Chapter Ten

India–Physical Setting

Chapter Concepts

- Size and Location
- Major Passes of India
- Natural Vegetation
- Water Resources of India
- Power Resources
- Iron and Steel Industry
- Drainage of India
- Monsoon
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Size and Location

In area, India is the seventh largest country in area, and the second largest in population after China in the world. India is the cradle of human civilisation and the mother of history. India stretches from the snow-capped Himalayas in the north to sun drenched coastal villages of the south and the highly fertile valley of Brahmaputra in the east to the barren sandy desert in the west. It covers an area of 32,87,263 sq km. India extends between 8° 4′ and 37°6′ north and longitudes 68°7′ and 97°25′east. It extends 3,214 km from north to south and 2933 km from east to west. India has a frontier of about 15,000 km. The total length of the coastline of the mainland, Lakshadweep and Andaman and Nicobar Islands is 7,517 km. The states and union territories of India have been given in **Table 10.1**.

***Table 10.1**: States and Union Territories of India*

	State/Union Territory	*Capital*
1.	Andhra Pradesh	Hyderabad
2.	Arunachal Pradesh	Itanagar
3.	Assam	Dispur
4.	Bihar	Patna
5.	Chhattisgarh	Raipur
6.	Goa	Panaji
7.	Gujarat	Gandhinagar
8.	Haryana	Chandigarh
9.	Himachal Pradesh	Shimla
10.	Jammu & Kashmir	Srinagar (summer) & Jammu (winter)
11.	Jharkhand	Ranchi

12.	Karnataka	Bangaluru (Bangalore)
13.	Kerala	Thiruvananthapuram
14.	Madhya Pradesh	Bhopal
15.	Maharashtra	Mumbai
16.	Manipur	Imphal
17.	Meghalaya	Shillong
18.	Mizoram	Aizawl
19.	Nagaland	Kohima
20.	Odisha (Orissa)	Bhubaneshwar
21.	Punjab	Chandigarh
22.	Rajasthan	Jaipur
23.	Sikkim	Gangtok
24.	Tamil Nadu	Chennai
25.	Tripura	Agartala
26.	Uttar Pradesh	Lucknow
27.	Uttarakhand	Dehra Dun
27.	West Bengal	Kolkata

Union Territories

Andaman & Nicobar	Port Blair
Chandigarh	Chandigarh
Dadar & Nagar Haveli	Silvassa
Daman & Diu	Daman
Delhi, NCR	New Delhi
Lakshadweep	Kavaratti
Puducherry	Puducherry

India has common border with Afghanistan, Pakistan, China, Nepal, Bhutan, Myanmar, and Bangladesh. Sri Lanka is separated from India by a narrow channel of sea known as the Palk Strait and Gulf of Mannar. The length of international boundaries of India with the adjacent countries has been given in **Table 10.2.**

***Table 10.2**: Border of India with Neighbouring Countries*

	Country	*Length km*	*Percentage of total length of border*
1.	Bangladesh	4096	26.95
2.	China	3917	25.99
3.	Pakistan	3310	21.78
4.	Nepal	1752	11.53
5.	Myanmar	1458	9.89
6.	Bhutan	587	3.86
7.	Afghanistan	80	0.52

Border of Indian States with Neighbouring Countries

1. Afghanistan: Jammu and Kashmir.
2. Bangladesh: Assam, Meghalaya, Mizoram, Tripura, and West Bengal.
3. Bhutan: Arunachal Pradesh, Assam, Sikkim, and West Bengal.
4. China: Arunachal Pradesh, Himachal Pradesh, Jammu and Kashmir, Sikkim and Uttarakhand.
5. Myanmar: Arunachal Pradesh, Manipur, Mizoram, and Nagaland.
6. Nepal: Bihar, Sikkim, Uttarakhand, Uttar Pradesh, and West Bengal.
7. Pakistan: Gujarat, Jammu and Kashmir, Punjab, and Rajasthan.

India: Geographical Extremes

Hottest Place: Briawali, Bikaner District, 56°C, 5th June, 1991.

Coldest Place: Dras in Ladakh (Jammu & Kashmir), - 45°C on 28th December, 1910.

Wettest Place: Mawsynram (Meghalaya) average annual rainfall about 11,875 m.

Highest Peak: K^2 (5611m) Jammu & Kashmir.

Longest River: Ganga River, 2510 km, catchment area 861,400 sq km.

Largest River Island: Majuli, Brahmaputra River (Assam), area about 1500 sq. km.

Largest Desert: Thar Desert, area 259,000 sq.km.

Largest Plateau: Deccan Plateau, 100,000 sq. km.

Highest Waterfall: Jog Falls on Sharavati River (Karnataka), height 253 m.

Longest Coastline: Gujarat, 1600 km.

Longest Beach: Marina Beach-Chennai, 13 km. It is one of the longest sea beaches in the world.

