Johnson**. A number of Indian scholars have also made attempts in this direction. Among them **Subrahamanyam**, **K.S. Ahmad, R.L. Singh** are worth mentioning.

Stamps Climatic Regions

The views of **L. Dudley Stamp** are identical to that suggested by **Kendrew**. They divided India into two main regions by Tropic of Cancer. This line more or less follows 18^{0}C isotherm of mean monthly temperature of January. The northern part of this line is defined as Temperate India and the southern part is defined as Tropical India. These two main climatic regions are further divided into eleven regions depending upon the amount of rainfall and temperature. This classification is quite rational and subjective.

(A) **Temperate India-** It is also called continental India. This does not experience the temperature of January month more than 18^{o}C. It is sub-divided in five regions on the basis of amount of rainfall and physiography

(1) **Himalayan Region-** It extends from Kashmir in west to Arunachal Pradesh in east. It includes Jammu & Kashmir, Himachal Pradesh, large part of Uttarakahand, Sikkim and Arunachal Pradesh. The summer and winter temperatures remain between 13°C to 18°C in June and 4°C to 7°C in January respectively. The temperature in some western parts goes down to freezing point in winter. The amount of rainfall is 200 cm. The eastern part receives the rainfall from Bay of Bengal Monsoon. The western part receives the rainfall mainly from Arabian Sea Monsoon and in winter from temperate cyclones. Shimla in the west and Darjeeling in the east are its representative cities.

(2) **North-West Region-** It extends on the region Sutlej and Beas Rivers, and enjoys dry conditions. It covers north Punjab and South Jammu & Kashmir. It receives rainfall in summer as well as in winter. The average annual rainfall is 38 cm. Rains are mostly received by temperate cyclones. The average temperature of January is 16°C and of June is 24°C. Amritsar is its representative city.

(3) **Dry Desert Region-** It includes most part of Rajasthan, North Gujarat, South Punjab, Haryana and Delhi. The average amount of rainfall is less than 25 cm. In western part, it goes down to 13 cm. The January temperature is between 13°C and 24°C, while the average temperature of July remains nearly 43°C. Jaipur is the representative city.

(4) **Moderate Rainfall Region-** It includes western and central part of Uttar Pradesh, North Madhya Pradesh and some parts of east Rajasthan. The temperatures of January month remain between 13°C and 24°C and July temperatures between 33°C and 35°C. It experiences warm air in May-June months, locally known as 'Loo'. These help in the increase of temperature. The average amount of rainfall remains 38 to 76 cm. Most of the rainfall is

received in summer season. A little amount of rainfall is received by temperate cyclones in winter season. Delhi is the representative city.

(5) The Transitional Region- It is extended on east part of Uttar Pradesh and Bihar. The temperature of July is 32^0C to 35^0C and of January is 15°C to 19°C. The average annual rainfall is 100-150 cm. It receives rainfall from Bay of Bengal Monsoon winds.

(B) **Tropical India-** It is extended in the south of Tropic of cancer. The temperature of January month remains more than 18°C. This isotherm line does not fully follow the Tropic of Cancer line. It is sub divided intosix sub division.

(6) Very Heavy Rainfall Region- It includes Meghalaya, Assam, Tripura, Mizoram, Nagaland and Manipur. The average annual rainfall is more than 200 cm. This rainfall is received in between April and September from Bay of Bengal Monsoon. Temperatures remain around 32°C to 35°C in July and reaches to 18°C in January. Cherrapunji is situated here and receives 1080 cm annual rainfall.

(7) Heavy Rainfall Region- It includes Chhatisgarh, Jharkhand, West Bengal, Odisha, East Maharastra and north-east Andhra Pradesh. July temperatures remain around 29°C to 35°C and in January around 18°C to 24°C. The average annual rainfall is 100 to 200 cm. The rainfall is received from Bay of Bengal Monsoon and also from tropical cyclones. These cyclones frequently come before and onset of Monsoon. Kolkata is the representative city.

(8) Moderate Rainfall Region- It includes Gujarat, South-West Madhya Pradesh, Central Maharashtra, East Karnataka, and West Andhra Pradesh. It receives rainfall on an average of 76 cm., which is quite low, and thus, is defined as Rain Shadow Area. Rains are brought by Arabian Sea Monsoon. The temperatures of

January are 18°C to 24°C. May temperatures remain near 32°C. It has not much variation in temperature. Hyderabad is the representative city.

(9) **The Konkan Coast Region-** It extends from Narmada River in the north to a little north part of Kerala. The average amount of rainfall is more than 200 cm. It is provided by Arabian sea branch. The annual range of temperature is very low. The average annual temperature is 24°C. Dry months are seven in number. Mumbai in the representative city.

(10) **The Malabar Coast Region-** It covers most of Kerala State and also includes Kanyakumari district of Tamilnadu. Dry season is only for three months. The average annual rainfall is more than 300 cm. The average temperature is 21°C. Thiruvanthpuram is the representative city.

(11) **The Coastal Region of Tamilnadu-**It includes most part of Tamilnadu, south-east Andhra Pradesh. The rainfall varies from 100 to 150 cm and is mainly received by the retreating monsoons in November and December. The temperatures remain from 24^0C to 27^0C. Chennai is the representative city.

The above classification is accepted by most of Indian Geographers. It is most easy to understand.

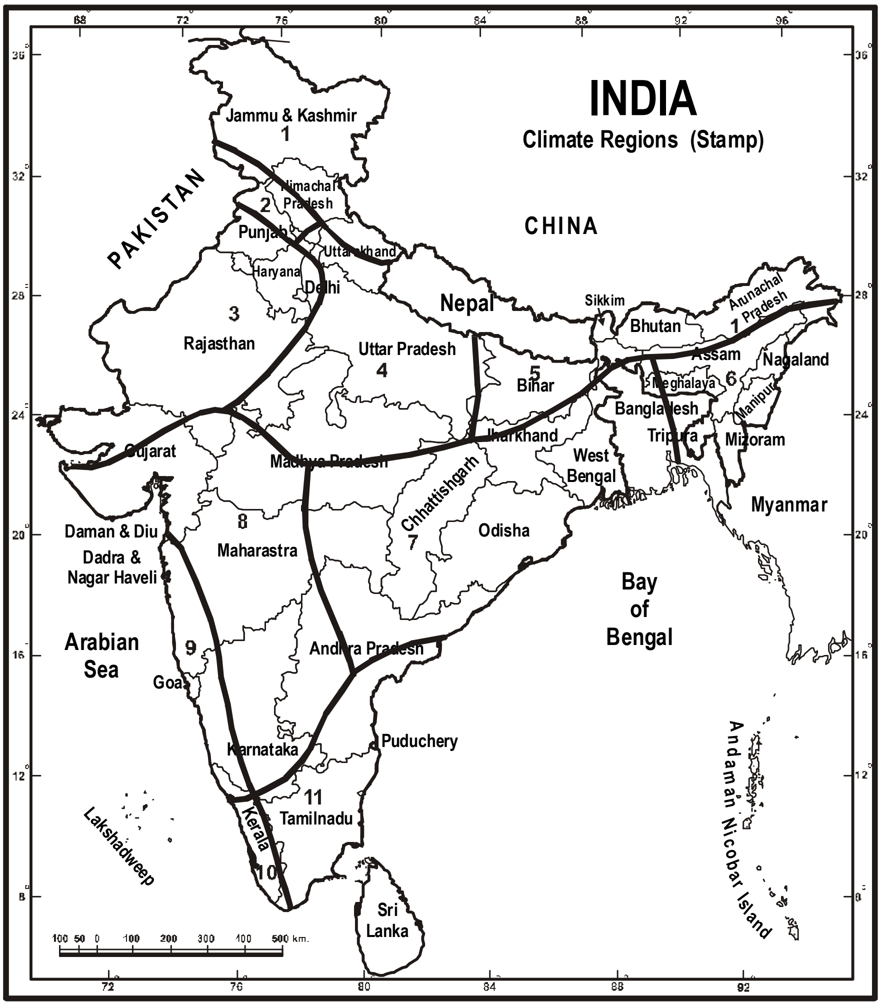

Fig. No. 4.6 Climate Regions : Stamp

Climatic Regions According to Thornthwaite

This American Scholar presented his classification of climatic regions of India on the basis of following four bases-

(i) Seasonal distribution of rainfall,

(ii) Effect of temperature,

(iii) Precipitation effectiveness,

(iv) Use of English words.

He was of the opinion that the plant growth depends upon precipitation and as well as on its effectiveness. The precipitation effectiveness is determined by dividing total monthly precipitation by evaporation and is called the P/E ratio. He also examined soil, drainage and vegetation and determined the effect of precipitation on the growth of plants. He recognized eleven climatic regions of India which can be summarized as-

(i) **AA'r-** It is tropical wet climate. Rainfall occurs in all the seasons. It has dense evergreen vegetation. It is found in Mizoram, Meghalaya and Tripura.

(ii) **BA'w-** It is tropical humid climate. Rainfall is deficient in winter. It is found on eastern slopes of Western Ghats, and in West Bengal.

(iii) **BB'w-** It is temperate humid climate. Rainfall is less in winter; Assam, Meghalaya and Nagaland enjoy it.

(iv) **CA'w-** Sub-humid tropical climate, deficient in winter rainfall, climate suitable for grasslands only. It covers large parts of the Peninsular India.

(v) **CB'w-** Sub-humid sub-temperate climate. Deficiency in winter rainfall. It covers most parts of the Great Plains.

(vi) **DA'w-** Tropical semi-desert climate. Deficiency of rainfall in summer season. Suitable for steppe vegetation. It covers Gujarat and some parts of Rajasthan.

(vii) **DB'w-** Semi-dry desert climate. It covers western Punjab and Haryana.

(viii) **DB'D-** Semi-dry desert climate. Rainfall deficiency in all months. It covers rain shadow area of the peninsula.

(ix) **D'**- **Cold climate-** It covers eastern Himalaya, Uttrakahand, Northern parts of Punjab and Haryana.

(x) **E'- Cold climate-** It is found in higher altitudes of Himalayas and Laddakh.

(xi) **EA'D-** Tropical desert climate. Rainfall deficiency throughout the year, desert vegetation. It covers western part of Rajasthan.

This classification is quite complex, as India enjoys the climate of Equatorial areas to Polar areas.

Climatic Regions According to Koppen

Dr. Vladimir Koppen of Austria divided India into three climate Regions in 1918- (i) Dry India (ii) Semi-dry India and (iii) Humid India. After some time he presented a new scheme of climatic classification in 1936. This classification is based upon the following four points:

(i) Annual and monthly average temperature

(ii) Amount of rainfall,

(iii) Local natural vegetation,

(iv) **Use of English alphabets-** i.e. A- for tropical rainy, B- for dry, C- for middle, latitude rainy climate with mild winters, D- for middle latitude climate with sever winters, E- for polar climate. For further sub-division small letters a, c, f, w, s, g, are used.

Koppen has put India into nine climatic regions

1. **Amw-** (Monsoon type with short dry winter season)- This is found in Western coastal plain. It receives more than 200 cm rainfall in summer, winters are dry. It has tropical evergreen forest.
2. **AW-** (Tropical Savannah type) - This climate is found in most parts of peninsula. Rainfall occurs in summer season, winters are dry. Summers are quite warm. The average annual rainfall is 75 cm.
3. **AS-** (Monsoon type with dry season) - This region receives its most of the rainfall in winter season from the retreating monsoon. It covers south-eastern coastal plains. Summer is dry.
4. **BShw-** (Semi arid steppe type)- It occupies Rajasthan, Karnataka and parts of Haryana and Gujarat. Rainfall occurs in summer but

in little amount. Winters are completely dry. The average annual temperature is 18°C.

5. **BWhw-** (Hot desert type)- The western part of the desert enjoys such climate. The annual rainfall is less than 12 cm. Temperatures are very high is summer.

6. **Dfc-** (Temperate wet climate)- It is cold with humid winters Summers are very short but rainy. It covers Arunachal Pradesh, Assam and Sikkim. The temperature in winters is recorded near to 10^0C.

7. **Cwg-** (Monsoon type climate)- This type of climate is found in most parts of the Great Plains, east Rajasthan, north Madhya Pradesh, north Jharkhand. The summers are very hot but with rainy seasons. Winters are dry.

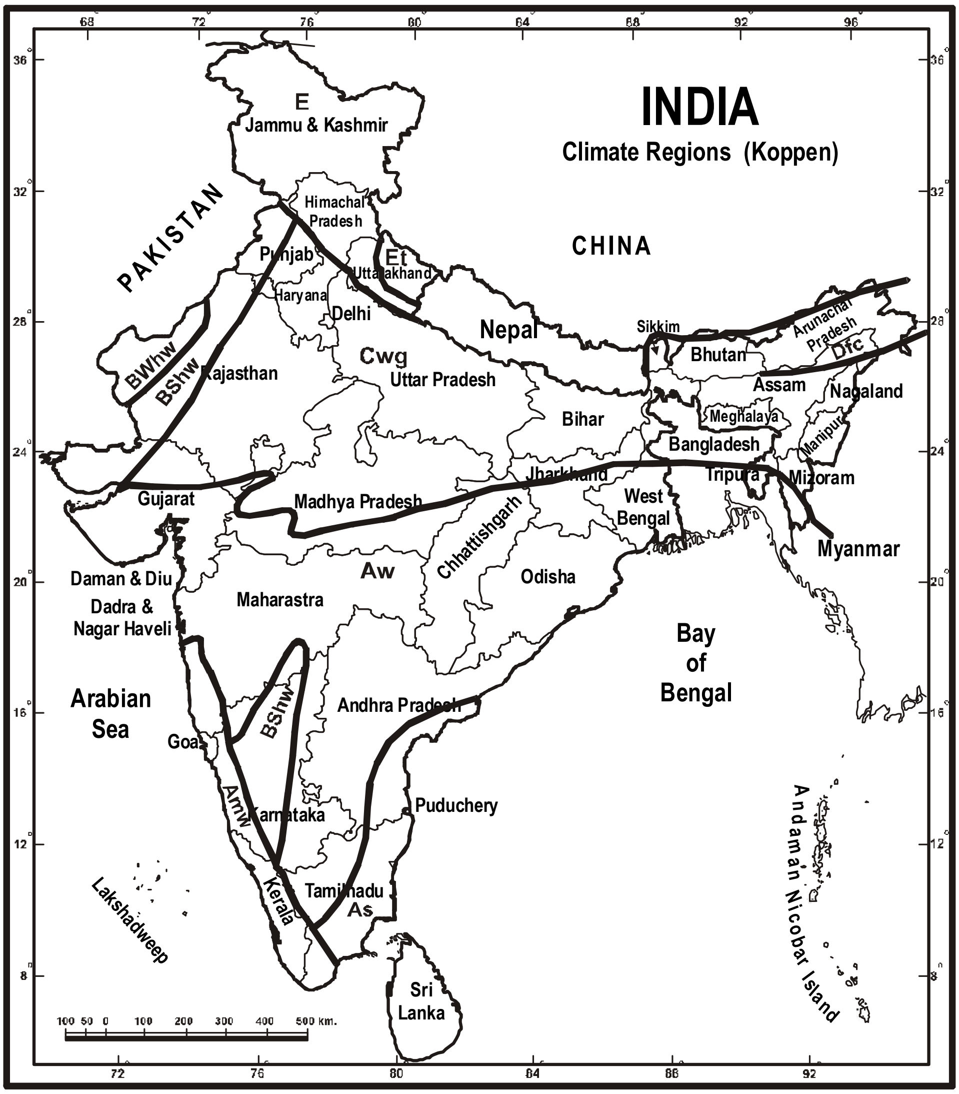

Fig. No. 4.7 Climate Regions : Koppen

9. **E-** (Polar type)- It is extended on Jammu & Kashmir and Himachal Pradesh. The temperature of the warmest month remains less than 10°C.

10. **Et-** (Tundra type)- This is found in north part of Uttrakhand. Summers are cold with temperature from 0°C to 10°C. The temperature decreases with the increase in altitude.

Criticism- According to **Koppen**, India entertains all type of climate i.e., from Tundra type to tropical wet type. He has not accepted the climatic difference of Upper Ganga Plain. He has also put eastern Maharastra and coastal region of West Bengal into one type of climate.

Climatic Regions according to Trewartha

This American Geographer has forwarded his views on the climate of India in his book, “An introduction to Climate”. He has modified and simplified Koppen’s scheme. His classification is an easy and rational. He has used the English word A, B, C and H and put India into seven types of climatic regions. He used A for tropical humid, B for dry, C for sub-tropical and H for mountain climate. Thus, India has A, Am, Aw, Bs, Bsn, Bwh, Caw and H type of climatic regions.

Climatic Regions according to R.L. Singh

R.L. Singh presented his climatic divisions of India in 1971 in his book ‘India: A Regional Geography’ His scheme is forwarded with certain modifications in the divisions of Kendrew and Stamp. His classification is based on the temperatures of hottest and coldest months and an amount of annual rainfall. This classification is easy, explanatory and rational. It explains ten climatic regions of India:

1. **Per Humid North-East-** It covers nearly all north eastern states Sikkim, Meghalaya, Mizoram, Assam, Arunachal Pradesh, Nagaland and Darjeeling Himalaya of West Bengal. The warmest month is July with 25°C to 33°C temperature. The temperature of coldest month January is 11°C to 24°C. The average annual rainfall is more than 200 cm.

2. **Humid Sahyadri and West Coast-** It is extended on West coastal region from the south of Narmda River to Kanyakumari. It also includes the western slopes of the Sahyadri. July is the hottest month with 26^0C to 32^0C temperature. The month of January has the temperatures from 18^0C to 28^0C. The average annual rainfall is more than 200 cm.

3. **Humid South-East-** It covers Chhatisgarh, Odisha, Jharkhand, West Bengal and north-east part of Andhra Pradesh. The hottest month is July with temperatures from 26°C to 34°C and January is

the coldest month with 12°C to 27°C temperature. The annual average rainfall is 100-200 cm.

4. **Sub-humid Transition-** It is extended on middle Ganga Plain covering east Uttar Pradesh and Bihar. July is the hottest month with 24⁰C to 41⁰C and January is the coldest month with 9⁰C to 24⁰C temperature. The average annual rainfall is 100-200 cm.

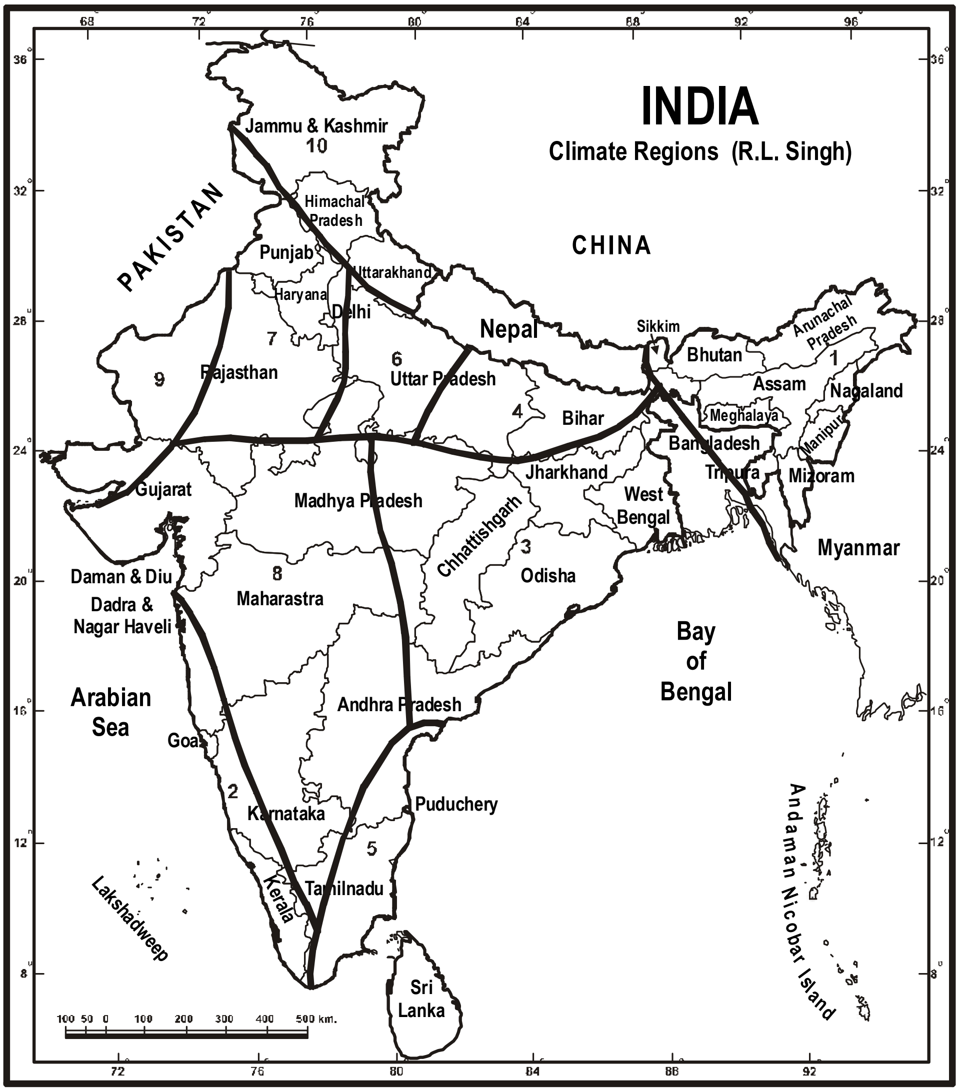

Fig. No. 4.8 Climate Regions : R.L. Singh

5. **Sub-Humid Littorals-** East Tamilnadu and Coastal region of Andhra Pradesh enjoy such climate. May is the hottest month with 28°C to 33°C temperatures. January is the coldest month with 20°C to 29°C temperatures. It means that the temperature never goes

below to 20°C. The area as a whole receives 75-150cm. annual rainfall, most of which is received from retreating monsoon in November December.

6. **Sub-humid Continental-** It covers Upper Ganga Plain. July with 26°C to 33°C temperature is the hottest month, while January with 7°C to 23°C is the coldest month. It shows high difference in the temperatures of summer and winter seasons. The annual average of rainfall is 75-150 cm.

7. **Semi-Arid Sub-Tropical-** It is extended on Sutlej-Yamuna divide and thus includes Punjab, Haryana, central east Rajasthan, Chandigarh and Delhi. May becomes very hot, and the temperatures remain from 26°C to 41°C. January has the temperature from 6°C to 23°C. The average of rainfall is 25-100 cm. Some rainfall in winter is caused by western disturbances.

8. **Semi-Arid Tropical-** Large parts of Gujarat, Maharastra, Madhya Pradesh, Chhatisgarh, Karnataka and Western Andhra Pradesh have such type of climate. July is the hottest month with 26°C to 34°C temperature. The temperature of January month is 13^0C to 21^0C. The average of rainfall is 50 to 100 cm.

9. **Arid-** This most dry part is extended on Thar Desert, Rann of Kutch, South west Haryana. It is the hottest part of India, and also has high range of temperature. Thus, there is a high difference in temperatures of summer and winter seasons. June has the temperature 28°C to 45°C and January temperatures are 6°C to 23°C. The rainfall is less than 25 cm.

10. **West-Himalayan-** Jammu-Kashmir, Himachal Pradesh and Uttrakhand are included in it. July has the high temperatures from 5°C to 30°C. January temperatures are very low and sometimes reach near to freezing point. The temperature is 0°C to 4°C. The average of rainfall is 150 cm, mainly received from western

disturbances. It also receives a little amount of rainfall from monsoon winds.

4.6 SOILS OF INDIA

Soil is the thin surface layer on the earth comprising mineral particles. It is formed by the break-down of rocks, decayed organic materials, living organisms, water and air. It serves as a medium for plant growth. It is an important natural resource. The rich, deep fertile soils support high density of population through agricultural prosperity. The history of civilization begins with the soil. The Indus valley is known as cradle of civilization.

India is a country of vast dimensions with varied conditions of geology, relief, climate and vegetation. Therefore, India has a large variety of soil groups, distinctly different from one other. Thus, it is very typical to classify Indian soils. Any classification based on any one of the aforesaid criteria has its own inherent drawback. A number of scholars and various institutions have classified these soils on various criterion by no one is an accurate and complete one. The study of Indian soils has also been made in consideration of surface features, thus these soils are put into four main groups: (1) Peninsular soils (2) Great Plains Soils (3) Himalayan Region soils (4) Other soils.

The earlier studies of Indian soils were made by foreign scholars, like **Volekar** (1893), **Leather** (1898), **Scholaskaya** (1932), **Champion** (1936) etc. and Indian scholars including **Wadia** (1935). **Vishwanath** and **Ukil** (1944), **S.P. Chatterjee, S.P. Roy Chaudhary** (1954) also forwarded their views on types of soils in India. Indian geologists have classified Indian soils in consideration of rock structure, and thus have divided them into five groups. On the basis of place of formation, these soils are residual soils and transported soils.

The Indian council of Agricultural Research (ICAR) in 1953, divided Indian soils into 8 major groups, which are: (i) Alluvial soils,

(ii) Black soils, (iii) Red soils, (iv) Laterite soils, (v) Forest soils, (vi) Arid and desert soils, (vii) Saline and Alkaline soils, (viii) Peaty and organic soils. This classification is very logical and is widely acceptable. An account of these soils is discussed here as under:

1. Alluvial Soils- These are by far the largest and the most important soils group of India. They cover 7.7 lakh sq km area, 34.0 percent of the total land. They contribute the largest share of our agricultural production and support the bulk of India's population. Most of the alluvial soils are derived from the sediments by the rivers as in the Great Plains, and in deltas, and sea waves along the coasts. These soils constitute the surface of the Great Plains from Punjab to Assam. They also occur in the valleys of the Narmada and Tapi in Madhya Pradesh and Gujarat, Mahanadi in Chhatisgarh and Odisha, Godavari and Krishna in Andhra Pradesh, and Kaveri in Tamilnadu. Along the coastal areas, these are referred to as coastal alluvium and in the deltas as deltas alluvium. These alluvial soils are transported soils. These are yet immature and have weak profiles.

These alluvial soils differ greatly in texture and consistency. These range from sands and loams to silts and heavy clay. Their depth is still not fully estimated. Their depth in the plains is not less than 400m. At some places, these are more than one thousand metre deep. Their depth is quite less near the sides of plateau and hilly areas.

Alluvial soils are generally deficient in nitrogen, phosphorus, and humus. Inspite of that these are very fertile. These soils are rich in lime and potash, the same is with the peninsular alluvial soils. In most areas, it is as yellow loam. The variation of rainfall leaves its impact on the quality and texture of soils. Because these are made up of fine particles, it can hold a lot of water.

On the basis of texture, variation in rainfall, variation in percentage of sand and clays, these are put into following types-

(i) **Older Alluvium-** These are known as Bhangar. They have more clayey composition and darker colour. These are coarser in texture and contain nodules (Kankar) and are found higher up in the plains at river terraces away from rivers. These soils are affected by the heavy floods and steep flow of water during the rainy season, and thus, suffers from the erosion. The areas of which have accumulation of sodium, magnesium and potassium salts at several places make it **Usar**, which is unsuitable for agriculture. Uttar Pradesh, Punjab, Haryana, Bihar and certain parts of Rajasthan have the presence of such soils.

(ii) **Newer Alluvium-** These are called Khadar, and occur near river bed where deposition takes regularly. These are flooded almost every year. They are pale brown, sandy clay and loams, more dry and leached, less calcareous and carbonaceous. These are highly porous and more fertile than Bhangar.

(iii) **Deltaic Alluvium-** These are found in river deltas. On the mouth the flow of rivers is reduced due to least slope, and in such condition the depositional power of the river is highly increased. These are highly porous, light and fine. These soils are suitable for the cultivation of rice, jute and sugarcane mainly.

(iv) **Bhabar and Terai Soils-** Siwalik foot hills is composed of alluvial fans with coarse, often pebble soils. The zone is called Bhabar. It is a long narrow strip of swampy land with salty soils. To its south occurs the swampy lowland with salty soils and known as Terai. These are rich in nitrogen and organic matter but are deficient in phosphate.

The Alluvial soils of peninsular India are quite different to Great Plains alluvial soils. These are the dust of old igneous rocks. These are fertile and are found in delta and valleys of Godavari, Krishna, Kaveri, Mahandi. The north and east parts of Gujarat also have alluvial soils. Here, new alluvial is known as Mata and old alluvium as Gordu. Most of the soils are new and deep. The alluvial soils of Odisha and Chhatisgarh are light sandy and of yellow colour. Andhra coastal region has black alluvial soils along its long coastal line and Godavari- Krishna delta. The alluvial soils of Kaveri River in Tamilnadu are not so deep. Kerala has two types of alluvial soils- (i) Sea coastal alluvium-it is sandy and poor, (ii) Riverine alluvium-it is fertile. Rice and sugarcane are grown there.

2. **Black Soils-** After the alluvial soils, these soils occupy the largest area in the country. It covers most of the Deccan Plateau especially the region in Maharastra and Madhya Pradesh is known as Deccan Trap. It is also found in most of Gujarat northern parts of Karnataka, South Chhatisgarh, South Odisha, West and south parts of Andhra Pradesh, Western Tamilnadu, Bundi and Tonk districts of Rajasthan and plateau region of Uttar Pradesh. These soils are also called Regur (from the Telgu word Reguda). These are also as black cotton soils, because the most important crop is grown on these soils. These are also known as Tropical chernozems or tropical black earths.

These soils have developed over Deccan Lavas to gneisses and granites under semi-arid conditions. These are essentially mature soils. These soils occupy over 5.46 lakh sq. km. area (16.6 percent of the total geographical area) encompassed between 10°N to 25°N latitude and 73°E to 82°E longitudes. This is an area of high temperature and low rainfall.

These are very fertile and are being used without adding fertilizers and manures. These are clayey in nature with fine grained particles. These are highly retentive of moisture. The black colour is due to its iron content. It is rich in lime, potash, magnesium, calcium carbonate and alumina. The amount of phosphorous and nitrogen is low. Black soils are somewhat sandy, shallow and poor in fertility on uplands and darker, deeper and richer in valleys and lowlands. The lowlands soil is more fertile.

In rainy season, it swells moisture greatly and becomes sticky. In hot dry season, this moisture is evaporated; the soil is shrinked and is seamed with broad and deep cracks. This permits oxygenation of the soil to sufficient depths, and the soil gains extraordinary fertility. It means that it ploughs itself. These soils are very popular for the cultivation of cotton, wheat, tobacco and oilseeds are also grown on large scale. Rice and sugarcane are equally important where irrigation facilities are available.

3. **Red and Yellow Soils-** Most part of south India has the distribution of these soils. They occupy the states of Kerala, Tamilnadu, Karnataka, Goa, eastern parts of Andhra Pradesh, Odisha, eastern Madhya Pradesh, plateau districts of Uttar Pradesh. They occupy nearly 8 lakh sq. km. area.

These soils are derived from crystalline and metamorphic rocks. The main parent rocks are acid granites and gneisses, Quartzitic and felspathic. The colour of these soils is generally red, often grading into brown, chocolate, yellow, grey or even black. The reddish colour evidences the presence of iron compounds.

It is less fertile as it is deficient in phosphorous, nitrogen, lime and humus. But crops can be cultivated in this type of soil with the use of fertilizers. The soil is coarse and crumbly. It is thicker in the plain areas and are more fertile than on the slopes of the hills. Rice, wheat, sugarcane, cotton and pulses are grown on it with the use of fertilizers. Groundnut and potato are also grown on upland soils.

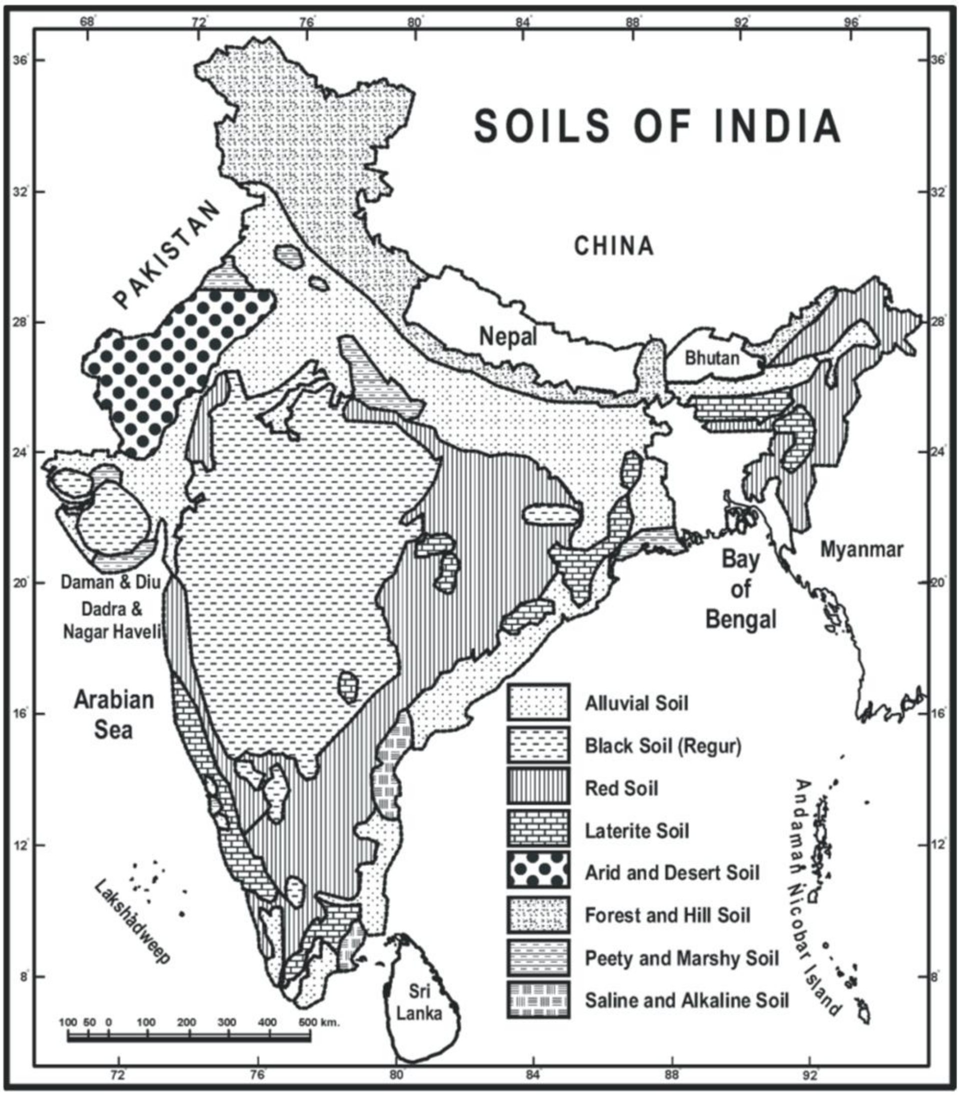

Fig. No. 4.9 Soils of India

4.

Laterite Soils- The word laterite has been derived from the word later of Latin language. It means brick. It was first applied by **F. Buchanan** in 1910. This soil is of typical type. It is formed under the condition of high temperature and rainfall with alternate wet and dry periods. It is a residual soil. It is developed as a result of leaching in areas of heavy rains. Here, leaching means, a process by which the nutrients in the soil are washed away by heavy rains. In dry season, it becomes so hard, that it look like a brick or rock, but in the wet season, it becomes sticky just like curd. This soil is acidic in nature, and coarse and crumbly in texture.

Laterite soil is found in the hilly regions of the Western Ghats, Kerala, Chhota Nagpur Plateau and the hills of Assam and Meghalaya. It covers an area of 1.26 lakh sq. km. Due to leaching, the proportion of lime and silica is reduced while the proportion of iron and aluminum compounds becomes higher in the upper layer. This gives a reddish colour to the soil. As a whole, it is deficient in lime, nitrogen Magnesium and organic elements, so it is not suitable for cultivation but it does support pastures and scrub forests. With the use of manures sugarcane, Ragi and rice are cultivated on low lands, coffee, rubber, cashew and tapioca crops are also cultivated.

5. **Arid and Desert Soils-** These soils are formed under arid and semi-arid conditions in the north-western parts, where they occupy about 1.42 lakh sq. km. area. The entire area west of the Aravalli Range in Rajasthan, Rann of Kutch, southern districts of Haryana and Punjab have these soils. The soils of this whole area consist of sands interrupted by low rocky projections. Sand dunes are common in the western and southern parts.

The mechanical weathering of rocks, due to the hot and dry climate results in the formation of sand. The wind carried away the sand and this soil results from the depositional work of wind. The soil contains a high proportion of soluble salts, very low humus. It is rich in phosphorus but poor in nitrogen. The soil is alkaline in nature and coarse in texture. With irrigation facility, this soil grows crops like wheat, gram, jowar, bajra, grapes and melon.

6. **Saline and Alkaline Soils-** These soils are found in Andhra Pradesh, Karnataka, drier areas of Bihar, Uttar Pradesh, Haryana, Punjab, Rajsthan and Maharastra. These soils occupy an area of 6800 sq. km. These soils are liable to saline and alkaline efflorescences and are known by different names such as reh, Kallar, usar and chopan. These are formed due to ill drainage which causes water logging. Dissolved salts sodium, calcium and magnesium in the sub soil are carried to the

surface by capillary action, when water is evaporated. The layer of these salts is of white colour and is called Reh. Thus, Reh is a mixture of sodium carbonate, sulphate, chloride, calcium and magnesium salts. Such reh is generally found also in canal irrigated areas. The accumulation of these salts makes the soil infertile and renders it unfit for agriculture.

It is observed that there are three sources of salts to these soils- (i) The water of Himalayan Rivers has these salts in dissolved form, (ii) South west monsoon winds coming from Rann of Kutch also bring particles of salts, (iii) In coastal areas; tidal waves bring sea water there, thus deposit salty soil on marshy areas.

These soils are used for the cultivation with the supply of organic fertilizers.

7. **Mountain Soils-** These are found in the hilly regions of Jammu & Kashmir, Himachal Pradesh, Uttrakhand, Sikkim and eastern states. These are of various types and are still in the stage of formation. These are formed due to mechanical weathering caused by snow, rain, temperature variation etc. The weathered material is washed away in the direction of down slope. So these have depth in the lower areas and river valleys. These are light sandy, thin and with pieces of rock. These are heterogeneous in nature and their character changes with parent rocks, grand configurations and climate. Consequently, they differ greatly even it they occur in close proximity to one another. In Himalayan Region, there are mainly found in valley basins, depressions and less steeply included slopes. The slopes of western Himalaya have fine sandy soil. Central Himalaya have rather fertile soils because of good contents of humus. These soils may be classified into following groups due to their structure, size of particles, and production of certain crop.

(a) **Calcareous and dolomite soils-** These are found, where lime and dolomite rocks have their presence. The content of lime in these rocks is affected by amount of rainfall. This land is known for pine and sal trees on slopes and rice cultivation in the valleys. The areas near Nainital, Mussorrie and Chakrota do record the presence of such soils.

(b) **Igneous soils-** These are made with the weathered material of granite and diorite rocks. These have good retentive power of moisture, and thus, are used in cultivation.

(c) **Tea soils-** The hilly slopes of central and east Himalayas have such soils. These have good content of iron. These are known for tea plantations, so are called tea soils. Kangra, Dehradun, Darjeeling of North Bengal and hilly slopes of Assam are known for these soils.

(d) **Stony soils-** The southern slopes of Himalayas have such soils. These are coarse and contain pieces of rock.

(e) **Tertiary soils-** These are found in the valleys. Though, these are less deep but are very fertile. Kashmir and Dun valleys are more prominent. Rice, potato and tea are the main crops.

8. **Peaty Soils-** These are originated in humid regions as a result of accumulation of large amounts of organic matter in the soils. They also contain considerable amount of soluble salts and 10-40 percent of organic matter. These are found in Kerala and also at few places in Tamilnadu. These are highly acidic, heavy and black, and are used in rice cultivation after the rainy season.

9. **Marshy Soils-** These are found in the coastal areas of Odisha, Tamilnadu, Sunderbans of west Bengal, mid parts of Bihar and Terai belts of Uttar Pradesh. It contains a high proportion of iron and organic substances. The soil is useful for the cultivation of Jute.

4.7 NATURAL VEGETATION- TYPES & CLASSIFICATION

Natural vegetation refers to a plant community unaffected by man either directly or indirectly. It has its existence in certain natural environment. The term 'forest' is generally used for a large group of trees and plants. Forests are more important for man as compared to grasses and scrub. In India, forests are dominant natural vegetal cover. They have acquired increasing importance in the recent past for their role not only in meeting the material requirements but also for their ecological and environmental functions.

Factors Affecting Vegetation

Complex physiographic, climatic and pedological conditions have given rise to as many as 30,000 species of plants in the country ranging from thorny bushes (Rajasthan) to evergreen forests (Assam etc). India enjoys tropical vegetation due to its location, while polar type of vegetation due to much height of certain land surface.

Climate is the most determining factor of natural vegetation in India. Two factors are important i.e. rainfall and temperature. Rainfall is the more significant in India than temperature. **Rainfall** varies from place to place and effects vegetation more. The amount of annul rainfall has a great bearing on the type of vegetation. Areas with more than 200 cm. rainfall have evergreen forests, while areas with the rainfall between 100 and 200 cm. have monsoon deciduous forests. Areas with less than 50 cm. rainfall have dry thorny scrub and bushes. **Temperature** has not its significant influence on Indian vegetation. In south-west coastal region, the high temperature with heavy rainfall determines the types of vegetation. Arunachal Pradesh has different vegetation from Assam, in spite of heavy rains, but of low temperature. **Soil** is another factor. Sandy soils have scrub vegetation. Khadar soils vegetation differ from Bhangar soils vegetation. **Topography** also affects forests in those species that suit to plant. The vegetation changes with the altitude. In Himalayas, the height from the sea level and the temperature has determined vegetation regions. It has the vegetation from tropical to sub-tropical, temperate, Alpine and polar.

Types and Classification

A number of scholars from various disciplines have made attempt to classify Indian natural vegetation. In 1936, **H.G. Champion** and in 1960 **G.S. Puri** have classified Indian forests on the basis of ownership and administrative control. **Champion** classified India's vegetation into as many as 116 types. **Puri** and **Sethi** merged many of champion's type and evolved simple schemes with fewer types and sub-types. Keeping in view all the schemes and geographical factors, Indian forests have been put into five main categories:

- Four types of forests are based on variation of rainfall-

  (1) Tropical evergreen forests, (2) Tropical deciduous forests

  (3) Tropical dry forests, (4) Desert and semi-desert forests

- Two types of forests are based on relief-

  (5) Mountain forests, (6) Alpine forests

- Three types of forests are based on their specific location:

  (7) Tidal forests, (8) Coastal forests, (9) Riverine forests

1. **Tropical Evergreen Forests-** These are found in areas with 200 cm. or more annual rainfall. The annual temperature is about more than 24^{o}C and the average annual humidity exceeds 70 percent. These are lofty, very dense multilayered forests. The trees grow vigorously, sometimes reaching a height of more than 60m. These are of equatorial types, and remain always evergreen.

There are three main areas of these forests- (i) At the height of 600 to 1800 m. of Western Ghats in Maharashtra, Karnataka and Kerala states, (ii) Andaman-Nicobar Islands, (iii) At an height upto 1200m in Assam, West Bengal and north-east states-Nagaland, Tripura, Mizoram, Manipur and Meghalaya.

The timber of these forests are fine-grained, hard and durable, and is useful for making good quality furniture. It is very difficult to exploit them as they are found at high elevation with dense undergrowth. The most important trees are rubber, Mahogany, ebony, rosewood, sisam, coconut, bamboo, cincona, candes, palm, iron wood, cedar. These have not fully exploited also due to lack of transport facilities.

2. **Tropical Deciduous Forests-** These are found in the areas with 100 to 200 cm. annual rainfall. These are called Monsoon Forests. The mean annual temperature remains about 27°C and the average annual relative humidity is 60 to 70 percent. The trees of these forests drop their leaves during the spring and early summer. The sub-soil of these forests does not retain much water, and because of that they fall their leaves in the dry season. Here, each species of the tree has its own time. The forests are quite dense with an undergrowth of creepers.

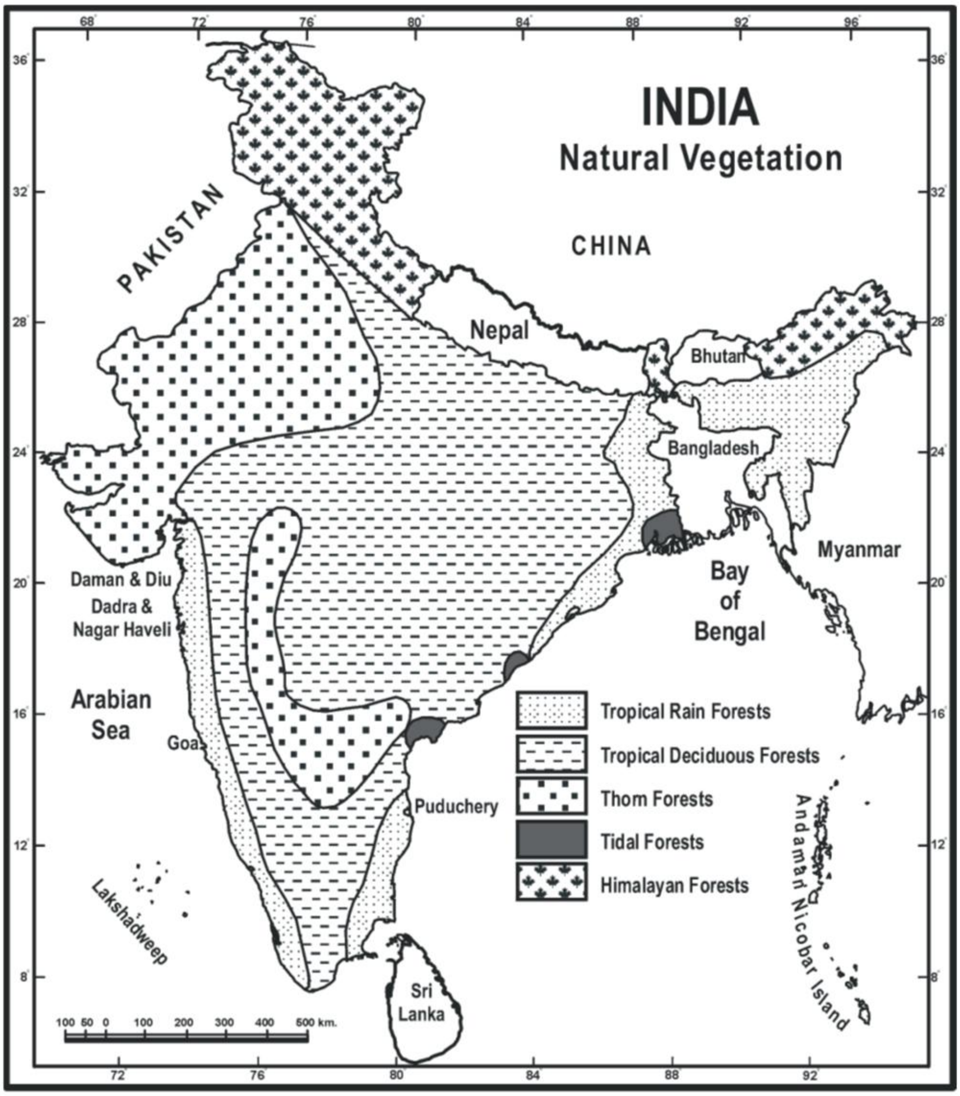

Fig. No. 4.10 Distribution of Natural Vegetation

There are five main areas of these forests- (i) Sub Himalayan-Region from Punjab to Assam, mainly on outer and lower slopes of Himalayas, (ii) Great Plains- Punjab, Haryana, Uttar Pradesh, Bihar, West Bengal, (iii) Central India- Jharkhand, Madhya Pradesh, Chhatisgarh, (iv) In South India- from the east side of western ghats to Maharastra, Karnataka, Telangana, Anadhra Pradesh, Tamilnadu and Kerala, (v) South -east Hills.

These forests are of economic importance to India. These forests cover nearly 7 lakh sq. km. area. Most of these forests are reserved forests. Teak and sal are the most important trees. Teak is mostly found in Maharastra and Karnataka. These timber trees are very valuable in the manufacturing of fine quality furniture and building construction. Sandalwood, Rosewood, Shisham, Kusum, Mahua, Palas, Haldu, Amla, Padauk, Bamboo, Tendu and other trees of economic importance. These forests provide also fragrant oil, varnish, sandal oil and perfume. It is comparatively easy to exploit these forests due to their high degree of gregarious. In past few years, large tracts under these forests have been cleared for cultivation.

3. **Tropical Dry Forests-** These are found in the areas with 50 to 100 cm. annual rainfall. The trees have 6 to 9 m. height, but their roots are very deep. They represent a transitional type of forests. These are found in east Rajasthan, Haryana, Punjab, Western Uttar Pradesh, Madhya Pradesh, Eastern Maharastra, Telangana, West Karnataka, East Tamilnadu. These are mainly concentrated in low fertile areas. In south India, these forests are found in dry areas. The important species are mango, mahua, banyan, amaltas, palas, haldu, Kikar, bamboo, babool, khair. Terai regions are known savana grasses, which are called as savai, munj, elephant and kans grasses. Large tracts of these forests have been cleared for agricultural purposes and these forests have supported from severe biotic factors such as over cutting, over grazing and fire etc
4. **Desert and Semi-desert Forests-** These are also called as tropical thorn forests. These are found in the areas having annual rainfall less than 50 cm. They have low humidity and high temperature. The trees are low (6 to 10 metres maximum) and widely scattered. They have long roots which enable them to obtain water from deep underground. Most of them have sharp spines (leaves modified to reduce surface area) or thorns which help the trees and bushes to conserve water and protect them from animals.

These forests are found in north-west India which includes west Rajasthan, south-west Haryana, north Gujarat and south-west Punjab. They are also found in the very dry parts of the Deccan plateau in Karnataka, Maharastra and Andhra Pradesh. These are rain shadow areas of south India.

Babul, Kikar and wild palms are common trees found here. Species of aacia, Kher, neem, khejra, palas, as Nagphani and Rambans are also very common.

5. **Mountain or Montane Forests-** These forests on the basis of altitude and amount of rainfall, basically are of two types. Eastern Himalayas receive more rainfall than the Western Himalayas; hence they have differentiation in vegetation. So these are classified into two groups-

(i) **Eastern Himalayan Forests-** These are found on the slopes of the mountains of north-east states. These states receive rainfall more than 200 cm. but due to variation in altitude are responsible for various types of vegetation in the area. The vegetation is of evergreen type.

(a) **1200-2400 Metre-** At this altitude, the dense tropical forests are found. Sal, oak, laurel, amura, chestnut, Cinnamon are main trees. It is also known for sandalwood, shisham, khair and semal trees. Bamboo is the main tree. Here, savannah type of grass is also grown.

(b) **2400-3600 Metre-** At this altitude, temperate evergreen forests are found. These are coniferous forests. Oak, Maple, birch, silver, fir, pine, spruce, Juniper are the main trees. Blue pine and larch trees are also scattered here. Trees are short stature.

(ii) **Western Himalayan Forests-** Here, the moderate amount of annual rainfall has affected the type of trees in the area. Along with it, the variation in altitude is also responsible for the variety of trees in the area. These forests are found in Jammu & Kashmir, Himachal Pradesh and Uttarakhand states. The main types are as follows:

(a) **Height upto 900 Metre-** Here, the vegetation is semi desert in nature, especially in low rainfall areas. It is known for bushes and small trees. It has grasslands at several places, suitable for animal herding.

(b) **900-1800 Metre-** At this altitude, Chir tree is the most common. It is Indian pine. The other trees of importance are sal, semal, dhak, sisham, jamun and jujube. Low temperature and less amount of rainfall have affected their density and variety.

(c) **1800-3000 Metre-** At these altitudes, semi temperate coniferous forests are found. The trees upto the height of 2500m are broad leave trees. Chir, deodar, blue pine, poplar, birch, elder are the main trees. The mountain slopes with more than 2500m height have silver fir and yellow pine trees.

6. **Alpine Forests-** Such forests occur all along the Himalayas at altitudes above 2400 metre. These are purely coniferous forests. These are most common between the altitudes of 2400 to 3600 metre. Oak, maple, silver fir, pine and juniper are the main trees of these forests. Here alpine grasses and fruit plants are also found. The eastern parts of Himalayas have large extent of these forests. These trees look like a dense bush, and are short stature.

Tundra type of vegetation is found at an altitude of 3600 to 4800 metre. It has tiny bushes and lichen. There is not the sign of any type of vegetation above the height of 4800m, as because these slopes are always covered with snow. This limit of the snow of Himalayas is known as snow line.

7. **Tidal Forests-** These forests occur in and around the deltas, estuaries and creeks prone to tidal influences and as such are also known delta or swamp forests. The delta of the Ganga- Brahmaputra has the largest tidal

forest. The other deltas of Mahanadi, Godavari, and Krishna Rivers are also known for tidal forests. These are also known as mangrove forests. These trees grow in areas that are submerged in water during high tides. Mangroves provide excellent conditions for nesting and feeding a variety of marine fish, reptiles, birds and animals, canes, palm screw pines are also found in upper part of deltas.

Ganga-Brahmputra Delta is known for Sundri tree, after which the Sunderbans are named (Ban meaning forest in Bengali). Economically, sundri is the most important tree of tidal forest. It yields hard, durable and strong wood. It is used for building boats and boxes. Sunderban is the home of Bengal Tiger.

8. **Coastal Forests-** These are littoral forests. Those coastal areas, which are sandy, have these forests. Here, the trees are of casurina type, and are of deciduous and evergreen of the both types. Palm and coconut are the dominant trees. Eastern and western coasts both have the extent of these forests. The coasts of Kerala, Goa are more important.
9. **Riverine Forests-** These forests are found along the rivers on Khadar areas. These are known for their, sis, tamarisk and tamarind. The rivers of Great Plains are more prominent for these trees.

4.8 CONCLUSION

Indian climate is affected by a number of factors. Physiography and location are most important. With all diversities, Indian climate is defined as Tropical Monsoon Climate. It is affected by seasonal winds called as monsoon winds. South-west monsoon winds are responsible for the rains in the country. Tropical cyclones and western disturbances also provide rain. Monsoon, the seasonal winds are the product of thermal contrast between land and sea. Land and Sea air masses are also considered responsible for its origin. Monsoon rains are also affected by such factors which happen out of the limit of India. Jet streams, El-Nino, La-Nina, southern oscillation also affect it intensity. A number of Indian and foreign scholars have divided Indian into climatic regions. Most of them have considered the average temperature of cold and hottest months, amount of rainfall, time of rainy season. Stamp, Koppen and R.L. Singh have forwarded their views, which are more acceptable. Because of vast dimensions with varied conditions of geology, relief, climate and vegetation, India has a large variety of soil groups distinctly different from one another. Main soils of India are alluvial, black, red and yellow, laterite, alkaline, desert, mountain, peat, marshy and forest soils. Alluvial and black soils are more important for the cultivation of crops. Most soils are mature. Complex physiography, climate, soils have given a variety of natural vegetation in India from Equatorial to Polar regions. The location and amount of rainfall are most dominant factors. Indian vegetation is defined as forests. There are nine main types of forests in the country.

4.9 SUMMARY

The climate of India is known as 'Tropical Monsoon climate'. It has the influence of a number of factors such as its locational extent, in both the zones, changing nature of monsoon winds, the circulation of the air in the upper layer of troposphere, and the extent of Himalayan mountain range. All these factors, though have given India one type of climate, but there are remarkable diversities in its climate due to its vastness. Indian climate has two contrast seasons, designed by south-west winds in summer and north-east winds in winter. Indian climate is also influenced by these factors which take place beyond its limits.

Areas in the south of Tropic of Cancer have tropical climate whereas the areas in the north of this line experience semi temperate climate. Himalaya protects it from the effect of polar winds. Coastal areas have mild climate. Physiography leaves its effect on temperature, air pressure, direction of winds and the amount of rainfall. Altitude variations leave its effect on temperature. El-Nino current, a warm current effects the monsoon. La-Nina current makes monsoon showers

strong. The temperature variations of Indian and Pacific Ocean have their effect on the monsoon rainy winds. The low pressure in Pacific Ocean is conductive to weak monsoon rainfall. Tropical cyclones in the onset and offset of monsoon seasons and western disturbances in the winter season also affect the climate.

The term **Monsoon** means season. Monsoon winds are seasonal winds on large scale. Sometimes, it is known for rainy winds. Most of the scholars accept it as double system of winds. Three theories have been proposed on its origin. The classical concept is based on the contrast in land and sea temperatures. The air mass concept is based on the convergence of two winds of different nature at the point known as inter-tropical front. This inter tropical convergence shifts its position according to seasons,. The Jet stream is a recent concept. Jet stream are upper air circulation winds. These winds make the monsoon active in India. It forces monsoon winds by putting pressure on the surface winds. They increase or decrease the monsoon rain and also make the distribution uneven. Various scholars have defined jet stream and its impact on monsoon rain in their own way.

Most of the scholars have divided India into climatic regions on the basis of temperature and amount of rainfall. Stamp has divided India into two main regions on the basis of Tropic of Cancer, which follow the isotherm of 18°C. Both these regions i.e. temperate India and tropical India have been put into 11 sub divisions on the basis of physiography and rainfall. **Koppen, Trewartha** and **Thornthwaite** have also classified India into climatic divisions. **R.L. Singh** has put the scheme with certain modifications in the divisions of Kendrew and stamp. He has divided India into ten climatic regions taking into consideration, the temperature of hottest and coldest months and an amount of annual rainfall.

Soils serve as a medium for plant growth. Indian soils have developed under varied conditions of rock structure, relief, climate and vegetation. It has given a large variety of soil groups, and thus, it is not an easy to put Indian soils into one type of agreeable soil classification. Alluvial soils occupy the largest area and are the base for the high production of foodgrains. These are of various types like Bhangar, Khadar, Bhabhar and Terai, Black soils are the product of deccan lava rocks. This is known for production of cotton. Red and yellow soils are less fertile and are used for cultivation of rice, Sugarcane, oilseeds with the use of fertilizers. The other main soils are laterite, desert, saline and alkaline, mountain, peaty and marshy soils.

Natural vegetation denotes a group for trees, plants, grasses, and shrubs. Their variety is affected by physiography, climate and soils. Rainfall is more effective than temperature. Tropical evergreen, tropical deciduous, tropical dry, desert and semi desert vegetation have variations due to amount of rainfall. Mountain forests and alpine forests are based on the physiographic characteristics. The vegetation changes with the increase in altitude. Tidal, riverine and coastal forests have developed because of their specific location.

4.10 GLOSSARY

- Monsoon - seasons, seasonal winds, south-west and North east
- Equable climate - No change in climate throughout the year
- Himalaya - acts as Meteorological barrier
- Inter-tropical Convergence - Zone of low pressure
- Perturbation - New concept of monsoon
- Jet Stream - Upper circulation winds, flow at a height of 8 to 10 km
- El-Nino - Warm ocean current

- La-Nina - Cold water current
- Tropical cyclone - Bay of Bengal and Arabian sea cyclones
- Western disturbances - Temperate cyclones
- Precipitation - Total humidity obtained by the surface
- Soil - Upper layer of the surface
- Alluvial - River drained soils, or transported soil
- Bhangar - Old Alluvium
- Khadar - New Alluvium
- Bhabar - Pebbly soils
- Black soil - Cotton soil, regur soil
- Laterite - Brick, later of Latin language
- Desert soils - Result of mechanical weathering
- Reh - Layer of salts-sodium, calcium and magnesium
- Mountain soils - coarse and pebbly soils
- Tea soils - known for tea plants
- Natural vegetation - Trees, grasses, shrubs
- Evergreen - do not leave in any part of the year
- Deciduous - Shed the leaves in spring season
- Sal. Shisham - useful timber
- Savannah - Tropical grass
- Riverine - Along river

4.11 ANSWERS TO CHECK YOUR PROGRESS

1. The main components of environment are climate, soil and natural vegetation.
2. India enjoys Tropical Monsoon climate.
3. India has climatic diversities due to its vastness.
4. South-west winds blow in summer.
5. North-east winds blow in winter.
6. Nearly half part of India lies in the north of Tropic of Cancer i.e. in temperate zone but enjoys sub-tropical climate due to Himalayas in the north.
7. Coastal areas have equable climate
8. Aravalli Hills are not capable to obstruct monsoon winds.
9. High attitude areas in peninsular area have cooler climate.
10. Monsoon winds are seasonal winds.
11. El-Nino is a warm current.
12. Jet streams are upper circulation winds.
13. Tibet plateau functions as a steam engine.
14. El-Nino current affects the temperature of Indian ocean.
15. La Nina is just opposite to El-Nino as it is a cold current.
16. High and low pressure over the pacific and Indian ocean is called southern oscillation.
17. Tropical cyclones mostly originate in Bay of Bengal.
18. Tropical cyclones affect the climate of coastal and its nearby areas.
19. Western disturbances are temperate cyclones.
20. Western disturbances provide rainfall in winter season mainly to north-west India.
21. Monsoon means season.
22. The classical concept of origin of Monsoon is based on thermal contrast in land and sea.
23. Monsoon is a seasonal migration of planetary winds.
24. Inter-tropical convergence is a meeting point of land and sea winds.
25. ITC is really a zone of low pressure.
26. Jet Stream is a recent concept.
27. Perturbation school is a recent concept.
28. Jet Stream also affect the amount and distribution of monsoon rainfall in India.

29. Koteswaram and M.T. Yin have forwarded their views on the Jet stream concept.
30. Large variation in the climate is responsible for climatic regions.
31. Stamp has divided India into two main climatic regions on the basis of 18°C isotherm.
32. Stamp has given sub-division on the basis of rainfall.
33. Stamp has divided India into 11 climatic regions.
34. Thornthwaite’s classification is based on precipitation effectiveness.
35. Thorthwaite classification is quite complex.
36. Koppen’s classification is based on amount of rainfall and monthly and annual average temperature.
37. Trewartha has simplified Koppen’s scheme.
38. R.L. Singh in his book India: A Regional Geography has given a map on climatic regions of India.
39. Singh classification is based on rainfall, temperatures of hottest and oldest months.
40. Soils makes the history of civilization.
41. India has a large variety of soils.
42. Rich, deep fertile soils support high density of population.
43. Alluvial soils are the most dominant soils of India
44. Alluvial soils are fertile soils and are known for the production of food and commercial crops.
45. Bhangar is the old alluvium and darker in colour.
46. Khadar is the new alluvium and light in colour.
47. Black soils are the dust of Deccan lava.
48. Black soils are famous for the production of cotton.
49. Red and yellow soils have variations in colour due to iron content.
50. Laterite soils are typical soils, known for pastures and scrub forests.
51. Alkaline soils are salty soils.
52. Reh is a mixture of salts like sodium Carbonate, sulphate calcium and magnesium.
53. Mountain soils are the product of mechanical weathering in the hilly region.
54. Peaty soils are the soils of humid region.
55. Forest soils are organic soils.
56. Marshy soils are found on the dry surface of rivers and lakes.
57. Natural vegetation means plant community.

58. Forests means a large group of trees and also include grasses and scrub
59. India has as many as 30,000 species of plants.
60. Climate and physiography are the most determining factor to determine the types of forests.
61. Rainfall is a great bearing on the type of vegetation.
62. The amount of rainfall has determined tropical evergreen, tropical deciduous, tropical dry and desert forests.
63. Relief has given two main types-Mountains and Alpine forests.
64. Location has produced tidal, coastal and riverine forests.
65. Among soils, sandy, khadar, Bhangar have affected the types of vegetation.
66. Himalayas have variation in vegetation with the change in altitude.
67. Tropical Deciduous Forests are known as monsoon forests.
68. Tropical deciduous forests are economically more important.
69. Tropical evergreen forests are the forests of high amount of rainfall area.
70. Desert forests are the product of scanty rainfall.
71. Himalayas have dense vegetation upto an altitude of 3000m.
72. Alpine forests are high altitude forests.
73. Tidal forests are also known as deltaic forests
74. Sunderban are tidal forests of Ganga delta, these are home of Bengal Tiger.
75. Coastal forests are littoral forests.
76. Riverine forests are khadar forests.

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4.14 TERMINAL QUESTIONS

Long Answer Questions

1. What do you mean by Monsoon? Discuss its various meanings.
2. Give brief analysis of theories on the origin of Monsoon.
3. Discuss the Jet Stream Theory of Monsoon.
4. Discuss those external factors, which affect on the origin of Monsoon.
5. Discuss those factors which influence the climate of India.
6. India is known as a Tropical Monsoon Climate country, inspite of that, it has a lot of climatic variations. Analyse it.
7. Divide India into climatic regions and discuss the basis of your classification.
8. Examine the views of various scholars given on the climatic regions of India.
9. The division of India into climatic regions made by R.L. Singh present a correct and clear picture. How do you agree with this statement? Discuss.
10. Give a classification of Indian soils.
11. Discuss the main types of soils of India.

12. Physiography and climate are the main factors affecting the types of vegetation in India. Explain it.
13. Write an essay on the main forest types of India.

Short Answer Questions

1. Which two factors mostly affect the climate of India?
2. Physiography is the most determining factor of Indian climate. Explain.
3. How the location has affected Indian climate? Explain.
4. Discuss the El-Nino affect on the climate.
5. Discuss the effect of western disturbances on India climate.
6. Tropical cyclones are more disastrous in coastal areas than the inner area. Discuss
7. What do you mean by term Monsoon.
8. Monsoon is a dual system of winds. Justify it.
9. Discuss the main definitions of Monsoon.
10. Discuss the classical concept on the origin of Monsoon.
11. Air mass school is based on the location of Inter-tropical convergence. Justify it.
12. Explain the perturbation school of monsoon origin.
13. Define Jet Stream and explain its effect on Indian Monsoon.
14. Differentiate between El-Nino and La-Nino ocean currents.
15. What do you mean by southern oscillations.
16. Discuss the main characteristics of Jet Stream
17. Give your comment on the views of scholars on Jet Stream.
18. Discuss the views of Koteswaram on Jet Stream.
19. Discuss the climatic regions of India forwarded by Dudley Stamp.
20. Explain climatic regions according to Thornthwaite.
21. How Koppen has divided India into climatic regions. Explain.
22. Discuss climatic regions forwarded by R.L. Singh.
23. Discuss the importance of soils.
24. Discuss the views of various scholars on types of soil of India.
25. Define alluvial soils and their types.
26. Discuss the characteristics of black soils.
27. Red and yellow soils are most important soils of south India. Discuss.
28. What do you mean by laterite soils.

29. Explain the distribution of arid and desert soils.
30. Saline and alkaline soils are the product of ill-drainage.
31. Explain mountain soils and their types.
32. What do you mean by natural vegetation.
33. Discuss the main factors affecting the vegetation.
34. What are main forests of India.
35. Discuss forest types based on variation in rainfall.
36. Classify the forests on the basis of relief.
37. Tropical Deciduous Forests are economically more important. Examine it.
38. Write an essay on mountain forests of India.
39. Discus the distribution of tidal forests.

Objective type questions

1. Which of the following factor is most important affect the climate of India-
   (a) Location and latitudinal extent (b) Distance from the sea
   (c) Altitude (d) Southern oscillation
2. Physiography of India do not have its influence on which of the climatic factor-
   (a) Temperature (b) Atmospheric pressure
   (c) Amount of rainfall (d) Tropical cyclones
3. Monsoon winds are-
   (a) Rainy winds (b) Seasonal winds
   (c) Warm winds (d) Cold winds
4. El-Nino is what type of-
   (a) Cold current (b) Counter current
   (c) Warm current (d) Polar current
5. Which of the following characteristic is not of tropical cyclones-
   (a) Originate in Bay of Bengal (b) Originate in Arabian Sea
   (c) Frequency more before the monsoon
   (d) Frequency more in winter season
6. Monsoon rains have not the affect of which of the following factor-
   (a) Jet stream (b) El- Nino
   (c) Tibbetean plateau (d) Polar winds
7. Jet Stream are winds of-
   (a) Upper troposphere winds (b) South-east trade winds

(c) North-east trade winds (d) Mediterranean winds

8. Which of the following scholar has not forwarded his views on perturbation school-

(a) Koteswaram (b) M.T. Yin

(c) H.G. Dobby (d) Flohn

9. The views of which foreign scholar are more significant in the determination of climatic regions of India-

(a) Trewartha (b) Thornthwaite

(c) Koppen (d) Dudley stamp

10. R.L. Singh in his classification of Indian climate, which factor has not taken into consideration-

(a) Temperature of hottest month (b) Precipitation effectiveness

(c) An amount of annual rainfall

(d) Temperature of coldest month

11. Black soil is not found in which of the state-

(a) Maharstra (b) Gujrat

(c) Karnataka (d) Madhya Pradesh

12. Alkaline soils do not have which of the salts-

(a) Sodium (b) Calcium

(c) Bromide (d) Magnesium

13. Which soil is the residual soil-

(a) Alluvial (b) Black

(c) Laterite (d) Red & yellow

14. Which factor is more influencial in determining the types of natural vegetation-

(a) Temperature (b) Soil (c) Surface (d) Rainfall

15. Which state is not known for tropical evergreen forests-

(a) Rajasthan (b) West Bengal (c) Meghalaya (d) Nagaland

16. Which state is known for sundri forest as tidal forest-

(a) Assam (b) Odisha (c) Manipur (d) West Bengal

17. Which of the following tree is not found tropical deciduous forests-

(a) Teak (b) Ebony (c) Sal (d) Shisham

18. Tropical Dry Forests are not found in which of the state-

(a) Bihar (b) Haryana

(c) S.W. Uttar Pradesh (d) West Karnataka

Answer-1 (a), 2 (d), 3 (b), 4 (c), 5 (d), 6 (d), 7 (a), 8 (c), 9 (d), 10 (b), 11 (c), 12 (c), 13 (c), 14 (d), 15 (a), 16 (d), 17 (b), 18 (a)

BLOCK 2 - RESOURCES

UNIT 5 - FOREST RESOURCES

5.1 OBJECTIVES

After reading this unit, you should be able to understand the:

- Significance of the forests as a resource.
- Valuable products and indirect uses of forest.
- Forest conservation programmes and policies in India.

5.2 INTRODUCTION

Among the most precious resources of India, its magnificent forests play a very important role in its climate as well as economic development.

Forests are our renewable resources and help in maintaining ecological balance, reduce pollution, maintain humidity, purify air and are a source of timber, fruit, flowers, fuel and fodder. As we know the forest prevent soil erosion and provide habitat to a variety of wild animals, birds and insects.

India is one of the ten most forest rich countries of the world along with the Russian federation, Brazil, Canada, United States of America, China, Democratic Republic of Cango, Australia, Indonesia, and Sudan. Together, India and these countries account for 67% of total forest area of the world. India's forest cover grew at 0-22% annually over 1990-2000 and has grown at the rate of 0.46% per year over 2000-2010, after decades where forest degradation was a matter of serious concern.

As of 2010, the food and AgricultureOrganisation of the United Nations estimates India's forest cover to be about 68 million hectares by 2012, per satellite measurements; this represents an increase of 5, 871sqkms of forest coverin 2 years. However, the gains were primarily in northern, central and southern Indian states, while north eastern states witnessed a net loss in forest coverover 2010 to 2012.

5.3 FOREST AS A RESOURCE (DISTRIBUTION, PRODUCTS AND INDIRECT USE)

In India, forest is a significant rural industry and a major environmental resource. The term natural resources mean "the collective wealth of a country". Forests are one of the most important natural resources. As per the last report of Forest Survey of India published in 2011, the total forest cover of the country has been assessed to be 692027 sq.km., which constitutes about 21.05% geographic area of the country. Forests are not only provided in- tangible services like protection of environment, clean air and water but also provide subsistence to dwellers of villages in and around them. They also have a potential of supporting livelihoods and, in the process, participate in poverty alleviation. Apart from this these are some auxiliary resources associated with forests like grazing land, wastelands, etc, which have a potential to provide space for tree cover. India had rich forest resource in the past and was extended over major part of the country. With time, deforestation for cultivation, food, shelter and pasture, diversion for developmental purposes and removal of valuable timber trees affected the forest resources adversely.

India is a large and diverse country. Its land area includes regions with some of the world's highest rainfall to very dry deserts, coast line to alpine regions, river deltas to tropical islands. The variety and distribution of forest vegetation is large, there are 600 species of hardwoods, including Sal(Shorearobusta).India is one of the 17 mega bio-diverse regions of the world State wise distribution of forest in India as shown in table 5.1.

Table 5.1: Area Under Forest cover (Km^2), 2011

S.No.	State/UTs	Geographic Area	Actual Forest cover	Recorded forest cover	Recorded Forest Area as percentage of Geographic Area	Per Capita Forest Cover (Ha)
1	A & N Islands	8249	6724	7171	86.93	1.7697
2	Andhra Pradesh	275069	46389	63814	23.2	0.0548
3	Arunachal Pradesh	83743	67410	51540	61.55	4.8756
4	Assam	78438	27673	26832	34.21	0.0888
5	Bihar	94163	6845	6473	6.87	0.0066
6	Chandigarh	114	17	34	29.82	0.0016
7	Chhattisgarh	135191	55674	59772	44.21	0.218
8	Dadra & Nagar Haveli	491	211	204	41.55	0.0615
9	Daman & Diu	112	6	8	7.14	0.0025
10	Delhi	1483	176	85	5.73	0.0011
11	Goa	3702	2219	1224	33.06	0.1522
12	Gujarat	196022	14619	18927	9.66	0.0242
13	Haryana	44212	1608	1559	3.53	0.0063
14	Himanchal Pradesh	55973	14679	37033	66.52	0.2141

15	Jammu & Kashmir	222236	22539	20230	9.1	0.1796
16	Jharkhand	79714	22977	23605	29.61	0.697
17	Karnataka	191791	36194	38284	19.96	0.0592
18	Kerala	38863	17300	11265	28.99	0.0518
19	Lakshadweep	32	27	0	0	0.0419
20	Madhya Pradesh	308245	77700	94689	30.72	0.1070
21	Maharashtra	307713	50646	61939	20.13	0.0451
22	Manipur	22327	17090	17418	78.01	0.6279
23	Meghalaya	22429	17275	9496	42.34	0.5828
24	Mizoram	21081	19117	16717	79.3	1.7522
25	Nagaland	16579	13318	9222	55.62	0.6724
26	Odisha	155707	48903	58136	37.34	0.1166
27	Puducherry	480	50	13	2.71	0.0040
28	Punjab	50362	1764	3084	6.12	0.0064
29	Rajasthan	342239	16087	32639	9.54	0.234
30	Sikkim	7096	3359	5841	82.31	0.5528
31	Tamil Nadu	130058	23625	22877	17.59	0.2327
32	Tripura	10486	7977	6294	60.02	0.2173
33	Uttar Pradesh	240928	14338	16583	6.88	0.0072
34	Uttarakhand	53483	24496	34651	64.79	0.2421
35	West Bengal	88752	12995	11879	13.38	0.0142
36	Total	3287563	692027	769538	1148.44	13.9212

Source: India state of Forest Report 2011, Forest survey of India.

Forests are classified under three categories by the Forest Department-

Reserve Forest

The most valuable forests are classified as Reserved Forests. These forests are protected under the conservation acts. More than half of the total forest land in India comes under reserved forests.

Protected Forest

Forests that are protected from further destruction are called Protected Forests. One third of the total forest areas in India are classified as protected forests.

Unclassed Forest

Forests and wastelands belonging to both government and private individuals and communities are classified as Unclassed Forests.

Some important facts about distribution of forest in India-

- Madhya Pradesh has the largest area under permanent forests.

- Andhra Pradesh (including Telagana), Uttarakhand, Kerala, Tamilnadu, West Bengal and Maharashtra have large percentages of reserved forests.
- Bihar, Haryana, Punjab, Himanchal Pradesh, Orissa, and Rajasthan have large percentage of protected forests.
- All North-eastern states and parts of Gujrat have a very high percentage of Unclassed forests managed by local communities. State wise distribution of these categories in table 5.2.

Table 5.2 Category wise recorded Forest area (Km^2)

S.No.	State./U.T.s	Reserved	Protected	Unclassed
1	A & N Islands	5613	1558	0
2	Andhra Pradesh	50479	12365	970
3	Arunachal Pradesh	10546	9528	31466
4	Assam	17864	0	8968
5	Bihar	693	5779	1
6	Chandigarh	31	0	3
7	Chhattisgarh	25782	24036	9954
8	Dadra & Nagar Haveli	199	5	0
9	Daman & Diu	0.24	0	8.03
10	Delhi	78	7	0
11	Goa	253	845	126
12	Gujarat	14122	479	4326
13	Haryana	249	1158	152
14	Himanchal Pradesh	1898	33130	2005
15	Jammu & Kashmir	17643	2551	36
16	Jharkhand	4387	19185	33
17	Karnataka	28690	3931	5663
18	Kerala	11123	142	0
19	Lakshadweep	0	0	0
20	Madhya Pradesh	61886	31098	1705
21	Maharashtra	49226	8195	4518
22	Manipur	1467	4171	11780
23	Meghalaya	1113	12	8371
24	Mizoram	7909	3568	5240
25	Nagaland	86	508	8628
26	Odisha	26329	15525	16282
27	Puducherry	0	2	11
28	Punjab	44	1137	1903
29	Rajasthan	12454	17416	2769
30	Sikkim	5452	389	0
31	Tamil Nadu	19388	2183	1306

32	Tripura	4175	2	2117
33	Uttar Pradesh	11660	1420	3503
34	Uttarakhand	24643	9885	123
35	West Bengal	7054	3772	1053
36	Total	422536.24	213982	133020.03

Source: India State of Forest Report 2011, Forest Survey of India

Forest Products and their uses

In 2002, forestry industry contributed 1.7% to India's GDP in 2010, the contribution to GDP dropped to 0.9% largely because of rapid growth of the economy in other sectors and the government's decision to reform and reduce import tariffs to let imports satisfy the growing Indian demand for wood products. India produces a range of processed forest (wood and non-wood) products ranging from wood panel products and wood pulp to make bronze, rattazikistan ware and pern resin. India's paper industry produces over 3000 metric tons annually from more than 400 mills. The furniture and craft industry is another consumer of wood. India's wood based processing industries consumed about 30 million cubic metres of industrial wood in 2002. India annually consumes an additional 270 million tons of fuelwood, 280 million tons of fodder and about 12 million cubic meter of forest products valued at about Rs.27500 crore (US$ 4.3 billion) a year.

India is the world's largest consumer of fuel wood. India's consumption of fuel-wood is a out five times higher than what can be sustainably removed from forests. However, a large percentage of this fuel-wood is grown as biomass remaining from agriculture and is managed outside forests. Fuel-wood meets about 40% of the energy needs of the country. Around 80% of rural people and 48% of urban people use fuel-wood. Unless India makes major, rapid and sustained effort to expand electricity generation and power plants, the rural and urban poor in India will continue to meet their energy needs through unsustainable destruction of forest and fuel-wood consumption.

Forest resource in India is more than just about wood and fuel. India has a thriving non-wood forest products industry, which produces latex, gums, resins, essential oil, flavors, fragrances and aroma chemicals,incense sticks, handicrafts, thatching materials and medicinal plants. About 60% of non-wood forest products category. In 2002,non-wood forest products were a source of significant supplemental income to over 400 million people in India, mostly rural areas.

Some Important facts about forest and their uses

- Forest are the storehouse of timber for house-making and furniture, fuel, fruits, herbs, honey, bamboo, canes and fibres.
- Forests provide employment to thousands of people direct and indirect.
- Many other products like bees-wax, materials for dyeing and tanning, oil and lac are gifts of forests.
- They provide raw material to many industries, e.g., paper.
- They are a source of income to the government.
- Forests help in maintaining ecological balance.
- They provide shelter for wildlife and a sanctuary to birds.
- Forest prevent soil erosion as the roots of the trees hold the soil together. They also prevent floods and help in checking the wind erosion.
- Forest provide clean environment. Hence, it is advisable to have forestaround the industries as the trees take in the carbon dioxide and provide the surroundings with oxygen.
- The forest play on important role in the development of soil and enrich their fertility by supplying humus.
- Forests help in conserving water in the subsoil and also help in conserving top layer of the soil.

5.4 FOREST CONSERVATION MEASURES IN INDIA

The term natural resources mean “the collective wealth of a country.”Forest are one of the most important natural resource of our country.

Unfortunately, although it is said that the land under forest in our country is 21% , the effective forest cover as revealed by all kinds of survey is hardly between 12%- 14%. This is really a serious fact. This is a consequence of indiscriminate cutting down of the trees due to Jhooming (or Slash and Burn)practices to clear the forests for cultivation and construction purposes. There is also uncontrolled and at times unauthorized cutting down of trees due to by unscrupulous timber merchants for the purpose of trade. This depletion of forest cover is termed as Deforestation. It has brought about complete deterioration of flora and fauna of which our country has been so proud of for centuries. Deterioration of natural vegetation has also affected our countries, physical and climatic conditions and drastically deteriorated the natural environment of rural as well urban area.

To revitalize our forest cover, systematic preventive measures should be taken. These measures will help in maintaining the most essential ecological balance required to protect our forest resources, environment and endangered wildlife.

Most important step towards this regarding is taken by Government of India which was set up a central Board of Forestry, after Independence under the five-year plan. A number of policies were evolved to be implemented for conservation of forests.

Van Mahotsava Programme

One of the most important policy is "Van Mohotsava Programme" was started in 1950. Under this programme, all government organizations are supposed to plant trees in the months of July and August.

Afforestation

Another scheme which has been adopted is "Afforestation". Under this scheme a programme has been proposed to plant trees in Rajasthan, West Uttar Pradesh and Kutch desert to prevent soil erosion.

Reforestation

Although "Jhooming" cultivation has been banned in North-East India, indiscriminate cutting of trees without bothering about the depletion of forest cover is still very common.

This activity has resulted in severe problems connected with soil erosion and massive floods. To resolve this problem Government of India has started a programme under which two saplings are planted for every felled tree. This is known as Reforestation.

The latest reports of National Remote Sensing Agency (NRSA) indicate that the country is losing about 1.3 million hectares of forest cover every year. This will be detrimental to our national interest. Hence the urgent need for conservation of forests. In India, forests facing a serious threat by their own people. The Government of India has taken serious view of this problem and as such has introduced a proramme to protect, conserve and develop the forest area. This step is known as "Programme of Forest conservation" some important measures taken under this programme are-

- To prevent destruction of forests.
- To protect both trees and species, several forest regions have been declared 'Reserved forests" in Rajasthan, Nilgiri, Cochin and Meghalaya. Under Biosphere reserved

forests, about 400 lakh hectares “Reserved forests” are laid down whereas protected forest are covers about 200 lakh hectares.

- To protect the forests from fire, a strip of land between the two sections of forest is cleared to prevent the spread of fire. This is called fire line.
- Prevention of wildlife as many species have become extinct and many are on the edge of extinction. This is being done by promoting Biosphere reserved forests.
- In various States and Union Territories, Forest Development Corporation has been established for taking care of forest products and developing new forest resources.
- To get sustained yield to timber, Silviculture is being practiced.
- Apart from these measures the Forest Research Institute of Dehradun conducts research in “Forests and forest products.

Some important facts about forests and their distribution and their use

S. No.	Forest	Climate	Distribution	Forest & Trees	Species and their uses	Special feature
1	Tropical Evergreen Forests	Rainfall: 200-300cm, high Humidity. Temperature: 25°C to 27°C	Windward side of the Western GhatGaro-Khasi, Jantia Hills, Lower Slopes of Eastern Himalayas (wet parts). Andaman & Nicobar Islands. States : West Bengal, Kerala, Tamil Nadu, Karnataka and Maharashtra	Forest: Dense, thick undergrowth. Tall trees in layer arrangement. Climbers, creepers, ferns, bamboo, epiphytes, luxuriant growth. Trees: Some over 60m, boad-leaved, fine grained and hard wood.	1. Rosewood, Ebony and Shisham used for making high quality furniture. 2. Gurjan used in making railway sleepers and furniture. 3. Toon, iron wood and bamboo are the other trees found here.	1. Dense forests mixed stands, thick canopy, dense under growth also called rain forests. 2. Everygreen forests are called as different species shed their leaves at different times and the forests thus appear green always.
2.	Tropical Deciduous Forests (Monsoon forests)	Rainfall: 150-200cms temperature 20°C	Extent from shivaliks in the North to eastern edge of western Ghats N.E. Deccan Plateau, lower slopes of the Himalays. States: Orrissa, M.P., Bihar, T.N, Karnataka, Tripura, Assam, U.P.,	Forests: Dense, undergrowth, shed leaves for 6-8 weeks in summer during conditions of drought (March to May)	1. Sal: Resistant to termits (West Bengal) used for railway sleepers. 2. Teak: It is termit resistant and iron nails do not rust in teak. Used for furniture.	1. Deciduous forests commercially the most useful forest. 2. Trees shed their leaves for 6 to 8 weeks in the hot weather. 3. The deciduous forests are found in pure stands,

			Uttarakhand and Andhra Pradesh		3. Sandalwood: It is used for oils, handicrafts, perfumes and soaps (Karnataka) 4. Myrobalan: It is used for tanning of hides, dyeing of cotton, wood and silk.	hence they are ideal for lumbering and easy to transport.
3.	Thorn Forests	Rainfall : 25-100 cmsTemperature: 20°C+	Drier parts of North-western India, Rain shadow region of the Western Ghats. States: Rajasthan, Punjab, Western U.P, and Gujarat	Trees are widely scattered within the forest. They are stunted, with long roots, glossy leaves and spines.	1. Khajuri fruit is edible. 2. Khair yield timber and dye. 3. Khair and Babool yield gum for tanning leather.	
4.	Tidal forests	Rainfall: over 200cm Temperature: over 20°C	Found in areas flooded by sea water, e.g., delta of Ganga-Brahmaputra] Mahanadi, Krishna, Godavari, States: West Bengal Orissa and Andhra Pradesh	Dense forests. Trees have stilt roots and phenmato-phores.	Sundari is hard and durable therefore, used for boats, boxes and telephone posts. Casuaina checks transgression of the sea and erosion along the coast.	Also called littoral and mangrove forests. Popularly known as Sunderbans in West Bengal due to the occurrence of Sundari tree.
5.	Mountain Forests	Varies with height altitude	Eastern Himalayas, Western Himalays i.e.	Tropical Deciduous forests in the Shiwaliks:	Soft wood of coniferous used for making paper, matches,	Suitable for wildlife sancturaries.Due to less rain,

		form deciduous to coniferous. High altitude have bushes, shrubs and thickets of Rhododendrons. Rainfall : 150-250 cms. Temperature : less than 20°C opr even cooler	Kumoun Hills, and Nilgiris. States: Jammu & Kashmir, Himachal Pradesh, Uttara Pradesh, Uttarakhand, Kerala and Tamil Nadu	Sal, Temperature Deciduous forests at higher altitudes:Chir, Pine and Coniferous forests: Pine, Cedar, Fir and Spruce.	packing cases and planks, Deodar used for railways sleepers. Pine used for its resin, turpentine, varnishes and medicines.	low temperature and snowfall. The trees are mainly evergreen with needle shaped leaves, more wood and less leaves.
6.	Desert Vegetation	Rainfall: less than 25 cms Temperature : 25°C to 27°C	Drier parts of southern Punjab, Rajasthan and the Deccan Plateau states.	Xerophyticforests, thorny bushes, scattered trees, deep roots, thick fleshy stems, and waxy leaves.	Wild berries, cactii, Kikar, Babool (Acacia) yields gum used for tanning hides and skins.	

5.5 CONCLUSION

Forest constitute an important component of India covering about 23% of its geographic area. They not only provide intangible services like protection of environment, clean air and water but also provide subsistence to dwellers of villages in and around them. Forests also have a potential of supporting livelihoods and, in the process, participate in poverty alleviation. There are some auxiliary resources associated with forests like grazing land, wasteland etc. which have a potential to provide space for tree cover. India has rich forest resource in the past and was extended over major part of the country.With time, deforestation for cultivation, food, shelter and pasture, diversion for developmental purposes and removal of valuable timber trees affected the forest resources adversely.

Forest constitutes the largest, complex and most important resource covering about one-third of the earth's land area. Forests regulate the earth's temperature regime, water cycle, control floods, contain energy fuels and minerals and help balance the Co_2 and O_2 in the atmosphere. They also check soil erosion. The forests maintain soil fertility by returning the nutrients to the soil through litter. Minerals such as calcium, potassium and nitrate disappear from an area following deforestation, without forests, many environmental pollutants from urban and industrial areas would not be effectively buffered and detoxified.

The man has now cleared forests to have more access to agriculture and urbanization.Forests are reserved for timber and fuel. These activities result in recurrent floods, soil, erosion, loss of fertility of soil and at times, in greater incidence of diseases because of loss of organisms which help in controlling the vectors.

There is need for scientific management of forest resources. Monocultures drain the soil of specific nutrients required by the species in greater quantities, e.g., teak requires more calcium thereby leaving the soil impoverished. Many of the introduced species create new problems, e.g., Eucalyptus – a fast growing species withdraws large quantities of under ground water and also removes nutrients in large quantities. On the other hand, its litter is negligible in quantity, does not decompose rapidly and trees do not support any animal life which may bring even small quantity of organic matter to the soil. This requires plantations of mixed forests and recycling of forest products in order to reduce exploitation of natural forests. Two common management systems are used in forest ecosystems.

(i) Uneven age management: Strands of trees are periodically harvested producing large blacks of continuous forest dominated by relatively mature trees. These forests, however, lack distinct successional stages, thus, affecting the type of wildlife found in the area.

(ii) Even age management: forests are retained to produce a crop with little or no difference in the age. Entire strands are cut at different times with the result that blocks of different successional stages are found throughout the forest area.

We have conclude the unit with this valuable thought that the forests are very important for the earth's environment and human life. Conservation and management of the forests are also important.

5.6 SUMMARY

The above written unit explains the significance of the forests as a natural resources. Unit also describes the distributions of various forests types and their different and valuable products in very detail. Uses and importance of forest products are also explained. For the management and conservation measures for forests in India is also described in this unit. Measures and policies are not working very effectively and rapidly. So we need more action in this particular matter.

5.7 GLOSSARY

Alleviation	:	make something less strong or bad (impact of pain or harm)
Aroma	:	a smell, especially a pleasant one.
Biosphere	:	(Technical) the part of the earth's surface and atmosphere in which plants and animal can live.
Buffer	:	a thing or person that reduces the unpleasant effects of sth or prevents violent contant between two things, people, etc.
Decompose	:	to slowly be destroyed by natural chemical processes.
Deforestation	:	cutting down trees over a large area.
Degradation	:	the action of making somebody be less respected; the state of being less respected.

Deterioration	:	becoming worse stage.
Detoxified	:	poison free.
Epiphyte	:	a plant growing on another plant put using it only for support and not for food. Epiphytes are most common in areas of tropical rain forest.
Fodder	:	food that is given to farm animals.
Fuel	:	material that is burned to produce heat or power.
Gums	:	either of the firm pink parts of your mouth that hold your teeth.
Humus	:	a substance made from dead leaves and plants, that you put into the ground to help plants grow.
Jhooming	:	it is a type of cultivation. It is also known as shifting cultivation.
Latex	:	a thick white liquid that is produced by some plants and trees especially rubber trees.
Mangroves	:	It is applied to a number of types of low trees and shrubs which grow on mud flats in tropical coastal areas where the tidal range is slight. They are especially well developed in south and east Asia.
Monoculture	:	a farming system given over exclusively to a single product. Its advantages are the increased efficiency of farming and a higher quality of output. Disadvantages include a greater susceptibility to price fluctuations, climate hazards and the spread of disease.
Pasture	:	a field or land covered with grass, where cows, etc. can feed.
Pern resin Rattazikistan ware	:	these are processed forest wood or non-wood product to make bronze ware. These are environmental friendly.
Sanctuary	:	a place where birds or animals are protected from being hunted.
Soil erosion	:	the removal of the soil by wind and water and by the mass movement of soil downslope.
Silviculture	:	is the practice of controlling the establishment, growth, composition, health and quality of forests to meet diverse needs and values.
Timber	:	wood that is going to be used for building.
Xerophyte	:	a plant which is able to grow in very arid condition because it has adapted to restrict any water loss. Such adaptations include dense hairs or waxy leaves and shedding leaves at the start of the arid season. Succulent xerophytes incorporate water into their structure.

5.8 ANSWER TO CHECK YOUR PROGRESS

Q1. Describe the significance of forests as a resource.

Q2. Name a few important forest products.

Q3. Describe the classification of forests.

Q4. Estimate the forest resources of India.

Q5. Write a short note on forest conservation measures in India.

Q6. Explain some useful suggestions for conservation of forests.

Q7. Describe forest products and their uses.

5.9. REFERENCES

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2. Kler, D.S., and Dhaliwal, G.S., (1995). Principles of Agricultural Ecology.Himalaya Publishing House.

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4. Vaughan J.G, and Geissler, C.A. (1997). The new Oxford Book of Food Plants, Oxford University Press, Oxford, U.K. [Beautifully Illustrated reference book on major food plants of the world, their varieties and regions of origin; mainly domesticated and crop plants are included, but there are sections on wild plants and mushrooms.

5.10 SUGGESTED READINGS

1. A Geography of India by Gopal Singh 1979, Atma Ram & Sons, Delhi, Lucknow.
2. Annual Report 2013-14, Ministry of Environment and Forests, India.

5.11 TERMINAL QUESTIONS

Q1. What is the significance of forests?

Q2. Explain in detail, the major products of forests and their uses.

Q3. Write an essay on the policies and programmes for conservation of forest by Indian Government.

Q4. Give an analysis on Indian National Forest Policy.

Q5. Discuss in brief, what are the main causes of failures of programmes for conservation of forests in India?

UNIT 6 - WATER RESOURCES & NATIONAL WATER POLICY

6.1 OBJECTIVES

After reading this unit, you should be able to understand that:

- Water resources in India, its geographical distribution, sectoral utilization, and methods of its conservation and management.
- To discuses availability and demands of water resources in India.
- Various issues and strategies for developing a holistic approach for sustainable development and management of the water resources of the country.

6.2 INTRODUCTION

India has more than 18 percent of the total world's population, but has only 4% of world's water resources and 2.4 percent of world's land area. The distribution of water resource is highly uneven in terms of both space and time. Precipitation over the greater part of the country is seasonal, mainly concentrated to three or four months of the rainy monsoonal season. It varies from about 20 Cm in *Jaisalmer* (Rajasthan) to over 1000 Cm at *Mawsinram* (Meghalaya). Hence, there is a water surplus in one part of the country and water deficit in another part. The average annual water availability of the country is assessed at 1869 Billion Cubic Metres (BCM)**.** The per-capita availability of water at the national level has been reduced from about 5177 Cubic Meter in 1951 to the estimated level 1800 Cubic Meter in 2005 with variation in water availability in different river basins.