Largest Brakish Water Lake: Chilka Lake (Odisha, area 916 sq km.).

Longest Tunnel: Kharbude Tunnel (6.45 km). It connects Mumbai with Goa.

Longest Canal: Indira Gandhi Canal, 682 km in length.

Highest Dam: Bhakra Dam on Satluj River (Punjab), 226 m.

States of India lying exclusively in the Himalayas: Arunachal Pradesh, Himachal Pradesh and Sikkim.

States lying partly in Himalayas and partly in plains: Assam, Jammu and Kashmir, and Uttrakhand.

Boundary between India and Pakistan is known as Red Cliff Line.

Boundary Line between Pakistan and Afghanistan: Durand Line.

The Islands of Andaman and Nicobar are separated by Ten Degree Channel.

The Great Channel lies between Little Andaman and South Andaman.

***Table 10.3**: States with Longest Coastline*

	State/Union Territory	*Length of coastline (km)*
1.	Andaman and Nicobar	1962
2.	Gujarat	1215
3.	Andhra Pradesh	907
4.	Tamil Nadu	974
4.	Maharashtra	653

Physiographic Divisions of India: On the basis of physiography, India is divided into the following divisions:

1. The Himalayan Mountains.
2. The Great Plains of India.
3. The Peninsular Plateau.
4. The Coastal Plains.
5. The Islands.

The Himalayas (Himadari): The Himalayas are one of the youngest, loftiest and mightiest mountains in the world. They are about 2400 km from the Indus Gorge in the west to the

Brahmaputra Gorge in the east. Their width varies from about 560 km in Jammu and Kashmir to about 200 km in Arunachal Pradesh. The southern boundary of the Himalayas is formed by the foothills of Shiwaliks (300 m contour), but the northern boundary is obscure and merges with the Tibet Plateau (Fig. 10.1).

The highest peaks of the Himalayas have been shown in **Fig. 10.2**. In Himalayas, the number of peaks higher than 8000 m is 21, and those over 7500 m are 40. Most of the main ranges fall in India, Nepal, Bhutan and along the southern border of Tibet. The first ten highest peaks of the Himalayas are shown in **Fig. 10.2** and their heights are given in **Table 10.4**.

***Table 10.4:** Highest Peaks of Himalayas*

Peak	*Nepali Name*	*Chinese Name*	*Height above the Sea Level (M)*
1. Mt. Everest	Sagarmatha	Gomolangma	8848
2. K^2 (Karakoram)	-	-	8611
3. Kanchenjunga	Kangchenjanga	-	8598
4. Lhotse	Lhotse	Lhotse	8516
5. Makalu	Makalu	Makaru Shan	8463
6. Cho Oyu	Cho Oyu	Qowowuyng	8201
7. Dhaulagiri	Dhawalagiri	-	8167
8. Manaslu	Manaslu	-	8163
9. Nanga Parbat	-	-	8126
10. Annapurna	-	-	8091

The Great Himalayas are classified into four parallel longitudinal zones which have distinguished orographical and geological features as follows:

(1) Tethys/Tibetan or Trans-Himalayas including Karkoram, Ladakh and Zaskar (Zanskar) Ranges.

(2) Inner / Higher or Greater Himalayas.

(3) Lesser or Lower Himalayas.

(4) Outer Himalayas/Sub-Himalayas or Shiwaliks.

1. **The Tethys or Tibetan Himalayas**: It is about 40 km wide and lies just north of the Higher Himalayas. Its altitude varies between 3000 m and 4300 m. It is made up of highly fossiliferous rocks ranging in age from the earliest Paleozoic (Cambrian) to Tertiary (Eocene). It is separated from the Eurasian Plate by the Indus-Tsangpo Suture Zone.

2. **The Inner/ Higher or Greater Himalayas**: It forms the northern-most line of high ranges, over 6000 m in altitude, covered with perpetual snows and contains several of the highest peaks of the world. Formed mainly of the Central Crystalline (granites and gneisses) rocks, it is about 50 km wide.

3. **The Lesser or Lower Himalayas**: The Lower Himalayas consist of middle ranges and is closely related to the Inner Himalayas. It has an intricate system of ranges which are some 60 to 80 km wide. The important ranges of Lesser Himalayas include Pir-Punjal and Dhauladhar, stretching in Jammu and Kashmir and Himachal Pradesh. This zone is composed mainly of unfossiliferous formations.

4. **The Outer or Sub-Himalayan Zone**: It is separated from the Lesser Himalays at

Fig. 10.1 – Mountain ranges

some places by flat-bottomed valleys. It is represented by the autochthonous foothills of the Shiwalik ranges which are made up entirely of folded, poorly fossiliferous sediments of the Tertiary Age. The Shiwalik range makes almost a continuous chain of more than 2400 km from the Indus gorge in the northwest to the Brahmaputra in Assam. Having a width of 10 to 50 km, the height of Shiwaliks seldom exceeds 1300 m. The

The Himalayas have great geo-climatic, socio-economic and cultural significance for the people of India. Their significance may be summarised as under:

1. **Climatic Influence**: The Himalayas influence the climate of India significantly they intercept the summer monsoon, coming from the Arabian Sea and the Bay of Bengal, and protect the Great Plains of India from the Siberian cold winds in winters.
2. **Defence**: The Himalayas protected India from the outside invaders. In fact, India has never been attacked from the northern side.
3. **Source of Perennial Rivers**: Most of the mighty and perennial rivers of India originate from the Himalayan glaciers.
4. **Fertile Soils**: The great rivers of India deposit fertile soils in the Great Plains of India, making them one of the most productive plains of the world.
5. **Forest Wealth**: The Himalayas are very rich in forest and pharmaceutical herbs. They provide fuelwood, timber, edibles, fodder, medicinal herbs and raw materials for industries.
6. **Hydro-electricity**: The Himalayas offer numerous sites for the generation of hydroelectricity. Dulhasti, Baghliar, Silal (Chenab), Pong, Dehra on Beas, Bhakra-Nangal, Giri-Bata, Bassi, Chamera, Nathpa-Jhakri on Satluj, Tehri, Koteshwar, Palra (Bhagirathi), etc. are some of the important hydel projects in the Himalayas.
7. **Minerals**: The Himalayas are rich in metallic and non-metallic minerals. Coal is found in Kashmir, copper, lead, zinc, nickel, cobalt, tungsten, gold, silver, limestone, precious and semi-precious stones, gypsum, magnesite, marble and building materials, etc. are the other minerals found in the states of Uttarakhand, Himachal Pradesh, Jammu and Kashmir, Sikkim and Arunachal Pradesh.
8. **Tourism**: There are numerous hill stations in the Himalayas which attract thousands of international and domestic tourists throughout the year. Some of the important tourist stations in the Himalayas are Gulmarg, Sonmarg, Pahalgam, Yushmarg, Srinagar, Dalhousie, Dharamshala, Chamba, Shimla, Kullu, Manali, Mussoorie, Nainital, Ranikhet, Bageshwar, Almora, Darjeeling, Gangtok and Itanagar.
9. **Holy Places**: There are numerous religious and sacred places in the Himalayas which are visited by the people. A large number of pilgrims visit the sacred shrines of Amarnath, Badrinath, Gangotri, Kedarnath, Jwalaji, Uttarkashi, Vaishno Devi, Yamnotri, etc.
10. **Alpine Pastures**: The alpine pastures at high altitude provide nutritious fodder to the sheep, goats, and yaks of the tribal people of the Himalayas.
11. Himalayas are the abode of rich cultural heritage of tribes.

Mountain Ranges and High.est Peaks of India

The highest peak in India: K^2 (Godwin Austin) – 8611 m **(Fig. 10.2)**.

The highest peak in Aravallis: Guru Shikhar (Mt. Abu) – 1722 m **(Fig. 10.3)**.

The highest peak in Satpura: Dhupgarh (Mahadeo Hills) – 1350 m **(Fig. 10.3)**.

The highest peak in Eastern Ghats: Dewodi = Munda (Odisha) – 1598 m **(Fig. 10.3)**.

The highest peak in Western Ghats and the highest peak in the Peninsular India: Anaimudi (Annamalai Hills – Kerala) – 2695 m **(Fig. 10.3)**.

The highest peak in Nilgiri (Tamil Nadu – Kerala border): Doda Betta – 2636 m **(Fig. 10.3)**.

The highest peak in Andaman and Nicobar: Saddle Peak – 737 m **(Fig. 10.3)**.

The highest peak in Arunachal Pradesh: Kangto – 7090 m (near Tibet Border)