6.3 WATER RESOURCES & NATIONAL WATER POLICY

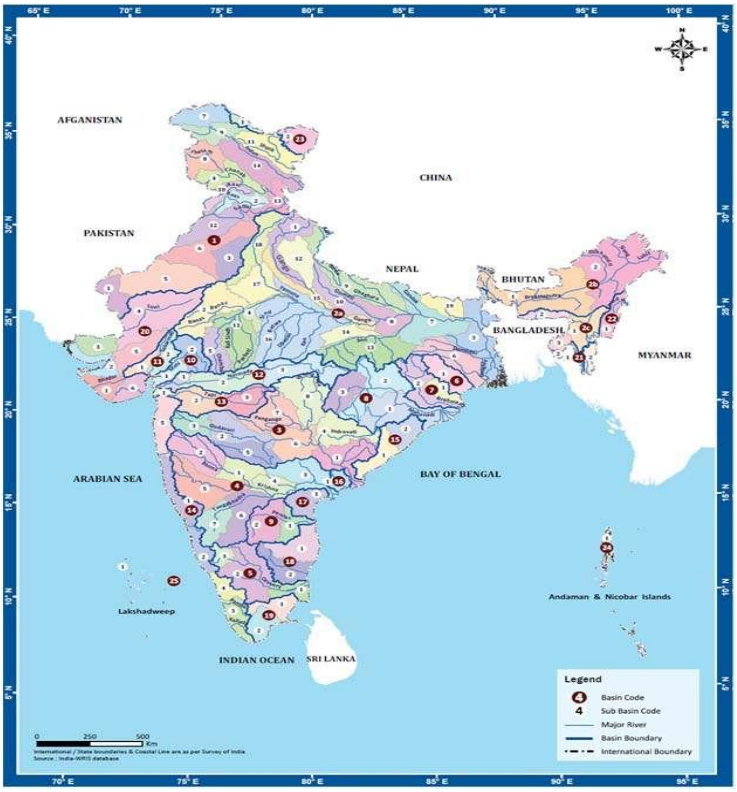
Water is a basic need and precious national assets but uneven distribution of water and population, and in addition floods and droughts in India are the challenge of the country. The significance of water is increasing with the tremendous increase of population. We need water for drinking, domestic consumption, irrigation, industrial purpose, generation of hydro-power, transport and recreation etc. The main problems associated with the utilisation of water are high fluctuations in the regimes of the rivers, uneven spatial distribution of precipitation, unscientific utilisation of water, pollution of rivers and disputes on water sharing among the states or nations. The government of India designed the national water policy for the optimum utilisation and conservation of water resources in the country. The main objective of the policy is to provide water from the surplus areas to the deficit areas. The U.N. report 2003 at the time of the third World Water Forum in *Kyoto* (Japan) says that water reserves are drying up fast with booming population, and global warming will combine to cut the average person's supply by a third by 2020, the report also ranked 122 countries on the quality of their water provision and India was placed at the bottom of the list.

We will discuss here first about water resource of India before policy framework and relate issue. The total utilizable water resources of the country are assessed as 1086 Cubic Km. A brief description of surface and groundwater water resources of India is given below.

1. Surface water.
2. Underground water.

a. **Surface Water:** There are four major sources of surface water. These are rivers, lakes, ponds and tanks. In the country, there are about 10,360 rivers and their tributaries longer than 1.6 km each. The mean annual flow in all the river basins in India is estimated to be 1,953 Cubic Km. However, due to topographical, hydrological and other constraints, only about 690 Cubic Km (32 percent) of the available surface water can be utilized. Water flow in a river depends on size of its catchment area or river basin and rainfall within its catchment area. The National Commission for Integrated Water Resources Development estimated the basin-wise average annual flow in Indian River systems as 1953 Cubic Km. The utilizable annual surface water of the country is 690 BCM.

Map 6.1: **River Basins of India**



Source: *River Basin Atlas of India, CWC and ISRO, 2012.*

There is considerable scope for increasing the utilization of water in the Ganga-Brahmaputra basins by construction of storages at suitable locations in neighboring countries. Therefore based on the above, the total utilizable water resources of the country have been assessed as 1123 BCM. A table showing the river basins of the country catchment area, average water resources potential and the utilisable surface water resources is given below (Table 6.1).

Table 6.1: Water Resources Potential of River Basins of India

S. No.	River Basin	Catchment area (sq.km)	Average Water Resources Potential (BCM)	Utilizable surface water Resources (BCM)
1	Indus	3,21,289	73.3	46
2	Ganga-Brahmaputra-Meghna			
	(a) Ganga	8,61,452	525	250
	(b) Brahmaputra	1,94,413	537.2	24
	(c) Barak & others	41,723	48.4	
3	Godavari	3,12,812	110.5	76.3
4	Krishna	2,58,948	78.1	58
5	Cauvery	81,155	21.4	19
6	Subernarekha	29,196	12.40	6.8
7	Brahmani-Baitarni	51,822	28.50	18.3
8	Mahanadi	1,41,589	66.90	50
9	Pennar	55,213	6.30	6.9
10	Mahi	34,842	11.00	3.1
11	Sabarmati	21674	3.80	1.9
12	Narmada	98796	45.60	34.5
13	Tapi	65145	14.90	14.5
14	West Flowing Rivers from Tapi to Tadri	55940	87.40	11.9
15	West Flowing Rivers from Tadri to Kanyakumari	56177	113.50	24.3
16	East Flowing Rivers between Mahanadi and Pennar	86643	22.50	13.1
17	East Flowing Rivers between Pennar & Kanyakumari	100139	16.50	16.5
18	West Flowing Rivers of Kutch and Saurashtra including Luni	321851	15.10	15
19	Area of Inland Drainage in Rajasthan	---	--	--
20	Minor Rivers draining into Myanmar (Burma) and Bangladesh	36202	31.00	--
	Total		**1,869.4**	**690**

Source: Report of The National Commission for Integrated Water Resources Development, "*Integrated water resources development: A plan for Action*", Ministry of Water Resources, New Delhi.

b. **Groundwater Resource:** India is reach in ground water resource. The ground water resource is a function of geological structure, topography, slope precipitation, run-off, soils, and hydro-geological condition of a region. The annual potential natural groundwater recharge from rainfall in India is about 342 Cubic km, which is 8.56 % of total annual rainfall of the country. The annual potential groundwater recharge augmentation from canal irrigation system is about 89.46 Cubic Km. Thus, total replenishable groundwater resource of the country is assessed as 431.89 Cubic Km. After allotting 15% of this quantity for drinking, and 6 Cubic km for industrial purposes, the remaining can be utilized for irrigation purposes. Thus, the available groundwater resource for irrigation is 361 Cubic km, of which utilizable quantity is 325 Cubic km (about 90 %). The estimates by the Central Ground Water Board (CGWB) of total groundwater resources for future use are given in the Table 6.2.

Table 6.2: Groundwater Resources of India

S.N.	Groundwater Resources of India	(in Cubic Km/ Year)
1	Total replenishable groundwater resource	432
2	Provision for domestic, industrial and other uses	071
3	Available groundwater resource for irrigation	361
4	Utilizable groundwater resource for irrigation (90% of the sr. no. 3)	325
5	Total utilizable groundwater resource (Sum of sl. No. 2 & 4)	396

Source: Report of CGWB, *Groundwater Resources of India*, Central Groundwater Board, New Delhi.

6.3.1 Water Resource Management in India

In view of the existing status of water resources and increasing demands of water for meeting the requirements of the rapidly growing population of the country as well as the problems that are likely to arise in future, a holistic, well planned long-term strategy is needed for sustainable water resources management in India. The water resources management practices may be based on increasing the water supply and managing the water demand under the stressed water availability conditions. Data processing, monitoring, storage and retrieval are the major aspects of the water resources management. These data may be utilized for the planning and water resources management. Also, water sharing cooperation, people's participation and capacity building are essential for effective water resources management. Some important aspects of such water sharing strategies are described as follows for better water resource management:

a. **Flood Management:** Among all natural disasters, floods are the most frequent to be faced in India. According to Central Water Commission, Government of India, the annual average area affected by floods is 7.563 Mha. On an average floods have affected about 33 million persons during last fifty years. There is every possibility that this figure may increase due to rapid growth of population and increased encroachments of the flood plains for habitation, cultivation and other activities. The main causes of floods in India are inadequate capacity within river banks to contain high flows, river bank erosion and silting of river beds. After the disastrous floods of 1954 a national programme of flood management was launched by the Government of India, has taken a number of steps and policies for flood management. Various types of structural and non-structural measures have been taken up to reduce the flood damages. The structural measures, such as the construction of embankments, levees, spurs, etc. have been implemented in some of the states. A large number of reservoirs have been constructed and these reservoirs have resulted in reduction of intensity of floods. The non-structural measures such as flood forecasting and warning are also being adopted. The flood forecasting and flood warning in India cover most of the flood-prone inter-state river basins in India. The CWC has established a flood forecasting system covering 62 major rivers with more than 157 stations for issuing flood forecasts covering almost all the flood-prone states. Some of the states e.g. Rajasthan and Manipur have enacted the flood plain zoning legislation, the major flood-affected states e.g. Assam, Himachal, Goa and Sikkim have not considered such legislation. Flood management also calls for community participation. Farmers, professional bodies, industries and voluntary organizations have to be aware about flood management. People's participation in preparedness, flood fighting and disaster response is required.

b. **Drought Management:** The planning and management of the effects of drought appear to have a low priority due to associated randomness and uncertainty in defining the start and end of droughts. Further, most of the drought planning and management schemes are generally launched after persisting drought conditions. Impacts of drought may be extended to groundwater depletion, damage to perennial trees, plantations, orchards and depletion in fertility of livestock. Food, fodder, agricultural inputs and water banks may be established in vulnerable areas instead of their storage in surplus regions to avoid transport bottlenecks during drought. Robust and rainfall independent off-farm livelihood opportunities may be targeted in the drought mitigation strategy. Conjunctive use of surface and groundwater, aquifer recharge and watershed management with community participation is another important policy paradigm shift to be internalized fully. Most of the time the execution of the drought management scheme is based on the administrative units, while planning of water resources is based on basin scale. Therefore, an integrated basin development approach is required to be developed and implemented for preparing the drought management plan before, during and after the occurrence of the drought. In this regard, there is a need for the development of the decision support systems (DSS) for the monitoring and management of drought on basin level. The drought-prone area assessed in the country is of the order of 51.12 Mha. In the drought-prone areas awareness may be launched for water conservation and necessary steps may be taken at administrative, social and political levels to encourage people’s participation in the drought management for optimum use of the available water resource to meet the demands.

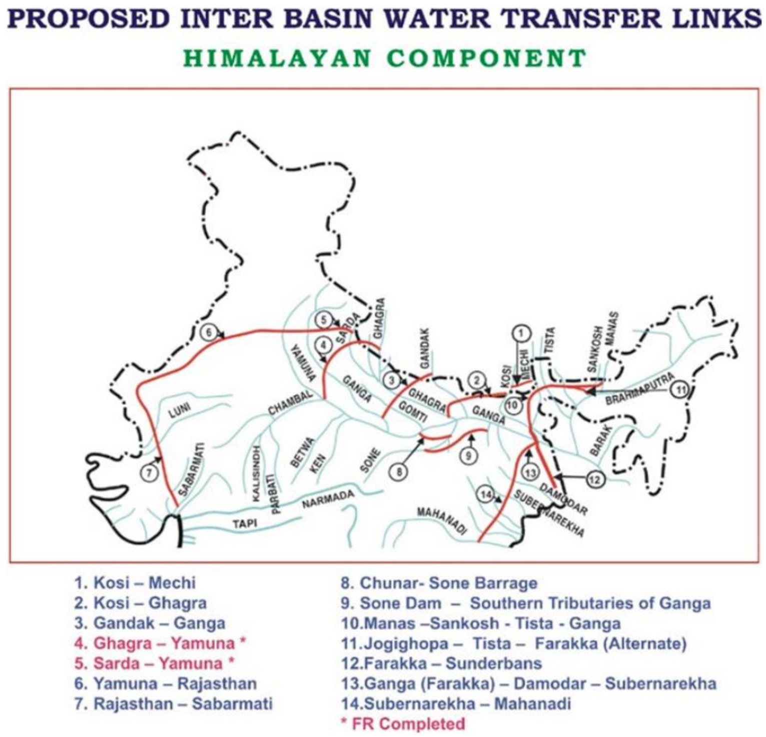
6.3.2 Inter-linking of Rivers

The acute spatial and temporal variations in precipitation patterns have greatly influenced water resources planning, management, and development in India. Specifically, these patterns have led to the development of several water transfer projects in the country. The Inter-Linking of Rivers (ILR) project is a grand example of such a water transfer project. We will discuss necessity, justifications and challenges to the implementation of the ILR project and discuss potential alternative policy recommendations for water resources management and planning in India.

Regional water transfer is an attempt to redistribute water from “surplus” to “deficit” zones within India. The ILR project in India envisions linking 37 rivers of 20 major basins in the country through 31 links and canals. The project has been promoted as a solution to the ‘paradox of floods and drought’ in India and will also provide water for irrigation and power generation. However, several issues have been raised and debated on the basis of technical feasibility, environmental, social, ethical, institutional, financial, and political criteria, which question the very rationale, viability and decision-making process of the project. These concerns make it difficult to determine when water transfer can be justified as desirable.

The spatial and temporal variations in the precipitation over India often lead to human sufferings through scarcity of drinking water, inundation of agricultural lands, failure of crops, etc. The logic behind the interlinking project is based on the view that there is 'surplus' water in some river basins or sub-basins, which, if transferred to the other ‘deficit’ river basins. On the basis of the National perspective on water resource development, the interlinking project has two components - the Himalayan and the Peninsular. The Himalayan component includes construction of storage dams on the main tributaries of Ganga and Brahmaputra to transfer surplus water to the west.

Map: 6.2



Source: National Water Development Agency (NWDA) India "A study on Inter- basin Water Transfer in India", New Delhi.

The Peninsular component involves connecting rivers like Godavari and Mahanadi that have 'surplus' water with rivers like Krishna and Cauvery. These river link have 31 link-canals are envisaged, of which 14 will be in the Himalayan component and 17 in the peninsular component. On the whole, the interlinking project is aimed at providing large scale human-induced connectivity for water flows in almost all parts of India. This, indeed, is the largest construction project thought of in the world as of now. One of the claimed benefits of the interlinking project is that it will provide drinking water to large areas in the country facing drought and water scarcity. The official process for the identification of river basins as 'surplus' or 'deficit' clubs together all water needs, and agricultural requirements dominates that classification. If the domestic water needs are considered separately, and not clubbed with their irrigational or industrial requirements, and compared with the water availability over smaller watersheds and sub-basins, a completely different picture of availability will surely emerge. On this basis, the interlinking project is seen to have the potential for generating four distinct types of conflicts. They are:

- Over compensations for resettlement and rehabilitation of the displaced,
- Over compensation for environmental damages from the project,
- Over sharing the benefits and costs of the project among the states of India
- Over cooperative management of the project in an international river basins.

6.3.3 Water Conservation

Since there is a declining availability of fresh water and increasing demand, the need has arisen to conserve and effectively manage this precious life giving resource for sustainable development. Given that water availability from sea/ocean, due to high cost of desalinization, is considered negligible, India has to take quick steps and make effective policies and laws, and adopt effective measures for its conservation. Besides developing water saving technologies and methods, attempts are also to be made to prevent the pollution. There is need to encourage watershed development, rainwater harvesting, water recycling and reuse, and conjunctive use of water for sustaining water supply in long run.

a. **Rain-water Harvesting:** Rain Water Harvesting (RWH) is a simple method by which rainfall is collected for future usage. The collected rainwater may be stored, utilised in different ways or directly used for recharge purposes. With depleting groundwater levels and fluctuating climate conditions, RWH can go a long way to help mitigate these effects. Capturing the rainwater can help recharge local aquifers, reduce urban flooding and most importantly ensure water availability in water-scarce zones. Though the term seems to have picked up greater visibility in the last few years, it was, and is even today, a traditional practice followed in rural India. Some ancient rainwater harvesting methods followed in India include *Johad*, *Ahar-pynes*, *Surangas*, *Tanks* and many more. This water conservation method can be easily practiced in villages, individual homes, apartments, parks, offices and temples too, across the world. Farmers have recharged their dry bore wells, created water banks in drought areas, green their farms, increased sustainability of their water resources. and even created a river. Technical knowhow for the roof-top RWH with direct storage can be availed for better implementation.

b. **Roof Water:** Slightly sloping roofs allow water to run into gutters, down pipes, and into specially prepared drums. Filters of wire mesh, sand, gravel, and charcoal clean the water. It is funnelled into underground sumps or above ground tanks. Tanks are sealed to keep out air, sunlight, and organic matter; treatment with alum reduces turbidity; and bleaching powder kills bacteria. This water can be used for gardening, flushing toilets, washing clothes. Further treatment can make it potable. Excess water can be collected into wells or directed underground to replenish the water table. Most popular urban method.

c. **Percolation tanks and *Rapats*:** Small tanks built on sandy or rocky soil to store rainwater. Some of the water is used, but the remainder percolates through to aquifers, which replenish wells.

d. **Bhandaras or *Kunds*:** Underground tanks built to intercept water from springs, channeling it to storage tanks for city use.

6.3.4 Water Pollution

The use of water is multifold. The survival of human being is not possible without the water. Human being cannot live without the water. For a healthy life pure and pollution free water is indispensable. If in any area the water is polluted then people or the other living creatures are forced to drink that polluted water because they have no other option nor can they live without it. In recent years, water pollution has become a serious problem across the country, mostly due to the presence of untreated effluents, chemicals and pesticides in it. There are many causes of water pollution. These causes can be removed or at least controlled with the awareness amongst the people and by the strong implementation of the legislative measures.

Water pollution is a serious problem in India as almost 70 percent of its surface water resources and a growing percentage of its groundwater reserves are contaminated by biological, toxic, organic, and inorganic pollutants. In many cases, these sources have been rendered unsafe for human consumption as well as for other activities, such as irrigation and industrial needs. This shows that degraded water quality can contribute to water scarcity as it limits its availability for both human use and for the ecosystem.

Many extensive studies have been undertaken to find socio-economical feasible alternatives for water and waste-water treatment. A number of methods such as coagulation, membrane process, adsorption, dialysis, foam flotation, osmosis, photo catalytic degradation and biological methods have been used for the removal of toxic pollutants from water and river water, to exterminate the pollutants in river, it is necessary to treat the river water. Here we will take a example of *Ganga* river about pollution mechanism and its functioning in the country. Cleaning of river Ganga was started under Ganga Action Plan (GAP) Phase-I. GAP-I was launched as a centrally funded scheme in 1985 and later GAP Phase-II was initiated in 1993 with the objective of improving the water quality of river Ganga. Various pollution abatement schemes including interception & diversion of sewage and setting up of sewage treatment plants were taken up under the Plan. A total of 869 MLD and 229 MLD has been established under GAP-I and II respectively. The work of Ganga cleaning was continued under National Ganga River Basin Authority in 2009. The Union Budget 2014-15 has set up an Integrated Ganga Conservation Mission namely "*Namami Gange*". The Cabinet approved the Namami Gange program on May 13, 2015 as a comprehensive approach to rejuvenate the river Ganga by inclusion of all tributaries under one umbrella at a total cost of Rs. 20,000 Crore for 5 years. As of now 93 schemes including 82 investment projects in 55 towns along the river Ganga and Yamuna are under different stages of construction, out of which 26 projects have been completed.

6.3.5 National Water Policies (NWP) of India

Water is a prime natural resource, a basic human need and a precious national asset. Planning, development and management of water resources need to be governed by national perspectives. Water is a scarce and precious national resource to be planned, developed, conserved and managed as such, and on an integrated and environmentally sound basis, keeping in view the socio-economic aspects and needs of the States. As the country has entered the 21st century, efforts to develop, conserve, utilize and manage this important resource in a sustainable manner, have to be guided by the national perspective. The main objective of the National Water Policy (NWP) is to take cognizance of the existing situation and to propose a framework for creation of an overarching system of laws and institutions and for a plan of action with a unified national perspective. So that the perspective planning can cater all these emerging issues and manage the scare equitably for sustainable development. The government of India formulates its first National Water Policy in 1987 and subsequently modified in 2002. However, with rapid changes in the socio-economic environment and looming threat of climate change, it further amended and prepared a draft national water policy 2012.

The first national water policy of 1987 explicitly stated water allocation priorities but issued a rejoinder "However these priorities might be modified if necessary in particular regions with reference to area specific considerations. The NWP 2002 deviated from the NWP 1987", by removing this rejoinder, juggled and added priorities to include ecology, navigation and divided industries into agricultural and non-agricultural. The NWP 2002 also encouraged private sector participation in planning, development and management of water resources. Whereas, The main objective of the draft National Water Policy 2012 is to propose a framework for creation of a system of laws and institutions for a plan of action with a unified national perspective, a comparative overview of the national policies is given in the below table 6.3.

Table: 6.3

India's National Water Policies over the Years

Source: Seth, B.L. (2012), "National Water Policy, 2012 silent on priorities", available at Source:

Issue	National Water Policy (1987)	National Water Policy (2002)	National Water Policy (2012)
Allocation priority	1. Drinking water 2. Irrigation 3. Hydro-power 4. Navigation 5. Industrial and other uses "However these priorities might be modified if necessary in particular regions with reference to area specific considerations."	1. Drinking water 2. Irrigation 3. Hydro-power 4. Ecology 5. Agro-industries and non-agricultural industries 6. Navigation and other uses	Done away with explicit priorities, "Water, over and above the pre-emptive need for safe drinking water and sanitation, should be treated as an economic good so as to promote its conservation and efficient use"."After meeting the minimum quantity of water required for survival of human beings and ecosystem, water must be used as an economic good with higher priority towards basic livelihood support to the poor and ensuring national food security".
Service provision	No mention.	Private sector participation should be encouraged in planning, development and management of water resource projects for diverse uses, wherever feasible. Depending upon the specific situations, various combinations of private sector participation, in building, owning, operating, leasing and transferring of water resources facilities, may be considered.	On the one hand the draft says that "Water needs to be managed as a community resource held, by the state, under public trust doctrine to achieve food security, livelihood, and equitable and sustainable development for all". On the other it mentions that: "The service provider role of the state has to be gradually shifted to that of a regulator of services and facilitator for strengthening the institutions responsible for planning, implementation and management of water resources. The water related services should be transferred to community and / or private sector with appropriate public private partnership model".

http://www.dwntoearth.org.in/content/national-water-policy-2012-silent-priorities, accessed on 27 September, 2015.

There is no disputing the fact that we need to have a national water perspective in our country while planning, managing and developing this scare, natural resources. This is become very complicated given the constitutional framework of our country where water, barring Interstate River and their management is a state subject.

However, the earlier policies stated that success for the endeavour will depend on a commitment of achieve the objectives and adoption of sate water policies backed by an optional action plan. In the past decade only 11 states drafted their own policy. In this background, the draft NWP 2012 is surely a step ahead in the right direction in more ways than one but it still leaves a lot to be desired. On one hand there are several progressive features in this draft but at the same time some very issues have either been left out from the previous policy. The draft does not categorically priorities the use of water as was done in the previous policies and this looks like a half baked effort. Further, national water policy is to be guided not only by the fundamental right to water but also by all other rights whose realisation depends on water. This includes food, health and sanitation.

6.4 RIVER VALLEY PROJECTS

River valley projects in India were started with the basic aim of meeting the critical requirements of irrigation for agriculture, electricity for industries and flood control. The importance of the dams at that time can be inferred from the fact that dams were regarded as "the temples of modern India" by J.L Nehru. Accordingly, dam construction was given such a high priority in India's economic plans, till now Irrigation and hydro-power have been the major objectives of the water resources development in India. Water is a dammed, a reservoir or lake forms behind the dam, which represent a temporary storage of water. A dam can capture high spring water flows resulting from heavy rainfall and melting snow in mountains above the dam, these projects having some merits and demerits of its functioning as follows:

a. Benefits of River Valley Projects:

1. They produce cheap hydroelectric power.
2. They reduce the danger of flooding in areas below the dam.
3. They provide a controllable and reliable flow of water for agricultural, industrial, and domestic uses in the areas below the dam.
4. They create a large water reservoir that can be used for water recreation.

b. Problems related to River Valley Projects

1. Change in upstream and downstream river flow, morphology and hydrology.
2. Reduction of biodiversity due to the blocking of movement of organisation.
3. Reduction in riverine, riparian, floodplain habitat diversity because of elimination of floods.
4. Displacement related problems and issues.

The development of multi-purpose river valley projects in India started in 1951. Flood control, irrigation, hydroelectric generation, navigation, fishing, and tourism are some of the chief aims of these projects. We will discuss here on some important river valley projects of

India in following section which are the multi-purpose projects/dam built across a river often serves more than one purpose at a time.

6.4.1 Bhakra Nangal Project

It is the largest and the most important multi-purpose project named after the two dams built at Bhakra and Nangal on the Satluz River. It's a joint venture of the Punjab Haryana and Rajasthan states design to harness the precious water of Satluz for the benefit of the concerned states. The project comprises of two dams at Bhakra and Nangal.

a. **The Bhakra Dam:** is one of the highest straight gravity dams in the world. It has been constructed on the Satluz at the site of Bhakra gorge near Roper. The dam is 226 meter high and 518 meter long with its maximum width at the base as 362 meter. The dam has created a huge reservoir of water which is 88 Km long and 8 Km wide with a storage capacity of 9869 million cubic meter. This reservoir is named as *Gobind Sagar* Lake.

b. **The Nangal Dam:** This dam has been constructed at Nangal about 13 Km downstream of the Bhakra dam. This 29 meter high, 305 meter long and 121 meter wide is an auxiliary dam which serves as a balancing reservoir for taking up daily fluctuations from the Bhakra dam. This project has helped in obtaining additional 1.3 million tonnes of food grains a year, 0.8 millions tones of cotton, 0.5 million tonnes of sugarcane and 0.1 million tonnes of oilseeds. No other river valley project in the world has so much potential as the project.

The main Bbhakra canal is 174 km long. The length of the canal system and that of the distributaries is 1,104 km and 3,360 km respectively. This canal system commands a gross area of about 27 lakh hectares and provides irrigation to about 15 lakh hectares. Of this 37.7% is in Punjab, 46.7% in Haryana and the remaining 15.6 % is in Rajasthan.

Bhakra Nangal dam suffers from the problem of the silting. Water coming from the higher reaches deposits its silt at the bed of the reservoir, thereby reducing its capacity to store water. The capacity of the reservoir was 6.03 million acre feet in 1963 which was reduced to 5.5 million acre feet in 1988, thereby causing a reduction of over half a million acre feet in a short span of only 25 years. However, this project has helped in obtaining additional 1.3 million tonnes of food grains a year, 0.8 million tonnes of cotton, 0.5 million tonnes of sugarcane and 0.1 million of oilseeds. No other river valley project in the world has so much potential as this project.

6.4.2 Tehri Dam

This dam is Tehri was conceived in 1949, situated at the confluence of the Bhagirathi and the Bhilangana rivers in Garwal district of Uttarakhand. This Tehri dam said to be the highest dam (with 2160.5 metere) in Asia was commissioned in 1972, but work on it began only in 1978. And ever since environmental and safety aspects threatened the project. This rock-fill dam, expected to generate 3500 MW of hydropower, will irrigate 270,000 ha of arid land between the Ganga and Yamuna. A gigantic reservoir would be created over an area of 4,200 ha which would feed an underground power house with a racing torrent generating enough electricity. The 2400 MW dam has submerged town of Tehri, which is well known as a seat of Garhwali culture, and 23 villages in its vicinity. About 72 other villages along the river will also be partly submerged. People from 21 villages have already been displaced for constructing the new Tehri Township, thus displacing about 70,000 people from their ancestral lands. The dam would also flood 1000 ha of cultivated land 1000 ha of forest land and 2000 ha of pasture land.

6.4.3 The Damador Valley Project

The Damodar River is a tributary of the Hugli River. It flows more or less in the west to east direction through Jharkhand and West Bengal. Its total length is about 541 Km, the Damodar valley covers an area of 24,235 Km^2 in Jharkhand and west Bengal. Bokaro, Barakar and Konar are its important tributaries. The Damodar River was termed river of sorrow. Its notoriety was demonstrated by the devastating floods in 1823, 1848, 1856, 1863, 1890, 1898, 1901, 1905,1923,1935,1943. Which major floods occur at intervals, minor floods are experienced almost every year. The Damodar floods enquiry committee suggested a comprehensive plan. This plan was based on the memorandum submitted by Er. W.L. Voordwin, an engineer with the Tennessee Valley Authority (TVA) of U.S.A. The Damodar Valley Corporation (DVC) was established on 18th February, 1948 to except the Damodar valley project. The original plan was to construct seven major dams. These dams were to be Aiyer and Panchet hill on the Damodar River. Maithan, Belpahari and Tilaiya on the Barakar River. Konar on the Konar River and Bokaro on Bokaro River. But the DVC has constructed only four dams Tilaiya, Maithan, Konar and panchet hill dam.

i. **Tilaiya Dam:** This dam has been constructed on Barakar River. The construction on this dam was started in 1950 and completed in 1953, with the length of 366 meter. It was a only concrete dam in the area. Two power stations of 2000 KW each have been setup here. The dam provides irrigation facilities to forty thousand hectares of land.

ii. **Konar Dam:** Construction on this dam started in 1950 and it was completed in 1955. It has an installed capacity of 10 MW. Bokaro steel plant and Bokaro thermal plant receive hydroelectric power and clean water, respectively from this dam. It provides irrigation to 45,000 hectares of agricultural land. It has been constructed on Konar River in Hazaribag district of Jharkhand. It is 3549 meter long and it has maximum height above river bed is 49 meter. It is an earthen dam with concrete spill way. Its gross storage capacity is 337 Million Cubic meters and live storage capacity is 276 Million Cubic meter.

iii. **Maithan Dam:** It has been constructed on Barakar river, a little upstream from the confluence of river Barakar and Damodar. It is 994 meter long and its maximum height above the river bed is 49 meters, with the gross storage capacity of 1,357 Million Cubic meter. Construction on this dam was started 1951 and completed in 1958. It has an installed capacity of 60 MW hydropower generations.

iv. **Panchet Hill Dam:** This is an also an earthen dam with concrete spill way which has been constructed on the river Damodar. Construction started in 1952 and was completed in 1959. This dam is 2,545 meters long and its maximum height above the river bed is 49 meters. Its gross storage capacity is 1,497 Million Cubic meter while its live storage capacity is 1,307 Million Cubic meters. It has an installed capacity of 40 MW hydropower generations and it irrigates about 28 lakh hectares of agricultural land.

v. **Durgapur Barrage:** The barrage was completed in 1955. It's located at about 23 km from Raniganj has been created for the storage of irrigation water. It is 831 meters long and about 12 meter high. It stores the waters released from Konar, Tilaiya, Maithon, and Panchet hill dams. This irrigation water is reregulated through a network of canals extending over an area of about 5,000 Km^2 in Bakura, Bardhman, Hugli, and Hawra district in West Bengal.

Benefits from the Damador Valley Project

1. Flood control in the land flood prone area of Jharkhand and West Bengal.
2. Irrigation facilities to about 5.15 lakh hectares of land.
3. Installed capacity of 2, 60,000 KW of hydropower at various dam sites.
4. Check on soil erosion through regulated flow of water.

5. Additional land reclamation for agriculture.
6. Navigation in Damodar and its tributaries river.
7. The project has provided a broad industrial base to the area.
8. Encouragement to fishing in the reservoirs and other water bodies.

The Damodar valley project was primarily conceived for flood control and target has not been achieved fully. Only four dams have been constructed in place of the original suggestions of seven dams. Problems of siltation occur in this reservoir. However, the Damodar Valley Corporation has been an important example of integrated regional development. Its efficiency can be improved with better management and foresight.

6.4.4 The Narmada Valley Project

The Narmada is the fifth largest river of India and the largest among the west flowing rivers of the peninsula, originating in the *Amarkantak* plateau of Madhya Pradesh. The volume of average annual flow of water is 40,700 Million Cubic meter, 90 percent of which flows during the monsoon season. Only 5 percent of this flow is utilised and 95percent unutilised to the Gulf of *Khambhat*. The Narmada valley aims at harnessing this flow for the economic prosperity of the concerned area. This is going to be one of the largest river valley project of the world because the entire project includes the construction of 30 major , 135 medium and 3,000 minor dams on the river.

Narmada project is designed to benefit the peoples of Gujarat, Madhya Pradesh, Maharashtra and Rajasthan tagged as a marginal beneficiary to get more drinking water. The dams on the river are designed to produce about 3000 MW of hydropower. The canal system to be built in the integrated scheme is expected to provide irrigation facility to Gujarat (17.92 Lakh hectares), Madhya Pradesh (1.40 Lakh in hectare) and Rajasthan (73,000 hectares). Although 87 per cent of the Narmada river flow is in Madhya Pradesh, 11.5 per cent of its water flows in Gujarat and 1.5 percent in Maharashtra state. Gujarat is the main beneficiary state of the project. Therefore, Narmada is called the life line of Gujarat. The increased irrigation potential is estimated to tack up the food grains production by 43 Lakh tonnes per year. Further, Guaranties claims a positive impact on the health scene. There would be substantial reduction in scabies and skin diseases in Saurashtra, Kuchchh and northern Gujarat due to the availability of potable water.

6.4.5 Rihand Valley Project

This is important multipurpose project of Uttar Pradesh. It consists of 934 metre long and 92 metre high straight gravity concern dam across the Rihand River in Mirzapur district of Uttar Pradesh. The reservoir created by this dam has been named as Govind Ballabh Pant Sagar. It spreads over an area of 466 Km^2 and is the largest man made reservoir in India. It has the capacity to hold 11.4 Lakh hectare meters of water. Another dam about 25 Km north of the Rihand dam has been constructed at Obra. The power house near the Rihand dam has 6 units each with a 5 MW power generation capacity. Besides, power house at Obra also has 6 units, each having a capacity of 50 MW this power is supplied to the Eastern Uttar Pradesh, Western parts of Bihar and Northern parts of Madhya Pradesh. The Son river valley, within a radius of 200 Km from Pipri, is blessed with vast deposits of Coal, Iron-ore, Limestone, Mica, Bauxite, Feldspar etc. The hydroelectric power generated by the Rihand valley project goes a long way to help in exploiting these mineral resources and usher into a new era of economic prosperity. About 5000 wells in Uttar Pradesh have been energised. Another 2.25 Lakh hectares of land has been provided with tube-well irrigation in Bihar.

Benefits of the Rihand Valley Project:

1. Flood control in Son river valley.
2. Fishing in Govind Vallabh Pant Sagar
3. Tourism
4. Prevention and control of soil erosion in *Baghelkhand* region.

6.4.6 The Chambal Valley Project

This is a joint venture of Rajasthan and Madhya Pradesh initiated in 1954 on the Chambal River. The project aims at harnessing the Chambal River for irrigation, power generation and for prevention and control of soil erosion in the valley. The project has been executed in three successive stages.

i. **First Stage:** Consist of construction of the 64 meter high and 514 meter long Gandhi Sagar Dam about 8 Km downstream of the Chaurasigarh fort in Bhanupura tehsil at the border of M.P. and Rajasthan. Constructed in 1960, the dam has created the Ganga Nagar reservoir which spreads over area of 688 Km^2. It has a capacity to hold 6920 Million Cubic meter of water which provides irrigation to 4.44 Lakh hectares. Five units of 23000 KW capacities each have been set up at the dam site.

ii. **Second Stage:** Include the construction of the 54 meter high and 1143 meter long Rana Pratap Sagar masonry dam at Rawatbhata about 56 Km downstream of the Gandhi Sagar dam. It has a gross storage capacity of 2900 Million Cubic meter spreading over an area of 198 Km^2. It provides irrigation to 1.2 Lakh hectares of land. The Ranapratap power station is located on the left bank just at the toe of the dam, with four generating units of 43,000 KW each are installed here.

iii. **Third Stage**: Consist of the construction of a 45 meter high and 548 meter long gravity dam, known as the Jawahar Sagar dam or Kota Dam, about 29 Km upstream of Kota city. It was completed in 1972. The reservoir created by this dam has a potential of 68 Million Cubic metres. Three generating units of 33,000 KW each have been installed here. The area benefited by the project include Kota, Bundi, Bharatpur, Jaipur, Sawai Madhopur, Tonk, Ajmer, Pali, Bhilwara, Sirohi and Udaipur district of Rajasthan and Mandsaur, Indore, Ujjain, Gwalior and Ratlam districts of Madhya Pradesh.

6.5 CONCLUSION

Water is one of the most essential natural resources for sustaining life and it is likely to become critically scarce in the coming decades, due to continuous increase in its demands, rapid increase in population and expanding economy of the country. The uneven distribution of the precipitation results in highly uneven distribution of available water resources both in space and time, which leads to floods and drought affecting the vast areas of the country. There is a need for increasing the availability of water and reducing its demand. For increasing the availability of water resources, there is a need for better management of existing storages and creation of additional storages by constructing small, medium and large sized dams considering the economical, environmental and social aspects. Decision support system required to be developed for planning and management of the water resources programs and systems. Such systems provide an integrated approach for water resources management considering the various water-related disciplines together with socio-economic aspects. With the rapid industrialization and increasing use of fertilizers and pesticides, the quality of surface and groundwater resources is deteriorating. The movement of pollutants in the rivers, lakes and groundwater aquifers needs to be regulated. In this regard, regular water quality monitoring programme has to be launched for identifying the areas likely to be affected because of the water quality problems. The capacity building and awareness programmes may also be needed for the water resources managers and developers for updating the knowledge and technology in the area of water resources management.

6.6 SUMMARY

Water is essential for human civilization, living organisms, and natural habitat. It is used for drinking, cleaning, agriculture, transportation, industry, recreation, and animal husbandry, producing electricity for domestic, industrial and commercial use. India accounts for about 2.45 per cent of world's surface area, 4 percent of the world's water resources and about 17.5 percent of world's population. India has traditionally been an agrarian economy, and about two-third of its population have been dependent on agriculture. Hence, development of irrigation to increase agricultural production has been assigned a very high priority in the Five Year Plans, and multipurpose river valleys projects like the Bhakra-Nangal, Hirakud, Damodar Valley, Nagarjuna Sagar, Indira Gandhi Canal Project, etc. have been taken up. In fact, India's water demand at present is dominated by irrigational needs. While efforts should be made to avert water related disasters like floods and droughts, a greater emphasis should be on preparedness for floods and droughts. If there is no water, there is no life. Hence, water conservation is essential. There is a wide scope to use rainwater harvesting technique to conserve precious water resource. It can be done by harvesting rainwater on rooftops and open spaces. National Water Policy is formulated by the Ministry of Water Resources of the Government of India to govern the planning and development of water resources and their optimum utilization. Large areas of the country suffer from droughts and floods. Droughts and floods are two sides of the same coin. We can resolve this issue through river linking projects. We should implement these projects taking consideration of environmental, social and economic concerns.

6.7 GLOSSARY

- Contamination: Degradation of water quality compared to original or natural conditions due to human activity.
- Drought: A prolonged period of less than normal precipitation such that the lack of water causes a serious hydrologic imbalance.
- DVC: Damodar Valley Corporation
- Eutrophication: The process by which water becomes enriched with plant nutrients, most commonly phosphorus and nitrogen.

- Hydrograph: Graph showing variation of water elevation, velocity, stream-flow, or other property of water with respect to time.
- Hydrology: The science that deals with water as it occurs in the atmosphere, on the surface of the ground and underground.
- ILR: Inter Linking of Rivers
- Infiltration: The downward movement of water from the atmosphere into soil or porous rock.
- Irrigation: Controlled application of water to arable land to supply requirements of crops not satisfied by rainfall.
- MCM: Million Cubic Meters
- MLD: Million Litters per Day
- NWP: National Water Policy
- Permeability: The capacity of a rock for transmitting a fluid; a measure of the relative ease with which a porous medium can transmit a liquid.
- Potable Water: Water that is safe and palatable for human consumption.
- Run-off: That part of precipitation or snowmelt that appears in streams or surface-water bodies.
- Wetland: Ecosystems, whose soil is saturated for long periods seasonally or continuously, including marshes, swamps, and ephemeral ponds.

6.8 ANSWER TO CHECK YOUR PROGRESS

i. What are the main sources of surface water?

ii. Mention the main component responsible for the uneven distribution of water in India.

iii. Wheat is a water crisis?

iv. Name any two methods of rain water harvesting.

iv. What are the main objectives of river valley projects?

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6.11 TERMINAL QUESTIONS

1. Answer the following questions in about 50 words.
   (i) It is said that the water resources in India have been depleting very fast. Discuss the factors responsible for depletion of water resources?
   (ii) What is significance of River linking project in India. Explain its advantages and disadvantages of river linking projects.
   (iii) Why the share of agricultural sector in total water used in the country is expected to decline?
   (iv) What can be possible impacts of consumption of contaminated/unclean water on the people?

2. Answer the following questions in about 150 words.
   (i) Discuss the availability of water resources in the country and factors that determine its spatial distribution?
   (ii) The depleting water resources may lead to social conflicts and disputes. Elaborate it with suitable examples?
   (iii) Critically examine the National water policy-2012 in the light of previous national water policies?
   (iv) Highlights the reasons of Ganga pollution and suggest remedies for abatement of Ganga pollution?

UNIT 7 - MINERAL AND POWER RESOURCES

7.1 OBJECTIVES

After going through this unit, you should be able to:

- Describing major mineral resources of India.
- Detail study of metallic and non-metallic minerals.
- Detailed analysis of power resources of India.
- Understand the utilization of power resources and mineral resources.

7.2 INTRODUCTION

A mineral is an aggregate of two or more than two elements. A mineral has a definite chemical composition and is formed by inorganic processes.

Minerals generally occur in the earth's crust. It is extracted in the form of ore, processed and used for various purposes.

Minerals form the basis of the industrial development of a country. India is fortunate to have rich deposits of some essential minerals. There are large reserves of iron ore, mica, manganese ore, magnesite, bauxite and thorium. It is possible for India to export these minerals. Reserves of coal, limestone, dolomite, uranium, copper ore and gypsum are adequate for the needs of the country. India is very poorly endowed with a few essential minerals. These are the minerals which yield mercury, tungsten, molybdenum, silver, cobalt, nickel, tin, zinc, antimony and platinum . Production of petroleum, phosphates and sulphur also falls considerably short of the requirements of the country. India, therefore, depends on other countries for the supply of these minerals. The country is, however, actively engaged in the search for minerals and it is a very likely that it will be able to discover more deposits of minerals in the near future.

In ancient times, before power developing machines such as steam engine, electric dynamo and internal combustion engine were invented, animal and human energy were the only sources of power on farm and trade routes. In India, the human and animal is still the main sources of energy in the rural areas. Production of industrial power on a large scale is a thing of the last few decades only. Coal, oil and water are the major sources of power. Natural gas, alcohol and the atom are other sources of power. The plateau of Chhota Nagpur and the neighboring parts of West Bengal being rich in good quality coal, form the leading steel manufacturing and steel fabricating region of India. Without adequate resources of power, no country can emerge as a powerful nation. Power resources are in fact, the basis for the industrial and agricultural prosperity of a nation.

Types and Minerals:

Normally minerals are found in two forms:

(i) Metallic minerals

(ii) Non-Metallic minerals

(i) Metallic minerals – These minerals contain metals and are generally found in igneous rocks. They provide a strong base for the development of metallurgical industry and hence are vital for the industrialization and economic growth of the country. E.g., Iron ore, manganese, nickel and copper.

(ii) Non-metallic minerals – These minerals do not contain metals and are found in sedimentary rocks e.g., mica, limestone, gypsum etc.

Minerals are exhaustible and non-renewable resources i.e. they are exhaustible; it is not easy to replace them. They take a long time to develop geologically. Therefore, they should be conserved and not misused.

7.3 MINERAL RESOURCES OF INDIA

Mineral resources in India are adequately rich, widespread and are of huge varieties which provide the nation with a strong industrial base. The most important mineral resources which India possesses include Manganese ore, Coal, Bauxite, Iron, Monazite and Salt. Further, these other varieties too that are not found in abundance. For instance, Petroleum, Chromites, Gypsum, Tin, Mercury, Copper, Nickel, Lead and Zinc are not found in sufficient amount. India is mostly rich in iron resources. Iron and coal, actually forms the basis of the machine age. As per estimation, India possesses virtually worlds one fourth of iron ore resources. Its capital is rich not only quantitatively but also qualitatively. A further significant mineral required by the ferrous industries is manganese, and it is also found in abundance in India. It is used to manufacture steel alloys.

Types of Mineral Resources in India

Mineral resources in India can be categorized into two groups, namely metallic minerals and non-metallic minerals. Metallic mineral resources are the ones, which have the properties of lusture, solidity and hardness. These metals can be melted, drawn into wires and rolled into sheets. Usually metals exist as compounds in chemical combination with other minerals. Only few of these minerals occur in a pure state. Gold, silver and copper are examples of such minerals. Metallic minerals are extracted from the earth in raw state, called as mineral ore. The major metallic mineral found in India are iron, copper, lead, zinc, tin, silver and gold. On the other hand, there are some minerals that do not contain metal in them and are used for the extraction of non-metals like Sulphur, Phosphorous, Carbonate and so on. Limestone, Antimony, Mica and Gypsum salts are some of the significant non-metallic minerals that are found in abundance in India. Madhya Pradesh, Bihar, Orrisa, Goa, Karnataka, Andhra Pradesh, Maharashtra, Kerala , Tamil Nadu and Rajasthan are the major producers of iron are in India.

7.3.1 Metallic Minerals (Iron ore, Mangenese…………….)

Metallic minerals contain metals and are generally found in igneous rocks.

Iron Ore

Indian is extra ordinarily rich – both in quantity and quality of its iron ore deposits. These ores primarily comprise hematite and magnetite.

Uses and types

Iron ore is the backbone of our modern industries and industrial development. The economic growth of a country is judged by its consumption of iron. Iron exists in the form of iron ore and contains varying percentage of iron- accordingly, there are four varieties of iron ore found:

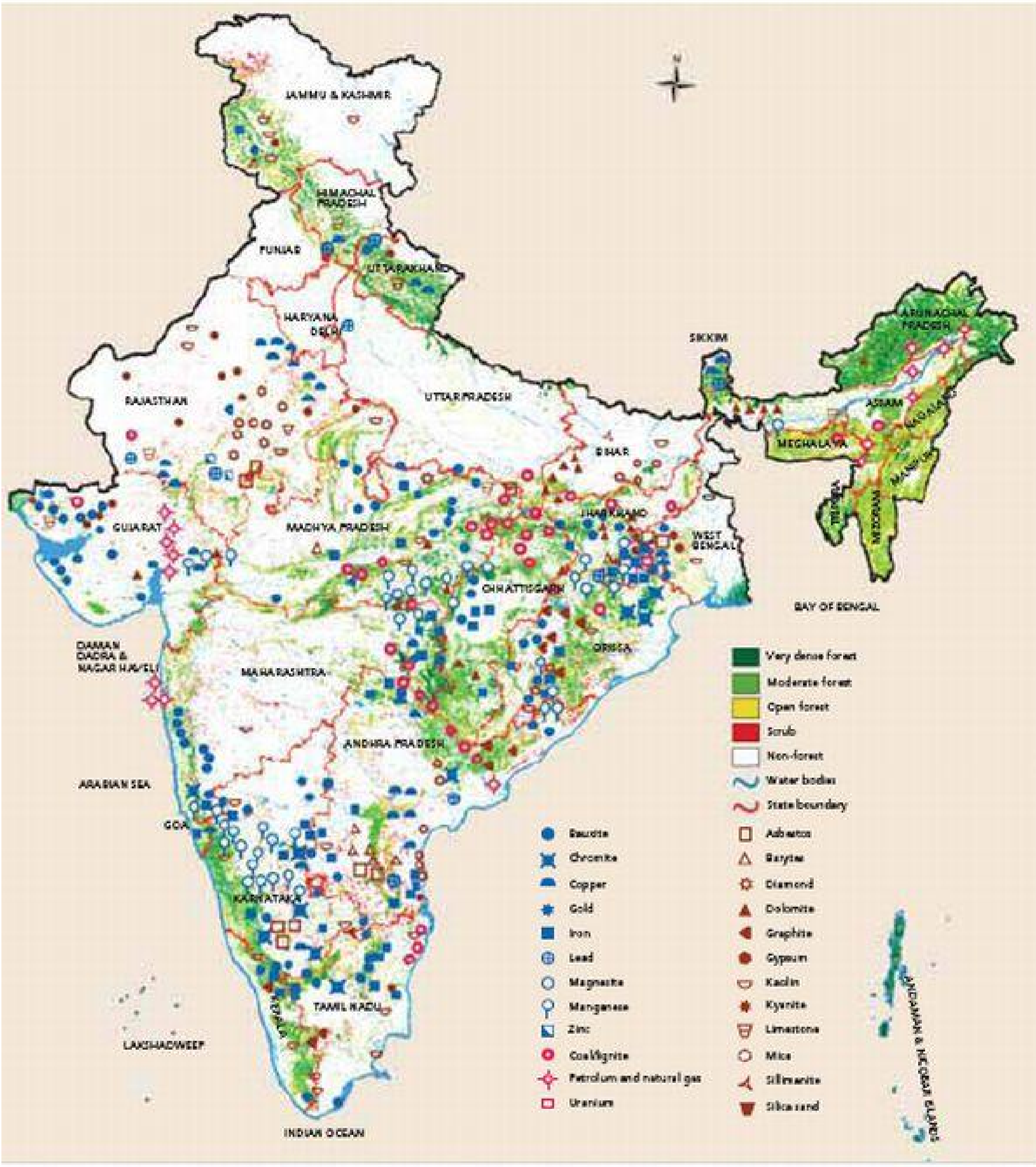
(i) **Magnetite :** This is also known as blado-ore, this is the best quality of iron are and contains 72% pure iron. It possesses magnetic property, hence it is called magnetite. It is found in Andhra Pradesh, Goa, Kerala, Tamil Nadu and Karnataka.

(ii) **Hematite:** It contains about 60-70% pure iron and is found in Andhra Pradesh, Jharkhand, Orissa, Chhattisgarh, Madhya Pradesh, Goa, Karnataka and Maharashtra.

(iii) **Limonite:** It contains 40% to 60% pure iron. It is yellow-brown in colour. It is inferior limonite. It is found in Raniganj (West Bengal), Uttar Pradesh, Uttarakhand and Himachal Pradesh.

(iv) **Siderite:** It is an inferior ore and has many impurities. It has only 10 to 40% pure iron.

Map-7.1 Mineral of India



Source: Google

Distribution: Iron Ore in India

India has the world's largest reserves of iron – approximately 6.6% of world's known reserves. Most of the iron ore of India comes from peninsular India. Orrisa, Jharkhand, Goa, Madhya Pradesh, Karnataka, Maharashtra, Andhra Pradesh and Tamilnadu are the important producers of ore in India.

Karnataka has large reserves of magnetite and hematite. The important deposits are found in Bellary, Hospet and Sandur in Bellary district. Also Baba Budan hills and Kudremukh are important mining areas in Chickmagalur district. Chitradurga, Shimoga and Tumkur districts also produce the ore.

Chhattisgarh is a major producer of iron ore in India. The deposits are found in Durg and Bastar districts. Dalli and Rajhara iron ore fields and Bailadila are the major mining areas where good quality hematite iron ore is found. Much of the iron ore from Bailadila is being exported to Japan.

Orissa is the largest producer of iron ore. Here good quality hematite is mined in the districts of Sundergarh, Mayurbhanj, Keonjhar, Cuttack and Koraput districts. Also, Badampahar, Gurumahisani, Kirburu, Bohnai, Sulaipet and Umarkot are important iron ore fields.

Jharkhand is also an important producer of iron ore and has large reserves of hematite. Singhbhum district is the major producer of iron ore where Noamandi and Gua are the main mining areas.

The other states where iron ore mines exist are Maharashtra: Chandrapur and Ratnagiri; Tamil Nadu: Tiruchirappalli, Salem and Kerala: Kozhikode. There are some deposits in Rajasthan too.

Manganese

Ferro-alloys are amalgamated metals with iron as the base. These are valued for their strength and as a result they have become pretty, significant in the age of commanding giant machines. Manganese is used for this purpose and hence its escalating importance.

Uses – (i) It is the most important mineral for making iron and steel. Nearly 10kg manganese is required for manufacturing one tone of steel.

(ii) It is also used for manufacturing bleaching powder, insecticides, paints and batteries.

Distribution

India, the third largest producer of manganese, used to export but now it has been relegated to seventh position due to increased production of manganese in other countries of the world. Like other minerals, manganese is also produced in peninsular India with Orissa, Maharastra, Jharkhand, Madhya Pradesh, Andhra Pradesh and Karnataka being the main producers. Indian manganese is of high quality and is in great demand. More than $2/3^{rd}$ of the country’s manganese reserves and deposits are found in the Nagpur and Bhandara belt of Maharastra and Balaghat, Chhindwara belt of Madhya Pradesh.

Orissa is largest manganese producing state (about 40%) is Orissa, where it is mined in the districts of sundergarh, Kalahandi, Koraput, Keonjhar, Bolangir and Mayurbhanj.

Karnataka is the second largest producer with about 30% production. It is mined in north Canara, Bijapur, Chickmagalur, Bellary, Shimoga, Chitradurga and Tumkur districts. Panch Mahal and Vadodara districts of Gujarat; Banswara district of Rajasthan, Vishakhapattanam, Kurnool and Srikakulam districts of Andhra Pradesh; Singhbhum district of Jharakhand and Madhya Pradesh also produces manganese. India exports manganese to Japan, USA and the west European countries.

Bauxite

Bauxite is the raw material for making aluminium. It is rock, consisting of hydrated aluminium oxides. It is used for making air crafts, ships and Utensils etc. Aluminium alloy are used in the manufacture of automobile engines because of its light and tough. Bauxite is used in manufacture of cement and chemicals. High grade bauxite is found in abundance in India. Bauxite is widely distributed as surface deposits in those areas where laterite soil is found.

India is the largest producer of bauxite in south Asia and self-sufficient in aluminium production. Bauxite is mined at several places in the country. The major deposits of bauxite are situated in Ranchi, Jamnagar, Jabalpur, Kolhapur and Shevaroy hills. Apart from these areas, the other places where its chief deposits are found include poonch and Riasi in Jammu and Kashmir, Balaghat in Madhya Pradesh and more. Moreover, in Kutch district in Gujarat too large deposits of Bauxite are found. Of late, deposits in Orissa have been developed and the biggest plant of its kind in Asia has been constructed to produce alumina and aluminium. It utilizes the latest French technology, which economizes on the use of electricity. Bauxite ore is exported to Japan and European countries. In Orissa, there are two very big high grade deposits of Bauxite. The first one at Panch Patmali is regarded as the largest in the country and the second one is at Gandhmardan bauxite deposit. Interestingly, production of bauxite is registered particularly in those regions that supply alumina plants with this ore.

Bauxite ore has benefited in importance because aluminum – a very light but exceedingly by functional metal, is made from it. It is a must for aircraft engineering. It is now also being increasingly used in day by day life. But the manufacture of alumina and aluminium depends fundamentally on the handiness of cheap and ample generation of electricity. Bauxite deposits in India are extensively distributed Orissa, Andhra Pradesh, Madhya Pradesh, Gujarat, Maharashtra and Bihar ore the foremost states where bauxite reserves ore predominately located. The total reserves are approximated to be more than 2462 million tones. Major reserves are centralized in East Coast of Orissa and northern Andhra Pradesh.

Aluminium is obtained from bauxite in two stages. In the first stage bauxite is refined and transformed into alumina by a chemical process and in the second stage aluminium metal is obtained by the electrolysis of alumina. Of the total bauxite produced in the country, the major portion is used for making aluminum metal. A small quantity of it is exported to other countries.

Chromite

Chromite is an iron chromium oxide. It is an mineral belonging to the spinel group. Mangnesium can substitute for iron in variable amounts as it forms a solid solution with magnesio chromite substitution of aluminium occurs leading to hercynite.

It is an industrially important mineral for the production of metallic chromium, used as an alloying ingredient in stainless and tool steels. It is found in metamorphic rocks such as some serpentinites.

As a major source of the metal chromium, the extracted chromium from chromite is used in chrome plating and alloying for production of corrosion resistant super alloys, nichrome and stainless steel. Chromium is used as a pigment for glass, glazes and paint and as an oxidizing agent for tanning leather.

In 2002, 14,600,000 metric tons of chromite were mined. India is one of the largest producers (18%) of chromite in world. Places of occurrence of chromite as a primary ore of magmatic origin are:

Bihar is the important chromite deposits occur in singhbhum district. There are sporadic occurrences in Bhagalpur district and near Silli in Ranchi district.

Kashmir has large deposits of chromite occurring in dunite intrusions forming hill masses have been discovered in the Drass valley of Laddakh and at Burzil in Kashmir.

Maharashtra is known chromite deposits are located in Ratnagiri district and near Pauni in Bhandara District.

In **Orissa** High grade deposits are situated in the keonjhar, Cuttack and Dhenkanal districts. The Cuttack Dhenkanal chromite belt runs for 30 miles in Cuttack district by way of Dhen-kanal.

With the country's developing steel industry, more chromite is expected to be utilized within the country in the production of ferrochrome, other alloys and refractories.

Copper

As a metal, copper came to be used by man much earlier than iron. Being malleable, it can be beaten into utensils of any shape. When alloyed with zinc it is known as “brass” and with tin “bronze”, both of which are commonly used for making cooking utensils and other objects of common utility. In modern time, it is widely used for transmission of electricity from power station to consumers, copper being a good conductor of electricity.

Further, for the refining of copper, cheap and abundant electricity is required. India manufactures only a little amount of copper and it imports a huge quantity of this mineral resources annually to meet domestic needs. At present, most of the copper ore is mined in the district of Singhbhum (Jharkhand), Balaghat (Madhya Pradesh) and Jhunjhunu District and Alwar in Rajasthan. The small producers of copper include Khammam district of Andhra Pradesh, Chitradurga and Hassan district of Karnataka and also in some part of Sikkim.

In **Andhra Pradesh** during the Vijaynagar Empire copper ores were worked in Kurnool, Guntur and Nellore districts. Preliminary geo-physical surveys indicate the presence of copper ore near Yellambailu in Khanmmam district, Nellore and Krishna districts.

Bihar’s copper ores occur along a belt extending for about 80 miles. These copper bearing rocks persist along a zone of over-thrust in the Dharwar schists and intrusive granite. The deposites worked at the Masabani mines, Singhbhm consist of sulphide ore assaying around 2.4% of copper; somewhat richer ore shoots have also been noticed elsewhere in the same area. Mosabani and Rakha are the chief mining area. Copper occurrences are also known at Chhota Nagpur, Hazaribagh and Santhal Parganas district.

Jammu and Kashmir’s copper ores, including sulphides, oxides and carbonates occur in the Shumahar area (Anantnag district) in Lidar Valley in impersistent quartz – veins associated with lead ores. Sulphides and carbonates of copper have been discovered in the Kangan area, Srinagar district, in quartz veins.

Rajasthan still bears evidence of the flourishing copper industry of India in former centuries when large quantities of copper and bronze were produced from Rajasthan and Singh bhum (Bihar) mines; these sites are indicated by extensive slag heaps and refuge “copper working. Even within historic times, important copper mines existed in Alwar, Ajmer and Khetri. Copper is also reported from Ajmer, Banswara, Bikaner, Bharatpur, Bundi, Udaipur and Tonk districts.

In **Uttarakhand** copper ores are reported from a large number of localities in Uttarakhand. The occurrences at Pokhari, Khandhara. Many old workings are reported from these places near Dewal, Thal and Almora.

In the Himalayan region recent work has proved the existence of workable ore reserves in Sikkim and in some parts of Kumaon.

Zinc

The commonest reference made to zinc is in connection with the corrugated roofing sheets made of iron and coated with zinc to prevent rusting. When zinc is alloyed with copper, the familiar alloy brass is obtained. Zinc is also used in the manufacture of collapsible tubes containing drugs, pastes and the like. Zinc oxide and zinc sulphide ore used as pigments, while zinc chloride is used is soldering and as a coating in preventing decay in wood. Zinc does not occur free in nature; it occurs commonly as the sulphide mineral sphalerite or zinc-blende. Sphalirite is common only associated with galena, the ore of lead.

In **Jammu and Kashmir** a workable deposit of zinc- blende of considerable purity, occurring in lenticular veins and lodes, has been discovered in a permo-carboniferous limestone in the Riasi district of Kashmir is association with Tertiary rocks. The veins sometimes swell to nests of 500 cubic feet, while some thousand tones of detrital float – ore occur in the vicinity. The presence of sphalerite (zinc sulphide) in the limestone of the Darabi area in Udhampur district is also an indication of the possibility of small reserves of zinc ores being found in the area.

In **Rajasthan** the Geological Survey of India has done considerable work, in recent years, on the zinc –lead deposits of Zawar in Udaipur district, an area which produced considerable quantities of metallic zinc a century or two ago. The re-opened Zawar mines, which show occurrences of zinc-lodes (blende) in association with lead ores, galena, are so far, the only source of workable zinc in the country.

Lead ore is also reported to occur in Dungarpur, Banswara, Sawai Madhopur and Alwar district.

In **West Bengal** small pockets of argentiferous galena, cerussite, sphalerite and limonite occur in the dolomite bands in the Buxa Duars area of Jalpaiguri district. Lead ores occur also in a umber of other places in Dargeelig district and the western Duars area. Minor deposits of lead zinc have been located at Almora, Tehri Garhwal and Bhotang (Sikkim). The main ore bodies are sphalerite, calamine and hemimorphite, in association with lead compounds and minor amounts of cadmium and silver. In the new smelter plants that are being projected for zinc, the recovery of these, along with sulphur, for manufacture of sulphuric acid, will be carried out.

Lead

Lead is a soft but heavy metal. Modern civic amenities require lead pipe for sanitary fittings, but the most important industrial use of lead is as a constituent of alloys, such as type metal, bronzes and anti-friction metal. Lead oxide is used in lead sheeting, cable covers, ammunition, glass-making and rubber industry. Lead – oxide paints are used extensively in painting ships to prevent rusting. Lead nitrate is used in calico-dyeing and in printing processes. Lead does not occur free in nature; it occurs as a cubic sulphide known as galena. Both sphalerite (sulphide of zinc) and galena occur associated to gether in nature. Galena characteristically breaks into small cubic pieces if harmmered. Lead was formerly produced in India on a large scale, though very little lead is now produced in the country. Large mounds of slag found in Mewar, Jaipur and in parts of Bihar, indicate that a considerable amount of ingotlead was produced in several parts of the country in medieval times. Ores of lead, chiefly galena, occur at a number of places in the Himalayas, Chennai, Rejasthan and Bihar, enclosed either among the crystalline schists or as veins and pockets in the pre-cambrian and later limestones.

Lead ores are found at following localities:

Andhra Pradesh: Galena occurs at Chityala and Chelima in Kurnool district, Karempudi in Guntur district and Zangamrajupalle in Cuddapah district. The chityala occurrence is in granites, presumably associated with the fault breccia of quartz. The other occurrences are in shales and limestone of Cuddapah. Galena is also reported to occur near Chintakunta in Nalgonda district and Jestaipalli in Khammam district.

Bihar: The lead ores of Hazaribagh and Manbhum are on a fairly large scale and are often argentiferous, yielding a few ounces of silver per ton of lead. Galena is found in parts of singhbhum, Ranchi, Hazaribagh and palamau districts but with little chance of success in their working.

Rajasthan : Galena is found associated with zinc – blende in Zawar mines in Udaipur district operating at the site of the old abandoned mines. The zawar ores belong, geologically, to the class of metasomatic replacements, an Aravalli limestone, being replaced by the sulphides and carbonates of lead and zinc by the process of molecular replacement. Lead ore is also reported to occur near Rikhabdeo and Debari in Udaipur district, Ghughra and Mando in Dungarpur district, Wardalia in Banswara district and Gudha Kishori Das in Alwar district. The lead ore of Mewar is on a fairly large scale and is often argentiferous, yielding a few ounces of silver per ton of lead. Madhya Pradesh, Jharkhand, Chhattisgarh, West Bengal and Jammu and Kashmir are other states in India which produces lead.

Nickle

Nickel does not occur free in nature when iron is alloyed with some chromium and nickel, an alloy known as nickel –steel is obtained. This is the rust proof "stainless steel" of a superior quality used for making utensils, etc. Because of its greater hardness and tensile strength than carbon steel, nickel-steel is used in the manufacture of armoured plates, motor cars etc.

Nickel finds its usage in various industries such as engineering, electrical and electronics, infrastructure, automobile and automobile components, packaging, batteries etc. Among base metals Nickel is the most volatile owing to its strong demand is derived demand based on the growth of different industrial sector thus exhibits high volatility. About 65 percent of nickel is used in manufacture of stainless steel and 20 per cent in other steel and non-ferrous including ''super'' alloys, often for highly specialized industrial, aerospace and military applications.

Nickel market in India is of total import dependent India imports around 30,000 tons of Nickel. With growth in the stainless steel sector nickel import demand is expected to increase in the coming years. When copper is alloyed with nickel and zinc, "german silver" is obtained.

The following occurrences may be noted:

Bihar : Lately nickel ore has been found in a small but significant proportion associated with uranium ore in Singhbhum, Bihar. If this association proves to be constant and of uniform distribution, nickel mining would be commercially remunerable. Small scale nickel mining can then be carried out along with the mining of uranium ore, at present being developed at five or six locations by the Department of Atomic Energy.

Rajasthan: A sulphide of cobalt and nickel is found in the famous copper mines of Khetri-Jaipur region; but the quantity available is insignificant.

Jammu and Kashmir, Kerala and Orrisa are other main states which produces nickel in very little quantity.

Tungsten

Tungsten possesses several valuable properties which give to its great industrial and strategic defence utility. Among these the most important is the property of "Self – hardening" which it imparts to steel when added to the latter. Over 95% of the tungsten is absorbed by the steel industry. All high speed steel cutting tools have to contain a certain proportion of tungsten. Tungsten steel is largely used in the manufacture of munitions, armour plates, heavy guns, etc., and enables them to stand the heavy charge of modern explosives. In World War II Indian ordanance factories produced some tungsten steel along with other alloys for munitions use. Tungsten, by repeated heating, acquires the property of great ductility. Hence, wires of extreme fineness and great strength suitable of electric lamps, the fine glowing wires of filament not melting even at white heat within the electric bulbs are a familiar sight. Tungsten compounds are also used in textiles, ceramics, paints and emulsion. The only Indian occurrence of tungsten, the chief ore, is near Degana in Jodhpur district of Rajasthan. This and some sporadic occurrences of tungsten in Bankura district in West Bengal and Andhra Pradesh.

Pyrite

Pyrite, is a sulphide of iron. It is a mineral of very wide distribution in many formations from the oldest crystalline rocks to the youngest sediments. The economic value of pyrite lies in its being a source of sulphur and not as an ore of iron, because the high proportion of sulphur in it is injurious to iron.

The main occurrences on any considerable scale are those of the pyritous shale deposits lately found in the lower son valley of Amjor; Bihar, Chitaldurg district in Karnataka and the pyritous coal and shale of the Assam coal fields.

Gold

Gold is a precious metal but in India at present the reserves of gold ore are low. Gold mining in India has a long history and official records have confirmed that old gold mines are found which are of 200 years old. Presently , gold is mined Hutti mines in the Raichur district of Karnataka. The other mine is located in Anantpur district of Andhra Pradesh.

Pure Gold has a bright yellow colour and luster traditionally considered attractive which it maintains without oxidizing in air or water.

India is the largest importer and consumer of gold but gold mining remains at very low level. India's domestic gold production was at 3.05 tons during the financial year 2006. The Geological survey of India and the Mineral Exploration Corporation of India are two of the major government agencies that carry out verifications surveys on gold mining in India, In India, identification of gold bearing zones is done by gathering rock chip specimens from favourable places for gold mineralization while planning the geological chart of the region. In case the rocks are not exposed stream sediment sampling method is implemented to spot the gold anomalous areas. Geographical methods can also be arranged to situate any conductive bodies below the soil cover. Three dimensions sampling of gold bearing zones is carried out by reverse circulation drilling and diamond core drilling. Based on this three dimension sampling of the gold bearing zone, a global resource of the gold deposit is estimated. The global resource is again worked upon by close spaced diamond core drilling along length and dip of ore, body and sampling to develop the dependability of the global resource approximation.

The Hutti gold mines, which is owned by the government of Karnataka expects its gold production to touch 3.5 tones in three to five years from now, from the current 2.8 tones. Present gold- producing centres of India have observed very old and modern mining activities.

There are three gold fields in the country namely Kolar Gold field; Kolar district, Hutti Gold field in Raichur district (both in Karnataka) and Ramagiri gold field in Anantpur district (Andhra Pradesh)

Karnataka is the largest producer of gold in India. The state has recoverable reserves of 17.5 million tones of gold ore containing 42,023 kg of metal, mainly in Kolar, Dharwad, Hassan and Raichur districts. Some gold reserves are also reported from a number of scattered localities in Gulbarga, Belgaum, Bellary, Mysore, Mandya, Chikmagalur and Shimoga districts. This state used to produce about 88.7 per cent of India's gold.

In 2002-03, Karnataka produced 2705 kg gold worth Rs. 1232.3 million. Although every district of Karnataka has some reserves of gold, the most important reserves are found in Kolar Gold fields, Kolar district and produces about 57.75 percent of the total production of the state.

The deposit in Kolar gold field occur in a 80km long (north-south) and 3-4 km wide belt in which gold bearing quartz veins are confined to 6-7km section near Marikuppam. The first mining operation in the Kolar Gold Fields started in 1871 and the area still continues to be the largest supplier of gold in India.

About 3,539 thousand tones of gold ore having 17738kg of gold content have been proved during the recent surveys conducted by the Geological Survey of India for locating new lodes. The main gold mine at Kolar is one of the deepest mines of the world and the production from this mine is decreasing day by day due to heavy cost of extraction.

Moreover, most of the gold has already been taken out and very little gold in left in the mine. Now gold is available at depth of more than 3000 metres and it is not economically viable to extract gold at this depth.

Next to Kolar, but for below in production are the Hutti mines in Raichur district. In the Hutti gold field the gold mining belt is 3.7km long and 1220m wide with six auriferous quartz reefs. It produces 593.3kg gold in 1915, but the production fell and the mine had to be closed down in 1920.

The main problem with the Hutti mines is the low grade of ore. The mine reopened in 1948 and has been operating irregularly since then. The in situ gold reserves of gold fields of Raichur district are estimated at 4.5 million tones with a total gold content of about 45,000kg.

Some gold is found in the Gadag field in Dharwad district. New field have been discovered in Ballara (Tumkur district) Kempinkole (Hassan district), Honnoli (Shimoga district), Siddarhalli (Chikmagalur district) and Munghur (Gulbarga district) areas.

Though lagging far behind Karnataka, Andhra Pradesh is the second largest producer of gold in India. On the basis of the detailed mapping done by the Geological Survey of India in recent years, a total of 7.06 million tones of ore and 37,025kg of gold metal have been assessed in the state.

The main deposits are found in Ramagiri in Anantpur district. However, this field is almost exhausted. The other areas of gold deposits are Bisanattam and Palachchur in Chittoor district and Jannagiri in Kumool district.

Aluvial Gold

Apart from the gold mines in the above mentioned areas, some gold in collected from the sands and gravels of several rivers. Gold is often liberated for the rocks by weathering and its particles get concentrated at certain places in the rivers. Such deposits are called placer deposits from which gold is recovered by panning. Although very small in quantity, this type of gold is widely spread in a large number of rivers.

Jharkhand

Apart, from the above mentioned two states, Jharkhand is an important producer of gold in India. This state produces 344kg of gold in 2002-03 which accounted for over 11percent of the total gold production of India. Jharkhand has both alluvial and native gold.

Alluvial gold is obtained from the sands of the Subarnarekha (gold streak) river, as its name suggests Sona nadi in Singhbhum district and the streams draining the Sonapat Valley. Native gold is found near Lowa in Singhbhum district and in some other part of Chhota Nagpur plateau.

Kerala

The river terraces along the Punna Puzha and the Chabiyar Puzha have tracts of gold.

Alluvial gold is found in the Ambankadawa Puzha, Chabiyar Puzha and in the rivers near Mannarkkat.

Small quantities of gold are collected from rivers in Shimla and Bilaspur in Himachal Pradesh, Kargil area along the terraces of the Indus River in Jammu and Kashmir, Balaghat and Seoni districts in Madhya Pradesh, Bastar, Raipur and Raigarh in Chhattisgarh and parts of Purulia district of West Bengal.

Silver

The principal ore minerals of silver are argentite, prostate, pyrargyrite, polybasite and cerargyrite. Silver is mainly used for making ornaments, table wares, vases and other articles of decoration.

It is alloyed with copper to make coins. Like gold it can be drawn into very fine and can be used in costly fabric and in jewellery. Silver leaves are used in high class confectionary, medicines and also as tonics. Silver is also employed in electro plating and its salts are used in photography.

Silver is a mineral of primary origin occurring in acid igneous rocks. It is found as nuggets in detritus desist, derived by the denudation of igneous rocks. A large part of the silver is derived from the ores lead, zinc and copper from where it is obtained as a by-product.

There have been wide fluctuations in the production of silver in the country. India produced 5,941 kg of silver in 1961 which fell down to 1,220kg in 1966. In 1977 the total production of silver rose to 13,228 kg valued at Rs. 147.68 lakhs which increased to 40,540kg valued at Rs. 2714 lakhs in 1989-90. In 1996-97 the production of silver was 36,689kg valued at Rs. 2802 lakhs; while in 1997-98 production stood at 50,408kg and it is increasing year by year.

Andhra Pradesh is the largest producer (42.43%) of the silver in the country, followed by Bihar – Jharkhand (32.18%), Rajasthan (25.03%) and Karnataka (0.36%). In Andhra Pradesh bulk of the production comes from the lead mines of Cuddapah, Guntur, Kurnool and Vishakhapattanam districts.

Bihar is the second largest producer of silver (32.18%) in the country. Here silver is obtained from lead and copper mines of Singhbhum , Dhanbad, Santhal Pargana (Jharkhand) and Bhagalpur (Bihar) districts.

Rajasthan contributes 25.03 percent of the total production of silver in the country. Here silver is obtained as a by-product from the smelting of Galena ore in Hindustan Zinc Smelter. The silver content in the zinc and lead concentrates at Zawar varies from 171.4 to 774.5gm/ton. The Tundoo lead smelter has an installed capacity of about 4,500kg of silver production per year.

The gold deposits in Kolar and Hutti gold fields produce a small quantity of silver (about 1gm/tone) as by – product in the gold refining processes.

The lead ores of Baroda (Gujarat), Baramula (Jammu & Kashmir), Bellary (Karnataka) and Almora (Uttarakhand) contain some amount of silver. But the low content of silver has prevented their exploitation for economics use.

Export: India exports some silver to Dubai, U.K., U.S.A., Belgium and Germany. In 1976 India exported about, 1270 kg of silver valued at Rs. 16 lakhs.

7.3.2 Non-Meatalic Minerals (Mics, Limestone ….)

Non – metallic minerals are that have no metallic luster and break easily. These are also called industrial materials and are typically some form of sediment. Sand, limestone, marble, day and salt are all examples of non-metallic minerals. They are not recyclable because they cannot be reshaped significant and repurposed, unlike metals that can be melted down and easily reshaped into a new product.

These are called industrial minerals because they are used in the creation of many different products. For example, glass is made from sand, silica and limestone. Each type of mineral has a use for industrial means, such as abrasion, fire resistance and absorbency that makes it necessary in industry.

Mica

India has large reserve of mica. India produces good quality mica. Mica looks like a sheet of glass and are a non-metal. It is a non-conductor of electricity and can tolerate extreme heat.

Mica is used exclusively in the electrical industry. A mica sheet of 1mm thickness remains unchanged even when 1000 to 1500 Volts of electricity is passed through it. It can tolerate nearly 1000° temperature.

Compared to muscovite, phlogopite can tolerate more heat. Muscovite is found in sheets which can be separated till even 0.006mm thickness. So, it is used in radio receivers, hazaks or large lanterns, audio systems or gramophone, television, decoration, paints etc.

Mica is found in mines in sheets at various depth. Mainly two types of mica are found.

1. White mica or muscovite,
2. Phlogopite or low quality mica.

India mostly produces muscovite. Others varieties of mica are biotite, paragonite, and lepidolite.

The mica belt of India is situated along the northern fringe of the Bihar Plateau and comprises parts of Gaya and Hazaribagh districts. It occurs in the venis of the metamorphic rocks particularly mica schists which form a narrow strip of land about 130km long and 18 km broad. This mica belt runs in the east-west direction. Kodarma, Giridih and Domchanch are the chief collecting centres where it is processed generally by women who by virtue of a long experience have now attained a skill unsurpassed by the workers of any other country in the world in splitting mica. This mica belt produces more than half of the total mica produced in India.

India produces the largest amount of mica in the world and controls nearly 60% of the international trade in mica. But, it is not known yet about the estimated deposits in India. This is because the presence of mica in nature does not follow any known rules. In identifying mica producing areas the role of an experienced mica mine laborer is more important than an investigating geologist.

Mica is mainly found in pegmatite rocks, which is irregularly distributed. Again, pegmatite itself does not always have the same amount of mica. Mica mines are found usually by following the veins of the pegmatite rocks from the earth's surface into the earth's interior.

Distribution in India

1. **Jharkhand:** This state ranks first in mica production. Jharkhand producing 60% of the total production in India. Main producing area of mica are – Kodarma area of Hazaribagh district, Munger and Gaya districts.
2. **Andhra Pradesh –** Andhra Pradesh ranks second in mica production. The major mica producing districts are Guntur, Kabhali in Nellore district.
3. **Rajasthan –** This state ranks third in mica producing Jaipur and Ajmer areas are the major areas.

Other areas of mica production in India are Kerala, Tamilnadu, Madhya Pradesh, Bihar etc.

A small quantity of mica is now used in the country for the manufacture of mica powder mica bricks and micanite. Mica powder is used in the manufacture of paint and rubber goods. Mica bricks are used as an insulating material in steel and thermal power plants and petroleum refineries.

Micanite made by joining mica splitting with insulating cements is used in the manufacture of electrical equipments.

The amount of mica produced in India exceeds demand so large amounts of exports take place to USA, Great Britain, Germany and Japan etc.

Limestone

Limestone is an aggregate of calcium carbonate, carbonate of calcium and magnesium or a mixture of the two limestones also contains small quantities of silica, alumina, iron oxides, phosphorus and sulphur limestone deposits are of sedimentary origin.

Limestone is required in various industries namely chemicals (for soda ash, caustic soda, bleaching power etc.), paper, cement, iron and steel, glass and fertilizers. Limestone occurs in almost all the states in India.

Limestone deposits are of sedimentary origin and occur in almost all geological formations of the country except Gondwanas.

Limestone is mainly consumed in cement industry (76%), iron and steel industry (16%), chemicals (4%), sugar, paper, fertilizer and ferro-manganese industries (4%).

The total recoverable reserves of limestone of all categories and grades are placed at 75,679 million tones. The total conditional reserves have been estimated at 701 million tones.

The production of limestone increased to 144.55 million tones in 2002-03 from 2.96 million tones in 1951 exhibiting a forty-nine times growth during the last 52 years. The value of production has increased more than 1488 time during 1951 and 2002-03 (from 10.25 million Rs. To 15,249.4 million Rs.)

Distribution in India

Almost all the states in India produce some quantities of limestone, but about 75% of the total production comes from Madhya Pradesh, Chhattisgarh, Andhra Pradesh, Rajasthan, Gujarat and Karnataka.

1. **Madhya Pradesh – Chhatisgarh:** These two states produce about 27% of the total limestone production in India. The extensive deposits occur in Jabalpur, Bilaspur, Damoh, Rewa and Satna districts. The other producing districts are Bastar, Betul, Rajgarh, Durg.
2. **Andhra Pradesh:** It produces about 16% of the total limestone production in India. It is the second largest producer and the main, producing districts are Cuddappah, Vishakhapatnam, Kurnool, Guntur, Karimnagar, Nalgonda, Adilabad, Warangal and Mahbubnagar.
3. **Rajasthan:** Rajasthan, the third largest producer (14%) has limited reserves of limestone. Here the cement grade limestone is obtained from Ajmer, Banswara, Dungarpur, Jodhpur, Kota, Tonk, Alwar, Sirohi, Bundi, Sawai Madhopur, Nagaur, Udaipur and Pali districts.
4. **Gujarat:** In Gujarat, good quality of limestone is produced in Banaskantha district. The other limestone producing districts are Amreli, Kachchh, Junagarh, Surat, Kheda, Panch Mahal and Subarkantha districts. The state produces about 10% of total production.
5. **Karnataka:** The cement grade limestone is mainly produced in Bijapur, Belagaum, Shimoga, Chittradurga, Tumkur, Mysore and Gulbarga districts. Karnataka Produces about 8% of the total production in India.

Other limestone producing states are Tamilnadu (Ramanathapuram, Tirunelveli, Tiruchirappalli, Salem, Coimbatore, Madurai and Thanjavur districts); Maharashtra (Yavatmal, Chandrapur, Nanded and Ahmednagar districts); Himachal Pradesh (Bilaspur, Kangra and Chamba districts); Orissa (Sundargarh, Sambhalpur and Kalahandi districts); Haryana, Assam, Meghalaya Uttar Pradesh and Jammu & Kashmir.

Dolomite

When limestone contains over 45% of magnesium (MgCo) it is called dolomite. Economic use of dolomite are mainly metallurgical, as refractoriness (in Iron, lead and Copper smelting furnaces), as blast furnace flux, as a source of Co_2 gas and magnesium salt, as line-mortars and other minor uses.

Dolomite occurrences are widespread in almost all parts of the country. The total recoverable reserves of all grades of dolomite are 4,387 million tones.

About 92% of the reserves of dolomite are distributed in 7 states of Madhya Pradesh Chhattisgarh, Orissa, Gujarat, Karnataka, West Bengal, Uttarakhand and Maharashtra. The production of dolomite has witnessed 238 times increase between 1951 and 548 times 2002-03. The production was only 14,000 tones in 1951 which increased to 33.29 lakh tones in 2002-03. The value of production has recorded still faster increase of 12, 247 times during this period.

Distribution in India

Orissa is the largest producer of dolomite contributing 28.81% of the national production. Here, important deposite of dolomite occur in Sundargarh, Sambalpur and Koraput districts. Birmitrapur (reserves 256 m. tones), Hathibari, Khatepur, Bildih (in Sundargarh district) and Sulai (Sambalpur district; reserves 5m. tones) are the important producers. The production from Birmitrapur area is sent to the steel plants at Rourkela, Jamshedpur and Burnpur.

Chattisgarh (including Madhya Pradesh) is the second largest producer of dolomite supplying 30.85% of the national output. Here, bulk of the supply comes from Kodwa-Mohbatta (Durg district), Chatane, Hirri, Dhurarbatta, Atta and Baraduar (Bilaspur district). The mineral is supplied to the Bhilai steel plant.

In Jharkhand dolomite occurs in Singhbhum (North of Chaibasa). Shahbad (Near Bangari), Palamau and Daltonganj districts. Jharkhand contributes 7.75% of the total dolomite production of the country.

Other important areas of dolomite production in the country include Vadodara and Bhavnagar districts in Gujarat; Jalpaiguri district in West Bengal; Salem and Tirunelveli districts in Tamilnadu and the Krol hill area of Himachal Pradesh.

Most of the dolomite produced in the country is utilized in steel plants. The production from Gujarat is steel plants. The production from Gujarat is pulverized into chips, while from Uttarakhand (Dehradun) is consumed in Naya Nangal fertilizer plant.

Magnesite

Magnesite is the carbonate of magnesium (MgCo3). The primary use of raw magnesite is in the colcination industry where it is calcined to form caustic magnesia (low calcined magnesite), dead burnt magnesite of fused magnesia. About 98% of raw magnesite is consumed in calcination industry. The other industries where raw magnesite is used are mosaic tiles, electrodes, chemicals and manufacture of magnesium metal. The dead burnt magnesite and fused magnesia are used in refractory industry to manufacture various refractory products. The caustic magnesia or low calcined magnesite is used as animal feed stuff and in the manufacture of exichloride cement etc.

The refractory industry is the most important consumer of magnesite. In India, about 98% of the total consumption is accounted for by the refractory industry. It is used as a refractory material in steel industry, in making bricks arid liquid carbondioxide.

Magnesite ($MgCo_3$) is a mineral associated with ultra- basic igneous rocks or dolomitic limestones. The mineral formed from igneous rocks is amorphous in nature where as that originating from dolomite is crystalline.

India produced 1.19 lakh tones of magnesite valued at Rs. 1.86 millions in 1951. There was gradual increase in the production which reached its peak of 5.4 lakh tones valued at Rs. 355.99 millions in 1992-93. The production dropped down to 3.34 lakh tones in 1994-95, but had witnessed some recovery in recent years (production in 1996-97 being 3.77 lakh tones)

Distribution in India

Chennai is the largest producer of magnesite contributing 74.1 percent of the country's production. Next in order comes Uttarakhand (19.49%) followed by Karnataka (6.30%) and Rajasthan (0.10%).

In Tamilnadu the chalk hills in Salem district produces the largest quantity of magnesite in the country. Here deposits are spread over an area of 18.13Km2 with estimated reserves at 82.5 million tones (mineral content 46-48%). These deposits are being worked out by Burn and company, Salem magnesite Ltd., Dalmia Magnesite Ltd. and TISCO.

In Karnataka, Dodkanya and Dokatur areas in Mysore district are very important. Less important deposits occur near Sinduvalli, Solepur, Navinapalli, Burmpur, Kupya and Kollegal. Inferior quality of mineral occurs near Holenarsipur, Summahat, Hosur, Dodkadnur, Kabbur, Idegondanchalli and Haradnur, in Hassan district. Small deposits have also been discovered in Coorg and Billary districts.

Gypsum

Gypsum ranks next to coal and iron as a mineral of great importance in the industrial economy of the country. Before the Second World War, it was used mostly as a raw material in the production of cement and Plaster of Paris. It has now gained in importance as a raw material in the manufacture of ammonium sulphate, an important fertilizer. It can be used as source of sulphuric acid. With the setting up of a fertilizer factory at Sindri, increasing attention is being paid to deposits available in India.

Gypsum is a hydrated sulphate of calcium. As a colourless or white opaque mineral in the form of massive lumps or transparent plates, gypsum occurs abundantly in nature in sedimentary formations. In some cases it occurs as transparent crystals (selenite) associated with days. Its large bedded masses or aggregates occur in association with rocks of various geological formations. Gypsum, being a naturally occurring sulphate of calcium finds its most popular use in making ammonium sulphate. It is also used as a surface dressing for land with considerable benefit to certain crops. The handsome, Massive, granular variety of gypsum, known as alabaster is used in Europe for statuary, while the silky fibrous variety, known as satin spar, is used as a medium for small ornamental articles. State wise distribution of gypsum is as follows:-

Gypsum deposits are known to exist in several parts of India. The more well known gypsum bearing regions are in Rajasthan and in South India, but smaller deposits occur also in

Tehri Garhwal, Himachal Pradesh and parts of western India. The latter have not been fully explored yet.

With few exceptions, gypsum in India occurs mostly in thin beds, veins lenses and as isolated clusters of crystals in various formations. Anhydrite, a common associate of gypsum has not been noticed in the known gypsum deposits in India.

1. **Rajasthan:** The most important deposits are in the Jodhpur, Bikaner and Jaisalmer divisions of the state. They vary in thickness from a few inches to 10 feet and over.
2. **Tamilnadu**: Gypsum in thin veins varying in thickness from a fraction of an inch to 6 or 7 inches and associated with clays occurs in the Tiruchirapalli district. The reserves of gypsum in the gypsum-bearing clays in this area have been estimated at 15.3 million tones to a depth of 50 feet but he working of this gypsum is likely to be attended by a large percentage of loss. Thin beds of gypsum also occur in recent marine silts within a depth of 3 or 4 feet in an area of over 100sq. miles near Sulurpet, Nellor district.
3. **Gujarat** : Gypsum in veins and thin beds and as crystals distributed in sedimentary strata is also found in Saurashtra and Kutch in Gujarat. The reserves are estimated at 6.4 million tones.
4. **Northern India** : Small deposits of gypsum as pockets and thin beds are also known to occur in the Dehradun, Nainital and Tehri Garhal districts of Uttarakhand. The reserves are estimated at about 200,000 tonnes. Among the other deposits are those in the Sirmor district of Himanchal Pradesh, which are estimated to contain about 1 million tones and small deposits in Kashmir Valley and Rewa district in Madhya Pradesh.

7.3.3 Energy Resources (Coal, Petroleum, Natural Gas …..)

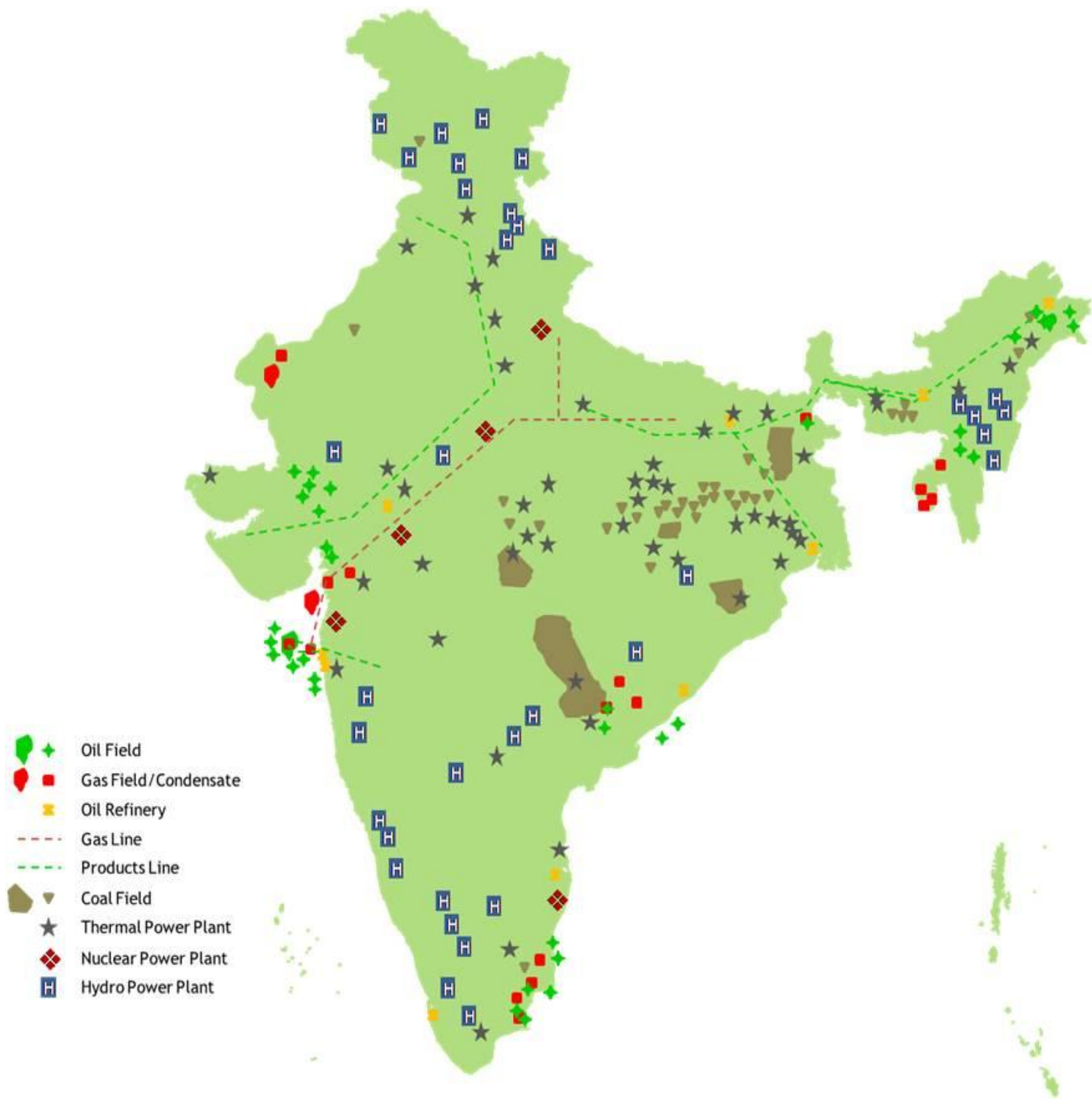
Energy is a fundamental component to our daily lives and every day we use energy or power in some form or another. The law of conservation of energy states that energy can neither be created nor destroyed. What this means is that as energy is used, it does not disappear, but rather, is converted into another form of energy. For example automobiles use energy from gas that is converted into chemical energy. Thus, energy is all about performing work. Animals and humans require energy resources in order to function and machines do not function any differently, they require energy resources to work as well.

There are many different energy resources on the earth, but they are all classified into two primary groups – renewable energy resources and non-renewable energy resources. Some energy resources generate additional energy, which is then converted into electrical energy. Examples of these types of energy include geothermal energy and hydro electric energy.

Renewable energy resources are energy resources that are directly available, immediately accessed and can be consistently replaced. In other words, renewable energy resources are energy resources that replace or renew themselves and that will never run out. Solar energy, energy that is harmessed form the sun, is a good example of one of many renewable energy resources, because we will never run out of the sun's rays or its power. Other examples of renewable energy sources include wind energy, water energy and wave energy.

Non Renewable energy resources on the other hand are just the opposite. These energy resources are as the name implies, non – renewable. Our earth is fixed with a finite amount of these energy resources, and once we run out, we will not be able to use those energy resources ever again. Fossil fuels, coal, oil and gas are all examples of non renewable energy resources.

Map-7.2 Energy Resources of India



Source: Google

Coal

Coal is a conventional source of energy. It is an inflammable organic substance composed of hydrocarbons found in sedimentary rocks.

Coal is the main source of power generation in India. Most of the industries for e.g. iron and steel and variety of chemical industries depend upon the availability of coal for their intake of power.

Depending upon the percentage of carbon present, four varieties of coal are available.

(i) Anthracite:

a) It is the best quality of coal and contains over 80% carbon.
b) It is hard, compact and black in colour. It is found only in Jammu and Kashmir in small quantity.

(ii) Bituminous coal:

(a) It is the most widely used variety of coal and contains about 60-80% carbon.
(b) Its calorific value is very high due to high proportion of carbon and low moisture content.
(c) It is mainly used for heating, steam raising and production on coke.
(d) It is mostly found in Jharakhand, Orissa, west Bengal, Chhattisgarh and Madhya Pradesh.

(iii) Lignite:

(a) It is also called brown coal. It is of inferior quality. It is friable in nature.
(b) It contains more of moisture and less of moisture and less of combustible matter.
(c) It is found in Palna of Rajasthan, Nayveli in Tamil Nadu, Lakhimpur in Assam and Karewa in Jammu & Kashmir.

(iv) Peat:

(a) It is the first stage of transformation of wood to coal.
(b) It contains about 50-60% carbon.
(c) It emits more smoke and leaves lot of ash after burning.

In India, Jharakhand, Orissa, west Bengal and Madhya Pradesh account for nearly 90% of coal reserves.

Coal is used in generation of power. It is used in the generation of electric power for mineral based industries like iron and steel and cement industries. The demand of coal for railways has been reduced due to electrification of rail ways.

Coal mining is hazardous. It can be dangerous due to occurrence of poisonous gases in the mines.

Indian coal is mostly associated with Gondwana series of rocks and is primarily found in Peninsular India.

About 2% Indian coal is of tertiary type and is found in Assam and Jammu & Kashmir.

Distribution of Coal in India

Majority of the coal producing states are found in the eastern part of India comprising part of Jharkhand, Orissa, Chhattisgarh and West Bengal. Jharkhand is the largest coal producing state in the country followed by Orissa, Chhattisgarh, West Bengal, Madhya Pradesh, Andhra Pradesh and Maharashtra.

1. **Jharkhand :** In Jharkhand 38% of the total reserves of India are found in this state. Darla is the most important and most productive coal field in India. The field accounts for 100% of the country's prime coking coal production. Other significant coal producing regions of this state are Bokaro, North Karanpura, South Karanpura, Giridih, Ramgarh, Daltongunj and Rajmahal.
2. **Orissa (Odisha):** Orissa account for around 13.4% of the country's total production. Talcher and Ranapur, Himgir are the two important coal fields. Talcher accounts for nearly 3/4th of the total coal reserve of the state.
3. **Chhattisgarh and Madhya Pradesh:** Major coal fields are Korba, Umaria, Singrauli, Chirmiri and Sohagpur. Other coal fields include Pench Kanhan, Mohpani, Sonhat, Jhilimili, Bisrampur, Raigarh and Tatapani- Ramkola.
4. **Andhra Pradesh:** The Major coal producing districts are Adilabad, Karimnagar, Warangal, Khammam, East Godavari and West Godavari. Major Coal fields are Tandur, Singareni, Kothagudem and Ramagundam.
5. **Maharashtra**: the major coal fields are found in Nagpur – Wardha region. The important mining areas are – wardha, Ballarpur, Chanda and Kampati.
6. **West Bengal :** Raniganj is the largest coal field of West Bengal and the second biggest in India in terms of total reserve. The coal fields of Asansol are also famous. Recently a large coal field has been discovered in Mejia in the Bankura district.

Tertiary coalfields

Assam accounts for 63% of the total tertiary coal reserves. Major coal fields in Assam are the Makum, Nazira, Mikir Hills and Dilli Jeypore. Of these, the Makum is the most developed field. Among the other fields West Darrangiri, Langrin and Bapung in Meghalaya, Namchik in Arunanchal Pradesh and Borjan in Nagaland are important.

Lignite coalfields

Lignite coal is mainly produced in two states – Tamil Nadu and Gujarat small lignite coal fields are also found in Rajasthan and Jammu and Kashmir. Neyveli is the lignite field in Tamil Nadu which is located in South Arcol district. Neyveli is the largest lignite coal mine of India. This field supplies fuel for thermal power generation in Tamil Nadu.

Petroleum

The word ‘petroleum’ has been derived for two Latin words Petra (meaning rock) and Oleum (meaning oil). Thus petroleum is oil obtained from rocks; particularly sedimentary rocks of the earth. Therefore, it is also called mineral oil.

Petroleum is an inflammable liquid that is composed of hydrocarbons which constitute 90-95 percent of petroleum and the remaining is chiefly organic compounds containing oxygen, nitrogen, sulphur and traces of organ metallic compounds.

Petroleum and petroleum products are mainly used as motive power. It is a compact and convenient liquid fuel which has revolutionized transportation on land, in the air and on water. It can be easily transported from the producing areas to the consuming areas with the help of tankers and more conveniently, efficiently and economically by pipelines.

It emits very little smoke and leaves no ash (as is the case in coal utilization) and can be used upto the last drop. It provides the most important lubricating agents and is used as an important raw material for various petro-chemical products.

Petroleum has an organic origin and is found in sedimentary basins, shallow depressions and in the seas (past and present). Most of the oil reserves in India are associated with anticlines and fault traps in the sedimentary rock formations of tertiary times, about 3 million years ago.

Petroleum, coal and natural gas originated from animal or vegetable matter contained in shallow marine sediments, such as sands, silts and clays deposited during the periods when land and aquatic life was abundant in various forms, especially the minor microscopic forms, of flora and fauna conditions for oil formation were favorable especially in the lower and middle Tertiary period. Dense forests and sea organisms flourished in the gulf, estuaries, deltas and the land surrounding them during Tertiary period. The decomposition of organic matter in the sedimentary rocks has led to the formation of oil. Though oil is mainly found in sedimentary rocks but one more important thing is that the all sedimentary rocks do not contain petroleum.

As we know oil as well as natural gas in India occur in sedimentary rocks. About 14.1 lakh sqkm or about 42% of the total area of the country is covered with sedimentary rocks out of which about 10 lakh sqkm from marine basins of Mesozoic and Tertiary times.

Besides, the country has offshore areas having Mesozoic and Tertiary rocks of marine origin covering an area of 2.5 lakh sqkm upto a depth between 100 and 200 metre. Thus the total continental shelf of probable oil bearing rocks amounts to 3.2 lakh sq.km.

The total sedimentary area including both on shore and off shore comprises 27 basins. The geological and geophysical studies have been conducted in 14 basins while exploratory drilling has been done in 9 basins. Mumbai high, the Khambhat gulf and the Assam are the most productive areas.

Petroleum producing regions in India

The major oilfields of India are as under –

1. **The Western Coast offshore Oil fields**
   (i) **The Mumbai high oilfields –** this is the largest petroleum production oilfield contributing over 65% of the total production of crude oil. This oil field lies about 176 km to the south-west to Mumbai. It has about 35 million tones of crude oil and about 40,000 million cubic metres of natural gas. Production of oil from this field was started in 1976. Owing to over exploitation the production of this oil field is declining fast.
   (ii) **Basein oilfield –** This oil field lies to the south of Mumbai high. Here oil occurs at a depth of over 1900 metres. It has rich deposits of oil and natural gas.
   (iii) **Aliabet oil field –** The Aliabet oilfield is located about 45km to the south of Bhavnagar.
2. **The Gujarat Coast –** This is the second largest oil producing area of the country. Its main oil fields are in Ankleshwar, Combay-Luni area and Ahmadabad-Kolal region.
   (i) **Ankleshwar :** This region is situated in the district of Bharauch, it stretches over an area of about 30sqkm. The oil of this region belongs to the Eocene period. Oil production in this region was started in 1961. Ankleshwar oil is rich in gasoline and Kerosene. The crude oil from this region is sent to the Koyali petroleum refinery.
   (ii) **Cambay- Luni Region –** This oilfield lies about 60km to the west of Vadodara. The drilling operations in this region were started in 1958. The estimated

reserves of crude oil are over 30 million tones. The oil of this region is very light with a sulphur content of less than 0.1 percent.

(iii) **The Ahmadabad- Kalol Region** : This crude oil region lies to the north of gulf of Khambat (Cambay) around the city of Ahmadabad and extends up to Mehsana. Kalol, situated about 25km to the north of Ahmadabad is an important oil field of the region. Oil production from this region was started in 1961. Crude oil from this region is supplied mainly to the Koyali refinery.

3. **The Eastern Coast –** This oil fields petroleum and natural gas have been discovered in marine delta regions of Mahanadi, Godavari, Krishna, Kaveri rivers. The Rawa field in the Godavari-Krishna offshore is expected to produce about 3 million tons of crude oil annually. Petroleum has also been discovered in the Bilaspur tehsil of Rampur district of Uttar Pradesh, Jawalamukhi area of Punjab and in the Barmer district of Rajasthan. There are strong possibilities of petroleum and natural gas deposits to be found on the offshore of Andaman and Nikobar, Gulf of Mannar, Baleshwar coast, Punjab, Haryana and Uttar Pradesh.
4. **The Brahmaputra Valley –** Crude oil/petroleum was first discovered in the Brahmputra valley. The oil bearing rocks spread from the Dehang Basin upto the Surma Valley. The main oil producing wells, however, lie in the Dibrugarh and Sibsagar districts of upper Assam. Some of the important oil producing centres of this region are given below.

(i) **The Digboi oilfield:** Streching over an area of about 15 Sqkm, the Digboi oilfield is one of the oldest oilfields of the country. The oil of this region belongs to the Eocene and Miocene periods. There are 85 oil wells in this region. Most of the oil is sent to the refinery of Digboi. Since 1959, the Digboi oilfields are worked by the oil India Limited (Oil).

(ii) **The Naharkatiya Oilfield:** This oil field lies about 35km to the south-west of Digboi. Oil production from the Naharkatiya oilfields was started in 1954. Crude oil fro this region is supplied to the refineries of Noonamati, New Bongaigaon (Assam) and Barauni (Bihar)

Table 7.1: Oil Refineries in India (year 2010-2011)	
1. Barauni Refinery. 2. Bongaigaon Refinery 3. Chennai Petroleum Corporation Ltd. 4. Digboi Refinery-oldest refinery	9. Haldia Refinery 10. Jamnagar Refinery- Biggest Refinery 11. Kochi Refinery

5. Essar Refinery 6. Gujarat Refinery 7. Guru Gobind Singh Refinery 8. Guwahati Refinery	12. Mangalore Refinery and Petro chemicals Ltd. (MRPL) (PSU) Public Sector Under Taking. 13. Mathura Refinery 14. Mumbai Refinery 15. Panipat Refinery 16. Visakhapatnam Refinery

Table : 7.2: Production of Crude oil and Natural Gas (Year 2010-2011)

Item	2007-08	2008-09	2009-10
1	2	3	4
1. Crude Oil production ++ ('000' Tonnes)			
a) On Shore:			
Gujarat	6177	5944	5961
Assam/Nagaland	4357	4673.4	4740
Arunanchal Pradesh	102	102.4	131
Tamil Nadu	298/	265	238
Andhra Pradesh @	279	289	304
Rajasthan	-	-	447
Total (a)	11213	11274	11821
Of which AOC OIL ONGC JVC/Private	3100 7921 192	3468 7568 243	3572 7515 734
(b) Off Shore"			
ONGC (Mumbai High)	18020	17801	17341
JVC/Private (Joint Venture Company of Assam oil India Ltd.	4885	4431	4529
Total (B)	22905	22232	21870
Grand Total (a+b)	34118	33506	33691

Source: ONGC, OIL and DGH

Natural Gas

Natural Gas (chiefly gas with some other gaseous hydro-carbons) usually accompanies the petroleum accumulations. It is naturally occurring hydro carbon gas mixture consisting primarily of methane, but commonly including varying amounts of other higher alkanes and sometimes a small percentage of carbon dioxide, nitrogen and or hydrogen sulfide. It is formed when layers of decomposing plant and animal matter are exposed to intense heat and pressure over thousands of years. The energy that the plants originally obtained from the sun in stored in the form of chemical bonds in the gas.

Natural gas is a fossil fuel used as a source of energy for heating, cooking and electricity generation. It is also used as fuel for vehicles and as a chemical feedstock in the manufacture of plastics and other commercially important organic chemicals. It is a non-renewable resource.

Natural gas may occur in separate sands containing little or no oil, but most of the natural gas of India is found closely associated with the oil, and supplies the pro-pulsive force which carries the oil from the oil sands into the wells and, if the pressure is sufficient, brings the oil up to the surface. Since gas is essential for production of oil and is also valuable as a source of fuel on the oil fields, care is taken to prevent waste of gas which was formerly so common in oil-fields.

India has a very large proportion of tertiary rock and alluvial deposits particularly in the extra peninsular India. These sedimentary rocks, which were once under the shallow seas, hold the possibility of harbouring oil and gas deposits. Hence, this oil and natural gas happens to be one of the main power resources in India.

Distribution of Natural gas in India

In India Natural Gas has been found at a few places in the Godavari – Krishna Delta area. Natural gas has also been struck at some places. Important offshore gas fields are located in Mumbai high, an offshore area about 9kms north-east of Port Blair (Andaman Island) and off Porto Novo (Tamil Nadu coast). In the on shore areas gas has been struck at some places in Gujarat namely Akhaj in Mahesana districts, the Sisodra field near Ankleshwar and Dahej. It has also been found in the Baramura structure, 30km east of Agartala (Tripura). India has also discovered large reserves of natural gas both offshore and on land. During 2002 two large gas fields were discovered. (i) Oil and Natural Gas Corporation (ONGC) discovered large reserves of natural gas in an offshore field situated north of Mumbai High and west of the coast of Daman. (ii) In October 2002, Reliance Industries (RIL) struck very large reserves of natural gas in the Krishna-Godavari offshore Basin, located in the Bay of Bengal. The gas field has been christened “Dhirubhai Gas field”. Natural gas will be brought through pipeline to Kakinada where it will be processed and distributed.

Natural gas has also been struck in the gulf of Khambhat near Surat and in Barmer district of Rajasthan.

In June 2005, Gujarat state petroleum Corporation (GSPC) struck huge reserves of natural gas in Krishna – Godavari Offshore Basin located in the Bay of Bengal.

Compressed Natural Gas (CNG) : It is used for running motor vehicles. It is now preferred to other fuels namely coal and naphtha for generating electricity. It is also used for producing fertilizers and petro chemicals.

Lignified Natural Gas (LNG) : In some countries namely Iran, Qatar, Oman, Abu Dhabi and Yemen, there are huge deposits of natural gas but because of long intervening stretches of seas between the exporting porting and importing countries, transportation of natural gas through pipeline is expensive and even risky when it passes near a hostile country. Therefore, natural gas is first liquified and then the liquified gas is shipped to other countries where it is regasified.

7.4 POWER RESOURCES

Modern world is a world of scientific and technological development in which national economy depends upon the quality and quantity of its industrial production. No nation can reap its fruits of industrialization without being self –sufficient in energy and power resources.

Power or energy resources provide solid base for the industrial growth of a country. Since industries form a very important sector of economy, minerals and power resources contribute a lot towards economic progress.

The resources which are used to give motion to industrial machines and transport vehicles, help in mechanizing agriculture or are used in domestic work are called power resources.

Power resources are the bases for the the industrial and agricultural prosperity of a country. In fact, per capita utilization of energy is an indicator of measuring standard of living in a country. These resources are a measure of strength and advancement of the civilization of a nation. Their abundance and even distribution can ensure high standard of living for a country provided that the people are also intelligent and enterprising.

7.4.1 Hydro-Electricity

Hydro electricity is the term referring to electricity generated by hydro power; the production of electrical power through the use of the gravitational force of falling or flowing water. It is the most widely use form of renewable energy, accounting for 16 percent of global electricity generation – 3,427 tera watt-hours of electricity production in 2010, and is expected to increase about 3.1% each year for the next 25 years.

The cost of hydro electricity is relatively low, making it a competitive source of renewable electricity. It is also a flexible source of electricity since the amount produced by the station can be changed up or down very quickly to adapt to changing energy demands. Once a hydro electric complex is constructed, the project produces no direct waste, and has a considerably lower output level of the green house gas carbon dioxide (Co_2) than fossil fuel powered energy plants.

India was the 6th largest producer of hydro electric power after Norway. It produced 114 TWh and 3.5% the world total in 2008. The potential for Hydro-electric power in India is one of the greatest in the world. The first hydro-electic power station in India was established in Karnataka at "Shivasamudram".

Hydro power is considered as one of the most economic and non-polluting sources of energy. Power generated from water is termed as Hydro electricity. Hydro electricity means electricity generated by hydropower or from the use of the gravitational force of falling and flowing water.

India is fortunate to have a large potential of hydro-electricity. By 1977, India had exploited only about 23.0% of the total hydro electric potential. It means that India can look hopefully towards water as a potential source of power. Hydro power potential is quite evenly distributed in India. Of the total hydro-electric potential of the country, rivers of Assam, Arunachal Pradesh, Manipur, Nagaland and Tripura account for 30.4%, eastward flowing rivers of the peninsular India 20.9% westward flowing rivers of the western Ghats (South of the Tapti) 10.5%, the Ganga Basin (excluding the potential of Nepal) 11.7%, the Indus Basin 16.0% and rivers of central India 10.5%.

It is not necessary that a region with high hydro-electric potential should also lead other regions in the generation of hydro electric power. Many factors influence the selection of the sites for power generation. The principal factors are (i) character of the river valley and the waterfall (ii) volume of water, (iii) distance of the market, (iv) size of the market, and (v) non-availability of other sources of power.

Waterfalls exist mainly in the cardamom hills, the shillong Plateau and the sea-facing margins of the Western and the Eastern Ghats. Some of them have been harnessed for power generation. It may be noted that volume of water in the rivers fluctuates widely due to seasonal character of the rainfall and its pronounced variability.

In India, hydro electricity is developed mainly in the Western Ghats, Kerala, Western Uttar Pradesh, Punjab, Himanchal Pradesh and Uttarakhand because besides having power sites these areas are located far away from the coal mines.

In the Indian plateau, the rivers flow in broad valley plains. As annual rainfall is less than 100cm. Some of the rivers have been harnessed not only for developing electricity but also for providing irrigation. Important hydro-electric power stations other than those mentioned above are Mettur and Mettur Tunnel (2.5%) in Tamil Nadu, Machkund and Sileru (4.6%) in Andhra Pradesh, Hirakud and Balimela (6.6%) in Orissa, Rihand (3.2%) in Uttar Pradesh.

Dense populated Indo-Gangatic plains of Northern India require enormous quantity of electrical power. The plains of both northern Bihar and Eastern Uttar Pradesh cannot derive benefits of a great power potential of the nearby Himalayas because here they are within the territory of Nepal. West of Nepal, the Himalayas have one-fourth of the total hydro-electric potential of the country. At some places power plants have been set up. Electricity generated by these plants is used in western Uttar Pradesh, Punjab and Jammu and Kashmir states. Most important and promissing, however is the Bhakra Nangal Power and Irrigation Project of Punjab. Tehri Dam of Uttarakhand on Bhilangana river plays a very important role in power resource in India.

7.4.2 Wind Power

Wind power or wind energy is extracted from air flow using wind turbines or sails to produce mechanical or electrical energy. Wind mills are used for their mechanical power, wind pumps for water pumping and sails to propel ships. Wind power as an alternative to fossil fuels, is plentiful, renewable, widely distributed, clean, produces no green house gas emissions during operation and uses little land. The net effects on the environment are far less problematic than those of non-renewable power resource.

The development of wind power in India began in the 1986 with first wind farms being set up in coastal areas of Gujarat (Okha), Maharashtra (Ratnagiri) and Tamil Nadu (Tuticorin) with 55 KW Vestas wind turbines. The capacity has significantly increased in the last few years. India has the fourth largest installed wind power capacity in the world.

The potential for wind farms in the country was first assessed by Dr. Jami Hossain using a GIS platform at around 3000GW in 2011. This was subsequently –validated by Lawrence Berkley National Laboratory, US (LBNL) in an independent study in 2012. In the year 2015, the MNRE set the target for wind power generation capacity by the year 2022 at 60,000 MW.

As of 31 October 2015 the installed capacity of wind power in India was 24,677 MW, mainly spread across south, west and north regions.

Distribution of Wind Power in India

There is a growing number of wind power installations in different states of India are following.

Table: 7.3 : Capacity of wind power in India.

State	Capacity (MW), as of 31 March 2015
Tamil Nadu	7455.2
Gujarat	3645.4
Maharashtra	4450.8
Rajasthan	3307.2
Karnataka	2638.4
Andhra Pradesh	1031.4
Madhya Pradesh	879.7
Kerala	35.1
Others	4.3
Total	23447.5

1. **Tamil Nadu :** Tamil Nadu's wind power capacity is around 35% of India's total. The Government of this state realized the importance and need for renewable energy and set up a separate agency, as registered society, called the Tamil Nadu Energy Development Agency (TEDA) as early as 1985. Now, Tamil Nadu has become a leader in wind power in India. In Muppandal wind farm, Tamil Nadu the total capacity is 1500MW, which is the largest in India. As per TEDA, the total installed capacity in Tamil Nadu is 7253MW. During the fiscal year 2014-15, the electricity generation is 9.521 billion Kwh which is nearly 15% capacity utilization factor.

2. **Gujarat:** State Government of this state has a focus on tapping renewable energy has led to sharp rise in the wind power capacity in the last few years. According to statistical data, wind power generations capacity in the state has increased a staggering ten times in just six years.
3. **Maharashra :** This is one of the prominent states considering the installation of wind power projects second to Tamil Nadu in India. As on 30 September 2014, installed capacity of wind power is 4167.26MW. As of now there are 50 developers registered with state nodal agency "Maharashtra Energy Development Agency" for development of wind power projects. All the major manufactures of wind turbines have presence in Maharashtra.

   Madhya Pradesh, Rajasthan, Kerala, Odissa and Jammu & Kashmir are the other promising states in the field of generating wind power in India.

7.4.3 Solar Power

Solar Power is the conversion of sunlight into electricity, either directly using photovoltaics (PV), or indirectly using concentrated solar power (CSP). Concentrated solar power systems use lenses or mirrors and tracking system to focus a large area of sunlight into a small beam. Photovoltaics convert light into an electric current using the photovoltaic effect.

Solar cells directly convert light into electricity. Solar cells are also called "Photovoltaic" or "Photoelectric" cells.

Enough power can be generated to run a 100 Watts light bulb from just one square meter of solar panel. Solar cells were originally developed in order to provide electricity for satellites. Today solar cells are used in everyday applications, such as calculators and outdoor lighting.

The International Energy Agency projected in 2014 that under its "high renewable" scenario, by 2050, solar photovoltaics and concentrated solar power would contribute about 16 and 11 percent, respectively, of the world wide electricity consumption and solar would be the world's largest source of electricity. Most solar installations would be in China and India.

Concern over pollution, environmental degradation and resources depletion have led to an increasing awareness of the importance of developing solar energy.

Advantages

1. Once solar panels are installed, they produce energy without generating waste or pollution. They operate with little maintenance or intervention.
2. Once the initial capital cost of building a solar power plant has been met, operating costs are low when compared to existing power technologies.
3. Solar electric generation is economically competitive where grid connection or fuel transport is difficult, costly or impossible.
4. Solar plants are applicable for low power uses such as solar powered garden lights and battery chargers.
5. A solar panel saves approximately 0.7 pounds of coal per KWH, or 2 pounds of carbon dioxide per KWh.

Over its 35 year expected life, a 10 KW system will provide Co_2 reduction equivalent to planting 1450 trees. In comparison to a coal fired power plant, a 10 kw system will prevent emissions of 960,000 lbs carbon dioxide, 4,200 lbs sulfur dioxide and 1,400 lbs nitrogen oxides. It will produce 575,000kwh of electricity, as much as would be generated by burning 583,000 lbs coal.

Disadvantages

1. Solar power systems do not work at night.
2. Solar cells are currently costly and require a large initial capital investment.
3. The cast effectiveness of a solar energy system is dependent upon the location and climate.
4. For larger applications, many photovoltaic cells are needed, corresponding to high investment costs and large land requirements.

Solar Power in India

With approximately 300 sunny and clear days in a year, India's theoretically calculated solar power incidence on its land area alone, is about 5,000 trillion kilowatt – hours per year. The solar power available in a year exceeds the possible energy output of all fossil fuel energy reserves in India. The daily overage solar power plant generation capacity over India is 0.25 kilowatt – hours per m^2 of used land area, which is equivalent to about 1,500-2000 peak (rated) capacity operating hours in a year with the available commercially – proven technologies.

On May 2011, India's first 5 MW of installed capacity solar power project was registered under the Clean Development Mechanism. The project is in Sivagangai village, savaging district, Tamil Nadu. In January 2015, the Govt. of India significantly expanded its solar plans, targeting 100 billion us dollar of investment and 100 GW of solar capacity by 2022.

Government – funded solar electricity in India was approximately 6.4MW per year as of 2005. India is ranked number one in terms of solar electricity production per watt installed, with an insolation of 1,700 to 1,900 kilo watt- hours per kilo watt peak (KWh/KWp).

Table: 7.4: State wise installed solar power capacity 2015

State	MWp
Andaman &Nikobar	5.10
Andhra Pradesh	279.44
Arunachal Pradesh	0.27
Chandigarh	2.04
Chhattisgarh	73.18
Daman & Diu	2.50
Delhi	6.71
Gujarat	1000.05
Haryana	12.80
Jharkhand	16.00
Karnataka	104.22
Kerala	12.03
Lakshadweep	0.75
Madhya Pradesh	673.58
Maharashtra	378.70
Odisha	56.92
Puduchery	0.03
Punjab	200.32
Rajasthan	1199.70
Tamil Nadu	157.98
Telangana	72.25
Uttar Pradesh	5.00
Uttarakhand	71.26
West Bengal	7.21
Others	0.79
Total	4346.82

Source: Ministry of New and Renewable Energy, Govt. of India, 13 July 2015.

1. **Andhra Pradesh:** This state is the installed capacity is 279 MW as of September 2015. During the year 2014, Andhra Pradesh Tran Co. has entered into agreements with IPPs to install 619MW. NTPC also entered into agreement in the year 2015 with Andhra Pradesh Tran Co. to install 250MW plant in the economically backward Anantpur district.
2. **Gujarat:** Gujarat has been a leader in solar power generation and contributes 2/3rd of the 900MW of photovoltaics in the country. The state of Gujarat has commissioined

Asia's largest solar park at Charanka village. The park is already generating 2MW Solar power out of its total planned capacity of 500MW. The park has been functioning on a multi-developers and multi-beneficiaries paradigm and has been awarded for being the most innovative and environment friendly project by the CII.

With a view to making Gandhinagar a solar power city, the state Govt. has launched a roof top solar power generation scheme. Under this scheme, the state plans to generate 5MW of solar power by putting solar panels on about 50 state government buildings and on 500 private buildings. The state has also a plan to emulate this project in Rajkot, Surat, Bhavnagar and Vododara in 2012-13.

The state plans to generate solar power by putting solar panels on the Narmada canal branches. As a part of this scheme, the state has already commissioned a 1 MW solar plant on a branch of the Narmada canal near Chandrasan are of Anand taluka. This also helps by stopping 90,000 liter water/ year of the Narmada river from evaporating.

3. **Rajasthan :** Rajasthan is one of the most solar power developed state of India. There is a total photovoltaic capacity has passed 500MW having reached 510.25MW by the end of the 2012-13 fiscal year. Jodhpur district leads with 42 projects totalling 293MW, followed by Jaisalmer and Bikaner. A 4000MW Uttra Mega Green Solar Power Project (UMPP) is being built near Sambhar Lake in Rajasthan. After completion, it would be world's largest Solar Power Plant.
4. **Maharashtra:** In this state "The Shri Sai Baba Sansthan Trust has the world's largest solar steam system. It was constructed at the Shridi Shrine. The system is used to cook 50,000 meals per day for pilgrims visiting the shrine, resulting in annual savings of 100,000kg of cooking gas and has been disgned to generate steam for cooking even in the absence of electricity to run the feed water pump for circulating water in the system. Osmanabad region in Maharashtra has been blessed with abundance of sunlight and is ranked the third best region in India in terms of solar insulation. A 10MW solar power plant in Osmanabad, Maharashtra by generates approximately 18 lac units per MW which is the highest generation in Maharashtra by any other solar power plants.
5. **Madhya Pradesh:** The Welspun Solar MP Project, the largest solar power plant in India which is set up on 305 hectares of land with the cost of Rs. 1,100 crore and will supply power at Rs. 8.05KWh. The project of a 130MW solar power plant at Bhagwanpur in Neemuch was launched by the previous Gujarat CM, Narendra Modi. This is the largest solar poroducer and one the top three companies in renewable energy sector in India.

"Ujaas Energy Limited", an Indore based company which is listed on BSE/NSE. It has installed over 105 MWs in five solar parks viz., Rajgarh, Barod, Ichchwar, Rajhani and Susner, in Madhya Pradesh.

In Mdahya Pradesh there is an upcoming 750 MW Solar power plant project in Madhya Pradesh in the district of Rewa which, when completed will be the world's largest solar power plant, backing the Desert Sunlight Project in California (USA).

7.4.4 Nuclear Energy

The energy released during nuclear fission or fusion, especially when used to generate electricity.

Nuclear energy is energy in the nuclear (Core) of an atom. Atoms are tiny particles that make up every object in the universe. There is enormous energy in the bonds that hold atoms together. Nuclear energy can be used to make electricity. But first the energy must be released. It can be released for atoms in two ways: nuclear fussion and nuclear fission. In nuclear fusion, energy is released when atoms are combined or fused together to form a larger atom. This is how the sun produces energy. In nuclear fission, atoms are split apart to form smaller atoms, releasing energy. Nuclear power plants use nuclear fission to produce electricity.

Advantages of Nuclear Energy

1. The generation of electricity through nuclear energy reduces the amount of energy generated from fossil fuels (coal and petroleum). Less use of fossil fuel means lowering green house gas emissions (Co_2 and others)
2. Another advantage is the required amount of fuel: less fuel offers more energy. It represents a significant save on raw materials but also in transport, handling and extraction of nuclear fuel. The cost of nuclear fuel (over all Uranium) is 20% of the cost of energy generated.
3. The production of electric energy is continuous. A nuclear power plant is generating electricity for almost 90% of annual time.
4. It reduces the price volatility of other fuels such as petrol.

Disadvantages of Nuclear Energy –

1. Despite the high level of sophistication of the safety systems of nuclear power plants the human aspect has always an impact. Facing an unexpected event or managing a

nuclear accident we don't have any guarantee that discussions we took are always the best. Two good and major examples are Chernobyl and Fukushima.

2. One of the main disadvantages in the difficulty in the management of nuclear waste. It takes many years to eliminate its radioactivity and risks.
3. The life of Nuclear plants is very limited. In other worlds, the energy generated is cheap compared to the cost of fuel, but the recovery of its construction is much more expensive.
4. Very risky disadvantage of the Nuclear plants they are objectives of terrorist organizations.

Nuclear Energy in India

Except for coal-rich north–eastern plateau of India, all other parts of the country suffer from chronic shortage of power. In order to meet the need of the existing industrial units and to encourage the establishment of more industries in this over populated country, it is being planned to use nuclear power for the generation of electricity.

In India the first nuclear station was constructed at Tarapur (Thane district) started generating electricity in 1969. It has two reactors with a total capacity of 420MWe (Mega Watts electrical). One nuclear power station of 440MWe capacity is located at Rana Pratap Sagar. It was established during 1972. A third nuclear power station of 235 MWe capacity has been constructed at Kalpakkam about 60km. south of Chennai. The fourth nuclear power station is located at Narora on the Ganga in Bulandsahar district of western Uttar Pradesh. This power station has two power units. Each of these two units has a capacity of 235MWe. The fifth atomic power station is located at Kakrapar 80km. away from Surat. An atomic power plant has been set-up at Kaiga about 60km. east of Karwar in north western Karnataka.

Nuclear energy is the fourth largest source of electricity in India after thermal, hydroelectric and renewable sources of electricity. As of 2013, India has 21 nuclear reactors in operation in 7 nuclear power plants, having an installed capacity of 5780 MW and producing a total of 30,292.91 GWh of electricity while 6 more reactors are under construction and are expected to generate an additional 4,300MW.

India's domestic Uranium reserves are small and the country is dependent on Uranium imports to fuel its nuclear power industry. Since early 1990s Russia has been a major supplier of nuclear fuel to India.

Uranium, the only atomic fuel used for the generation of nuclear power at present is available in India but deposits of pitch blende (the principal source of uranium) are poorer than those of monazite (the chief source of Thorium). India is fortunate to possess rich deposits of atomic minerals containing Thorium, but natural thorium is not a fissile metal. It is first converted into Uranium ^{233} which being a fissile material can be used as a nuclear fuel.

Realising the importance of nuclear power for peaceful purposes, the Government of India has constituted the Atomic Energy Commission which is responsible for conducting research connected with the development of atomic power.

Although pitchblende is the main ore of uranium, beach sands of both east and west coasts have also traces of uranium. Beach sands of Kerala, particularly those found south of Quilon are rich in monazite, ilmenite, rutile and silimanite. Amoung these minerals, it is only monazite which is the source of uranium and thorium. Monazite itself constitutes less than 3% of the beach sand. Though uranium (about 0.3%) and thorium (about 9%) are present in small quantities in monazite, their extraction is of paramount importance to this country in this atomic age. In monazite sands, however, the percentage of uranium may rise to 4.5 and that of thorium to 33. A factory for processing monazite has been constructed at always in Kerala. Rare earth chlorides and oxides are manufactured in this factory for meeting home needs and for export.

India has signed bilateral deals on civilian nuclear energy technology co-operation with several other countries, including France, the United states of America, the United Kingdom, Canada and South Korea. India has also Uranium supply agreements with Russia, Mangolia, Kazakhstan, Argentina and Namibia.

Large deposits of natural Uranium, which promises to be one of the top 20 of the world's reserves, have been found in the Tummalapalle belt in the southern part of the Kadapa basin in Andhra Pradesh in March 2011.

Table: 7.5: Nuclear power generation (2010-11 to 2015-16)

Year	Gross generation (Mus)	Capacity factors (%)	Availability factor (%)
2010-11	26472	71	89
2011-12	32455	79	91
2012-13	32863	80	90
2013-14	35333	83	88
2014-15	37835	82	88
2015-16	24863	75	78

(Upto Nov. - 2015)			

Source: Nuclear Power Corporation of India Limited, Department of Atomic Energy, Govt. of India.

Table: 7.6: Major Nuclear Power Plants in India

Plant	Unit	Type	Capacity (MWe)	Date of Commercial Operation
Tarapur Atomic Power Station (TAPS) Maharashtra	1	BWR	160	October 28, 1969
Tarapur Atomic Power Station (TAPS) Maharashtra	2	BWR	160	October 28, 1969
Tarapur Atomic Power Station (TAPS) Maharashtra	3	PHWR	540	August 18, 2006
Tarapur Atomic Power Station (TAPS) Maharashtra	4	PHWR	540	September 12, 2006
Rajasthan Atomic Power Station Rajasthan (RAPS)	1	PHWR	100	December 16, 1973
Rajasthan Atomic Power Station Rajasthan (RAPS)	2	PHWR	200	April, 1, 1981
Rajasthan Atomic Power Station Rajasthan (RAPS)	3	PHWR	220	June 1, 2000
Rajasthan Atomic Power Station Rajasthan (RAPS)	4	PHWR	220	December 23, 2000
Rajasthan Atomic Power Station Rajasthan (RAPS)	5	PHWR	220	February 4, 2010
Rajasthan Atomic Power Station Rajasthan (RAPS)	6	PHWR	220	March 31, 2010
Madras Atomic Power Station (MAPS) Tamil Nadu	1	PHWR	220	January 27, 1986
Madras Atomic Power Station (MAPS) Tamil Nadu	2	PHWR	220	March 21, 1986
Kaiga Generating Station (KGS) Karnataka	1	PHWR	220	November 16, 2000
Kaiga Generating Station (KGS) Karnataka	2	PHWR	220	March 16, 2000
Kaiga Generating Station (KGS) Karnataka	3	PHWR	220	May 6, 2007
Kaiga Generating Station (KGS) Karnataka	4	PHWR	220	January 20, 2011
Kudankulam Atomic Power Project, Tamil Nadu	1	VVER-1000 (PWR)	1000	December 31, 2014
Narora Atomic Power Station (NAPS) Uttar Pradesh	1	PHWR	220	January 1, 1991
Narora Atomic Power Station (NAPS) Uttar Pradesh	2	PHWR	200	July 1, 1992

Kakrapar Atomic Power Station (KAPS), Gujarat	1	PHWR	220	May 6, 1993
Kakrapar Atomic Power Station (KAPS), Gujarat	2	PHWR	220	September 1, 1995

Total Nuclear Power Plant Capacity: 5780 MWe.

Source: Nuclear Power Corporation of India limited, Department of Atomic Energy, Govt. of India.

7.5 CONCLUSION

Minerals and power resources form the life blood of the world's present day industrial civilization. India has lately awakened to this. The importance of planning and development of industries based on minerals and power resources as capable of bringing in ample dividends is now being realized.

India is fortunate to have rich deposits of some essential minerals. Manganese ore, magnesite, bauxite and thorium. It is possible for India to export these minerals. Reserves of coal, limestone, dolomite, uranium, copper ore and gypsum are adequate for the needs of the country. India is very poorly endowed with a few essential minerals. These are the minerals which yields mercury, tungsten, molybdenum, silver, cobalt, nickel, tin, zinc, antimony and platinum. Production of petroleum, phosphates and sulphur also falls considerably short of the requirements of the country. India, therefore, depends on other countries for the supply of these minerals and resources. The country is, however, actively engaged in the search for minerals and its is very likely that the country will be able to discover more deposits of minerals in the near future.

In India, Jharkhand, Chhattisgarh, Odissa, West Bengal, Gujarat, Assam, Rajasthan etc. are the promising states for the production of different minerals and power resources.

India has a large potential for solar and hydro power. Punjab, Haryana, Uttarakhand and North-Eastern states can play a vital role in the field of hydro power, while the other side Rajasthan, Gujarat and Maharashtra has a large possibilities and potential for solar energy.

7.6 SUMMARY

India is a land of rich natural resources, mineral resources. Mineral and power resources provide solid base for the industrial growth of a country.

Mineral and power resources are the bases for the industrial and agricultural prosperity of a country. In fact, per capita utilization of energy is an indicator of measuring standard of living in a country. These resources are a measure of strength and advancement of the civilization of a nation.

This unit describes the mineral and power resources of India. State wise production, distribution, mineral reserves, international trade of minerals, potential and possibilities of mineral and power resources are explained in detail.

The Himalayan region and north –eastern states of India has a great potential of resources.

In this unit, the significance and benefits of power resources (hydro-electricity, wind, solar and nuclear) are also discussed.

7.7 GLOSSARY

Abrasion	:	A damaged area of the skin where it has been rubbed against something hard and rough.
Aerospace	:	The industry of building aircraft and vehicles and equipment to be sent into space
Alabaster	:	Is a name applied to varieties of two distinct minerals, when used as a material gypsum and calcite, a carbonate of calcium
Ammunition	:	The supply of bullets, etc. that you need to fire from a weapon.
Argentiferous	:	Rocks or minerals containing silver
Bilateral	:	Involving two groups of people or two countries
Collapsible	:	That can be folded into a shape that makes something easy to store.
Combustible	:	able to begin burning easily
Conventional	:	Always behaving in a traditional or normal way.
Corrugated	:	Shaped into folds (used about metal or cardboard)
Detritus	:	Natural waste material that is left after some thing has been used or broken up

Electrolysis	:	A way of separating a liquid into its different chemical parts by passing an electric current through it.
Fluctuations	:	to change frequently from one thing to another
Friable	:	easily broken into fragments.
Granular	:	made of a mass of small hard pieces.
Hazaks	:	It is a technical word: extra large outdoor lanterns used in cottages.
Intrusive	:	(In geology) a mass of hot liquid rock that has been forced up from below the earth's surface and cooled in between other layers of rock.
Metamorphic rocks	:	rocks which have been changed from their original from by heat or by pressure beneath the surface of the earth.
Photovaltaics	:	(PV) is the name of a method of converting solar energy into direct current electricity using semiconducting materials that exhibit the photovoltaic effect, a phenomenon commonly studied in physics. A photovoltaics system employs solar panels composed of a number of solar cells to supply usable solar power.
Pigment	:	a substance that gives colour to things.
Radioactivity	:	a process, sending out powerful and very dangerous rays that are produced when atoms are broken up.
Spinel	:	a hard glassy mineral occurring as octahedral of variable colour and consisting chiefly of magnesium and aluminium oxides
Sporadic	:	Not done or happening regulary.

7.8 ANSWER TO CHECK YOUR PROGRESS

Q1. What is the importance of power resources in the industrial growth of a country?

Q2. Name the minerals which occur abundantly in India. Where are they mined and what foreign exchange do they earn from the world's markets?

Q3. Discuss the production and distribution of petroleum in India and write a note on its importance as an energy source.

Q4. Give an account of Non-conventional sources of Energy in India.

Q5. Write notes on : (a) hydro-electricity in India (b) reserves of coal in India (c) mica production in India (d) solar power.

Q6. Mention (i) uses (ii) sources of supply and (iii) production of the following minerals of India:

Natural Gas, Manganese, Iron ore and Gold.

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7.11 TERMINAL QUESTIONS

Q1. Write note on :

(a) Coal in India (b) Solar Energy

(c) Copper distribution in India (d) Oil Refineries

Q2. In which important metallic minerals in India in short supply? What steps are being taken to make good the shortage.

Q3. Describe the states that leads in the production of Iron ore in India.

Q4. Differentiate between metallic and nonmetallic mineral resources.

Q5. Give description of state-wise production of petroleum.

Q6. Write an essay on Nuclear Energy in India.

Q7. Describe future perspective of wind power in India.

UNIT 8 - POPULATION GROWTH, DISTRIBUTION & DENSITY

8.1 OBJECTIVES

After reading this unit, you should be able to understand that:

Population Growth - The studies of Population Change give an insight to the stage of demographic transition, the level of socio-economic development and the dominant society of the region.

Population Distribution - The pattern of population distribution highlights the immediate demands of the state. What, the pattern of population growth conceals; the population distribution makes it prominent.

Population Density- The way in which the policies should work in different states is guided by the population density. It helps to know who needs what, where and in what amount.

8.2 INTRODUCTION

The study of Population Statistics holds keen importance in the study and the interpretation of the demographic history of the country. When a country like India is taken into consideration, which is composed of various ethnic, racial, religious and linguistic groups, the study of not only temporal but spatial data also holds importance. The given unit discusses the three basic demographic attributes – Population Change also known as Population Growth, Population Distribution and Density.

For a Population Geographer, the population growth is an important index, which reflects the level of economic development, social awareness, historical and cultural background and political ideology. It is the most important attribute of the population defining and characterizing all other attributes of the population. The projections and models are the base of various development projects, programs and policies initiated by the Government for the welfare of the community. The spatial and the temporal study of the data helps us to understand the determining factors of the disparity and how they can be reduced.

The developmental processes taking shape in the less developed countries under the stress of explosive state of demographic transition have often initiated redistributive tendencies in the spatial patterns of employment opportunities. Consequently, there are qualitative changes in the distributional pattern of the population in these countries (Chandna, 1986). These redistributive tendencies are prevalent in the less developed countries like India. Hence, the study of Population distribution assumes much significance. The problems related to congestion and the deficiency can only be dealt when a proper study of the population distribution is conducted. At micro-scale the concept of density is used to study the spatial pattern of distribution of population. It offers a scale to measure the resource and population potential. A kind of man land ratio, it helps in understanding the demographic characters of the population and the determinants responsible for it.

8.3 POPULATION GROWTH

The concept of population change or growth of population is often used to connote the change in the number of inhabitants of a territory during a specific period of time, irrespective of the fact that the change is negative or positive (Chandna,1986). The population growth is measured in absolute numbers and in percentage. The basic data for calculation is derived from the census. Hence, the population growth is actually the inter-census change in population of the region. The change can be either decennially (ten years) or quinquenially (five years).

The growth of the population is the function of its three components. They are Fertility, Mortality and Migration. Fertility refers to the occurrence of birth, commonly calculated per thousand of population. Mortality has been defined as permanent disappearance of all evidence of life at any time after birth has taken place (United Nation, 1953, p. 48). Migration refers to the permanent or semi-permanent change in the residence of the person, which involves a complete change and readjustment of the community affiliations of the individual. Population Growth is calculated as = Fertility – Mortality + (Immigration – Emigration). The natural growth of population is calculated as Fertility – Mortality. The population growth in percentage or growth rate is calculated by dividing the obtained value by mid-period population and multiplying it by 100. Since, the mid-period population is generally not available; therefore, actual size of population at the beginning point is used. Hence, the population growth can also be calculated as the difference between the populations of the two censuses. A care should be taken that only comparable data is used to calculate the growth of population.

Factors affecting Population Growth: The factors affecting the components of population change are responsible for bringing about the population change. These factors play a significant role in defining the stage of demographic transition. The factors of fertility, mortality and mobility vary significantly from each other. An effort has been made to compile these factors yet a distinction could be made among them concerning the different components of the population change. These factors can be classified into four broad categories: - Biological, Social, Economic and Demographic Determinants.

1. Biological Determinants: The factor of *race*, *the fertilitypotential in women* and *genetic fertility* in men are the most established biological factors determining fertility. Different races have different fertility rates and they vary from person to person. The *general health conditions* also define the fertility and the mortality rates. While the healthy and hygienic society has low rates of fertility and mortality, the other side has high rates of both fertility and mortality. With the improvement of better health conditions, people go for small family norms.
2. Social Determinants: These are the most influencing and widest range of factors affecting the population. The fertility is today the main cause of population change in India. Population change is determined by the *religious background* – each religion has its own norms of population control and freedom to migrate; *ethnic composition* – the minor groups usually have higher fertility levels to increase their numbers; *level of education* – the more educated a mother is, the lesser children she would have, the higher education level also develops a tendency to migrate for better opportunities; *age of marriage* – higher the age of marriage, lesser the number of children; *traditions and customsrelating to marital and sexual life*; *status granted to females* and desire for a son; *attitude towards thefamily planning measures* and *governmental policies* about abortions, initiatives about population redistribution, population policies etc. Other social factors concerning mobility is *socio-economicstatus* – people having lower social status are most mobile because they have no property to tie them at a place. The *status of women*, *prevalence of infanticide*, and *availability of medical facilities*, *facilities and conditions of housing, sanitation, nutrition, education and traditional lifestyle* influences the mortality rates appreciably.
3. Economic Determinants: The *income level* of the population determines the fertility and mortality levels. The rich and most importantly middle class apply strictest control over the family size. They also show low mortality levels. The *standard of living* also defines the

fertility rates; the poorest people have the highest fertility rates. The *dietary habits*, protein intake also controls fertility, the regions with high protein intake have low fertility. However, when the medical facilities are universally available the disparity in the mortality rates significantly reduces. A person migrates for a better economic stability, hence he moves towards the regions of higher *urban- industrialized economy* and where better and bigger *agricultural lands* are available.

4. Demographic Determinants: The factors like *higher population in reproductive age group*, *lower ageof marriage, and paucity of females, urban living* and *more the number of working women* decrease the fertility rates of the region. *Higher the number of young population*, higher is the tendency of mobility. The crowed backward regions have high out-migration and high fertility rates. The *age structure*s having more the number of Middle Ages and old ages have shown high mortality rates. In the less developed countries where *malnutrition* and *high maternal mortality rates*have shown high rates of female mortality. Different stages of urban development show different pattern of mortality rates.

Table:8.1India: Natural Rate of Increase, 1901 - 2011

Year	Birth rate per thousand	Death rate per thousand	Rate of natural increase
1911	49	43	6
1921	48	47	1
1931	46	36	10
1941	45	31	14
1951	40	27	13
1961	42	23	19
1971	37	15	23
1981	34	12	22
1991	31	11	20
2001	25	8	17
2011	21.8	7.1	14.7

Source: Census of India, Handbook of Population Statistics (1988), Table 35, p. 99 and Census of India, 2011.

Growth of Population in India (1901-2011): Growth of population in India has gone through the different phases of population increase. On an average, the growth rate of population had been at the rate of 1.64% per annum against the 1.3% of China. The population estimates for India are available from 1750 but the census data is available from 1871. During this time, the growth of population was very slow due high mortality rate due to constant epidemics, famines and less developed medical facilities. The population in this period increased by only 33 million. The population growth from the beginning of the 20th century to 2011 shows four distinct phases of population growth. These four phases were:

Table:8.2 India: Growth of Population, 1901-2011

Year	Population (in millions)	Average Annual Exponential Growth (percent)	Progressive growth over 1901 (percent)	Percentage increases during preceding decade
1901	236	-	-	-
1911	249	0.56	5.75	+5.75
1921	248	-0.03	5.42	-0.31
1931	276	1.04	17.02	+11.00
1941	315	1.33	33.67	+14.22
1951	360	1.25	51.47	+13.31
1961	439	1.96	84.25	+21.64
1971	548	2.20	129.94	+24.80
1981	685	2.22	186.64	+24.66
1991	844	2.16	255.05	+23.87
2001	1028	1.97	331.52	+21.54
2011	1210	1.64	407.64	+17.64

Source: Census of India, Provisional Population Totals, 2011, p. 41.

1. Period of Stagnant Population (1901-1921): During this period, the population of India grew at the rate of only 0.25% per annum, increasing from 236 million to 248 million. This period witnessed high rates of both fertility and mortality. In 1911-21, mortality even outmatched fertility, when the population showed marginal decline of -0.03%. This was due to frequent epidemics, food shortages, floods and famines. The year of 1921 is marked as the Demographic Divide between the periods of fluctuating growth and continuous growth of population.

2. Period of Steadily Increasing Population (1921-1951): The rate of annual growth of population during this period was 1.51%, increasing from 248 million to 360 million. The population increased due the significant decrease of mortality rate from 47 in 1921 to 37 in 1951, with decrease in birth rates from 48 in 1921 to only 40 in 1951. The decrease in mortality was due to the control on famines, epidemics, food shortages, better medical, sanitation, and transport and communication facilities. The year of 1951 is also marked as a Demographic Divide for the reason that the population showed unprecedented increase after this this period.

3. Period of Rapidly Increasing Population (1951-1981): The annual growth rate of population during this period was 3.01%, increasing from 360 million to 685 million. This unprecedented increase in country's population was due to large-scale developmental activities, improving conditions of food supply and medical facilities. They helped to further bring down the mortality rates 27 in 1951 to 12 in 1981. The highest growth rate was recorded in 1961-1971 was highest 24.80%, i.e. 2.48% annual growth and 2.20% exponential growth of population. This exponential growth of population further increased to 2.22% in 1981. The 1981 is an important Demographic Divide for the reason that growth rate population decreased after this period.

4. Period of Slowing Growth of Population (1981-2011): Population of India increased from 685 million to 1210 million, at a rate of 2.55% per annum. During this phase of population growth, the growth rate of population decreased from one census to other. It was 24.66% in 1981 decreasing to 23.87% in 1991, 21.54% in 2001 and to 17.64% in 2011. This marks the beginning of a new era in the demographic history of India. The birth rates decreased substantially from 34 in 1981 to 21.8 in 2011. The death rates decreased further low from 12 in 1981 to 7.1 in 2011.Due to this the population growth rate of India decreased to such an extent that in 2011 the absolute number of persons added to the population were less than the persons added to in 2001.

The process of demographic evolution which started in 1921-31 has been accentuated during the past two decades (1991-2011) due to the improving literacy rates, particularly of females, improving levels of education attainments, increasing age at marriage and increasing strain on individual purse coupled with higher level of social – economic awakening of the general masses (Chandna, 1986).

Population Growth during 1991-2001: The growth of population during the decade of 1991-2001 was lower than the decade of 1981-1991, being 21.54%, down by 2.31%. This was due to the fact of decreased mortality from 11 in 1991 to 8 in 2001, which initiated the decrease in fertility from 31 in 1991 to 25 in 2001.

Amongst the states, Kerala recorded the lowest growth of population of only 9.43% in 2001 against 14.3% in 1991. Tamil Nadu (11.72%) and Andhra Pradesh (14.59%) followed it. The sharpest decline in population growth in comparison to the previous decade was seen in Tripura, where growth rate decreased from 34.3% in 1991 to 16.03% in 2001.

The other states, which showed the population growth rate below national average, were Goa (15.71%), Orissa (16.25%), Karnataka (17.51%), Himachal Pradesh (17.54%), West Bengal (17.77%), Chhattisgarh (18.27%), Assam (18.92%), Uttarakhand (19.41%) and Punjab (20.10%). The states which recorded the high growth of population were Nagaland (64.53%), Sikkim (33.06%), Manipur (24.86%), Meghalaya (30.65%), Mizoram (28.82%), Jammu and Kashmir (29.43%), Bihar (28.62%), Rajasthan (28.41%), Haryana (28.43%), Arunachal Pradesh (27.0%), Uttar Pradesh (25.85%), Madhya Pradesh (24.26%), Jharkhand (23.36%), Maharashtra (22.73%) and Gujarat (22.66%).Almost 23 out of 28 states showed the decrease in the growth rate as compared to the previous decade which is a healthy sign of increasing awareness among people about the family planning and population problems. Only the states of Nagaland (+8.45%), Sikkim (+4.49%), Bihar (+5.24%), Haryana (+1.02%) and Gujarat (+1.47) showed increase in the growth rates. The increased rates in north eastern are attributed to the large scale illegal immigration from the neighboring countries. The population growth in Haryana and Gujarat is also due to migration from other states. The states which showed sharpest decline in growth rate were Tripura (-18.27%), Arunachal Pradesh (-9.83%), Mizoram (-10.88%) and Andhra Pradesh (-9.61%).

Union Territories have normally recorded high rate of population growth due to high level of urbanization. Only Puducherry (20.62%) and Lakshadweep (17.30%) recorded growth rate below the national average. While Dadra and Nagar Haveli (59.2%), Daman and Diu (55.73%), Delhi (47.02%), Chandigarh (40.28%) and Andaman and Nicobar Islands (26.90%) recorded substantially high growth of population. Only 2 Union territories of Dadra and Nagar Haveli (+25.65%) and Daman and Diu (27.11%) recorded increase in population growth rate. The sharpest decline in population growth rate was seen in Andaman and Nicobar (-21.8%).

The pattern of Population growth in **1991-2001** reveals:

1. There are high state to state variations in the population growth from 9.4% in Kerala to 64.5% in Nagaland, putting each state in different stages of demographic transition.

2. There is a clear North-South divide in the population growth rates, where the northern states have higher growth rates. This puts Southern states in the final stage of demographic transition.

3. Though the Mortality rates have decreased appreciably, but for a more pronounced decrease in population growth rates, further decrease in fertility rates holds importance.

4. Urban – Rural differentials in the natural growth rate have been narrowed down significantly. This certainly speaks of growing degree of socio-economic awareness in rural areas of the country.

Hence, the decreasing rate of population puts India into the take-off stage of the demographic evolution. The coming decades would show further decrease in the growth rates bringing about a new era of sustainability and awareness in India.

Population Growth during 2001-2011: The growth of population in the decade further decreased to 17.64% recording lowest decrease of 3.9%. It is the first time in the recent demographic history of India that the decade recorded addition of lesser number of people to the population as compared to the previous decade. In 2011 Census, 182 million people were added to the population against 184 million people in 2001. These heralds a new era of population stabilization in India.

The crude birth rate and the crude death of India according to the census 2011 was 21.8 and 7.1 respectively. However, the death rates have reached to their near lowest levels that their further decrease is appreciably decelerated. For better population stability,soaring fertility rates should be controlled. In various places across India, the fertility levels are low and have reached to replacement levels. The life expectancy at birth has increased to 67 years, with female expectancy of 68.1 years outmatching male 65.8 years. This feature shifts India to the list of developed countries. The area of concern lies in high maternal mortality rate and decreasing child sex ratio.

The increase of population at National level was 17.64%, but the spatial variation existed. The state which recorded highest population growth was Meghalaya (27.82%) followed by Arunachal Pradesh (25.92%), Bihar (25.07%), Jammu and Kashmir (23.71%), Mizoram (22.78%), Chhattisgarh (22.59%), Jharkhand (22.34%), Rajasthan (21.44%), Madhya Pradesh (20.30%) and Uttar Pradesh (20.30%). These states witnessed the population growth higher to 20%. The district of KurungKumey (111.0%) of Arunachal Pradesh recorded the highest growth rate of population during 2001-11. The other states with population growth of more than national average include Manipur (18.65%), Uttarakhand (19.17%) and Gujarat (19.90%). The states, which recorded low growth of population were Kerala (4.86%), Goa (8.17%), Andhra Pradesh (11.1%), Punjab (13.73%), West Bengal (13.93%) and Odisha (13.97%). Only the state of Nagaland witnessed a negative growth of population. It recorded the population growth of -0.47%. The districts of Longleng (-58.39%) and Kiphire (-30.54%) of Nagaland had the distinction of registering highest decline in their population during 2001-11.

Most of the Union Territories in the country have recorded the high growth rate, except Lakshadweep (6.23%), Andaman and Nicobar (6.68%) and Chandigarh (17.1%). While Dadra and Nagar Haveli (55.5%) recorded the highest, followed by Daman and Diu (53.54%), Puducherry (27.72%), and Delhi (20.96%). Yanam (77.15%) in Puducherry had the second highest growth rate of population in 2001-11. The high growth rate in Union Territories is due to the increased rate of in migration from the other parts of the country.

Only two states and one Union territory recorded the increase in the growth of population namely, Puducherry (+7.10%), Chhattisgarh (+4.32%) and Tamil Nadu (+3.88%). The sharpest decline in the population growth was seen in Nagaland (-65.0%), Delhi (-26.06), Chandigarh (-23.18%), Sikkim (-20.7%), Andaman and Nicobar (-20.22%), Lakshadweep (-11.07%), Haryana (-8.53%), Goa (-7.04%), Rajasthan (-6.97%) and Maharashtra (-6.74%). In most of these states the mortality rates have decreased below 10 per thousand, hence any change in the fertility is reflected in the growth rate. Due to the decreasing employment opportunities in the UTs, the migration pull towards them has decreased resulting the decreased growth of population. Due to the decreasing trend of population growth, the average exponential growth by 2011 had come down to the level of 1.64%, which is much below the replacement level of 2.1.

The population Trend in **2001-2011** India reveals that:

1. With the annual growth rate of 1.64% against the world annual growth rate of 1.23%, the country would enter to the final stage of demographic transition in nearly 20 years to come.

2. The decrease in the population growth was started in 1991 and is continuing until the census of 2011, with the sharpest decline of 3.9%.

3. The growth rate of population during 2001-11 in EAG states (Rajasthan, Uttar Pradesh, Uttarakhand, Bihar, Jharkhand, Madhya Pradesh, Chhattisgarh and Odisha) (20.92%) was much higher than the non-EAG states (14.99%). This is because the mortality rates in these states have decreased but their fertility rates are still high.

4. The North-South divide in the population evolution is narrowing since many states of the North are witnessing decreased growth in population.

5. The rural- urban differential in the natural increase of population have also narrowed down further.

6. India as a whole was in third stage of the demographic transition, with fairly low levels of mortality and decreasing rates of fertility. However, spatial variations existed putting the states and Union Territories in the different stages of demographic Transition.

7. The effect of low fertility in Southern states is spreading to north, reaching Maharashtra, Orissa and West Bengal.

8. The concept of EAG states was first introduced in the census. The natural growth rate of the EAG states is much higher than that of the non-EAG states.

9. The National Population Policy 2000 targeted values have been exceeded in 2011 by 110 million.

10. Nearly 22 states in the country had less than 14% of their population below 6 years. Hence, the youth bulge in the country's age pyramid is on decline.

Table:8.3 India: Change in Growth Rates, 1991-2011

State/ Union Territory	Growth rate in 1991	Growth rate in 2001	Growth rate in 2011	Change in 1991-2001	Change in 2001-2011

INDIA	**23.86**	**21.54**	**17.64**	**-2.32**	**-3.9**
States					
Nagaland	56.08	64.53	-0.47	+8.45	-65.0
Sikkim	28.47	33.06	12.36	+4.59	-20.7
Manipur	29.29	24.86	18.65	-4.43	-6.21
Meghalaya	32.86	30.65	27.82	-2.21	-2.83
Mizoram	39.70	28.82	22.78	-10.88	-6.04
Jammu and Kashmir	30.34	29.43	23.71	-0.91	-5.72
Bihar	23.38	28.62	25.07	+5.24	-3.55
Rajasthan	28.44	28.41	21.44	-0.03	-6.97
Haryana	27.41	28.43	19.90	+1.02	-8.53
Arunachal Pradesh	36.83	27.00	25.92	-9.83	-1.08
Uttar Pradesh	25.55	25.85	20.09	-0.30	-5.76
Madhya Pradesh	27.24	24.26	20.30	-3.02	-3.96
Jharkhand	24.03	23.36	15.99	-0.67	-1.02
Maharashtra	25.73	22.73	22.34	-3.00	-6.74
Gujarat	21.19	22.66	19.17	+1.47	-3.49
Punjab	20.81	20.10	13.73	-0.71	-6.37
Uttarakhand	24.23	19.41	19.17	-4.82	-0.24
Assam	24.24	18.92	16.93	-5.32	-1.99
Chhattisgarh	25.73	18.27	22.59	-7.46	+4.32
West Bengal	24.73	17.77	13.93	-6.96	-3.84
Himachal Pradesh	20.79	17.54	12.81	-3.25	-4.73
Karnataka	21.12	17.51	15.67	-3.61	-1.84
Orissa	20.06	16.25	13.97	-3.81	-2.28
Tripura	34.30	16.03	14.75	-18.27	-1.28
Goa	16.08	15.21	8.17	-0.87	-7.04
Andhra Pradesh	24.20	14.59	11.10	-9.61	-3.39
Tamil Nadu	15.39	11.72	15.60	-3.67	+3.88
Kerala	14.32	9.43	4.86	-4.89	-4.57
Union Territories					
Dadra and Nagar Haveli	33.57	59.22	55.50	+25.65	-3.72

Daman and Diu	28.62	55.73	53.54	+27.11	-2.19
Delhi	51.45	47.02	20.96	-4.43	-26.06
Chandigarh	42.16	40.28	17.10	-1.88	-23.18
Andaman and Nicobar Islands	48.70	26.90	6.96	-21.80	-20.22
Puducherry	33.64	20.62	27.72	-13.02	+7.10
Lakshadweep	28.47	17.30	6.23	-11.17	-11.07

Source: Census of India 2001, Primary Census Abstract, Total Population, Table A-5 and Census of India 2011, Provisional Population Totals.

Demographic Transition in India: Historical and contemporary trends have shown that the transition itself and its pattern, sequence and timing may vary greatly from country to country and over time (United nations, 1971). The Theory of Demographic Transition helps to study the pattern and trend of population growth. It also helps to predict the future trends of population change. The Demographic Transition in India started in the decades of 1920s and 1930s when India entered in the second stage of the demographic evolution. Before this period, India had a stagnant growth of population when both the birth rates and the death rates were high, that the marginal difference between them was responsible for the growth of population.

However, after the decades of 1920 and 1930 the population of India has increased at a considerable rate and has increased nearly four times since the beginning of the century. In addition, today India stands in the final period of the third stage of the demographic transition with decreased death rates and rapidly decreasing birth rates. The second stage of the transition commenced in 1920s ended in 1960s. The period was characterized by decreasing mortality and marginally decreasing high birth rates. The rate of growth was high due to near stationary birth rates. Due to which the exponential growth of population was very high. In 1961 and 1971, it was 1.96% and 2.20% per annum. In the decade of 1961-71 when the birth rates declined to 37 per thousand India entered in the third stage of the demographic transition from 'early expanding stage' of population.

The decline in death rates was more rapid in India than elsewhere in the world. While the birth rates attained unexpected decline. In the third stage of the demographic transition, the death rates are nearly 7.1 per thousand (2011) in almost all parts of India, with the fertility (21.8, 2011) at its near replacement level. They have decreased from 15 (CDR) and 37 (CBR) in 1971 respectively. However, India is a vast country with a greater number of regional disparities in social, economic, historical, cultural, topographical and demographic aspects. When this diversity is taken into account, many states of India are still in the beginning of the third stage of transition, and many of the southern and the north eastern states in the late third stage of demographic transition. Though the North-South divide in growth rate pattern is diminishing, yet the disparity in the stage of transition is still visible. The southern states are much farther than their northern counterpart. The EAG states need to be worked upon, to reduce their fertility rates, so that they can establish a better population-resource relation. Efforts in this direction would help the country to the early proceed into the fourth stage of the demographic transition.

8.4 DISTRIBUTION OF POPULATION & FACTORS INFLUENCING THE DISTRIBUTION OF POPULATION

In the early human history, man followed the linear pattern of settlement, basically near a perennial water body. However, with the spread of technology, and consequent spread of population over the vast irregular units of land, the study of population distribution became complex for easy interpretation. The analysis of population distribution and density holds immense significance for population geographers, as its successful understanding holds the key to the analysis of entire demographic character of area. (Chandna, 1986).

Density and Distribution of population are not identical but are intimately related to each other. Distribution refers to the actual pattern of the spacing of units of individuals' i.e. spatial pattern in which the population finds its location. On the other hand, Density is the ratio between the size of population and the area occupied by it. Hence, the distribution stands for the locational aspect (*spread of population*) of the population while and density deals with the proportional aspect (*man land ratio*) of the concerned population.

Measures of Distribution of Population: Scholars from the various fields of humanities and science have contributed to the development of various methods and techniques to study the distribution of population. Some of them are given below:

1. Percentage Distribution: In this method, the given geographic area is divided into major units (most commonly administrative units), and the percentage of population living in each unit is calculated, that the total percentage of population in the given geographic area is 100.

2. Rank Order Method: Temporal trends in distribution and redistribution of population are studied on the basis of ranking of the units from census to census. This method is commonly employed in the study of urban population.

3. Median Point: It is obtained at the point of intersection of the median lines. The median lines are two orthogonal perpendicular lines, which divide the area concerned in such a way that each part contains equal number of inhabitants.

4. Mean Point: The mean center is considered as the center of gravity of any special distribution. It is the point upon which the plane would balance itself assuming the weightless plane, each individual having equal weight and to exert pressure on the central point proportionate to his distance from the point.

5. Modal center: According to Clarke (1972), the modal center refers to the maximum surface density in an area, coinciding with the principal peak of population potential.

6. Point of minimum aggregate travel: It is the point, which can reached by all the individuals, with the least total straight line travel.

7. Population potential: The concept was developed by Stewart and Warntz(1958) which is the measure of closeness of people to a point. The influence of a point to an individual decreases as the distance of it from the individual increases, hence the total population potential of the point would be the sum of the reciprocals of the distances of all individuals from the point.

8. Lorenz curve: In this method, the cumulative percentage of population and cumulative percentage of area are plotted on the different axis of the graph. The points so obtained are joined for a smooth free hand curve. The deviation of the curve from its diagonal line is in proportion to the level of inequality in the distribution of population in relation to area in the region.

9. Cartographic methods: Monkhouse has suggested different methods to depict the distribution of population on map. The use of a certain method depends upon the type of data

available and objective of expression. These methods include dot method; multiple dot method; dot, circle and sphere method and pie diagrams.

Factors affecting distribution of population: The distribution of population on the earth's surface varies from place to place, from one region to another. *Ecumene* and *nonecumene* or *anacumene* are the terms used by geographers to differentiate between permanently inhabited parts and the uninhabited parts or very sparsely populated parts of the world. It has been estimated that approximately 60 percent of the earth's land may be called ecumene, while the rest constitutes nonecumene.

The variability in the distribution of population can easily be noticed in India. For instance, the Indo-Gangetic plain is the most densely populated region in India, while the mountainous regions of Shivaliks, North-eastern have very low densities. Metropolitans and other developing townships have high densities in comparison to their rural counterparts. The coastal regions, cities near rivers have higher densities. Fertile lands and Industrial regions have high densities than their non-developed counterparts. The islands have comparatively low densities in comparison to the mainland. It has also been found that densely populated regions and sparsely populated regions coexist together, yielding sharp-edged boundaries between the two.

These contrasts in distribution of population are due to the influence of a variety of factors, which may be broadly classified into physical, socio-cultural and demographic factors. The United Nations' (1973) Population Studies No. 50, *The Determinants and Consequences ofPopulation Trends*, offers a good account of these factors.

Physical Factors: The physical factors include the climate, geology and the topography of the region. They are the most direct and influencing factors determining the distribution of the population in the area. However, the technology has been able to make many of the non ecumene regions habitable for man, but pattern of population distribution still reflects the physical landscape of the region.

(i) Climate: The *temperature, amount of precipitation and length of growing* are the most important influences of the climate. The regions experiencing extremes of temperature have sparse distribution of population. Hot lands experiencing scarcity of water, and cold lands are sparsely populated. Due to a good amount of rainfall in equatorial regions, they are densely populated due a long growing season and comparatively better conditions for human settlement.

(ii) Landforms: Staszewski (1957) observed that only 20 percent of the world population is found in the regions with *altitude* more than 500 meters. It is due to the difficulties man faces in regions of high altitude and rugged terrain. Plains are more populated than mountainous regions and lands of rugged terrain. The *rivervalleys* may promote (as in Egypt and Indo-Gangetic plain) or restrict (as in tropical swamps and dissected plateaus) depending upon the geographic conditions. In the mountainous regions, the *degree of slope* determines the population size. Low and moderate slopes enjoy higher population concentrations than steep sloped regions where limited arable land is available. The *sun facing slopes* provide better locations for the growth and emergence of the settlements. Poor *drainage conditions* delimit the scopes of human settlements like in marshes and swamps (for example- Rann of Kutchh). Subsoil water table also determines the concentration of population. Regions where level of *water table* is high~~,~~ have a high density of population.

(iii) Soils: Man survives on food. He settles in those areas, which provide him his most basic needs easily. Soil is important for the production of food. Therefore, fertile tracts of river basins have high concentrations of human population. It is important to note that the soils, which generally hinder intensive agricultural practices, have low population like podzols. Soils are the combined effect of geology, climate and topography of a region hence, precise assessment of the role of soil in determining human settlement poses difficulties.

(iv) Geology and Minerals: The geology of a place and mineral occurrence in an area also determines the level of population concentrations in an area. The regions rich in economic deposits of coal, crude oil, ores, limestone, marble etc. attract human population.

(v) Accessibility: The places with well-connected facilities of transportation and communication have high concentrations of populations. Therefore, we see coastal regions are densely populated than their interior counterparts. The big cities, which provide the similar facilities, are also populated. It is due to this reason that Mumbai is more populated than Delhi.

Socio-cultural Factors: According to Clarke (1971, p 435) the role of physical factors is decreasing with *advent of urbanization*. As the man's increasing technological advancement is enabling him to survive in non-acumen and adapt to different climatic conditions, the importance and effect of socio cultural factors is increasing. The *history of settlement* is a determining factor in the present concentration of populations. Regions, which enjoy a long history of settlement as Indo-Gangetic plain, River valleys of South India still have a high concentration of human population. The distribution of population in Old and New World varies due to this factor. Each *stage of economic development* is marked with distinct changes in population density and distribution. Hence, the technological and economic advancement is responsible for the concentration and redistribution of population in an area through its employment opportunities, better transport facilities, better incomes and standard of living and variability in economic activities. Density of urbanized region is large due to the fact that the supporting capacity of an industrial worker is more than an agrarian worker. Therefore, small sized closely spaced settlements are common in agrarian regions. The political factors also effect the redistribution tendencies. *Wars, Political Events* and *Government policies* have brought about a profound effect. In some countries, government is initiating redistribution of population to sparsely populated regions, for example China to redistribute its population to western parts. *Social Organization* and *InterGroupIncompatibilities* influence distribution at micro level.

Demographic Factors: The changes in the distribution and the density of the population in the world take place through variations in the rate of natural increase and also through the medium of migration between areas. Variations in the factors of *mobility, fertility* and *mortality* give rise to disparity in the distribution of population in the area. It is normally observed that the regions having *a huge population base* and a comparatively high natural increase would have a higher density of population.

Zelinsky (1966, p 46-47) observed that the social and physical disasters have been responsible to alter the population map of the world, temporarily. The distribution and density of population depends on the product of the physical and socio-cultural factors through time. Hence, Zelinsky (1966, p-53) rightly observed that in order to understand the meanings lying behind the contemporary patterns of population, one must wield encyclopedic knowledge of the area's physical setting, the minutes of his economic behavior, the broader lineaments of its cultural and social structure and virtually all aspects of its human geography.

8.5 DENSITY OF POPULATION- DISTRIBUTION, PATTERN

The term density of population stands for the number of persons occupying a unit area. The density of population is generally expressed as persons per square kilometer or per square mile of land area. It is a term to establish a relationship between the population pressure and the available resources. At present, it is difficult to find geographic studies of population especially at micro scale, which has not made use of the density concept.

To arrive for the better understanding of the man and land relationship, various ways are suggested by the geographers to calculate population density. Glenn T. Trewartha suggested arithmetic, nutritional and agricultural densities, Vincent suggested comparative density and George suggested economic density

1. Arithmetic Density: Also known as crude density or general density it is one of the most common, simple and yet an extremely useful measure of population resource relationship. It stands for the simple ratio between the total population and the total land area. It is most commonly used because data for such calculation is easily available.

2. Nutritional or Physiological Density: It stands for the ratio between the total population and total cultivated area, is expressed in terms of persons per unit of cultivated land. This type of calculation holds importance to the countries of agrarian economy.

3. Comparative Density: According to Vincent, all the land in a region is not of the uniform quality, hence the density should be calculated keeping in account the productivity of the land (one hectare of the cultivated land is equal to three hectares of grassland). The Nutritional and the Comparative Density were criticized on the ground that even in the agrarian societies, the whole of the population is not dependent on agriculture and the non-arable lands can also productive.

4. Agricultural Density: It offers a relationship between the agrarian population and the total cultivated land. It is expressed in the terms of agricultural population per unit of cultivated area.

5. Economic Density: It is the ratio between the requirements of the population and the resources made available to it by the production in the areas it occupies. It is calculated through the following formula: $ED = \frac{NK}{SK'}$ where, N is the number of people occupying the region, K' is the per capita quantity of requirements, S is the area of the region in square kilometers and K

is the quantity of resources produced per kilometer square. In an industrial economy, it is hard to make an accurate calculation of this type density due to the paucity of data.

6. Room Density: Due to the vertical expansion of the residential complexes, the validity of the man land relationship diminishes since they do not help to know the concentration of the population within the buildings. Here, the room density is calculated i.e. average number of persons per room. It is a useful index widely used by the planners and geographers.

Characteristics of Indian Population: The population of India carries various political, social and economic implications both at National and International Levels. The main characteristics of India's Population include – a huge population of nearly 1.2 billion, multiple ethnicity, concentration of major part of population in the rural regions and unevenness in the distribution of the population in India.

India would have emerged as a strong socio-economic power if the population of India would not have been this large. The problems associated with its population size inhibit its proper development. The problem of ethnicity is not a small one. The social togetherness and cooperation for the proper socio-economic development in the nation is still lacking in many parts of the country and the different sections of the society. The large rural base of the population has its own implications. Government has to make a huge expenditure to the socio-political awareness, proper infrastructure, and proper living amenities for the rural population. The unevenness in the distribution of the population in India causes overcrowding in some regions while very sparse population in other. This misbalance in the population resource relationship creates various other problems. There is the scarcity of the proper amenities in the dense regions and inadequate mobilization in the low density regions.

Pattern of Population Distribution in India: The distribution of population in India follows nearly a fixed pattern of distribution. This pattern of distribution is based upon the factors influencing the distribution. The history of settlement, terrain, climate, employment, trade and commerce are some of the basic factors working in India.

The Indo-Gangetic plain is the most densely populated region in India. Due to the agrarian base of the economy in India, the region provides the most fertile stretch of flat lands, plenty of water for irrigation, favorable climate and cheap labours. The deltaic regions of the southern rivers of Mahanadi, Godavari, Krishna and Cauvery show the similar pattern of settlement. States of Kerala, Karnataka, Tamil Nadu and Andhra Pradesh also have many agricultural and industrial advantages and show high concentration of population. However, the density in Southern states is lower in comparison to the Northern states. This disparity is due attributed to the relative rugged terrain and greater awareness towards the population growth.

Various towns in India, which have a long history of human settlement, are presently experiencing Industrial development and display high population concentration. In comparison, the towns, which are not yet industrialized and are physically unfavorable for human habitation have a low population density.

Since, Refugees enter India from Pakistan, Nepal and Bangladesh the states and districts bordering them have high concentration of population in comparison to the area bordering China and Myanmar. This disparity is also because of the socio-cultural, linguistic and religious similarities.

The Northern and North Eastern states which have rugged Himalayan terrain and opposing climatic conditions have a low density of population. This is also attributed to the non-agricultural conditions, poor conditions of law and order and inadequate developmental initiatives. Throughout the period of past sixty years, the density of this zone has remained the lowest. The mountainous regions of the south also show the similar patterns.

Some regions of Central Highlands, *Thar* Desert, *Kachchh* Peninsula of Gujarat, rain shadow regions of peninsula and the islands of Bay of Bengal and Arabian Sea also show low concentration of population. This is attributed to the paucity of arable land, extreme climatic conditions, low rainfall and huge distance from mainland respectively.

The mineral regions of Jharkhand, Bihar, Chhattisgarh, Odisha and West Bengal also have a heavy concentration of population due to the various developmental activities and creation of employment facilities.

The eastern and western coast is densely populated that many of its cities are today million cities. This is attributed to the optimum temperature, adequate rainfall, high level of urbanization and industrialization, facilities of export and import through sea, accessibility to islands and far regions etc. The density of the region is comparable to the high density region of the Indo-Gangetic Plain.

The union territories of Delhi, Pondicherry, Chandigarh and various other metropolitan centers of Mumbai, Kolkata, Bangalore, Pune etc. and the other million cities have a huge population pressure; it is due to the high level of urbanization, better standards of living, employment opportunities etc. Their high density is also attributed to the high level of in–migration into these areas. Due to which these regions are expanding at an alarming rate encompassing fertile agricultural lands. The creation of slums, problems of effective waste disposal, and problems of traffic, housing, pollution, health and hygiene are some of the common difficulties faced by the people of the region.

Change of Density of Population in India, 1991-2001: The average density of population of India in 2001 was 325 persons per square kilometers with the addition of 58 persons per square kilometer since the last census in 1991 with the average density of 267 only. The increase of density at such an alarming rate shows the increasing population pressure, required mobility of resources and increased incidences of poverty.

With the alarming increase of 136 persons per km², West Bengal maintained its position of most densely populated state in India. However, the highest increase in density was seen in Bihar (196) and became second most densely populated state India with the density of 881 persons per km². In 1991, Kerala was second most densely populated state in India, now it occupied the third position with density of 819 persons per km² with an increase of 70 persons per km². The other states with more than 100 persons increase in density include Uttar Pradesh (142) and Haryana (106).The lowest density and the lowest growth in density was seen in Arunachal Pradesh with an increase of only 3 persons per km² from 10 in 1991 to 13 in 2001. The other states with low growth in population density include Uttarakhand (26), Chhattisgarh (24), Meghalaya (24), Jammu and Kashmir (23), Manipur (21), Sikkim (19), Himachal Pradesh (16) and Mizoram (10). The state of Nagaland exchanged its position with Jammu and Kashmir for 21st position in population density with an average density of 120 persons per km².

All the Union territories witnessed a very high increase in population density, of which the highest growth was seen in Delhi of 3088 persons per km², from 6252persons per km² in 1991 to 9340 persons per km² in 2001. The other Union territories with significant growth include Chandigarh (2268), Daman and Diu (506), Puducherry (347), Lakshadweep Islands (279) and Dadra and Nagar Haveli (167). Only Andaman and Nicobar Islands witnessed low increase in density of only 9 persons per km².

Hence, in 2001 the most densely populated states were West Bengal (903), Bihar (881), Kerala (819), Uttar Pradesh (690), Punjab (484), Tamil Nadu (480), Haryana (478), Goa (364), Assam (340), and Jharkhand (338) with an average density greater than National average. The states with average density below 120 included Nagaland (120), Himachal Pradesh (109), Manipur (103), Meghalaya (103), Jammu and Kashmir (100), Sikkim (76), Mizoram (43) and Arunachal Pradesh (13).

The highest densities in India were recorded in Union Territories of Delhi (9340), Chandigarh (7900), Puducherry (2030), Lakshadweep (1895) and Daman and Diu (1413). Only Dadra and Nagar Haveli (449) and Andaman and Nicobar Islands (43) showed comparatively low densities.

Table:8.4 India: Density of Population 1991-2011

State/ Union Territory	2011	2001	1991	Change in 1991-2001	Change in 2001-2011
INDIA	382	325	267	58	57
States					
West Bengal	1029	903	767	136	126
Bihar	1102	881	685	196	299
Kerala	859	819	749	70	40
Uttar Pradesh	828	690	548	142	138
Punjab	550	484	403	81	66
Tamil Nadu	555	480	429	51	75
Haryana	573	478	372	106	95
Goa	394	364	316	48	30
Assam	397	340	286	54	57
Jharkhand	414	338	274	64	76
Maharashtra	365	315	257	58	50
Tripura	350	305	263	42	45
Andhra Pradesh	308	277	242	35	31
Karnataka	319	276	235	41	43
Gujarat	308	258	211	47	50

Orissa	269	236	203	33	33
Madhya Pradesh	236	196	158	38	40
Rajasthan	201	165	129	36	36
Uttarakhand	189	159	133	26	30
Chhattisgarh	189	154	130	24	35
Nagaland	119	120	73	47	-1
Himachal Pradesh	123	109	93	16	14
Manipur	122	103	82	21	19
Meghalaya	132	103	79	24	29
Jammu and Kashmir	124	100	77	23	24
Sikkim	86	76	57	19	10
Mizoram	52	43	33	10	9
Arunachal Pradesh	17	13	10	3	4
Union Territories					
Delhi	11297	9340	6252	3088	1957
Chandigarh	9252	7900	5632	2268	1352
Puducherry	2598	2030	1683	347	568
Lakshadweep	2013	1895	1616	279	118
Daman and Diu	2169	1413	907	506	756
Dadra and Nagar Haveli	698	449	282	167	249
Andaman and Nicobar Islands	46	43	34	9	3

Source: Census of India, 2001: Primary Census Abstract, Total Population: Table A-5 and Census of India, 2011, Provisional Population Totals, p. 160

Change in Population Density in India, 2001-2011: The average density of population of India in 2011 was 382 persons/km² with the addition of 57 persons/km² since the last census in 2001 with the average density of 325 persons/km² only.

With the highest increase of 299 persons/km², now Bihar with an average density of 1102 persons/km² occupied the position of most densely populated state in India. With the increase of 126 persons/km², West Bengal with a density of 1029 persons/km² became second most densely populated state India. With and high increase of 138 persons/km² Uttar Pradesh

(828) occupied the fourth position in density while Kerala (859) with increase of only 40 persons occupied third position. The lowest growth in density was seen in Nagaland with a decrease of only 1 person per km² from 120 in 2001 to 119 in 2011. The other states with low growth in population density include Arunachal Pradesh (4), Mizoram (9), Sikkim (10), Himachal Pradesh (14), Meghalaya (19), Manipur (19), Jammu and Kashmir (24) and Uttarakhand (30).

All the Union territories witnessed a very high increase in population density, of which the highest growth was seen in Delhi of 1957 persons per km², from 9340 persons per km² in 2001 to 11297 persons per km² in 2011. The other Union territories with significant growth include Chandigarh (1352), Daman and Diu (756), Puducherry (568), Dadra and Nagar Haveli (249) and Lakshadweep Islands (118). Only Andaman and Nicobar Islands witnessed low increase in density of only 3 persons per km². The rate growth in Delhi and Chandigarh has reduced substantially since the last census growth of 1991-2001. Still, their density is higher than the most densely populated country in the world, Singapore with an average density of 7143 persons/km².

Hence, in 2001 the most densely populated states were Bihar (1120), West Bengal (1029), Kerala (859), Uttar Pradesh (828), Haryana (573), Tamil Nadu (555), Punjab (550), Jharkhand (414), Assam (397) and Goa (394) with an average density greater than National average. The states with average density below 125 included Jammu and Kashmir (124), Himachal Pradesh (123), Manipur (122), Nagaland (119), Sikkim (86), Mizoram (52) and Arunachal Pradesh (17). The north eastern zone with sparsely populated states of Arunachal Pradesh, Manipur, Meghalaya, Mizoram and Nagaland has recorded has recorded the lowest density of 175 persons /km².

The highest densities in India were recorded in Union Territories of Delhi (11297), Chandigarh (9252), Puducherry (2598), Lakshadweep (2013) and Daman and Diu (2169). Only Dadra and Nagar Haveli (698) and Andaman and Nicobar Islands (46) showed comparatively low densities.

In 2001, there were 22 districts in India, which had the density of 2000 persons/km² of which 10 districts had the density above 12,000. These ten districts included: 5 in Delhi, 2 in Mumbai, Kolkata, Chennai and Hyderabad. The ten districts with lowest population densities were 6 in Arunachal Pradesh, 2 in Jammu and Kashmir, and one in Himachal Pradesh and Sikkim. Dibang Valley of Arunachal Pradesh recorded the lowest density of 1 person. 253 districts with the density of below 250 were sparsely distributed in India.

In 2011, the number of densest districts increased from 22 to 28, while the top 10 districts remained the same, though their ranking changed. In the same way, the bottom ten districts remained the same except the addition of Kinnaur (Himachal Pradesh), and removal of Kurung Valley (Arunachal Pradesh) whose density increased from 7 to 15.

The belt of districts starting from the plains of Punjab, runs through the Ganga-Yamuna plains, the middle and lower reaches and the delta of Ganga System, winds through the eastern coast of Kanyakumari, traversing the deltas of Mahanadi, the Godavari, the Krishna, The Cauvery and the other rivers and finally turns around the western coastal districts, especially Kerala, have a density well above the national average. In comparison, the districts of north east, especially those of Arunachal Pradesh, Manipur and Mizoram, and a few from Himachal Pradesh, Jammu and Kashmir, Uttarakhand, and arid districts of Rajasthan have recorded very low densities.

Hence, according to the density three density areas can be classified as follows:

1. Areas of High Population Density: It includes such areas, which have the population density of more than 500 persons/km². The states of Bihar, West Bengal, Kerala, Uttar Pradesh, Haryana, Tamil Nadu and Punjab and Union Territories of Delhi, Chandigarh, Puducherry, Lakshadweep, Daman and Diu and Dadra and Nagar Haveli come under this category. The traditional Hindi speaking belt, Malabar Coast, Tamil Nadu Uplands, Mahanadi Delta, Godavari Delta, Bari and Bist doabs and highly urbanized regions of Mumbai, Hyderabad, Bengaluru, Ahmedabad, Kheda, Indore and Lakshadweep come under this category. These regions are characterized by rich industrial and agricultural economy.

2. Areas of Moderate Population Density: It includes such areas, which have the population density between 500 and 200 persons/km². The states of emerging Urban Industrial Economies are included there. They are Jharkhand, Assam, Goa, Maharashtra (365), Tripura (350), Karnataka (319), Andhra Pradesh (308), Gujarat (308), Orissa (269), Madhya Pradesh (236) and Rajasthan (201). These are the areas where the agriculture is handicapped by the undulating topography and scarcity of water for irrigation, but the urban-industrial

development is responsible for the growth of the population clusters. Some of these areas have been used to settle the displaced population after independence, which has contributed substantially to their economic development.

3. Areas of Low Population Density: It includes such areas, which have the population density of less than 200 persons/km². Uttarakhand (189), Chhattisgarh (189), Meghalaya (132), Jammu and Kashmir, Himachal Pradesh, Manipur, Sikkim, Mizoram and Arunachal Pradesh. The Union Territory of Andaman and Nicobar is also included in this class. These areas suffer from physical handicaps like hilly terrain, desert conditions, marshy lands and forested tracks. The agriculture in the areas is also under developed. The extensive soil erosion, the paucity of water and thick forests have hindered the development of agriculture. Most of these areas are inhabited by the tribes whose living conditions are very poor. The agricultural development in some of these areas like Dandakaranya, Chambal Valley etc. has been initiated to improve the economic base of these areas, to initiate the process of social upliftment and to remove regional imbalances.

8.6 CONCLUSION

The country's demographic ethos seems to have undergone a sea change. With a huge reduction in the mortality rates, gone are those days when the mortality ruled the demographic scene of India. Now, the fertility and the migration are responsible for opening a whole new chapter in the demographic history of India. Today, India is approaching towards better population stabilization, and heading to a new stage of demographic transition. The census of 2011 has brought hopes for the much better results in the decades to come. The largest young population in the world may prove useful for the upliftment of the country's economy against the fears of the demographers considering it a burden and a hindrance to the developing economy of the country.

The pattern of population growth and the pattern of population distribution are not same. For example, in Kerala, West Bengal and Tamil Nadu exhibit low growth rates but have high population concentration. On the other hand, northeastern states show high growth rates but have the lowest densities in India. Hence, the population distribution reflects the demographic history of the state while the population growth reflects the social awareness and level of development of the region. In India, the social factors play a pivotal role in determining the demographic statics of the country. The other factors are in most of the time over ruled by this set of determinants. It reflects not only the traditional way of the society but sometimes, they act as important hindrances to the social upliftment and the economic development of the country.

The development of the Southern states in nearly each part is better than the northern counterpart, Hence, to end this disparity and bring the whole of the India to a single level, needs attention not only from the part of the government but also from the part of the citizens. The over burden in the metropolitan is now characterized by slums, low standard of living, loss of fertile agricultural lands, degrading standards of proper health. The facilities of proper living should be provided outside the metropolitan also. It will not only lessen the burden from million cities but would aim in providing equal opportunities and facilities to all the citizens of the country. The youth will no longer be the worry of government, but will become a precious resource serving to the upliftment of the country and society as well. A gradual but determined effort on the part of the country to turn its teeming millions into a productive asset, slowly but definitely improving standards of living and the constructive role the country has played in the global issues of import, all have gone a long way in the attempt to achieve an international politico-economic status corresponding to its population size (Chandna, 1986).

8.7 SUMMARY

The unit discusses the statistics of population growth, distribution and density and the factors affecting them. The growth of population in the last decade of 2001-2011 was reduced to 17.64% witnessing a decrease of 3.90% from the previous decade. The spatial variations in the growth patterns of the country were attributed to the different social, economic, biological and demographic factors. India reached to the third stage of the demographic transition characterized by stagnant low death rates and steadily decreasing birth rates. However, in this case too, the spatial variations existed, creating a North – South divide. The annual exponential growth rate declined from 1.97% in 1991-2001 to 1.64% in 2001-11. The magnitude of decrease in population rates varied spatially across different parts of the country. The decadal growth declined by nearly ten points in Northern states to only 18.2% in 2001-2011. The

Southern states exhibited decadal growth rate of only 12.6%. In the Union Territories, the decrease in the decadal growth rate was significant.

The Distribution Pattern is determined by the various physical, socio-cultural and demographic factors. The micro level study of distribution is done through the analysis of density patterns to establish better man land ratios. The average national density of population increased by 57 points reaching 382 persons/km² in 2011. The north eastern zone with the density of 175 persons/km² was the most sparsely populated region. Indo-Gangetic plain remained the most densely populated region in India. Bihar with the density of 1102 persons/km² emerged as the most densely populated state and Arunachal Pradesh with the density of 17 persons/km² emerged as the most sparsely populated state. Delhi with the density of 9,340 persons/km² was the most densely populated UT in India.

8.8 GLOSSARY

- Agricultural Density: It offers a relationship between the agrarian population and the total cultivated land.
- Arithmetic Density: It stands for the simple ratio between the total population and the total land area.
- Demographic Transition Theory: The theory was given by W. S. Thompson and Frank W. Notestein and is based on the fertility and mortality trends observed in Europe, America and Australia. The theory postulates a particular pattern of demographic change from a high fertility and high mortality to low fertility and low mortality, when a society progresses from a largely rural, agrarian and illiterate society to a dominantly urban, industrial and literate society. The three hypotheses involved in the process are (i) decline in mortality comes before decline in fertility, (ii) fertility later eventually declines to match mortality and (iii) the socio-economic transformation of the society takes place simultaneously with its demographic transformation.
- Distribution of Population: The actual pattern of the spacing of units of individuals' i.e. spatial pattern in which the population finds its location.
- Economic Density: It is the ratio between the requirements of the population and the resources made available to it by the production in the areas it occupies.
- Fertility: It refers to the occurrence of birth, commonly calculated per thousand of population.

- Migration: It refers to the permanent or semi-permanent change in the residence of the person, which involves a complete change, and readjustment of the community affiliations of the individual.

Mortality: It has been defined as permanent disappearance of all evidences of life at any time after birth has taken place.

Nutritional or Physiological Density: It stands for the ratio between the total population and total cultivated area, is expressed in terms of persons per unit of cultivated land.

Population Change: The change in the number of inhabitants of a territory during a specific period of time, irrespective of the fact that the change is negative or positive.

Population Density: It stands for the number of persons occupying per unit area.

8.9 ANSWER TO CHECK YOUR PROGRESS

Q1. What do you understand by the term Population Growth? Explain the factors responsible for the spatial disparity of growth rates.

Q2. What are the different methods by which the density and distribution of population is studied?

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8.12 TERMINAL QUESTIONS

Q1. Population has gone through the different phases of growth. Discuss the statement with the close reference to the demographic transition in India.

Q2. Show the spatial temporal change in the population growth in last two decades.

Q3. Distinguish between the terms population growth and population density. How does the density help in the study of distribution patterns in India?

Q4. What are the different factors responsible for the distribution of population?

Q5. To what extent has the distribution of the population has changed from 2001 to 2011?

UNIT 9 - POPULATION COMPOSITION

9.1 OBJECTIVES

Studying this lesson, you will be able to:

- Understand the demographic, social and economic dimensions of population.
- Understand the sex ratio and measures to balance it,
- Understand the age structure of population
- Understand the population growth and various factors affecting it.

9.2 INTRODUCTION

Population composition refers to the categorization of population based on various determinations like sex ratio, age composition, occupational characteristics and economic factors.

Sex ratio of population moulds the social and economic relations of a community. According to **S.H. Franklin,** sex ratio is an index of economy reviling in an area. The sex ratio deeply effects population. Knowledge of sex ratio helps us in understanding the employment, consumption and social requirements of a community.

Economic composition explains economic, demographic and cultural attributes of a region or community study of economic composition of population helps in planning for suitable type of economy-primary, secondary or tertiary for a region. It also supplies tools for planning of expansion of economic activity and employment opportunities.

9.3 SEX RATIO

Sex composition holds a prime place for population geographers. It provides separate data for males and females, which is important for various planning processes and for analyzing other demographic characteristics. The balance, which exists between the two sexes, determines the social and economic relationship within a community. Franklin further elaborates the importance of sex ratio and observes that 'Sex ratio is an index of economy prevailing in an area and is a useful tool for regional analysis' further the knowledge of sex ratio is essential for understanding the employment and consumption patterns, and social needs of a community. Trewartha in 1953 remarked that, the proportion of the two sexes is fundamental to the geographic analysis of an area because it is not only an important feature of the landscape but it also influences the other demographic elements significantly and as such provides an additional means for analyzing the regional landscape.

Measurement of Sex Composition

Sex ratio is numerical measurement of sex composition of a population. This ratio is calculated differently in different countries. In some countries like the U.S.A., the sex ratio is expressed in terms of number of males for hundred females. Whereas in countries like Russia, it is expressed in terms of percentage of male or female population.

In India, the sex ratio is calculated in terms of number of females for thousand males.

$$\frac{P_t}{P_m} \times 1000$$

Where, P_m = number of males

P_f = number of females

P_t = the total population

There is also an inherent distinction between various types of sex ratios. There are three types of sex ratios – Primary sex ratio, Secondary sex ratio and Tertiary sex ratio.

Primary sex ratio: It denotes the ratio between two sexes at the time of conception.

Secondary sex ratio: It denotes the ratio between the two sexes at the time of birth.

Tertiary sex ratio: It refers to the ratio of the two sexes at the time of enumeration.

Determinants of tertiary sex ratio

There are wide regional variations in the tertiary sex ratio. This ratio in mainly determined by three basic determinants, which are:

- The sex ratio at birth
- The sex ratio at death
- The sex ratio of the migrants

If we examine the sex ratio of registered births of different countries, they reveal a similar pattern of having excess males at the time of birth for each hundred females. Yet, not all the countries in the world would have similar natural sex ratio, and this is due to various factors. According to Thompson and Lives, "since the natural sex ratio in itself is governed by the differences in the pre-natal mortality of the two sexes and since more males die before birth than females, it is often said that these countries where pre-natal bases are low, natural sex ratio is more masculine and it is less masculine where the pre-natal basses are great".

It is quite interesting to know that within the same country, one can find differences in the natural sex ratio of the various population groups as is the case in India where the Muslims, the Christians, the Hindus have different natural sex ratio.

The differences in the mortality ratio among males and females create difference in the tertiary sex ratio. As the mortality rate is closely associated with the socio-economy development, therefore the developed countries with their better medical facilities and quite low maternity deaths and equality among the children of the bath sexes depicts higher male mortality ratio than the female mortality rates at all ages and more so among the infants. In contrast to the developed countries are such that more females die in comparison to the males, and this is the direct result of their socio-economic setup. Therefore, we conclude that as compared to natural sex ratio, the sex ratio at death is much more variable from country to country. The difference in the sex ratio at death among various countries are to be associated with their differences in the stage of socio-economic development, standard of living, status granted to women, type of economy, degree of participation in work by females etc.

The third factor, which affects the tertiary sex ratio, is the selectivity among the migrants on the basis of sex. Basically, the migrations that take place due to economic reasons are mainly sex-selective for example, in India the rural to urban migration that takes place is highly male dominated and is an economically motivated migration. In more developed countries, the urban sex ratios are more in the favour of females. The socially determined migration is also sex-selective. The perfect example is of India, where migrations for matrimony involve the movement of females from the place of residence of their parents to the place of residence of their spouses. There is also one aspect which must be discussed here, i.e. the rural-urban differential sex ratio. In the developed countries, males outnumber females in the countryside whereas female outnumbers males in urban areas. In the less developed countries like India, opposite is the case.

Apart from there three basic determinants, the sex ratio of population at any point of time is also affected drastically by wars, epidemics, and certain practices partial to a particular sex.

The Changing Patterns of Sex Ratio in India

If we look at the census data of last 11 decades, we come to a general conclusion that the overall sex ratio in India has been under favourable to females and this difference has further increased during 1901-2011, especially between 1901 and 1971. It slightly improved in 1981 but declined again in 1991. There has been improvement in last two censuses becoming 940 females per 1000 males in 2011.

Between 1981 and 1991, when the sex ratio of our country's population improved, a unanimous opinion was raised. Everyone thought that the discrimination against women and girl child has been curled, this would bed to further improvement in the ratio. However, it was a false perception as the ratio again declined by 6 points between 1981 and 1991. This was a shock. Nevertheless, when the sex ratio improved in 2001and 2011, it indicated towards better social status to women in the country.

Sex Ratio in India, 1991

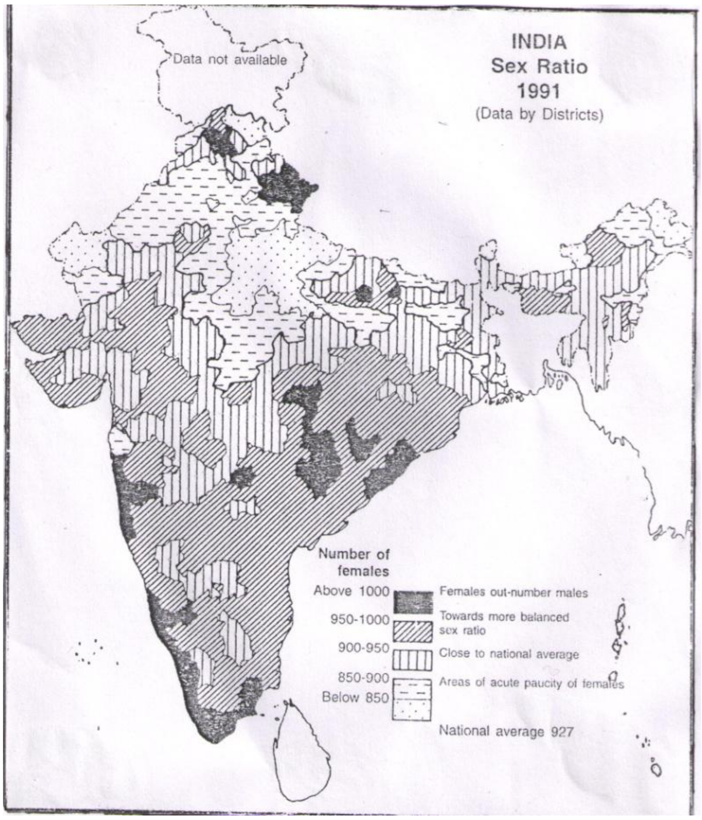
Like any other developing country in the world, India is also characterized by a deficiency of females in its population. As per the 1991 census, the sex ratio of Indian population was only 927;which means a further decline from 934 in 1981 to 927 in 1991. There were also huge regional variations from one part of the country to another.

Kerala with its less fertility and mortality rates and male excessiveout migration displayed a sex ratio of 1034, was the only state in the country, which had excess of females over males. At the other end of the scale was Arunachal Pradesh with only 859 females for every thousand males. Among the union territories, Pondicherry displayed the highest sex ratio of 797, Chandigarh due to excess male in migration, with a sex ratio of 790 displayed the highest female ratio in the country.

Some states, which displayed high sex ratio above the national average of 927 included Tami Nadu (974), Andhra Pradesh (972), Orissa (971), Goa (967), Manipur (958), Karnataka (960), Meghalaya (955) and Tripura (945). By contrast, the statuses with fairly large paucity of females were Arunachal Pradesh (859), Haryana (865), Sikkim (878), Uttar Pradesh (876), Punjab (882) and Nagaland (886). These states had a sex ratio of less than 900.

In general, as compared to the northern states, the southern states displayed high sex ratio. Peninsular India hill regions, tribal regions too displayed relatively higher sex ratio.

Map-9.1



Source: Geography Book

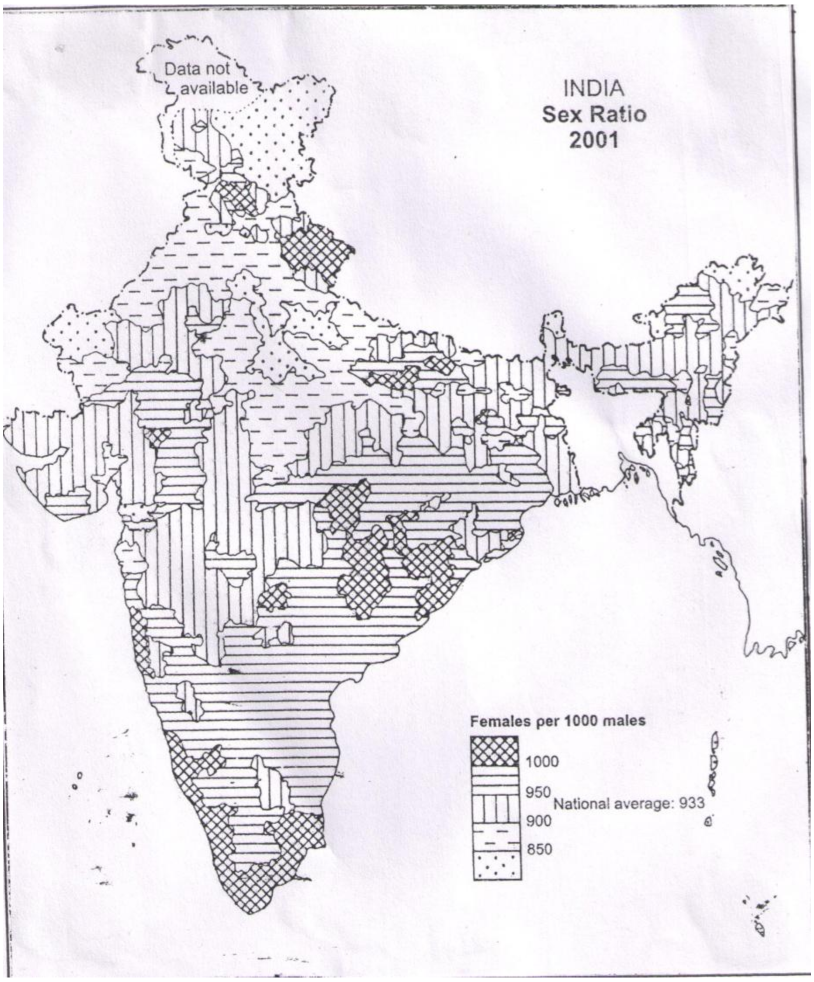
During 1991-2001, the sex ratio of the country improved from 927 in 1991 to 933 in 2001. This marginal improvement was recorded due to improvement in enumeration in some states such as Bihar, Arunachal Pradesh, Uttaranchal etc. and decline in female mortality rate due to improvement health services. From among various states, Kerala led the way with a sex ratio of 1058, whereas Haryana, due to notorious, ill- practice of female infanticide, displayed the lowest sex ratio of 861 females over thousand males. Among main territories, Puducherry displayed a healthy sex ratio of 1001, on the other hand Daman and Diu recorded lowest sex ratio, of 710.

Other states, which recorded sex ratio, higher than national average (933), were Chhattisgarh (989), Tamil Nadu (987), Andhra Pradesh (978), Manipur (978), Meghalaya (972), Odisha (972), Himachal Pradesh (968), Karnataka (965), Uttaranchal (962), Goa (961), Tripura (948), Jharkhand (941), Mizoram (935), and West Bengal (934). At the other end of the scale, apart from Haryana were Punjab (876), Sikkim (875), J & K (892), Arunachal Pradesh (893) and Uttar Pradesh (898).

The huge difference, which exists between Kerala and Haryana, must be discussed here. In Kerala, females enjoy higher status in the society and also there is male selective out migration in the state whereas opposite is the case of Haryana. On the other hand low sex ratio of union territories is due to male-selective in migration, as the UT's are highly urbanized, although the case of female feticide and infanticide cannot be ruled out.

However, the most remarkable salient feature of the country's sex ratio at the turn of new century was that, out of 28 states (2001) in the country recorded an improvement in their sex ratios during 1991-2001.

Map:9.2



Source: Geography Book

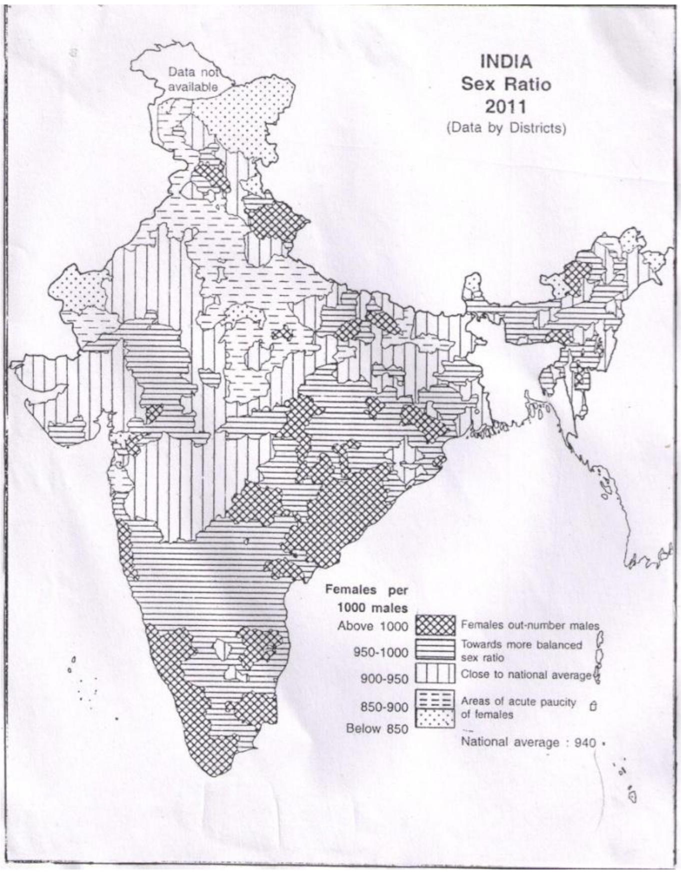
Sex Ratio in India, 2011

As per the latest census of 2011, there has been a marginal improvement in the country's sex ratio from 933 in 2001 to 940 in 2011. Kerala among states and Puducherry among union territories displayed highest sex ratio of 1084 and 1038 respectively.

Kerala among states was followed by Tamil Nadu (995), Andhra Pradesh (992), Chhattisgarh (991), Manipur (987), Meghalaya (986), Odisha (978), Mizoram (975) and Himachal Pradesh (974). At the other end of the scale were states like Haryana closely followed by Jammu and Kashmir (883), Sikkim (889) and Punjab (893). Among the tail-enders apart from J & K, all other states recorded marginal improvement in their sex ratios.

Among the union territories, Puducherry was followed by Lakshwadeep (946), Andaman & Nicobar Islands (878), NCT of Delhi (866), Chandigarh (818), Dadra and Nagar Haveli (775), and Daman & Diu (618). The explanation for the above mentioned patterns have already been discussed in the preceding section.

Map:9.3



Source: Geography Book

If we closely analyse the Census data, we come to a general conclusion that:

(i) North India, N.W. India and western India displayed low sex ratios, whereas the southern, N.E. and eastern states displayed comparatively higher sex ratios.

(ii) Christian predominant and hilly regions displayed higher sex ratios.

Sex Ratio at District Level

The number of districts in the country has grown from 593 in 2001 to 640 in 2011. The following table makes a comparison between 2001 and 2011 data and also the nature of shift between the two time points. With the rise of sex ratio in the country, the number of districts with sex ratio above 1000 has increased from 78 in 2001 to 98 in 2011. There is also an upward shift in the next category (951-1000) as well resulting in decline in the number of districts in certain other categories especially below 850.

Table 9.1 Distribution of districts by overall sex ratio 2001 and 2011:

Range	2001	2011
> 1000	78	98
951 – 1000	175	198
901 – 950	210	199
851 – 900	122	125
801 – 850	45	12
Up to 800	10	8
Total	**640**	**640**

Source: Census of India 2011.

Concentrations of those districts displaying high sex ratios are found in Uttarakhand, Kerala and Odisha, and in parts of Himachal Pradesh, Arunachal Pradesh, Karnataka and Tamil Nadu. Districts with low sex ratios are found in Punjab, Haryana and western U.P.

Child Sex Ratio

If we want to get a real picture of country's sex composition, we can only get it through child sex ratio. As per the Census, 2011the child sex ratio of our country's population was 914. What is discouraging and even horrifying is that as our society is progressing and becoming more techno centric at the same time it is becoming partial to females. If we compare last three Censuses, we can easily comprehend that not only it is low but also declining. It is new becoming a critical area of serious concern. In addition, if the current situation is not controlled, then it is likely to have for reaching implications for the country's demographic scenario.

Table 9.2 India: Change in Sex Ratio, 1981-2011

Sate/Union Territory	1981	1991	2001	Change 1991-2001	2011	Change 2001-11
India **Sates**	**934**	**927**	**933**	**+60**	**940**	**+7**
Kerala	1032	1036	1058	+22	1084	+26
Chhattisgarh	NA	985	989	+04	991	+2
Tamil Nadu	977	974	987	+13	995	+8

Andhra Pradesh	975	972	978	+06	992	+14
Manipur	971	958	978	+06	987	+9
Meghalaya	954	955	972	+22	986	+14
Orissa	981	971	972	+01	978	+6
Himachal Pradesh	973	976	968	-08	974	+6
Karnataka	963	960	965	+05	968	+3
Uttarakhand	NA	936	962	+26	963	+1
Goa	975	967	961	-06	968	+7
Tripura	946	945	948	+03	961	+13
Jharkhand	NA	922	941	+19	947	+6
Mizoram	919	921	935	+14	975	+40
West Bengal	911	917	934	+17	947	+13
Assam	919	919	935	+16	954	+19
Maharashtra	937	934	922	-12	925	+3
Rajasthan	919	910	921	+11	926	+5
Bihar	946	907	919	+12	916	-3
Gujarat	942	934	920	-14	918	-2
Madhya Pradesh	941	912	919	+07	930	+11
Nagaland	863	886	900	+14	931	+31
Arunachal Pradesh	862	859	893	+34	920	+27
Jammu & Kashmir	892	896	892	-04	883	-9
Uttar Pradesh	885	876	898	+22	908	+10
Sikkim	935	878	875	-03	889	+14
Punjab	879	882	876	-06	893	+17
Haryana	870	865	861	-04	877	+16
Union Territories						
Puducherry	985	979	1001	+22	1038	+37
Lakshadweep	975	943	948	+05	946	-2
Andaman & Nicobar Islands	760	818	846	+28	878	+32
Delhi	808	827	821	-60	866	+45
Dadra & Nagar Haveli	974	952	812	-140	775	-37
Chandigarh	769	790	777	-13	818	+14
Daman & Diu	1062	969	710	-259	618	-92

Source: Census of India 2001: Primary Census Abstract, Total Population : Table A-5 and Census of India. (2011) Provisional Population Totals.

Among the states, Mizoram displayed the highest child sex ratio of 971, whereas Haryana showed the last ratio of 830. Among union territories, Andaman and Nicobar displayed the highest child sex ratio of 966, whereas NCT of Delhi displayed the lowest ratio of 866. Unlike general sex ratio, no state on union territory had a child sex ratio of more than 1000.

Table 9.3 India: Change in Child Sex Ratio 1961-2011

Year	Child Sex Ratio
1961	976
1971	964
1981	962
1991	945
2001	927
2011	914

Source: Census of India, 2011

Other states with a child sex ratio of above national (914) average included: Chhattisgarh (964), Arunachal Pradesh (960), Kerala (959), Assam (954), Tripura (953), West Bengal (950), Tamil Nadu (946), Nagaland (944), Sikkim (944), Karnataka (943), Andhra Pradesh (943), Jharkhand (943), Manipur (934), Orissa (934), Bihar (933) and Goa (920). On the other hand, these states, which had a low child sex ratio of less than 900, included Gujarat, Uttarakhand, Maharashtra and Uttar Pradesh. Among Union territories apart from NCT of Delhi, Chandigarh (867) displayed the lowest child sex ratio. This implies that the Pre-Natal Diagnostic Technique (PNDT) (Regulation and Prevention of Misuse Act), 1994 and its revision to make it more effective did not have much impact on the areas where female foeticide has been rampant. If we really wish to curb this menace, then certain story steps have to be taken such as improving literacy levels, exhausting antenatal tracking, and regular counseling of mothers to be and increased role of electronic media. Only with concentrated serious effect and policies, the child sex ratio of India's population can be lifted upto a normal level.

India's Workforce

All over world an often, mode distinction is between total population and human power. Total population is the entire populace inhabiting the area. Human power denotes those persons who are able to engage in economically gainful activities. Many countries classifyhuman power into two sub-categories. These sub-categories are economically non-active population and economically active population. Economically active population carries on production of goods and services. Economically non-active population is engaged in household duties, academic studies, looking after relatives or infirm people etc.

In India, population is divided into two categories of **working** and **non-working population** instead of above discussed-economically active and non-active populace. The concept of worker was introduced in India in 1961. According to the Census of India, 1971, 'A worker is a person whose main activity was participation in any economically productive work either by his physical or by his mental activity. Since introduction in 1961, the concept of worker was changing from census to census. Such changes can be easily understood by comparison of concepts of 1961 and 1971.

1961	1971
Any person who had worked for at least one hour a day on an average during the reference period was classified as worker.	If a person worked on any one of the days during the reference period of one week prior to the date of enumeration, was considered as a worker provided his/her main activity was economically productive work.

Thus, homemakers, students, social workers, pensioners, rent-receivers fall in non-worker category. The 1981 census made a distinction between main workers and marginal workers. A **main worker** is one who worked in some economic activity over a period of six months (183 days) or more in both the agricultural seasons. On the other hand,**marginal worker** is one who worked any time at all in the year but not for the major part of the year (less than 183 days). Thus census of India, 1981, attempted to divide population into workers and non-workers for the first time. The working force is computed as percentage of workers to total population:

$$= \frac{\text{No of worker}}{\text{Total population}} \times 100 = \%\text{ of worker}$$

The size of working population is impacted upon by various factors. These factors may be demographic, social or economic. These factors have several components, which are as follows:

1. **Demographic factors: the** birth rate, the age structure, life span, the migration behavior and average size of the family.

2. **Social factors:** level of literacy and education, status of women in the society age at marriage and general health standards.
3. **Economic factors:** the type of economy, availability of employment opportunities and levels of income.

Composition of India's Workforce

India is a developing or less developed country like all less developed countries it has low work participation rate. According to 2011 Census, only 39.8% of population is at work. Following table shows India's percentage of working population:

Table 9.4

Census	Work Participation Rate in %
1981	36.70
1991	37.50
2001	39.1
2011	39.8

Source: Census of India, 2011

Such a low proportion of working force may be due to country's high rate of natural increase, social perceptions and prejudices against female work participation effects overall participations. Female work participation was 14.0% in 1981, 22.3% in 1991, 25.6% in 2001 and 25.5% in 2011. It means that only one female out of four females is working. For males, it turns out that one out of every two males is working. According to census of India, 2011, top five bottom five state on the basis of work participation are as follows:

Table 9.5 Top five states or Union Territories

Status / UT's	Work Participation Rate (%)
Himachal Pradesh	51.9
Sikkim	50.5
Daman & Diu	49.9
Nagaland	49.2
Chhattisgarh	47.7

Table 9.6 Bottom five states or Union Territories

Status / UT's	Work Participation Rate (%)

Lakshadweep	29.1
U.P.	32.9
Bihar	33.4
J & K	34.5
NCT of Delhi	33.3

Source: Census of India, 2011

According to R.C. Chandra, "the patriarchal system of India society, age old prejudices against female mobility, prejudices against their education, their relatively low social status in the society, frequent child births, limited job opportunities for them and limited desire on the part of the female themselves to participate in economic struggle are the factor that have contributed to poor female participation in work in India. Therefore, it is not surprising that top five states in India on the basis of female work participation ratio have sizeable tribal population. Tribal societies accord comparatively higher status to females as compared to traditional societies in India.

Table 9.7 Top five and Bottom five states of Union Territories on the basis of female work participation ratio:

Status / UT's		**Work Participation Rate (%)**
Top:	Himachal Pradesh	44.8
	Nagaland	44.7
	Chhattisgarh	39.7
	Sikkim	39.6
	Manipur	38.6
Bottom:	NCT of Delhi	10.6
	Lakshadweep	11.0
	Punjab	13.9
	Daman & Diu	14.9
	Chandigarh	16.0

Source: Census of India, 2011

As you can see the level of female participations great variation. It varies between 10.6% (Lakshadweep) to 44.8% (H.P.). However, in case of participation the state-to-state variation is very little. As per 2001 census, it was between 57.6% (Tamil Nadu) to 46.1 percent (Uttarakhand).

The industrial composition of India workforce is dominated by primary sector. Still more than half of the workers in India (54.6%) are engaged in primary sector's related activities. Secondary sector accounts for only 3.8%. Tertiary sector has seen high growth in workers participation. In 1981, tertiary sector accounted for only 17.4% of workers, which has risen to 41.6% in 2011. Sector wise participation of workers in given below:

Tale 9.8

Sector	1981	1991	2001	2011
Primary	69.3%	67.4%	58.2%	54.6%
Secondary	13.3%	12.1%	4.2%	3.8%
Tertiary	17.4%	20.5%	37.6%	41.6%

Source: Census of India, 2011, Provisional Population Totals.

The declining percentage of workers in secondary sector underlines the weakness of secondary sector of India economy to create jobs and absorb labour. It also exposes countries weak manufacturing base.

By summarizing, we can say that India has low work participation rate as other less developed countries (LDC's) have. It is chiefly due to very young population and high birth rate. Female participation in workforce is abysmally low due to many social and economic factors. Female participation has great state-to-state variation. However, male participation in workforce is also some across the country or has little variations. States with sizeable tribal population have great work participation ratio as well as female participation in workforce. Literacy has little effect on work participation ratio as Kerala has quite low rank in work and female participation. Indian economy's work manufacturing base reflects in lower workforce participation in secondary sector. Tertiary sector's growth in work participation indicates its potential of employment and lopsided nature of economy where tertiary sector is growing at the cost of secondary sector. Primary sector still dominates the employment segment and indicates agriculture and related activities has still great role in countries economy.

9.4 OCCUPATIONAL STRUCTURE

A detailed analysis of a population's economic composition brings out the diverse economic, demographic and cultural attributes of an area, which forms the basis for that particular region's social and economic development. In addition, its study remains incomplete without its reference to the occupational composition of a population. Like any other structure, the occupational structure of a society is the amalgamation of a number of intimately related factors. Occupation is a very significant social attribute of population. It exerts vital influence on social, economic, demographic and cultural characteristics (**G.S. Gosal**).

According to M.S. Sidhu, 'Analysis of occupational structure of a region undertakes the percentage of workers, engaged in different occupations. Participation of rural, urban, male and female workers in different age-groups depends upon the physical resource base, social organization and the economy of the region. Therefore, the working force and occupational structure bring about overall changes in the social-economic setup of the area. So, one can conclude on the basis of preceding paragraph that the nature and variety of physical resource base, lays down the layout and the basic foundation for the generation of occupations by providing fertile land for agriculture, indented coast for fishing, unstinted vegetation cover for forestry, opulent geological strata for mining etc.

Whereas the primary resource is utilized on a commercial scale, then the occupational structure gets diversified. In addition, this process gets further impetus from industrialization because industrialization generates a variety of traditional jobs. According to R.C. Chandra, 'Advancement in science and technology introduces an element of specialization in the occupational composition by creating highly specialized types of jobs'. Through these developments, a new scenario and a new pattern emerges in space, which becomes the hub of new urban culture, or a more service oriented culture, which modifies occupational structure considerably.

The societies are often classified into primary, secondary and tertiary civilizations. As the diversification of economy is intimately related to the stage of technological advancement and socio-economic development, the countries with more than 60% of their male workers deriving their livelihood from agricultural sector are considered under-developed. These countries where the agricultural workers from less than 35% of the total workforce are considered developed and those with 35 to 60% of their workers in agricultural sector are considered semi-developed.

Classification of Occupations

Occupations are of almost infinite variety, and many classifications have been suggested, based either on the nature of the activities or on their social and professional characteristics. However, here the desirable element is that as many countries as possible should adopt the same groupings, so as to facilitate international comparisons. Moreover, in this direction United

Nations has worked considerably, for providing standardization of occupations. In 1964, the UN gave the following classifications:

(i) Professional, technical and related workers;
(ii) Managerial, executive and administrative workers;
(iii) Clerical workers;
(iv) Sales workers;
(v) Farmers, fishermen, hunters, lumberman and related;
(vi) Workers in mines, quarries and related workers;
(vii) Workers in transport and communication;
(viii) Craftsman production process workers and labourers not classified elsewhere;
(ix) Service, sport and recreation workers;
(x) Workers not classified by occupations;
(xi) Members of the armed forces.

In India, the Indian Census has refined its industrial classification considerably and has made it almost synonymous with that bring followed by the United Nations. The 1971 Indian Census adopted the following industrial classification:

(i) Cultivation
(ii) Agricultural labour
(iii) Livestock, forestry, fishing, hunting, plantations, orchards and allied activities.
(iv) Mining and quarrying
(v) Manufacturing, processing, servicing and repair
    a. Household industry
    b. Other than household industry
(vi) Construction
(vii) Trade and Commerce
(viii) Transport and storage
(ix) Other services

The 1981 census of India published its data about its workers into four main categories, these are:

(i) Cultivators
(ii) Agricultural labourers
(iii) Household industrial workers

(iv) Other workers

Here one should be quite clear about the additional information, provided by the census of India 1981, with regard to the marginal workers. The Census of India decided to go back to its nine-fold classification of occupation at the time of 1991 Census. Thus, one can clearly comprehend that the classification followed by Indian Census with regard to industrial composition of its population is fairly comparable with the one being followed by the United Nations.

However, attempting international comparisons of even the above mentioned nine categories is not easy. Therefore, the world is often divided into following three types of societies by groping the various industrial categories together:

(i) Societies dominated by primary activities (Agriculture, forestry, hunting, fishing, livestock etc.)

(ii) Societies dominated by secondary activities (Manufacturing, construction, power generation etc.)

(iii) Societies dominated by tertiary activities (Commerce, storage, transport, miscellaneous services)

The above mentioned three-fold division of world's societies is quite simple but points out towards the basic structure of the world's pattern of economy.

India's Occupational Structure

The Indian Census divides its workers into four major categories- cultivators, agricultural, labourers, household industry workers and other (miscellaneous) workers. As per the Indian Census, the primary sector still dominates the Industrial composition (54.6%). In addition, this clearly reflects the backwardness of the Indian economy. Over two-thirds of our working population is engaged in the primary sector i.e. agriculture and allied activities. Nevertheless, here one thing should be mentioned that by 2001, the country's occupational structure has undergone sea changes and in 2011, it has seen tremendous modifications. Only 24.6% of total workers were recorded as cultivators as against 37.1% in 2001, 39.7% in 1991 and 42.6% in 1981.

However, the preparation of agricultural labours, which stood at 24.9% in 1981, improved to 27.7% in 1991, again declined to 26.5% in 2001 and increased upto 30.0% in 2011. Thus, the agricultural sector in 2011 together accounted for 58.2% of total workers in the country.

The proportion of workers in the household industry has not undergone much change. Only 3.8% of the country's total workers are engaged in household industries. The share of such workers improved from 2.4% in 1991 to 4.2% in 2001, and again declined to 3.8% in 2011. The category of other workers accounted for 41.6% of total workers in the country, which was the highest among all the four major categories. Thus, one can infer from the above mentioned information that India's occupational structure seems to have reached the threshold point where the non-agriculture sector may soon take over the agricultural sector.

However, there are wide regional variations in the country's industrial sector. On one end of the scale, we have states like Chhattisgarh, Himachal Pradesh, Nagaland, Arunachal Pradesh, Rajasthan, Uttar Pradesh, Bihar and Madhya Pradesh where the majority of workers are engaged in agricultural sector. At the other end of the scale were states like Goa, Kerala, Punjab, West Bengal, Gujarat, Tripura, Haryana, Tamil Nadu, and Maharashtra where the proportion of other workers was much more pronounced.

9.5 CONCLUSION

After analysis the census data from last three Censuses, we come to a conclusion that there has been a constant decline in the share of workers who are engaged in agriculture sector in Indian economy, which clearly shows that the limited rural resource base is unable to sustain the ever increasing population load. But on the other hand there is an increase in the show of agriculture labourers, which indicates that the small uneconomic landholding does not yield enough productivity, and also that the marginal formers in all the states are being excluded in the process of restructuring of the country's industrial composition.

The share of household industry in the economy, which was already low earlier, is now diminishing, implying that the current political scenario is not favouring this particular sector Globalization has also severely affected this particular sector. Therefore, the one sector, which could really provide strength to rural resource base, is in abysmal condition. The most significant feature of India's occupational structure is that the proportion of other workers to total worker has increased in all the states considerably not only in non-agricultural states but also in states where cultivation was the chief activity.

Such a trend of restructuring of India's occupational structure is likely to get accentuated during the current decade. If that happens it might have for reaching impact upon the demographic scenario of India. Bu what is most discouraging is that the share of secondary sector is quite low and for balanced growth, the growth of tertiary sector must be preceded by the growth of secondary sector otherwise any disproportionate growth in tertiary sector may lead to more problem rather than solving them, as is happening with the case of India and other developing countries.

9.6 SUMMARY

Population composition is not just another part of population studies. It is the sum total of political, economic, social and demographic condition of any country. Only by looking at its various elements, one can easily comprehend a country's development index and its prosperity. It includes various elements such as; sex composition, age composition, age composition, economic composition and occupational composition provides separate data for males and females and gives important information about the status of women in the country. Economic and industrial composition gives are account of an economy prevailing in any area, whereas the occupational compositional further refines the data related to economic structure. This is the reason why it assumes importance for the academicians from all fields of social sciences. It is in this context that the analysis of population composition becomes inevitable.

9.7 GLOSSARY

- **Active Population –** the population that is concerned with the production of goods and services.
- **Main worker –** a worker who worked in some economic activity over a period of sex months, (183 days).
- **Marginal worker –** a worker who worked any time at all in the year but not for the major part of the year (less than 183 days).
- **Occupation –** the occupation of an individual refers to his trade, profession, type of work etc.
- **Primary sex ratio –** denotes the ratio between the two sexes at the time of conception.
- **Secondary sex ratio –** denotes the ratio between the two sexes at the time of birth.
- **Tertiary sex ratio –** refers to the ratio of the two sexes at the time of conception.

9.8 ANSWER TO CHECK YOUR PROGRESS

Q1. What is tertiary sex ratio? Explain the factors affecting it.

Q2. The rural sex ratio of developed countries is more masculine whereas the rural sex ratio of India is more feminine. Why?

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9.11 TERMINAL QUESTIONS

Q1. Why does the child sex ratio gives a more realistic picture than the general sex ratio?

Q2. What are the causes of continuously declining child sex ratio of India's population?

Q3. Give a brief account of the changes which have occurred from time to time in India's Industrial classification.

Q4. How has India classified its manpower?

Q5. What type of changes does secondary and tertiary sector bring in industrial composition.

Q6. What is the prime cause of continuously declining share of primary sector in India's industrial composition?

UNIT 10 - LITERACY

10.1 OBJECTIVES

Studying this lesson, you will be able to:-

- Understand the literacy and literacy pattern of India.
- Understand the spatial patterns of literacy,
- Understand the trend literacy.
- Understand the male female literacy rate of India.

10.2 INTRODUCTION

Literacy plays a significant role in the calculation of Human Development Index (HDI). HDI is calculated on the basis of a long and healthy life, as reflected in life expectancy at birth, the acquisition of education and knowledge, as reflected in the mean years of schooling (adjusted for out of school children) and literacy rate (age 7 years and above) and the standard of living and command over resources, as reflected in the monthly per capita expenditure adjusted for inflation and inequality. In 2010, India ranked 119 among 192 countries across the world, with a medium level HDI of 0.52, moving one notch higher as compared to 2005. According to United Nations Development Program (UNDP) data, it is among the top 10 movers in gross domestic product (GDP) growth. However, despite this, certain sections of society remain excluded, especially in terms of improvements in human Growth of Literacy in India – A Trend Analysis Shiv Prakash Katiyar Indian Journal of Adult Education January-March 2015 6 Shiv Prakash Katiyar capabilities and entitlements (Source: India Human Development Report, 2011).

Literacy is generally defined as a person's ability to read, write with understanding. Literacy reflects the socio-economic and cultural set-up of nation, ethnic group or community. The concept of literacy, whichvaries from country to country, refers to the minimum level of literacy skills. as well as to do some simple calculation. Despite this liberal definition, the rate of literacy in India is not very high.The United Nations Educational, Scientific and Cultural Organisation (UNESCO) has drafted a definition of literacy as the "ability to identify, understand, interpret, create, communicate, compute and use printed and written materials associated with varying contexts.

Literacy involves a continuum of learning in enabling individuals to achieve their goals, to develop their knowledge and potential, and to participate fully in their community and wider society.

The National Literacy Mission defines literacy as acquiring the skills of reading, writing and arithmetic and the ability to apply them to one's day-to-day life. The achievement of functional literacy implies (i) self-reliance in 3 R's, (ii) awareness of the causes of deprivation and the ability to move towards amelioration of their condition by participating in the process of development, (iii) acquiring skills to improve economic status and general well being, and (iv) imbibing values such as national integration, conservation of environment, women's equality, observance of small family norms.

The working definition of literacy in the Indian census since 2011 is as follows:

***Literacy rate*: The total percentage of the population of an area at a particular time aged seven years or above who can read and write with understanding. Here the denominator is the population aged seven years or more.

***Crude literacy rate*: The total percentage of the people of an area at a particular time who can read and write with understanding, taking the total population of the area (including below seven years of age) as the denominator.

Crude literacy rate = number of literate person divided by total population multiplied by 100

Effective literacy rate (or literacy rate) = number of literate persons aged 7 or above divided by population aged 7 and above multiplied by 100.

10.3 SPATIAL PATTERNS OF LITERACY

According to the Census of India 2011, the average literacy rate in India is 74.04%. This percentage does not include the population below 7 years of age-group. The relatively low literacy rate in India may be the rigid caste system of the Hindu and the religious orthodoxy of the Muslim and some of the castes, mainly living in the rural and remote areas. The rate of literacy varies a great deal from one part of the country to the other.

The discussion on spatial pattern in literacy was mainly based on maps using district-wise and state-wise data from the Census 2011. Literacy rates were depicted through five categories (85 per cent and above, 70-85 per cent, 55-70 per cent, 40-55 per cent, and below 40 per cent). However, as the districts in the first two categories and the last two categories were found in close proximity, the spatial pattern of literacy was discussed under three categories:the spatial pattern of literacy was discussed under three categories: (A) Areas of relatively high literacy (above 70 per cent) (B) Areas of relatively low literacy (below 55 per cent) (C) Areas of moderate literacy (55-70 per cent).

State level Pattern

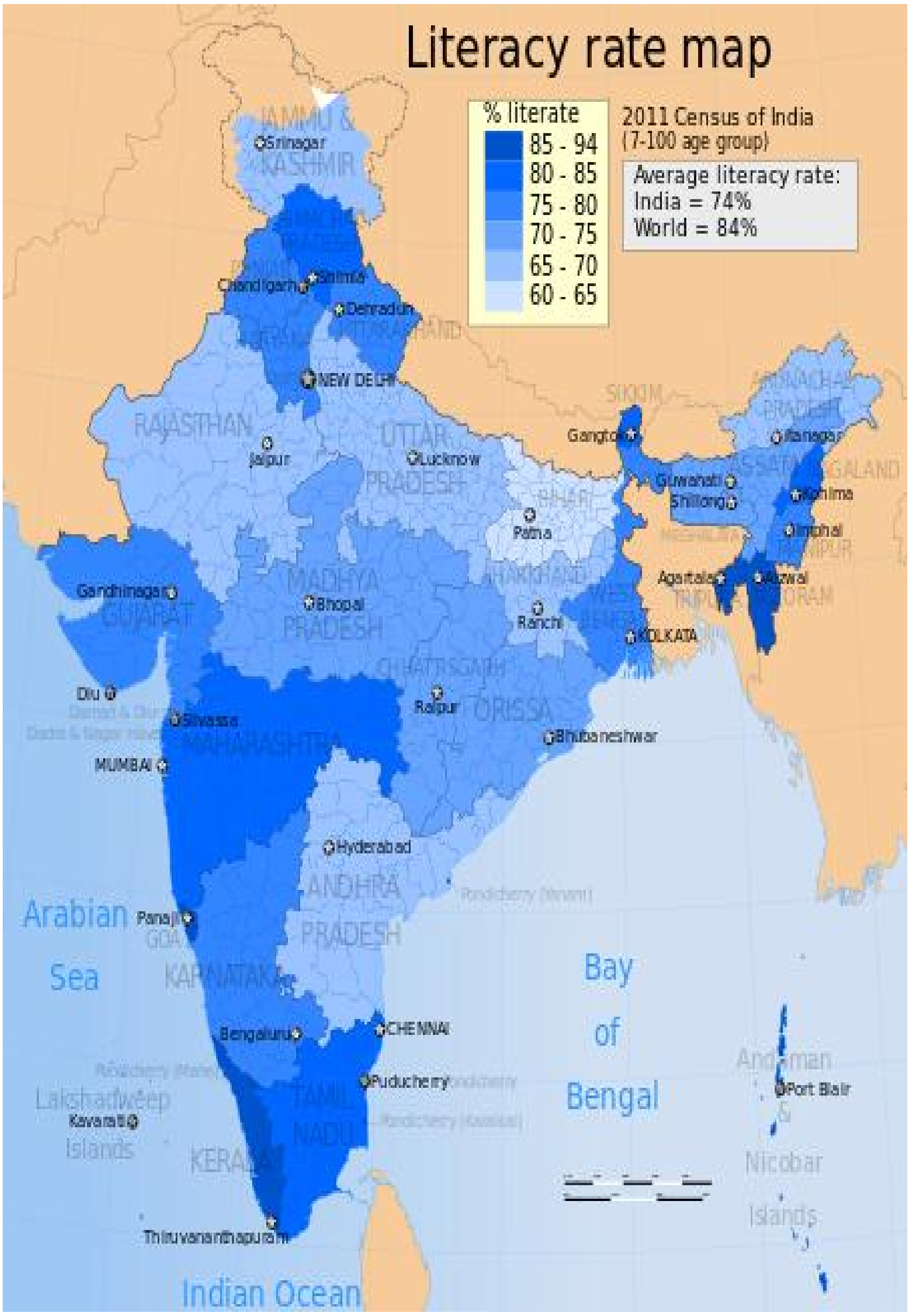
On the one hand, it is the state of Kerala having literacy rate as high as the 91.98percent and on the other extreme is the state of Bihar, where this rate is only 63.82percent. In the Union Territories, Lakshadweep has the highest rate of literacywhere it is 92.28 percent and the lowest rate is in Dadra & Nagar Haveli (77.6percent). The rate of literacy varies between males and females also. The average rate ofliteracy among the males in India is 82.14 percent which is higher than the females (65.4). Kerala has the distinction of highest literacy among both, males andfemales (94.20 and 87.86 respectively), whereas Bihar has the lowestliteracy rate among both males and females (73.39and 53.33 percent respectively).Ten States and Union Territories viz., Kerala, Lakshadweep, Mizoram, Tripura, Goa, Daman & Diu, Puducherry, Chandigarh, NCT of Delhi and Andaman & Nicobar Islands have achieved literacy rate of above 85 per cent, the target set by the Planning Commission to be achieved by 2011- 2012.

Large variations in literacy exist even between contiguous states. While there are few states at the top and bottom, most states are just above or below the national average.

District level Pattern

District level pattern analysis of literacy reveals that the literacy rates vary between 98.76Serchhip (Mizoram) Alirajpur (Madhya Pradesh) 37.22 Aizawl (Mizoram) 98.50 Bijapur (Chhattisgarh) 41.58 . You have understood High literacy present of this districts Serchhip in Mizoram has the highest literacy rate of 98.76%.Aizawl in Mizoram has a literacy rate of 98.50,Mahe in Puducherry(U/T) has a literacy rate of 98.35% ,Pathanamthitta in Kerala has a literacy rate of 96.93% ,Kottayam in Kerala has a literacy rate of 96.40% and Alirajpur in Madhya Pradesh has the lowest literacy rate of only 37.22%.Bijapur in Chhattisgarh has a literacy rate of just 41.58,.Dakshin Bastar Dantewada in Chhattisgarh has a literacy rate of 42.67% ,Jhabua in Madhya Pradesh has a literacy rate of 44.45,Nabarangapurn Orissa has a literacy rate of 48.20%.

Map:10.1



Source: Google

10.4 SPATIAL DISTRIBUTION AND TREND OF LITERACY

As per 2011 census, literacy rate in India has been reported as 74.04% with a 14% increase to that in 2001, whereas the hike is maximum for rural women at 26% in the last decade, which may be attributed to literacy mission of Government of India. Overall female literacy rate in India much lower than that of male literacy rate. The female literacy levels according to the Literacy Rate 2011 census are 65.46% whereas the male literacy rate is over 80%.Literacy rate of India in 2011 is 74.04%. The Male literacy rate is 82.14% and Female literacy rate is 65.46% according to Census 2011.Among the Indian states, Kerala has the highest literacy rate 93.91% and then Mizoram91.58%.Among the Union Territories, Lakshadweep has the highest literacy rate of92.28%.Biharhasthelowestliteracyrateinindiawith63.82% .The Male literacy is highest in Lakshadweep96.11% and Kerala 96.02%.The Female literacy is highest in Kerala 91.98% and Mizoram89.40%.Lowest male literacy is in Bihar73.39%.Jammu & Kashmir the lowest at 78.26 percent as shown in Table no.10.1.

Table 10.1: Distribution of Population by Literates and Literacy Rates by Sex-wise (Census-2011)

	Literacy rate(%)		
	Persons	Males	Females
INDIA	74.04	82.14	65.4
Andhra Pradesh	67.66	75.56	59.74
Arunachal Pradesh	66.95	73.69	59.57
Assam	73.18	78.81	67.27
Bihar	63.82	73.39	53.33
Chhattisgarh	371.04	81.45	60.59
Goa1	87.40	92.81	81.84
Gujarat	79.31	87.23	70.73
Haryana	76.64	85.38	66.77
Himachal Pradesh	83.78	90.83	76.60
Jammu & Kashmir	68.74	78.26	58.01
Jharkhand	67.63	78.45	56.21
Karnataka	75.60	82.85	68.13
Kerala	93.91	96.02	91.98
Madhya Pradesh	70.63	80. 60	.02
Maharashtra	82.91	89.82	75.48
Manipur	79.85	86.49	73.17

Meghalaya	75.48	77.17	73.78
Mizoram	91.58	93.72	89.40
Nagaland	80.11	83.29	76.69
Orissa	73.45	82.40	64.36
Punjab	76.68	81.48	71.34
Rajasthan	67.06	80.51	52.66
Sikkim	82.20	87.29	76.43
Tamil Nadu	80.33	86.81	73.86
Tripura	87.75	92.18	83.15
Uttar Pradesh	69.72	79.24	59.26
Uttarakhand	79.63	88.33	70.70
West Bengal	77.08	82.67	71.16
Union Territory:			
A.& N.Islands	86.27	90.11	81.84
Chandigar	86.43	90.54	81.38
D.& N.Haveli	77.65	86.46	65.93
Daman & Diu	87.07	91.48	79.59
Delhi	86.34	91.03	80.93
Lakshadweep	92.28	96.11	88.25
Puducherry	86.55	92.12	81.22

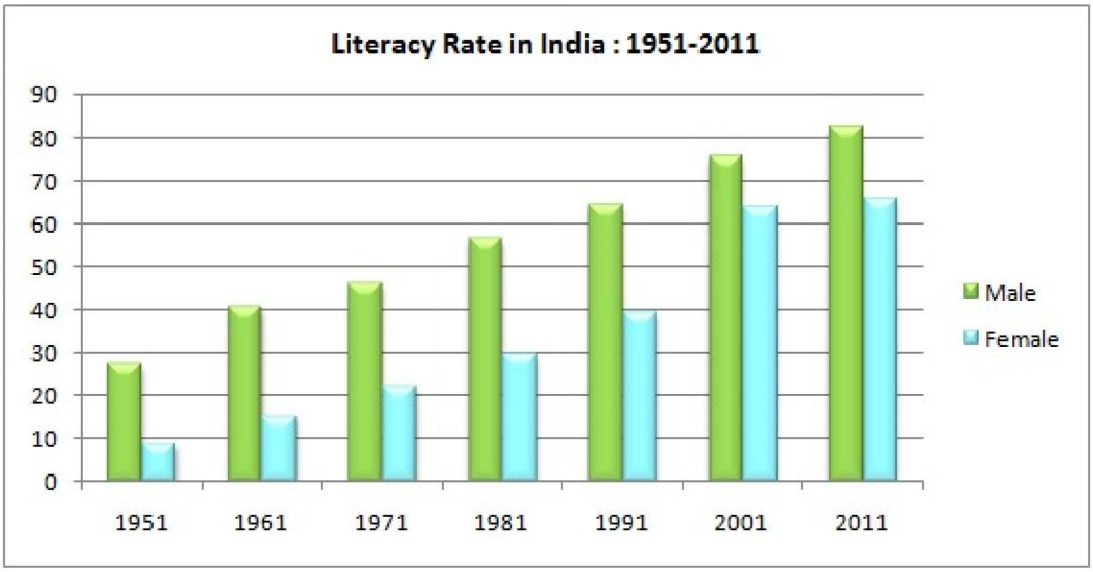
Source: Statistical Year Book, India 2012, & Office of Registrar General of India

Table: 10.2 Literacy rate of India1951-2011

Census year	Person	Males	Female	Gaps male-female
1951	18.33	27.16	8.86	18.30
1961	28.3	40.4	15.35	25.05
1971	34.45	45.96	21.97	23.98
1981	43.57	56.38	29.76	26.62
1991	52.21	64.13	39.29	24.84
2001	64,83	75.26	53.67	21.59
2011	74.04	82.14	65.46	16.68

Source: Statistical Year Book, India 2012, & Office of Registrar General of India

Bar Graph:10.1



The table and figure above reveals that the literacy rate has quadrupled from 1951 to 2011.You shoud have learnt by now,Despite such improvement, 27% people of the country are still illiterate. If we look at a gender wise distribution, nearly 20% males are illiterate while nearly one third females are still illiterate as per 2011 census. If we compare the literacy rates of males between 1951 and 2011, it has trebled while of females, it has increased sevenfold. The total growth in literacy rates is 54.67% from 1951 to 2011. If we look at an annual average growth of literacy rate during 1951 to 2011, it is 0.91% per annum. If we look at gender distribution, the growth for males is 53.74% during 1951 to 2011 which implies that the growth rate is 0.90% per annum. The growth rate for females is 55.74% which implies that the growth rate is 0.93% per annum. Regarding regional literacy rates, during 1 961 to 2011.

10.5 CONCLUSION

Literacy is generally defined as a person’s ability to read, write with understanding. According to the Census of India 2011, the average literacy rate in India is 74.04%.14% increase to that in 2001, whereas the hike is maximum for rural women at 26% in the last decade, which may be attributed to literacy mission of Government of India. Overall female literacy rate in India much lower than that of male literacy rate. The female literacy levels according to the Literacy

Rate 2011 census are 65.46% whereas the male literacy rate is over 80%. Here are some facts about different states literacy rate, Kerala is the only state in India to have 100% literacy rate. It is followed by Goa, Tripura, Mizoram, Himachal Pradesh, and Maharashtra, Sikkim. The lowest literacy rate in India is seen in the state of Bihar. We also need to think why is the literacy rate is low here in India compared to other developed countries. Basically the population in India is very high. Being the 7th largest country its population stands 2nd in the world after China. There are over 1 billion people in India. The number of schools and educational centers especially in rural areas is less. Even today many people are below the poverty line. Also people aren't aware that children should get free education according to the law.

10.6 SUMMARY

You should have learnt by now, there is a wide gender disparity in the literacy rate in India: effective **literacy rates** (age 7 and above) in 2011 were 82.14% for men and 65.46% for women. The low female literacy rate has had a dramatically negative impact on family in India. Studies have indicated that female literacy is a strong predictor of the use of contraception among married Indian couples, even when women do not otherwise have economic independence. The census provided a positive indication that growth in female literacy rates (11.8%) was substantially faster than in male literacy rates (6.9%) in the 2001–2011 decadal period, which means the gender gap appears to be narrowing.

Kerala is the most literate state in India, with 93.91% literacy. Bihar is the least literate state in India, with a literacy of 63.82%.

Every census since 1881 had indicated rising literacy in the country, but the population growth rate had been high enough that the absolute number of illiterates rose with every decade. The 2001–2011 decade is the second census period (after the 1991–2001 census periods

Large variations in literacy exist even between contiguous states. While there are few states at the top and bottom, most states are just above or below the national average.

10.7 GLOSSARY

Literacy - a person's ability to read, write with understanding. : effective literacy rates (age 7 and above)

Effective literacy rate - number of literate persons aged 7 or above divided by population aged 7 and above multiplied by 100

Literacy rate - The total percentage of the population of an area at a particular time aged seven years or above who can read and write with understanding. Here the denominator is the population aged seven years or more. and the Indian literacy rate has grown to 74.04% (Census2011 figure)

$$\text{Crude literacy rate} = \frac{\text{Number of literate person}}{\text{Total population}} \times 100$$

$$\text{Effective literacy rate} = \frac{\text{Number of literate person}}{\text{Total population}} \times 100$$

10.8 ANSWER TO CHECK YOUR PROGRESS

1.What is literacy?

2..What are literacy pattern of India ?

3.What is literacy rate overall India?

4.What are the trends of literacy in state and union territory different states?

ANSWER

1- Literacy is generally defined as a person's ability to read, write with understanding.
2- Spatial pattern in literacy was mainly based on maps using district-wise and state-wise.
3- Census of India 2011, the average literacy rate in India is 74.04%.
4- Literacy trends in the state of Kerala having literacy rate as high as the 91.98percent and on the other the state of Bihar, where this rate is only 63.82 percent. In the Union Territories, Lakshadweep

has the highest rate of literacy where it is 92.28 percent and the lowest rate is in Dadra & Nagar Haveli (77.6 percent).

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10.11 TERMINAL QUESTION

1. On the basis of the data given in the text regarding to census 1951-2011 literacy trend, draw graph for male, female and compare them.

UNIT 11 - MIGRATION OF POPULATION

11.1 OBJECTIVES

This study has following objectives:

1) To study the migration of India.
2) To study the migration types and trend of India.
3) To understand inter-state and intra-state migration of India.

11.2 INTRODUCTION

Migration is the movement by people from one place to another with the intention of settling temporarily or permanently in the new location. The movement is typically over long distances and from one country to another, but internal migration is also possible. Migration may be individuals, family units or in large groups.[2]

Nomadic movements are normally not regarded as migrations as there is no intention to settle in the new place and because the movement is generally seasonal. Only a few nomadic peoples have retained this form of lifestyle in modern times. Also, the temporary movement of people for the purpose of travel, tourism, pilgrimages, or the commute is not regarded as migration, in the absence of an intention to settle in the new location.

One important facet of study on population is the study of migration arising out of various social, cultural, economic or political reasons. For a large country like India, the complexity of movement of population in different parts of the country helps in understanding the dynamics of the society. At this crucial juncture in economic development in our country, study on migration assumes special importance. A person is considered as migrant by place of birth if the place in which he is enumerated duringthe census is other than his place of birth. As a person could have migrated a number of times during his lifetime, migration by place of birth would not give a correct picture of the migration taking place currently. A person, on the other hand, is considered as migrant by place of last Residence, if the place in which he is enumerated during the census is other than his place of Immediate last residence. By capturing the latest of the migrations in cases where persons have Migrated more than once, this concept would give a better picture of current migration scenario. At the time of enumeration in census, a person could have moved from another village or town in the Same district, or from another district of the state, or another state in India or even from another Country. Census provides migration data on all these migration streams by both the concepts to Understand the dynamics in the movement of population and the broad reasons behind. Till 1961 Census, migration data was presented with reference to place of birth only. The information on place of birth was being collected since 1872. In 1961 the scope of collecting information on migration was enlarged by including the rural or urban status of the place of birth and duration of residence at the place of residence. Since 1971 Census, data are being collected on the basis of place of last residence in addition to question on birth place. Question on 'Reason for migration' was introduced since 1981.

The pattern adopted in 1991 and 2001 Census remainedsame as in 1981 except that in 2001 Census, the rural urban status of place of birth was not collected. Also the category 'Natural Calamities' as one of the reasons for migration in 1991 wasexcluded and a new reason 'Moved at birth' added in 2001.

The United Nation (UN) defined migration as a form of geographical or spatial mobility between one geographical unit and another. It involves a change in residence from the place of origin or departure moreover; Census of India (2001) considered "A person is considered as a migrant by place of last residence, if the place in which he is enumerated during the census is other than his place of immediate last residence." On the basis of above said definitions we can say that migration is related to long term phenomenon and is different from the mobility of populations. Thus, the term population mobility is broader than migration, because, in measurement of mobility, both (i.e., short and long) time period is considered, while migration is related to only long term mobility of the population/individual. In nutshell, permanent or semi-permanent change in the place of residence of an individual is a basic characteristic of the migration.

Migration is a universal phenomenon and it is the third component of population change, while two other important components of population change are fertility and mortality rate. Further, migration is the most observable and impressive fact in the growth of cities and it is also considered as an essence of urbanization in the globe. In India, major cities have noticed an increase of around 75 per cent population due to migration.

In general we can divide factors causing migrations into two groups of factors: Push and pull factors. In general:

i) Push Factors ; and
ii) Pull Factors

Push and pull factors are those factors which either forcefully push people into migration or attract them. A push factor is a flaw or distress that drives a person away from a certain place. A pull factor is something concerning the country to which a person migrates. It is generally a benefit that attracts people to a certain place.

Push Factors

- Not enough jobs
- Few opportunities
- “Primitive” conditions
- Famine/drought
- Political fear/persecution
- Poor medical care

Pull Factors

- Job opportunities
- Better living conditions
- Political and/or religious freedom
- Enjoyment
- Education

Poor living conditions, violence and armed conflicts, environmental problems, a lack of economic perspectives and the growing gap between rich and poor countries: all these factors play their part. Global mobility and the new media likewise have a great influence on current migration trends.

11.3 TYPES & TRENDS OF MIGRATION

Migration is the geographic movement of people across a specified boundary for the purpose of establishing a new permanent or semi-permanent residence. Along with fertility and mortality, migration is a component of the population change. The term “in migration” and “out migration” are used for movement between areas within a country (internal migration). The parallel terms “immigration” and “emigration” are used to refer to moves between countries (international migration). There has been a basic difference in the processes of migration in developing countries from that of the developed countries. In developing countries like India, migration mostly takes place not due to the so called pull forces of the destination place as usually happens in case of developed countries, but because of poverty, unemployment, natural calamities and underdevelopment at the origin place. Migration in developing countries is still viewed as a survival strategy. Poverty and prosperity both are responsible for inducing migration. While the former is mostly true in developing countries, the latter kind of migration is found in developed countries.

The movement of population is divided into four streams of migration.

(a) Rural- to -urban migration (R-U)

(b) Urban- to- Urban (U-U)

(c) Rural- to -rural (R-R)

(d) Urban- to- Rural (U-R)

These streams are defined on the basis of source of origin and destination of the migrants.

Sometimes people move from a village to a small town and later to city. Such movements are described as step-wise migration.

Table no- 11.1 Statement 9: Migrants by place of last residence indicating migration streams (duration 0-9 years) INDIA 2001

	2001			2001 (in %)		
Migration stream	Persons	Males	Females	Persons	Males	Females
Total migrants	98,301,342	32,896,986	65,404,356			
Intra state Migrants	80,733,441	23,998,283	56,735,158	100.0	100.0	100.0
Rural to Rural	48,880,074	9,985,581	38,894,493	60.5	41.6	68.6
Rural to Urban	14,222,276	6,503,461	7,718,815	17.6	27.1	13.6
Urban to Rural	5,213,151	2,057,789	3,155,362	6.5	8.6	5.6
Urban to Urban	9,898,294	4,387,563	5,510,731	12.3	18.3	9.7
Unclassified	2,519,646	1,063,889	1,455,757	3.1	4.4	2.6
Inter state Migrants	16,826,879	8,512,161	8,314,718	100.0	100.0	100.0
Rural to Rural	4,474,302	1,759,523	2,714,779	26.6	20.7	32.7
Rural to Urban	6,372,955	3,803,737	2,569,218	37.9	44.7	30.9
Urban to Rural	1,053,352	522,916	530,436	6.3	6.1	6.4
Urban to Urban	4,490,480	2,201,882	2,288,598	26.7	25.9	27.5
Unclassified	435,790	224,103	211,687	2.6	2.6	2.5
International Migrants	740,867	386,461	354,406	100.0	100.0	100.0

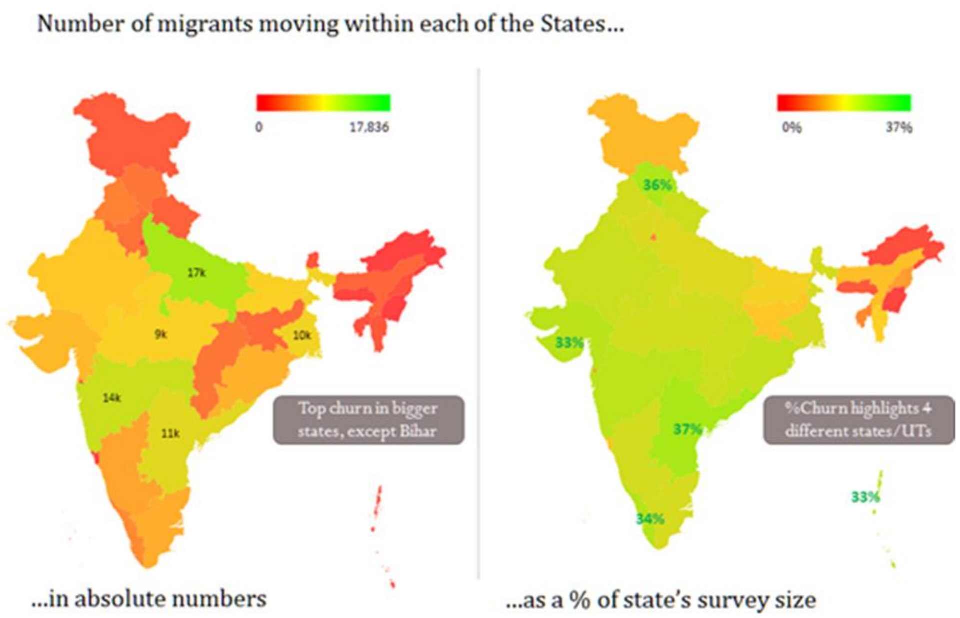
To Rural areas	392,807	188,518	204,289	53.0	48.8	57.6
To Urban areas	348,060	197,943	150,117	47.0	51.2	42.4

Source: Table D-2, Census of India 2001

INTRA-STATE MIGRATION

According to the 2001 census, out of 315 million migrants enumerated on the basis of their last resident 98 million had changed their place of residence in last ten years. Out of these 81 million were Intra -state migrants. The stream was dominated by women and these migrations were mostly related to marriage. Out of 98 million migrants in the country based on last residence during last ten years, 80 millionwere those who migrated from one part of the state or district to another within the same state. Outof these intra-state migrants, 48.8 million (60.5%) migrants moved from rural to rural area, themajority of them being females who usually move out from their natal residence after marriage. Rural to urban stream constituted 17.6% and those moving from urban to rural areas only 6.5%.For those who were residing in urban areas there are likelihood that they move to another urban area and such urban to urban stream comprised of 12.3% of intra-state migrants.

Map-11.1



Source: Google

The map on the left has the intra-state migration pattern (excluding inter-state numbers) showing the *absolute number* of migrants moving within each state/UT. Green indicates higher migration and red is the opposite. Based on this map, the 5 most populous states in India account for the top 5 intra-state movements, except for Bihar which comes a close 6th. If we rescale the numbers by taking migrants as a percent of the state/UT's survey size, as shown in the right map, the results change completely. The top 5 states with highest percent churn are Andhra Pradesh, Himachal Pradesh, Kerala, Gujarat and Andaman & Nicobar Islands.

INTER –STATE MIGRATION

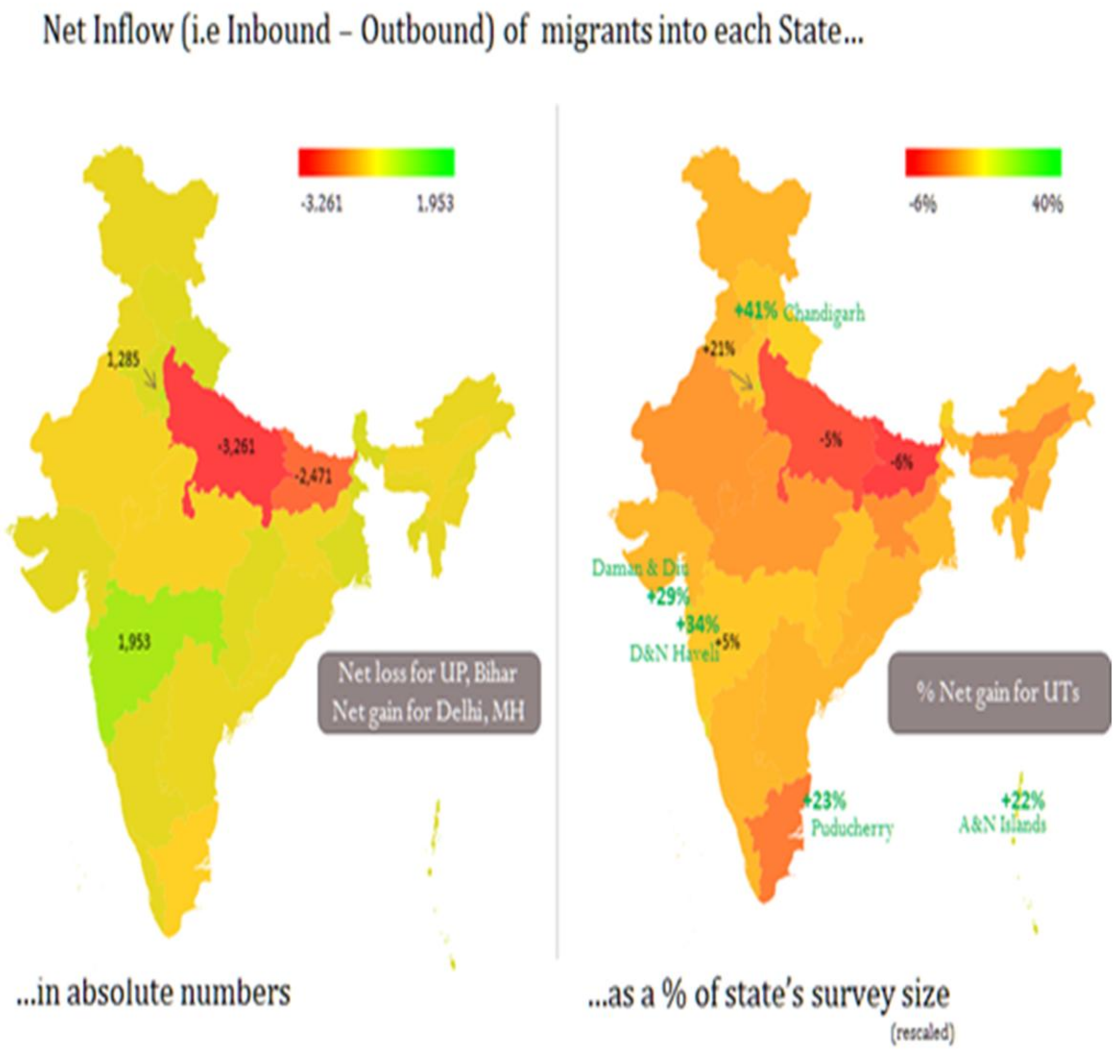
For inter-state migrants, rural to rural migration is low in comparison to the intra-state category, mainly due to the small number of women migrating due to marriage outside the state. Only 4.4 million out of 16.8 million migrants coming from outside the state belong to this stream of rural to rural migration. The rural to urban migration was higher (37.9%) indicating that the choice of town is not limited to those within the state while migrating. Urban to urban migration among inter-state migrants was also quite high (26.7%) and evenly distributed among both males and females.

INTERNATIONAL MIGRATION

International migration implies that when the national boundary of a country is involved in migration, while, when migration takes place within the national boundary of a country it is called internal migration. Further, the internal migration is also classified into two types (i.e., Migration Streams and Distance Categories). Moreover, in regard to international migration, the departure of an individual or group from a country is termed as emigration (Out-Migration). In addition, migration can be either voluntary or forced. Voluntary migration includes the choice of a person, while forced migration involves a perception of compulsion against the will or choice of a concerned individual. Individuals forced to move are usually compelled by political factors whereas, voluntary migration is usually for economic reasons.

About international migrants coming to this country, 53.0% were found in rural areas and the remaining 47% in the urban areas, thus indicating no particular preference, at least in the intial period.

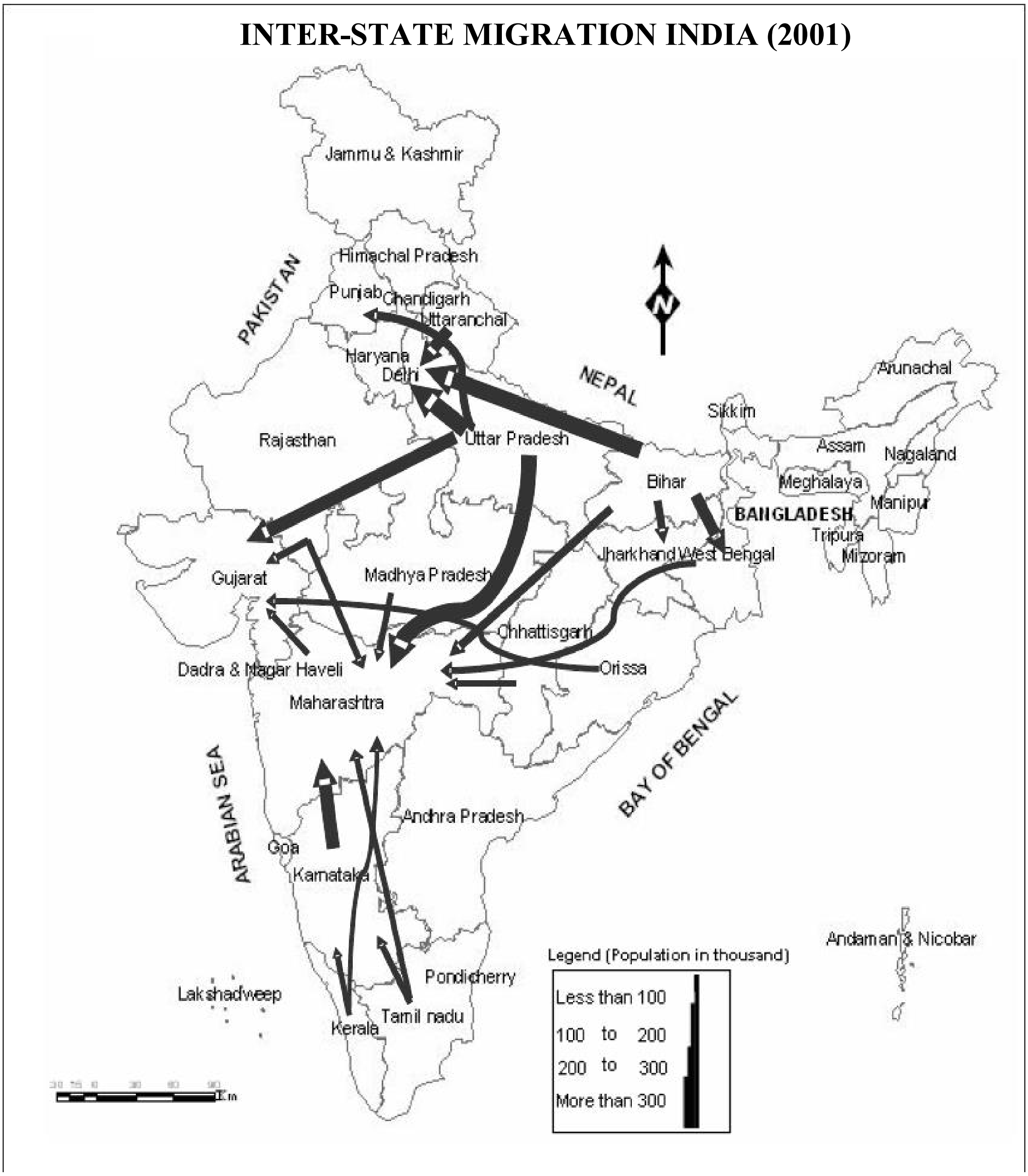
Map-11.2



Source: Google

If we now look at the Inter-state migration pattern (excluding within-state movements) by plotting the Net Inflow of migrants into each state/UT (left-hand-side map), the states with highest net outflow of migrants are Uttar Pradesh and Bihar, while those with highest net inflow are Maharashtra and Delhi. If we rescale the numbers, as a percent of the state/UT's survey sample, the story changes, yet again. All the Union Territories in India have the highest Net percent Inflow, with Chandigarh showing the highest value at 41%.

Map-11.3



Source: Google

Table 11.2 INTER STATE MIGRATION IN INDIA 2001

S No.	State / UT	Total migrants Persons	Males	Females
1	India	41,166,265	19,098,082	22,068,183
2	Andaman & Nicobar Islands	84,380	48,008	36,372
3	Andhra Pradesh	1,032,753	400,238	632,515
4	Arunachal Pradesh	136,050	80,626	55,424
5	Assam	407,141	224,189	182,952
6	Bihar	1,619,031	224,706	1,394,325
7	Chandigarh	554,474	307,835	246,639
8	Chhattisgarh	936,415	415,913	520,502
9	Dadra & Nagar Haveli	67,328	41,045	26,283
10	Daman & Diu	61,272	41,558	19,714
11	Delhi	5,324,052	2,979,333	2,344,719
12	Goa	228,869	122,365	106,504
13	Gujarat	2,182,741	1,262,884	919,857
14	Haryana	2,675,920	1,073,999	1,601,921
15	Himachal Pradesh	350,834	165,326	185,508
16	Jammu & Kashmir	158,003	83,834	74,169
17	Jharkhand	1,730,938	708,870	1,022,068
18	Karnataka	2,074,471	945,236	1,129,235
19	Kerala	454,259	234,168	220,091
20	Lakshadweep	5,561	4,315	1,246
21	Madhya Pradesh	2,169,350	736,366	1,432,984
22	Maharashtra	7,313,139	4,178,677	3,134,462
23	Manipur	14,783	8,276	6,507
24	Meghalaya	83,082	45,980	37,102
25	Mizoram	35,293	22,907	12,386
26	Nagaland	81,577	51,095	30,482
27	Orissa	662,800	267,675	395,125
28	Pondicherry	252,727	102,288	150,439
29	Punjab	1,749,122	828,260	920,862
30	Rajasthan	1,741,411	561,342	1,180,069
31	Sikkim	46,033	25,574	20,459
32	Tamil Nadu	727,172	330,283	396,889
33	Tripura	63,778	30,504	33,274
34	Uttar Pradesh	2,824,746	825,083	1,999,663
35	Uttaranchal	859,598	388,335	471,263
36	West Bengal	2,457,162	1,330,989	1,126,173

TABLE 11.3: REASONS FOR MIGRATION OF MIGRANTS BY LAST RESIDENCE WITH DURATION (0-9 YEARS) INDIA 2001

Reason for migrations	Number of Migrants			Percentage to Migrants		
	Person	Males	Females	Persons	Males	Female
Total migrants	98,301,342	32,896,986	65,404,356	100.0	100.0	100.0
Reason for migration : Work / Employment	14,446,224	12,373,333	2,072,891	14.7	37.6	3.2
Business	1,136,372	950,245	186,127	1.2	2.9	0.3
Education	2,915,189	2,038,675	876,514	3.0	6.2	1.3
Marriage	43,100,911	679,852	42,421,059	43.8	2.1	64.9
Moved after birth	6,577,380	3,428,673	3,148,707	6.7	10.4	4.8
Moved with households	20,608,105	8,262,143	12,345,962	21.0	25.1	18.9
Other	9,517,161	5,164,065	4,353,096	9.7	15.7	6.7
Source: **Table D3, Census of India 2001**						

11.4 CONCLUSION

On the basis of the foregoing discussion we conclude that the stream of women migration is not favourable for the social structure in general and rural area in particular. Because, in long term, a vacuum of female population in rural will emerge due to the following basic reasons.

(1) Mortality rate of girl is higher in rural area as compared to urban areas.

(2) No. of involuntary unmarried person in rural areas has been increasing continuously in rural area due to unavailability of girls.

(3) The rate of women migration from rural to rural and urban to rural areas has decreased, while rural to urban has been increasing significantly over the period under study and .

When migration was viewed from the perspective of movement across Rural – Urban areas, a surprising trend found was the extent movement within Rural Areas – more than half of migration in India happens amongst the Rural regions. About 40% of migration is towards Urban areas. A contra-trend noticed here was for the Union Territories and North-Eastern States – over 70% of migration in these areas is towards the Urban regions, unlike the rest of India.

The distribution of migrants by migration streams (i.e., rural to rural, rural to urban, urban to rural and urban to urban areas) is generally associated with the degree of economic and social development. Population pressure on land, increased opportunities for work, education and a variety of reasons including marriage in case of females contribute to migration to a rural or urban area. It may be important to note that in case of intra-state migrants majority of the migration is from one rural area to another, due to marriage in case of females and in search of work in case of males. For inter-state migrants, however, the flow is mainly towards urban areas.

Streams of inter-sate migration a presented in the above table. In inter-state migration, rural to rural migration is low in comparison to intra-state category. Only 4.4 million out of 16.8 millions migrants coming from out side the state belong to this stream of rural to rural migration. The rural to urban migration was higher (38 percent) indicating that more people are migrating to cities for employment. Urban to urban migration among inter-state migrant was also quite high (27percent) and evenly distributed among both males and females (Census 2001).

11.5 SUMMARY

1) Areas with urban centres, administrative head quarters, and business sectors attract the migrants from backward areas where employment opportunities are very less. Maharashtra and Delhi witnessed largest in migration of population during the last ten years from different states. Maharashtra received 20percent and Delhi received 13percent share of total in-migration from the various states of India.

2) On the other hand, U.P and Bihar are the two most important states where share of the total out-migration is highest, U.P. - 23 percentage and Bihar 13 percentage of share in total out-migration of the country

3) In some of the states like Haryana, Gujarat, Maharashtra, Punjab, Delhi, etc there is significant in-migration as well as out-migration. Development may be responsible for both in and out migration.

4) Total migration variation among 1991-2001 census periods is positively 52 percent increasing. And in case of male it is 62 percent and female it is 43 percent positively increase.

5) Sex ratio of in-migration and out-migration of India in 1991 is 90 males per 100 females. But in 2001 census shows opposite picture of sex ratio of migrants. It shows 102 males per 100 female. It means male migration has increased in 2001 census.

6). But in 2001 census gives an opposite picture of sex ratio of the migrants in some states. U.P and Bihar show very peculiar picture. Sex ratio of in-migration is very much female dominated on the other hand out-migration is very much male dominated

7) There is a negative relationship between rate of in-migration and poverty. That means if the level of poverty is high, there will be less in-migration to these states, when level of poverty declines and per capita bank deposit, per capita bank credit to industries increase, there will be more in migration. It means increasing economic development will ultimately attract more migrants.

8) The volume of in-migration is positively correlated with percentage of urban, per capita bank deposit and per capita bank credit to industry. It indicates that those states which have high percentage of urban population, high capita bank deposit and high bank credit to industry will have high volume of in-migration.

9) Regional disparity in development influences flow of inter-state migration streams. Migration is a natural outcome of inequality in the distribution of resources. It is positively related to modernization, industrialization and development. So, migration is essential for development. It is a desirable phenomenon. But what is not desirable is the distressed migration found in most of the developing countries resulting in overcrowding of cities and mushrooming of slums. In India the inter-state migration pattern reflects that there is an inequality in the regional development. Some states which have higher investment and resources for development experience high in migration. At the same time, the backward states like U.P, Bihar, M.P, etc are experiencing heavy out-migration. Hence, there is a need for balanced regional development. More focus for development and investment should be given to those states which are lagging

behind in development parameters. This may retain the labour force at the native state and thereby reduce overcrowding and congestion in cities. This will result in a more prosperous and balanced migration flow leading to a qualitative shift in the pattern and trend of migration flow in India. The migration policy should focus more on the development at the area of origin rather than at the destination place.

11.6 GLOSSARY

- Emigrant - A person who leaves a homeland to settle in another country.
- Immigrant - A person entering a country for the purpose of living there.
- Migration - Movement by people from one place to another place.

11.7 ANSWER TO CHCK YOUR PROGRESS

1. Why do people migrate?
2. Name the four stream of migration within a country?
3. What are the push and pull factors?
4. What are the trends for people migrating to different states?

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11.10 TERMINAL QUESTIONS

1. On the basis of the data given in the text regarding intra-state and inter-state migration trend, draw separate graph for categories and compare them.

2. Why do people migrate? Discuss various factors giving Indian examples?

BLOCK 4 - INDIAN ECONOMY

UNIT 12 - AGRICULTURE

12.1 OBJECTIVES

You should be aware of the fact that agriculture is demographically the broadest economic sector and plays a significant role in the overall socio-economic fabric of the country. The objective of this unit is to focus on the present scenario of Indian agriculture that can be associated with the traditional systems as well as adoption of new technology to enhance returns from traditional farming. Going through this unit you will be able to understand:

1. The history and development of Indian agriculture
2. Agricultural productivity and food security in India and challenges faced by traditional farmers in the fast growing technology and global environmental change
3. Diversification of agriculture through white, blue, yellow and pink revolutions which may lead to sustainable agriculture and food security.
4. Locate Agricultural Regions in India, cropping patterns in different areas and thus, recognizing the uneven development of agriculture across regions.
5. Addressing problems of traditional agricultural systems and efforts required towards modernized as well as sustainable agricultural practices.

12.2 INTRODUCTION

You know that India is a large country with physiographic and climatic variations. You studied these variations in the previous units. Now, we will study about agriculture which is the backbone of Indian economy. Agriculture as a base of Indian civilization includes different types of farming, combination of trees, cereal crops, leguminous pulses and oilseeds along with a mix of livestock and their interrelationships with each other. Studying this unit, you will be able to understand some important facts associated with the development of Indian agriculture. The written history of agriculture in India dates back to the Rigveda. Afterwards, up to the tenth century, agriculture and other economic activities were developed in India. Agricultural production was sufficient for the existing population at that time.Internatioal trade was not possible at all. During the Muslim rule in India, agriculture became stabilized. At that time, originally all the land belonged to the king but practically owners were micro level administrators, who were employed to collect tax from the farmers. The farmers worked as labours without ownership. Forest and agricultural land belonged jointly to the villagers. The division of labour was purely on caste basis. In this system, physical labour was done by the lower castes. In the seventeenth and eighteenth century East India Company came to India for trade. The British ignored the traditional agricultural and irrigation systems. During this period the land could be bought, sold and also could be divided. Later on, this system created different types of complications in the agricultural system.

The famine commission in 1880 and irrigation commission in1903 had given creative suggestions for development of agriculture in India. On the basis of these suggestions Department of Agriculture was established in some states of India. A Royal Commission of Agriculture was also established.In1884; two land reform bills were passed. The government also employed an agricultural chemist in 1892, an Inspector General of Agriculture and an Entomologist in 1901.In the twentieth century, the government started paying attention towards agriculture. In 1906, All India Agricultural service was organized. With the efforts of Lord Curzon, a central Research Organization and an Agricultural University were started. A Veterinary Research Institute in Mukteshwer, Animal Husbandry and Dairy farming were established in Carnal, Bangalore and Wellington.

In 1926, A Royal Commission on Agriculture was appointed. Lord Linlithgow was its President. This commission established the Imperial Council of Agricultural Research which is at present known as Indian Council of Agricultural Research. Reserve Bank of India and its Agricultural Credit Department were established in1935. Due to partition of India in 1947 the network of canal irrigation system, cotton belt and the area of Punjab (known as wheat bowl) went to Pakistan after independence. Similarly the jute belt and rice bowl was awarded to East Pakistan, which is now Bangladesh. Before 1960, India imported food items for the food requirements of the people of the country. After two years of continuous drought in 1965 and 1966 India had to reform its agricultural policy. Instead of relying on foreign aid to solve problems of the country, India adopted significant policy reforms focused on the goal of food grain self-sufficiency. Green revolution transformed Indian agriculture was with modern techniques, seeds, fertilizers and pesticides. With success in wheat, India's Green Revolution technology spread to rice. When gains from the new technology reached their limits in the states of initial adoption, the technology spread in the 1970s and 1980s to the states of eastern India —Bihar, Odisha and West Bengal. The lasting benefits of the improved seeds and new technology extended principally to the irrigated areas which account for about one-third of the harvested crop area. In the 1980s, Indian agriculture policy shifted to emphasis to other agricultural commodities like oilseed, fruit and vegetables. Farmers began adopting improved methods and technologies in dairying, fisheries and livestock, and meeting the diversified food needs of India's growing population. Then started the white revolution which stands for remarkable increase in milk production and establishment of a national milk grid, crossbreeding of indigenous cows with high milk yielding European breed; pasteurization of milk for keeping it for a longer duration; collection of quality milk from members in rural areas; and refrigerated transport system which helps sending milk to far off metropolitan centres both by road and rail. With the blue revolution catching of fresh water and marine fish showed a big rise. Yellow and pink revolution increased in supply of poultry products and apples respectively. Still, in the agricultural sector, benefits of innovative ideas, materials and improved farming technologies depends on whether India develops infrastructure such as irrigation network, flood control systems, reliable electricity production capacity, all season rural and urban highways, cold storage to prevent food spoilage, modern retail, and competitive buyers of produce from the Indian farmer. This is increasingly the focus of Indian agriculture policy.

Up to now, you would be able to understand that agriculture of India has gone through significant changes especially in the post independence era.

12.3 SALIENT FEATURES OF INDIAN AGRICULTURE

After studying the previous two units, you must have understood the development of agriculture during the pre-independence and post- independence period. Studying this unit you will be able to explain the following salient features of Indian agriculture;

1. Subsistence agriculture

In India, the farmer owns a small piece of land grows crops with the help of his family members and because of the traditional framings consumes almost the entire farm produce. In subsistence agriculture, cultivation techniques are primitive and little surplus remains to sell in the market. This type of agriculture has been practised in India for the last several hundreds of years and still prevails in spite of the large scale changes in agricultural practices after Independence.

2. Pressure of population on agriculture

The population in India is increasing at a rapid pace and exerts heavy pressure on agriculture. While looking into the present need of food grains, we require an additional 12-15 million hectares of land to cope with the increasing demands for our population. Over one-fourth of the Indian population lived in urban areas in 2001 and it is estimated that over one-third of the total population of India is living in urban areas at present. This requires more land for urban settlements which will ultimately encroach upon agricultural land. It is now estimated that about 4 lakh hectares of farm land is now being diverted to non-agricultural uses each year. This clearly shows that the pressure on the squeezing agricultural land is increasing day by day.

3. Uncertainity of Monsoon

Indian agriculture is mainly dependent upon monsoon which is uncertain, unreliable and irregular.Sometimes, the monsoon is too late and sometimes it arrives earlier. In both the situations, the Indian farmer is at risk. In spite of the large scale expansion of irrigation facilities since Independence, only one-third of the cropped area is provided by perennial irrigation and the remaining two-third of the cropped area has to bear the burden of the vagaries of the monsoons.

3. Importance of animals

Animal force has always played a significant role in agricultural operations such as ploughing, irrigation, threshing and transporting the agricultural products which have been practiced in India for the last several hundreds of years. Complete mechanisation of Indian agriculture is still a distant goal and animals will continue to dominate the agricultural scene in India for several years to come. The combination of livestock with crop production risk aversion mechanism, developed out of generations of experience of farmers in most parts of our country. These types of farming practices are good for sustainable agriculture, because it recycles all farming by-products and utilizes the household waste in a very good way. Still the existing system has to be improved with proper research and planning.

4. Variety of crops

India is a vast country with varied types of relief, climate and soil conditions. Therefore, there is a large variety of crops grown in India. Both the tropical and temperate crops are successfully grown in India. Very few countries in the world have a variety of crops comparable to that produced in India. This variation gives India an opportunity to enjoy a variety of food items in different parts of the country.

5. Predominance of food crops

Since Indian agriculture has to feed a large population, production of food crops is the first priority of the farmers almost everywhere in the country. More than two-thirds of the total cropped area is devoted to the cultivation of food crops. However, with the change in cropping pattern, the relative share of food crops came down from 1947 up to now.

6. Insignificant place of fodder crops

Although India has the largest population of livestock in the world, fodder crops are given a very insignificant place in our cropping pattern. Only four per cent of the reporting area is devoted to permanent pastures and other grazing lands. This is due to pressing demand of land for food crops. Therefore, the domestic animals are not properly fed and their productivity is very low compared to international standards.

7. Seasonal cropping pattern

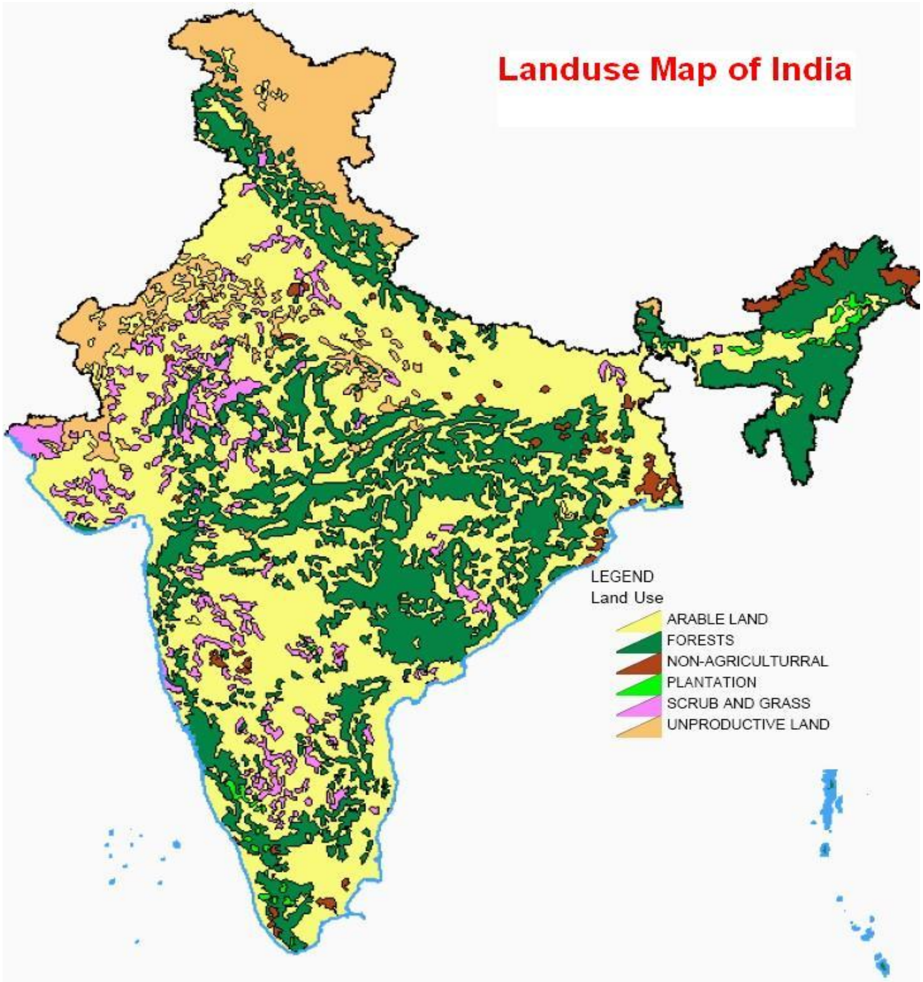
You should know that India has three major crop seasons. The first one is the Kharif season starts with the onset of monsoons and continues till the beginning of winter. Major crops of this season are rice, maize, jowar, bajra, cotton, sesamum, groundnut and pulses such as moong, urad, etc.The second is Rabi season starts at the beginning of winter and continues till the end of winter or beginning of summer. Major crops of this season are wheat, barley, jowar, gram and oil seeds such as linseed, rape and mustard. The third is summer cropping season known as Zaid in which crops like rice, maize, groundnut, vegetables and fruits are grown. The major crop areas in India can also be seen in the map (Figure1). Now some varieties of pulses have been evolved which can be successfully grown in summer.

12.4 LAND USE AND LAND HOLDINGS

You should have learnt by now that Agriculture is the major occupation of the people of India. Different types of land uses are seen in Map12.1. Land use determines the use of land for production of food grains, commercial crops, horticulture, grazing and other related activities. Land is used for agriculture, for growing forests, for grazing animals, for mining, for installing industries and for construction of houses, roads, railways, etc. For sustainable development and prosperity of any country, the proper and wise use of the land is required. The land use depends on the kind of land, its depth, fertility, water retention capacity, available mineral contents, and means of transportation, etc. The use of land for agriculture depends on soil type, irrigation facilities, and climate.

In this unit you will be able to understand the classification of land and the changes in land classification since independence. This unit also highlights that how the operational land holdings has reduced by half in between1970-71 and 2010-11.

Map-12.1



Source: Google

You must know the fact that in India, the land use data collection started during the British rule. To enhance its revenue collection, the British administration was interested in the compilation of land data. Due to the Second World War, the British administration exported food supplies to the war zones in Europe, creating a shortage of food commodities in India, which ultimately led towards the Great Bengal famine. To come out of the situation, identification of the causes was the immediate requirement. To fulfil the need, the land classification identified five indicators like:

1.Forest,

2.Area not available for cultivation,

3.Other uncultivated land excluding current fallows,

4.Fallow land and

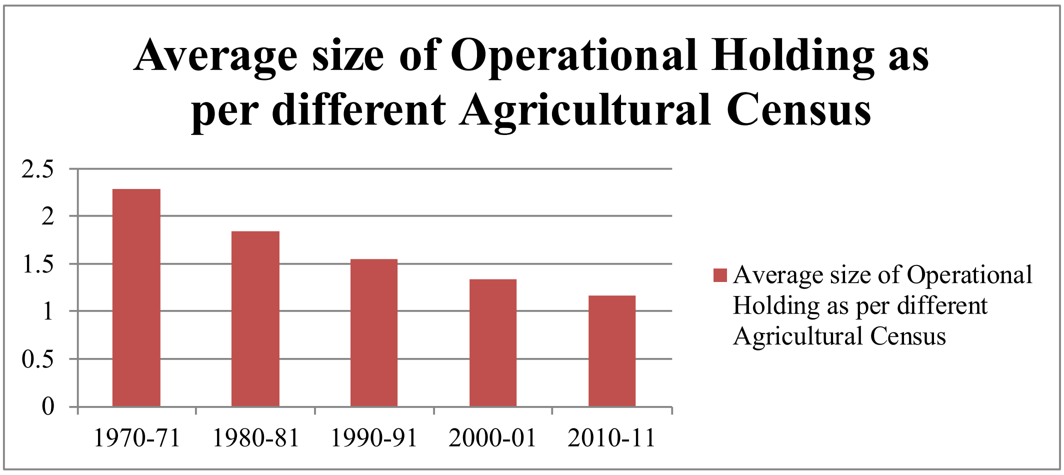
5.Net sown area.

After the independence of India, realising the significance of agriculture for the people of the country, this sector was given special weightage in the first five year plan. The ministry of agriculture set up a technical committee on coordination of agricultural statistics in1949 suggested that four more classifications added to the previous five fold classification could help more for the betterment of the Indian agricultural system. The following are the nine fold classification followed in India since independence. These are- Forests, Area under non agricultural uses, Barren and uncultivable land,Permanant pastures and other grazing land ,Fallow land other than current fallows ,Current fallows and Net sown area.

Agricultural Land Holdings Pattern in India

The last four decades has witnessed a sharp decline in the average size of operational land holdings in India. This is reflective of the immense population pressure on the limited land resource available for cultivation. The average size of operational land holdings has reduced by half from 2.28 ha in 1970-71 to 1.16 ha in 2010-11 (Bar Graph.12.1).The size of the land holdings has implications for investments in agriculture, its productivity, farm mechanisation and sustaining farm incomes itself. Land holdings in the marginal category (less than1 ha.) constitute 67 per cent of the operational holdings in the country (2010-11). marginal and small and holdings together, constitute 85 per cent terms of number of operational holdings and 44 per cent of the operated area in the country (Diagram12.1 and 12.2). Thus, over the period, the marginal category has emerged as a distinct and dominant class by itself. Indian agriculture is undergoing a heavy stress as average land holdings is decreasing day by day.

Bar Graph: 12.1



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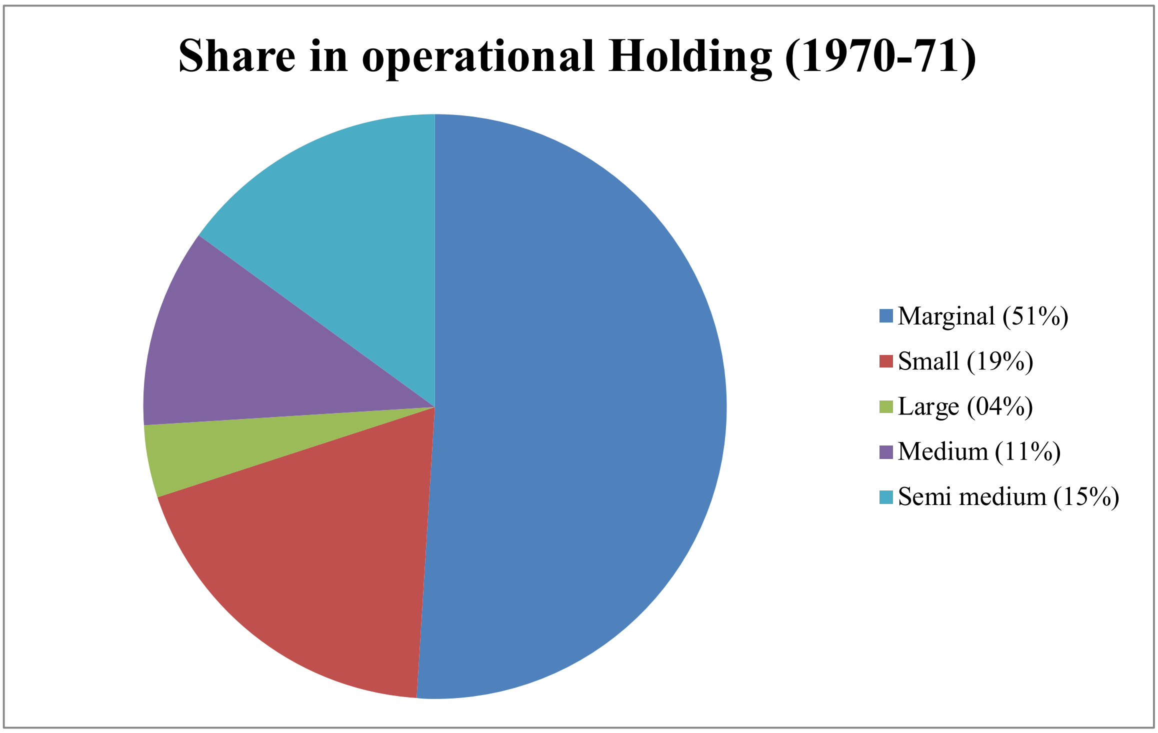
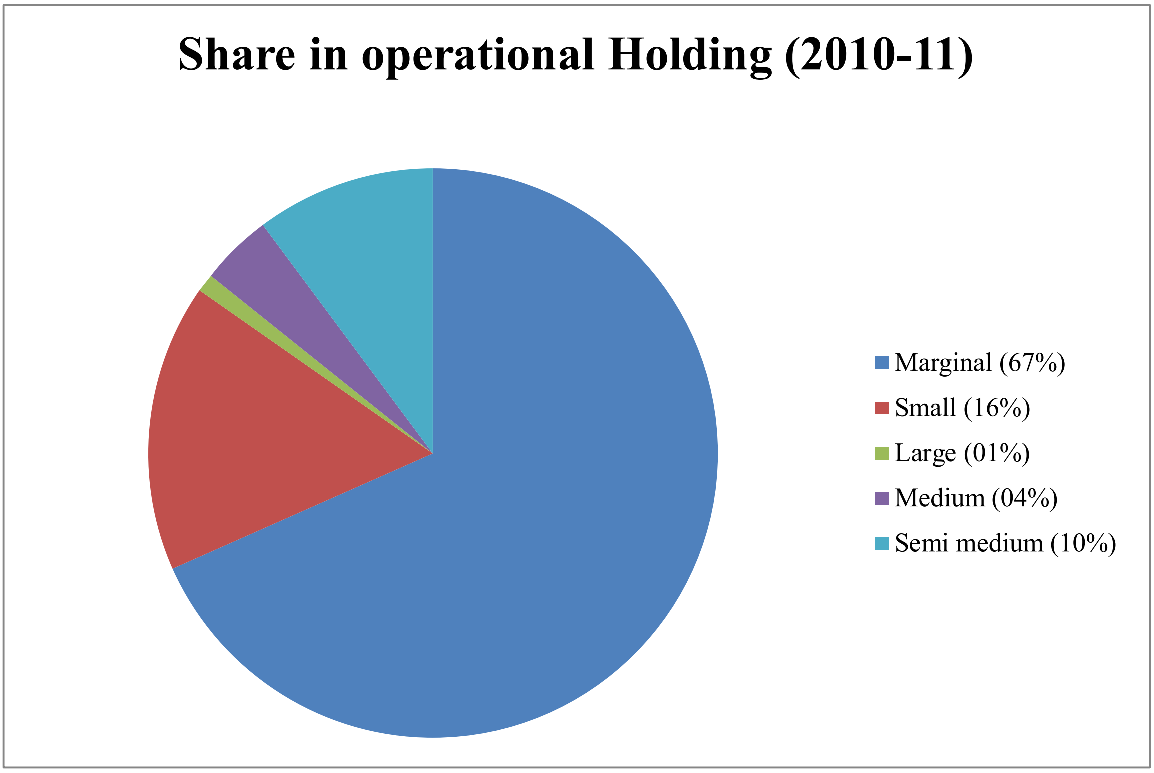


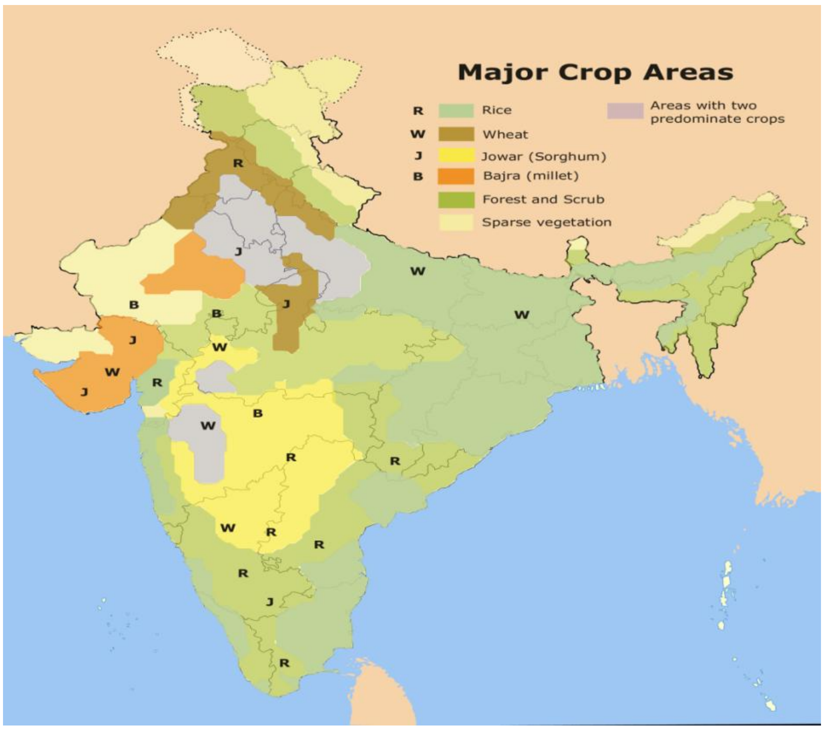
Diagram: 12.2



12.5 CROPS: DISTRIBUTION AND PRODUCTION

It is necessary for you to understand variations in agriculture in a vast country with diverse geographical conditions like India. The northern part of the country is mountainous terrain with a little area suitable for agricultural practices but the plains of Ganga, Yamuna and their tributaries have fertile agricultural land and different types of crops are grown here. The southern part of India has black soil which is ideal for growing cotton. Many other crops are also grown here .The coastal plains with their unique geographical conditions, also grow a variety of cash-crops and food grains. Studying this unit, you can be able to understand in a better way different types of agricultural products grown in different parts of India along with their geographic locations. Map 12.2 shows distribution of major crop areas within the country. The map shows that there are some areas in the country which grow a single crop but most of the areas grow multiple crops. Some parts of the country have areas with two predominate crops. In some areas one major crop is grown but another crop can also be grown in some parts. For example rice is the major crop which grows in eastern part of India but wheat is also grown to some extent.

Map:12.2



Source: Google

You must also know that after independence, special attention was paid by the Indian government to develop the agricultural sector. In this way, the production of food grains has increased 4 times during the planning period. With the starting of green revolution in India decision taken to adopt superior yielding, disease resistant wheat varieties in combination with better farming knowledge to improve productivity. Punjab went ahead in this revolution and was known as the bread basket of India. Production of other food grains increased substantially and India became self sufficient. Initially; the production was centred on irrigated areas of Punjab, Haryana and Utter Pradesh. With both the farmers and the government officials focusing on productivity in agriculture and knowledge transfer, country's total production increased drastically. Up to 1975, a hectare of Indian wheat farms produced 4.7 tonnes of wheat that produced an average of 0.8 tonnes in 1948.Such rapid growths in farm productivity enabled India to become self-sufficient by the 1970s.The production of oilseeds has also increased up to 29.8million tons (2011-12) which was just 5.1 million tons in 1950-51.The production of sugarcane was 57 million tons in1950-51which soared up to 361.04 in 2012. The Statistics Office of the Food and Agriculture Organisation reported that, per final numbers for 2009, India had grown to become the world's largest producer of fruits, including citrus fruits, fresh fruits, millet, pulses, castor oil and sunflower seeds, Chick peas Pigeon peas, Millet, Okra, Jute, Indigenous Buffalo Meat, Pulses, Sorghum, Areca nuts, Chillies and peppers, Spices, dry Anise, fennel, coriander, Beeswax etc.

You should also know this significant fact that, India is the world's second largest producer of the agricultural products including Wheat, Rice, Fresh vegetables, Sugar cane Groundnuts with shell, Lentils, Garlic, Cauliflowers and broccoli, Peas, green Sesame seed, Cashew nuts with shell, Silk-worm cocoons, Cow milk, (whole, fresh) Tea, Potatoes, Onions, Cotton lint, Cottonseed, Indigenous Goat Meat, Cabbages and Pumpkins, squash and gourds (2009). India was the world's third largest producer of eggs, oranges, coconuts, tomatoes, peas and beans in the same year.

In addition to growth in total output, agriculture in India has shown an increase in average agricultural output per hectare in last 60 years. The table below presents average farm productivity in India over three farming years for some crops. Improving road and power generation infrastructure, knowledge gains and reforms has allowed India to increase farm productivity in between 40% to 500% over 40 years. India's recent accomplishments in crop yields while being impressive are still just 30% to 60% of the best crop yields achievable in the farms of developed as well as other developing countries. Additionally, despite these gains in farm productivity, losses after harvest due to poor infrastructure and unorganised retail cause India to experience some of the highest food losses in the world.

Table 12.1- Production of some major crops in India

Crops	Average Yield (1970-1971)	Average Yield (1990-1991)	Average Yield (2010-11)
	Kg/ hectare	Kg/ hectare	Kg/ hectare
Rice	1123	1740	2240
Wheat	1307	2281	2938
Pulses	524	578	689
Oilseeds	579	771	1325
Oilseeds	579	771	1325
Sugarcane	48322	65395	68596
Tea	1182	1652	1669
Cotton	106	225	510

India and China are competing to establish the world record on rice yields. This is also noticeable that the total production and economic value of horticultural produce, such as fruits, vegetables and nuts has doubled in India over the 10 year period from 2002 to 2012. In 2012, the total production from horticulture exceeded grain output for the first time. Of this, India in 2013 produced 81 million tonnes of fruits, 162 million tonnes of vegetables, 5.7 million tonnes of spices, 17 million tonnes of nuts and plantation products (cashew, cacao, coconut, etc.), 1 million tonnes of aromatic horticulture produce and 1.7 million tonnes of flowers (7.6 billion cut flowers).During 2013 fiscal year, India exported horticulture products worth ₹14365 crore (US$2.3 billion), nearly double the value of its 2010 exports. Along with these farm-level gains, the losses between farm and consumer also increased, and are estimated to range between 51-82 million metric tonnes a year.

Some Indian states produce two to three times more grain per acre than in other Indian states. The table compares the state-wide average yields for a few major agricultural crops within India, for 2001-2002.

Table: 12.2 Variations in average crop yields in some of the states in India

Crops	Average farm yield in Bihar	Average farm yield in Karnataka	Average farm yield in Punjab
	Kg/ hectare	Kg/ hectare	Kg/ hectare
Wheat	2020	unknown	3880
Rice	1370	2380	3130
Pulses	610	470	820
Oil seeds	620	680	1200
Sugarcane	45510	79560	65300

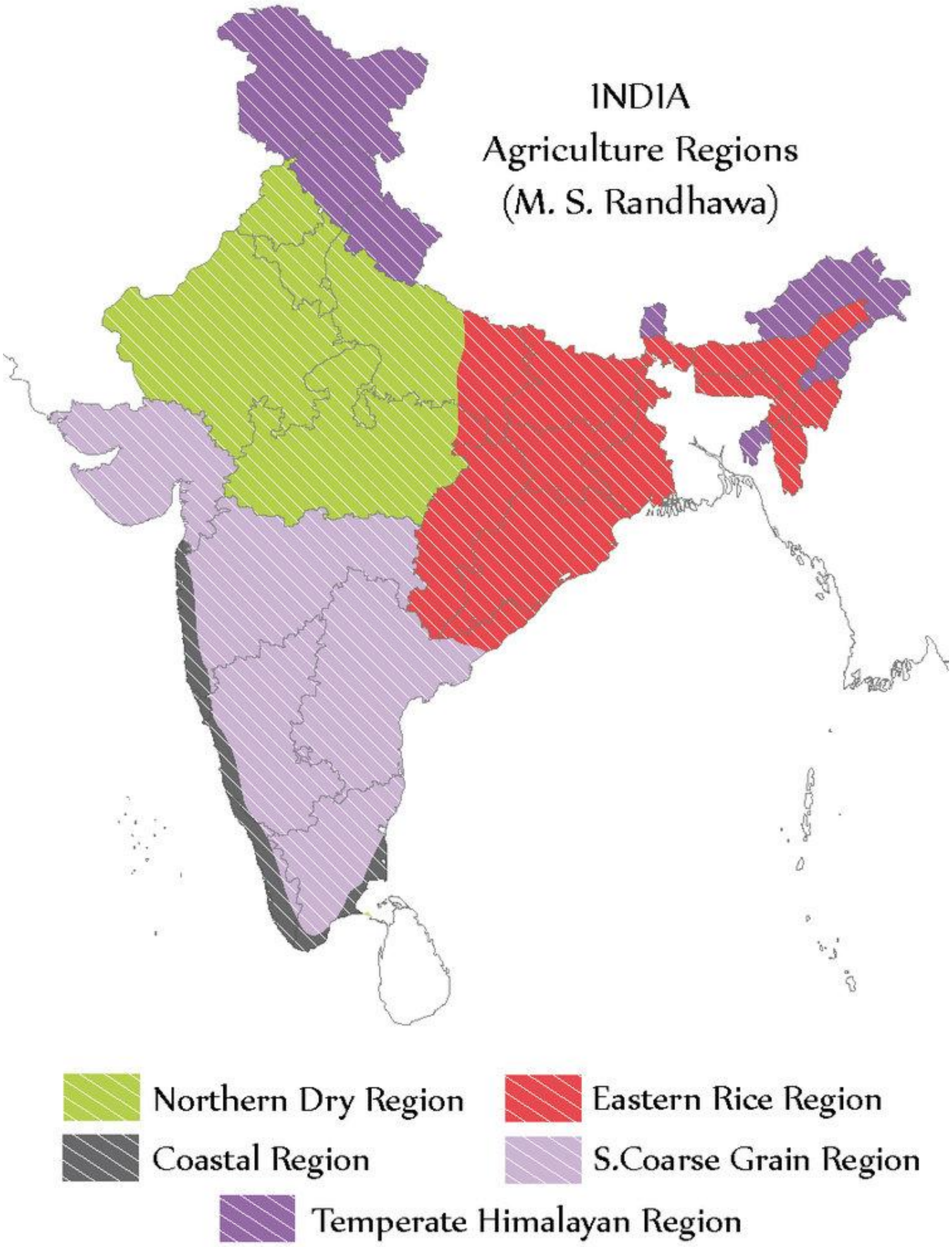
Crop yields for some farms within India are within 90% of the best achieved yields by farms in developed countries such as the United States and in European Union. In spite of all these fact and figures, Indian farmer receives just 10 to 23% of the price the Indian consumer pays for exactly the same produce, the difference going to losses, inefficiencies and middlemen.

12.6 AGRICULTURAL REGIONS

You should have learnt by now that India is a vast country and is endowed with diverse geographical conditions which are bound to bring in regional variations in agriculture. Now, you must also know about these variations in different parts of the country. An agricultural region is defined as an area having homogeneity in relief, soil type, climatic conditions, farming practices, crops produced and crop association.

Several scholars have attempted to delineate the agricultural regions of India. Prominent among them are E. Simkins (1926), D. Thomer (1956), M.S. Randhawa (1958), L.D. Stamp (1958), R.L. Singh (1971) Jasbir Singh (1975) and many others. In general, based on different crops and crop associations the following division (Map 12.3) gives a broad idea of crops grown in different parts of the country:

Map: 12.3



Source: Google

1. Eastern Rice-Jute-Tea Region

This vast region includes lowlands, valleys and river deltas in the states of Assam, Arunachal Pradesh, Tripura, Meghalaya, West Bengal, and Orissa, northern and eastern Bihar parts of Jharkhand and Chhattisgarh and Tarai region of Uttar Pradesh.

The rainfall varies from 180 to 250 cm. Rice are the predominant crop due to fertile alluvial soils, abundant rainfall and high summer temperatures. Jute is mainly grown in the Hugli basin of West Bengal but some areas have been brought under jute cultivation in Assam, Meghalaya, Tripura, Orissa and Tarai region of U.P. Tea is mainly grown in Assam, Darjeeling and Jalpaiguri areas of West Bengal and Tripura. Sugarcane ,tobacco(Bihar), Coconut(coastal areas)and fruits such as mango, pineapple, betal leaves, bananas, jack fruits, and oranges are the main rops.

2. Wheat and Sugarcane Region

This region comprises the Northern region of India including Bihar, Uttar Pradesh, Punjab, Haryana, Western Madhya Pradesh and north eastern Rajasthan. Most of the areas have rich fertile alluvial soils with some parts having black and red soils. Rainfall is moderate, large part of which is caused by south-west monsoons in summer. Some rainfall is caused by western disturbances in winter.

Irrigation is a vital input in drier areas. As its name indicates, this region is dominated by wheat and sugarcane cultivation. The main wheat belt of India extends over Punjab, Haryana, Ganga-Yamuna doab of Uttar Pradesh and north-eastern Rajasthan. Sugercane is mainly grown in Uttar Pradesh and contiguous parts of Bihar. Rice, pulses and maize are the other important crops.

3. Cotton and Coarse Crops Region

It spreads on the regur or black cotton soil area of the Deccan plateau, Rajasthan and northern Gujarat where the rainfall varies from 75 to 100 cm. Cotton is the main crop but jowar, bajra, gram, sugarcane, wheat, etc. are also grown. Agriculture is possible only with the help of irrigation. Maize is mainly grown in the Mewar plateau where wheat and ragi are also produced. In the southern part, rice, cotton and sugarcane are grown. Bajra and pulses are grown throughout the region.

4. Millets and Oilseeds Region

This region includes areas of poor soils and broken topography in Karnataka plateau, parts of Tamil Nadu, southern Andhra Pradesh and eastern Kerala. The rainfall varies from 75 to 125 cm. The millets include bajra, ragi and jowar while the oilseeds grown are groundnut and caster. Pulses are also grown. Mangoes and bananas are important fruit crops.

5. Himalayan fruits and vegetable region

This region extends from Kashmir Valley in the west to Assam in the east. The rainfall varies from 60 cm in the west to 200 cm in the east. Apple, peach, cherries, plum, apricot are grown in the west while oranges are important in the east. Besides, rice, maize, ragi potatoes, chillies and vegetables are also grown.

12.7 CONCLUSIONS

Going thoroughly through this unit, you must have understood that agriculture is the very source of survival for the people of our country. Studying this chapter, you might have also known that two third of India's population has been directly and indirectly employed in this sector. The land use from agricultural to non agricultural has changed rapidly after independence. The change has taken place in the urban sprawl and the industrialized areas. Ever increasing human and livestock population particularly in a country like India is negating the technology driven progress in agriculture. It is predicted that Indian population will stabilize around 1.4 billion by 2025. To meet the food demand of our people, the yield is required to be enhanced at all levels keeping the sustainable agriculture goal in the centre. Poverty alleviation and overall development through indigenous knowledge used as a base for research and development for sustainable agricultural development in India is required. In the present scenario agriculture is becoming less remunerative because of fall of prices of major agricultural produce in recent years, increasing share of middlemen, liberalized economy driving towards commercialized agriculture, less attraction of youth to work in this sector , lack of efforts to agriculture for employment-led growth in rural areas, and little link of agricultural education and agricultural occupation etc. An important ray of hope, which one can notice in this complex changing scenario of agriculture, is that at least there is a new generation of farmers who are more educated, young and energetic. They could be keen on getting more knowledge about the new technology while carrying forward the family farming traditions more rationally and also logistically. The challenge is to develop technologies and packages that may improve productivity and production in a sustainable, environment enriching and energy efficient manner but without competing for human food. To achieve the goal, environmentally sustainable technologies such as soil conservation, sustainable natural resource management and biodiversity protection, are essential for holistic development of a country like India. New technologies restricted to some of the selected crops, growing disparity between potential yields due to improper technology transfer mechanism, low productivity from rain fed crops, lack of food processing and value addition to horticultural and vegetable crops (2 per cent of total produce), high post harvest losses especially in horticultural produce (20-40 percent), very low agricultural produce export (1 per cent of global export); poor market infrastructure, untrained human resource in agriculture sector are points to be noted. Special efforts need to be made to raise the productivity and production of crops, livestock, fisheries, horticultural crops to ensure food and nutritional security for the people and generating surplus for export. Therefore, one should always look forward to addressing both sustainability and development in Indian agriculture in the years to come.

12.8 SUMMARY

In the first part this unit, we have tried to show you that India's agricultural scenario in India is undergoing structural changes. The population of this country was 345 million in 1947 at the time of independence. In the post independence period, especially after the Green revolution followed by White, Blue, Yellow and Pink revolutions revolutionized the agricultural sector to a great extent. The production increased manifold. Still, there were some negative points associated which we should also keep in mind. The revolution was limited to some crops in limited areas benefitting a handful of people. After studying the objectives of this unit you have known the salient features of Indian agriculture. Studying these features, you will be able to understand that subsistence agriculture, pressure of population on agriculture, significance of animals in agriculture, variety of crops grown in different seasons in different geographical locations make India a unique country. The population of this country was 345 million in 1947 at the time of independence. India has a land area of about 328 million hectares with 1210 million people living in this country according to 2011 census. The land use from agricultural to non agricultural has changed rapidly after independence especially in the urban sprawl and the industrialized areas. Another noticeable point is that ten percent of the landowners have about sixty two percent of the agricultural land. Today, India ranks second world-wide in farm output. Agriculture and allied sectors like forestry and fisheries accounted

for 13.7% of the GDP (Gross Domestic Product) in 2013. The total horticulture produce reached 277.4 million metric tonnes in 2013, making India the second largest producer of horticultural products after China. Still, an average farmers share is even less than 0.2 percent. In between 1970 and 2011, the GDP share of agriculture has fallen from 43 to 16%. In India where population is increasing continuously, it is predicted that it will stabilize around 1.4 billion by 2025. To meet the food demand of the population the yield level is required to be enhanced at all levels keeping the sustainable agriculture goal in the centre.

12.9 GLOSSARY

- Backbone of Indian economy: providing support for everything else in the country's economy
- Green revolution Green Revolution: It stands for a major technological breakthrough in India based on seeds of high yielding varieties, adequate irrigation facilities and appropriate use of chemical fertilizers for increasing agricultural production.
- White Revolution: It stands for remarkable increase in milk production and establishment of a national milk grid, removing regional and seasonal imbalances with various technological inputs.
- Blue Revolution: It refers to big rise in catching of fresh water and marine fish.
- Yellow Revolution: It refers to remarkably steady and assured supply of poultry products.
- Pink Revolution: It refers to a considerable rise in the production of quantity of apples particularly in the states of Himachal Pradesh and J&K.
- Subsistence agriculture: form of farming in which nearly all of the crops or livestock raised are used to maintain the farmer and his family leaving little surplus
- Environmentally sustainable technologies: balancing environmental protection and social responsibility with a healthy economy over time
- Soil conservation: prevention of soil from erosion or reduced fertility caused by overuse, acidification or other chemical soil contamination
- Natural resource management: refers to the management of natural resources such as land, water, soil, plants and animals with a particular focus on how management affects the quality of life for present and future generations.
- Biodiversity: totality of genes, species and ecosystem of a region

- Sustainable agriculture: act of farming using principles of ecology, the study of relationship between organisms and their environment
- Food security: access to healthy food and optimal nutrition for all
- Agricultural education: teaching of agriculture, natural resources and land management through hands on experience and guidance to prepare students for agricultural jobs
- Technology transfer mechanism: transfer and/or exchange of technology with industry, state and local governments, academia and other federal agencies

12.10 ANSWERS TO CHECK YOUR PROGRESS

1. Agriculture has been the base of Indian civilization which includes different types of farming, combination of trees cereal crops, leguminous pulses and oilseeds along with a mix of livestock and their interrelationships with each other. Therefore it is known as the backbone of the Indian economy.

2. In the 1970s and 1980s, Indian agriculture was transformed with modern methods including seeds, fertilizers and pesticides. India's Green technology later on followed by White, Yellow and Pink revolution stands for remarkable change in the agricultural sector.

3. The All India Agricultural service was organized in 1906.

4. i) Agriculture has no impact in the economy of India (F)
   ii) White blue pink and yellow revolutions developed the agricultural sector in India (T)
   iii) Unemployment and poverty increase when there is progress in agriculture (F)
   iv) Diversification of agriculture may lead towards sustainable agriculture (T)

5. It is estimated that about 4 lakh hectares of farm land is now being diverted to non agricultural uses each year.

6. Major crops of Kharif season are rice, maize, jowar, bajra, cotton, sesamum, groundnut and pulses such as moong, urad, etc.

7. It has been observed that livestock play a significant role in ploughing, irrigation, threshing and transporting the agricultural products which have been practiced in India for the last several hundreds of years. The combination of livestock with crop production risk aversion mechanism, developed out of generations of experience of farmers in most parts of our country. This type of agriculture also recycles all farming by-products and utilizes the household waste in a very good way.

8. The use of land for agriculture depends on soil type, irrigation facilities, and climate.

9. The Land use types in India are- Forests, Area under non agricultural uses, Barren and uncultivable land, Permanent pastures and other grazing land, Fallow land other than current fallows, Current fallows and Net sown area.

10.The marginal land holdings is the dominant land holding class which has sixty seven percent operational land holdings in 2010-11. 10. The green revolution starts in India with the production of wheat.

11. The production of fruits, vegetables and nuts has doubled in India over the 10 year period from 2002 to 2012.

12. India and China are competing to establish world record on rice yields.

13. After independence, the change in land use has taken place in the urban sprawl and the industrialized areas.

14. Fill in the blank spaces using the words given below

(i) The land use from agricultural to non agricultural has changed rapidly after independence.

(ii) Fruits and vegetables region extends from Kashmir Valley in the west to Assam in the east.

(iii) Maize is the major crop of the Mewar plateau.

(iv) Wheat and sugarcane are grown in rich, fertile alluvial soil.

(v) India and china are competing to yield world record in rice production.

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12.13 TERMINAL QUESTIONS

Q 1. Explain the history of agricultural development in India.
Q 2. Discuss the progress in the agricultural sector after independence.
Q 3. Which are the main agricultural products in India?
Q 4. What are the Green, Blue, Yellow and Pink revolutions? Discuss their impact on the Indian agriculture.
Q 5. Divide India into different agricultural regions.

Q 6. What challenges India is facing in the agricultural sector at present?

Q 7. What are the problems faced by Indian farmers in the agricultural sector.

Q 8. Give your suggestions regarding agricultural reforms in India.

Q 9. Why is Agriculture called 'backbone of Indian economy'?

Q 10. Which was the period of transformation of Indian agriculture?

Q 11. In which year was All India Agricultural service organized?

Q 12. Which of the following statements are true? Put T for a true statement in front of the statement and F otherwise.

i) Agriculture has no impact in the economy of India.
ii) White blue pink and yellow revolutions developed the agricultural sector in India.
iii) Unemployment and poverty increase when there is progress in agriculture.
iv) Diversification of agriculture may lead towards sustainable agriculture.

Q 13. At which rate is the farm land is being diverted to non-agricultural uses each year in India?

Q 14. Which are the major crops of the Kharif season?

Q 15. Describe the significance of animals in agricultural operations in our country.

Q 16. What does the use of land for agriculture depend on?

Q 17. Name the land use types in India.

Q 18. Which is the dominant operational land holding in India?

UNIT 13 - INDUSTRIES

13.1 OBJECTIVES

The following objectives will help us to understand the infrastructure, current state of industrialization in India and future perspectives for industrial development in the country.

1. Present stage of industrialization in India
2. Distribution of heavy, medium and small scale industries in India
3. To solve the unemployment problem through industrial development
4. Different types of industries in a particular area and export of the manufactured materials.
5. Role of government banks and other co-operative societies which promote industrial development.
6. To achieve optimal utilization of human Resources

13.2 INTRODUCTION

As we have studied in the previous unit that over the years agriculture has been the major source of livelihood of the Indian population. Other sectors, including industries were mostly agro-based and extremely underdeveloped. During the time of independence, India had and unbalanced industrial structure. Industries contributed less than one sixth part of national income. Whatever major industries were there, they were largely concentrated in a few areas such as Bombay, Surat, Ahmadabad, Jamshedpur, Calcutta and some other cities and ports. At present, industrial growth is directly or indirectly linked with economic development of any society. India has been successful in achieving autonomy in producing different basic and capital products since independence. The productivity of the major Indian industries incorporates aircraft, vessels, automobiles, steam engines, heavy electrical equipment, construction machinery, chemicals, precision equipments, communication instrument, power generation and transmission tools and computers. Since independence to 1980 there was restrictive growth of private sector and government's permission was required to set up any private enterprise in India. Despite this the GDP grew at a rate of 1.4% per annum from 1940 – 1970. Other factors such as poverty and famine lowered India's economic growth rate during this period and with the presence of very few top producers of major industrial goods the absorption of domestic productivity was greater, which lead to monopolistic pricing. India during this phrase lagged behind in terms of economic growth as the rest of world grew and flourished through overseas trade. India saw liberalization after 1980 and achieved further impetus in Mid-1991. The nation witnessed historical upsurge in per capita GNP. In 1994-95 the industrial output-growth registered 8.4% growth and the exports rose by 27%. This resulted in a 10% drop in inflation in the mid-1990s.Since its liberalization policy; India has opened several public sector enterprises. Apart from the major industries developed in the country, medium and small industries also have significant contribution in the growth and development of Indian economy.

13.3 TYPES OF INDUSTRIES

We will now talk about some of the industries which determine the path towards development in a country like India. For the convenience to study, we can divide them into three groups. The first group includes iron and steel industry, ship building and textile industry. The medium skill industries we will study here are leather, paper and sugar industry. The third group of industries include the small scale industries which is the most important employment providing sector of the economy.

HEAVY INDUSTRIES

At present, heavy Industry in India comprises of the heavy engineering industry, machine tool industry, heavy electrical industry, industrial machinery and auto-industry. These industries provide goods and services for almost all sectors of the economy, including power, rail and road transport. The machine building industry caters the requirements of equipment for basic industries such as steel, non-ferrous metals, fertilizers, refineries, petrochemicals, shipping, paper, cement, sugar, etc. Here, in this unit we have to focus on some of the heavy industries in India including Iron, Steel, Ship building and Textile industry.

Iron and steel industry

In India, steel industry can be traced back to 400 BC when the Greek emperors used to recruit Indian archers for their army who used arrows tipped with steel. There are evidences related to use of iron and steel for more than six thousand years and that some of the best products were made in India. The Iron Pillar near Qutab Minar in Delhi, (built between 350 and 380 AD) the famous Sun Temple at Konark in Orissa,(built around 1200 AD),are examples of steel used for the first time in the world.

The modernization of the industry started in1907 with the establishment of first iron and steel plant at Sakchi in Bihar which gave the village a new name Jamshedpur. The second plant in India was started in Hirapur and third in Bhadrawati. You should have learnt by now that up to independence, India had four plants with a total production of 12 lakh tonnes. After independence, the steel industry was considered as basic industry; old plants were modernized and the new ones were set up in the public sector. In this sequence, Steel Plants were established in Rourkela, Durgapur and Bhilai. Further; the Bokaro steel plant was set up in Jharkhand. In the same sequence, the fifth and sixth steel plants were established in Vishakhapattanam and Vijaynagar.In 1995, the production of steel in India was 177 lakh metric tons which soared upto 297 lakh metric tons in 2001.More than 130 metric tonnes iron ore is produced in the country. The iron and steel industry requires iron ore and coal as raw materials. The plants set up at Durgapur, Asansol, Kulti, Bokaro and Jamshedpur get coal from Damoder valley and iron ore from the nearby areas of Jharkhand and Orissa. Raurkela and Bhilai are also located nearby. The plant at Vishakhapattanam depends upon imported raw material. Vijaynagar and Bhadrawati plants use the iron ore of the nearby areas. Its capital contribution to the economy is more than 9000 crore. This industry has given employment opportunity to about 0.5 million people. The Iron and steel industry of India is mainly concentrated around Jharkhand, West Bengal and Orissa because of the high quality coal mines located at Jharia, Ranigang, Bokaro and Karanpura. In this area the iron ore mines are extended from Mayurbhanj ,Kyojhar,Brona from Sihabhumi district in Jharkhand. This area also has sufficient deposits of limestone, dolomite, mageneese, silicon and dolomite which are required in the industry. The map (Map13.1) shows location of steel industries in India.

Map13.1

Source: Google

Ship Building Industry

Ship building industry can be established where the sea waters are deep and navigable off the coast. There should also be a rich hinterland well connected with transport facilities. The hinterland provides the export products. It also supplies raw materials to the industries in the harbour area. Roads, railways and other means of transport start from the port and spread out to all parts of the hinterland. Large ship building units have their own plants to produce components like boilers, engines, propulsion and electrical machinery for ships. The smaller units are not capable to do so. Therefore, these units buy these from other industrial units and assemble them to make ships. For example, the port of Mumbai has a very large hinterland. The requirement for this industry is the availability of minerals and other raw materials mainly iron and steel. This includes the entire region of Western India. The first modern ship building plant was started in Vishakhapatnam by Schindhya Steam Navigation Company Limited in 1941but because of economic problems it was handed over to the central government. Since 1962it became a public sector undertaking. It makes barges, bulk carriers, cargo vessels, rigs and steel jackets. At present it is being run by Hindustan Shipyard Company. The central government has also undertaken Garden Reach Workshop (Kolkata) and Mazagoan Dock because of security reasons. Both make barges; tugs dredgers and coasters. These units also do all types of marine repairs of sea going merchant ships. The Mazagaon Docks, Mumbai were at first restricted to dry- dock repairs. This shipyard builds frigates, cruisers, naval ships, barges and small cargo ships. Another significant one is the Cochin shipyard at Kochi (Kerala) which was built with Japanese collaboration in 1972.This shipyard builds repairs and maintains naval ships, cargo and passenger vessels.

Textile industry

India's textiles sector is one of the mainstays of the national economy. The archaeological surveys and studies have found that the people of Harrapan civilization knew weaving and the spinning of cotton four thousand years ago. Reference to weaving and spinning materials is also found in the Vedic Literature. Later on, during the late 17th and 18th century, there were large exports of the Indian cotton to the western countries to meet the need of the European industries during industrial revolution. There was also export of Indian silk, Muslin cloth of Bengal, Bihar and Orissa to other countries by the East Indian Company.

The Indian textiles industry is extremely varied, with a hand-spun and hand woven sector at one end of the spectrum, and the capital intensive sophisticated mill sector at the other. The decentralised power looms/ hosiery and knitting sector form the largest section of the textiles. Indian textiles sector also provides the industry with the capacity to produce a variety of products suitable to the different market segments, both within and outside the country. India is the second largest producer of fibre in the world and the major fibre produced is cotton.Tamilnadu, Andhra Pradesh, Punjab Karnataka and Maharashtra are leading states in the textile industry in India. You will further study the distribution of textile industry in different parts of India. The fibres produced in India include silk, jute, wool and man-made fibres.60% of the Indian textile Industry is cotton based. Traditionally, after agriculture, textile industry in India is the only industry that has generated huge employment for both skilled and unskilled labour in textiles. The industry is the second largest employer after agriculture, providing direct employment to over 45 million and 60 million people indirectly. The Indian Textile Industry contributes approximately 5 per cent to GDP and 7 per cent share in the world market with16 per cent per annum growth. The map of India (Map 13.2) shows the location of textile and sugar industries in India.

Map 13.2

Source: Google

MEDIUM SCALE INDUSTRY

The Medium scale industries are neither too big nor too small. In these industries, normally the investment in plant and machinery is more than five crore rupees but does not exceed ten crore rupees. These medium size industries play a significant role in the overall industrial development of India. Here, in this unit, you will study about some of the medium scale industries including leather, paper and sugar.

Leather Industry

As all of you know that leather is one of the most widely-traded commodities globally. The growth in demand is driven by the fashion industry, especially footwear, furniture and interior design, and the automotive industry, among others.

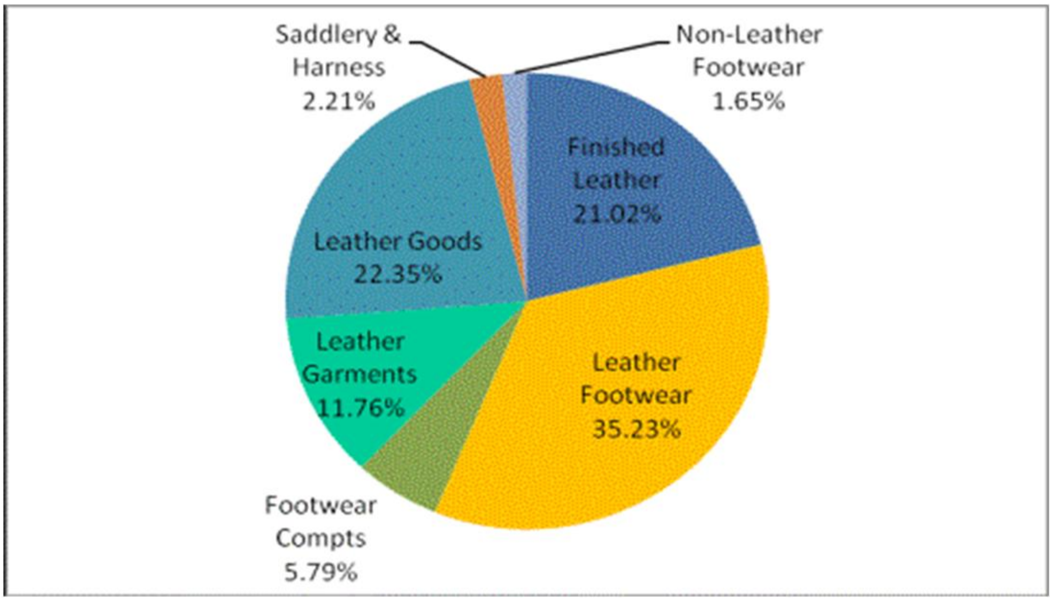
The export of leather and leather products increased manifold over the past decades and in 2013-14, India's leather exports recorded a growth rate of 17.81 per cent. This sector is known for its consistency in high export earnings and it is among the top ten foreign exchange earners for the country. The Leather industry is bestowed with an affluence of raw materials as India is endowed with 21% of world cattle & buffalo and 11% of world goat & sheep population. Added to this are the strengths of skilled manpower, innovative technology, increasing industry compliance to international environmental standards, and the dedicated support of the allied industries. The major production centres for leather and leather products in India are located in Chennai, Ambur, Ranipet, Vaniyambadi, Vellore, Pernambut, Trichy, Dindigul and Erode (Tamil Nadu),Kolkata (West Bengal) Kanpur, Agra, Noida, Saharanpur(U.P) Mumbai (Maharashtra); Jallandhar (Punjab); Bangalore(Karnataka) Hyderabad(A.P) ; Ambala, Gurgaon, Panchkula, Karnal and Faridabad(Haryana); DelhiDewas (M.P); Calicut and Ernakulam / Cochin(Kerala). Map13.3 shows the areas where leather industry is established in India.

Map13.3

Source: Google

Thus, you can understand that the industry has witnessed robust growth, transforming from a mere raw material supplier to a value-added product exporter. You can see the role of different leather products in the industry in the diagram (Diagram: 13.1).

Diagram: 13.1



Indian Paper Industry

India first Machine-made paper was manufactured in 1812. During this time there were 15 mills with a total production of lakh tones. In India the Soft wood is the principal raw material used for making paper especially newsprint and high class printing papers. With rise in population and broadening of education the demand for paper has been constantly escalated. Owing to very narrow forest resources wood pulp is in a shortage. Paper in India is made from 40% of hardwood and bamboo fibre, 30 % from agro waste and 30 % from recycled fibre. Newsprint and publication paper consumption account for 2 million tonnes, of which 1.2 million tonnes of newsprint paper is manufactured in India and the remaining 0.8 million tonnes is imported. The Indian Paper Industry has emerged as a diversified and specialized industry that produces numerous types of papers that comes in various use such as sheet paper, paper boxes, tissues, paper bags, stationery, envelopes, and printed-paper products such as books, periodicals, and newspapers. Some other forms of use are filter paper, Greeting Cards, Handmade paper Boxes, paper Albums, etc. are manufactured and exported across the world. There are vast demands in the area of tea bags, filer paper, tissue paper, medical-grade coated paper, lightweight online coated paper, etc. Today, the Indian exporters export nearly Rs.400 crores worth of paper products per annum to the developed nations. The capacity of Indian Paper Industry has been raised to 75,000 tonnes a year. West Bengal and Maharashtra are the leading states for the industry. The industry provides employment to more than 0.12 million people directly and 0.34 million people indirectly. Indian paper and newsprint industry has a huge potentials and prospects in coming future. In our, country, demand for paper and newspaper is rapidly increasing. The location of paper and pulp industry in India can be seen in the map below (Map 13.4).

Map 13.4

Source: Google

Sugar Industry

Now, you should know the fact that sugar industry is set up across India in most of the states at present. You will study their details when going through the industrial regions of the country. It was in 1950-51 the government of India made serious industrial development plans and set the targets for production and consumption of sugar. It projected the license and instalment capacity for the sugar industry in its Five Year Plans. The sugar industry can be divided into two sectors including organized and unorganized sector. It was India which began producing sugar following the process of pressing sugarcane to extract juice and boil it to get crystals. Sugar is produced followed by several steps such as extracting juice by pressing sugarcane, boiling the juice to obtain crystals, creating raw sugar by spinning crystals in extractors, taking raw sugar to a refinery for the process of filtering and washing to discard remaining non-sugar elements and hue, crystallizing and drying sugar and packaging the ready sugar. Indian sugar industry uses sugarcane in the production of sugar and hence maximum number of the companies is likely to be found in the sugarcane growing states of India including Uttar Pradesh, Maharashtra, Gujarat, Tamil Nadu, Karnataka, and Andhra Pradesh. Uttar Pradesh alone accounts for 24% of the overall sugar production in the nation and Maharashtra's contribution can be totalled to 20%. Sugar factories belong to the organized sector. There are 453 sugar mills in India. Co-operative sector has 252 mills and private sector has 134 mills. Public sector boasts of around 67 mills.

Small Industries:

You may perhaps know that India consists of more than 600000 villages and small industries are giving are giving employment to a large number of our village population. The industrial undertakings having fixed investment in plant and machinery, whether held on ownership basis or lease basis or hire purchase basis not exceeding Rs. 1 crore, are called small scale industries. At much smaller levels, small scale service establishments in personal or household services in rural areas and town with population not exceeding 50000 and having fixed investment in plant and machinery which may not exceed Rs. 25 lakhs. Skilled craftsman and technicians who can work in their own houses also come under this category. In Indian economy small-scale and cottage industries occupy an important place, because of their employment potential and their contribution to total industrial output and exports. It also contributes a substantial part of manufacturing output. The small industries fall in two categories: cottage industries and small scale units. The cottage industries are mostly traditional industries employing traditional methods to produce traditional products. They are essentially household enterprises employing little hired labour. Metal and wood work, artistic handicrafts such as jewellery cutting and polishing of diamonds, toys, dolls, small plastic and paper products, electronic and electrical gadgets are some examples of these industries. Some examples of such type of industries can be seen in Figure 13.1 .The owner is activity involved in all the decisions concerning business. The area of operation of small units is generally localised catering to the local or regional demand. The overall resources at the disposal of small scale units are limited and as a result of this, it is forced to confine its activities to the local level. These industries use local or indigenous resources and as such can be located anywhere subject to the availability of these resources like labour and raw materials. Small industries are fairly labour intensive with comparatively smaller capital investment than the larger units. Therefore, these units are more suited for places where capital is scarce and there is abundant supply of labour. They are more flexible to adopt changes like new method of production; introduction of new products etc.The development of small scale units in rural and backward areas promotes more balanced regional development and can prevent the influx of job seekers from rural areas to cities.

On the other hand; the small scale industries generally employ a small number of wage workers. The ownership lies mostly with individuals or partnerships

Figure13.1

These industries can create more employment opportunities, can remove economic backwardness of rural and less developed regions of the economy, reduce regional imbalances, ensure optimum utilisation of unexploited resources of the country, improve standard of living of people, to ensure equitable distribution of income and wealth, solve unemployment problem, attain self-reliance, adopt latest technology aimed at producing better quality products at lower costs.

Small-scale industries are at a distinct advantage as far as mobilisation of capital and entrepreneurial skill is concerned. A number of entrepreneurs are spread over small towns and village industries are distributed over the entire length and breadth of the country. In addition, a large number of other resources spread over the country can be put to an effective use by the small-scale and cottage industries.

Figure 13.2

You may be familiar with the fact that earlier, the small-scale and cottage industries were either agro-based or based on large industries but in recent years trends have changed. In the picture (Figure13.2) you can see a small industrial unit near Kakdighat, Uttarakhand. Different local products (spices and herbs) added to the salt and other local fruit products are prepared and sold here in different forms. Around 93 percent exports of the small-scale industries consists of non-traditional items like readymade garments sports-goods, finished leather, leather products, woollen garments and knitwear, processed foods, chemicals and allied products, and a large number of engineering goods.

You may also know the fact that the share of the small-scale sector in manufacturing exports is about 45 percent. Government of India has taken a number of steps to promote them. As per the rules of the government, you need not procure a license either from the state or central government to set up a small business venture anywhere in India. The government bodies such as the Department of Industries provide financial assistance to these industries. Nowadays, State Financial Corporations and other commercial banks disburse medium to long term loans, too. The National Small Industries Corporation is also a government body which assists the small business owners in availing financial assistance machinery on hire-purchase basis.

13.4 INDUSTRIAL REGIONS

1. Eastern Industrial Region

This industrial region includes the industrial regions of West Bengal which extends as a narrow belt running along the river Hugli for a distance of about 100 km from Bansbaria and Naihati in the north to Birlanagar in the south and Midnapur district in the west. The river Hugli offered the best site for the development of an inland river port as nucleus for the development of Hugli industrial region. The old trading centre of late 17th century has developed into the present industrial hub of Kolkata. Thus Kolkata-Haora forms the nucleus of this region. It is very well- connected by the Ganga and its tributaries with the rich hinterland of Ganga-Brahmaputra plains. Besides navigable rivers, roads and the railways provided subsequent links to the great benefit of Kolkata port. Establishment of first jute mill at Rishra in 1855 ushered in the era of modem industrial clustering in this region. The port site was best-suited for export of raw materials to England and import of finished goods from that country.

Kolkata's industries have established by drawing in the raw materials from adjoining regions and distributing the finished goods to consuming points. Thus, the role of transport and communication network has been as important as the favourable locational factors in the growth of this region. By 1921, Kolkata-Hugli region was responsible for two-thirds of factory employment in India.

The problem of shortage of jute was solved by gradually increasing home production of jute which rose after the partition of old Bengal province in 1947 and similar was the case of textile industry.

Paper, engineering, textile machinery, electrical, chemical, pharmaceuticals, fertilizers and petrochemical industries have also developed in this region. Factory of the Hindustan Motors Limited at Konanagar and diesel engine factory at Chittaranjan are landmarks of this region.

Location of petroleum refinery at Haldia has facilitated the development of a variety of industries. The major centres of this industrial region are Kolkata, Haora, Haldia, Serampur, Rishra, Shibpur, Naihati, Kakinara, Shamnagar, Titagarh, Sodepur, Budge Budge, Birlanagar, Bansbaria, Belgurriah, Triveni, Hugli, Belur, etc. The discovery of coal and iron ore in Chotanagpur plateau, tea plantations in Assam and northern parts of West Bengal and the processing of deltaic Bengal's jute led to the industrial development in this region. Cheap labour could be found easily from the thickly populated states of Orissa, Bihar, Jharkhand and eastern part of U.P. Kolkata, having been designated capital city of the British India (1773-1912) attracted large scale British investment of capital. The birth and growth of this region is linked with the discovery of coal in Damodar Valley and iron ore in the Jharkhand-Orissa mineral belt. As both are found in close proximity, the region is known as the 'Ruhr of India'.

Alarming rate of silting of the Hugli River was a very serious problem. The depth of water in the channel from bay head to Kolkata docks must be kept at 9.2 metres for big ocean ships to come in. Dredging out of the silt rapidly filling up the water channel was very costly solution to save the life of Kolkata port. The industrial growth of this region has slowed down as compared to the other regions. There are several reasons for this sluggish growth but decline in jute industry is said to be one of the main reasons.

2. Mumbai-Ahmadabad Industrial Region:

This region extends from Ahmadabad up to Pune. The seeds of its growth were sown in 1774 when the island-site was obtained for construction of Mumbai port. The opening of the first railway track of 34 kms between Mumbai and Thane in 1853, opening of the Bhor and Thai Ghats respectively to Pune and Nashik and that of Suez Canal in 1869 led to the development of Mumbai.

The growth of this industrial region is fully connected with the growth of cotton textile industry in India. Cotton soil area of the Narmada and Tapi basins provide raw material for the industry.

Mumbai High petroleum field and erection of nuclear energy plants added additional magnetic force to this region. The discovery and production of oil at a number of places in the Gulf of Khambhat area led to the establishment of petrochemical industries around Ankleshwar, Vadodara and Jamnagar. Petroleum refineries at Koyali and Jamnagar provide necessary raw materials for the proper growth of petrochemical industries.

Now the industrial centres have developed, from Mumbai to Kurla, Kolaba, Thane, Ghatkopar, Ville Parle, Jogeshwari, Andheri, Thane, Bhandup, Kalyan, Pimpri, Pune, Nashik, Manmad, Solapur, Ahmednagar, Satara and Sangli.In addition to cotton textile and chemical industries,pesticides engineering goods, leather, oil refineries; petrochemicals, diesel engines, textile machinery, pharmaceuticads synthetic and plastic goods, drugs, fertilizers, electricals, electronics, software, ship-building, transport ,dairy products and food processing industries have also developed here.

The other industrial centres of this region are Ahmedabad, Vadodara, Bharuch, Koyali, Anand, Khera, Surendranagar, Surat, Jamnagar, Rajkot and Valsad. Ahmedabad is nearer the sources of raw material as well as the marketing centres of the Ganga and Satlui plains. Availability of cheap land, cheap skilled labour and other advantages helped the cotton textile industry to develop. In this region, greater factory employment is provided to people. The region may become more important in the years to come.

3. Bangalore-Tamil Nadu Industrial Region:

Spread in two states of Karnataka and Tamil Nadu, this region experienced the fastest industrial growth in the post-independence era. This region is a cotton-growing tract and is dominated by the cotton-textile industry. But it has large number of silk-manufacturing units, sugar mills, leather industry, chemicals, rail wagons, diesel engines, radio, light engineering goods, rubber goods, medicines, aluminium, cement, glass, paper, cigarette, match box and machine tools, etc.

This region is away from the main coal-producing areas of the country but cheap hydroelectric power is available from Mettur, Sivasamudram, Papanasam, Pykara and Sharavati dams. Cheap skilled labour and proximity to vast local market as well as good climate have also favoured the concentration of industries in this region.

Coimbatore has grown rapidly mainly owing to its industrial growth based on Pykara power, local cotton, coffee mills, tanneries, oil presses and cement works. Coimbatore is known as Manchester of Tamilnadu because of its large-scale cotton textile industry. The establishment of public sector units at Banglore like Hindustan Aeronautics, Hindustan Machine Tools, Indian Telephone Industry and Bharat Electronics etc. has further pushed up the growth of industries in the region.

Madurai is known for its cotton textiles. Visvesvarayya Iron and Steel Works is located at Bhadravati. The other important centres of this region are Sivakasi, Tiruchirapalli, Madukottai, Mettur, Mysore and Mandya. Petroleum refinery at Chennai and Narimanam and iron and steel plant at Salem are recent developments.

Availability of raw materials, power from the dam sites in the Damodar Valley and the thermal power stations, based on the local coal and cheap labour from highly populated states of Jharkhand, Bihar, Orissa and West Bengal favour the industrial growth. The Tata Iron and Steel Company at Jamshedpur, Indian Iron Steel Co., at Bumpur-Kulti, Hindustan Steel Limited at Durgapur, Rourkela and Bokaro are the important steel plants located in this region.

Heavy engineering, machine tools, fertilizers, cement, paper, locomotives and heavy electrical are some of the other important industries in this region. Important nodal centres of this region are Ranchi, Dhanbad, Chaibasa, Sindri, Hazaribagh, Jamshedpur, Daltonganj, Garwa and Japla.

4. Vishakhapatnam-Guntur Industrial Region:

This industrial region extends from Vishakhapatnam district in the north-eastern part of Andhra Pradesh to Kurnool and Prakasham districts in the south-east and covers most of the coastal Andhra Pradesh. The industrial development of this region mainly depends upon Vishakhapatnam and Machilipatnam ports. Developed agriculture and rich mineral resources in the hinterlands of these ports provide solid base to the industrial growth in this region. Hindustan Shipyard Ltd. set up at Vishakhapatnam, set up in 1941 is the main focus. Petroleum refinery at Vishakhapatnam facilitated the growth of several petrochemical industries. Vishakhapatnam has the most modern iron and steel plant which have the distinction of being the only plant in India having coastal location. It uses high quality iron ore from Bailadila in Chhattisgarh. The other industries of this region include sugar, textiles, paper, fertilizers, cement, aluminium and light engineering. The important industrial centres of this region are Vishakhapatnam, Vijaywada, Vijaynagar, Rajahmundry, Kurnool, Elum and Guntur. Recent discovery of natural gas in Krishna- Godavari basin is likely to provide much needed energy and help in accelerated growth of this industrial region.

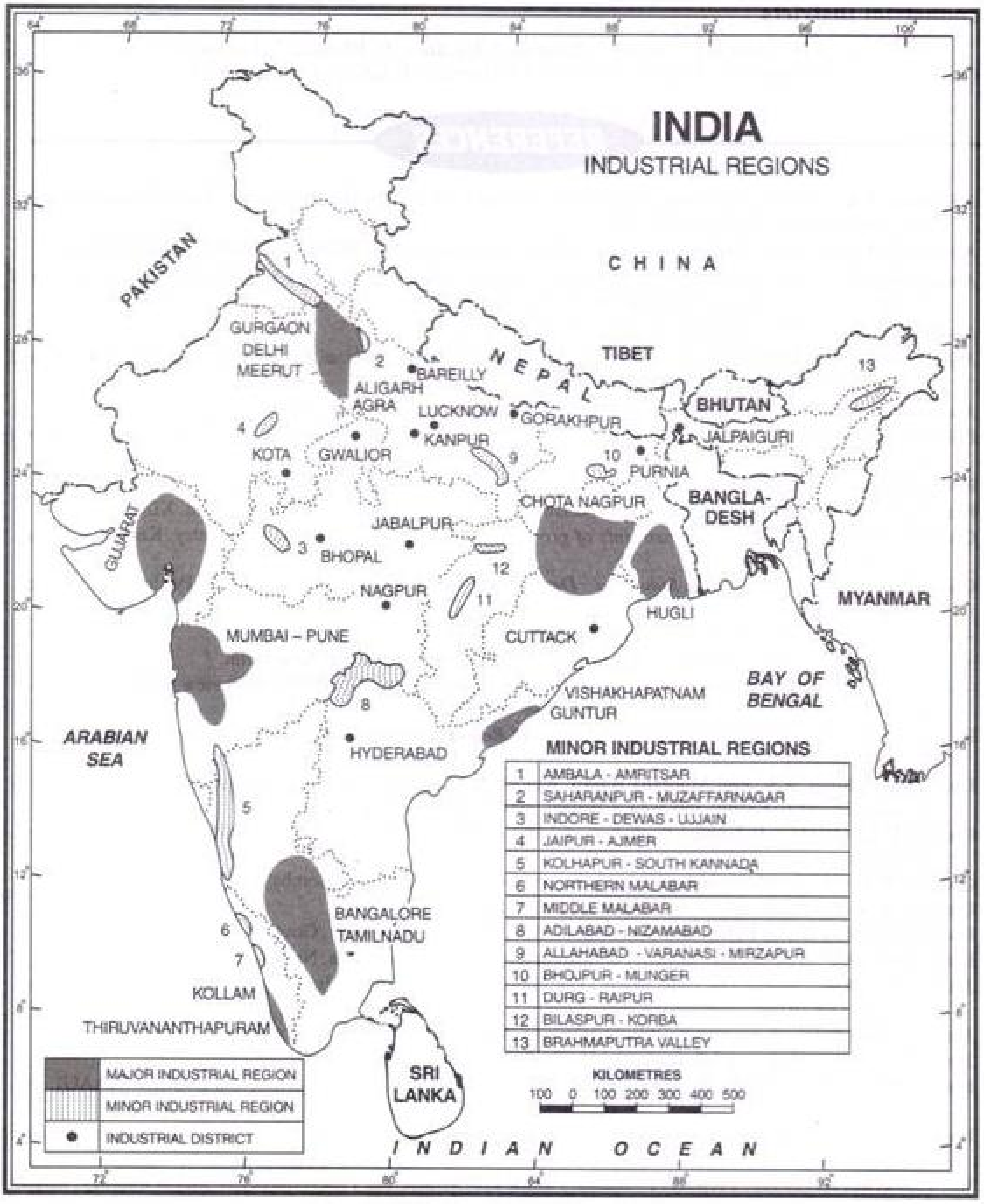
5. Gurgaon-Delhi-Meerut Industrial Region:

This region developed after independence, but is one of the fastest growing regions of India. It consists of two industrial belts adjoining Delhi. One belt extends over Agra-Mathura-Meerut and Saharanpur in U.P. and the other between Faridabad-Gurgaon- Ambala in Haryana. The region is located far away from the mineral and power resources, and therefore, the industries are light and market oriented. The region owes its development and growth to hydro-electricity from Bhakra-Nangal complex and thermal power from Harduaganj, Faridabad and Panipat. Sugar, agricultural implements, vanaspati, textile, glass, chemicals, engineering, paper, electronics and cycle are some of the important industries of this region. Software industry is a recent addition. Agra and its environs have glass industry. Mathura has an oil refinery with its petro-chemical complex. One oil refinery has been set up at Panipat also. This will go a long way to boost the industrial growth of this region. Gurgaon has Maruti car factory as well as one unit of the IDPL. Faridabad has a number of engineering and electronic industries. Ghaziabad is a large-centre of agro-industries. Saharanpur and Yamunanagar have paper mills. Modinagar, Sonipat, Panipat and Ballabhgarh are other important industrial nodes of this region.

6. Kollam-Thiruvananthapuram Industrial Region:

This is comparatively small industrial region and spreads over Thiruvananthapuram, Kollam, Alwaye, Emakulam and Allapuzha districts of south Kerala. No mineral resources are found in the nearby region of this area.Therfore, there is limited scope for the development of heavy industries. Agro based industries including food processing and market oriented light industries are located in this region. Plantation agriculture and hydroelectricity provide the industrial base to this region. The main industries are textiles, sugar, rubber, match box, glass, chemical fertilizers, food and fish processing, paper, coconut coir products, aluminium and cement. Oil refinery set up in 1966 at Kochi provides solid base to petrochemical industries. Important industrial centres are Kollam, Thiruvananthapuram, Alluva, Kochi, Alappuzha and Punalur. Besides the above mentioned six major industrial regions, India has other minor industrial regions including Ambala-Amritsar in Haryana-Punjab, Saharanpur-Muzaffamagar-Bijnaur in Uttar Pradesh, Indore-Dewas-Ujjain in Madhya Pradesh, Jaipur-Ajmer in Rajasthan, Kolhapur-South Kannada in Maharashtra-Karnataka, Malabar in Kerala, Adilabad-Nizamabad in Andhra Pradesh, Allahabad-Varanasi-Mirzapur in Uttar Pradesh,Bhojpur-Munger in Bihar, Durg-Raipur- Bilaspur-Korba in Chhattisgarh,Brahmaputra Valley in Assam. The map (Map 13.5) shows the industrial regions of India.

Map 13.5



Source: Google

13.5 CONCLUSION

After studying this unit, you may have been able to understand that after independence, especially during the past fifty years, the Indian economy has undergone remarkable structural change. Government of India had to undertake effective measures for the growth of industrialisation. The Industrial policy reforms from time to time seeks to create a favourable investment climate for the private sector as well as mobilise resources for the investment in the industrial growth in the country also highlights their role in this sector. You may be able to say that growth in the industrial sector is one of the vital figures that affect the Gross Domestic Product (GDP) in India. Experts believe that the contribution of India in the world GDP is estimated to increase from 6% to 11% by the year 2025, while on the flip side the contribution of US in world GDP is presumed to decline from 21% to 18%. This indicates towards the emergence of India as the third biggest global economy after US and China. The evaluation is supported by the overall development in all the sectors in India, in which the key sector is the industry sector. Industrial policy also aims at correcting regional imbalances in industrial development. Taking specifically the case of India, the geographical location of the industrial area is also an important factor. It is quite well-known that some regions in the country are industrially quite advanced e.g., Maharashtra and Gujarat while others are industrially backward, like Bihar, Orissa. Going through this unit, you may have noticed that there has been massive concentration of large-scale industries in the states of Maharashtra, West Bengal, Gujarat and Tamil Nadu which have also caused disparities in industrial development. Even within these industrialized states, industries have tended to get concentrated in a few large cities like Mumbai and Chennai. People migrate in large numbers from villages and lower order urban centres to these centres of industrial development. This swells the population of slums and creates various social and personal problems. As against this, the small-scale industries are mostly set up to satisfy local demand and they can be dispersed overall the state very easily and bring about qualitative changes in the state economy. You can take an example of Punjab regarding this which has more small- scale industrial units than even the industrially developed state of Maharashtra. Therefore, for a country like India, Promotion of job creating industries with educational support to the needy, subsidized housing and health facilities for the workers in the sector and research and development promotions in the required fields can lead towards sustainable industrial growth.

13.6 SUMMARY

In this unit you have had an overview of the industries in India .You have learnt that post Independence period has experienced unprecedented industrial growth. The more important factor is that the industrial sector has become greatly diversified. Apart from the development of the traditional items such as textile and sugar, the country has created a sizable base of heavy industries including iron and steel as well as ship building industry. In the course of our industrial development, it has been noticed that medium and small scale industries paper, defence products, cottage, retail textile, manufacturing, also play a significant role in the economic development of the country.

Paper and leather industries are employment intensive sectors, providing job to millions of people, mostly from the weaker sections of the society. Women employment is predominant in leather products sector with about thirty percent share. India is the second largest sugar producing country after Brazil and sugar consumption rate is highest in India as shown in the statistics received from USDA Foreign Agricultural Service. The rapid development of small-scale industries in the post-Independence period is a proof that given the necessary credit, power and technical knowledge a large quantity of latent resources of the economy can be mobilised for purposes of industrial development. The small-scale and cottage industries ensure a more equitable distribution of national income and wealth because the ownership of small-scale industries is more widespread than the ownership of large- scale industries. In this way, they possess a much larger employment potential as compared to the large industries.

In a country having a large geographical extension like India, it is quite obvious that different areas produce different types of raw materials as base. Land requirement and climatic factors also affect setting of industrial units in a particular area. Going through this unit you have also studied the location of industries in specific regions in the country. Up to now, you have studied different types of industries and have understood the significance of industrial development in a country like India. In addition to ensuring stability in the industrial sector, infrastructure development, skill formation, technology support, innovative experiments, can create additional employment opportunity for people and sustainable growth.

13.7 GLOSSARY

- Autonomy: capacity of a rational individual to make an informed, un-coerced decision
- Inflation: A general increase in prices and fall in the purchasing value of money
- Monopolistic pricing: pricing strategy followed by a seller who prices a product to maximize profits without worrying about competition
- Liberalization: lessening of government regulations and restrictions in exchange for greater participation by private enteritis
- Archers: have no preferred target when attacking
- Accelerated growth: operational performance improvement for industrial sector
- Industrial clustering: geographic concentration of interconnected companies and institutions in a particular field
- Indigenous resources: originating in and characteristic of a particular region or country
- Sluggish: stagnant, static
- Decentralised power looms: one of the most important segments of Indian textile
- Hosiery: garments worn directly on the feet and legs
- Petrochemical: chemicals derived from petroleum or natural gas
- Hinterland: the area surrounding a port, over which the port exerts its influence. ,
- Dock: A platform entering from a share over water use to secure, protect and provide access to a boat or ship.
- Sericulture: silk farming
- Unprecedented: unparallel, unequalled

13.8 ANSWER TO CHECK YOUR PROGRESS

1. Before independence agriculture was the only source of livelihood of the Indian population. India had an extremely underdeveloped and unbalanced industrial structure where major industries were largely concentrated in a few areas such as Bombay, Surat, Ahmedabad, Jameshedpur, Calcutta and some other cities and ports.

2. Broadly speaking at present the Indian industries include heavy industries such as iron and steel industry, ship building industry, textile industry; medium skill industries including leather, paper, sugar; and various small scale and cottage industries.

3. In the decade of 1991-2001 India showed maximum industrial growth after independence.

4.Heavy Industry in India include heavy engineering industry, machine tool industry, heavy electrical industry, industrial machinery and auto-industry which provide goods and services for almost all sectors of the economy, including power, rail and road transport.

5. The first modern steel plant was established in India in1907 at Sakchi in Bihar which gave the village a new name Jamshedpur.

6.Sugar is produced followed by several steps such as extracting juice by pressing sugarcane, boiling the juice to obtain crystals, creating raw sugar by spinning crystals in extractors, taking raw sugar to a refinery for the process of filtering and washing to discard remaining non-sugar elements and hue and then crystallizing and drying.

7. The textile industry in India is concentrated around the states of Tamilnadu, Andhra Pradesh, Punjab Karnataka and Maharashtra.

8. Availability of the raw material, skilled manpower, innovative technology, increasing industry compliance to international environmental standards, and the dedicated support of the allied industries are the strengths of leather industry in India.

9. These industries use local or indigenous resources and can be located anywhere .They can create more employment opportunities, can remove economic backwardness of rural and less developed regions of the country, reduce regional imbalances, ensure optimum utilisation of unexploited resources of the country, improve standard of living of people, ensure equitable distribution of income and wealth, solve unemployment problem, adopt latest technology and produce better quality products at lower costs.

10. Mumbai-Ahmadabad Industrial Region and Eastern Industrial region are some of the oldest industrial regions of India.

11. Agriculture and rich mineral resources in hinterlands of the ports base to the industrial growth of the Vishakhapatnam-Guntur Industrial Region in India.

12. Mumbai, Ahmedabad, Ankleshwar, Vadodara, Jamnagar, Thane, Ghatkopar, Ville Parle, Andheri, Kalyan, Pune, Nashik, Manmad, Solapur, Ahmednagar, Satara ,Sangli, Bharuch, Koyali, Anand, Khera, Surendranagar, Surat, Jamnagar, Rajkot and Valsad are the major industrial centres of Mumbai-Ahmadabad Industrial Region.

13. Gurgaon-Delhi-Meerut Industrial Region is the fastest growing industrial region in North India.

14. Fill in the blanks with the help of the words given below.

i) Mettur, Sivasamudram, Papanasam, Pykara and Sharavati dams supply power to Bangalore-Tamil Nadu Industrial Region .

ii) Alluva, Kochi, Alappuzha are located in Kollam-Thiruvananthapuram industrial region.

iii) Diesel engine factory at Chittaranjan is landmark of the Eastern Industrial region.

vi) Madurai is known for its cotton textiles.

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13.11 TERMINAL QUESTIONS

Q 1. Where are the major steel plants located in India and why? Explain.

Q 2. Name the ship-building centres in India.

Q 3. Which are the major factors responsible for location of iron and steel industry in India?

Q 4.Which types of industries can be best developed in Uttarakhand and how?

Q 5. Cottage and small industries provide employment than other industrial sectors. Explain.

Q 6. Describe the major industrial regions in India.

Q 7. Write an essay on leather industry in India.

Q 8. Explain in detail the development of sugar industry in India.

Q 9. Industrialization in India developed speedily in the post-independence period. Explain.

Q 10. Do you think India has been able to progress because of industrial development. Give reasons for your answer in 4-5 sentences.

UNIT 14 - TOURISM IN INDIA

14.1 OBJECTIVES

14.2 INTRODUCTION

14.3 TYPES OF TOURISM IN INDIA

14.4 TRENDS OF TOURISM IN INDIA

14.5 MAJOR TOURIST PLACES IN INDIA

14.6 CONCLUSION

14.7 SUMMARY

14.8 GLOSSARY

14.9 ANSWER TO CHECK YOUR PROGRESS

14.10 REFERENCES

14.11 SUGGESTED READINGS

14.12 TERMINAL QUESTIONS

14.1 OBJECTIVES

1. After studying this unit you will be able to:
2. Study the development of tourism in Indian perspective
3. To be aware of different types of tourism in the country
4. To study and analyze the modernized and latest trends in tourism
5. To know the major tourist places in terms of their location as well as causes of their popularity
6. Find out the possibilities to promote healthy relationship among tourists and local people.
7. Increase better understanding of different cultures, customs, lifestyles, traditional knowledge and beliefs.
8. Define the role of tourism as a contributor to the country's economy

14.2 INTRODUCTION

As you all know that tourism involves activities of people conducted for a short period of time travelling to and staying at places apart from their usual destinations for leisure, business and their desire to research and explore the unknown. The history of mankind tells us that from the ancient past the curiosity and desire to visit new places meet new people and interact with them. You must know that from the ancient times up to the modern era of technology and communication revolution the type of travel and tour have changed because of the changing cultural social economic and political factors. It has become easier because of the rapidly growing and easier availability of transport means. In this unit, you will study different aspects of tourism in India which has been practiced far behind from the times of Ramayana and Mahabharata. Technology has changed the world today into a global village. Apart from these developments, Indian tourism can help flourish the most significant factor of Indian philosophy of *vasudheiv kutumbkam* through globalization in a new way. This sector has a vast scope of development in a country like India and is growing rapidly. The Indian tourism industry has outperformed the global tourism industry in terms of growth in the volume of international tourists as well as in terms of revenue. Tourism in India is growing faster than any other sector and has possibilities to play a dominant role in the economic geography of the country. The tourism activity within the country is domestic tourism which involves trips made by local residents within the country. For example: An Indian, who lives in Delhi, takes a business trip to Nainital. International tourism involves trips by the residents of India to another country or visit by foreigners to India. When we talk about the tourism in Indian context, we should also be aware of the fact that this type of tourism encourages foreign currency inflows, infrastructure development, and introduction of new management and educational experience. Both domestic as well as international tourism actively affect various sectors of economy, which have a positive impact on the social and economic development of the country. Domestic tourism plays a vital role in achieving the national objectives of promoting social and cultural cohesion and national integration. Its contribution to generation of employment is very high. With the increase in income levels and emergence of a powerful middle class, the potential for domestic tourism has grown substantially during the last few years. All tourists' weather they are domestic or foreigners and whatever their interests are have different places to visit, various activities to be involved with and refresh themselves with relaxation and the innovation when they return.

India, as all of you know is a country with unity in diversity. Each part of the country is different from the other. With a glorious past, rich cultural heritage and diversity of religions, numerous fairs and festivals, picturesque nature, wildlife sanctuaries and National Parks, palaces, majestic forts, shopping malls altogether are responsible for the rising number of international tourists and increase in domestic tourism. Whereas pilgrimage and cultural tourism are the traditional tourism types and the number of tourists is increasing every year, ecotourism, medical tourism and adventure tourism have significantly been increasing recently. The trend of tourism have also been changed with globalization and educational trips, innovative as well as experimental tourism, volunteerism and luxury travels are becoming more and more common these days. This unit also makes you familiar with the tourist destinations of north, south, east west and central part of the country. With enormous possibilities of progress in this sector, it is predicted to grow at an average annual rate of 7.9% from 2013 to 2023. People from urban India, mainly from metropolitan cities, need some relaxation from the busy schedule of urban lifestyles. The requirement for the middle class city dwellers is destinations with affordability and connectivity. India ranks third among countries with the fastest growing tourism industries over the next decade. Planning and management of possibilities of growth in this sector must be the key concern for most tour operators. It is critical for them to plan their operations, and develop the capacity for any likely expansions given that this sector still has a reasonable growth potential. There is also the need for a better understanding of the profile and characteristics of the tourist. With growing pressures of development in some regions of the country, there is the need to expand the existing boundaries of the products and services to some unusual areas with innovation and experimentation.

Ministry of Tourism, Indian Institute of Tourism and Travel Management, National Council for Hotel Management and Catering Technology, India Tourism Development Corporation Limited, Indian Institute of Skiing and Mountaineering and National Institute of Water Sports are the organizations involved in the development of tourism. The Ministry of Tourism is responsible for formulation and implementation of policies and programmes for the development of tourism within the country and for attracting foreign tourists to India by way of developing tourism infrastructure, publicity and promotion, dissemination of information, co-ordination and supervision of activities of various segments of industry such as hotels, travel agencies, tour operators, etc.There are 20 field offices of the Ministry of Tourism in India and 13 in other countries to undertake both developmental and promotional activities. While the overseas offices are in constant contact with tourists, travel intermediaries and media to promote tourism in India, the field offices in India provide facilitation services to tourists and co-ordinate with the State Governments on tourism infrastructural development. The main objectives of the overseas tourist offices are to position India in the tourism generating markets as a preferred tourism destination, to promote various Indian tourism products with competition faced from various destinations and to increase India's share of the global tourism market. These objectives are met through an integrated marketing strategy and synergised promotional activities undertaken in association with the State Governments.

14.3 TYPES OF TOURISM IN INDIA

You must have noted in your previous studies that India has tremendous diversities. These diversities offer a lot to in terms of tourism and related activities. Therefore, there is something to do for all type of tourists in India no matter what their interests. Different types of tourism have been developed in India because our country has always been known for its hospitality, uniqueness, and charm – attributes that have been attracting foreign travellers to India in hordes. The Indian government, in order to boost tourism of various kinds in India, has set up the Ministry of Tourism and Culture. You must have heard about the just launched campaign called 'Incredible India!' of the ministry to encourage different types of tourism in India. Different types of tourism in India are as follows:

Adventure tourism

As a kind of tourism in India, adventure tourism has recently grown in India. This involves exploration of remote areas and exotic locales and engaging in various activities. For adventure tourism in India, tourists prefer to go for trekking to places like Ladakh, Sikkim, and

Himalaya. Himachal Pradesh and Jammu and Kashmir are popular for the skiing facilities they offer. White water rafting is also catching on in India and tourists flock to places such as Uttarakhand, Assam, and Arunachal Pradesh for this adrenalin-packed activity.

Figure14.1

River rafting is very popular among youth these days as .In the picture (Figure 14.1), you can see a group of young tourists at Rishikesh (Uttarakhand) enjoying the water sport.

Medical tourism

Tourists from all over the world have been thronging India to avail themselves of cost-effective but superior quality healthcare in terms of surgical procedures and general medical attention. There are several medical institutes in the country that cater to foreign patients and impart top-quality healthcare at a fraction of what it would have cost in developed nations such as USA and UK. The city of Chennai attracts around 45% of medical tourists from foreign countries. A glimpse of a part of the town can be seen in the picture (Figure 14.2) which has a significant place in medical tourism.

Figure 14.2

Pilgrimage tourism

You know that India is famous for its temples and that is the reason that among the different kinds of tourism in India, pilgrimage tourism is increasing most rapidly. The various places for tourists to visit in India for pilgrimage are Vaishno Devi, Golden temple, Char Dham, and Mathura Vrindavan, Hardwar, Dwarka, Rameshwaram etc. Hardwar, (Uttarakhand) can be seen in the picture (Figure 14.3) which attracts number of tourists because of the holy river, Ganga.

Figure 14.3

Wildlife and Eco tourism

You must know that among the types of tourism in India, ecotourism have grown recently. Ecotourism entails the sustainable preservation of a naturally endowed area or region.

This is becoming more and more significant for the ecological development of all regions that have tourist value. The rate of growth of ecotourism and other nature-based tourism activities is higher than most other tourism segments which is about 15% per year. You can see the well developed eco tourism in the backwaters in Kerala in Figure 14.4. Apart from this, India has a rich forest cover which has some beautiful and exotic species of wildlife – some of which that are even endangered and very rare. This has boosted wildlife tourism in India. There are many challenges to biodiversity and tourism planners are to choose the appropriate type of tourism with the aspirations of stakeholders as well as the capacity of land, culture and communities. The places where a foreign tourist can go for wildlife tourism in India are the Sariska Wildlife Sanctuary, Keoladeo Ghana National Park, Kaziranga National Park, Gir National Park, and Kanha National Park and Corbett National Park.

Figure 14.4

Cultural tourism

India is known for its rich cultural heritage and an element of mysticism, which is why tourists come to India to experience it for themselves. Encouraging individuals, local authorities, and other organizations to support and promote the tourism industry by documenting, publicizing and disseminating information on cultural attractions. Encouraging institutions in the field of the performing arts and other related institutions to establish calendars of artistic events and performances for wider circulation within the tourist industry. The various fairs and festivals that tourists can visit in India are the Pushkar fair, Taj Mahotsav, and Suraj Kund mela.The types of tourism in India have grown and this has boosted the Indian economy. Efforts must be taken by the Indian government, so that the tourism sector can contribute more substantially to the nation's GDP.

14.4 TREND OF TOURISM IN INDIA

Tourism in India has grown substantially over the last three decades. Foreign tourist arrivals in India have increased year by year. Travelling has transformed and it has become more experimental. Several luxury tented camp accommodation can be seen from deserts, mountains, national parks and beaches. This trend is well-developed in Jaisalmer (Rajasthan) in the sand dunes which are one of the ideal examples of unique desert features and planned tourism. Luxury tent accommodation can be found in the Himalayan Mountains and Morjim beach also. While certain states like Kerala have adopted IT based tools and services to leverage their product offerings and promotional efforts, other states also need to tap these tools to fully harness their tourism potential. Mobile-based technologies are being used in many regions of the country to promote tourism in different ways. Apart from the traditional trends of tourism, some of the recently emerging tourist trends are as follows:

Educational visits

Visiting the other regions, understanding the cultures and values of the other people helps the students as well as researchers to actually learn many facts and applied aspects of geography. Students of India are travelling to far corners of the country getting enriched by experience and gaining knowledge. For example, the students of geography may be able to better understand the different physical and cultural features in different parts of the country through detailed field investigations. Thus, on the one hand this type of tourism broadens their vision, and; on the other hand may promote cross-cultural interaction and nationalism. You can see in the picture(Figure 14.5) students of geography on the way with the staff members of the department to see the landforms created in an area of Karst topography (stalactites and stalagmites) at Patal Bhuvenshwer.Patal Bhuwneshwar is a limestone cave temple 14 km from Gangolihat in the Pithoragarh district of Uttarakhand state in India.

Figure 14.5

Innovation

The travellers who hate the usual tours and prefer to take the road less travelled and want to visit the untouched places such as the far off places in the Himalayan terrain or to discover the simple living of some remote villages nurtured by some great river valleys of our country. A different type but latest trend in tourism is spending days exploring unseen parts of your own city and trying to take in its diverse experiences. People Stay at a hotel in their own city, take spa treatments and enjoy swimming in the hotel pool in the same town. You can sometimes just enjoy the beauty of some experiencing moments of nature as seen in the picture (Figure14.6); the sunset seen from Bright End corner, Almora, Uttarakhand.

Figure 14.6

Voluntarism

Voluntarism is basically a form of travel which includes volunteering. It combines the pleasures of visiting a new site while contributing to efforts to sustain its community. By visiting new places you can help local communities in various fields such as environmental issues, social welfare, disaster mitigation measures etc. For example, people from different countries are visiting Nepal to help the people who are affected due to a powerful earthquake which hit the country recently.

Experimental tourism

The impact of youngsters can be clearly seen in the past few years in experimentation while visiting new places. They are starting earning at an early age, they are much more active, and are more likely to travel with friends in organized groups. These groups enjoy sports, adventures, mountaineering and other forms of experimental tourism. They also participate in the cultural activities organized by their self created groups.

Luxury travel

Tourists who are looking for a quiet holiday for rest and recreation in a pollution free environment health cum holiday resorts may be a very good option. Tourists from the upper economic strata, choose this option owing to the freedom of travel and the comfort of travel that it offers. The senior age group mostly travel for rest and relaxation and they need quieter and comfortable stays. They are the wealthiest travellers and have a wide range of choices. Many more resorts can be developed with adequate tourist facilities to promote tourism.

14.5 MAJOR TOURIST PLACES IN INDIA

From north to south and east to west; India's changing landscapes and landforms, different social and cultural heritage, diverse food habits, varied economic activities lead people to travel from one place to another. Each and every part of India, from Kashmir in the North to Kanyakumari in the South ,From Thar Desert in West up to the States known as Seven sisters in the East have their own beauty and attractions . If we study the different tourist places according to geographical variations, we can learn more and easily about the Major tourist places in India as follows:

North India includes the states Jammu and Kashmir, Haryana, Himachal Pradesh, Punjab, Uttar Pradesh and Uttarakhand. It also includes the Union Territory Chandigarh and

Delhi. Delhi as the capital of the India and Chandigarh as the well planned city of the India attract a number of tourists. This region of India has a diverse culture, and includes the Hindu pilgrimage centres of Char Dham, Haridwar, Mathura, Allahabad and Varanasi, the Buddhist Mahabodhi Temple, the Sikh Golden Temple in Amritsar, Punjab. It houses the world heritage sites such as the Valley of flowers, Qutub Minar, Taj Mahal etc. A visit to the Taj is a dream for domestic as well as foreign tourists.the Agra Red Fort and Itmad-Ud-Daulah's Tomb; remains of Fatehpur Sikri are the other attractions. Folk dances like the Bhangra of the Punjab, Rouf and Bhand pather of Kashmir are quite famous. Jammu and Kashmir is known as the paradise of the India. Himachal Pradesh houses the famous hill stations Manali, Shimla, Dharamsala, Palampur etc.The Great Himalayan National Park in the state of Himachal Pradesh is situated in the beautiful district of Kullu. Uttarakhand is often referred to as the Land of Gods with snow-capped mountains (Figure14.7) and mountain-top villages which attract a number of tourists every year. River valleys, steep cliffs natural beauty and many holy Hindu temples also seem to welcome the tourists. Other attractions are places like Mussoorie, Dehradun, Nainital, Almora, Berinag, Munsyari etc.The state offers adventure sports such as trekking, skiing and rafting which attract a large number of youth every year.

Figure 14.7

Further, we will know about tourist places located in the eastern part of India. It includes the states West Bengal, Bihar, Jharkhand, Orissa and the seven eastern states Assam, Meghalaya, Nagaland, Sikkim, Manipur, Mizoram and Tripura. Bihar is denoted as the 'land of Buddha'. Owing a rich cultural heritage, ancient monuments and famous temples, it attracts a number of tourists. The famous cities in this region are Patna, Ranchi, Jamshedpur, Bhubneshwar, Puri(Konark), Kolkata, Gawhati, Imphal, Shillong, Aizawl, Gangtok, Agaratala, Itanagar etc. It also houses famous hill station like Darjeeling which is worth to visit. This region has mesmerising scenic beauty. It has captivating tea farm, from where the tea is exported to other parts of India as well as abroad. The ruins of ancient Nalanda University can be found near Rajgir. This part includes many pilgrimage centres for Jain and Buddha communities. Bodhgaya and puri are the most famous pilgrimage centres in this region. Odyssey dance and music is the only classical dance and music in eastern India. Assam is famous for the world heritage sites like Kaziranga and Manas and tea gardens. Manipur means a land with jewels. It is famous for its classical Manipuri dance, arts, theatre and sculpture. Some of the rare things found in Manipur are the beautiful and seasonal Shirui Lily at Ukhrul and floating islands at Loktak.Polo, known as a royal game, also originated from this state. With wonderful, undiscovered scenic beauty and known as the "land of the rising sun" Arunachal Pradesh is famous for cultural festivals, religious places, rafting and trekking. Andaman and Nicobar Islands in the Indian Ocean a Union Territory of India, have several attractions like tribal reserves, national parks and wildlife sanctuaries and above all; the wide extension of sea waters.

Now, we will study about the tourist places located in the western part of our country which also attracts a number of tourists every year. The region includes the states of Gujarat, Rajasthan, Maharashtra, and Goa. The Union Territory of Daman and Diu; Dadra and Nagar Haveli are also having some famous tourist destinations. The capital of Gujarat, Gandhinagar is about 32 kms north east of Ahmedabad. This city is located on the Sabarmati River. The north east of Gandhinagar is flanked by Ahmedabad. This is known as the "Manchester of the East". Bhuj is most famous for the wide variety of handicrafts which includes Kutchi embroidery with mirror work, bandhini, hand printed textiles and saris etc. Jaipur, the capital of Rajasthan, founded by Maharaja Jai Singh is also known as Pink City.The main drawers of tourists in this city are the Hawa Mahal, Jantar Mantar and Amer Fort. Pushkar in the state of Rajasthan is situated at a distance of about 14 km off Ajmer.Pushkar is encircled by hills on three sides and sand dunes on the other. Ajmer is the holy city of Rajasthan. This is located 131 kilometres west of Jaipur. Jaisalmer, popularly referred as the "golden city of India", is one of the most alluring tourist destinations in Rajasthan, India. Sand dunes, the unique geomorphic features of the Thar Desert have been developed as attractive tourist destinations of India. Tent accommodations (shown in the picture, Figure14.8) invite a number of people to Jaiselmer, Rajasthan every year.

Figure 14.8

Jodhpur has grown to become the second largest city of Rajasthan. The walled city or old Jodhpur has eight gates, of which Jalori Gate and Sojati Gate on the south are the most important. The Keoladeo Ghana National Park, Kumbhalgarh wildlife sanctuary situated across the Aravali Mountain spreads over an area of about 578 sq km and at an altitude of about 500m to 1,300m. The Salim Ali bird sanctuary is predominantly of mangrove vegetation which helps as breeding grounds for several varieties of fish and insects which forms the first level in the food chain.Goa, a tiny emerald on the West Coast of India, is the smallest state of the Indian Union. Goa with its long beach along the Arabian Sea is a principal tourist resort. The wildlife sanctuary and national parks located in the region on the one hand attract tourists; and on the other hand preserve the flora and fauna of the area. Margao one of the most busiest and 2nd biggest town in Goa, is known for its scenic beauty. Bogmalo Beach is a small beach side village at a distance of about 9 kilometres from the port town of Vasco de Gama. The second smallest union territory in India Daman and Diu also has several tourist attractions.

Mumbai, the "Gateway of India" is one of the most important cities of the world after India's independence. The silver sands of the Juhu beach is one of the fashionable holiday spots of Mumbai. Aurangabad is in the northern part of the state of Maharashtra. Kailash Temple is famous for 200,000 tonnes of rock. Nasik is a major Hindu pilgrimage centre. The Netravali Wildlife Sanctuary is surrounded by high range of mountains which is considered as religiously very important by the local habitants. You should also know about Bhagwan Mahavir Wildlife Century which is situated in the northwest of Maharashtra which is about 185 km from Mumbai. Nasik is encircled by nine hills. This sanctuary situated in Goa is at a distance of about 53 kilometres away from the state capital, Panaji and is oriented more towards the eastern side of the state in the vicinity of the Mollem village The Netravali Wildlife Sanctuary is surrounded by high range of mountains which is religiously very important by the local habitants. Pune is at a distance of about 192kms away from Mumbai. The Film and Television Institute of India and National Defence Academy are located here. It is a big educational centre. The Union Territory of Dadra and Nagar Haveli are situated between the highly industrialized cities of Mumbai, Surat and Vapi.

When we travel towards central India it includes the states of Madhya Pradesh and Chhattisgarh. It is situated at the heart of the country. The main cities in this region are Bhopal, Indore, Ujjain, Gwalior etc. This part of India is famous for its temples, historical heritage etc. The famous cities in the state are Bhopal, Indore, Ujjain, Gwalior etc. Madhya Pradesh is famous for its temples, historical heritage etc. Some of them are Sanchi stupa in Sanchi, Khajuraho temple etc. Gwalior is famous for its forts and numerous temples, with the Gwalior fort being the most visited by tourists. Indore is one of the fastest developing cities in India. It has huge shopping malls, industrial establishments and a lot of monuments worth sightseeing. There are a lot of ayurvedic and yoga centres nearby, which brings in tourist for some peace and meditation. New Raipur is being developed in a planned manner where the art, culture and rich cultural heritage of Chattisgarh has been presented in a very good way The picture(Figure 14.9)shows a view of Purkhauti Muktangan in New Raipur. This region also houses Wild Life Sanctuaries like Bandhavgarh National Park, Kanha National Park, Satpura National Park, Sanjay National Park, Madhav National Park, Van Vihar National Park, Mandla Plant Fossils National Park, Panna National Park, Pench National Park etc.

Figure 14.9

South India

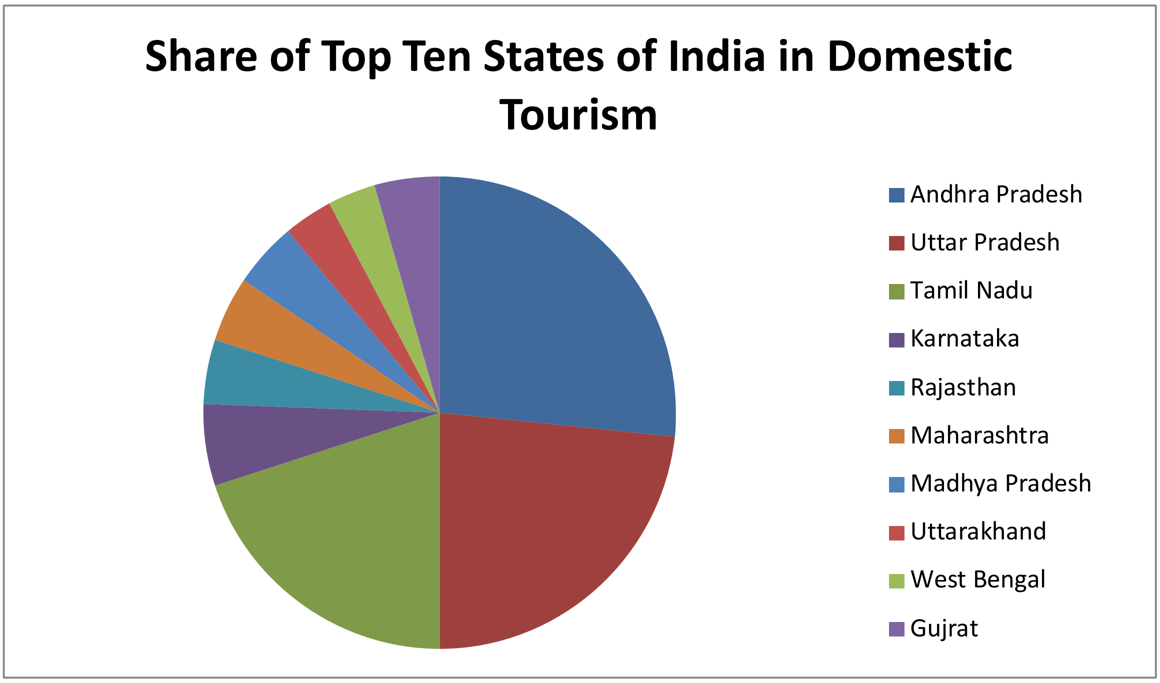
South India includes the states Andhra Pradesh, Karnataka, Kerala and Tamilnadu. It also includes the Union Territory Pondicherry and Lakshadweep Island in the Arabian Sea. The Godavari, Krishna, Tungabhadra and Kaveri rivers are important non-perennial sources of water. This part of India has enormous beaches, waterfalls, forests, lakes, backwaters, Wild Life Sanctuaries etc. Southern region speak one of the Dravidian languages: Kannada, Malayalam, Tamil, Telugu, and Tulu. The classical dances of India like "Bharat Natyam" and "Kathakali" have South Indian origin. Kuchipudi is the Andhra pradesh's best-known classical dance form. The famous cities in this region are Hyderabad and its twin city Secunderabad, The famous places in the state are Charminar, Osman Sagar(Gandipet) Lake, Hussain Sagar Lake, Golkonda Fort, Salar Jung Museum, Statue of Buddha on the Hussain Sagar Lake, Tirumala Venkateswara Temple, Belum Caves, Araku Valley etc.Hyderabadi Biryani, fish curry, brinjal curry, and Gongura pachadi are the most popular dishes of Andhra Pradesh.

Karnataka has contributed significantly to both forms of Indian classical music, the Carnatic (Karnataka Music) and Hindustani traditions. Tourists get to see scenic parks, historical forts and palaces, calm backwaters and modern technological hubs. The famous cities in the state are Bangalore, Mysore, and Mangalore etc. Places to visit are Sri Lakshmi Narayana Swamy Temple, Mysore Palace, Mysore Dusshera, Bangalore Palace, Bandipur National Park etc. Kerala is a popular tourist destination famous for its backwaters for houseboat cruising, Ayurvedic treatments, long stretches of golden beaches, tropical greenery fragrant spice and tea gardens and plethora of flora and fauna in the various wildlife parks. The famous cities are Trivandrum (Thiruvananthapuram), Cochin (Kochi), Munnar Hill station, Alleppy. Some famous places are Kovalam Beach, Varkala Beach, and Padmanabha Swami Temple. Lakshadweep means "A hundred thousand islands". This island is situated in the Arabian Sea. Ten Islands are inhabited which are Agatti, Amini, Andrott, Bitra, Chetlat, Kadmat, Kalpeni, Kavaratti, Kiltan and Minicoy. One of the main attractions in the Lakshadweep Islands is the abundance of fisheries items and the variety of fishes from the Arabian Sea. Oceanic birds flying over the Islands is an eye catching experience. Pondicherry is also considered an educational hub of southern India, having many medical, engineering, law, agricultural colleges. It is famous for its churches, temples and beaches. Tamil Nadu is home to many natural resources, grand Hindu temples of Dravidian architecture, hill stations, beach resorts, multi-religious pilgrimage sites. It is known as the 'temple state of India'. The famous cities are Chennai, Kanyakumari, Ooty, Rameshwaram, Kodaikanal Hill Station etc. Kanchipuram and Rameshwaram are famous pilgrim destination. The Vivekanand Rock Memorial is a popular tourist monument in Vavathurai,which is located about 500 meters east of mainland of Vavathurai at Kanyakumari.It was built in 1970 in honour of Swami Vivekanand who attained enlightment on this rock seen in the picture(Figure 14.10).

Figure 14.10

As far as domestic tourism is concerned, the state wise share in domestic tourism can be seen in Figure 14.11 in which the top ten states have been included. As far as the state of Uttarakhand is concerned, even being a small state, it attracts significant number of tourists and it can increase in the coming years.

Figure14.11



14.6 CONCLUSION

Studying this unit carefully and keeping in view the changed scenario, you must have understood that India is a vast country with immense growth in the tourism sector. As far as tourism in India is concerned, diverse physical as well as cultural setting of the country motivates people to visit different parts of it. Northern part of the country not only attracts people to climb the highs of the Great Himalayas and its snow-capped peaks, but also interact with the people living here who have the courage to face the difficulties in this mountainous terrain. The southernmost tip of Indian subcontinent seems to invite people to have a look at the marvellous sunrise and the vast extension of Indian Ocean with Bay of Bengal on the eastern side and Arabian Sea to the west at Kanyakumari. Travelling towards west, the Great Thar Desert has the extension of sand dunes and hardly any plants grow except bushes and cactus, but the people living here invite tourists accompanying with the 'ship of the desert' to their beautiful tents. The famous cities Patna, Ranchi, Jamshedpur, Bhubneshwar, Puri(Konark), Kolkata, Gawhati, Imphal, Shillong, Aizawl, Gangtok, Agaratala, Itanagar and the famous hill station Darjeeling are located in East India which are worth to visit. This region has scenic beauty and has captivating tea farms, from where the tea is exported to other part of India as well as abroad. Central part of India is the country's heart without which part the country cannot survive. Keeping in mind the size of the country, tourism development also requires accommodation, transport, recreational and shopping facilities in a balanced manner. Further, demands for goods services and establishments such as improvement of these facilities have made tourism as an instrument for employment generation, poverty alleviation and sustainable human development. While the religious and social visits will always remain the biggest reason for domestic travel undertaken, now cross cultural exchange between destinations are more common with Indians. The tour organizers and the other people attached with this sector realizing the options that the country like India with a large geographical area as well as differences in climate, natural vegetation, soils, agriculture, industries and human resource development has a vast scope of possibilities. During the last few decades, there has been a progressive rise in the number of tourists visiting India. The increased tourism activity has an impact on the economy of the nation .As a result of tourist activity; a large number of seasonal workers are able to seek employment in the tourist towns and some other places visited by the tourists. These people provide various types of services to the visitors either they are from India or foreigners coming to see India as gardeners, watchmen, porters, taxi-drivers, boat-pullers, managers, tourist guides and small scale industrialists. Apart from these services, employment opportunities for a variety of skilled labour as plumbers, painters, electricians, masons, carpenters etc.who are required in hotels, tourist bungalows, tourist inns, youth hostels, cafeterias, restaurants, cinema halls, guest houses, tourist lodges and other tourist oriented establishments.

You must also be aware of the fact that in India, there are some drawbacks also among the accommodation options available in the country in the form of youth hostels, dharamshalas, hotels, lodges and tents etc.The cleanliness and hygiene at these places should be maintained properly. The infrastructure in terms of railways, road networks mostly fail to realize their worth owing to poor connectivity problems. For many states in the country, owing to geographical or demographical congruencies, it makes sense to collectively market as a destination, especially if one is targeting longer stays.

The above description gives you the picture of tourism in India. The All of us know that tourism has a strong socio-economic impact. Therefore, for all the activities related to the development of tourism in a particular region, the local people should be actively involved which would provide for a more authentic tourist experience. Efforts are therefore being put into inculcating local community views on tourism planning and destination management. Making the tourist spots comfortable for the visitors can only be made possible with the co-ordination with the people at the grass-root level, the travel agencies and central and state governments. Understanding the emerging trends and present structure of the industry, its economic, cultural, and environmental impact and creation of sustainable mechanisms to maximize the benefits of the sector in view of these impacts is a crucial strategy statement. Tourism as tool for development needs to address all these issues so that it continues to fulfil its original mandate for tourism development in the country.

14.7 SUMMARY

Going through this unit, you must have understood the significance of Tourism in India .India has diversity in terrain, climate, vegetation, soils, and agriculture. You must also have studied these diversities earlier. In every part of this country there are variations of occupations, culture and living standards. Historical evidences tell us that from the ancient times up to the modern era of technology and communication revolution the type of travel and tour have changed because of the changing cultural social economic and political factors. If we observe the whole scenario carefully, we can say that this sector is growing day by day. At present, Ministry of Tourism, Indian Institute of Tourism and Travel Management, National Council for Hotel Management and Catering Technology, India Tourism Development Corporation Limited, Indian Institute of Skiing and Mountaineering and National Institute of Water Sports are the organizations involved in the development of tourism in our country. These are promoting both domestic and international tourism sectors. India ranks third among countries with the fastest growing tourism industries over the next decade. World Travel and Tourism Council have named India along with China as one of the fastest growing tourism industries for the next 10 to 15 years. This unit also explains different types of tourism in the country; analyze the modernized and latest trends in tourism, to know the major tourist places in terms of their location as well as causes of their fame. The unit also helps you understanding of different cultures, customs, lifestyles, traditional knowledge and beliefs and the possibilities to promote healthy relationship among tourists and local people. For urban middle class, who has rapidly increased numbers in tourism in the last few decades, destinations with affordability and connectivity are required. Accommodation, catering, transport, in-house travel agency, duty free shopping, entertainment, publicity, consultancy, etc., under a single window can also help in tourism growth because these facilities attract foreign tourists as ITDC has tried to do. Further, the WTO has forecast the Travel & Tourism Industry in India to grow by 8% per annum, in real terms, between 2008 and 2016. Still more has to be done in terms of infrastructure development, especially in the state of Uttarakhand where tourism is the only sector which can upgrade the economic condition of the people living here. Thus, you must have understood up to now that tourism is an important sector which not only ties the knots in between the people living in different places and belonging to various casts, creed and population making people more tolerable and sensitive towards others but also contributes to the national GDP and provides employment in opportunities in India. More than 20 million people are now working in the India's tourism industry. Tourism is an important source of foreign exchange earnings in India and is expecting to generate US$275.5 billion by 2018 at a 9.4% annual growth from this sector.

14.8 GLOSSARY

- Vasudheiv kutumbkam (वसुधैवकुटुम्बकम): The ancient Indian philosophy which sees the whole world as a family.
- Globalization: process of international integration arising from the interchange of world views, products, ideas and other aspects of culture.
- Skiing: A recreational activity or winter sport in which the participant uses skis to glide on snow.
- Mountaineering: describes the sport of mountain climbing.
- Domestic tourism: tourism involving is t tourism involving residents of one country travelling only within that country.
- Tourism infrastructure: a range of devices and institutions constituting material and organizational basis for tourism development.
- Metropolitan cities: Consultancy services: A professional practice that gives expert advice within a particular field.
- Tremendous: very great in amount, scale or intensity.
- Diversities: A range of different things, varieties.
- Substantially: considerably, significantly, greatly.
- Thronging: horde, assemblage.
- Ecotourism: tourism which builds environmental and cultural awareness and respect.

- Exotic species: plant or animal species introduced into an area where they do not occur naturally.
- Non-perennial: seasonal.
- Wildlife sanctuaries: places of refuge where abused, injured and abandoned captive. wildlife may live in peace and dignity for the remainder of their lives.
- Heritage: patrimony.
- Mesmerising: enthral.
- Authenticity: originality.
- Endangered: threatened with a danger.

14.9. ANSWER TO CHECK YOUR PROGRESS

1. Those activities of people which include travelling to and staying at places apart from their usual destinations for leisure, business and their desire to research and explore the unknown are known as tourism.
2. Domestic tourism promotes social and cultural cohesion and national integration. Apart from this, the potential for domestic tourism in generating employment has grown substantially during the last few years.
3. Ministry of Tourism, Indian Institute of Tourism and Travel Management, National Council for Hotel Management and Catering Technology, India Tourism Development Corporation Limited, Indian Institute of Skiing and Mountaineering and National Institute of Water Sports are the organizations involved in the development of tourism in India.
4. The major objective of tourism in India is to study the development of tourism in Indian perspective.
5. Educational visits are important for students for gaining knowledge, understanding the cultures and values of the other people.
6. Some tourists prefer to travel and visit the untouched and the far off places in India because they want to try some innovative and unknown places and do something new.
7. Voluntarism has become a form of tourism these days as it combines the pleasures of visiting a new site while contributing to efforts to sustain its community having some purpose such as environmental issues, social welfare, disaster mitigation measures etc.
8. Youngsters enjoy adventures, mountaineering and other forms of experimental tourism.

9. The tourist attractions of Himanchal Pradesh are the famous hill stations Manali, Shimla, Dharamsala, Palampur ,the Great Himalayan National Park in the state of Himachal Pradesh situated in the beautiful district of Kullu and unlimited natural beauty.

10.Tourists want to visit Uttarakhand because of the snow-capped mountains, river valleys, steep cliffs natural beauty, holy Hindu temples and places like Mussoorie, Dehradun, Nainital, Almora, Berinag, Munsyari etc.Adventure sports such as trekking, skiing and rafting also attract a large number of youth every year.

11. Ajmer is located in Rajasthan, 131 kilometres west of Jaipur.

12. Goa is the smallest state of the Indian Union located on the West Coast of India

13. Sanchi stupa in Sanchi, Khajuraho temple, Gwalior fort and numerous temples are located in Central India.

14. Krishna, Tungabhadra and Kaveri rivers are important non-perennial rivers of South India.

15. Lakshadweep means "A hundred thousand islands".

16. What is tourism?

17. Highlight the significance of domestic tourism in India.

18. Which are the organizations involved in the development of tourism in India?

19. What is the major objective of tourism in India?

20. Why are educational visits important for students?

21. What is the reason that some tourists prefer to travel and visit the untouched and the far off places in India?

22. How has Voluntarism become a form of tourism these days?

23. Which types of tourism do youngsters enjoy?

24. Which are the tourist attractions of Himanchal Pradesh?

25. Why do tourists want to visit Uttarakhand?

26. Where is Ajmer located?

27. Name the smallest state of the Indian Union located on the West Coast of India.

28. Which temples and historical heritages are located in Central India?

29. Which are the non-perennial rivers of South India?

30. What does Lakshadweep mean?

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14.12 TERMINAL QUESTIONS

1. Mark out the remarkable changes in the tourism sector in the last two decades?
2. Write down some of the recent trends of tourism in India.
3. Explain the significance of ecotourism in India.
4. Which are the tourist places of North India?
5. Give your views on “Development of tourism in Uttarakhand”.
6. ‘Tourism has been developed in West India in a unique manner’. Prove the statement with relevant examples.
7. Which are the famous tourist destinations in East India?
8. Write in brief note on the future prospects of tourism in India.
9. Which are the common accommodation options available in the country for tourists?
10. Match the following:

(a) Gateway of India	Madhya Pradesh
(b) Land of the rising sun	Uttarakhand
(c) Pink city	Mumbai
(d) Heart of India	Aruranchal Pradesh
(e) Land of Gods	Jaipur

BLOCK 5 - TRANSPORT AND TRADE

UNIT 15 - DEVELOPMENT OF TRANSPORT NETWORK

15.1 OBJECTIVES

After studying this unit you should be able to:

- Describe the transport system.
- Describe various types of transports and their role played in the economy of the country.
- Important routes and their significance.
- Discuss relative advantages and limitations of different transport facilities.
- Know about the significant developmental changes in the transport network from the past till today.

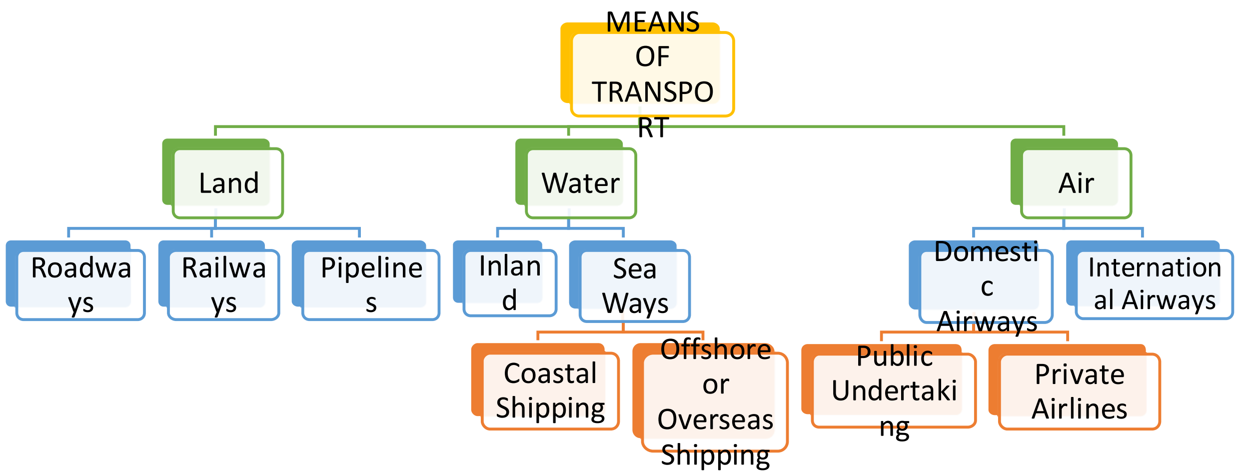
15.2 INTRODUCTION

Provisions of quality and efficient infrastructure service are essential to realize the full potential of growth impulses surveying through the economy. And to this, in fact, a well-knit and coordinated system of transport plays an important role in the sustained economic growth. But in simple means, what is Transport? We can say, ***transport is a system in which passengers and goods are carried from one place to another.*** It symbolizes a real interaction between them which is a very vital part of the geographic study. Also the economic development depends mainly on how efficiently different areas are linked through transport. Backwardness and poverty are associated with immobility. The transport helps in the better and fuller utilization of resources of any backward region by linking the same with the relatively more advanced and developed one.

India is a vast country with long distances from Kashmir in the north to Kanniyakumari in the south and from Kandla in the west to Kohima in the east. It has vast natural resources of great diversity. In addition, India has great diversity in economic, social, cultural and ethnic structure. In such a diverse and developing country like India, without an efficient transport system no dream of economic development and self-reliance can be achieved. Transport is an important part of India's economy, as, development of cheap and effective means of transport is necessary for the progress of a large and developing country like India. ***Transport routes function as the basic economic arteries of the nation.*** The expansion of transport facilities accelerates the process of industrialization and urbanization.

Transport also helps in maintaining the uniformity in prices, removes scarcity of goods during the time of crisis, minimizes the effect of natural calamities, aids in maintaining law and order and good governance and promotes national investigation and cohesiveness. It is the transport which helps in the movement of raw material, fuel, machinery, etc. to the points of production and finished products to the point of marketing and consumption. Transport has recorded a substantial growth over the years both in the spread of its network and in the output of its system and has come out as a mirror of economic development and material prosperity. It won't be wrong if we say that transport serves as the lifelines of the Indian Economy. The Ministry of Transport is responsible for the formation and implementation of policies and programmes for the development of various modes of transport except the railways and the civil aviation.

Here an attempt has been made to analyze the spatial patterns of different modes of transport and various problems associated with them. In this chapter, you will see how modern means of transport serve as the lifelines of our nation and its modern economy.



15.3 DEVELOPMENT OF TRANSPORT

Development of transport has been very steady in India. There have been many types of phases in which this development took place, mainly in roadways and railways. In other sections also developmental procedures took place but not to the extent of roadways and railways. Various growth trends are explained below of the different sectors of transport.

15.3.1 Growth and Development of Road Transport

About 70% of freight and 85% of traffic is carried by the roads. The pressure on the road network is increasing day by day. The numbers of vehicles have been growing at a rapid pace of 12% per annum over the last five years. The rapid expansion and strengthening of the road network, therefore, is imperative both to provide for present and future traffic, and for improved accessibility to the hinterland. In addition, road transport needs to be regulated for better energy efficiency, lesser pollution and enhanced road-safety.

Road transport in modern sense, *i.e.* vehicles driven by internal combustion engines using petrol or diesel as fuel was practically negligible in India before World War II. Following plans have been drawn to develop roadways in India:

i. **Nagpur Plan:** First serious attempt to develop roadways was made in 1943 when ***Nagpur Plan*** was drawn. This plan envisaged increasing of the kilometer age of major roads to 1, 96,800 km and of other roads to 3, 32,800 km by 1953. The highlight of the plan was that no village in a developed agricultural region should be more than 8 km from a major road or 3 km away from any other road while the average distance of villages from a major road should be less than 3.2 km. In a non-agricultural region, these distances were fixed at 32, 8 and 10 km respectively. This plan could not be implemented immediately because the country was ruled by number princely states outside British India. The concerted efforts to achieve the objectives of this plan were made only after the organization of the states. The targets of this plan were more or less achieved in 1961.

ii. **Twenty Year Road Plan:** After achieving the objective of the Nagpur Plan, another plan known as ***Twenty Year Road Plan*** was dawn in 1961. It aimed at increasing the road length from 6.56 lakh km to 10.60 lakh km and the density to 32 km of road per 100 sq. km by 1981. The other objectives of the Twenty Year Road Plan were:

   a) To bring every village in a developed agricultural area within 6.4 km of a metalled road and 2.4 km of any other road,
   b) To bring every village in a semi- developed area within 12.8 km of a metalled road and
   c) To bring every village in an undeveloped and uncultivated area within 19.2 km of a metalled road and 8 m of any other road.

iii. **The Rural Development Plan:** It includes construction of rural roads under Minimum Needs Programme (MNP), Rural Landless Employment Guarantee Programme (RLEGP), Jawahar Rojgar Yojana (JRY) and Command Area Development (CAD) programmes to collect all villages having a population of 1,500 or more with all weather roads and those having less than 1,500 population with the link roads.

iv. **Build Operate Transfer (BOT):** is a scheme under which private operators are invited to construct roads and bridges. They are allowed to collect toll tax from the vehicles using these roads and bridges for a specific period of time after which these assets are transferred to the government. The National Highways Act has been amended to facilitate private investment in real construction under BOT scheme.

v. **Central Road Fund (CRF):** is being raised for the betterment of roads by imposing additional excise/customs duty at the rate of 1.50 per litre on petrol with the effect from 2 June 1998 and on High Speed Diesel (HSD) with effect from February 28, 1999. The annual accrual through this sources will be about ₹5,500 crore. A part of this (₹ 0.4 per litre against sale of high speed diesel oil and ₹ 0.86 per litre against the sale of petrol) goes to the fund of NHDP.

The Central Road Fund Act 2000 was enacted in December, 2000 with the primary objective of providing regular and adequate flow of funds for development of the road sector. This is a non-lapsable fund. The Act empowers the Centre to administer, manage and allocate the accrued amount to the following:

a) Development of rural roads. About 43% of the levy on diesel will be spent on improving rural connectivity.
b) Development and maintenance of National Highways.
c) Construction of road under/over bridges and safety works at unmanned railway crossings, and
d) Development and maintenance of State roads.

vi. **Pradhan Mantri Gram Sadak Yojna:** This is a centrally sponsored scheme launched on Dec 25, 2000 to provide road connectivity to all villages with population of 500 and more (population 250 in hilly and tribal areas).

TABLE 15.1 Progress of Indian Roads (Length in km)

Year (as on 31st March)	National Highways	State Highways	Other P.W.D. Roads	Panchayat Raj Roads	Urban Roads	Project Roads	Total
1951	19,811	*	173,723	206,408	-	-	399,942
	(4.95)		(43.44)	(51.61)			(100)
1961	23,798	*	257,125	197,194	46,361	-	524,475
	(4.54)		(49.02)	(37.60)	(8.84)		(100)
1971	23,838	56,765	276,873	354,530	72,120	130,893	914,979
	(2.61)	(6.20)	(30.26)	(38.75)	(7.88)	(14.30)	(100)
1981	31,671	94,359	421,895	628,865	123,120	185,511	1,485,421
	(2.13)	(6.35)	(28.40)	(42.34)	(8.29)	(12.49)	(100)
1990	33,479	124,266	497,476	941,410	181,171	206,065	1,93,867
	(1.69)	(6.26)	(25.08)	(47.45)	(9.13)	(10.39)	(100)
1991	33,650	127,31	509,435	949,662	186,799	209,737	2,016,594
	(1.67)	(6.31)	(25.26)	(47.09)	(9.26)	(10.41)	(100)
1999	49,585	137,950	801,655	1,028,410	237,866	270,523	2,525,989
	(1.96)	(5.46)	(31.74)	(40.71)	(9.42)	(10.71)	(100.00)

*Included in Other P.W.D Roads

Figures in parentheses show the percentage share of each category of road to the total road length

Source: *(i)* Basic Road Statistics of India, 1995, Ministry of Surface Transport, Govt. of India, p. 24.
*(ii)*Statistical Abstract, India 2003, pp.230-234.

Table 15.1 shows that there has been over six-fold increase in the total length of roads in India between 1951 and 1999. While the share of the state highways had fallen from 6.20% in 1951 to 5.46% in 1999, the share of national highways had fallen from 4.95% in 1951 to only 1.67 % in 1991. However, the share of national highways increased slightly after 1991 and stood at 1.90% in 1999. The share of panchayat raj roads so fell from 51.61% in 1951 to 37.60%in 1961 and rose gradually to 47.09% n 1991. However it fell to 40.71 % in 1999.

15.3.2 Growth and Development of Rail Transport

The Indian Railways has a modest beginning in 1853 when the journey of the first railway train commenced from Mumbai to Thane covering a distance of 34 km. This was followed by the opening of another line between Kolkata and Raniganj (180 km) in 1854 and between Chennai (Madras) an Arkonam (70 km) in 1856. A detailed railway development was chalked out under Lord Dalhouise to connect all major cities of the country and by 1871 the three presidency towns of Kolkata, Mumbai and Chennai were interlinked through railway. The railway development was very fast and by 1900 the total length of railway line increased to 39,835 km. The growth was slowed down during the next 50 years so that the total length of rail line was 53,596 km in 1950-51. Originally the railways were operated by the private companies owned by the Britishers. In 1925, the Government of India too over the first railway company and up to 1950 the entire management came under the hands of the Government.

During the Post-Independence period with the beginning of the planning era new strategy was chalked out for the development of the railways. This included expansion in the route length, gauge conversion (from narrow/metre gauge to broad gauge), electrification of tracks, modernization of the system to improve the efficiency of operations, conversion of steam locomotives to diesel locomotive and electric traction, improvement of signaling and communication, improvement in passenger amenities and safety, self sufficiency in rolling stock, remove traffic bottleneck, better management of freight and passenger traffic, high priority to the development of freight terminals, introducing high speed passenger trains, use of computers in railway reservation and railway operation and expansion of railway traffic to remote and backward areas. Accordingly the route length has increased from 53,596 km in 1950-51 to 64,460 km in 2010-11 exhibiting a growth rate of 20.27% during the last 60 years. Table 15.2 shows the progress of Indian railways after 1950-51 in respect of route length, electrification of route length, passenger and goods movement, number of locomotives, coaches, and wagons.

TABLE 15.2 India: Progress of Railways

Years	Route Total	Electrified Length (km)	Passengers Originating (lakhs)	Passengers (billion km)	Goods Originating (lakh tonnes)	Number of Locomotives	Number of Coaches	Number of Wagons (thousands)
1950-51	53,596	388	12,840	66.5	930	8,209	19,628	206
1960-61	56,247	748	15,940	71.7	1,562	10,624	28,439	308
1970-71	59,787	3,706	24,311	118.1	1,965	11,158	35,145	384
1980-81	61,240	5,345	36,125	208.6	2,200	10,908	38,333	401
1990-91	62,367	9,968	38,576	295.6	3,414	8,417	38,511	346
2000-01	63,028	14,856	48,327	457.0	5,042	5,042	42,657	222
Years	Route Total	Electrified Length (km)	Passengers Originating (lakhs)	Passengers (billion km)	Goods Originating (lakh tonnes)	Number of Locomotives	Number of Coaches	Number of Wagons (thousands)
2001-02	63,140	15,994	50,927	490.9	5,222	7,739	44,069	216
2002-03	63,122	16,272	49,708	515.0	5,187	7,681	44,756	214
2005-06	63,327	17,900	57,250	--	6,823	6,823	50,080	207
2006-07	63,465	17,900	62,190	--	7,446	7,446	51,250	208
2009-10	63,974	20,227	72,458	--	8,992	8,922	57,535	220
2010-11	64,460	--	76,511	--	9,264	9,264	59,713	229

Source: *(i)* India 2005: A Reference Annual
(ii) India 2009
(iii) Statistical Year Book, India 2013
(iv) Economic Survey, 2004-05

Passenger Traffic: Passengers originating had risen from 12,840 lakhs in 1950-51 to 49,708 lakhs in 2002-03 and passenger kilometre from 66.52 billion in 1950-51 to 515 billion in 2002-03. Despite constraint of resources, the Railways have been able to cope with increasing demand of passenger traffic. Railways are the premier mode of passenger transport both for long distance and suburban traffic.

During 2000-01, Indian Railways introduced 99 new trains, extended the run of 88 trains and increased the frequency of 14 trains in non-suburban sector. Similarly, in the suburban sector, Railways introduced 89 new trains. Besides, 15 DMU/diesel Hauled Push Pull Trains and 22 main line EMU services were also introduced during the year.

Freight Traffic: Rapid progress in industrial and agricultural sectors has generated a higher level of demand for rail transport particularly in core sectors like coal, iron and steel ores, petroleum products and essential commodities such as food grains, fertilizers, cement, sugar, salt, edible oils, etc. Revenue freight traffic increased from 73.2 million tonnes in 1950-51 to 518.7 million tonnes in 2002-03. A look at the table shows that the progress is slow but a steady one.

Also the railway is concentrating on modernization. In fact the progress of the Indian railways has reached its plateau stage. That is why there has been a very little increase in the route length in recent years. Accordingly the route length has increased from 53,596 in 1950-51 to 64,460 km in 2010-11 exhibiting a growth rate of 20.27% during the last 60 years.

Many qualitative improvements were made namely:

i. **Gauge conversion:** 'Gauge' is the name given to the distance between the inner faces of the pair of rails in the track. Indian railway comprises three gauges viz., broad guage (1,653 metre), metre gauge (1,000 metre) and narrow gauge (0.762 metre and 0.610 metre). Different gauges had been the legacy of the British rulers. They constructed broad gauge railways on the trunk routes connecting the port cities of Mumbai, Kolkata and Chennai and some other major cities. In areas lying beyond the frame work of trunk routes, only metre gauge lines were constructed. Thus, the area lying north of the Ghagra-Ganga alignment, whole of Rajasthan and Gujarat as well as large parts of the peninsular India were covered by metre gauge.

Different gauges create serious hinderance in the smooth flow of traffic. Passengers have to change trains at the *break of gauge* station and are put to great inconvenience. Goods have to be transhipped which results in loss of time, increased cost of transportation, pilferage and damage to consignments. The Government of India have, therefore, adopted a policy of gauge conversion, mainly from metre gauge to broad gauge. *The unigauge system of railways assures large capacity, higher speed and cheaper transportation.* The process of gauge conversion was initiated immediately after independence but significant achievement has been recorded in recent years (Table 15.3).

TABLE 15.3 Gauge-wise Route Length of Railway in India

Year	Broad Gauge		Metre Gauge		Narrow Gauge		Total
	Length in km	Percentage of Total Route Length	Length in km	Percentage of Total Route Length	Length in km	Percentage of Total Route Length	
1991-92	35,109	56.12	23,283	37.28	4,066	6.51	62,458 (100)
1996-97	41,971	66.91	17,044	27.12	3,710	5.92	62,725 (100)
1997-98	43,083	68.94	15,804	25.29	3,608	5.77	62,495

							(100)
1998-99	44,216	70.39	15,178	24.17	3,415	5.44	62,809 (100)
1999-00	44,383	70.72	5,013	23.92	3,363	5.36	62,759 (100)
2000-01	44,776	71.04	14,987	23.78	3,265	5.18	63,028 (100)
2001-02	45,099	71.43	14,776	23.40	3,265	5.17	63,140 (100)
2002-03	45,622	72.28	14,364	22.75	3,136	4.97	63,122 (100)

Source: Data computed from Statistical Abstract, India, 2003, p. 213.

ii. **Rolling Stock:** A perceptible improvement in rolling stock, both locomotives and coaches, has been noticed. Upto 1950s and 1960s most of the trains were run by steam engines using coal as the source of energy. These engines had less traction power and caused environmental pollution by emitting smoke. An urgent need was felt to replace these engines by diesel and electric locomotives which are more powerful and their operation is more economical. On the Indian railways, introduction of diesel traction on a single line route can increase the capacity by 30 to 45% and electrification by nearly 100%. Moreover, diesel engines cause less environmental pollution as compared to coal engines, and electric engines do not cause any pollution. Therefore, the steam engines have been phased out and their production has been stopped in India. Coaching vehicles and wagons have also been improved to make the transportation of passengers and goods more comfortable and economical. Cushioned seats, toilets, pantry cars, etc, are provided in almost all the important trains. Earlier, many of such facilities were conspicuous by their absence. Till the beginning of the 20^{th} century, third class passengers were almost uncared for, although they formed 97% of the coaching receipts. Third class travel has now been replaced by second class travel. A.C. 3-Tier coach has been introduced to make AC travel cheaper and comfortable.

iii. **Track Electrification:** As mentioned earlier, use of electric locomotives increase the capacity by as much as 100%. But the use of electric locomotives is possible only if the railway tracks are electrified. Track electrification is the major thrust area by virtue of which efficiency of the railways can be increased considerably. Track electrification was firstly introduced in early 1920s and the first two section, from Victoria Terminus to Kurla and from Victoria Terminus to Bandra, totaling 16 route km were electrified in 1925. Thus the Indian railways entered the push button era. In the first four decades from 1920-21 to 1960-61, the process of track electrification was rather slow. The percentage of electrified track increased from a meager 1.33 in 1960-61 to 6.20 in 1970-71, 8.94 in 1980-81, 15.98 in 1990-91 and 25.78 in 2002-03. Much has been done but much more is yet to be done. Though capital intensive, electrification is unavoidable keeping in view the increasing pressure of passengers and freight on the railways.

iv. **Other improvements:** Automatic signals have been introduced on the trunk routes. For heavy traffic, track structure has been strengthened by providing heavier and stronger rails and concrete sleepers. For fast and comfortable journey several new trains including Rajdhani and Shatabdi trains have been introduced. Public amenities at the railway stations have been diversified and improved.

15.3.3 Growth and Development of Water Transport

Waterways are the oldest type of transport to be used and the cheapest. They were the chief mode of transportation before the advent of railways. Water suffered a great deal at the hands of roads and railways because it could not compete with the speed of road and rail transport. Although efforts are being made to revive the inland waterways, yet this mode of transportation is at its initial stage. Waterways only provide 1% of total transport of India. The total length of navigable waterways in India comprising river, canals, backwaters, creeks, etc. is 14,500 km, out of which only 3,700 km is navigable by mechanized boats. Only 2,000 km is actually used. As regards canals, we have a network of about 4,300 km of navigable canals, of which a stretch of 900 km is navigable by mechanized crafts. The emerging scenario shows that the inland waterways are greatly underutilized. However in order to increase the significance of inland waterways and to improve their efficiency, the Government has identified 10 important waterways which are to be given the status of National Waterways.

With respect to shipping India has a glorious past. India maritime trade flourished in ancient times. Indian boats and ships have been sailing in the Indian Ocean for the last 4,000 years taking merchandise to East Indies and Middle East. The Indian shipping got a serious setback with the arrival of European companies. However, necessity to develop shipping was realized during the First World War. Consequently, the ScIndia Steam Navigation was set up in 1919. At the time of Independence, there were only 59 ships with less than 2 lakh tonnes of GRT (Gross Registered Tonnage). Shipping in India has made considerable progress in the post-independence period. The strength of Indian merchant shipping fleet from 1991 to 2002 is given in Table 15.4.

TABLE 15.4 Strength of Indian Merchant Shipping Fleet (As on 31st December)

Year	Coastal Trade		Overseas Trade		Total	
	No. of Vessels	G.R.T. (Gross Registered Tonnage)	No. of Vessels	G.R.T. (Gross Registered Tonnage)	No. of Vessels	G.R.T. (Gross Registered Tonnage)
1991	169	5,60,807	246	53,78,014	415	59,38,821
1994	206	6,81,387	231	56,64,548	437	62,67,311
1995	219	6,97,563	251	63,04,295	470	70,01,858
1996	231	7,04,795	253	63,47,235	484	70,52,030
1997	232	6,54,226	244	62,23,899	476	68,78,125
1998	247	6,54,296	237	61,30,684	484	67,84,980
1999	269	6,79,707	241	63,72,555	510	70,52,262
2000	312	7,09,089	237	62,43,611	549	69,52,700

2001	329	7,31,367	228	62,36,390	557	69,67,757
2002	424	8,04,868	193	5,02,456	617	62,07,324

Source: Statistical Abstract, India, 2003, p.239

Currently, shipping plays a significant role in the transport sector of the country's economy. Nearly 90% of India's trade volume (77% in terms of value) is moved by sea. During 2001-2002, the total quantity of overseas cargo held by various Indian ports was to the tune of 274.76 million tonnes. It is estimated that the present fleet strength is not adequate to support the trade flow in shipping sector. Therefore, there is an urgent need for augmenting the tonnage capacity in the coastal sector to meet the projection which has been fixed for 14,273 million tonnes by 2020.

Coastal Shipping also has great scope in India. Coastal Shipping involves movement of goods and passengers from one port to another port within a country. It is quite distinct from overseas or offshore that implies shipping to locations of the shore such as oil rigs and platforms. Developing coastal shipping has many advantages. It decongests the railways and roadways, is relatively pollution free, is less capital intensive, provides large employment, involves continuous vigilance of the coasts and promotes sea based industries such as fisheries and luxury tourism. The peninsular shape of south India offers great opportunities for coastal shipping. The 7516.6 km long coastline of India is studded with 12 major and 185 non-major ports providing congenial and favourable conditions for the proper development of coastal shipping.

Action Plan has been made for the development of coastal shipping which is already on the anvil with the Central Government with a view to promote coastal shipping and sailing vessel industry, the home trade vessels and sailing vessels have been exempted from the payment of lighthouse dues. Meanwhile, a study has already been completed by the Tata Consultancy Services (TCS) to assess the potential of coastal shipping and the role of minor ports keeping in view the feasibility of routes and supporting environment needed for its development. Its report has been accepted by the Government in principle.

Sethu-Samudram Ship Canal Project

Ships sailing from eastern to the western coast of India and vice-versa have to take a long route south of Sri Lanka which is more time consuming and expensive. The problem attracted to the attention of the Britishers and A.D. Taylor of British navy in 1860 proposed a shipping canal across the Thoni-thurai peninsula which could not materialize. Since Independence detailed investigations were carried out in the 1950s and 1960s to examine the feasibility of the project. Six distinct alignments for the passage to go across Ram Sethu have been put forward. But only in 1998, Shri Atal Bihari Vajpayee, the then Prime Minister of the previous National Democratic Alliance (NDA) Government, finally launched the project. It was only inaugurated during the United Programme Alliances (UPA) Regime in 2005 by the Prime Minister, Dr. Manmohan Singh.

The Adam's Bridge or Ram Sethu is actually a discontinuous chain of sandbars dotting 30 km stretch in the east-west direction between the southern tip of Rameswaram Island in India and

Talaimannar in North-western Sri Lanka. It creates geological divide between the Park-Bay and the Gulf of Mannar which forms a part of the southern Kaveri Basin in the Bay of Bengal.

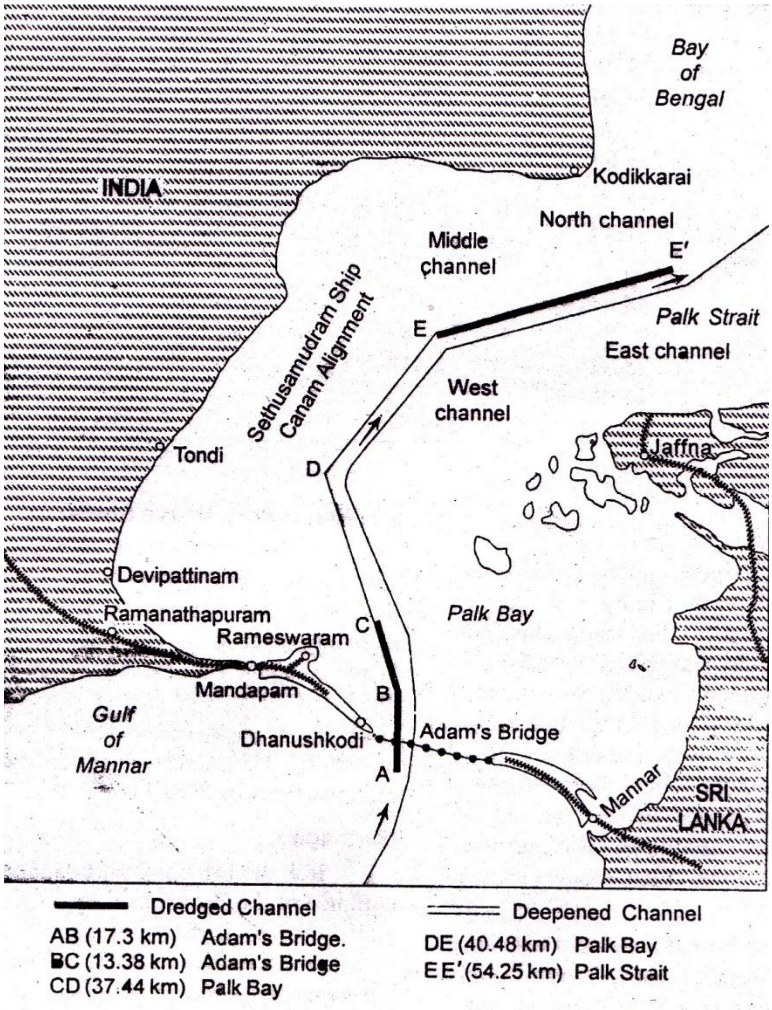


Figure 15.1: Sethu-Samudram Ship Canal Project

Sethu-Samudram Ship Canal Project (SSCP) is an ambitious project planned and designed on the pattern of the Suez Canal. It aims at constructing a 167.22 km long navigation channel linking the Gulf of Mannar with the Bay of Bengal through the Adam's Bridge, Park-Bay and Park-Strait. The channel will be within India's territorial waters, parallel to but keeping safe distance from the Indo-Sri Lanka maritime boundary. Of the total length of channel, 89 km would be dredged channel-the first across the Adam's Bridge, through the chain of islets and shallows between India and Sri Lanka, and the second through the shallows of the Park-Bay in between the two dredged channels has adequate natural depth and, hence, would not require any dredging. The project would involve a total cost of ₹2000 crore of which 77% would be spent on the 82 million cubic meters of dredging. It is estimated to be completed in 3 years.

The Channel will have an average width of 300m and depth of 12m facilitating the movement of average size vessels (10,000-12,000 gross tonnage). The Channel project, if developed and completed will not only cut down the fuel costs, it will galvanize traffic for 15 small, neglected seaports in Tamil Nadu, Andhra Pradesh, Odisha and West Bengal. It will shorten the distance of 424 nautical miles (780 km) and save 30 hours of sailing time. The fortunes of Tuticorin Port and town will improve dramatically from the transshipment of containers that originates from or are destined for ports on the coast of India. Moreover, the Indian Navy needs a channel in India's own territorial waters.

More than 3000 ships will transit through the channel which would not include laden crude oil carriers. The construction work of the project has been assigned to the Sethu-Samudram Corporation Ltd. in which Tuticorin Port Trust is a nodal agency.

The Project is facing rough weather due to the protest from the Hindu Orthodox, environmentalist and social thinker. A legal case is pending before the Supreme Court in India.

15.3.4 Growth and Development of Air Transport

Air transport is the fastest means of carrying passengers and goods from one place to another. Today air transport is an important means of passenger transport. It also carries about 1% of the cargo traffic. In terms of value of the cargo carried by air transport it accounts for about 35% of the export value of the products. It plays an important role in tourism as 97% foreign tourist use airways.

Air transport in India made a beginning in 18 Feb, 1918 when Henry Piquet carried mail from Allahabad to Naini. The British, French and Dutch introduced Air transport in 1929-30. The scheduled services began on October 15, 1932 when JRD Tata piloted a flight from Karachi to Mumbai. By the end of World War II major cities like Karachi, Mumbai, Delhi, Kolkata, Lahore and some other places were provided by air services. At the time of partition of the country in 1947, there were four countries namely Tata Sons Ltd. / Air India, Indian National Airways, Air Services of India and Deccan Airways. By 1951, four more companies viz. Bharat Airways, Himalayan Aviation Ltd., Airways India and Kalinga Airlines also came up. Under the Air Corporations Act of 1953, eight existing airlines operating in the country were nationalized to provide adequate, safe, efficient and economic air services. Under the Act, domestic air transport services were to be provided by Indian Airlines and the international services were to be provided by Air India International. The civil aviation sector has seen a number of changes since the implementation of this Act.

Indian Airlines and Air India International (later named as Air India), enjoyed a monopoly on the scheduled operations under the Air Corporations Act, 1953, for a long time. Later Helicopter Corporation of India and Pawan Hans Helicopters Ltd. were created to provide helicopter based services. Pawan Hans Helicopters Ltd. provides helicopter services to ONGC in its off-shore operations and to inaccessible areas and difficult terrains. Thereafter, the monopoly ended, however by repealing this act. Now a number of private airlines are operating in domestic sector and even in international aviation. The current policy on civil aviation envisages more emphasis on privatization in this sector. A number of private companies hold non-scheduled air taxi operator's permit. According to the domestic air transport policy of 1997 barriers to entry and exit from this sector have been removed.

In March 2007, Government of India decided to merge the two national carriers into a 100% government owned company, NACIL (Nation Aviation Company of India Ltd.). With effect from November, 2010 the name of the company has been changed from NACIL to Air India Ltd. Air India now operates both domestic and international services.

In the private sector currently five companies are providing air services in India. Out of these, Jet Airways and Air Sahara are operating on domestic as well as international air routes while Air Deccan, Kingfisher and Spicejet are operating on domestic routes only. Together they have a fleet of about 100 aircraft and undertake more than 500 flights per day. Six more airlines are waiting in the wings. Of them Paramount, GoAir and IndiGo are likely to start their operations in the near future.

TABLE 15.5
Growth of Civil Aviation in India

Item	Unit	1960-61	1970-71	1980-81	1990-91	1995-96	1999-00	2000-01	2001-02	2002-03	2003-04
Total fleet strength											
Air India		13	10	17	24	26	26	26	29	30	35
Indian Airlines		18	73	49	56	59	53	52	53	53	56
Revenue tonne-kilometers	₹ Crores										
Air India		7.56	27.52	98.01	138.10	161.90	145.65	150.14	139.90	156.10	177.30
Indian Airlines		10.00	20.00	40.03	69.92	72.27	74.03	77.73	75.55	84.51	87.75
Number of passenger carried	Lakhs										
Air India		1.25	4.87	14.18	21.61	28.53	33.50	33.00	31.30	34.56	38.35
Indian Airlines		7.90	21.30	54.29	78.66	77.40	59.30	59.90	55.25	56.54	59.00
Passengers handled at AAI Airports	Lakhs	N.A.	N.A.	107.38	177.23	258.40	390.04	420.27	399.83	437.23	487.01
Cargo Handled at AAI Airports	Thousand Tonnes	N.A.	N.A.	178.70	377.33	561.58	797.00	842.15	854.28	979.36	1068.20

N.A.: Data Not Available

Source: The Economic Survey, 2004-05.

Check Your Progress I

Q.1 What are the qualitative improvements made in the railway system? Give points along with short description.

Q.2 Explain the Sethu-Samudram Project in brief.

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15.4 PATTERN OF TRANSPORT

15.4.1 LAND TRANSPORT

1. Roadways

Road is the indigenous mode of transport in India. It is through roads that every village and hamlet can be reached. Roads offer door to door service and their construction can be undertaken even in the areas of difficult terrain and steep slopes. The movement of goods is safer through road transport. It helps the farmers to move their perishable agriculture products and commodities soon to the markets and *mandis*. In a developing country like India road is a harbinger of economic development and prosperity.

India has one of the largest road networks in the world with an aggregate distance of 4.2 million kilometers. India has a long tradition of building roads since ancient times having an existence for the last 5000 years. In the ruins of Indus Valley Civilization there is evidence of paved roads. Chandragupta Maurya an Ashoka were the great road builders but the real progress was made during the Sultanate and the Mughal rule. Sher Shah Suri and Mughal emperors took active interest in the road construction. One such road was constructed by Sher Shah Suri which connected Peshawar to Kolkata. It was named as the Grand Trunk Road (G.T. Road). With the consolidation of British Power in India greater attention was paid on road construction so as to promote gods movement and maintain law and order. The Grand Trunk Road following the old Mughal Road from Dhaka in Bangladesh to Lahore in Pakistan was the most important road connecting all the premier cities in the North India. Now, the G.T. Road joins Amritsar with Kolkata after partition of India. Presently, it is known as “Sher Shah Suri Marg”. Similarly, the Deccan Road provided a direct link to the South India from the North.

Importance of Roads

1. Roads play a very important role in the transportation of goods and passengers for short and medium distances.
2. It is comparatively easy and cheap to construct and maintain roads.
3. Road transport system establishes easy contact between farms, fields, factories and markets and provides door to door service.
4. Roads can negotiate high gradients and sharp turns which railways cannot do. As such, roads can be constructed in hilly areas also.

5. Roads act as great feeders to railways. Without good and sufficient roads, railways cannot collect sufficient produce to make their operation possible.
6. Road transport is more flexible than the railway transport. Buses and trucks may be stopped anywhere and at any time on the road for loading and unloading passengers and goods whereas trains stop only at particular stations.
7. Perishable commodities like vegetables, fruits and milk are transported more easily and quickly by roads than by railways.

Due to above mentioned advantages, the road transport has become very popular and its share is constantly increasing.

Classification of Roads

National Highways:-The National Highways are the main roads meant for inter-state and strategic defense movements. They connect the state capitals, big cities, important ports, big railway junctions and link up with border roads. The Central government is responsible for the development and maintenance of National Highways System. The Ministry of Transport manages the development and maintenance of the national highways through three agencies:

i. National Highway Authority of India (NHAI)
ii. State Public Works Department (PWD)
iii. Border Roads Organization (BRO)

Figure 15.2: India's National Highways

Border Roads Organization: The Border Roads Organization was established in1960 for the development of roads of strategic importance in the northern and north-eastern borders of the

country. The ***Border Roads Organization*** has not only linked the border areas of the North and North-East with the rest of the country, but has also developed the road infrastructure in Bihar, Maharashtra, Karnataka, Rajasthan, Andhra Pradesh, Andaman and Nicobar, and Chhattisgarh. It has also constructed roads and air fields in Tajikistan, Afghanistan, Bhutan and Myanmar. So far it has constructed more than 32,000 km of roads and surfaced 40,500 km of roads. The Zojila-Kargil and Manali-Leh roads were completed in 1998. The Pathankot-Jammu-Srinagar National Highway is also maintained by the Border Roads Organization.
In order to give a boost to the economic development of the country, the government has embarked on National Highway Development Project (NHDP), being implemented by the National Authority of India (NHAI).

National Highway Development Project (NHDP): Under the new National Highway Development Project (NHDP) efforts are being made to construct 4/6 lane 5,846 km. Golden Quadrilateral Highways connecting Delhi-Mumbai-Chennai-Kolkata-Delhi-Porbander and 7,300km, north-south and east-west corridors connecting Srinagar to Kanniyakumari and Silchar to Porbander. The project also provides port connectivity and construction of 1000 km of express ways. About 99% of GQ and 75% of NS-EW works have been completed.

Table 15.6 provides a summary of the National Highways passing through various states and the total length of these highways in different states.

TABLE 15.6 India: List of Statewise National Highways as on 31st March, 2012 (also including UT's)

S. No.	Name of State	National Highway No.	Total Length (in km)
1.	Andhra Pradesh	4, 5, 7, 9, 16, 18, 18A, 43, 63, 202, 205, 214, 214A, 219, 221, 222 & 234	4537
2.	Arunachal Pradesh	52, 52A, 153,229, 52B Ext, 37 Ext & 315A	2027
3.	Assam	31, 31B, 31C, 36, 37, 37A, 38, 39, 44, 51, 52, 52A, 52B, 53, 54, 61, 62, 151, 152, 153, 154, 127B & 315A	2940
4.	Bihar	2, 2C, 19, 28, 28A, 28B, 30, 30A, 31, 57, 57A, 77, 80, 81, 82, 83, 84, 85, 98, 99, 101, 102, 103, 104, 105, 106, 107, 110, 131A, 327 Ext, 333 & 527C	4106
5.	Chandigarh	21	24
6.	Chhattisgarh	6, 12A, 16, 43, 78, 200, 202, 216, 217, 111, 221 & 343	2289
7.	Delhi	1, 2, 8, 10, 24 & 236	80
8.	Goa	4A, 17, 17A & 17B	269
9.	Gujarat	NE-1, 6, 8, 8A, 8B, 8C, 8D, 8E, 14, 15, 59, 113, 228, 76A, 360, 947& 953	4032
10.	Haryana	1, 2, 8, 10, 21A, 22, 64, 65, 71, 71A, 71B, 72, 73, 73A, NE-2, 236 & 709 Ext	1633
11.	Himachal Pradesh	1A, 20, 20A, 21, 21A, 22, 70, 72, 72B, 88, 73A & 305	1506

12.	Jammu & Kashmir	1A, 1B, 1C & 1D	1245
13.	Jharkhand	2, 6, 23, 31, 32, 33, 75, 78, 80, 98, 99, 100, 114A, 333 & 343	2170
S. No.	Name of State	National Highway No.	Total Length (in km)
14.	Karnataka	4, 4A, 7, 9, 13, 17, 48, 63, 67, 206, 207, 209, 212, 218 & 234	4396
15.	Kerala	17, 47, 47A, 47C, 49, 208, 208, 212, 213 & 220	1457
16.	Madhya Pradesh	3, 7, 12, 12A, 25, 26, 26A, 26B, 27, 59, 59A, 69, 69A, 75, 76, 78, 86, 92, 927A	5064
17.	Maharashtra	3, 4, 4B, 4C, 6, 7, 8, 9, 13, 16, 17, 26B, 50, 69, 204, 211, 222 & 360	4257
18.	Manipur	39, 53, 150, 155, 102A, 102B & 137	1317
19.	Meghalaya	40, 44, 51, 62 & 127B	1171
20.	Mizoram	44A, 54, 54A, 54B, 150, 154 & 502A	1027
21.	Nagaland	36, 39, 61, 150 & 155	494
22.	Odisha	5, 5A, 6, 23, 42, 43, 60, 75, 200, 201, 203, 203A, 215, 217 & 224	3704
23.	Puducherry	45A & 66	53
24.	Punjab	1, 1A, 12, 15, 20, 21, 22,64, 70, 71, 72 & 95	1557
25.	Rajasthan	3, 8, 11, 11A, 11B, 11C, 12, 14, 15, 65, 65A, 71B, 76, 76A, 76B, 79, 79A, 89, 90, 113, 112, 114, 116, 116A, 158, 162 Ext, 709 Ext & 927A	7130
26.	Sikkim	31A & 310	149
27.	Tamil Nadu	4, 5, 7, 7A, 45, 45A, 45B, 45C, 46, 47, 47B, 49, 66, 67, 68, 205, 207, 208, 209, 210, 219, 220, 226, 226E, 227, 230, 234 & 532	4943
28.	Tripura	44 & 44A	400
29.	Uttarakhand	58, 72, 72A, 72B, 73, 74, 87, 94, 108, 109, 119, 121, 123 & 125	2042
30.	Uttar Pradesh	2, 2A, 3, 3A, 7, 11, 12A, 19, 24, 24A, 24B, 25, 25A, 26, 27, 28, 28B, 28C, 29, 56, 56A, 56B, 58, 72A, 73, 74, 75, 76, 86, 87, 91, 91A, 92, 93, 96, 97, 119, 231, 232, 232A, 233, 235, NE-2, 330A, 730, 730A, 931 & 931A	7818
31.	West Bengal	2, 2B, 6, 31, 31A, 31C, 31D, 32, 34, 35, 41, 55, 60, 60A, 80, 81, 114A, 116A & 117	2681
32.	Andaman & Nicobar Islands	223	300
		TOTAL	**76,818**

Table 15.7 explains different routes of major national highways.

TABLE 15.7 India: Some Important National Highways

NH No.	Route	Length (in km)
1.	Delhi-Ambla-Jallandhar-Amritsar	456
1A.	Jallandhar-Madhopur-Jammu-Srinagar-Baramulla-Uri	663
1B.	Batote-Doda-Kishtwar-Khanabal	274
2.	Delhi-Mathura-Agra-Kanpur-Allahabad-Varanasi-Barh-Kolkata	1465
3.	Agra-Gwalior-Shivuri-Indore-Dhulia-Nashik-Thane-Mumbai	1161
4.	Thane-Pune-Belgaum-Hubli-Bangalore-Ranipet-Chennai	1533
4A.	Belgaum-Anmode-Ponda-Panaji	153
5.	Baharagora-Cuttack-Bhubaneshwar-Vishakhapatnam-Vijaiwada-Chennai	1533
6.	Hajra-Dhule-Nagpur-Raipur-Sambhalpur-Bhargora-Kolkata	1949
7.	Varanasi-Rewa-Jabalpur-Nagpur-Hyderabad-Bangalore-Madurai-Kanniyakumari	2369
8.	Delhi-Jaipur-Ajmer-Udaipur-Ahemdabad-Vadodara-Mumbai	1428
9.	Pune-Sholapur-Hyderabad-Vijaiwada-Machlipatnam	841
10.	Delhi-Fazika	403
11.	Agra-Bharatpur-Jaipur-Bikaner	582
12.	Jabalpur-Bhopal-Kota-Bundi-Jaipur	890
13.	Sholapur-Chitradurga-Mangalore	691
14.	Beawar-Sirohi-Radhanpur	450
15.	Pathankot-Bhatinda-Bikaner-Samakhiali (Jaisalmer)	1526
16.	Nizamabad-Samkhiali-Jagdalpur	460
17.	Panvel-Mangalore-Edapally (Kochi)	1269
18.	Kurnool-Nandyal-Cuddapah-Chittor	369
21.	Chandigarh-Ropar-Mandi-Kulu-Manali	323
22.	Ambala-Kalka-Shimla-Narkanda-Rampur-Shipki La	459
24.	Delhi-Bareilly-Lucknow	438
28.	Barauni-Muzaffarpur-Gorakhpur-Lucknow	570
47.	Salem-Coimbatore-Thiruvananthapuram-Kanniyakumari	640
49.	Kochi-Madurai-Dhanushkhodi	440
58.	Delhi-Mana Pass	538
150.	Aizawal-Imphal-Kohima	700

The NHDP, being implemented, has many major phases taken up so far:

Phase I-Golden Quadilateral: The Golden Quadilateral is the network of National Highways connecting the four largest metropolitan cities in the country. Delhi-Kolkata-Chennai-Mumbai-Delhi sections of the quadrilateral have a total length of 5846 km. The project was started in 1999 with cost of ₹65,000 crore. It was to be completed by December 2003.

Phase II-Corridor Project: This phase with an estimated cost of ₹30,000 crore includes development of two corridors, the north-south and east-west corridors, with a total length of 7142 km. The north-south corridor connects the National Highways from Srinagar to Kanniyakumari. The east-west corridor aims to connect the National Highways from Silchar in Assam to Porbandar in Gujarat. The two corridors intersect at Jhansi.

Port Connectivity: This phase aims at providing connectivity of the Golden Quadilateral with the major ports of the country.

Phase III: It aims at upgradation scheme of highways with a cost of ₹80,626 crore.

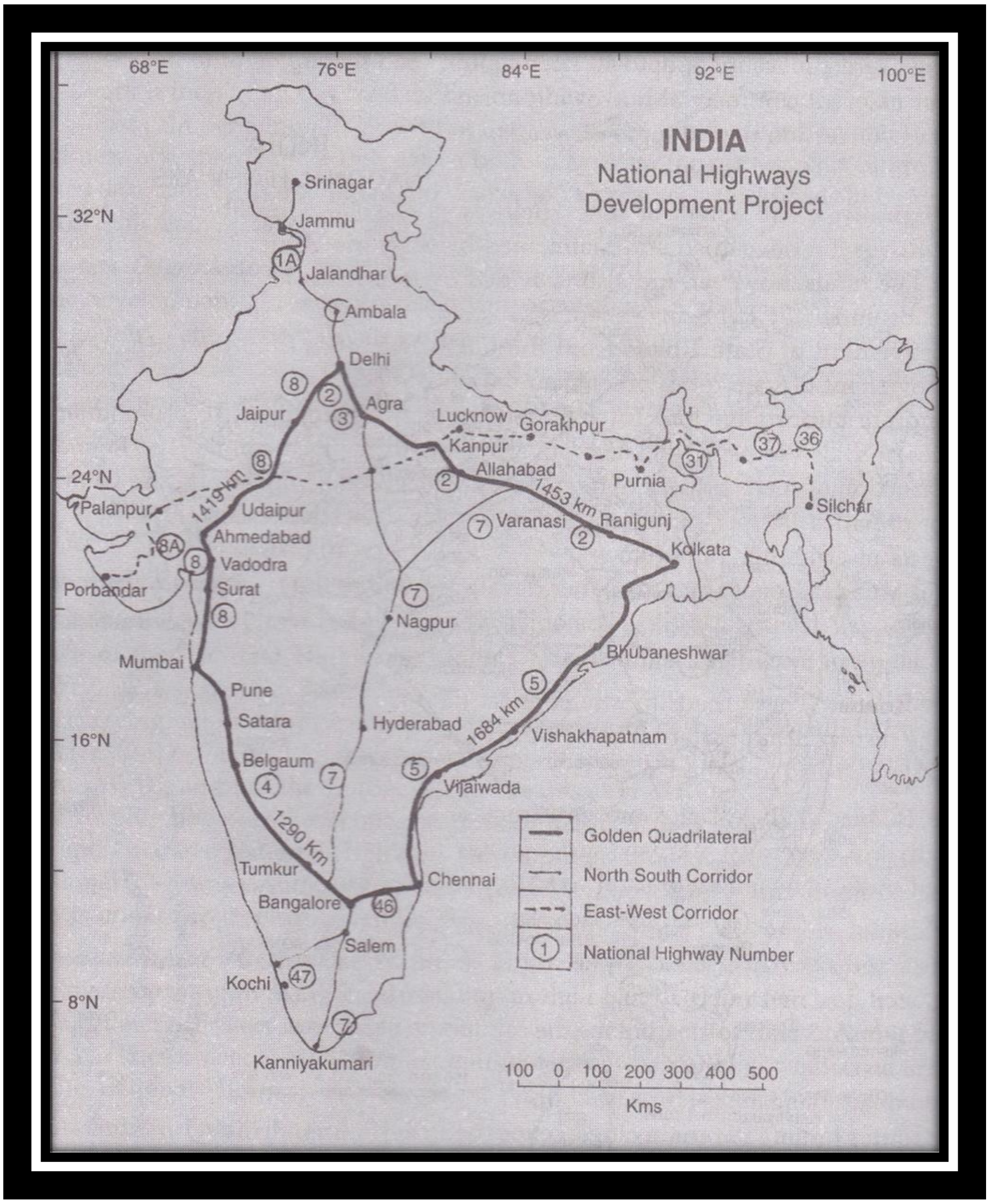

Figure 15.3: NHDP Project

Phase IV: This phase is concerned with construction of 2 lane National Highways for a distance of 20,000 km at a projected cost of ₹41,210 crore.

Phase V: It is concerned with construction of 6-lane National Highway of 6500 km and out of this 5846 km is Golden Quadrilateral.

Phase VI: This phase includes construction of 1000km length of expressways with a cost of ₹16,680.

TABLE 15.8: Status of NHDP as on December, 2011

NHDP Component	Total Length (in km)	Completed 4/6 lane (km)	Under Implementation (km)	Balance (km)
Golden Quadrilateral	5846	5831	15	-
NS-EW Corridor	7147	5914	803	420
Port Connectivity	380	341	39	-
Other NHs	1390	946	424	20
NHDP Phase III	12109	3024	6514	2572
NHDP Phase IV	20000	-	2549	17451
NHDP Phase V	6500	709	2768	3023
NHDP Phase VI	1000	-	-	1000
NHDP Phase VII	700	7	41	659
TOTAL	**55455**	**16777**	**13265**	**25421**

There are constraints faced in timely completion of NHDP which include:

(i) Delay in land acquisition and removal of structures,
(ii) Law and order problem in some states,
(iii) Lack of cooperation by certain states, and
(iv) Poor performance by some contractors

State Highways: - State highways are constructed and maintained by the state P.W.Ds. These provide link to all major towns and cities of the state, state capitals and district headquarters. They are the main arteries of the passenger and goods movement. In 2011, the total length of state highways was 163,898 km. Among the state Maharashtra has the longest network of state highways followed by Karnataka, Gujarat, Rajasthan and Tamil Nadu. These five states together have 57% of the total state highways of the country. The state-wise length of the state highways is shown in the Table 15.9.

TABLE 15.9: India: State-wise Length of State Highways, 2011 (including UTs)

States/UTs	Length of State Highway (in km)	Percent of the Country
Andhra Pradesh	10,491	6.40
Assam	3,134	1.91
Bihar	3,989	2.43
Chhattisgarh	5,240	3.20
Goa	279	0.17
Gujarat	18,421	11.24
Haryana	2,521	1.54
Himachal Pradesh	1,626	0.99
Jammu & Kashmir	67	0.04
States/UTs	Length of State Highway (in km)	Percent of the Country
Karnataka	20,770	12.67
Kerala	4,341	2.64
Madhya Pradesh	10,249	6.25
Maharashtra	32,823	20.03
Manipur	1,137	0.69

Meghalaya	1,134	0.69
Mizoram	700	0.43
Nagaland	763	0.46
Odisha	3,576	2.18
Punjab	1,477	0.90
Rajasthan	11,300	6.89
Sikkim	179	0.11
Tamil Nadu	10,561	6.44
Tripura	689	0.42
Uttar Pradesh	7,941	4.85
Uttarakhand	3,788	2.31
West Bengal	4,505	2.75
Andaman and Nicobar Islands	239	0.14
Puducherry	40	0.02
Dadra & Nagar Haveli	42	0.03
TOTAL	**163,898**	**100.00**

Source: Basic Road Statistics of India, 2010-11

District Roads: - These roads mostly connect the towns and large villages with the district headquarters. Formerly most of these roads lacked bridges and culverts. But now these roads are being converted into surfaced roads to improve the rural accessibility and pave the way for economic development. The construction and maintenance of these roads lie with Zila Parishad and the P.W.D. In 2008, these roads had a total kilometrage of 1,371,849 of which 63% were in the form of PWD roads and remaining as Zila Parishad Roads.

Village Roads: - Village Roads are constructed and maintained by the village Panchayats. The category includes the village panchayat roads, Panchayat Samiti roads and rural roads constructed under the Jawahar Rozgar Yojna. These roads are narrow, zig-zag and unsurfaced and are not suitable for heavy merchandised traffic. Their condition worsens during the rainy season when these are converted into muddy pools. Upto March 31st, 2008 the country had a total length of 11,68,788 kms of such roads, which is about 38.4% of the total road length of India. Under the Pradhan Mantri Gram Sadak Yojna efforts are being made to improve rural transport network and provide all-weather linkage to almost all villages.

International Highways: - Under the agreement with the Economic and Social Commission on Asia and Pacific (ESCAP) some of the country's highways linking the neighbouring countries have been declared international highways. These are of two types:

i. Main arterial routes linking the capitals of the neighbouring countries
    a) Lahore-Amritsar-Delhi-Agra-Kolkata-Golaghat-Imphal-Mandalay
    b) Agra-Gwalior-Hyderabad-Bengaluru-Dhanushkodi
    c) Barhi-Kathmandu
ii. Routes joining main cities, ports, etc, with the arterial road network
    a) Agra-Mumbai road
    b) Delhi-Multan road
    c) Bangalore-Chennai road
    d) Golaghat-Ledo road

The World Bank provides finance for the maintenance of these roads.

Express Highways: - These are multi-lane well paved highways with controlled access for fast movement of goods and traffic. Some important express highways are:

i. Western and Eastern Express Highway in Mumbai
ii. Kolkata-Dum Dum Airport Highway
iii. Sukinda-Paradwip Port Highway in Odisha
iv. Durgapur-Kolkata Highway
v. Delhi-Agra Yamuna Express Highway

Their total length is 200 km which is proposed to increase to 1000 km.

Problems of Road Transport

Although India has one of the longest road networks in the world, it is facing a number of problems. Some of the important problems are discussed below:

i. **Unmetalled Roads and their Improper Maintenance:** About 40% of the roads are not metalled. Moreover, the roads are not properly maintained which accentuate the problems, especially during the rainy season.
ii. **Mixed Traffic:** Mixed traffic is a serious problem of Indian road transport. In fact, over greater parts of the country including the megacities, the same road is used by cars, trucks, two-wheelers, tractors, harvesters, animal driven carts, cyclists, rickshaws and pedestrians. This increase travel time, congestion, pollution, tension and road accidents.
iii. **Multiple Check Posts:** There are multiple check posts, toll tax and octroi duties collection points on the roads which bring down the speed of the traffic, waste time and causes irritation. Moreover, the rate of the road tax varies from state to state and in the different regions of the same state.
iv. **Inadequate Side Amenities:** Along the roads, repair shops, first-aid centres, telephones, toilets, restaurants, rest places and cheap hotels are not adequately developed.
v. **Low Private Level Participation:** There is very little participation of private sector in road development in India because of long gestation period and low returns.
vi. **Shortage of Funds:** There is shortage of funds for the construction and maintenance of roads. Unfortunately, there is insignificant participation of the private sector as a result of which capital for development, extension and maintenance of roads is not adequately available.
vii. **Unstable Road Policy:** There is not a stable policy for the construction, extension and maintenance of roads. The road policy in the states, generally changes with the change of government. This leads to poor maintenance of roads.

2. Railways

The railways in India provide the principal mode of transportation for freight and passengers. It brings together people from the farthest corners of the country and makes possible the conduct of business, sightseeing, pilgrimage and education. Indian railways have been a great integrating force during the last 150 years. It has bound the economic life of the country and helped in accelerating the development of industry and agriculture. It is the main artery of the country's inland transport.

Factors affecting Railways

The pattern of Indian Railway Network has been influenced by geographical, economical and political factors.

i. **Geographical Factors:** The North India Plain with its level, high density of population and rich agriculture presents the most favourable conditions for the development of railways. However, the presence of large number of rivers makes it necessary to construct bridges which involve heavy expenditure. The plateau region of south is not as much suitable for railways as the North plain area. The Himalayan region in the north is almost entirely devoid of railways due to its rugged topography. Some railway terminals such as Jammu Tawi, Kotdwar, Dehra Dun, Kathgidam, etc. are found on the foothills. Some narrow gauge railway tracks are found in the Himalayan region. A link between Jammu and Kashmir valleys is being planned at a very high cost. The sandy areas of Rajasthan are also not much favourable for railways. There is no railway line between Jodhpur and Jaisalmer till 1966.Similarly, forested areas of Madhya Pradesh and Odisha, deltaic swamps of West Bengal and marshy areas of Rann of Kachchh and hilly tract of Sahayadri are also unfavourable for the development of railways. Sahayadri can only be crossed through gaps like Thalghat, Bhorghat and Palghat to reach the coastal rail heads like Mumbai, Vasco-de-Gama, Mangalore and Kochi. Obviously, *the railways tend to follow the path of least resistance.*

ii. **Economic Factors:** Railways develop more in the economically advanced areas where the need for railway network is felt more. Conversely, railways bring economic prosperity to the areas through which they pass. This is because of the economic linkages that we find the highest density of railways near big urban and industrial centres and in the areas which are rich in mineral and agricultural resources.

iii. **Political and Administrative Factors:** The present railway system in Indian is the legacy of the British rule. The British administration planned the direction and pattern of the railway lines in such a way that they could exploit the valuable raw materials of India for the benefit of their industries and flood the Indian markets with the finished goods from Britain. Besides the Britishers wanted to maintain their military supremacy, for which quick movement of troops and arms was necessary and construction of railways became unfavourable. Thus, top priority was given to big ports of Mumbai Kolkata and Chennai. These ports were connected with their hinterlands by railway lines to facilitate imports and export. It is from that the railway network spread to the other parts of the country.

Distribution of Indian Railways

The distribution pattern of the railways in India varied from region to region. The general distribution pattern of railways has been depicted in Figure below. The pattern of distribution of railways in four geographical regions of India is as follows:

Figure 15.4: Distribution of Indian Railways

<u>North Indian Plain:</u>

This region has a very dense network of railways from Amritsar to Kolkata. This plain region is economically well developed and also a highly populated region of India. This densely populated region has highly developed industry and agriculture, which has in turn helped in the development of railways. The main focal points of the railway in this region are Delhi, Kanpur, Mughal Sarai, Lucknow, Agra and Patna. Delhi, the capital of India is very well connected with all parts of the country, including major ports like Mumbai, Kolkata and

Chennai through superfast trains, due to many political, administrative and economic reasons. Delhi is the main point from where railway lines radiate in all directions.

Peninsular India:

In this region, the hilly and plateau terrain hinders the development of railway. The population density is also moderate. For such reasons, apart from railways have developed properly in Maharashtra and Tamil Nadu, a relatively open and more loose network has been developed in here. However, some trunk routes cross the peninsula and provide efficient rail service between Mumbai-Chennai, Chennai-Kochi, Chennai-Delhi, Mumbai- Kolkata, Chennai-Hyderabad and Mumbai-Thiruvananthapuram.

Himalayan Region:

The rugged terrain, hill, and valley topography, backward economy and sparse population are the factors responsible for the thin railways network in this region. There are three narrow gauge railway lines in the Himalayan region. These are Kalka-Shimla, Pathankot-Kangra and Siliguri-Darjeeling. The Kalka-Shimla Railway built in 1903 winds itself through picturesque country from Kalka to Shimla over a distance of 97 km. It has 103 tunnels, totaling 8 km in length; the longest tunnel is 1,144 metres. The Siliguri-Darjeeling Railway is 82 km long and was constructed in 1878. There is practically no railway line in the north-eastern states of Meghalaya, Tripura, Arunachal Pradesh, Mizoram, Manipur and Nagaland. However, plans are afoot to provide rail links to Meghalaya, Arunachal Pradesh and Tripura. But the population is sparse and the economy is in backward state. Moreover areas have rough terrain and are covered with thick forests. Construction of railways under these conditions is a difficult and costly affair. Similarly, the government has taken up an ambitious and challenging programme of constructing 291 km long Udhampur-Srinagar-Baramula railway line, like the earlier constructed 55 km long Jammu Tawi-Udhampur railway line. The constructed rail line runs through difficult hilly terrain and its construction involves 21 tunnels, that too on high and difficult terrain, the largest being 2.4 km across the Shiwalik Range. The Udhampur-Srinagar-Baramula railway line is proposed to have 80 tunnels, the highest passing through the Pir Panjal Range of 14.5 km length.

Coastal Plains:

There is a distinct contrast in the rail network between eastern and western coastal plains. The eastern coastal plain is quite wide and permits the construction of railways, as a result of which, there is a long trunk route along the east coast from Kolkata to Chennai. But, in western coastal plain, the terrain is not suitable due to outcrops of Western Ghats. However, the completion of Konkan railway line from Roha to Mangalore is dreams come true. It passes through several tunnels and over numerous bridges. This line has the longest tunnel in the country: 6.5 km long, about 23 km south of Ratnagiri. It has become the lifeline of the western coastal plain with a total saving in travel distance between Mangalore-Mumbai (1,050 km), Mangalore-Ahmedabad (1,218 Km), Mangalore-Delhi (707 km) and Kochi-Mumbai (437 km).

The above description has leaded us to the conclusion that railway services are unevenly distributed in India. The maximum concentration of the Indian Railways is found at the Indo-

Gigantic Plains followed by the Peninsular Plateau. The railways are practically absent from the Himalayan region. Such a lop-sided railway development has kept many areas away from the railway routes.

Railway Management

Railway Management is carried through the Railway Board. The entire network is divided into 16 railway zones (Table 15.10) which are subdivided into divisions. These divisions are the basic operating unit for the Indian Railways.

TABLE 15.10: India: Railway Zones

S. No.	Zones	Date of Formation	Headquarters	Route Kms.
1.	Southern	14.04.1951	Chennai	5,098
2.	Central	05.11.1951	Mumbai (CST)	3,905
3.	Western	05.11.1951	Mumbai (Churchgate)	6,182
4.	Northern	14.04.1952	New Delhi	6,968
5.	North-Eastern	14.04.1952	Gorakhpur	3,667
6.	South-Eastern	01.08.1955	Kolkata	2,631
7.	Eastern	01.08.1955	Kolkata	2,414
8.	North-East Frontier	15.01.1958	Maligaon (Guwahati)	3,907
9.	South Central	02.10.1966	Secunderabad	5,803
10.	East Central	01.10.2002	Hajipur	3,608
11.	North-Western	01.10.2002	Jaipur	5,459
12.	East Coast	01.04.2003	Bhubaneshwar	2,572
13.	North Central	01.04.2003	Allahabad	3,1514
14.	South-East Central	01.04.2003	Bilaspur	2,447
15.	South-Western	01.04.2003	Hubli	3,177
16.	West Central	01.04.2003	Jabalpur	2,965

Source: Railway Year Book, 2009-10

Significance of Indian Railways

i. **Easy Mode of Travel:** Railways provide the cheapest and the most convenient mode of passenger transport, both for short and long distances. Railways are particularly suited for long journeys.
ii. **Accelerated Industrialization:** Railways have played a vital role in the process of economic development, industrialization and urbanization of the country.
iii. **Agricultural Development:** Railways have played a significant role in the development and intensification of agriculture. In fact, the farmers can sell their perishable and non-perishable commodities to long distant market at a remunerative price. The fertilizers used in the High Yielding Varieties are also generally transported to the farmers in the different parts of the country by the railways.

iv. **Connects Remote Cultures:** Railways connect people from the areas of isolation and relative isolation with the urban centres and thus accelerate social interaction and national integration and help n the diffusion of new ideas and innovation.

v. **Helps in the Maintenance of Law and Order:** At the time of communal riots and tension as well as socio-political turmoil, railways play a significant role.

vi. **Fast Mode of Transportation:** Through super-fast container services in the major cities, India has ensured quick movement of people and commodities.

vii. **Cheapest Mode of Transportation for Bulky Materials:** Railways are particularly suited to long haulage of bulky materials like coal, petroleum and mineral ores.

viii. **Boon at the Time of Calamities:** Railways provide relief and rescue teams and essential items to the affected areas and save people from sufferings and starvation.

ix. **Connects Hinterland with the Seaports:** Railways connects hinterlands with the sea ports and thus help in the socio-economic development of the coastal areas as well as the hinterland.

x. **Helps in Administration:** Railways are playing an important role in the administration of the country and safeguarding its sovereignty and integrity. It facilitates easy movement of police, troops, defence equipments, etc. to the different parts of the country.

xi. **Promotes National Integration:** The areas of isolation and relative isolation have been connected by the railways with the mega and metropolitan cities. This has helped in the diffusion of innovations and new technology in the remote areas of the country.

Problems of Indian Railways

i. **Heavy Pressure:** With the increase in population, industrialization and urbanization there is a heavy pressure of passengers and goods on the railways.

ii. **Competition with Road Transport:** Railways are facing tough competition from road transport. Many a times a road transport is preferred as roads can deliver the goods at the doors.

iii. **Safety:** According to the Railway Board, 15% of the total railway accident in the world occurs in India. Thus, nowhere in the world do so many people die in train accidents as in India. Looking at the frequency of accidents, railway journey is no longer very secure. On some of the routes, frequent loots and robbery incidents have made the railway journey unsafe and full of tension.

iv. **Economic Burden:** There are about 17 lakh railway employees, out of which about 45% of the total man-power is unskilled. Many of the workers are not efficient and dedicated. This puts an economic burden on the railway budget.

v. **Faulty Planning:** Under the political pressure and interference, several projects of railways have been introduced which are not economically viable.

vi. **High Rates of Electricity and Diesel:** The Electricity Board and NTPC often make heavy increase in the tariffs. This adds to the financial burden on the electric traction. Railways are the largest consumers of diesel. The increase in the price of the diesel affects the finances of the railways adversely.

vii. **Slow Decision-Making Process:** The decision making process is in the hands of the Central Government. Being a lengthy process, often the decisions are delayed and the railways suffer adversely.

viii. **Obsolete Machinery:** A number of equipments used by the railways are obsolete and need replacement for which adequate capital is not available.

ix. **Obsolete Tracks and Equipments:** Many of the railway tracks are outdated and obsolete. Track renewal, improvement in signaling, communication system and safety measures are not adequate.

x. **Miscellaneous Problems:** Late running of trains, filthy trains, choked toilets, lack of passenger facilities, cleanliness at railway stations, lack of security arrangements on the railways result into frequent thefts, robberies and dacoities.

3. Pipelines

Pipeline transport network is a new arrival on the transportation map of India. In the past these were used to transport water to cities and industries. Now, these are used for transporting crude oil, petroleum products and natural gas from oil and natural gas fields to refineries, fertilizer factories and big thermal power plants. Solids can also be transported through pipelines when converted into slurry. The far inland locations of refineries like Barauni, Mathura, Panipat and gas based fertilizer plants could be thought of only because of pipelines. Initial cost of laying pipelines is high but subsequent running costs are minimal. It rules out trans-shipment losses or delays.

There are three important network of pipeline transportation in the country:

i. From oil field in upper Assam to Kanpur (Uttar Pradesh), via Guwahati, Barauni and Allahabad. It has branches from Barauni to Haldia, via Rajbandh, Rajbandh to Maurigram and Guwahati to Siliguri.

ii. From Salaya in Gujarat to Jallandhar in Punjab, via Viramgram, Mathura, Delhi and Sonipat. It has branches to connect Koyali (near Vadodara, Gujarat), Chakshu and other places.

iii. Gas pipeline from Hazira in Gujarat connects Jagdishpur in Uttar Pradesh, via Vijaipur in Madhya Pradesh. It has branches to Kota in Rajasthan, Shahjahanpur, Babrala and other places in Uttar Pradesh.

Check Your Progress II

Q.1 Classify roadways into different types.

Q.2 Discuss the problems of Indian Railways.

15.4.2 WATER TRANSPORT

Water transport is one of the oldest means of transport in India. Prior to the advent of rail and road transports, goods and people were moved from one place to another through water transport. Since there is almost very small cost involved in the construction and maintenance of waterways this transport system is always cheaper.

Waterways are of two types:

i. Inland Waterways
ii. Sea Ways

1. Inland Waterways

Inland waterways refer to using inland water bodies like rivers, canals, backwaters, creeks, etc for transporting goods and other people from one place to another. India has a long historical tradition of using such waterways. The decline of river transport began with the construction of the railways during the mid 19^{th} century. Later on the development of roads adversely affected the prospects of such transport. The diversion of river water into irrigation canals made many of these rivers unsuitable for navigation.

India is a land of many long and perennial rivers. But water transport is not very popular in the country. This is mainly due to the seasonal concentration of rainfall, fluctuating river regime, devastating floods during rainy season, shifting river courses, diversion of large quantity of river water into irrigation canals, heavy silting and formation of sandbars, undulating topography in hilly and plateau regions leading to the formation of delta and diversion channels making the mouth narrower for the entry of ships and big boats.

Factors Affecting Inland Waterways

i. The rivers and canals should have regular flow of sufficient water.
ii. The presence of waterfalls, cataracts and sharp bends in the course of river hinders the development of waterways
iii. Silting of the river bed reduces the depth of water and creates problem for the navigation. Desilting of river beds is a costly affair.
iv. Diversion of water for irrigation purposes reduces the quantity of water in the river channel and should be done carefully.
v. There should be sufficient demand for waterways to make it economically viable mode of transportation.

India has got about 14,500 km of navigable waterways which comprise rivers, canals, backwaters, creeks, etc. At present, however, a length of 3,700 km of major rivers is navigable by mechanised crafts but the length actually utilised is only about 2,000 km. As regards canals, out of 43,000 km of navigable canals, only 900 km is suitable for navigation by mechanised crafts. About 18 million tonnes of cargo is being moved annually by inland water transport (IWT), a fuel efficient and environment friendly mode.

Ganga is the most important inland waterway in India. It is navigable by the mechanized boats upto Patna and by ordinary boats upto Haridwar. It has been declared as National Waterway No. 1. The entire route has been divided into three parts for development purposes. These parts are Haldia-Farakka (560km), Farakka-Patna (460 km) and Patna-Allahabad (600 km). The National Waterways (Allahabad-Haldia stretch of Ganga-Bhgirathi-Hoogly River system) Act, 1982 has the provision that the regulation and development of the waterway is the responsibility of the Central Government.

Brahmaputra is also navigable by streamers upto Dibrugarh for a distance of 1,384 km which is shared by India and Bangladesh. Its 891 km long stretch from Sadiya to Dhubri in Assam has been declared as a National Waterway and is being developed as an important inland waterway.

Rivers of South India are seasonal and are not much suited for navigation. However, the deltaic areas of the Godavari, the Krishna and the Mahanadi, lower reaches of the Narmada and the Tapi,backwaters of Kera Mandovi and Juari rivers of Goa serve as Waterways. The Godavari is navigable upto a distance of 300 km from its mouth. The Krishna is used as a waterway upto 60 km from it mouth.

There are some canals also which serve as inland waterways. Buckingham canal in Andhra Pradesh and Tamil Nadu is one such canal which provides water transport for a distance of 413 km. It runs parallel to the eastern coast and joins all the coastal districts from Guntur to South Arcot. The other navigable canals are Kurnool-Cuddapah Canal (116.8 km), Son Canal (326 km), Odisha Canal (272 km), Medinipur Canal (459.2 km), Damodar Canal (136 km). Some of the canals of Uttar Pradesh and Punjab are also utilized for local transport.

The IWT is also known for higher employment generation potential. Its operations are currently restricted to a few stretches in the Ganga-Bhagirathi-Hooghly Rivers, the Brahmaputra, the Barak River, the rivers in Goa, the backwaters in Kerala and the deltaic regions of the Godavari-Krishna Rivers. Besides the organised operations by mechanised vessels, country boats of various capacities also operate in various rivers and canals.

Inland Waterways Authority of India

The Inland Waterways Authority of India (IWAI) constituted under the Inland Waterways Authority of India Act, 1985 (82 of 1985), came into existence on 27 October 1986 as a statutory body for development, maintenance, management and regulation of National Waterways in the country and to act as advisor to the Central and State Governments on matters relating to inland water transport. The head office of the IWAI is located at Noida in its own building. It also has its regional offices at Patna, Kolkata, Guwahati and Cochin and sub offices at Allahabad, Ballia, Bhagalpur, Farakka and Kollam.

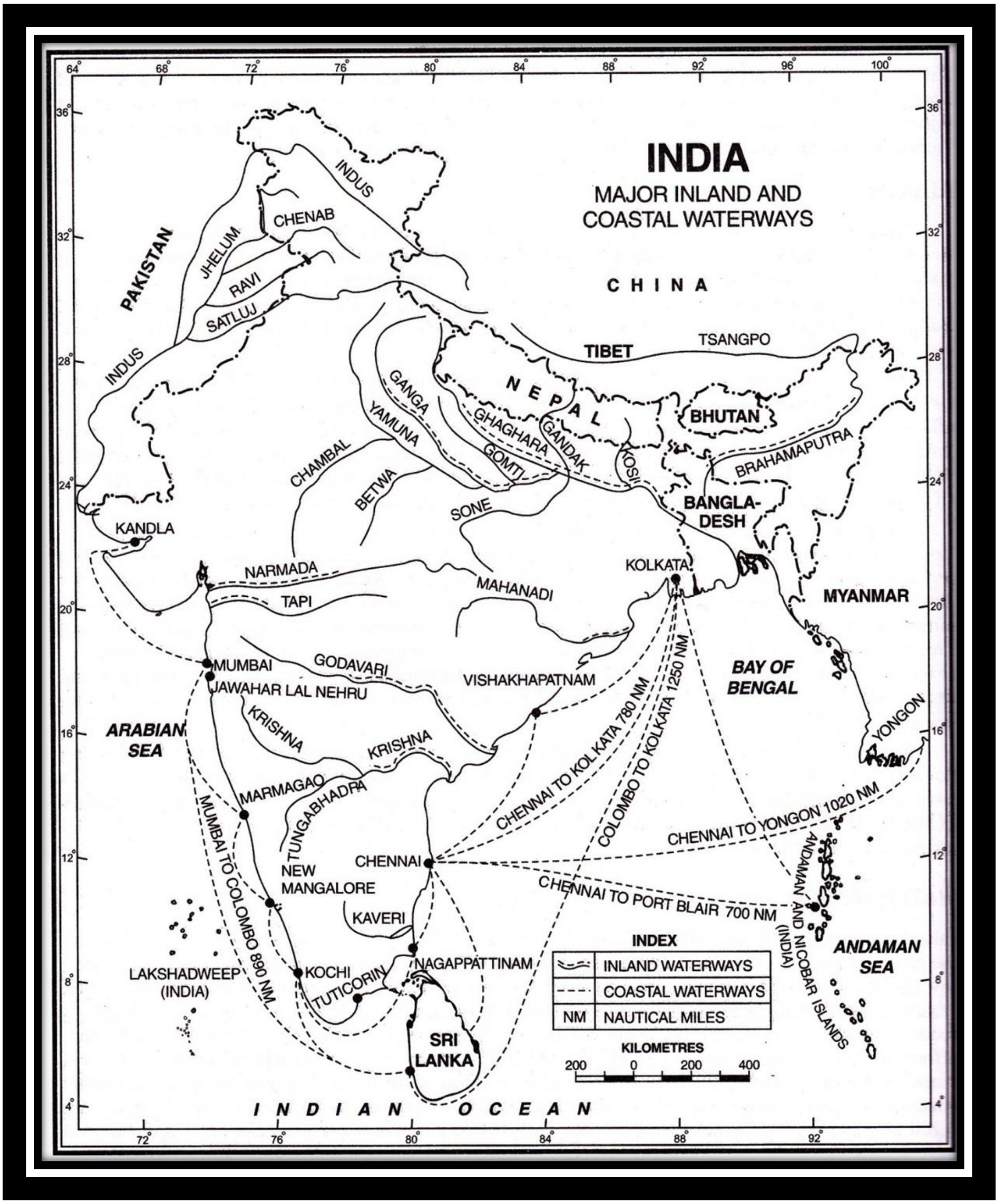

Figure 15.5: India's Inland and Overseas Routes

National Waterways

Considering the need to develop inland waterways and inland water transport to play its rightful role in the transport network of the country, the government had identified 10 important waterways for consideration to declare them as National Waterways:

i. The Ganga between Allahabad and Haldia (1,620 km) on 27 October 1986,

ii. the Sadiya-Dhubri stretch of river Brahmaputra (891 km) on 26 October 1988 and
iii. the Kollam-Kottapuram stretch of West Coast Canal (168 km) along with Champakara Canal (14 km) and Udyogmandal Canal (22 km) in Kerala with effect from 1 February 1993
iv. Specified stretches of Godavari and Krishna rivers along with Kakinada Puducherry stretch of canals (1078 km)
v. Specified stretches of Brahmani River along with Matai river, delta channels of Mahanadi and Brahmani rivers and East Coast Canal (588 km); have so far been declared as National Waterways and the same are being developed for navigation by IWAI.

Techno-economic studies on many other waterways such as Godavari, Krishna, Barak, Sunderbans, Buckingham Canal, Brahmani East Coast Canal, DVC Canal, etc., have been completed and found viable. Out of these, IWAI have proposed that: Godavari (Andhra Pradesh), Krishna (Andhra Pradesh), Barak (Assam), Buckingham Canal (Tamilnadu) and Brahmani East Coast Canal (Orissa) are declared as National Waterways. The proposals are under consideration of the government.

IWT Policy:
The Government of India has approved policy measures for promoting inland water transport which inter alia empower IWAI to raise bonds to mobilize funds from the market and to enter into commercial joint ventures to encourage investment in IWT sector. Policy guidelines for private sector participation have been formulated. The IWAI has formulated various schemes for creation of necessary IWT infrastructure and also for demonstration of the viability of IWT for creating awareness among the prospective private investors. Experimental cargo services are operated from Haldia Port to destinations in Bihar and Uttar Pradesh with this objective.

Central Inland Water Transport Corporation:
The Central Inland Water Transport Corporation (CIWTC) with its headquarters at Kolkata was set up as a public sector undertaking in May 1967. The CIWTC is mainly engaged in transportation of goods by inland waterways in the Ganga- Bhairathi-Hooghly, Sunderbans and the Brahmaputra rivers.

They are operating regular cargo services between Kolkata and Pandu (near Guwahati), between Kolkata and Karimganj (Assam), Kolkata-Bangladesh and between Haldia and Patna. The government has initiated a revival plan for the CIWTC so that it can concentrate on its core activity of river transportation and become a viable entity.

Protocol on Inland Water Transit and Trade:
The Indo-Bangladesh Protocol on Inland Water Transit and Trade, which came into operation in November 1972, has been renewed from time to time. This protocol was last renewed on 28 October 1999. The terms of the protocol are being extended from time to time. This protocol facilitates operation of both Indian and Bangladesh vessels on the following inter-country and transit routes:

i. Kolkata-Pandu
ii. Kolkata-Karimganj
iii. Rajshahi-Dhulian
iv. Pandu-Karimganj

2. Sea Ways

i. **Coastal Shipping:** Coastal shipping is energy efficient, environment friendly and economical mode of transport in the Indian transport network and a crucial component for development of domestic industry and trade. India has 7,516.6 km long coastline (including 1,962 km of Andaman and Nicobar Islands and 132 km of Lakshadweep Islands), studded with 12 major and 189 minor and intermediary ports providing congenial and favourable conditions for the development of domestic transport infrastructure. It is quite distinct from overseas or offshore that implies shipping to locations of the shore such as oil rigs and platforms. Developing coastal shipping has many advantages. It decongests the railways and roadways, is relatively pollution free, is less capital intensive, provides large employment, involves continuous vigilance of the coasts and promotes sea based industries such as fisheries and luxury tourism. Of 83 Indian shipping companies 49 are exclusively engaged in coastal trade and 15 in both coastal and overseas trades. To improve coastal shipping container service has been introduced in major ports.

ii. **Overseas or Offshore Shipping:** Shipping plays an important role in the transport sector of India's economy. Approximately, 90 per cent of the country's trade volume (77 per cent in terms of value) is moved by sea. Presently, India is the largest merchant shipping fleet among the developing countries and ranks 17th in the world in terms of shipping tonnage. Indian shipping sector facilitates not only the transportation of national and international cargoes but also provides a variety of other services such as cargo handling services, ship building/repairing, freight forwarding, lighthouse facilities and training of maritime personnel. As on 1 April 2002, the net operative tonnage consisted of 560 ships totalling 6.82 million gross registered tonnages (GRT).
The salient features of India's shipping policy are the promotion of national shipping to increase self-reliance in the carriage of country's overseas trade and protection of stake holder's interest in EXIM trade. India's national flagships provide an essential means of transport for crude oil and petroleum product imports.
National shipping also acts as a second line of defence in times of emergency. Indian shipping makes significant contributions to the foreign exchange earnings of the country. During 2000-01, the gross earnings of Indian shipping companies by way of freight and charter hire income were in excess of Rs. 5,500 crore.

Problems of Indian Shipping

The Indian Shipping is confronted with a number of problems which include inadequacy of tonnage capacity, shortage of container fleet, over aged vessels resulting into high operating costs, stiff competition from foreign shippings which provide better and cheaper service, congestion at the major ports and inadequate infrastructural support like ship repair facility, dry docking and cargo handling.

In the Eighth Plan the basic thrusts were towards the replacement of aged and uneconomic ships, diversification of the fleet through the acquisition of container ships and specialized carriers, achievement of self-sufficiency in tankers, and improvement of infrastructural facilities at the ports. The SCI is planning to acquire 14 new ships at the cost of ₹2600 crores.

Ports of India

There are12 major and 185 minor ports in India. Ports not only play a crucial role in facilitating international trade, they also act as fulcrums of economic activity and development in their surrounding areas. India has about 7,517 km of main coastline spread over 13 states/UTs. Out of the non-major ports 60 are handling traffic. The major ports are under the jurisdiction of the Central Government, while the minor and intermediate ports are managed and maintained by the respective State Governments. The number of cargo vessels handled at the major port is about 16,500 tonnes per annum. The total traffic carried by both the major and minor ports during 2005-06 was estimated at around 570 million tones. The 12 major ports carry about 75% of the total traffic with Vishakhapatnam as the top traffic handler in each of the last six years (2000-01 to2006-07).

Major Seaports of India

i. ***Chennai:*** Situated along the northern coast of Tamil Nadu, it is an artificial sea port. It spreads over an area of about 80 hectares with an average depth of about 16 metres. The harbor has an entry from the north. It can accommodate 22 vessels. The main exports from Chennai port are food-grains, hides and skins, iron-ore, mica, oil-cake, sugar, turmeric, timber and tobacco. The port imports chemicals, coal, cotton cotton-goods, edible-oils, fertilizers, machinery and petroleum products.
ii. ***Ennore:*** Situated about 20 kms to the north of Chennai, Ennore is a natural harbor. It was developed to ease the pressure of the Chennai-seaport. Ennore exports hides, machinery, mica, rice and sugar. The principal imports are cement, cotton, edible-oils, fertilizers, machinery and petroleum products.
iii. ***Jawahar Lal Nehru (Nhova Shiva) Port:*** Situated about 14 kms to the south of Mumbai, this sea-port was developed to ease the pressure on the Mumbai sea-port. It is a world class port equipped with all the modern facilities. The sea-port is connected by a four-lane highway with the hinterland. It is India’s largest container port.
iv. ***Kandla:*** Located at the head of Gulf of Kutch, Kandla sea-port was developed after Independence to take up the place of Karachi which went to Pakistan. It is a tidal harbor in the Kandla Creek with an average depth of 10 metres. The port has a vast hinterland in the states of Gujarat, Haryana, Punjab, Himachal Pradesh and Jammu and Kashmir. Its main imports are fertilizers, phosphates, sulphurs and petroleum, while the export includes bones, cotton, food-grains, naptha, salt and sugar.

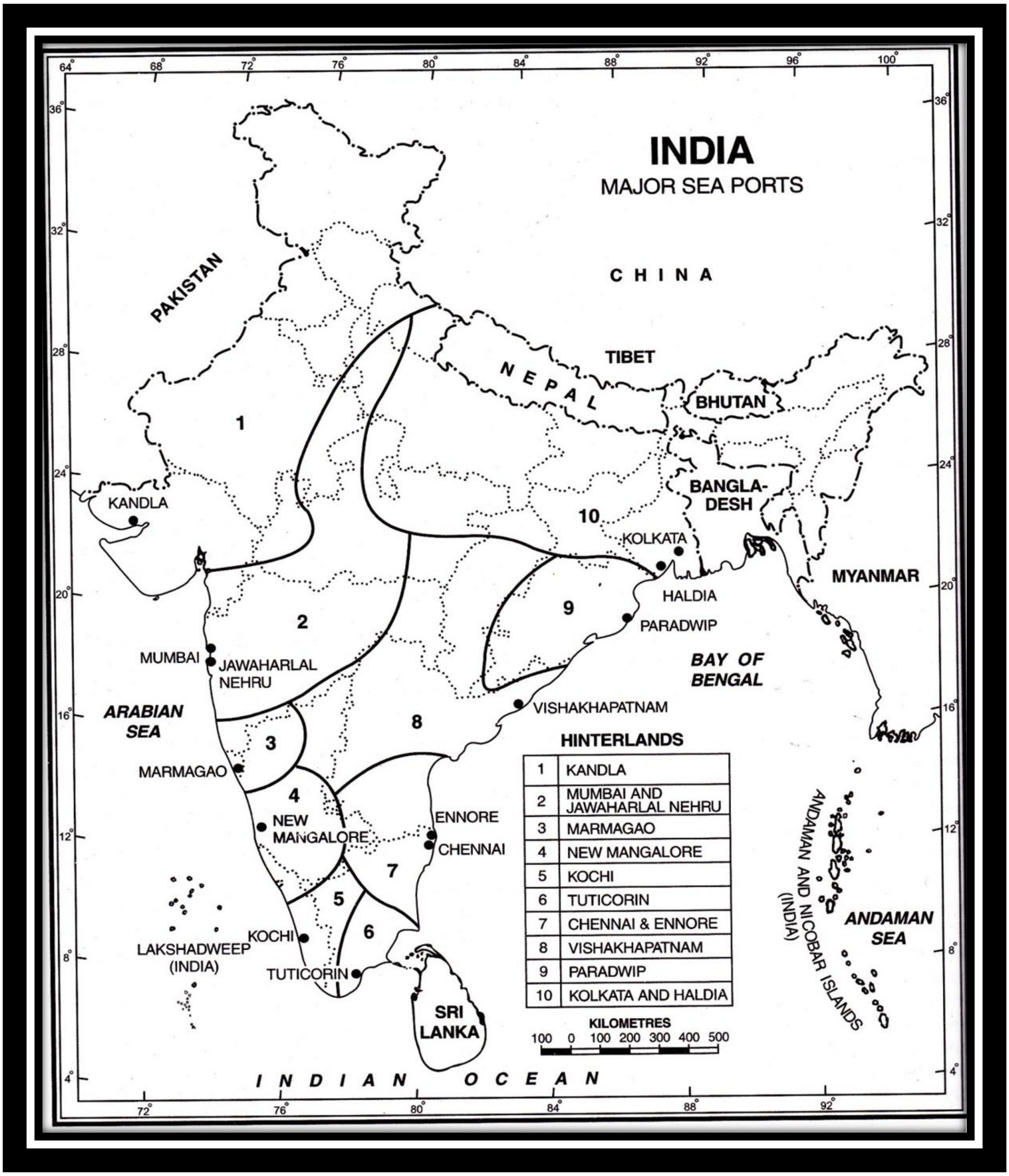

Figure 15.6: Major Sea Ports of India

v. ***Kochi:*** Situated along the coast of Kerala, Kochi is a natural sea-port and the largest shipyard in the country. The indigenous Aircraft Carrier for the Indian Navy is also present in the shipyard. It remains open for cargo traffic throughout the year. Being situated close to the Suez-Colombo route, it has great commercial and strategic importance. The main items of export are cashew-kernel, coconut, coir goods, copra, oil lubricants, rubber, fish and sea food, while the main imports include chemicals, coal cotton, fertilizers, machinery, edible oils, iron and steel, metals, food grains, hides and skins, tobacco, timber, sugar and oil-cakes.

vi. ***Kolkata-Haldia:*** The Kolkata-Haldia port is situated along the Hugli river. The port has a large hinterland which covers the seven states of Bihar, Chhattisgarh, Jharkhand, north-east India, Odisha and eastern Uttar Pradesh. The main exports of the port includes bones, bone-meal, bunker-oil, electrical goods, iron and steel, jute products, lac, leather goods, machinery, mica, scrap, tea and timber. The main imports include edible-oils, fertilizers, machinery, railway equipments and petroleum.

vii. ***Marmagao:*** Situated at the entrance of the Zuvari estuary in Goa it is the leading iron-ore exporting sea-port of the country. It also exports betel leaves, cashew nut, manganese and salt. The main imports include manganese, cement, crude-oil, food-grains, fertilizers and machinery.

viii. ***Mumbai:*** Mumbai is the largest and the most important sea-port along the western coast of India. It was developed by the British in 1672 as a substitute to the Surat sea-port. It has a natural harbor about 12 m deep. It has a vast hinterland stretching over Maharashtra, Gujarat, Madhya Pradesh, Delhi, Haryana, Punjab, Uttarakhand and Uttar Pradesh. The main exports of Mumbai sea-port include cotton goods, cotton yarn, electrical goods machinery and vehicles while, fertilizers, machinery, chemicals, electronic goods, raw cotton, petroleum and petroleum products are the main items of imports.

ix. ***New Mangalore:*** Situated along the coast of Karnataka, it was developed about 9 km to the north of the old port of Mangalore. The port is linked through Broad Gauge railway line and the National Highway NH17 with Mumbai. Its main exports are cashew-nuts, coffee, forest products, iron-ore, manganese-ore and timber while, the imports include crude-oil, fertilizers, machinery, petroleum and petroleum products.

x. ***New Tuticorin:*** The seaport has been developed about 8 km to the south to the old Tuticorin port. The port has an artificial deep sea harbor. It has a rich hinterland comprising the districts of Kanniyakumari and Ramananthapuram. It is well connected with railways and National Highway NH-7A. Its main exports are cardamom, cotton, cotton goods hides and skins while, the main imports consists of coal, hardware, fertilizers, machinery.

xi. ***Paradwip:*** Situated along the coast of Odisha, it is a deep water seaport In fact; Paradwip has the deepest harbor in the country. It exports cotton goods, iron ore, iron and steel, manganese, and scrap, while the imports include edible-oils, electronic goods, machinery and petroleum products.

xii. ***Vishakhapatnam:*** Developed in 1933, it has the best natural harbor in the country. It has a huge hinterland in the states of Andhra Pradesh, Chhattisgarh, Madhya Pradesh and Odisha. Vishakhapatnam port ranked first in India for the last six years (2000-01 to 2006-07) in respect of cargo traffic. Its main imports are petroleum, fertilizers, machinery and chemicals and metals while iron-ore, manganese ore, leather goods, timber and food grains are the main items of export.

Table 15.11 shows the cargo handled at the major sea-ports of India.

TABLE 15.11: India: Traffic Handled at Major Ports (Million Tonnes)

Ports	2005-06	2006-07	2007-08	2008-09	2009-10	2010-11	2011-12
Kolkata	10.80	12.60	13.74	12.43	13.05	12.54	12.23
Haldia	42.33	42.46	43.59	41.79	33.38	35.01	31.01
Paradwip	33.11	38.52	42.44	46.41	27.01	56.03	54.25
Vishakhapatnam	55.80	56.39	64.60	63.91	65.50	68.04	67.42
Ennore	9.17	10.71	11.56	11.50	10.70	11.01	14.96
Chennai	47.25	53.41	57.15	57.49	61.06	61.46	55.71
Tuticorin	17.14	18.00	21.48	22.01	23.79	25.72	28.11
Kochi	13.89	15.26	15.81	15.23	17.43	17.87	20.09
New Mangalore	34.45	32.04	36.02	36.69	35.53	31.55	32.94
Marmagao	31.69	34.24	35.13	41.68	48.85	50.02	39.00
Mumbai	44.19	52.36	57.04	51.88	54.54	54.58	56.18
J.L.N. Port	37.83	44.82	55.84	57.29	60.76	64.31	65.75
Kandla	45.91	52.98	64.92	72.23	79.50	81.88	82.50
TOTAL	**423.56**	**463.78**	**519.31**	**530.53**	**561.09**	**570.03**	**560.15**

Intermediate and Minor Seaports of India

Some of the intermediate and minor ports include Bhimunipatnam, Cuddalore, Kakinada, Kalingapatnam, Machlipatnam, Nagapattinam and Tuticorin along the eastern coast, and Alapuzzha, Calicut, Daman, Kollam, Karwar, Kozhikode, Murad, Porbandar, Tellicherry, Veraval along the west coast of India.

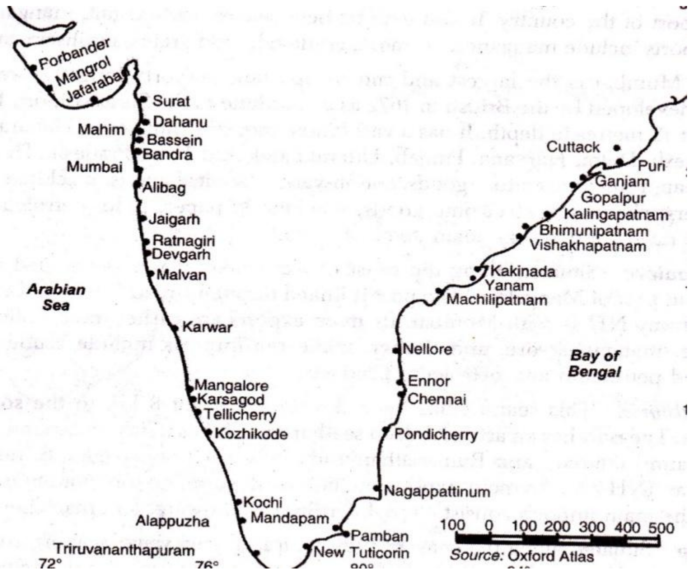

Figure 15.7: Intermediate and Minor Sea-ports in India

Major Problems of the Seaports in India

i. Indian ports are most congested.
ii. The ports are not adequately connected to the hinterland.
iii. There is heavy pressure on container traffic. The largest container port n the world is Singapore which handles 23.19 million TEUs (twenty foot equivalent units). In

comparison o this India's largest container port handled roughly 2.67 million TEUs in 2005-06.

Private Sector Participation in Ports

In order to improve efficiency, productivity and quality of services as well as to bring in competitiveness in port services, the port sector has been thrown open to private sector participation. This is in consonance with the general policy of liberalisation/globalisation of economy of the Government of India. It is expected that private sector participation would result in reducing the gestation period for setting up new facilities, also bringing the latest technology and improved management techniques.

Various areas of port functioning, such as leasing out existing assets of the port, construction/creation of additional assets, leasing of equipment for port handling and leasing of floating crafts from the private sector, pilotage and captive facilities for port based industries have been identified for participation/investment by the private sector.

Joint venture formations between major port and foreign port, between major port and minor port(s), without tender, as well as between major port and companies following tender route are permitted by the government. The measure is aimed at facilitating port trusts to attract new technology, introduce better managerial process, expedite implementation of schemes, foster strategic alliance with minor ports for creation of optimal port infrastructure and enhance confidence of private sector in funding ports.

During the Tenth Five-Year Plan (2002-07), it is proposed to enhance capacity and improve productivity in major ports with focus on measures aimed at modernization, rendering cost-effective services, enhancement of service quality, commercialization and increased private sector participation.

Check Your Progress III

Q.1 What do you mean by IWAI?

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Q.2 Differentiate between Coastal and Off-shore Shipping.

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15.4.3 AIR TRANSPORT

Air transport is the fastest mode of transport which has reduced distances and has led to drastic shrinking of the world. This mode of transportation is indispensible when speed and time are the main constraints. One can easily cross and reach remote, inaccessible and hostile areas like lofty mountains, thick forests, marshy areas and sandy deserts by air transport which is almost impossible by other modes of transport. Air transport plays a vital role at the times of emergency as well as in the event of natural or man-made disasters. Following are the main advantages and disadvantages of air transport:

i. With the help of air transport one can easily reach the remote and difficult terrains, like mountains, deserts, etc.
ii. It is the fastest mode of transport.
iii. Air transport plays a vital role at the time of emergency like a war situation and in the event of natural and man-made calamities.
iv. Air transport is, however, adversely affected at the occurrence of fog, mist and stormy weather.

Air Services: India has bilateral Air Service Agreement with 103 countries. Recently, new Air Service Agreement has been signed with Mexico and Chile. A revised Air Service Agreement between India and U.S.A. was signed in 2005 replacing earlier Agreement, signed in 1956, which grants unlimited access to the designated airlines to any point of call in the territory of the other country as against four airports under the earlier Agreement.

Civil Aviation: The Airport Authority of India (AAI), constituted on 1st April 1995, operates 127 airports including civil enclave and defence airfields for Commercial Airlines Operations. The Ministry of Civil Aviation is responsible for the formulation of national policies and programmes for the development and regulation of civil aviation and for the devising and implementing of schemes for an orderly growth and expansion of civil air transport. Its functions also extend to overseeing the provision of airport facilities, air traffic services, carriage of passengers and goods by air, safe-guarding civil aviation operations, regulation of air transport services, licensing of aerodromes, air carriers, pilots and aircraft maintenance engineers.

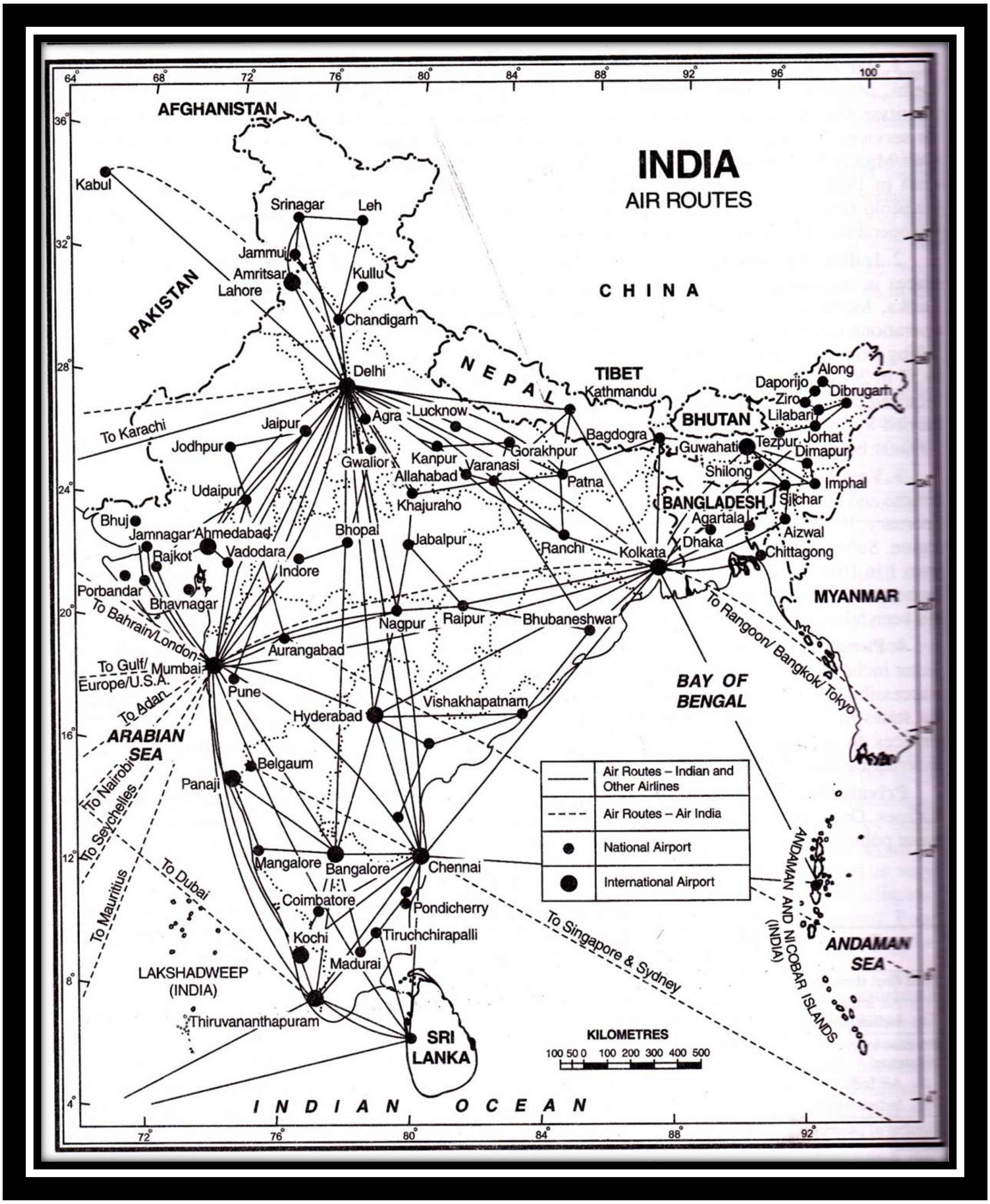

Figure 15.8: India's Air-Routes

Air Ports: There are 450 airports in the country in various stages of development. Out of these Ahmadabad, Amritsar, Bangalore, Chennai, Delhi, Guwahati, Hyderabad, Jaipur, Kochi, Kolkata, Mumbai, Panaji, Srinagar and Thiruvananthapuram are the international airports.

The improvements in the infrastructural facilities at the airports need heavy capital investment which the government cannot afford of its own. Therefore, private domestic and foreign investors including Non-Resident Indians have been encouraged to participate in the process of improvement of the Indian Airlines.

Cargo: In order to help the Indian exports to make their exports more competitive, the Government has introduced in April 1992 an 'Open Sky Policy' for cargo. Under this policy, foreign airlines or association of exporters can bring any number of freighters to the country for upliftment of cargo. The Government has also permitted market forces to determine cargo traffic with IATA rates as the floor rates.

As on 31 May 2002, India has bilateral Air Services Agreements with 97 countries:

i. Air India owns a fleet of 23 aircraft consisting of six B747-400, two B747-300 (Combi), four B747-200, three A300B4 and eight A310-300.
ii. In addition, Air India has inducted five A310-300 aircraft on dry lease basis (two from Singapore Airlines, two from GECAS and one from ILFC) and has plans to induct three more A310-300 aircraft on dry lease basis by the year-end.
iii. As on 31st March 2002, the staff strength of Air India is 16,776.
iv. Air India operates to 35 stations (12 domestic and 23 international) with its own aircraft. Air-India also has cooperative arrangements such as CS/BSA/JV with foreign airlines, serving 20 international destinations (including 09 destinations also served by Air India with its own aircraft).
v. Air India carried 2.85 million passengers during the period April 2001 to February 2002.

Indian Airlines is the major domestic air carrier of the country. It operates to 63 domestic stations (including 2 seasonal stations, i.e., Jaisalmer and Puttaparthy) with its wholly owned subsidiary Alliance Air. Indian Airlines also operates to 16 international stations, viz., Bangkok, Singapore, Kuala Lumpur, Yangon, Kathmandu, Colombo, Dhaka, Male, Kuwait, Sharjah, Dubai, Fujairah, Ras-al-khaimah, Muscat, Doha and Bahrain. Indian Airlines has a fleet of 57 aircrafts: 7 A-300s, 36 A-320s, 11 B-737s and 3 Dornier-228s including aircraft taken on lease. All B-737s aircraft are being operated by Alliance Air.

Private Companies: In addition to these, five companies are providing services in India: out of these Jet Airways and Air Sahara are operating on domestic as well as international air-routes, while Air Deccan, Kingfisher and Spice-Jet are operating on domestic routes only.

Problems of Air Transport

i. Running in Loss: Both the Air India and Indian Airlines are incurring constant losses. Some better airlines like Singapore and Lufthansa have shown willingness to join with Air India.
ii. Strikes: Strikes have become regular feature in the air-transport industry. For example, the September/October 2009, strike f pilots created great inconvenience to the passengers and heavy losses to the Indian Airlines.
iii. Decline in Quality of Service: There has been a constant decline in the quality of air service offered by the Air India and the Indian Airlines.

iv. **High Aircraft-Man Ratio:** The airlines manpower base is one of the highest in the world. Its average is about 700 employees per aircraft as against an average of 225 employees internationally.

v. **Stiff Competition:** The airlines are facing a stiff competition from foreign airlines which are providing better and efficient service.

vi. **Old Aircrafts:** The aircrafts of the airlines are more than 20 years old. The airlines need huge amount of replacement of the old aircrafts.

vii. **Expensive Fares:** The airlines in India are still serving only the elite class. Their fares are beyond the reach of middle and lower-middle class.

viii. **Management and Political Interference:** The inefficient function of the management and political interference are bringing a bad name to the airlines. People prefer to travel by some other airlines.

Check Your Progress IV

Q.1 Explain how air transport is useful and what all problems are faced by it?

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15.5 CONCLUSION

In a country like India, the importance of transport is more because of its vastness as well as varied nature of geographical conditions. In India, it is also a source of national integration. The present Indian transport system comprises several modes including rail, road, coastal shipping, air transport, etc. Transport has recorded a substantial growth over the years both in terms of length and output of the system. But great work is still needed to be done. It may be ascertain from the description and analysis of the transport network of the country that there is an urgent need of coordination in the railways, roads, air and water transport. There are still several areas in the country which are not easily accessible. In fact, many villages of the country are not linked by all-weather roads. Moreover there is a stiff competition between the railways and the roads transport which exposes a faulty transport planning. Very little efforts have been made to develop water transport. Country has to spend huge sum to pay shipping freight. Air travel is costlier, and confined to big cities only. Above description emphasizes for chalking out a comprehensive transport planning policy for the country.

Transport Planning

A planned transport system can endeavor great results, which we essentially need for our transportation economy. The following attempts as described below, if taken together may improve the transport system of the country appreciably.

1. **Geographical Basis of Transport Planning:** Planning for transport should be based on geographical conditions of terrain, topography, slope and climate For example, roads and railways are a good means of transport in the plains, while in the hilly areas or the mountainous regions, roads and airlines/helicopters can be a good alternative to remove the inaccessibility.
2. **Comprehensive Transport Plan:** A comprehensive transport plan should be chalked out and prepared to promote integration among different modes of transportation. While railways should be developed for long distance bulk traffic, roads should be laid down complementary to former short range traffic of diverse origin and door-to-door service. Similarly, inland waterways should be used for transporting heavy and bulky goods. It may also be developed in those areas where road-rail transports are not developed.
3. **Single Broad Gauge in Railways:** The entire railway transport should be brought under Broad Gauge to avoid transport delay and bottlenecks.
4. **Widening of Roads:** The road transport needs greater planning for improving its efficiency and performance. Road network should be extended to inaccessible areas inhabited by tribals.
5. **Planning Based on Long-term Perspectives:** While preparing plans long-term perspectives should be kept in mind. While railways should be developed to reduce pressure on road transport air services may be augmented to lessen burden on rail routes. Inter-city transport should be rationalized on the basis of actual travel times. This needs introduction in railway tracks and high-speed trains.
6. **Train-plane Inter-modality:** There is a need of train-plane inter modality so as to install railway stations inside the passenger terminals at airports and make room for easy transfer of passengers and freight from plane and rail and vice-versa.
7. **Similar Tariff System:** Disparities in road management and taxation should be removed to introduce similar tariff and taxation system throughout the country.
8. **Water Transport:** Water transport development and its maintenance deserve more attention as it is the cheapest mode of transportation.
9. **Infrastructure:** The social amenities at the railway stations, bus-stands and air-ports need a substantial improvement. The existing infrastructure for the transport sector should be optimally utilized through better management.
10. **New Technology:** The new technological upgradation should be promoted and taken as a preferential base.
11. **Involvement of Private Sector:** For the generation of funds there should be more involvement of the private sectors in the transport industry which will altogether help in transport upgradation and improve the working of transport services.

15.6 SUMMARY

- Transport is a system in which passengers and goods are carried from one place to another.
- Transport is an important part of India's economy, as, transport routes function as the basic economic arteries of the nation.
- Transport has recorded a substantial growth over the years both in the spread of its network and in the output of its system and has come out as a mirror of economic development and material prosperity.
- The Ministry of Transport is responsible for the formation and implementation of policies and programmes for the development of various modes of transport except the railways and the civil aviation.
- About 70% of freight and 85% of traffic is carried by the roads.
- Various plans were formed for the development of the road transport, like the Nagpur Plan, etc.
- The Indian Railways has a modest beginning in 1853 when the journey of the first railway train commenced from Mumbai to Thane covering a distance of 34 km.
- A detailed railway development was chalked out under Lord Dalhouise to connect all major cities of the country and by 1871 the three presidency towns of Kolkata, Mumbai and Chennai were interlinked through railway.
- During the Post-Independence period, expansion in the route length, gauge conversion (from narrow/metre gauge to broad gauge), electrification of tracks, modernization of the system to improve the efficiency of operations, conversion of steam locomotives to diesel locomotive and electric traction, improvement of signaling and communication, improvement in passenger amenities and safety, self sufficiency in rolling stock, remove traffic bottleneck, better management of freight and passenger traffic, high priority to the development of freight terminals, introducing high speed passenger trains, use of computers in railway reservation and railway operation and expansion of railway traffic to remote and backward areas took place.
- Waterways are the oldest type of transport to be used and the cheapest. They were the chief mode of transportation before the advent of railways.
- Nearly 90% of India's trade volume (77% in terms of value) is moved by sea.
- Coastal Shipping involves movement of goods and passengers from one port to another port within a country.
- Coastal Shipping decongests the railways and roadways, is relatively pollution free, is less capital intensive, provides large employment, involves continuous vigilance of the coasts and promotes sea based industries such as fisheries and luxury tourism.
- Air transport in India made a beginning in 18 Feb, 1918 when Henry Piquet carried mail from Allahabad to Naini.

- Roads offer door to door service and their construction can be undertaken even in the areas of difficult terrain and steep slopes. The movement of goods is safer through road transport.
- The National Highways are the main roads meant for inter-state and strategic defense movements. They connect the state capitals, big cities, important ports, big railway junctions and link up with border roads.
- State Highways provide link to all major towns and cities of the state, state capitals and district headquarters.
- The maximum concentration of the Indian Railways is found at the Indo-Gigantic Plains followed by the Peninsular Plateau. The railways are practically absent from the Himalayan region.
- Inland waterways refer to using inland water bodies like rivers, canals, backwaters, creeks, etc for transporting goods and other people from one place to another.
- Considering the need to develop inland waterways and inland water transport to play its rightful role in the transport network of the country, the government had identified 10 important waterways for consideration to declare them as National Waterways.
- There are12 major and 185 minor ports in India.
- The 12 major ports carry about 75% of the total traffic.
- Air transport is the fastest mode of transport and plays a vital role at the times of emergency as well as in the event of natural or man-made disasters.

15.7 GLOSSARY

- **Cohesiveness:** A state of togetherness; working together
- **Freight:** Goods or items in transport
- **Envisaged:** Visualised
- **Gauge:** Distance between the inner faces of the pair of rails in the track is called Gauge
- **Hinterland:** The rural territory surrounding an urban area is called a hinterland
- **MNP:** Minimum Needs Programme
- **RLEGP:** Rural Landless Employment Guarantee Programme
- **JRY:** Jawahar Rojgar Yojana
- **CAD:** Command Area Development
- **NHDP:** National Highway Development Programme
- **NHAI:** National Highway Authority of India
- **CRF:** Central Road Fund
- **BOT:** Build Operate Transfer
- **Locomotive:** It is the power unit of a train which does not carry passengers or freight itself, but pulls the coaches or rail cars or wagons
- **Coaches:** A railroad car drawn by a locomotive
- **Wagons:** A freight car on a railway is called a wagon
- **Cargo:** Freight carried by ship or aircraft is known as cargo
- **Fleet Strength:** Total number of group of vessels of containers that can be kept in the area
- **Decongest:** To make free of congestion

- **Dredged Channel:** A channel made deeper of wider by unearthening
- **Islets:** Small islands
- **NACIL:** Nation Aviation Company of India Ltd.
- **PWD:** Public Works Department
- **BRO:** Border Roads Organisation
- **IWAI:** The Inland Waterways Authority of India
- **ESCAP:** Economic and Social Commission on Asia and Pacific
- **CIWTC:** The Central Inland Water Transport Corporation
- **EMU:** Electric Multiple Unit
- **DMU:** Diesel Multiple Unit
- **Remunerative:** Having financial compensation
- **Slurry:** Any flowable suspension of small particles in liquid
- **Consonance:** Applied harmony
- **Indispensible:** Not a subject to release or exemption

15.8 ANSWER TO CHECK YOUR PROGRESS

Check Your Progress I

Ans.1 Refer to section 15.3.2.
Ans.2 Refer to section 15.3.3.

Check Your Progress II

Ans.1 Refer to section 15.4.1, point no. 1.
Ans.2 Refer to section 15.4.1, point no. 2.

Check Your Progress III

Ans.1 Refer to section 15.4.2, point no. 1.
Ans.2 Refer to section 15.4.2, point no. 2.

Check Your Progress IV

Ans.1 Refer to section 15.4.3.

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15.11 TERMINAL QUESTIONS

Q.1 Discuss the different types of plans introduced for the development of road transport over the years after independence.
Q.2 Give a comparative study the rail and railway transport.
Q.3 Differentiate between the National Highways and State Highways. Also explain the National Highways and its various phases along with developmental statistics in the earlier years.
Q.4 How is Indian Railways distributed all over the country? Explain in detail.
Q.5 What is the significance of overseas or offshore transport in India? Also explain the role played by different ports in detail.
Q.6 What do you mean by Transport Planning.

UNIT 16 - TRADE

16.1 OBJECTIVES

After reading this unit you will be able:

- To have an in depth knowledge about what trade is.
- To get aware of its perspectives.
- To know its growing trends.
- To know its role in the G.D.P.
- To know it significance and its salient features.
- Major trading partners of the country.
- Major trading policies and their implementation.

16.2 INTRODUCTION

The exchange of goods or merchandise or their sale-purchase is known as trade, or we can say, ***a flow of commodities from producers to consumers is known as trade.*** It is an important tertiary sector of economy which is carried out at the local, national and international levels. Trade is an important activity bringing the development and prosperity to a country or region. It provides opportunity for the growth of the economy and its diversification. A favourable trade balance is an indication of a stable and developed economy while unfavouable trade balance exhibits the stage of developing economy. Similarly, the volume and value of trade show the potentiality of the growth while the direction denotes the level of economic relation and dependence between countries and regions. India's economy is undergoing rapid transformation with the beginning of the planning era. This trend is well marked in the pattern of its foreign trade.

Historical Perspective

Before Independence the pattern of India's foreign trade was colonial in nature. That was the time when the commodities were imposed only for domestic consumption. The country was the supplier of raw materials and food stuffs to industrialized countries, and was the importer of manufactured goods. It exported almost entirely agricultural raw materials. India's traditional exports included jute, cotton, tea, spices, hides, skins, oil-seeds, especially groundnut. All this discouraged industrialization at home. The balance of trade was favourable with higher value of exports (Table 16.1). Common-wealth countries accounted for 54% of total Indian export during the post-war period followed by U.K. (34%), Japan (9%) and the U.S.A. (8%). Similarly imports were restricted. U.K. was the main supplier contributing over 31% of total imports in 1938-39.

TABLE 16.1
India' foreign Trade (1938-39 to 1947-48)

Year	Exports	Imports	Trade Balance
1938-39	169	152	+17
1945-46	266	245	+21
1946-47	319	288	+31
1947-48	403	389	+14

With the Independence, the colonial pattern of trade witnessed change to suit the needs of a developing economy. For this the imports of machinery and equipment became essential to promote industrialization. Some raw material was also imported to feed indigenous industries and also to fill up the deficit created by Partition. Foodgrains was another item of import to feed the growing population and maintain uniform price level. By 1947-48, foodgrain imports touched a high mark of 3 million tones. As economic development proceeded, the value of imports during the First Plan period was ₹622 crores. Thus the average annual trade deficit was ₹108 crores.

Growth-trends in India's Foreign Trade

Table 16.2 shows the trends of foreign trade in India. There has been a rapid increase in the imports between 1950-51 and 1960-61. India had to import machinery and other item for industrial progress during this period. The value of exports increased considerably between 1960-61 and 1970-71 reducing the trade deficit from ₹480 crores in 1960-61 to a mere ₹99 crores in 1970-71. After that both imports and exports have been increasing but imports have always been outpacing the exports. During 2008-09, the value of India's external trade reached 15,66,897 crores but the deficit also hiked at 1,73,901 crores. The rapid increase in India's overseas trade has been largely due to growth and diversification of India's economy in the post-Independence era. However, inflationary trends and devaluation of the Indian currency have also contributed to increase in the volume of India's international trade.

TABLE 16.2

Growing-Trends of Foreign Trade *(in Rupees Crore)*

Year	Exports	Imports	Total Value of Trade	Balance of Trade
1950-51	608	606	1,214	-2
1960-61	1,122	642	1,764	-480
1970-71	1,634	1,535	3,169	-99
1980-81	12,549	6,710	19,259	-5,839
1990-91	43,193	32,558	75,759	-10,635
2000-01	2,30,873	2,03,571	4,34,444	-27,302
2001-02	2,45,200	2,09,018	4,54,218	-36,182
Year	Exports	Imports	Total Value of Trade	Balance of Trade
2002-03	2,97,206	2,55,137	5,52,343	-42,069
2003-04	3,53,976	2,91,584	6,45,558	-62,394
2005-06	4,56,483	6,35,013	10,91,496	-178,530
2006-07	5,71,779	8,40,506	14,12,286	-268,727
2007-08	6,40,172	9,64,850	16,05,022	-324,678
2008-09	6,96,498	8,70,399	15,66,897	-173,901
2010-11	11,42,922	16,83,467	28,26,389	-540,545
2011-12	14,65,959	23,45,463	38,11,422	-879,504

Source: *(i)* Directorate General of Commercial Intelligence and Statistics (DGCI &S), Kolkata

(ii) India 2010

(iii) Economic Survey, 2012-2013

Balance of Trade and Balance of payment

All the countries of the world are importers as well as exporters of certain goods and services. The ***difference between the value of nation's exports and imports of all goods and services over a given period of time is called balance of trade***. The exports and imports of a country should be roughly equal in value, since the foreign exchange earned by exports is necessary to finance imports, but such a balance is rarely achieved. This is partly because trade passes through the hands of many different companies working independently, and thus an exact balance can never be reached, but it is also due to the fluctuations in markets leading to changes in import and export values over a period of years. If the value of total export is more than the value of the total import in the country, it is said to have a *favourable or positive balance of trade.* A country with a positive balance of trade is known as *trade creditor country.* If the value of total import of a country exceeds the value of total export, then the country is said to have an *adverse or negative balance of trade.* A country with a negative balance of trade is known as *trade debtor country*. Table 16.2 shows that India's balance of trade unfavourable. This is because of the growing demands and growing economy.

The balance of trade only takes in account of visible or the value of actual goods transferred from one country to another. But there are many other ways in which foreign exchange can be earned or spent. These are collectively called *invisible trade* which accounts for a quarter of all transactions with foreign countries can be worked out. This is called *balance of payment.*

Transactions which bring money into the country are called invisible exports and can be of several kinds:

1. **Payment for financial services** including insurance, banking, brokage, and other services carried out on behalf of foreigners.
2. **Payment of transport services** such as shipping or air transport of passengers or freight. Britain and certain other European countries have large invisible earnings in these two fields because of their importance in trade and financial dealings.
3. **Expenditure by foreign tourists.** This is often an extremely important source of foreign exchange.
4. **Interest and dividends on foreign investments.** India is earning a substantial amount in the form of interest and profit on foreign investment, annually.
5. **Remittance from emigrants.** Many emigrants send money to their families and thus countries like India which have supplied large number of emigrants, may receive considerable foreign exchange in this way.
6. **Loans and aids** from foreign countries or international organizations. Many underdeveloped countries receive aid or loans to finance development, while other countries may obtain loan to cover balance of payments deficits.

Transactions which take money out of the country are called *invisible imports*. Payment for services, payment of interest on investments, remittances of immigrants, repayment and interest of foreign loans, or deficit on tourism, may all be greater than invisible exports in the same fields.

When these invisibles, both exports and imports, are brought into account, many countries which would have an unfavourable balance of trade are found to have a more favourable balance of payments. It is much more important that total payments and receipts rather than the visible trade, should be well balanced as long-term loans may have to be obtained, which may be reduced; or overseas assets may be sold so that longer-term invisible exports are reduced; or currency values may be changed by devaluation or revaluation to alter the relative value of exports and imports thus balance total transactions more nearly.

All these measures may have detrimental effects on the economy in the long term but have to be resorted to by any countries. Other ways of balancing transactions are to increase visible or invisible exports, or to apply trading restrictions in order to cut down on imports. Countries may also reduce the mobility, restrict tourism, or confiscate foreign property to reduce the outflow of money.

Since the economic reform of 1991, the Balance of Payment (BoP) of India is continuously showing an upward trend. The growing strength of India's Balance of Payment, observed in the post reform period since the crisis of 1991 continued in 2005-06. This growing strength was in spite of widening of the current account deficit. With a burgeoning trade deficit, primarily on account of rising oil prices, the reversal from current account surplus witnessed between 2001-02 and 2003-04 to a current account deficit in 2004-05 appears to be continuing into 2006-07.

16.3 TYPES AND PATTERN OF TRADE IN INDIA

Types of Trade in India

Trade is of three types:

i. Local Trade
ii. Regional Trade
iii. Foreign Trade or Overseas Trade

Local trade is the trade which remains confined to some village, city or a town. Local trade mainly takes place through roads. It is the most minimal level of trade that occurs within a country. Regional trade is the trade which happens to be in between two or more regions. This trade can happen through roadways, railways and inland waterways. It is a sub-level trade of a country. Both Local Trade and Regional Trade are the examples of *Internal Trade.* When one country exchanges goods or merchandise with other country, it is known as overseas trade or foreign trade. Foreign Trades are *International Trade.* Advancement of international trade of a country leads to its economic prosperity. It is an important both as a source of import and as an outlet for exports. "International Trade of a country is rightly known as its *Economic Barometer*." The overseas trade depends upon several factors. Some important factors are discussed as under:

1. **Difference in Natural Resources:** The fundamental base of international trade is the natural resources of different countries. There are variation in relief, structure, geology, climate and soil from one country to the other. These variations lead to variation in natural resources. Some countries produce certain things more than their requirement and export them while some other countries may be lacking them and import those commodities.
2. **Marketable Surplus:** Some countries are capable of producing certain things more than their internal consumption. In other words, these countries have marketable surplus which they trade with those countries having demand for such products. For example, tea from India, coffee from Brazil, jute from Bangladesh, paper and pulp from Norway and Sweden, wood from Australia and petroleum from the Middle East are available for export. Advanced countries like United States of America, United Kingdom, Russia, Germany and Japan export finished goods.
3. **Scarcity of Goods:** There is not even a single country in the world which does not have scarcity of one commodity or the other. Japan and Britain do not have raw materials. Hence, these countries have to import raw materials from a large number of countries. Thus, scarcity of goods also encourages international trade. Japan depends heavily on Iron ore supply from India.
4. **Transport and Communication:** Trade involves exchange of goods which requires proper arrangement for transportation and communication, Land, water and air transport have helped international trade to a great extent. Heavy commodities like coal and iron ore as well as light and perishable commodities like milk and milk products, meat, fruits and vegetables, etc.. can be sent to all parts of the world by efficient means of transport. Countries with poor transport system have not been able to develop international trade. Realizing the significant role played by transport system for promoting trade, India has launched an ambitious programme to improve

surface transport. In addition, certain ports like Jawaharlal Nehru, Kandla, Tuticorin, Ennore, Paradwip, Haldia, etc. have either been developed or improved.

5. **Disparities in Economic Growth:** There are disparities in the economic growth in different parts of the world. Some countries are still engaged in primary activities such as agriculture, mining, etc. These countries mainly export minerals and agricultural raw materials. India's export consisted of raw materials for a pretty long time even after Independence. It is only recently that India has been able to diversify its export as a result of diversification of its economic activity.
6. **Trade Policy:** Free trade policy encourages international trade whereas restrictions of the trade discourage it. For example, India has restricted the export of oil-seeds to meet the domestic demand. Similarly, India has imposed heavy import duty on certain finished goods to encourage industries at home.
7. **War and Peace:** Peace is the most important condition for the development of international trade. International trade gets disrupted during the time of war.
8. **Political Relations:** Countries having cordial political relations have better exchange of goods which encourages international trade. For example, India and Russia have good political relations and trade between these two countries has increased. On the other hand, U.S.A. and Russia have strained political relations and trade between these two big countries is at low level. India's trade with the neighbouring Pakistan remained at low level ever since that country came into being in 1947 primarily due to strained political relations between the two countries. However, improved political relations between the two countries in the recent past have shown positive results. Exports to Pakistan had surged by almost three and a half times in April-October, 2004.

16.3.1 Composition of Exports

Britishers strongly believed that India was a country well suited to supply raw materials and other primary goods and a good market place for British manufacturers. So at the time of our Independence our exports were predominantly of primary goods and imports were of manufacturers. All the time of Independence agricultural commodities and light manufactured consumer goods dominated India's export basket. During the post Independence period India's composition of exports changed.

Now exports of India are broadly classified into following four categories:

i. Agricultural and Allied Products
ii. Ores and Minerals
iii. Manufactured Items
iv. Fuel and Lubricants

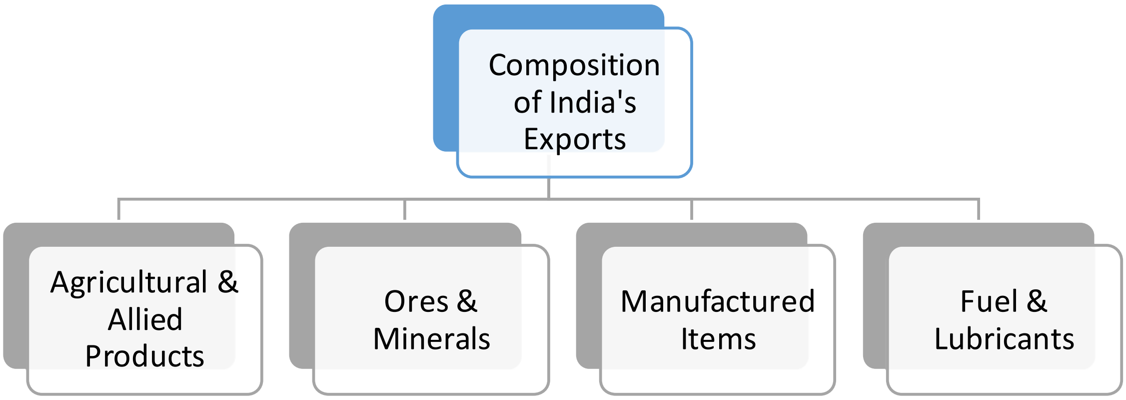


Table 16.3 shows composition of India's export from 1990-91 to 2005-06.

TABLE 16.3
Composition of India's Exports

Commodity Group	(Percentage Share)	
	1990-91	2005-06
Agricultural & Allied Products	19.5	10.2
Ores and Minerals	4.4	5.2
Manufactured Goods	73.0	72.0
Crude & Petroleum Product	2.9	11.5
Other Unclassified Items	0.2	1.1
TOTAL	100.0	100.0

Source: Economic Survey 2006-07

The composition of India's export can be summarized as follows:

1. Agricultural and Allied Products

The share of agriculture items in the total exports of India has declined between 1990-91 to 2005-06. The share of agriculture exports was 19.5% in 1990-91. It came down to about 10.2% in 2005-06. The top items of agriculture include:

a) Fish & Fish Products

b) Rice

c) Oil cakes

d) Fruits and Vegetables

The most important export item in the group over the period 1991-92 to 2005-06 has been “Fish and Fish Preparations”. From $585 million in 1991-92 export earnings export earnings from “Fish and Fish Preparations” rose to $1,589 million in 2005-06. However, in percentage terms, their share slightly fell from 3.3% in 1991-92 to 1.5% in 2005-06.

As far as agricultural exports are concerned, a significant development during the period since 1991 has been the considerable exports of rice in certain year. In fact, exports of rice were as high as $1,366 million in 1995-96 which was 4.3% of the total export earning in that year. In 2005-06, the exports of rice were worth $1,405 million which was 1.4 % of the total export earning in that year.

2. Ores and Minerals

The overall increase in this section is very slow and gradual. In percentage terms, the export performance of ores and minerals has increased from 4.4% in 1990-91 to 5.2% in 2005-06. A major share of ores and minerals export comes from the export of iron ore. It is the single largest metal exported by India. High quality magnetite and hematite ores are found in large quantities which are in great demand in the industrial countries. Japan is the largest buyer of our iron ore, purchasing more than two-thirds of our exports.

India also exports mica. In fact, India holds monopoly in the production of mica and is the largest exporter of mica in the world. In 2003-04, India exported mica valued at ₹106 crores.

3. Manufactured Goods

The share of manufactured items in the total export earning of India is on the increase. In 1990-91, the share of manufactured items in the total export earning was about 73% of the total export earnings. In 2005-06, the share of manufactured items in total export remained stagnant at 72%.

The top manufactured export items include:

a) Engineering Goods

b) Gems and Jewelry

c) Chemical and Allied Products, and

d) Readymade Garments

The export of engineering goods increased from \$2,234 million in 1991-92 to \$21,315 million in 2005-06. In percentage terms, the share of engineering goods rose from 12.5% in 1991-92 to 20.7% in 2005-06. Over the period 1991-92 to 2002-03, engineering goods occupied the second position in India's export earnings after gems and jewelry. However, thereafter engineering good have occupied the first place. In 2005-06, they contributed 20.77% (i.e. one-fifth) of total export earnings.

For most of the period since 1991, largest export earnings came from the exports of gems and jewelry. The share of gems and jewelry in India's total export was 15.3% in 1991-92 and 15.1% in 2005-06. However, gems and jewelry industry is a highly import intensive industry requiring large amount of import of pearls and precious stones.

Exports of chemicals and allied products rose significantly from \$1,583 million in 2005-06. In percentage term, their share stood at 11.6% in 2005-06 and they occupied the third place in India's export earnings in this year.

In percentage terms, readymade garments maintained an almost constant share throughout the period since 1991. They contributed 12.3% of export earnings in 1991-92 and 12.5% of export earnings in 2000-01. In 2003-04, their share fell to 9.8% and 9n 2005-06 to 8.3%.

4. Mineral Fuel and Lubricants

There has been an improvement in the export of mineral fuels and lubricants both in terms of value and in terms of percentage. In percentage terms, its share has increased from less than 2.9% in 1990-91 to 11.5% in 2005-06.

The composition of exports explains us two major facts:

- Some of Indian exports have moved upwards in value addition chain whereby instead of exporting raw materials, the country has switched over to export the processed goods.
- There are significant compositional shift within the major manufactured product groups such as engineering goods, chemical and allied products, etc.

Causes of Sluggish Export

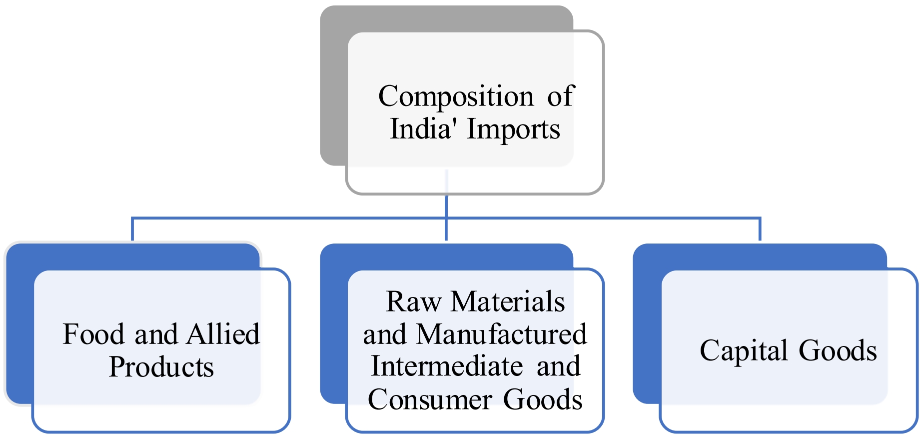
There are a number of external as well as internal factors responsible for the sluggish growth of exports. These may include recessions in the world trade, protectionist policies like quota restrictions, quality control, stiff competition in the world market, growing indigenous demand of raw materials in industries, falling output in view of industrial unrest, shortage of power and raw materials, growing cost of production, transport bottlenecks and lack of export promotion schemes by the Government, growth of regional trade organizations, defective policies of the WTO and hostilities like the Gulf War also had adverse impact over the exports.

16.3.2 Composition of Imports

Like exports, Indian imports have also increased manifold. India used to import mainly the manufactured goods before Independence, about a rough 70%. But after that, the import of manufactured goods decreased gradually and our imports saw a large variety of goods.

Now, the imports of India are broadly classified into three categories:

i. Food and allied products
ii. Raw materials and manufactured intermediate and consumer goods
iii. Capital goods



The Table 16.4 shows the percentage of changes in the import composition of major products between the years 1990-91 to 2005-06.

TABLE 16.4
Composition of India's Imports *(percent)*

Year	1990-91	2005-06
Petroleum Products	24.9	30.9
Capital Goods	24.1	22.3
Pearls and Precious Stones	8.7	6.4
Iron and Steel	5.0	3.1
Fertilizers	4.1	1.5
Edible Oils	0.8	1.4
Other	32.4	34.4
Total	100	100

Source: Statistical Outline of India 2006-07

The demand for petroleum and petroleum products increased tremendously which made it necessary to import large quantities of these items. The other major items of import are machinery, tools, cereals, fertilizers, edible oils, iron and steel, pearls and precious stones, etc. Like exports, India's imports are also trending to become broad based. The growth in imports has been contributed by the robust increase in imports of the three classified groups of the imports. The above Table 16.4 clearly shows the different products and their subsequent increase and decrease in imports over the years.

The percentage of petroleum products have increased from 24.9 in 1990-91 to 30.9 in 2005-06. Other than them India have got hiked up imports of edible oils from 0.8% in 1990-91 to 1.4 in 2005-06, whereas there is a subsequent fall in the import quantity percentage of other items.

16.3.3 Direction of India's Foreign Trade

Direction of foreign trade means those regions and countries with which India has trade relation. Although we have trade contacts with almost all the countries of the world, yet there are certain countries which are more important than others.

Britain was our most important trade partner before Independence. This was the result of the policy of exploitation of India by the British rulers. They exploited the natural resources of India to get the raw materials and created a vast market here for their manufactured goods. But the situation has drastically changed since Independence. Direction of India's exports and imports from different regions/sub-regions is outlined in Table 16.5.

TABLE 16.5

Direction of India's Foreign Trade *(percentage share)*

Country/Region	Exports			Imports		
	2001-02	*2002-03*	*2003-04*	*2001-02*	*2002-03*	*2003-04*
U.S.A.	19.4	20.7	18.0	6.1	7.2	6.4
U.K.	4.9	4.7	4.7	5.0	4.5	4.1
Germany	4.1	4.0	4.0	3.9	3.9	3.7
France	2.2	2.0	2.0	1.6	1.8	1.4
Belgium	3.2	3.2	2.8	5.4	6.0	5.1
Japan	3.4	3.5	2.7	4.2	3.0	3.4
OPEC Countries	12.0	13.1	15.0	5.8	5.7	7.2
Eastern Europe	2.3	1.8	1.8	1.4	1.3	1.6
Asia	22.4	25.3	27.6	15.3	16.0	1.3
Africa	3.7	3.2	3.3	1.9	1.8	1.3
Latin America and Caribbean	1.9	2.5	1.7	2.0	1.8	1.5

Source: The Economic Survey, 2004-05

It is evident from the table that the U.S.A., Japan, Germany, U.K. and the OPEC Countries are our major trading partners. Our exports to the U.S.A., Germany, U.K. and the OPEC Countries are more than the imports from these countries. India is exporting manufactured goods and technology to some of the least developed countries in Africa and Asia.

Although our exports to OECD Countries declined marginally in 2002-03, the share of exports to European Union was broadly maintained. Exports to all the major countries in the EU region (France, Germany, Italy, the Netherlands and the U.K.) registered high growth. Among the developing countries, exports to Asia and Africa region grew strongly by 32.2% and 23.2% respectively, resulting in increased shares of exports to these regions. Overall exports to Latin America region remained subdued as exports to Brazil and Mexico major destinations for India, declined. Exports to Eastern Europe witnessed a turnaround, mainly due to the higher exports to Hungry and Romania. Higher international crude petroleum prices resulted in the rise in the share of OPEC region in India's imports. Exports to ASEAN Countries maintained their rising profile with robust growth of 26.1% in 2003-04. Imports from ASEAN Countries also grew by 44.3%, taking the two-way trade to 9.3% of India's total external trade in 2003-04.This is mainly due to rising trends of trade with Indonesia, Malaysia, Thailand and Singapore. Trade with China, Japan and Korea is also on the rise. In fact ASEAN + 3 block (China, Japan and Korea) countries have emerged as India's dominant trading partners, accounting for 19.9% of India's total merchandise trade, comparing with a trade share of 19.0% for EU and 12.9% for North America in 2003-04. China has emerged as India's third highest trading partner, after U.S.A. and U.A.E., overtaking U.K. and Belgium in 2003-04. If China and Hong Kong are taken together, then these two accounts for 8.4% of India's trade, increased by 49.6% in 2003-04, imports from China were higher by 45.2% in 2003-04. China's share in India's trade had rising from 2.5% in 2000-01 to 5.0% in 2002-03 (Table 16.6). The increase in exports to China was accounted for mainly by iron and steel, iron ore, plastic, machinery and instruments. Higher imports from China were because of electronic goods, chemicals, medicines, coal, coke, silk yarn and fabrics. Another country whose share in India's trade has increased significantly in 2003-04 is United Arab Emirates (U.A.E.) which is now the second largest trading partner of India after the U.S.A. (Table 16.6)

TABLE 16.6
India's Major Trading Partners, 2000-04
Percentage share in total trade (exports + imports)

S. No.	Country	2000-01	2001-02	2002-03	2003-04
1.	U.S.A.	13.0	12.2	13.4	11.6
2.	U.K.	5.7	5.0	4.6	4.4
3.	Belgium	4.6	4.4	4.7	4.1
4.	Germany	3.9	4.0	4.0	3.9
5.	Japan	3.8	3.8	3.2	3.1
6.	Switzerland	3.8	3.4	2.4	2.7
7.	Hong Kong	3.7	3.2	3.1	3.4
8.	U.A.E.	3.4	3.6	3.8	5.1
9.	China	2.5	3.1	4.2	5.0
10.	Singapore	2.5	2.4	2.5	3.0
11.	Malaysia	1.9	2.0	1.9	2.1

Source: The Economic Survey, 2004-05.

16.4 SALIENT FEATURES OF TRADE

1. **Unavouarble Balance of Trade:** India is importing enormous quantity of crude-oil, petroleum, petroleum products, precious stones, gold, silver, copper, machinery, cashewnut, fertilizers and mainly exporting agro-based products, engineered goods, commercial automobiles, etc. The balance of trade and balance of payment are still

unfavourable as import exceeds the export. India's balance of payment in the post reform period (1991) is growing from strength to strength.

2. **More Export of Manufactured Goods:** India is exporting nearly 8000 commodities, and the number of exports of finished commodities is increasing appreciably.
3. **Worldwide Trade:** India exports its products to 200 countries and imports from 150 countries.
4. **Change in Import:** Earlier India used to import almost all types of machinery, precision instruments, surgical equipments, automobiles and electrical goods. Now India is exporting all sorts of machinery including vehicles, electronic and chemical goods and importing raw materials like diamonds, precious stones, gold, cashew-nuts, jute, mineral-ores and raw and semi processed raw material.
5. **Maritime Trade:** About 96% of our foreign trade is carried through sea routes. Trade through land routes is limited either because of the physical barriers of Himalayas or the less friendly relations with the neighbours.
6. **Trade through Selected Ports:** India has only 12 major international sea ports which handle about 92% of foreign trade. The remaining sea ports handle insignificant amount of the foreign trade.
7. **Insignificant Position in the International Trade:** India has almost 17% of the total population of the world but unfortunately, its share in the International trade is less than 1%.
8. **State Trading:** Over 95% of the overseas trade is done in public sector by the state agencies. There is insignificant trade done by the private undertakings.
9. **Increasing Import of Raw Material:** India is importing cashew-nut, cotton, gems, jute, mineral ores, pearls, precious stones and semi-precious stones and raw silk.
10. **Increasing Import of Capital Goods:** Goods like manufactures of metals, electrical and non-electrical machinery, transport equipments, chemicals and new technology are being increasingly imported.
11. **Numerous Bilateral Trade Agreements:** India has entered into trade agreements with a number of countries for the diversification of its trade. Trade agreements have been concluded with countries like Afghanistan, Czech, Finland, Egypt, Ghana, Iraq, Iran, Japan, Jordan, Hungary, Kenya, Mozambique, Liberia, Morocco, Nepal, Russia, Slovak,

Tunisia, Uganda, Yugoslavia, Myanmar, Zimbabwe, etc. The regional bilateral initiatives include agreements with European Commission, Indo-US Commercial Alliance, SAARC, SAPTA, etc. Recently concluded GATT has given new opportunity to India to have free access to the international market and improve its trade.

General Agreement of Tariff and Trade (GATT)

The General Agreement of Tariff and Trade (GATT) was established in Geneva to pursue the objective of free trade in order to encourage growth and development amongst all member countries of the world. The main objective of the GATT was to ensure competition in commodity trade through the removal and reduction of trade barriers. The first seven rounds of negotiation conducted under GATT were aimed at stimulating international trade through reduction in tariff barriers and also by reduction in non-tariff restricts on imports imposed by the member countries.

India's Trade policy has dual objectives of promoting exports and regulating the imports through import substitution. Since 1992, the trade policy is market oriented, liberal and global.

16.4.1 India's Trade Policy

India's exports and imports have been guided, if at all, under different relevant acts and rules and regulations. It was for the first time in 1988, that an Export Import Policy- that too for three years- was promulgated. It had three fold objectives:

- To stimulate industrial growth y providing easy access to essential imported capital goods, raw materials, and components to industry.
- To sustain the movement towards modernization and technological upgradation.
- To make the industry progressively competitive internationally.

The enforcement of the policy, however, has been sectoral and tentative, and it has been more or less like a declaration of intentions and objectives rather than a policy strategy of action. It is also not clear why the formulation of a national trade policy and its declaration had to wait until 2004. A detailed knowledge about the same is given under:

1. Export-Import (Exim) Policy, 1985

The policy was announced on a three-tier basis. The main objective of this policy was to curb import and promote export. The salient features of the Exim Policy were:

I. Import of as any as 53 items was decanalised.
II. As many as 20 items on OGL under the import policy-areas o benefit included leather, automobiles, electronics, jute garments and oil field services.
III. A new scheme-the “Import-Export Pass Book Scheme” was introduced with effect from October 1, 1985 to eliminate possible delays in acquiring licenses under duty exemption scheme.
IV. Import of 67 items was transferred to limited permissible list.
V. A two-tier policy was adopted for computer/computer-based systems. Those costing below ₹16 lakhs were allowed for import by all persons for their own use.

2. Export-Import (Exim) Policy, 1992

This policy was introduced on March 30, 1992 for the period of 1992-97. It took some revolutionary steps for increasing the exports besides liberalizing the import procedures of capital goods and other important imports. Its salient features are as follows:

I. A negative list was prepared for imports; all other commodities were made free for import.
II. A negative list was also prepared for the items of export; rests of the products were free for export.
III. Export Promotion Capital Goods (EPCG) Scheme was further liberalized.
IV. Newsprint, natural rubber non-ferrous metal, raw materials for fertilizer production all were decanalised.
V. Exim Policy was further liberalized during the English Plan Period. A Liberal Exchange Rate Management System (LERM) was introduced in 1992-93. Similarly, a negative list was pruned and the tariff rate was reduced to 45%.

3. Export-Import (Exim) Policy, 1997

The new Exim Policy was announced on 31st March 1997 for Ninth Plan period (1997-2002). Following were the important elements of the Exim Policy:

a) 542 items of the negative list were shifted to OGL and special import license list.
b) Sixty items were shifted to OGL from special import license list.

c) The Export Promotion Capital Goods (EPCG) Scheme continued and import of second hand capital goods was allowed with certain restrictions.
d) A new duty authorization scheme was introduced. It consists of duty free license and duty-entitlement pass-book.
e) The scope for deemed export was widened by according certain categories of supply of goods manufactured in India the 'deemed export' status. Such exports got benefit of:
    i. Special imprest license/ advance intermediate license
    ii. Deemed exports drawback scheme
    iii. Refund of terminal excise duty, and
    iv. Special import license at the rate of 6% of f.o.r. value.

4. Export-Import (Exim) Policy, 2002-07

The new Exim Policy for 2002-07, unveiled on March 31, 2002, is aimed at increasing India's share of global merchandise trade to 1%. It included a comprehensive package for the development of Special Economic Zones (SEZ), deregulation of agriculture sector to encourage higher export of farm products, setting up of 32 Agri Export Zones, dereservation from small scale industry for over 50 items, promoting value added exports in the garment sector, providing a strategic package for status holders, abolition of DEEC Book and withdrawal of Annual Advance License, giving package of incentive, including exemption from maintaining the average export obligation under EPCG Scheme, reducing transaction costs covering Director General of Foreign Trade, customs and bank, and setting up of "Business Centre" in Indian missions abroad for visiting Indian exporters and businessmen. The basic objective of the policy is to usher an environment free of restrictions and controls.

5. Foreign Trade Policy 2004-09

To make India a major player in world trade, a comprehensive view is necessary. While increase in exports is of vital importance, we have also facilitated those imports which are required to stimulate our economy. Thus, independent of the annual Exim Policy, it is necessary to take an overall view of India's foreign trade. This is the context of the new Foreign Trade Policy.

The objectives of the new Policy are:

1. To double our percentage share of global merchandise share within the next five years.
2. To act as an effective instrument of economic growth by giving a thrust to the employment generation.

   These objectives are proposed to be achieved by adopting the following strategies:

   a) Unshackling of control and enabling the innate entrepreneurship of our businessmen, industrialists and traders.
   b) Simplifying procedures and bringing down transaction costs.
   c) Neutralization incidence of all levies and duties on inputs used in export products based on the fundamental principle that duties and levies should not be exported.
   d) Facilitating development of India as a global hub for manufacturing trading and servicing.
   e) Identifying and nurturing special focus areas which would generate employment opportunities particularly in semi urban and rural areas and developing a series of 'initiatives' for each of these.
   f) Facilitating technological and infrastructural upgradation of all the sectors of the Indian economy, especially through import of capital goods and equipments, thereby increasing value addition and productivity while attaining internationally accepted standards of quality.
   g) Avoiding inverted duty structures and ensuring that our domestic sectors are not disadvantaged in the Free Trade Agreements/ Preferential Trade Agreements that we enter into in order to enhance our exports.
   h) Upgrading our infrastructural network, both physical and virtual, related to the entire foreign trade chain, to international standard.
   i) Revitalizing the Board of Trade by redefining its role, giving it due recognition and inducting experts on Trade Policy.
   j) Activating our Embassies as key players in our export strategy and linking our Commercial Wings abroad through an electronic platform for real time trade intelligence.

6. Foreign Trade Policy 2009-14

The year 2009 witnessed one of the worst global recessions in the post war period. Countries across the world were affected to varying degree and all major economic indicators of industrial production, trade, capital flows, employment, per capita investment and consumption were hit. It was in this background that the Trade Policy for 2009-14 period was drawn up. Following have been the key goals of this new trade policy of India:

I. Short term objective of this policy was to stop and reverse the declining trend of exports and to provide additional support to sectors hit badly by recession in the developed world.
II. Policy aimed at achieving an annual export growth of 15% with an annual export target of $200 billion by March 2011.
III. The Commerce Ministry hoped that the country would return to a high export growth path of 25% per annum and exports of goods and services would double by 2014.
IV. The long term policy objective of the policy is to double India's share in global trade by 2020 from 1.64% in 2008.

In order to achieve these goals, the Government decided to adopt a mix of policy measures such as:

a. Fiscal incentives, institutional changes, procedural rationalization, enhanced market access and diversification of export markets.
b. Improvement in infrastructure related to exports; bringing own transaction costs, and providing full refund of all indirect taxes and levies.

Following have been the salient features of Foreign Trade Policy 2009-14:

i. Special thrust to be provided to employment incentive sectors that have witnessed job losses in the wake of recession, especially in the fields of textile, leather, handicrafts, etc..
ii. **Support for market and product diversification:** 26 new markets were added in Focus Market Scheme (FMS) out of which 16 are in Latin America and 10 in Asia-Oceania. The Market Linked Focus Product Scheme (MLFPS) has been extended to pharmaceutical, synthetic fabric; value added rubber, plastic, textile, glass, iron and steel and aluminium products.

iii. Government wanted to provide a stable policy and environment conducive for foreign trade and accordingly it was decided to continue with the DEPB (Duty Entitlement Pass-Book Scheme) up to December 2010.
iv. Enhanced insurance coverage and exposure for export through Export Credit Guarantee Corporation (ECGC).
v. Special focus on the new emerging markets to make Indian exports more competitive.
vi. Additional resources have been made available under Market Development Assistance Scheme (MDAS) and Market Access Initiative Scheme (MIAS).
vii. The new policy also seeks to promote Brand India with six or more 'Made in India' shows across the world every year.
viii. Focus is on technology, upgradation and zero duty for engineering, electoral products, basic chemicals, plastics, handicraft and leather.
ix. Special incentives for the marine sector, gems and jewelry, tea and leather.
x. Thrust for value added manufacturing.
xi. Simplification of procedures and reduction in transaction cost to facilitate duty free import of samples by exporters.
xii. In order to reduce the transaction cost and institutional bottle-necks, e-trade projects are implemented in a time bound manner to bring all stake holders on a common platform. An Inter-Ministral Committee has been established to serve as a single window mechanism for resolution of trade related grievances.

7. Export Processing Zones (EPZs) and Special Economic Zones (SEZs)

India recognized the effectiveness of the Export Processing Zones (EPZs) model in promoting exports quite early and was the first in Asia to set up Export Processing Zones (EPZs) for promoting exports. The Government of India created seven Export Processing Zones, the first one being at Kandla in 1965. The zones and their headquarters are as under:

i. Chennai (Tamil Nadu)
ii. Falta (West Bengal)
iii. Kandla (Gujarat)
iv. Kochi (Kerala)

v. Noida (Uttar Pradesh)

vi. Santa Cruz (Maharashtra)

vii. Vishakhapatnam (Andhra Pradesh)

Each zone provides the basic infrastructural facilities in addition to whole range of fiscal incentives. Customs clearance facilities are offered within the zones. However, EPZs were not able to emerge as effective instruments for export promotion on account of multiplicity of controls and clearances, absence of world class infrastructure, and an unstable fiscal regime.

Since EPZs could not deliver desired benefits the policy was modified to create Special Economic Zones (SEZs). With the objective of overcoming the multiplicity of controls and clearances; absence of world-class infrastructure; and unstable fiscal regime to attract larger foreign investments in India, the Government formulated this policy of Special Economic Zones (SEZs) in April 2000. The SEZs function from November 1, 2000 to February 9, 2006 under the provisions of the Foreign Trade Policy and fiscal incentives were made effective though the provisions of relevant statutes. The SEZ Act 2005 came into effect on February 10, 2006. The Act provides for simplification of procedures and for single window clearance of matters relating to Central as well a State Governments. The SEZ Rules provide for different minimum land requirements for different classes of SEZs.

These are the following objectives of SEZs:

I. To overcome the shortcomings experienced on account of the multiplicity of control and clearances.

II. of FDI. To overcome the absence of world class infrastructure to attract larger amounts

III. To generate additional economic activities.

IV. To promote exports of goods and services.

V. To promote investment from domestic as well as foreign sources.

VI. To create additional employment opportunities.

In addition to seven Central Government SEZs and 12 State/Private-sector SEZs set up prior to the enactment of the SEZ Act 2005, formal approval has been granted to more than 580 SEZs out of which 380 SEZs have been notified. The performance of SEZs has been reasonably good despite criticism from various sources which are evident from the share of these special zones in the total value of national exports.

TABLE 16.7
Share of SEZs in Total Exports of India

Year	Total Export Value *(₹ Crores)*	Share of SEZs in Total Value of Exports *(percent)*
2003-04	13,845	4.7
2004-05	18,314	4.9
2005-06	22,840	5.0
2006-07	34,615	6.1
2007-08	66,638	10.2
2008-09	99,689	11.9
2009-10	2,20,711	26.1
2010-11	3,15,867	29.7

Initially some scholars and policy formulators had apprehensions of misuse of the scheme and relocation of existing industries into SEZs. Also there were apprehensions that good cultivable land will be taken over for establishing SEZs. But these fears have been proved wrong. The Government gives priority to barren and waste land and single crop cultivation area in the land acquisition policy. Not more than 10% of the total area of a SEZ can be 2 hectares of crop area. The land requirement for Multiproduct SEZs is 1000 hectares or more, for Service SEZs, it is 100 hectares or more, and for Gems and Jewelry, IT, Biotech SEZs it is 10 hectares or more. Hence not all SEZs are likely to acquire large area and relocation of existing industries in the SEZs is not very likely.

8. Export Promotion Industrial Parks (EPIP)

It is a centrally sponsored scheme introduced in August 1994, to involve the State Governments in the creation of infrastructural facilities for export-oriented production. It provides for 75% of the capital expenditure towards creation of infrastructural facilities limited to ₹10 crore grant to the State Government. So far 25 such proposals from the states have been approved by the Central Government.

16.5 CONCLUSION

India has remarkably transformed from what it was before Independence. The all through policies and Trade Agreements, both, on the national as well as international level, gives us a clear picture of its great indulgence and extreme efforts in creating better trade relations and better units, ultimately for the economic growth of the country. The different statistics shows us about how many potholes have been faced in coming to this situation of today's scenario. The enhancement of trade has been gradual in the past years gaining a good speed around 1990-91.Composition of India's Foreign Trade has undergone a positive change. It is a remarkable achievement that India has transformed itself from a predominantly primary goods exporting country into a non-primary goods exporting country. Under import too, India's dependence on food grains and capital goods has declined. The trend indicates structural transformation of Indian Economy. There was a time when commodities were imported for domestic consumption. But now raw materials are being imported, not just for the domestic consumption, but to process them further and export them after value addition. *Indirectly, what the country exports are the items of human skills.* For example, India exports raw cashew-nuts only to re-export them after they are further reprocessed. India imports crude diamonds and other precious stones only to process them further and re-export them as highly finished fine products at a considerable upward margin. India also imports gold and silver and exporting them in the form of attractive and expensive ornaments. Thus, it clarifies that foreign trade has played a crucial role in India's economic growth.

16.6 SUMMARY

- A flow of commodities from producers to consumers is known as trade.
- A favourable trade balance is an indication of a stable and developed economy while unfavouable trade balance exhibits the stage of developing economy.
- Before Independence, the commodities were imposed only for domestic consumption. It exported almost entirely agricultural raw materials. The balance of trade was favourable with higher value of exports.
- There has been a rapid increase in the imports between 1950-51 and 1960-61.

- The rapid increase in India's overseas trade has been largely due to growth and diversification of India's economy in the post-Independence era. However, inflationary trends and devaluation of the Indian currency have also contributed to increase in the volume of India's international trade.
- The difference between the value of nation's exports and imports of all goods and services over a given period of time is called balance of trade.
- If the value of total export is more than the value of the total import in the country, it is said to have a *favourable or positive balance of trade.* A country with a positive balance of trade is known as *trade creditor country.*
- If the value of total import of a country exceeds the value of total export, then the country is said to have an *adverse or negative balance of trade.* A country with a negative balance of trade is known as *trade debtor country.*
- Many other ways in which foreign exchange can be earned or spent is called *invisible trade* which accounts for a quarter of all transactions with foreign countries and that is, *balance of payment.*
- International Trade of a country is rightly known as its *Economic Barometer.*
- Exports of India are broadly classified into following four categories:
    - i. Agricultural and Allied Products
    - ii. Ores and Minerals
    - iii. Manufactured Items
    - iv. Fuel and Lubricants

- the imports of India are broadly classified into three categories:
    - i. Food and allied products
    - ii. Raw materials and manufactured intermediate and consumer goods
    - iii. Capital goods

- Britain was our most important trade partner before Independence. It is evident that now the U.S.A., Japan, Germany, U.K. and the OPEC Countries are our major trading partners.
- The main objective of the General Agreement of Tariff and Trade (GATT) was to ensure competition in commodity trade through the removal and reduction of trade barriers.
- The first EPZs of Asia was set up at Kandla in 1965.
- Since EPZs could not deliver desired benefits the policy was modified to create Special Economic Zones (SEZs) with the objective of overcoming the multiplicity of controls and

clearances; absence of world-class infrastructure; and unstable fiscal regime to attract larger foreign investments in India.

16.7 GLOSSARY

- **Merchandise:** A commodity offered on sale; an article of commerce
- **Commodities:** Goods that are bought and sold
- **Indigenous Industries:** Native industries of the region
- **Deficit:** Deficiency in amount or quality
- **Remittances:** Payments to remote/distant recipients
- **Detrimental Effects:** Damageable or harmful effects
- **Burgeoning:** A new growth or expansion
- **OPEC:** Organisation of Petroleum Exporting Countries
- **OECD:** Organisation for Economic Co-operation and Development
- **ASEAN:** Association of Southeast Asian Nations
- **EU:** European Union
- **SAARC:** South Asian Association for Regional Cooperation
- **SAPTA:** SAARC Preferential Trading Arrangement
- **GATT:** General Agreement of Tariff and Trade
- **Promulgated:** To make known by open declaration
- **OGL: Open General Licences**
- **EPCG:** Export Promotion Capital Goods
- **LERM:** Liberal Exchange Rate Management System
- **Decanalise:** To deregulate the supply of any commodity which implies that a number of intermediaries can stock and supply the commodity
- **Fiscal Incentives:** Incentives pertaining generally to finance
- **FMS:** Focus Market Scheme
- **MLFPS:** Market Linked Focus Product Scheme
- **DEEC:** Duty Exemption Entitlement Certificate; an Export Promotion Scheme, which enables duty free import of.

- **DEPB:** Duty Entitlement Pass-Book Scheme
- **ECGC:** Export Credit Guarantee Corporation
- **MDAS:** Market Development Assistance Scheme
- **MIAS:** Market Access Initiative Scheme
- **EPZs:** Export Processing Zones
- **SEZs:** Special Economic Zones
- **FDI:** Foreign Direct Investment
- **EPIP:** Export Promotion Industrial Parks

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16.10 Terminal Questions

Q.1 What is meant by Trade? Explain the difference national and local trade.

Q.2 Explain the growth in Indian Trade with respect to the international scenario.

Q.3 Give a comparative analysis of Composition of Imports and Exports in India.

Q.4 Explain India's Trade policy with reference to Foreign Trade Policies.

WEATHER MAPS AND CLIMATE DATA (LAB/PRACTICAL)

BLOCK-1 WEATHER MAPS

UNIT 1: WEATHER INSTRUMENTS

1.1 OBJECTIVES

This part of the study is to note and determine the changes in weather elements like temperature, air pressure, winds, and rainfall. These elements affect the life and conditions of the people everywhere. Weather, because of its uncertainties has been our concern for many years. There is a necessity to have the observations of weather phenomena in a systematic way.

1.2 INTRODUCTION

Weather denotes the atmospheric conditions of weather elements at a particular place and time. The climate of a place is the overall conditions of temperature, pressure, winds, humidity, cloudiness and precipitation of a large area or region over a long period of time. All these are basic weather elements. A change in one weather element will, in turn, change some or all the others. Hence, on the basis of predominant weather elements weather conditions can be generalized. For instance, predicting weather a few days in advance may prove very useful to farmers, aviators, tourists, planners. This, at any rate is not a simple task. To do it accurately, we require a number of weather instruments devised especially for the purpose. These help us to take safety measures in advance.

The places, where weather conditions are continuously recorded are called weather stations. These stations are of three types – surface, upper air and space based observation stations. These are coordinated by the world meteorological organization (WMO), a specialized agency of the United Nation, headquarters at Geneva. We are here mainly concerned with the meteorological instruments of surface observations.

1.3 TYPE OF WEATHER INSTRUMENTS

The prediction of weather is not a simple task. To do it accurately, we require a number of weather instruments devised especially for the purpose. It is also necessary to know the use of these instruments. The elements of weather need different type of instruments. The temperature, air pressure, humidity, clouds, winds and rainfall are main elements and need the use of specialized weather instruments for accurate recording of weather data at certain interval.

1.3.1 Temperature Measuring Instruments

The knowledge of the temperature of freely moving air is the primary concern of weatherman, because it is responsible for a variety of weather changes. The instruments designed to measure accurately the changes in temperature is called a thermometer which literally means ‘heat measurer’. These are categorized into following types: -

(i) The simple Thermometer
(ii) Maximum and Minimum Thermometer
(iii) Thermograph

1.3.1.1 The Simple Thermometer

The design of a thermometer is based on the fact that any substance, whether solid, liquid or gas expands when heated are expanded in a particular manner. Generally, liquids are preferred. Liquid thermometers are smaller and easier to read and handle. It is a most common type. Mercury or alcohol is used as a thermometric liquid in standard thermometers. When the mercury heated, it expands more than the glass, and when cooled, it contracts more than the glass.

Temperature is indicated in degrees of Celsius and Fahrenheit. These are the two type of scales named after two scientists, who devised them. Fahrenheit scale was devised by Danial Fahrenheit in 1714. He was German physicist. The Celsius scale was devised by Anders Celsius in 1742. He was a Swedish Astrologist. This scale is mainly used in those countries, which have metric system. In our country, we use mainly the Celsius scale. In Celsius thermometer, the temperature of melting ice is marked 0ºC and that of boiling water 100°C, and the interval between the two is divided into 100 equal parts. On the Fahrenheit thermometer, the freezing and boiling points of water are graduated as 32°F and 212°F, respectively and the interval between them is divided into 180 equal parts. Therefore, one Celsius degree is equivalent to 1.8° Fahrenheit degrees. The following formula is used for the conversion from one scale to another: -

From Celsius to Fahrenheit

$$F = \left(C \times \frac{9}{5}\right) + 32 \text{ or } \frac{F - 32}{180} = \frac{C}{100}$$

From Fahrenheit to Celsius

$$C = \frac{F - 32}{5} \text{ or } \frac{C}{100} = \frac{F - 32}{180}$$

Example:

The normal temperature of the human body is 40°C. Convert it into Fahrenheit: -

- $\frac{F - 32}{180} = \frac{C}{100}$
- $\frac{F - 32}{180} = \frac{40}{100}$
- $F = \frac{40 \times 180}{100} + 32$
- F = 72 + 32 = 104°

The normal Temperature of the human body is 104°F, convert it into centigrade:

- $\frac{C}{100} = \frac{F - 32}{180}$

- $C = \frac{104 - 32}{180} \times 100$
- $C = \frac{72 \times 100}{180}$
- C = 40°C

In meteorology, the real air temperature is measured with the help of a thermometer placed in a sheltered place to protect it from direct sunshine or reflected radiant heat. The thermometer is placed inside a double walled wooden white painted box. This box is placed at a height of about a metre above the ground in an area. It should be away from the trees or walls of the buildings.

The thermometer consists of a narrow-sealed glass tube of a small uniform bore sealed at one end with an expanded bulb at the other. The bulb and the lower part of the tube are filled with mercury. Fig. 1.1

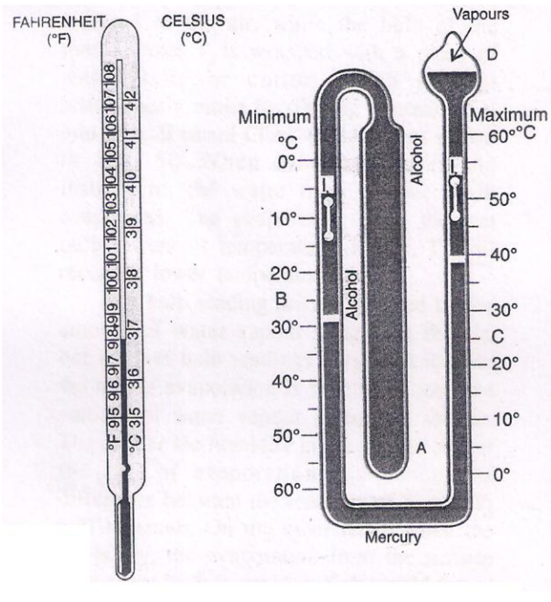

Fig 1.1 Clinical and Six's Maximum and Minimum Thermometer

1.3.1.2 Maximum and Minimum Thermometer

This is a combination of two thermometers. These register maximum and minimum temperatures. The purpose of this thermometer is to record the highest and the lowest temperatures occurring during a given period, preferably for twenty-four hours.

The thermometer used for measuring the maximum and minimum temperature in a day is called the Six's Maximum and Minimum Thermometer. The maximum thermometer tube has mercury in it, while the minimum thermometer has alcohol in it, which does freeze easily.

This thermometer consists of a cylindrical glass bulb A connected to a U-shaped tube. B.C., which terminates in another bulb D as shown in Fig. 1.1. The lower part of BC contains mercury. The parts of the limbs B and C above the mercury surface and the bulbs A and D contain alcohol. This alcohol is known as thermometer liquid.

Above the mercury surface in each limb, there are two steel indices I_1 and I_2, each provided with a spring arrangement which keeps them pressed to the sides of the tube. To set the thermometric, each index is moved up or down the tube by a small horse-shoe-shaped magnet. This magnet brings I_1 and I_2 indices in contact with the mercury. This situation is defined as the setting of the thermometer. This shows that the thermometer now can be used for the reading.

Both limbs of B and C are graduated with the values of Celsius and Fahrenheit scales. The left limb A registers the minimum temperature with the scale of graduation running downwards from top. The right limb registers the maximum temperature with the graduations running upwards from the bottom. It means the value of scale decreases from bottom to top in minimum tube, while the value of scale increases from bottom to top in maximum tube.

The alcohol in the bulb 'A' expands with the rise in temperature, and it pushed down the mercury surface B. Naturally mercury rises in the limb 'C', and it pushes up the index I_2 when temperature falls the mercury level in C falls. In this situation the index I_2 remains at the same position. It doesn't come down. This results in the rise of mercury in B limb, and the index I_1 is pushed up until the temperature ceases to fall. Hence, the readings against the lower ends of the indices I_1 and I_2 give the minimum and maximum temperatures, respectively, reached during the period of observation.

After noting the readings of maximum and minimum temperatures, for the given period, generally for the last 24 hours, which is usually one date or day, the thermometer is again set-up with the help of the magnet. Both the indices I_1 and I_2 are brought again in contact with the mercury levels in both the limbs. It is practiced again to record both the temperatures of the following day. The readings of both the temperatures give us with the average and range of temperatures of the day.

Example : Suppose, a place has recorded 10°C as the minimum, and 40°C as the maximum temperature in that the case the:

Average Temperature of the day is : $\frac{\text{Maximum} + \text{Minimum}}{2}$

Here, $\frac{40°C + 10°C}{2} = \frac{50°C}{2} = 25°C$

The total of both the temperatures is divided by 2, as it has an addition or total of two temperatures.

Range of Temperature of the day : Maximum – Minimum

Here : 40°C – 10°C = 30°C

In metrological observatories the readings of temperature are taken at fixed intervals every day. Now-a-days separate thermometers are used for obtaining the maximum and minimum temperatures. In this case maximum thermometer contains mercury, whereas the minimum thermometer contains alcohol. Both, these thermometers are attached on single piece of wood. This is then defined as Rutherford’s thermometer.

Thermograph: It is a self-recording instrument, and records the temperatures automatically and continuously. The values are noted on a graph paper. It has bimetallic strip, used as a reactor. This strip is made by two such metals, which have their different nature of thermal expansion. These strips have curvature shape, and are joined with the pen of the graph by applying levers. This graph not only records the maximum and minimum temperature of twenty four hours, but also records variations in the temperature during aforesaid period.

1.3.2Humidity Measuring Instruments

Humidity is known as the amount of water Vapour in the atmosphere. The water vapour holding capacity of the air increases with the increase in temperature and decreases with the fall in temperature. The maximum and minimum amount of water vapour, the air can hold at given temperature is called vapour capacity. The amount of water vapour present in the air is expressed in terms of grams per cubic metre.

Humidity is expressed in two ways:

(i) **Absolute Humidity:** It is the weight of water vapour in a given volume of air at particular temperature

(ii) **Relative Humidity:** It is a ratio between the total capacity of the air for holding moisture under a given temperature and the actual amount of moisture being carried by it at the moment. It is expressed in percentage.

Example: The temperature of a sample of air is 35°C. It can hold 30 grams of moisture per kilogram. (It can be defined as maximum humidity) Suppose, it is 6 grams at the moment i.e. is the absolute humidity. The relative humidity at the temperature will be as follows:

$$\text{Relative Humidity} = \frac{\text{Absolute Humidity} \times 100}{\text{Maximum Humidity}} = \frac{\text{Actual Amount of coater vapour}}{\text{Vapour capacity of the air}}$$

$$= \frac{6 \times 100}{30} = 20\%$$

Thus, its relative humidity is 20 percent. The air at this temperature is said to be saturated when its relative humidity is 100 percent. Suppose, here in the above case, the moisture is increased more than 30 grams, which, the air will not be able to hold, and it will come out in the form of rain. Relative humidity is the touchstone of humidity of the air. It acquaints us with the present condition of air, that how much it is dry or humid.

The humidity of the place can be found out with the help of dry and wet bulb thermometer, Hygrograph and Hair hydrometer. Among these wet and Dry bulb thermometer is widely used for the purpose.

1.3.2.1 Wet and Dry-Bulb Thermometer

It is a simple instrument. It was devised by Manson, so it is also named as Manson's Hygrometer. It has two thermometers. Both of these are identical fixed to a wooden frame. The bulb of the thermometer (Dry) T_1 is kept uncovered and is exposed to the air, while the bulb of the thermometer T_2 is wrapped with a piece of wet Muslim or cotton which is kept continuously most by dipping a strand of it into a small vessel filled with water. (Fig.1.2). When air blows over the instrument, the water is evaporated from the wet bulb. This amount of evaporation affects the temperature of wet-built. More evaporation of T^2 thermometer will bring down the temperature and it will indicate the dryness of the air. If T^2 thermometer is affected by less evaporation, in that case the temperature will not go down. It will not have much difference with T_1 thermometer.

Dry-bulb reading is not affected by the amount of water vapour present in the air, whereas the wet-bulb reading will vary with it since the rate of evaporation is dependent upon the amount of water vapour present in the air. If the air is more humid, it will slower the rate of evaporation, and hence, the difference between the readings of T_1 and T_2 will be small. On the otherhand, when the air is dry, the evaporation from the surface of wet-bulb is rapid, it would lower down its temperature and the difference between the two readings would be large. Hence, the difference of the readings of T_1 and T_2 determines the humidity of the atmosphere. The larger the difference, more is the arid air. The small the difference, less is the arid air. In case, if both the thermometers T_1 and T_2 have not any difference in the temperature, it means the air is fully humid or saturated. In that condition, the atmosphere will soon have rains.

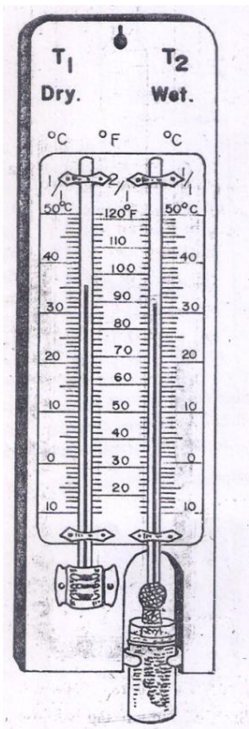

Fig. 1.2 Wet and Dry Bulb Thermometer

For Example:

- If dry-bulb temperature is 20°C and wet-bulb temperature is 18°C, it denotes the humid air.
- If dry-bulb temperature is 20°C and wet-bulb temperature is 5°C, it denotes the dry air.

The amount of humidity can be determined with the help of a table known as Relative Humidity Table No. 1.

Dry-bulb temperature (°C)	Difference between wet-bulb and dry-bulb temperatures (°C)																			
	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20
0	81	64	46	29	13															
2	84	68	52	37	22	7														
4	85	71	57	43	29	16														
6	86	73	60	48	35	24	11													
8	87	75	63	51	40	29	19	8												
10	88	77	66	55	44	34	24	15	6											
12	89	78	68	58	48	39	29	21	12											
14	90	79	70	60	51	42	34	26	18	10										
16	90	81	71	63	54	46	38	30	23	15	8									
18	91	82	73	65	57	49	41	34	27	20	14	7								
20	91	83	74	66	59	51	44	37	31	24	18	12	6							
22	92	83	76	68	61	54	47	40	34	28	22	17	11	6						
24	92	84	77	69	62	56	49	43	37	31	26	20	15	10	5					
26	92	85	78	71	64	58	51	46	40	34	29	24	19	14	10	5				
28	93	85	78	72	65	59	53	48	42	37	32	27	22	18	13	9	5			
30	93	86	79	73	67	61	55	50	44	39	35	30	25	21	17	13	9	5		
32	93	86	80	74	68	62	57	51	46	41	37	32	28	24	20	16	12	9	5	
34	93	87	81	75	69	63	58	53	48	43	39	35	30	28	23	19	15	12	8	5

Precautions for the use of the thermometer

1. The vessel of wet-bulb should be filled with distilled water.
2. The cotton cloth should be changes at least once in a month.
3. The thermometer should not be exposed to direct sunshine.
4. It should be housed in a shelter place.
5. The wood on which T_1 and T_2 thermometer are attached should be painted white.
6. It should be kept at such site, from where the air has free movement.
7. It is kept at a height of about a metre and placed away from buildings in an area not enclosed by walls or trees

Hygrograph: It is a self-recording instrument. It is an advanced form of hair hygrometer. Its built is just identical to thermometer. It also indicates its measurements on a graph paper.

1.3.3Atmospheric Pressure: Measuring Instruments

Air pressure is an important element of weather and is measured in inch or millibar. It is defined as the pressure exerted by the atmosphere on an unit area.

It is well known that air has weight and that it exerts great pressure on the earth's surface. It is observed that sea level, in normal conditions, has the pressure of air 14.7Lb (pounds) on every square inch or 1.03 kg. per sq. cm. As a result of the constant movement of air, the changes in temperature and the variation in its vapour content, the weight of the air above any point is continuously changed. Therefore, like temperature, atmospheric pressure also has variations with time and space. It is an important feature of weather study. It helps in forecasting as it has very close relationship with other weather elements.

The instrument designed to measure atmospheric pressure is called a barometer. These are mainly of two types – (i) Aneroid barometer and (ii) Fortin's Barometer.

1.3.3.1 Aneroid Barometer: It is a very common instrument, used for the measurement of atmospheric pressure. It has derived its name from Greek word, aneros (a – not, neros-moisture), meaning without liquid. It was invented by Lucien Vidie in 1843. It has a circular shape like a time watch.

It consists of a corrugated metal box made of silver or some similar thin alloy, sealed completely. The chamber is air tight and has vacuum inside. Inside the box, there is a spring pressing lid upwards against the pressure of the atmosphere. When the pressure of the atmosphere from outside increases, it pushes the lid downwards and when the pressure of the atmosphere is less outside the lid is pushed upwards by the spring. This relative movement of lid results in the rotation of the needle on the dial that indicates the atmospheric pressure. (Fig. 1.3)

This barometer can easily be transported. So, it has special significance in aviation and mountaineering. The dial of the barometer has the indication of certain weather elements like vary stormy rainfall, change, fair, very dry. It is now very common in use. It is very easy to note the variations is pressure from the instrument.

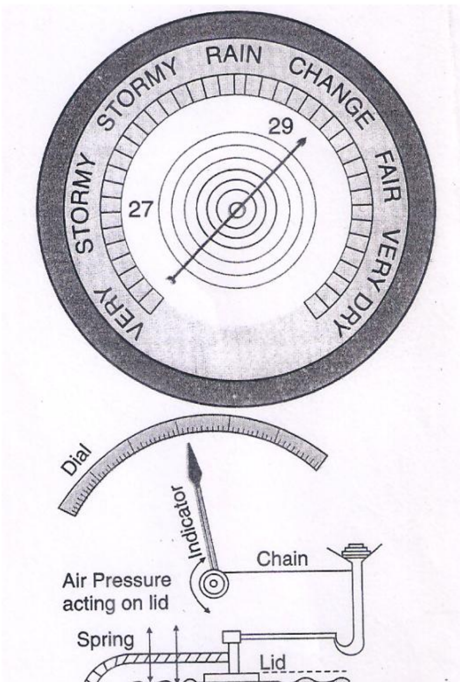

Fig. 1.3 Aneroid Barometer

1.3.3.2 Fortin's Barometer: This is known as Mercury Barometer. It was devised by **Evangelista Torricelli** in 1643. He was the disciple of Galileo of Italy. Though it is costly instrument, but the measurement of air pressure is quite easy. It is based on a simple principle as explained here:-

Principle: It can easily be followed by a simple experiment. Take a thick glass tube of uniform bore. It should be a metre long. Fill it with mercury close the mouth of the tube with a finger, then invert and immerse its open end in a cup of mercury without allowing air to enter in the tube and then remove the finger. The mercury will flow out of the tube into the cup and stand at a definite height above the level of the liquid in the cup. This is because the weight of the column of mercury in the tube, above the surface of the mercury in the cup is balanced by the weight of the air column of an indefinite height exerted as pressure upon an equal cross-section of the liquid surface. The height of the column of mercury in the tube, therefore, becomes the measure of the pressure of air. The height of the column is graduated in millimeters or in inches. (Fig. 1.4)

Fortin's barometer is generally used by metrological observatories. It consists of a vertical glass tube, filled with mercury. The upper end of the tube is closed and the bottom open. The open end of this tube is inverted into a cistern of mercury. This cistern has a flexible bottom with an adjusting screw (s) to bring the mercury level in the cistern to a fixed point before taking reading.

With the decrease in pressure, some of the mercury flows out of the tube into the cistern. While with the increase, some of the mercury in the cistern flows into the tube. Therefore, to provide a fixed point above which the height of the column may be measured, an ivory index 'I' is fixed to the top of the cistern. The zero of the scale corresponds to the tip of the ivory index which points down vertically.

The barometer tube is encased in a brass tube, AB, for protection, and the scales indicating centimeters, inches or millibars of air pressure are inscribed on it. It has a slit, through which the mercury level in the tube can be easily seen.

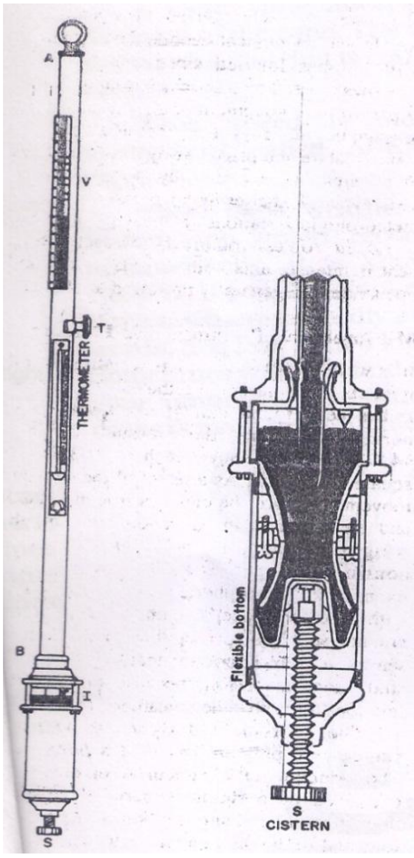

Fig. 1.4 Fortin's Barometer

The instrument is provided with a vernier scale. 'V' which slides in the slit. Its position is adjusted by means of the screw 'T.' There is a brass plate attached to the vernier and is behind the barometer tube. The lower edge of this brass plate and the lower edge of the vernier are in the same horizontal line and they move together when 'T' works. There is also an attached thermometer. It helps us to make the correction for every pressure reading.

Precautions for its use: It needs certain adjustments before the reading is taken:

(i) The mercury level in the cistern should be made to just touch the tip of 'I.'

(ii) The zero of 'V' should be made to coincide with the surface of the mercury in the tube.

Barograph: It is a self-recording instrument to measure the air-pressure. The reading can be noted from the graph paper which has its connection with levers of the instrument.

Unit Measures of Pressure:

There are mainly two major units to measure air pressure-one is Inch scale and the second is Bar Scale.

1000 millibar = 75 centimeter = 29.53 inches = 1 Bar

1.3.4 Instruments of Wind Observation

Wind is another basic weather element. The Horizontal movement of air is called wind, which always blows from high pressure to low pressure areas. Two basic measurements about wind need to be observed with care namely (i) Direction , (ii) Speed.

1.4.4.1 Wind Direction: Our main directions are North, East, South and West. These are cardinal points. These directions of the wind are determined by means of a **wind vane**. The wind vane always points to the direction of wind. This vane is a revolving plate. This plate is perfectly balanced on a rod. There are ball bearings on which it turns smoothly without frictions, so that it responds even to a slight blow of wind. In a simplest form, the vane has a light thin metallic or wooden structure having a pointed end known as arrow (made of heavy metal) and a broad end called the tail (Fig.1.5)

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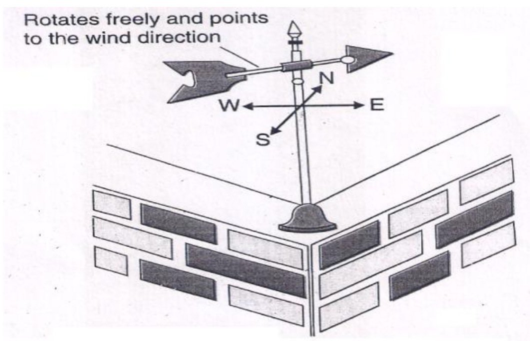
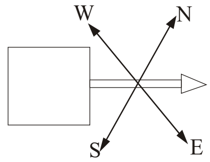


Fig. 1.5 Wind Vane

The arrow always points towards the direction from which the wind blows and the tail helps in keeping the point of the vane nosed into, or towards the source of the wind. Below the vane, the vertical rod carries a cross indicating the four main directions. For example, the arrow of the vane indicating towards North direction, it means that the winds are blowing from north to south. In this case, the winds will be named as northern winds. If supposed, the arrow has its direction towards south direction, it means that the winds are blowing from south to north direction

It is to be kept in mind that the arrow indicates the direction of the prevailing wind. The wind flows from what direction is called as windward direction and the wind is moving to that direction is called as Leeward direction.



It indicates north east direction.

If the wind is moving from North, it will be named as North wind and suppose it is blowing from east to west, in that case it will be defined as Eastern winds. Here, eastern side is windward side and western side is leeward side.

Wind Speed: Wind speed is measured by an instrument called Anemometer. An Anemometer is an instrument used for measuring the wind velocity. This wind speed indicator consists of three or less commonly four hemispherical cups attached by horizontal arms to vertical spindle.

These cups start to rotate with the blowing of winds. These cups spin in horizontal direction. The rotary motion of horizontal arms, in turn, cause the vertical spindle to rotate. At the bottom of the spindle, there is a mechanical device which records the number of its revolution. These revolutions indicate the velocity of the wind.

1.4.4.2 The anemometer: It is sometimes electrically connected to a dial inside the weather station. This dial indicates the speed of wind in kilometers or miles or knots (nautical miles) per hour. The rotation of the cups depends on speed of wind. If the wind is blowing with a high speed, in that situation, these cups will rotate with a great speed. It means the rotation of cups is an indication of wind speed. (Fig. 1.6)

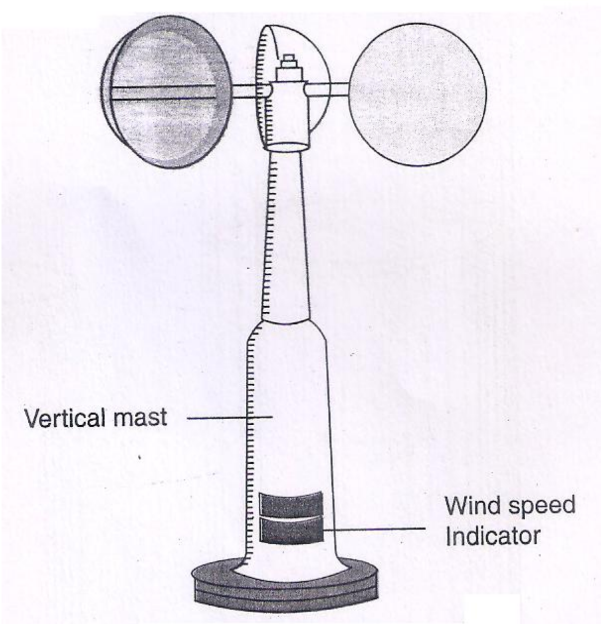


Fig. 1.6 Anemometer

It we mark that smoke is rising vertically, it means that there is hardly any speed of the wind. It can be said that wind is calm. Sometimes if we feel that it is quite difficult to move on the road, the wind speed in such cases is more than 40 kms. per hour. In a storm, when trees get uprooted, the wind speed is more than 100 kms. per hour.

Precautions in its use:

(i) The wind instruments should be placed at such points, which must be free from the interference of local hindrances.

(ii) These should be placed in open space, where the air movement is quite without any obstacle.

(iii) It should be placed at high objects.

The anemometer is also known as Robinson's cup Anemometer as because it was devised by Robinson.

Anemograph: It is a self-recording instrument. It is mainly used by observation. All the changes in the speed of wind are recorded on the graph.

1.4.5 Rain Measuring Instruments

Rainfall is such a weather element which depends on the relative humidity of atmosphere, direction of winds and air pressure conditions. When the air is fully saturated, then with the fall in temperature, the water vapour presents in the moist air start to convert into water drops due to condensation. This process helps in the formation of clouds and thus the water drops start to fall in the form of rain. At this juncture, if the air temperature with a great fall reached near to freezing point, in such situation the water drops are converted into snow, and when it falls it is called as snowfall.

1.4.5.1 The instrument used to measure the amount of rainfall is known as Rain Gauge. It is a simple instrument and consists four parts:

i. **Outer Cane:** It is a metal cylinder

ii. **Inner Cane:** This cane is made by copper metal. This circular cane is fitted accurately in the outer cane. The rain water is collected in it.

iii. **Funnel :** The outer cane has a circular funnel on its mouth. It helps in the collection of water of each drop. Its circumference is equal to the circumference of the base of the receiving bottle.

iv. **Graduated Cylinder:** This is a measuring Jar, which is graduated in millimeter. The reading is taken every 24 hours at a fixed time of the day, generally 8.00 a.m. It shows the amount of rainfall in a given day. Suppose, if we measure one cm. rainfall in the last twenty four hours, it means that the entire surface must have a layer of one cm. water, with the condition that it should neither be evaporated or absorbed nor have any flow to other area. (Fig. 1.7)

Four accurate readings, the instrument should be exposed in an open and level area 30 cms. above the level of the ground to prevent splash. To allow free and un intercepted fall of raindrops in the rain gauge, it should be placed far away from trees, buildings, and other high objects. Also it needs to be protected from stray animals as they are likely to overturn the rain gauge.

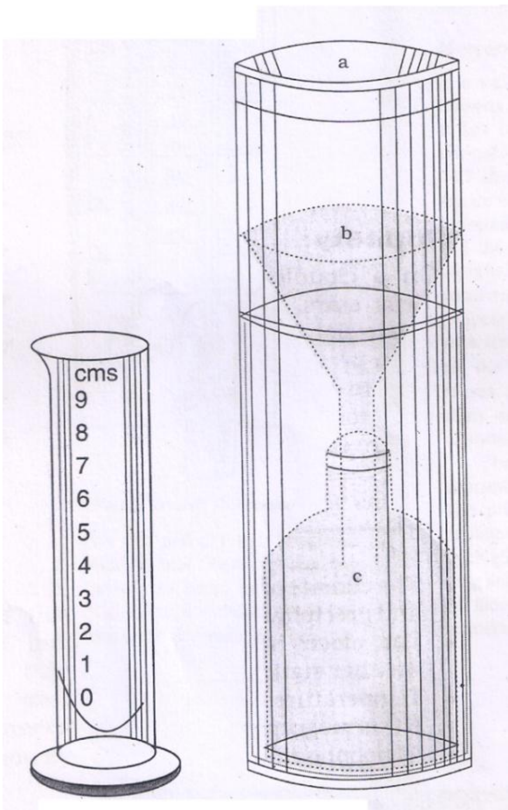


Fig. 1.7: Rain Gauge

1.4 CONCLUSION

It is quite necessary to use various weather instruments for the knowledge of weather elements. Weather is a changing phenomenon. The change is one element of weather brings the change in another element. With the help of certain weather instruments such change can be noted and defined. Their analysis helps us to take safety measures in advance.

1.5 SUMMARY

Temperature, air pressure, amount of rainfall, wind speed and wind direction, presence of water vapour in air, or dryness of the air, sky conditions, form of precipitation are main weather elements. Temperature is measured in Fahrenheit and Celsius units. Celsius is the most common. It has 0^0C as freezing point and 100°C as boiling point. Simple thermometer is used to measure the temperature of human body, mainly in Fahrenheit. Maximum and minimum thermometer is used to measure the lowest and highest temperatures of the day. It acquaints us with the mean, range of temperature of the day. It is of U-shaped and the temperature is indicated by lower point of steel indices. Thermograph is a self-recording instrument used mainly by big meteorological observatories.

Humidity denotes the amount of water vapour present in the atmosphere. The air can hold more water vapour, when it is heated more. It is expressed in the form of absolute, maximum and relative. Absolute humidity expresses the present water vapour of the air at a particular temperature. Maximum humidity means the water vapour holding capacity of the air at that temperature. Relative humidity is the ratio between both the humidity i.e. absolute and maximum. It is expressed in percentage. If it is 100, it means the air is full saturated or fully condensed. Dry and wet bulb thermometer is the main instrument to measure this weather element. The more difference between both the temperatures is an indication of low humid atmosphere, on the other hand, the low difference shows that the air is fully saturated. Hydrograph is a self-recording instrument.

Air pressure is closely related with the temperature. Cold air has heavy weight, and exerts high pressure. Warm air is light in weight, and reels low pressure. Aneroid Barometer is most common instrument. It entails weather condition like storm, change, smooth, rainy, dry and very dry. Fortin's barometer is a mercury barometer, and is generally used by metrological laboratories. Air pressure is measured in inches, millimeters and milibars.

Wind direction is examined by wind vane. Its arrow indicates the direction of wind. If it indicated towards east, it means that eastern winds are blowing. Wind speed is measured by anemometer. It measures the speed in km. per hour. Anemograph is a self-recording instrument used by meteorological laboratories.

Rain gauge is used to measure the amount of rainfall. It is a cylindrical shaped instrument. Rainfall is measured in inches, millimeter and cm. Certain precautions are necessary for its use.

1.6 GLOSSARY

Anemometer:	An instrument meant for measuring wind speed
Aneroid Barometer:	A portable instrument, commonly used for measuring atmospheric pressure.
Barometer:	An instrument for measuring atmospheric pressure.
Rain Gauge:	An instrument for measuring accurately the amount of rainfall at a given place over a fixed duration.
Wind Vane:	An instrument used for determining wind direction.
Water Vapour:	It is the moisture in the atmosphere. It condenses to form clouds and precipitates in the form of rain and snow.
Absolute Humidity:	It denotes the actual amount of water vapour in the air.
Relative Humidity:	It denotes the ratio between the actual amount of water vapour and the maximum amount of water vapour, the air can hold at that temperature. It is expressed in percentage.
Air:	Air is a mixture of gases.
Wind:	Moving air is known as wind.
Aneroid:	Without liquid, a portable instrument used for measuring atmospheric pressure.
Celsius and Fahrenheit	are the units to measure the temperature.
Mean Temperature:	It is the average temperature of the day, month or year.
Range of Temperature:	Difference between maximum and minimum thermometer
Humidity:	Presence of water vapour in the air

1.7 ANSWER TO CHECK YOUR PROGRESS

1. The direction and wind speed vary greatly because different parts of the earth rotate at different speeds.
2. Air moves from high pressure areas towards the low-pressure areas.
3. The horizontal movements of air near the earth's surface is known as wind.
4. On a hot day, it feels cool under a fan- because of high temperature, we need cool air.
5. Fog usually disappears soon after sunrise- because of increase in temperature.
6. Dew is usually seen in the morning as because the night temperatures do not fall below 0°C
7. **Fill in the blanks:**

(a) A ___________ is the self-recording instrument that measures air temperature.

(b) Aneroid barometer is an instrument that measures air _____________

(c) Atmospheric Pressure is measured in _______________

(d) A wet and dry bulb thermometer is also known as _____________

(e) Celsius scale is the same as _______________ scale.

(f) It is the passage of air _______________ that makes the weather so variable.

(g) The small difference between dry and wet bulb thermometer readings indicates _______________

(h) If no difference between the temperature of both the thermometer indicate.

(a) Thermograph (b) Air Pressure (c) Millibar or inch
(d) Hygrometer (e) Centigrade (f) Mass
(g) High humidity (h) Air is saturated

8. Match various elements of weather given in column a with the units in which they are measured in column B

	Column 'A'		**Column 'B'**
1.	Atmospheric Pressure	a.	Kilometers per hour
2.	Wind Speed	b.	Millibars
3.	Relative humidity	c.	Degree of Celsius
4.	Rainfall	d.	Degree of Faherenite
5.	Temperature	e.	Percent
6.	Human body temperature	f.	Centimeters

1 (b), 2(a), 3(e), 4(f), 5(c), 6 (d)

9. Make correct pairs of the name of instruments in columns A and their uses in Column B.

	Column 'A'		**Column 'B'**
1.	Wet and Dry-bulb thermometer	a.	to find out wind speed
2.	Rain Gauge	b.	to find out wind direction
3.	Six thermometer	c.	to measure precipitation
4.	Aneroid barometer	d.	to find out humidity
5.	Wind vane	e.	to measure atmospheric pressure
6.	Anemometer	f.	to find out the maximum and minimum temperature of air for a given period

1 (d), 2(c), 3(f), 4(e), 5(b), 6 (a)

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1.10 TERMINAL QUESTIONS

1. Define thermometer.
2. Define daily range of temperature.
3. What do you mean by atmospheric pressure? How is it measured?
4. What is the relation between temperature and pressure.
5. What is temperature? How is it measured?
6. Distinguish between-
   (a) Absolute and Relative humidity
   (b) Weather and climate
   (c) Mist and fog
   (d) Condensation and precipitation
7. What do you mean by wind vane?
8. How can humidity be expressed?
9. Define Rain- Gauge.
10. Define weather. Why should we study it?
11. Explain briefly or define the following terms-
    (a) Evaporation (b) Condensation (c) Precipitation

12. Give the name of six important weather instruments needed by you to record the data of all-weather elements.
13. What are the precautions to be taken in placing a rain gauge?
14. What are the precautions to be taken for the use of dry and wet-bulb thermometer?
15. Discuss the utility of aneroid barometer. What conditions of weather are indicated by it?
16. Explain the functioning of Fortin's barometer.
17. Which instrument is used to determine the direction of wind? Also explain the main directions.
18. Wind velocity is measured by which instrument? Explain.
19. How the rain is measured? Explain in detail.
20. How can you convert the Fahrenheit scale into Celsius scale? Discuss it with an example.

UNIT 2: INTERPRETATION OF INDIAN WEATHER MAPS

2.1 OBJECTIVES

Weather and climate are subject of universal interest and they affect the life and conditions of people everywhere. The uncertainties of weather have been our concern for many years. These days, the changes in climate and issues of global warming are great concerns to us. Hence, it becomes necessary to acquaint ourselves with the changes in weather phenomena. It is possible only to have a systematic knowledge of weather map of an area. These maps give full information of all-weather phenomena through which it is possible to predict more accurately the conditions of weather for a day, weeks, months or season. Forecast of monsoon, cyclonic storm, western disturbance, dust storm, snowfall are possible with the detailed analysis of day-to-day weather maps.

2.2 INTRODUCTION

Weather denotes the conditions of the atmosphere at a given place and time with respect to temperature, atmospheric pressure, humidity, precipitation, cloudiness and direction and velocity of winds. All these factors are known as weather elements. A change in one weather element will, in turn, change some or all the others. On the basis of predominant weather element weather conditions can be generalized by referring to them as rainy, sultry, cloudy, windy or sunny.

Weather forecasts help us to take safety measures in advance. The farmer can make more advantages of such weather predictions. Prediction of weather only a few hours a head may facilitate safe air flights. These are also very useful for navigators, fishermen, defence personnel, horticulturists; people connected with natural disasters and also the general public. It is for the benefit of all these people that weather bulletins are broadcast every day. This at any rate is not a simple test. To do it accurately the weatherman requires firstly the knowledge of weather instruments, devised especially for this purpose. The weather information thus collected; help us in the preparation of weather map of an area.

2.3 INTERPRETATION OF INDIAN WEATHER MAP

A weather map of the world or India shows the weather conditions of a stated time numerically or with the help of approved and listed metrological symbols. The need of weather maps was felt most by sailors for navigation purposes. In 1688 Edmund Halley published a weather map showing the trade winds and direction of prevailing monsoon. This map was rather a typical weather map as it recorded the weather condition over a period of time. Thus, it was necessary to develop such system, that within no time, the latest meteorological changes may be recorded and collected by the meteorological observatory.

The need of starting a Meteorological Service in India was first brought to the notice to the Government of India by the Asiatic Society of Bengal. The service was started by the Government in 1864 with headquarters at Shimla. After the first world war of 1914-18, this

Department was expanded and the central office was shifted to Pune. The Indian Daily Weather Reports are published every day from this city.

In India there are more than 350 observing stations grouped into five categories:

(i) **Class I:** observatories are equipped with self-recording instruments and transmit data to the central observatory at Pune twice a day.

(ii) **Class II:** These are equipped with eye reading instruments. These telegraph weather messages twice daily.

(iii) **Class III:** These observatories send their observations to the forecasting centres only once a day.

(iv) **ClassIV:** These observatories record the data of temperature and rainfall and do not send massages daily.

(v) **Class V:** These observatories record the amount of rainfall once. They send the data at 8.00 a.m. daily. This amount indicates rainfall for the last twenty four hours, daily, if it is occurred.

Meteorological Observations

There are types of observatories by three means at Global level. These are follows. These function in coordination of WMO.

(i) **Surface Observatories:** These observatories are distributed all over the country and take observations according to globally coordinated time and spacing. They record elements like radiation, Ozone, atmospheric trace gases, pollution and atmospheric electricity.

(ii) **Upper Air Observatories-** These are large in number, and are scattered around the globe. They have balloon borne instruments for sensing different weather elements. Rockets are also used. They have radiosonde contain sensors. They use wireless massages and data for the analysis at the ground stations.

(iii) **Space Based Platforms or Observatories-** These are new powerful tool. They collect the information from artificial satellites. These are mainly geo-stationary satellites. In India INSAT and Meterosats are providing valuable observations of temperature, cloud cover, winds, cyclonic storm and other elements. These platforms take observation once a day over an area.

All the observation made by above means are used by our Central Meteorological station of Pune. A weather map of India is daily prepared and printed to depict various weather elements. Data is also collected on the ships playing on the India seas. We also collect information from weather observatories in Antarctica.

On the basis of all these meteorological observatories, Indian Meteorological Department of Pune publishes Indian Daily Weather Report two times in a day i.e. 8.30 a.m. and 5.00 P.m. (IST). This Report contains six pages. The first page has the description of the data of observation, and day, time 8.30 morning, brief summary of weather observation, forecast of weather for next two or three days and seismic Report. The lower side of this page has those Weather information observed by various ships with their location in Bay of Bengal and Arabian Sea.

Page No. 2, 3, 5 and 6 of this Report have a long table, which is composed in 23 columns, which give details the observation of our 210 meteorological observatories in code language. The first column has the name of the observation station. The columns 2 to 8 have the description of observations 5.30 p.m. of previous day. Ninth and tenth columns give the details of the present day observations of 8.30 a.m. The remaining columns have the details of the observation of last 24 hours, regarding to maximum temperature, minimum temperature, departure of temperature from the normal, amount of rainfall received during last 24 hours, total rainfall of the season. Departure from normal rainfall, normal annual rainfall.

The page no. four has one big size map of India along with two small maps in the lower part of the paper. This large map has the details of isobars, and different weather conditions with the help of symbols and codes. The small maps show the departure of maximum and minimum temperature from the normal.

Reading a Weather Map

Before proceeding to read the Indian Daily Weather Map one should get familiar with the various symbols used on such maps. The following points are to be described while reading the Weather map:

(i) Introductory Information.

(ii) Air Pressure: (a) Location of high bar, (b) location of low bar, (c) trend of isobars, (d) gradient of air-pressure.

(iii) Wind: (a) direction, (b) velocity.

(iv) Skycondition: (a) Cloud cover, (b) nature of the cloud, (c) other atmospheric phenomena.

(v) Precipitation: (a) general distribution, (b) special area of heavy precipitation, (c) amount of rainfall.

(vi) Sea- Conditions.

(vii) Departure of air pressure from normal.

(viii) Departure of temperature from normal.

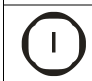
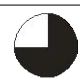
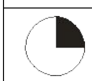
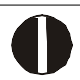
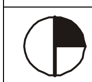
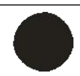
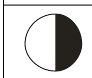
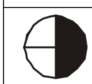
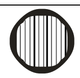
1. **Introductory Information:**The preliminary information of weather report is date, day and time. the report is of which date and day, firstly it should be noted. The weather conditions are shown for time- (i) 830 HRS IST- 3.00 GMT (ii) 1730 HRS IST (1200 HRS GMT). The year is mentioned with Hindu SakSamvat.

2. **Air Pressure:**It is shown with the help of isobars. These lines join the places having equal pressure. Their interval is of 2 millibar. The value of each isobar is given on the map. Low pressure and High-pressure areas are also marked. Their abbreviations are LP and HP. The trends of isobar indicate cyclonic or anti-cyclonic conditions. The space between two isobar helps in the examination of pressure gradient.

3. **Wind:** Wind speed and direction of winds are closely related with the distribution of air pressure. Areas with high pressure gradient have high wind speed. The relativity of air pressure indicates the wind direction. Winds blow from high pressure areas to low pressure areas. The location of high- and low-pressure areas also indicates the direction of wind. Wind direction and wind speed are shown with the help of an arrow. The back part of the arrow indicates the wind direction. This back part has the lines, which are the symbol of wind speed.

   On Indian weather map, the wind speed is shown in nautical miles (knot) per hour. Each half oblique line represents the speed of 5 knot, and the line of full length has the value of 10 knots. A complete triangle on the line indicates the speed of 50 knots. Generally, 5 knots wind is known as light Breeze, 10 knots wind as Gentle Breeze, 15 knots wind as Moderate Breeze, and 50 knots wind as Strong Breeze. If it is more than 50 knot, its disastrous effects are increased.

4. **Sky Conditions:** On Indian weather maps an effort is made to show, that how much sky is covered with clouds. Sky conditions are shown with the help of a circle. The amount of cloud is shown by the shaded part of the circle. If the circle has not shade, it means that sky is clear. The following table explains the amount of cloud on the Indian weather map.

	Cloud Amount		**Cloud Amount**
	1/8 Sky Covered with Cloud		¾ Sky Covered with Cloud
	¼ Sky Covered with Cloud		7/8 Sky Covered with Cloud
	3/8 Sky Covered with Cloud		Overcast Sky
	½ Sky Covered with Cloud		Obscured Sky
	5/8 Sky Covered with Cloud		High Cloud

These circles are shown on the map, where, the observations have been made.

5. **Other Atmospheric Phenomena:** All those atmospheric changes, which affect the weather of place in any form, are shown with the help of certain symbols. Our weather map, mainly uses the following weather symbols, the details of which is as follows:

(i) **Haze:** The obscurity of the sky is produced by dust particles or smoke. The visibility is decreased. Area only up to a distance of 2 km. may be visible.

(ii) **Mist:** The obscurity of the sky is produced by condensed water particle. It also has the visibility up to a distance of 2 km.

(iii) **Fog and Shallow Fog: Winter** season, generally in morning the obscured conditions are produced due to two reasons: - Sometimes condensed water particles are hanged in huge quantity in the atmosphere, which makes visibility very poor. Sometimes it is so dense, that visibility up to a few metre becomes more difficult. It happens generally when the condensed water particles in the air are developed near to the ground surface. If it is less intense then it is defined as shallow fog. Dense fog causes many aviation and road accidents. Fog disappears with the increase in temperature as water is evaporated.

(iv) Hail: These are known as hail storm. More or less transparent, hails are hard pellets of ice of various shapes and sizes, which fall from Cumulonimbus clouds. These attain great size with the fall in temperature of condensed air. When the pellets (grains) are opaque white and vary in size between 2 to 5 mm in diameter, it is called soft hail. In case, the grains consist of a nucleus of soft hail covered with a thin layer of clear ice, it is called a small hail. Actually these are pellets of ice with thunderstorms.

Indian Weather Symbols

Symbol		Symbol	Phenomenon	Symbol	Phenomenon
∞	Haze	$\bullet$	Rain	$\mathcal{S}\!\!\rightarrow$	Dust or sand Storm
$=$	Mist	∇	Shower	ξ	Dust Whirl
$\equiv$	Fog	$*$	Snow	K	Thunderstorm
$\overline{}$	Shallow Fog	$\uparrow\!\!\rightarrow$	Drifting Snow	$\bigtriangledown$	Squall
Δ	Hail	,	Drizzle	$\lessdot$	Lightning

(v) Drizzle : When the condensed water in the clouds falls on the surface in the form of water droplets, it is called as drizzle. It is less intense rain.

(vi) Shower : When, suddenly clouds drops the water drops continually for a short period of time, then it is defined as shower. Generally, the sky is cleared after such temporary incidence.

(vii) Rain : When, water drops from the clouds, fall continuously and the size of these water drops is quite big, it is known as rain. It is the most common form of precipitation. Rain drops are 0.5 mm to 6.50 mm in diameter.

(viii)Squall : A blast of wind of higher velocity than average which rises suddenly and after lasting for a few minutes dies away comparatively suddenly. It is in real sense a sudden blast of wind. Sometimes, it may provide rain.

(ix) Frost : When the temperature of air falls below the freezing point and the water vapour is directly converted into crystals of ice. An accumulation of these crystals is called frost. It is seen ice on solid surface. It is found in those regions where the night temperature falls below 0^0C. It causes severe damage to plants. It can make roads slippery, dangerous to movement.

(x) Sleet: It is a mixture of rain and ice. It rains with snowfall. Such incidents are very common in cold regions. High mountain areas also experience, sometimes such mixture of rain.

(xi) **Snow:** It is a powdery mass of ice crystals. These ice crystals are spread on the surface in a layer. The thickness of the layer depends on the intensity of ice crystals. These crystals may fall singly or a number of them may combine to form large flakes.

(xii)**Thunderstorm:** When the winds move with a high speed, with lightening and thundering or roaring clouds, and provide heavy and sudden rain, known as thunderstorm. This is caused due to sudden change in atmospheric pressure conditions. At some occasions, they are also accompanied with hailstorms.

(xiii)**Dust Devil:** When the dust particles, suddenly rise in the circular form generate the form of dust devil. Winds go up speedily in circular form and carry dust particles upto a great height in the atmosphere. They also move horizontally as dust bowl. After such movement, these are automatically disappeared. Hot desert areas, experiences such atmospheric incidents.

(xiv)**Drifting Snow :** It is the movement of the snow. Its speed of movement depends on the slope of the surface and gravity of snow. The change in temperature has its impact on it.

(xv) **Dew:** It is a drops of water on cool, solid surfaces. It is found in regions where the night temperature does not fall below 0°C. It is beneficial to plants. It is not confined in only cold places. It also occurs in hot and humid regions. In deserts, the formation of dew is an important source of water for many plants and animals. It disappears with the increase in temperature.

6. **Precipitation :** Precipitation is classified according to its form in which it reaches the ground. The temperature of the air, both inside and outside the cloud determines whether the precipitation is rain, snow sleet, or hail.

   On Indian weather map, all these phenomena are shown by certain weather symbols, as discussed above. The amount of rainfall is gives on the map in the following form. This amount is printed near the circles showing sky conditions:

   — = 0.25 to 0.74 cms.

   I = 0.75 to 1.49 cm.s

   The amount of rainfall 2 cm. or more than 2 cmsis mentioned in figures near sky condition circles. This amount of rainfall in related with the last twenty four hours.

7. **Sea Conditions:** On India weather map, the conditions of sea wave movement is shown with certain abbreviations of English language. These symbols help us to assess the movement of sea water, that whether it is calm or it is notorious or disastrous.

   Following symbols are used on Indian weather map to show the sea condition of Arabian Sea, Bay of Bengal, and adjoining Indian Ocean. Such details are very useful to navigators, boat sailors, and fishermen, and also to coastal population.

1.	Cm. – CalmSea	5.	Ro. – RoughSea
2.	Sm – SmoothSea	6.	V.R.O. – Very Rough Sea
3.	Sl. – SlightSea	7.	Hi – HighSea
4.	Mod – ModerateSea	8.	V. Hi. – Very HighSea
		9.	Ph. – Phenomenal

7. **Department of Air Pressure from Normal :** This feature of weather is shown on a small map printed below the main weather map. It shows the variation of air pressure from the normal, that it is high or less than the normal limit. This variation is shown by the symbol of + Plus and – Minus. If it shows the variation in Minus, it denotes that the air pressure is below the normal limit, whereas, if it is in Plus, it indicates that air pressure is more than the expectation.

8. **Departure of Temperature from normal :** This is shown an two small maps, printed with the large weather map. One map shows the departure of temperature from the maximum limit and the another one departure of temperature from the minimum limit of temperature.

Weather Map Interpretation

Here, two weather maps have been interpreted in detail. One for the month of July and another for the month of January.

(A) July Weather Map

This weather map represents the weather conditions for the date 20 July, 1981, and corresponds to the time of 8.30 morning. It also indicates weather phenomena for the last twenty four hours. It is published by Indian Meteorological Department of Pune. This map also shows weather conditions of adjacent countries of India, i.e. Pakistan, Nepal, Bhutan, Bangladesh and Sri Lanka. (Fig. 2.2)

(i) Air Pressure: It is shown with the help of isobars. The main feature of air pressure is that it is high on seas than the land. Air pressure is on increase from the central part towards the southern part.

(a) **Low Pressure Areas :** Two such areas can be marked. One area is located on southern part of Pakistan. It is surrounded by a bar of 998 mb. It has much intensity in its south part is comparison of its north part. Another low pressure area is extended on central east India. Its location entails that it may further proceed towards west and north-west. It is surrounded by an isobar of 1000 mb.

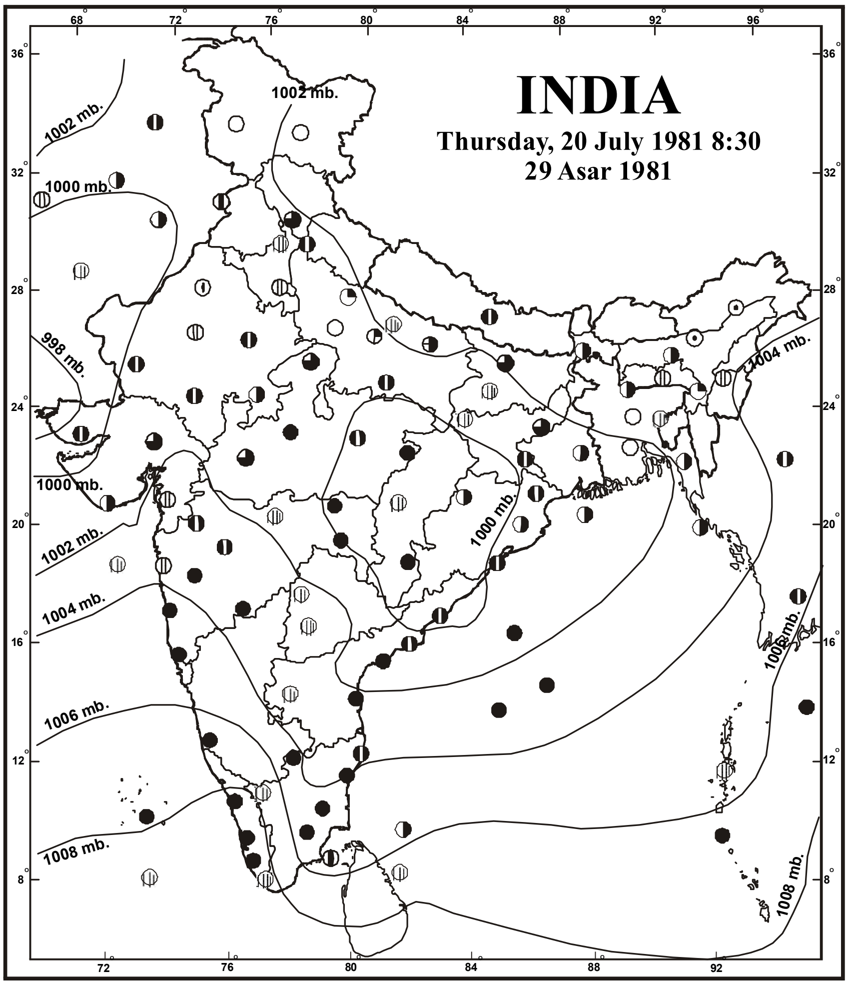


Fig. 2.2 India (Thursday, 20 July, 1981 (8.30 a.m. 29 Asar 1981)

(b) **High Pressure Area:** It is extended on Sea area. Arabian Sea has much high pressure than Bay of Bengal area. Arabia Sea High Pressure area has an isobar of 1008 mb. An High pressure area has developed on north-west boarder of Pakistan. It has air pressure 1002 mb which is Quite low than Arabian Sea High Pressure area. High Pressure is quite intense in the sea area.

(c) **Pressure Gradient:** South Indian has high pressure gradient. Here, isobars are very near to each other. On the other hand most central and north parts have low pressure gradient. The west and north parts rather have the absence of isobar. Pressure is on increase from north to south direction. ArabianSea has more gradient than Bay of Bengal.

(ii) Wind :

(a) **Direction :** Winds are blowing from Sea to land. Arabian Sea has South-west winds. These are blowing towards Western Ghat. In Bay of Bengal, winds are in south to north, and in north-west direction. In North-West of India, these have their direction towards Pakistan.

(b) **Velocity :** The speed of the wind on the sea is much faster than the land. The high pressure gradient has produced high speed winds in the area. The speed is between 5 to

15 knot in the sea area. The central and eastern parts of India have the wind speed less than 10 knot per hour.

(iii) Sky Conditions : Western and Eastern coast. Eastern and Central India are covered with clouds. The sky of north-central part is clear. South India sky is highly cloudy. Tripura, Mizoram, West Bengal and Terai Region have cloudy atmosphere. The sky of Odisha, and Andhra Pradesh is also covered with clouds.

(iv) Amount of Rainfall : Most Parts of India have received rainfall during the last 24 yours. Monsoon has been quite active in Kerala. The western Coasts, Lakshadweep have received heavy rain during the period. In Arabian Sea, Andaman-Nicobar islands are also in the grip of heavy rains. Odisha, lower Gangetic Plain, Central Madhya Pradesh, Chhatisgarh have also moderate rainfall. Hilly regions have also rainy atmosphere. Assam, Rajasthan, Punjab, Haryana and Western Uttar Pradesh have scattered rainfall or are dry. In Kerala, amount of rainfall is between 8 and 10 cm. Hyderabad has 6 cm. rainfall. In West Bengal it is 3 cm. in Birbhumi, Due to cyclonic depression. Chhatisgarh and west Odisha have enough rains.

(v) SeaCondition : Sea is quite smooth in Bay of Bengal. It is calm in PakStrait. It is rough on KeralaCoast. KonkanCoast has smooth and slight sea. North Arabian sea is smooth.

(vi) **Departure of temperature from normal :** The temperature in north-west India is below the normal. It is 8°C low than the normal in West Rajasthan. In Karnataka, Tamil Nadu it is also less than the normal. The remaining areas of the country have the temperature above the normal. Uttar Pradesh, Bihar, Jharkhand and West Bengal have the temperature 2°C high than the normal.

(vii) **Departure of air pressure from normal :** Two areas have developed of air pressure departure. The northern parts have air pressure above the normal. It is 4 millibar more than the normal in Himachal Pradesh, hilly areas and Pakistan. South India has air pressure below the normal limit. It is 2 millibar less than the normal on eastern coast.

(viii) **Weather Forecast :** Weather Department has predicted that Monsoon will make more progress in next few days. It will rain at all places. South Madhya Pradesh, Chhatisgarh, Telangana, AndhraCoast, KeralaCoast will receive heavy rainfall. Hilly areas may have heavy rainfall at few places.

(B) Winter Season Weather Map

This weather map shows weather conditions of India and its adjacent countries for the date 4 January 1993. The time is 8.30 a.m. It is published and printed by Indian Meteorological Department, Pune. (Fig. 2.3).

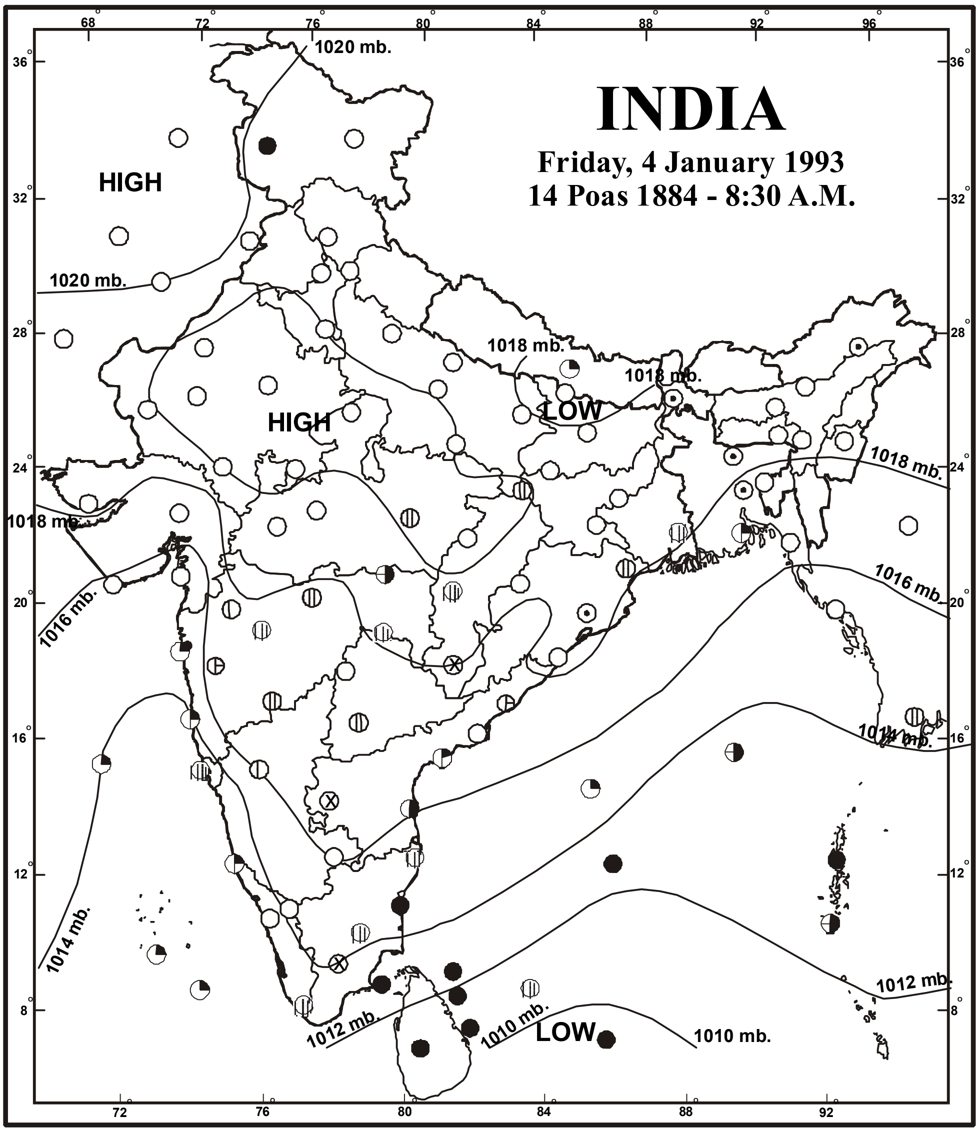


Fig. 2.2 India (Friday, 4 January, 1993 (8.30 a.m. 14 Poas 1884)

(i) **Air Pressure: The** pressure is on increase from south to north. This is the winter season, and it is quite natural that Indian ocean has low pressure than the Indian surface. Isobars have sufficient distance, giving evidence of normal air pressure conditions in the country.

(a) **High Pressure Area :** There are two areas of High Pressure. One is extended on Western India with a isobar of 1020 mb, and the another area is extended on Pakistan, also having an isobar of 1020 mb. Both seems to be interconnected to each other. Most parts of north India are having the air pressure between 1016 and 1020 mb. Isobars limiting high pressure area have sharp curves. These are not straight lines, reflecting high variations in the air pressure conditions.

(b) **Low Pressure Area :** Indian Ocean has the extension of low pressure area. It is surrounded by an isobar of 1010 mb. These isobars have their extension in V-shape. On land, these are more shifted towards south. Whereas, in sea area, these have north ward trend. A low pressure area has also developed in Nepal, but Its intensity is not so low.

(c) **Pressure Gradient :** It is not so high. In South India, the isobar has the value of 1012 mb, whereas the North India has the extension of 1020 mb isobar. As a whole, South India has more pressure gradient than the north India. Eastern India has not much variation.

(ii) **Wind**

(a) **Direction :** Winds have variations in their direction in North India. These are moving from high pressure area to towards east, and north. In south India, their direction is from land to sea. In east, they have variation in direction.

(b) **Velocity :** In most part of India winds are quite calm. Their speed is more in south India. In north India, their speed is 5 to 10 knot. The wind speed is slow, because of low gradient in air pressure.

(iii) **Sky-Conditions :** Most parts of India have clear sky. Jammu Kashmir has clouds in its western part. In central and south India. Clouds are high. Eastern coast has cloudy sky. It has rainy conditions in Tamilnadu. ArabianIslands have also cloudy weather.

(iv) **Amount of Rainfall :** There is no rain in north India. Jammu-Kashmir state has showering in few areas. Eastern coast has also enjoyed little rain in the last 24 hours. Andaman Nicobar Islands have recorded 3.0 cm. rainfall.

(v) **Sea Condition :** The sea waves are smooth in Bay of Bengal. Arabian Sea, in its north part is calm, while its south part has slight and moderate conditions. The sea is smooth near Lakshadweep.

(vi) **Departure of temperature from normal :** The minimum temperature in north India is high than the normal. In South India it is also high than the normal. The Eastern India has recorded the temperature low than the normal. The maximum temperature is below the normal. It is high only in the sea area.

(vii) **Departure of air pressure from normal :** There is an increase in the air pressure in land area during the last 24 hours. It is more in central India. In South India air pressure has shown reduction. Sea area has also shown the fall in air pressure.

(viii) **Weather Forecast :** Meteorological Department has made this forecast that. South-east India may have more rains in the next 24 hours. Here, the rainfall may be accompanied lightning. North India will have dry atmosphere with calm air.

2.4 CONCLUSION

The study of weather is an important and interesting, as it affects our life in various ways. Weather denotes the conditions of atmosphere of a particular time. Its forecast makes us aware. Weather is shown by a map. So weather map is a map of weather conditions of a particular time of that area. Indian meteorological Department publishes Indian Daily Weather Report. Its Report contains six pages, along with two maps. These represent for Indian standard time of 8.30 a.m. and 5.30 p.m. The morning weather map is very useful as it gives certain information for the last twenty four hours. These maps show air pressure, wind speed and wind direction, clearness of the sky, amount of cloud on the sky, amount of rainfall, certain important weather phenomena, movement of sea water, departure of temperature and air pressure from the normal. Weather forecasting is possible by the observation of all these weather phenomena.

2.5 SUMMARY

Weather is a state of atmosphere of a particular time. Its explanation depends on the observations of temperature, air pressure, sky condition, wind condition, and moisture. Such observation helps us in the forecast of weather. Our Indian Meteorological Department has made an attempt in this direction. It publishes daily weather maps of India, depicting weather conditions for 8.30 mornings. It is based on the observation and information received and collected from various laboratories, located in different parts of the country. These observatories are known as surface, upper air and space based.

Indian Weather Report consists six pages. It has two maps : one shows the weather conditions of the day at 8.30 a.m. gives the amount of rainfall for the last 24 hours. Another map depicts the weather conditions of the day at 5.30 p.m. It shows the changes in the weather have taken place during the last 9 hours. There are also given two small maps, showing the departure of maximum and minimum temperature and air pressure from the normal.

India weather map is studied with the help of certain symbols and codes. It has introductory information. i.e. time, day, data and year. Air pressure is shown by isobars. These are drawn with an interval of 2 millibar. Their shape, distance between two isobars entails us with changes in the weather. Their near location indicates much change instead of their distant location. High and Low Pressure areas are also marked on the Map. Their location acquaints us with the movement of winds, which are directly related to air pressure. Wind direction is indicated by an arrow. The back part of an arrow indicates that the winds are coming from that side. Wind speed is shown with the help of oblique lines on this arrow. Half oblique line is an indication of 5 knot per hour. One full oblique line is equal to 10 knot.

Sky conditions are shown by a circle. The shaded part of the circle indicates the amount of cloud. If it is full shaded, then it indicates that the sky is fully covered with the clouds. The other atmospheric phenomena are also shown with the help of approved symbols. These phenomena are haze, mist, fog, shallow fog, hail, drizzle, shower, rain, squall, frost, sleet, snow, thunderstorm, dust devil, drifting snow.

Amount of rainfall is given in cm. This indicates for the last twenty four hours. Sea waves are shown on the map. Sea is calm or it has notorious movement. The movement of sea water affects the fishing and navigation activities.

Department of temperature and air pressure from the normal also helps us to assess the weather conditions prevailed during the last twenty four hours. The departments of maximum and minimum temperature from the normal are also explained. In this chapter, July and January weather maps have been discussed in detail as an example.

2.6 GLOSSARY

ISI	-	Indian Standard time
GMT	-	Greenwich Meridian Time
Observatory	-	A place of recording and maintenance of weather data.
Isobar	-	An imaginary line drawn on map joining places with equal barometric pressure
Millibar	-	It is equal to 1 Bar or 756 millimeter
Knot	-	Nautical Miles per hour, wind speed
Overcast	-	Sky is fully covered by clouds
Obscured	-	Un-cleared Sky
Weather Forecast	-	Protection with a reasonable amount of certainly about the conditions of weather that would prevail in the next 24 to 48 hour in a certain area.
Isotherm	-	Imaginary line drawn on a map joining places with equal temperature, reduced to seal level.
Departure	-	The variation of Maximum and minimum temperature from the normal.
Mean Sea Level(MSL)	-	The average height of the surface of the sea for all stages of the tide.
Variable	-	Any Characteristic which varies.
Cardinal Point	-	North, South, East and West are main Points or directions.

2.7 ANSWER TO CHECK YOUR PROGRESS

1. Weather is the statement of a particular time.
2. Climate is an assessment of a long period of weather conditions.
3. Weather map denotes the weather conditions of that area of a definite time.
4. Weather forecast help us to take safety measures in advance.
5. Indian weather maps are published by India Meteorological Department, Pune.
6. Indian weather maps are for 8.30 a.m. and 5.30 p.m.
7. Weather maps are based on three observations- surface, upper air and space based platforms.
8. Air pressure is shown by isobars and the units of scale ismillibar.
9. India weather map shows the location of High and Low pressure area.
10. Air pressure gradient is identified by the distances between the isobars.
11. Wind Speed is explained in nautical miles per hour.
12. Main wind directions are North, North-east, South, South-east, East, South, South-west, North-west.
13. Sky condition denotes that how much area of the sky is covered by clouds.
14. Overcast sky is fully cloudy sky.

15. Obscured sky has low visibility.
16. The intensity of visibility is represented by dew, haze, mist, shallow fog, and fog. These are the forms of condensation.
17. As a form of precipitation drizzle, shower, rain, sleet, snow conditions are shown on weather map of India.
18. Squall duststorm or thunderstorm, dust devil, represent the nature of wind movement and its velocity.
19. Drifting show indicates the movement of snow.
20. The conditions of sea helps us in fishing and navigation.
21. Make Correct Pairs of the following Weather phenomena :

	Column-A		**Column-B**
1.	Haze	a.	High intense of condensed water vapour
2.	Mist	b.	Water vapour fall in form of ice crystals
3.	Fog	c.	Water droplets on the surface
4.	Shallow Fog	d.	Obscured sky with dust particles
5.	Dew	e.	Obscured sky by condensed water particles
6.	Frost	f.	Less intense condensed water vapour

Answer : 1 (d), 2(e), 3(a), 4(f), 5(c), 6(b)

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2.10 TERMINAL QUESTIONS

1. What do you mean by weather? Why should we study it.
2. What are the basic elements of weather?
3. What is a weather map?
4. Why and when the first weather map was produced?
5. Name the organization in India which records and monitors weather related data and information.
6. When Indian Meteorological Department was established. Explain its role in Weather forecasting.
7. Discuss how weather maps and charts are prepared and how are these useful to us?
8. Which organization in India records and monitors weather related data and information's?
9. What are three modes of meteorological observations used globally?
10. Discuss the weather map for the months of July and January.
11. Explain is detail those weather phenomena which are used by Indian Weather Map?
12. What do you mean by air pressure? How it is represented on the weather map of India?
13. How the amount of cloud is shown on Indian weather map? Explain.
14. How the movement of sea water is shown of weather map? Discuss.
15. What do you mean by the departure of air pressure and temperature? Discuss.

UNIT 3: REPRESENTATION OF CLIMATIC DATA

3.1OBJECTIVES

After realizing the significance of climatic data, the objectives of the present chapter will make you capable;

- To identify changes in the atmosphere and represent the results through appropriate methods of various weather phenomena.
- To understand weather phenomena and resultant climate changes in a better and effective manner
- To understand, how to represent data related to temperature, wind, humidity, and rainfall, as well as other atmospheric factors that describe the local weather and climate.
- Understand the interrelationships of these elements in different parts of the earth surface

3.2 INTRODUCTION

Climate of any particular place or country is the topic of interest for geographers all over the world. Scientific studies in the past few decades provide information that the global climate is changing in a way that it may challenge the survival of human beings. The pattern of human life in any particular region is largely dependent upon the type of climate of that particular region. Because of global warming the spectrum of world geography, economy and society will obviously change. Therefore, the changing climatic patterns all over the world are matter of concern for scientists and researchers in different parts of the globe today. For proper understanding of climatic conditions all over the world or a place or region within it, it is necessary for us to understand what is meant by the term weather. Weather is simply the current state of the atmosphere at a specific location at any given point in time. You know very well the fact that some places are dry, some are wet, some are hot, some are cold, and rest are different having a complex combination of different types of weather.

You can find out what the weather is like where you live by looking out the window or by stepping outside. In your daily life, you often use this term by asking a relative or friend about the weather conditions of his or her place. Weather refers to temperature, humidity, cloudiness, visibility, different forms of precipitation, and the wind's direction and speed. To understand better, you must know that the above-mentioned five factors determine the state and condition of the atmosphere and, therefore, influence and determine the weather. Each place on Earth has weather. However, weather typically varies in different places on the Earth surface. Scientists who study the weather collect information from different places on Earth and come up with averages, or typical types of weather, for a particular place. They include day-to-day state of the atmosphere in a region and its variations. The difference between weather and climate, which students often confuse, is, therefore very simple. Weather tells you about the atmospheric conditions at any given moments Real-time measurements of pressure, temperature, wind speed and direction, humidity, precipitation, cloud cover, and other variables. Thus, you can define weather as the day-to-day state of the atmosphere, and its short-term (minutes to weeks) variation.

You can directly feel the impact of weather in your daily lives and analyze its impact on a wide range of subjects including the social and economic well being of human beings in the place where they live. If you are planning for a tour or outing the first question you ask to yourself is about the weather conditions of the place you are going to visit so that you may carry your luggage accordingly. Now, let us know what climate is. Climate is statistical weather information that describes the variation of weather at a given place for a specified interval. Thus, you can say that climate includes weather conditions for a given location over a period. Climate determines mean values of weather elements over a fairly wider territory and a longer period. In popular usage, climate represents the synthesis of weather; more formally, it is the weather of a locality averaged over some period (usually 30 years), plus statistics of weather extremes. Thus, they are both used interchangeably sometimes but differ in terms of the length of time they measure and what trends affect them. The climatic conditions of a region are directly involved in determining the environment of that particular area including flora and fauna. Climate also has its impact on the houses people live, the clothes they wear and up to some extent the recreation opportunities of that particular area.

Analyzing climatic information involves seeking patterns, relationships, and connections. As you analyze and interpret information, meaningful patterns or processes emerge. After this, you can synthesize your observations into coherent explanations. During the process, it would be useful for you to note associations and similarities between areas, recognize patterns, and draw inferences from maps, graphs, diagrams, tables, and other sources. Using basic statistics, you will be able to look for trends, relationships, and sequences. Climatic analysis involves various processes. It is sometimes difficult to separate the processes involved in organizing climatic information from the procedures used in analyzing it; the two processes go on simultaneously in many cases. But in other instances, analysis follows the manipulation of raw data into an easily understood and usable form. However, interpretations of climatic data involve the use and development of spatial climatic data. Meteorological warnings and forecasts are very significant for the people and should be disseminated in a proper way, if they are to be of value to users. Different types of graphs and diagrams are used to represent weather conditions and climatic data. Rapid developments in technology, however has its significant impact in the area of graphics. On the one hand, developments in computer technology enable production of a vast array of graphic material, and on the other hand, need of formal training to produce expertise in graphics and training individuals with capabilities which can help in the representation of climatic data with computer cartography. With the information provided for a certain time in a certain area, trained personals can guide more efficiently and help to develop graphics to suit the unique needs and circumstances of a particular area. Thus, from the very beginning up to now, we will discuss some of the important climatic diagrams in this unit.

3.3 REPRESENTATION OF WEATHER–DATA

The weather describes the atmospheric conditions at a specific place at a specific point in time. Climatic conditions of a particular place on the earth surface or the planet as a whole is determined by collecting meteorological data, real-time measurements of atmospheric pressure, temperature, wind speed and direction, humidity, precipitation, cloud cover, and other variables. After knowing weather statistics for over periods of 30 years, you can determine the climate of your region.

Weather generally includes sunshine, rain, cloud cover, winds, hail, snow, sleet, freezing rain, flooding, blizzards, ice storms, thunderstorms, steady rains from a cold front or warm front, excessive heat, heat waves and more. Major weather phenomena are as follows-

- The first and most significant factor that determines weather is temperature. Temperature is measured using a thermometer in degrees Fahrenheit or Celsius.
- The second factor is air pressure that includes the amount of pressure exerted by the air in a particular air mass. Air pressure is also called barometric pressure because it is measured using a barometer and commonly measured in inches of mercury.
- The third factor that can determine the weather is if a place is experiencing humidity. Humidity is a measure of the water content of the air mass.

Weather instruments are used to take measurements of temperature, wind, humidity, and rainfall, as well as other atmospheric factors that describe the local weather and climate. Different types of instruments are used to measure different parameters and there are many types to choose from. The variables measured with these types of instruments are wind speed and direction, pressure, humidity, temperature, and precipitation, including rain and snow. For representation of weather- data it is necessary to view certain parameters in certain places. The user can define the month or season and place of interest. The weather data including past weather conditions and long term averages can be used for representation through various methods. Some of the methods with the help of which you can represent these data are given below:

3.3.1 Wind Rose Diagram

Wind rose is a graphic tool used by meteorologists. It was included on maps before the development of the compass rose. You can see a medieval wind rose diagram in the picture (Figure 6.1) which helped to let the reader know in which directions the 8 major winds (and sometimes 8 half winds and 16 quarter winds) blew within the plan view. No differentiation was made between cardinal directions and the winds which blew from said directions. North was depicted with a fleur de lis, while east was shown as a Christian cross to indicate the direction as seen in figure 1. With changing times, improvements were made to clearly show the speed and direction of the flowing wind. Wind rose is designed to show the frequency and direction of the wind at a weather station for a given time. The wind direction indicates the direction the wind is coming from. The number of wind directions and wind speed classes can change as required. For a better understanding we can say that it is a graphic tool used at meteorological stations. It gives a succinct view of the distribution of speed and direction of wind distributed at a particular location. Historically, wind roses were predecessors of the compass rose (found on maps), as there was no differentiation between a cardinal direction and the wind which blew from such a direction. At present, using a polar coordinate system of gridding, the frequency of winds over a time plotted by wind direction, with colour bands showing wind speed ranges. The direction of the longest spoke shows the wind direction with the greatest frequency.

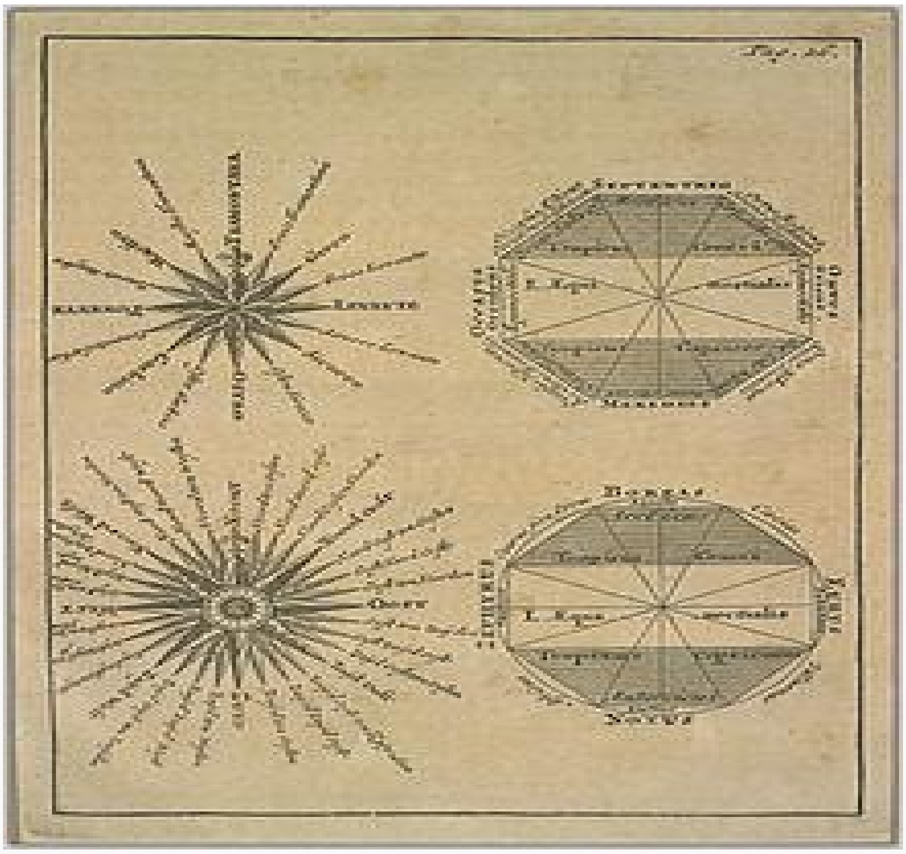


Fig. 3.1A medieval wind rose

The modern wind rose diagram shows the frequency of winds blowing from particular directions over a specific period. The length of each 'spoke' around the circle is related to the frequency of the wind from a particular direction per unit time. Each concentric circle represents a different frequency, emanating from zero at the centre to increasing frequencies at the outer circles. A wind rose plot may contain additional information, in that each spoke is broken down into colour-coded bands that show wind speed ranges. Wind roses typically use 16 cardinal directions, such as-

- North (N), NNE, NE, etc.
- They may be subdivided into as many as 32 directions.

Wind roses angle measurement in degrees as following

- North corresponds to 0°/360°
- East to 90°
- South to 180° and
- West to 270°.

The diagram (Figure 3.2.) shows speed of the wind flowing at different directions. The speed of the flowing wind towards different directions is measured in meters /second. Different colures of the spokes indicate towards the variations of wind speed that shows that the maximum speed of wind in the diagram is 15.50 m/second in the diagram .The circle in the centre indicates calm winds. Winds were calm 3.6 % of the time.

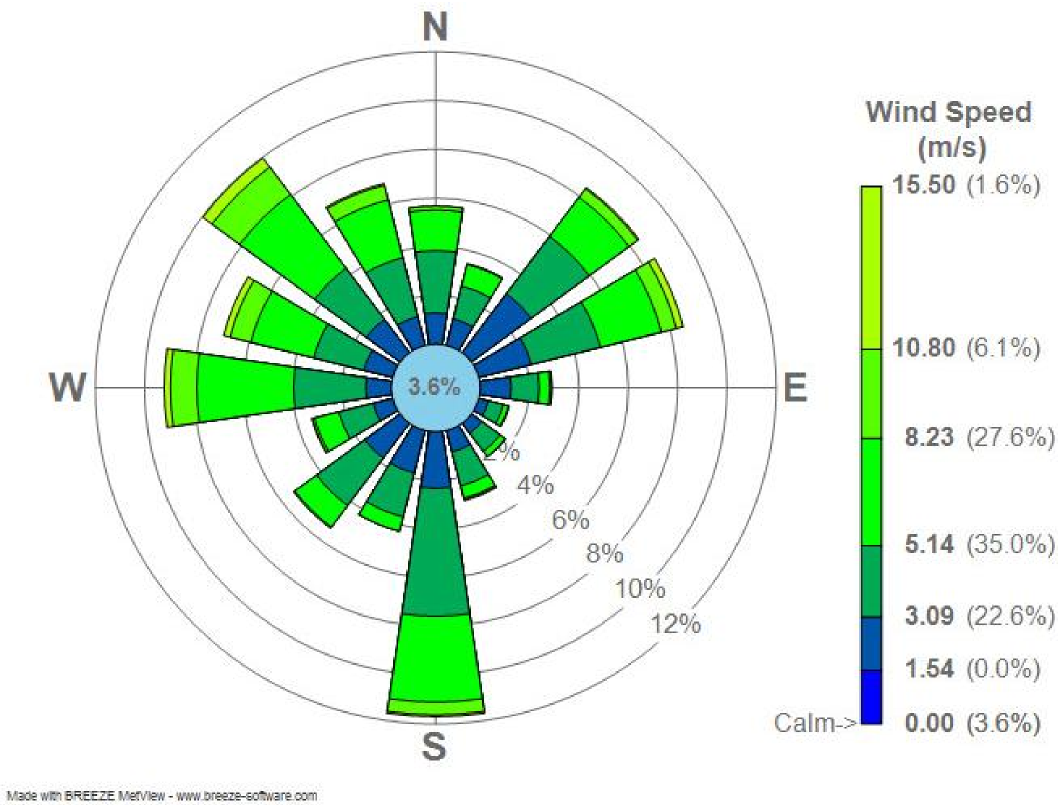


Fig. 3.2: A Modern Wind rose diagram

Compiling of wind rose is one of the preliminary steps taken in constructing airport runways as aircrafts typically perform their best take-offs and landing points into the wind. Below is a sample wind rose from December 6th - 7th from the Timber Weather Station.

The header identifies the weather station. In the example above, it is the Timber station at the Yellowstone Club. It displays the last 25 hours of data covering the date and time range shown on the upper right. A summary of average wind direction, average wind speed, and peak gust is given on the right as well.

The most important data is displayed by each "spoke." The length of each "spoke" tells the frequency of wind coming from a particular direction. In this case 72% of the given time (25 hrs), winds blew from the W. 24% of that time, winds blew from the WSW.

To determine wind speed frequency is a little more difficult. Wind speeds are indicated by colour. If a "spoke" is mostly one colour, then winds blew mostly at the wind speed denoted by that colour. In this case, 56% of the time, winds blew from the W at 5-15 mph. For the red section of the "spoke" which indicates winds at 15-25, you have to do a little math. The red section is between 72% and 56%. Subtract these two numbers and you get 16%. This means winds blew from the W at 15-25 mph for 16% of the time. The circle in the centre indicates calm winds. Winds were calm 0% of the time.

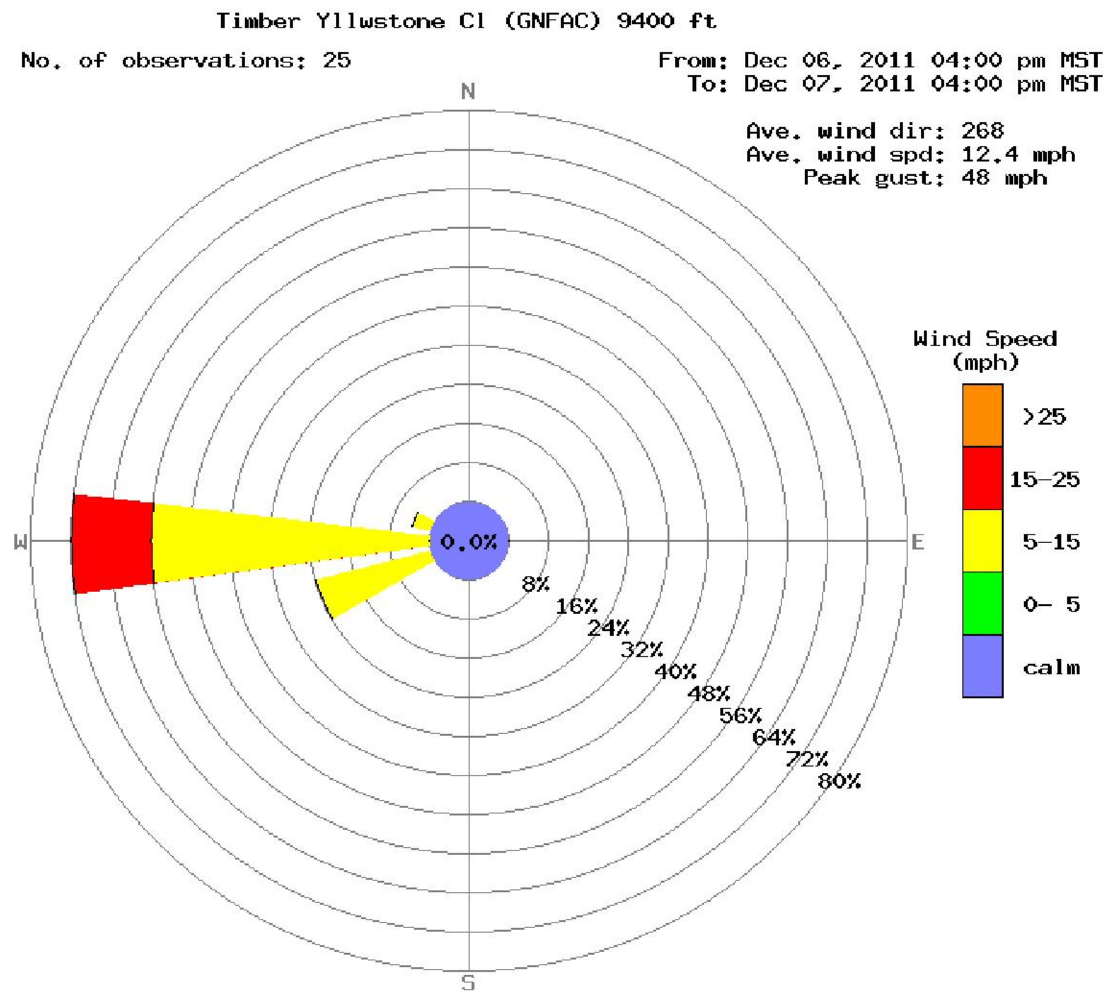


Fig. 3.3 Wind rose diagram for Timber station, Yellowstone Club

3.3.2 Rainfall dispersion diagram

Dispersion diagrams display the main patterns in the distribution of data. The graph shows each value plotted as an individual point against a vertical scale. It shows the range of data and the distribution of each piece of data within that range. It therefore enables comparison of the degree of bunching of two sets of data.

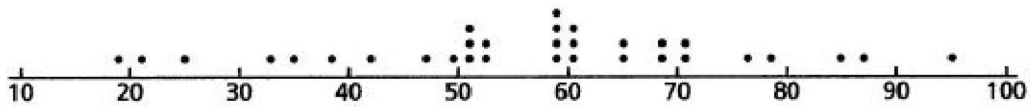


Figure -3.4:Dispersion diagrams

They are useful in presenting

- Maximum,
- Minimum

- Median
- Lower Quartile
- Upper Quartile

Rainfall Dispersion graphs display the main pattern in the distribution of rainfall data. The graph shows each value plotted as an individual point against a vertical scale.

Rainfall dispersion diagrams are drawn with the help of long-term meteorological data. To draw rainfall dispersion diagrams, first you will have to arrange all the data in ascending order. After arranging the data in such a way, you will be able to know the maximum and minimum amount of rainfall in every month. After that, you will calculate the median, lower quartile and upper quartile with the help of the formula given below.

Median=N+1/2th number

Lower quartile= N+1/4th number

Upper quartile= 3(N+1)/4th number

In the formula's given above 'N' value denotes the number of total given years for which data have been obtained. For ten years of meteorological data of Hapur, the maximum, minimum, median, lower quartile and upper quartile have been calculated for every month and the rainfall dispersion diagram (Figure 3.5) was drawn.

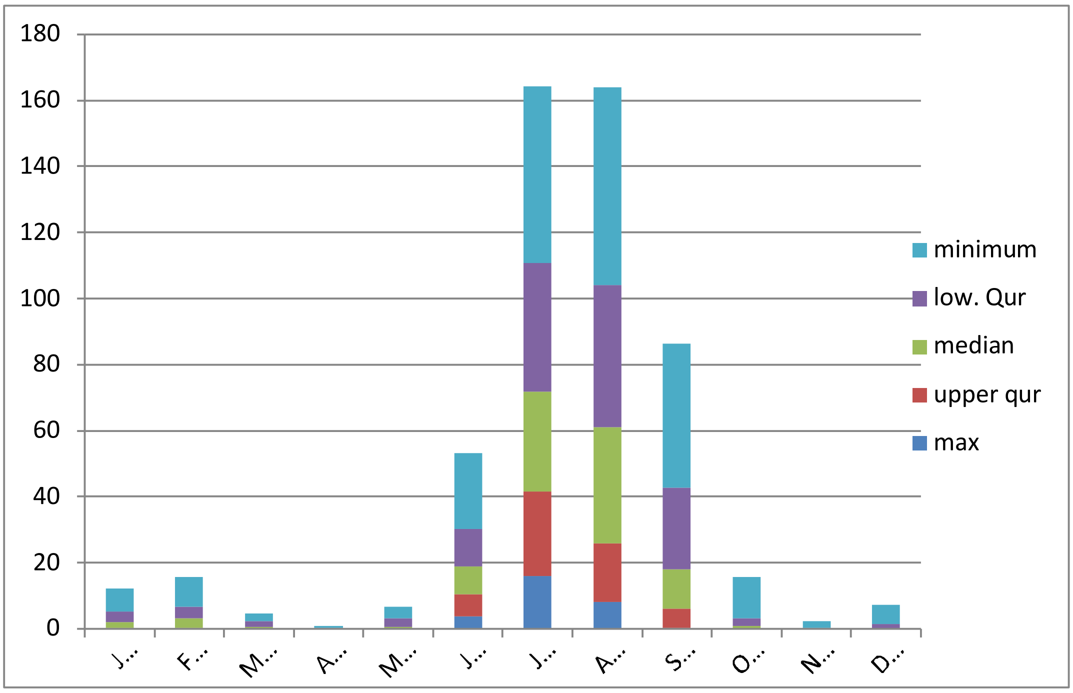


Fig. 3.5 Rainfall dispersion diagrams

3.3.3 Climograph

A graphical representation of basic parameters of climate (precipitation and temperature), which is monthly average at a certain location is known as climograph. It is used for a quick-view of the climate of a particular location. According to Monkhouse and Wilkinson "AClimograph or climagraph or climagram is a diagram in which the data for the elements of climate at any one station are plotted against one another″. In this way, you can say that a climograph is representing two climatic variables monthly means one as the abscissae and the other as the ordinates. The resultant twelve sided figure provides the general index of the climate of a particular station.

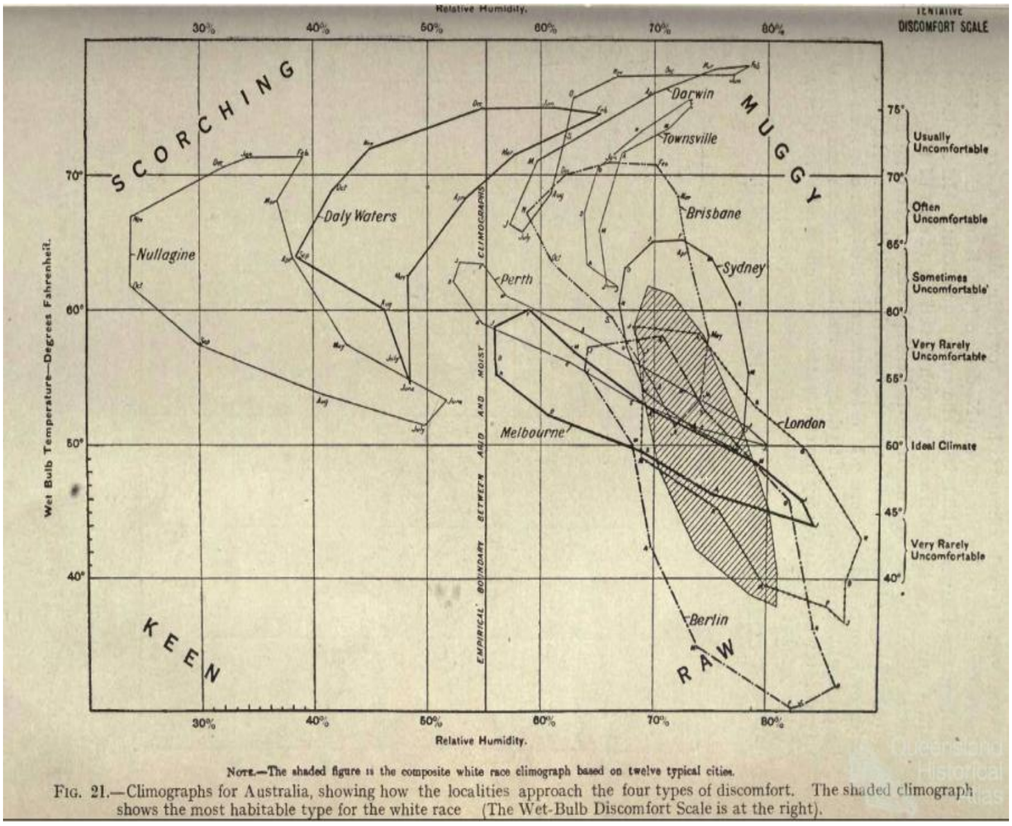


FIG. 21.—Climographs for Australia, showing how the localities approach the four types of discomfort. The shaded climograph shows the most habitable type for the white race (The Wet-Bulb Discomfort Scale is at the right).

Fig. 3.6Climograph by Griffith Taylor

Taylor's climograph represents wet –bulb temperatures (from 10°F-90°F) as ordinates and relative humidity (from20% to 100%) as abscissae. Each of the twelve points showing wet bulb temperatures and relative humidity for individual months is marked by initial letters of the month. The four corners N.W., N.E., S.W. and S.E. are marked as Scorching, Muggy, Keen and Raw respectively. They are very useful for comparative studies in climates, because they provide general climatic index, which can be understood at a glance.

Thus, a climograph also represents at least two elements of climate (temperature and rainfall, temperature and humidity) at one time. In 1918, Kuipan constructed climographs with the help of highest and lowest recorded temperatures in the warm and cold months giving a scientific base to the world climatic divisions. J.B.Laile used the average monthly data to construct such graphs. One form of representation uses an overlapped combination of a bar and line chart used to show the climate of a place over a 12-month period.

Another method uses a common horizontal axis while different vertical axis. Here both the precipitation and temperature are shown in bar charts. This method has an advantage that the range of temperature (average of minimum and maximum temperatures) can be shown, rather than just the average temperature.

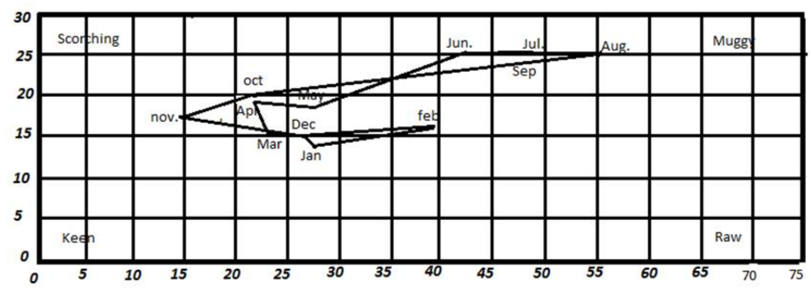
Climographs display temperatures in a clear and concise manner; however they may be misinterpreted when used in inappropriate situations. For this reason, it is important that they are utilized in a reasonable situation.

The climograph as developed by Dr. Griffith Taylor, but in a modified form in which data for air temperature and relative humidity are used in place of those for wet-bulb temperature and relative humidity, is believed to be useful in many ways beyond the simple showing of monthly averages of climatic conditions as heretofore. Thus, starting from the nineteenth century, climographs have been modified by numerous scientists all over the world. You can understand it clearly with the help of the example given below:

Example: Draw a climograph of Jodhpur with the help of following data:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Wet-bulb temperature (°C)	14	16	15	19	18	25	25	25	24	20	16	15
Relative humidity (%)	27	39	23	22	28	43	49	55	48	21	14	26

Choose suitable scales to represent relative humidity along the X-axis and wet bulb temperature along the Y-axis. Draw the co-ordinates of 27 %(relative humidity) and 14°c. (wet bulb temperature) to mark the point 'J'for January for Jodhpur. Similarly, mark the remaining eleven points. The twelve-sided polygon so obtained is the climograph of Jodhpur. Now write down Scorching, Muggy, Keen and Raw in their respective corners.



CLIMOGRAPH

Fig. 3.7 Climograph

3.3.4 Hythergraph

A plotted graph showing the relationships between precipitation and temperature is known as Hythergraph. This type of graph was first invented by Griffith Taylor in 1916.The Hyther graph as devised by G.Taylor is just like the climograph as defined by Raisz,Foster and Huntington. As explained in the climograph the twelve-monthly points are the temperature rainfall ratio in the hythergraph too. Temperature is plotted along the vertical coordinate and rainfall along the horizontal coordinate. The hither graph denotes the impact of evaporation in the earth surface and the actual availability of underground water in a particular place. During the period of high temperatures, even with sufficient amount of rainfall received the actual availability of water is low because of higher amount of evaporation. In the hythergraph presented by Griffith Taylor, limit of temperature and rainfall has not been given while in similar type of climograph Foster has included the maximum and minimum limits of temperature and rainfall. You can understand the significance of hythergraph with the following example :

Example: Draw hythergraph for Meerut with the help of following data:

	Jan	Feb	Mar	Apr	May	Jun	Jul	Aug	Sep	Oct	Nov	Dec
Average monthly temperature(°c)	14	16	22	28	31	32	30	29	27	24	18	14
Average monthly rainfall (cm.)	3	2	2	1	2	7	19	20	12	1	2	2

Choose suitable scales to represent rainfall along the X-axis and temperature along the Y-axis. Draw the coordinates of average monthly rainfall (3cm.) and average monthly temperature (14°c.)to mark the point 'Jan' for January. Similarly, mark the remaining eleven points Feb., Mar., Apr etc.. The twelve-sided figure so obtained is the hythergraph for Meerut.

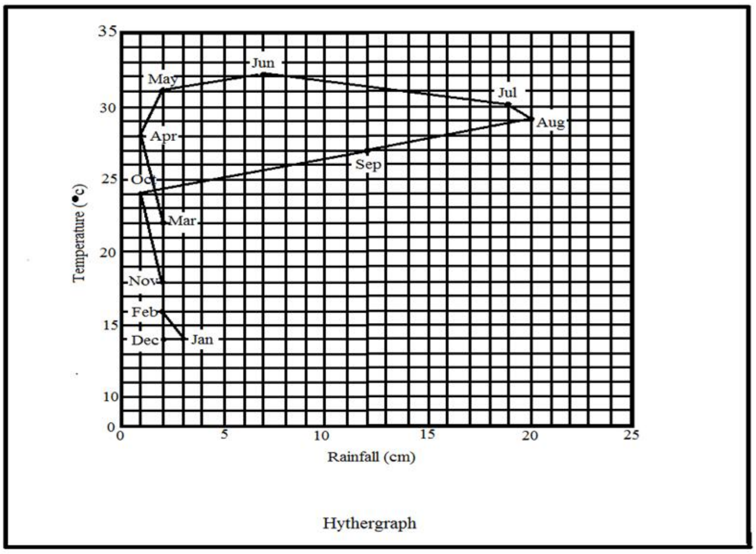


Fig. 3.9

Their major purpose is to provide general climatic differences, which occur in different parts of the earth surface and effect human life in various ways. They are much superior to the other combined rainfall and temperature graphs because they help a quick understanding of the relationship between varying atmospheric conditions. Moreover, they are also well suited for comparative studies.

3.4 CONCLUSION

Climate describes the average conditions of a place expected atgiven time .A region's climate is generated by the climate system, which has fivecomponents: atmosphere, hydrosphere, land surface, and biosphere. If you measure weather data calculate and analyze weather statistics over a long period, you will be able to understand the climatic conditions of that particular area. Temperature, rainfall, cloud cover, winds, hail, snow, flooding, blizzards, ice storms, thunderstorms, steady rains from a cold front or warm front, excessive heat, heat waves and more are the weather components that vary from place to place and time to time. In a long period, their impact upon the earth surface is well known as climatic variations. Representation of climatic data related to different regions such as hills, plateaus and plains have to be determined region-to-region and place to place.

Today, as you all know, the world is facing several challenges due to global warming and climate change. There are strong evidences, which indicate that, an increase in the mean maximum as well as minimum air and oceanic temperature, which is leading to widespread melting of glaciers, and rising sea levels. The increasing frequency and magnitude of disasters occurring due to climate change are posing threat to lives and livelihood at local level and; of course has its impact all over the earth. The Representation of these data is very important for you to understand. This may help you in a practical way to easily recognize the different climatic components and their changes along time at a particular place on earth or all over the globe. This may also help the communities adapt the challenges like soil erosion, land degradation, frequent flooding and rising sea levels. All the factors responsible for climate change need careful observations, continuous monitoring of climatic inputs, and research. This is only possible with data analysis and representation of the collected data bank.

Therefore, it is the requirement of the present hour to represent the collected data bank in a presentable manner to make it applicable in the areas concerned. With modern technology developing rapidly, the issue is no longer how to spread the information, but how to do it in the most efficient way. You must have understood up to now that collected data bank through different meteorological stations if represented through specific methods can help to compare them easily. This may help to deal with the problems related with changes in climatic conditions in general and the extreme weather conditions at different places around the world in particular that are matter of concern for scientists all over the world. The changes in the climate are at such a fast pace that many plants and animal species would vanish from the earth surface. By Identifying changes in the atmosphere and show the impact of human caused greenhouse gas emissions and other processes that are responsible for the same.

You must have understood up to now that the changing climatic conditions at different places all over the world requires continuous monitoring of weather data and representing them in a better way to make them useful for the poor people which are the most vulnerable to changing weather and climatic conditions. To show elements and processes of climatic in different parts of the earth surface so that they can be further used for solving multiple problems. Illustration of climatic data may help policy makers to make appropriate decisions immediately. Representation of weather- data accordingly may help in developing new ways of farming that support a healthy environment to minimize climatic impacts and create a better quality of life for farmers. Continuous monitoring and analysis of meteorological inputs can further be used for modelling. These methods may help policy makers to make appropriate decisions immediately.

3.5 SUMMARY

You learned in this unit that the average weather conditions at a specific place at a given time are known as climate. A region's climate is generated by the climate system, which has five components: atmosphere, hydrosphere, cryosphere, land surface and biosphere. Climate may include precipitation, temperature, humidity, sunshine, and wind velocity, phenomena such as fog, frost, and hail storms over a long period of time. Different types of instruments are used to measure different parameters. Weather stations collect meteorological information with the help of these instruments. These data can be analyzed and plotted through various methods and techniques. You have learned the methods which are very significant for representations of major components of climate .Thus; some of the methods included in this unit will help you to understand the weather phenomena which collectively represent climate in a better way. These are wind speed and direction, distribution of rainfall at a particular place at a certain period, varied temperatures, their interrelationships in a clear and concise manner and ultimately how they have their impact upon each other and on human beings in different parts of the earth surface. Thus, you must have understood up to now that all these methods are an initial part in understanding meteorological as well as climatic components up to a great extent.

Wind rose, a graphic tool used by meteorologists, was included on maps before the development of the compass rose. With the help of this diagram in order to let the reader was able to know which directions the 8 major winds blew within the plan view. Able to give more precise information, the modern wind rose diagram shows the frequency of winds blowing from particular directions over a specific period. The length of each 'spoke' around the circle is related to the frequency of the wind from a particular direction per unit time. In the rainfall dispersion diagrams graphs are used to display the main patterns in the distribution of data. The graph shows each value plotted as an individual point against a vertical scale. Drawn with the help of long term meteorological data, these diagrams predict the maximum, minimum, median, lower quartile and upper quartile .After arranging all the data in ascending order, you will be able to know the maximum and minimum amount of rainfall in every month. After that, you will be able to represent your data with the rainfall dispersion graphs.

To view the general climatic view at a glance, including more than single climatic parameters, a climograph represents at least two elements of climate (temperature and rainfall, temperature and humidity) at a given point of time. In 1918, Kuipan constructed climographs with the help of highest and lowest recorded temperatures in the warm and cold months giving a scientific base to the world climatic divisions. A plotted graph showing Griffith Taylor first invented the relationships between precipitation and temperature in the early twentieth century. This type of graph is known as Hythergraph. It resembles first invented by Griffith Taylor in 1916.

The Hythergraph as devised by G.Taylor is just like the climograph as defined by Raisz, Foster and Huntington. However, the climographsand hythergraphs both represent the relationship between rainfall and temperature . Moreover, hythergraphs also include the wind speed and direction. They well suit for comparative studies.

Thus, in this unit ,you have learned to represent climatic data mainly temperature, rainfall, direction of wind with the help of different methods which are very significant in the studies related with climatic differences that can be noticed after a careful observation of the available data collected from different parts of the world. Furthermore, after studying this unit, you may be able to think of the changes humanity needs to adapt to a world where changing climatic patterns is a matter of deep concern. All the above mentioned methods discussed in the unit are to facilitate analysis and prediction in the field of weather and climatic variability and changes for use, benefit and value to society.

3.6 GLOSSARY

Predecessors: A thing that has been followed or replaced by another.

Atmosphere: The atmosphere is a mixture of nitrogen (78%), oxygen (21%), and other gases (1%) that surrounds Earth. High above the planet, the atmosphere is the home for many plants and animals.

Cryosphere: The cryosphere is the frozen water part of the Earth system. Beaufort Sea, north of Alaska. One part of the cryosphere is ice that is found in water. This includes frozen parts of the ocean, such as waters surrounding Antarctica and the Arctic.

Biosphere: The biosphere is the biological component of earth systems, which also include the lithosphere, hydrosphere, atmosphere and other "spheres" (e.g. cryosphere, anthrosphere, etc.). The biosphere includes all living organisms on earth, together with the dead organic matter produced by them.

Temperature: An objective comparative measure of hot or cold a quantity

Humidity: Humidity represents the amount of water vapour in the atmosphere or in a gas.

Precipitation : Rain, snow, sleet, or hail that falls to or condenses on the ground.

Meteorology : The interdisciplinary scientific study of the atmosphere.

Fog : A visible mass consisting of cloud water droplets or ice crystals suspended in the air at or near the Earth's surface. Fog can be considered a type of low-lying cloud and is heavily influenced by nearby bodies of water, topography, and wind conditions.

Frost : The coating or deposit of ice that may form in humid air in cold conditions, usually overnight.

Hail storms : Any thunderstorm which produce hails that reaches the ground is known as a hailstorm has a diameter of 5 millimetres (0.20 in) or more. Hailstones can grow to 15 centimetres (6 in) and weigh more than 0.5 kilograms (1.1 lb). Unlike ice pellets, hailstones are layered and can be irregular and clumped together.

Greenhouse gases : The primary greenhouse gases in Earth's atmosphere are water vapour, carbon dioxide, methane, nitrous oxide, and ozone.

Blizzards : A severe snowstorm characterized by strong sustained winds of at least 35 mph (56 km/h) and lasting for a prolonged period of time—typically three hours or more.

Ice storms : A storm of freezing rain that leaves a coating of ice

Thunderstorms :A storm with thunder and lightning and typically also heavy rain or hail.

Cold front : The transition zone where a cold air mass is replacing a warmer air mass. Cold fronts generally move from northwest to southeast. The air behind a cold fronts is noticeably colder and drier than the air ahead of it.

Warm front : The transition zone where a warm air mass is replacing a cold air mass. Warm fronts generally move from southwest to northeast and the air behind a warm front is warmer and moister than the air ahead of it.

The median : A number that is halfway into the set. To find the median, the data should first be arranged in order from least to greatest.

The upper quartile : The median of the upper half of a data set. This is located by dividing the data set with the median and then dividing the upper half that remains with the median again, this median of the upper half being the upper quartile.

The lower quartile (Q1) : is the median of the lower half of the data set of the spatial climatic data.

Soil erosion : This is a naturally occurring process on all land. The agents of soil erosion are water and wind, each contributing a significant amount of soil loss each year.

Land degradation : A process in which the value of the biophysical environment is affected by a combination of human-induced processes acting upon the land. It is viewed as any change or disturbance to the land perceived to be deleterious or undesirable.

Scorching : high temperature (70°-80°F) and low relative Humidity (below40%)

Muggy : high temperature (70°-80°F) and high relative Humidity (over70%)

Keen :low temperature (below40°F) and low relative Humidity (below40%)

Raw : low temperature (below40°F) and high relative Humidity (over70%) becomes thinner until it gradually reaches space. It is divided into five layers. Most of the weather and clouds are found in the first layer.

Hydrosphere : The hydrosphere is the liquid water component of the Earth. It includes the oceans, seas, lakes, ponds, rivers and streams. The hydrospherecovers about 70% of the surface of the Earth.

3.7 ANSWER TO CHECK YOUR PROGRESS

6.7.1(Self-check Questions)

Q.1. What is climate?

Q.2. How can climate of a particular region are understood properly?

Q.3. How can you represent climatic data?

Q.4. What helps you to look for trends, relationships, and sequences in the available climatic data?

Q.5. Define ‘weather’.

Q.6. What is a wind rose diagram?

Q.7. What is the significance of each "spoke" in the wind rose diagram?

Q.8. Where are wind roses used as one of the preliminary steps taken in modern times?

Q.9. Who used climographs scientifically to divide the world into climatic divisions?

Q.10. What is the disadvantages of climographs?

Q.11. Who was the founder of hythergraph?

12. Fill in the blanks with the appropriate words given below
    (Ordinates, ascending, plotted, graphic tool)

i) Temperature is.......... along the vertical coordinate.

ii) Wind rose is a.......................... used basically by meteorologists

iii) Taylor’s climograph represents wet –bulb temperatures as ....and relative humidity as abscissae.

iv) In the rainfall dispersion diagrams, first you will have to arrange all the data in ....order.

3.7.2(Answers to self-check Questions)

1. Climate is detailed statistical weather information that describes the variation of weather at a given place for a specified interval.
2. The climatic conditions all over the world or a place or region within it, can be understood with collection, analysis and representation of weather data of that particular place or region.
3. Climatic data can be represented with the help of different types of graphs and diagrams.
4. With the help of basic statistical techniques you can find out trends, relationships, and sequences in the available climatic data.

5. The atmospheric conditions at a specific place at a specific point in time are known as weather.
6. The diagram, which shows the frequency of winds blowing from particular directions over a specific period, is a wind rose diagram.
7. In the wind rose diagram the length of each "spoke" tells the frequency of wind coming from a particular direction.
8. Compiling of wind rose is one of the preliminary steps taken in constructing airport runways as aircrafts typically perform their best take-offs and landing points into the wind.
9. In 1918, Kuipan constructed climographs giving a scientific base to the world climatic divisions. In his division, highest and lowest recorded temperatures in the warm and cold months were used.
10. Though climographs display temperatures in a clear and concise manner but if not used in appropriate situations there are chances of misinterpretation. Therefore, it is necessary that they may be used in a reasonable situation.
11. Hythergraph was first invented by Griffith Taylor in 1916.
12. Fill in the blanks with the appropriate words given below

i) Temperature isplotted along the vertical coordinate.
ii) Wind rose is a graphic tool used basically by meteorologists
iii) Taylor's climograph represents wet –bulb temperatures as ordinates and relative humidity as abscissae.
iv) In the rainfall dispersion diagrams, first you will have to arrange all the data in ascending order.

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3.10 TERMINAL QUESTIONS

1. Define 'weather'.
2. What can be the first step towards understanding the climate of a particular region?
3. What is climate?
4. What helps you to look for trends, relationships, and sequences in the available climatic data?
5. How can you represent climatic data?.
6. Highlight the major factors that determine the state and condition of the atmosphere?
7. Explain meteorology. Tell the significance of meteorological data for the students studying geography?
8. What is the relationship in between weather and climate?
9. What is a wind rose diagram? Are modern wind rose diagrams different from the previous ones? Explain.
10. What is the significance of each "spoke" in the wind rose diagram?
11. Where do we use wind roses as one of the preliminary steps taken in modern times?
12. Who used climographs scientifically to divide the world into climatic divisions?
13. What is the disadvantage of climographs?
14. Who was the founder of hythergraph?
15. Fill in the blanks with the appropriate words given below
    (Ordinates, ascending, plotted, graphic tool)
    i) Temperature is.......... along the vertical coordinate.
    ii)Wind rose is a.......................... used basically by meteorologists
    iii)Taylor's climograph represents wet –bulb temperatures as ....and relative humidity as abscissae.
    iv) In the rainfall dispersion diagrams, first you will have to arrange all the data in ....order.
17. Explain the changes in the modified form of climographs after Griffith Taylor.
18. In which senseare the words Scorching, Muggy, Keen and Raw used and by whom?
19. Explain dispersion graphs. How do these graphs represent rainfall?
20. What are hythergraphs? What do these types of graphs show?
21. Why is the representation of weather data included as a part of geographical studies?

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