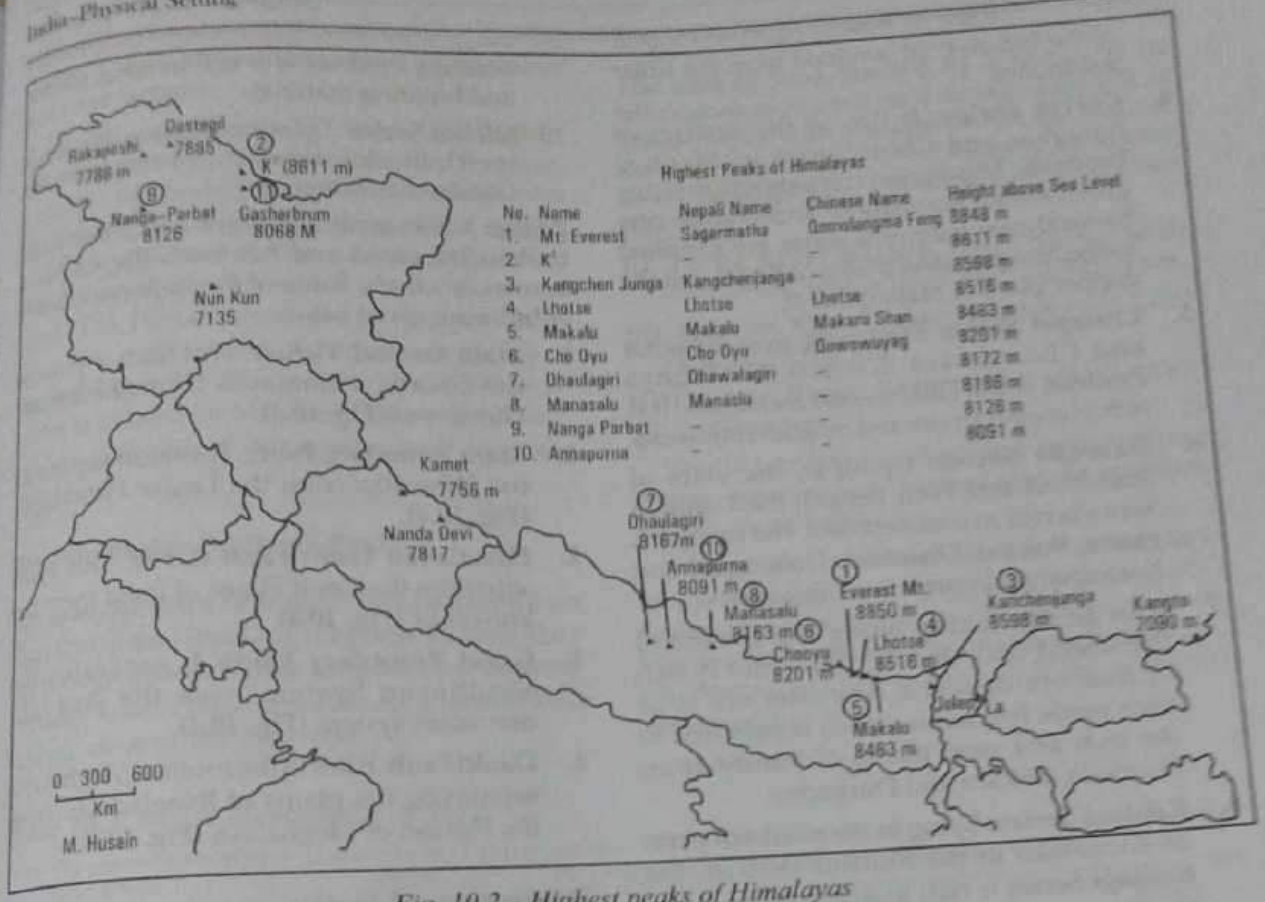


Fig. 10.2 – Highest peaks of Himalayas

The highest peak in Gujarat: Sarkala (Gir Hills) – 643 m **(Fig. 10.3)**.

The highest peak in Jharkhand: Parasnath – 1366 m **(Fig. 10.3)**.

The highest peak in Maharashtra: Kalsubai – 1646 m near Igatpur **(Fig. 10.3)**.

The highest peak in Mizoram: Blue Mountain – 2157 m **(Fig. 10.3)**.

The highest peak in Nagaland: Saramati Peak – 3826 m **(Fig. 10.3)**.

The highest peak in West Bengal: Tiger Hill – 2590 m **(Fig. 10.3)**.

The highest peak in Uttarakhand : Nanda Devi – 7817 m **(Fig. 10.3)**.

Series and Faults

Series is a structure of rock system. In a rock system there may be several series. Some of the economically important series and faults have been shown in **Fig. 10.4.** Their main characteristics have been described briefly in the following:

1. **Bijwar Series:** It is apart of the Vindhyam System. Rich in red sandstone, the Bijwar Series is known for diamonds and precious stones.
2. **Champaner Series:** It lies outside the Aravallis in the vicinity of Vadodra. It is known for conglomerates, marble and slate. An attractive variety of green marble is found in this series.
3. **Champion Series:** Lying in the state of Karnataka to the south-east of Banglore, this series belongs to the Dharwar System. Rich in gold, the Kolar goldmines lie in this series.The gold content in this series is about 5.5 grams per tone of ore. About 60 per cent

per cent of the Indian gold is mined from the Kolar goldmines.

4. **Chilpi Series**: It lies in the district of Balaghat and Chhindwara of Madhya Pradesh. The series consists of phyllite, green-stone, manganese and copper ore. Mineral ores from this series are supplied to the iron and steel plants of Bhilai and the copper plant of Malanjkhand.
5. **Closepet Series**: Stretching over Balaghat and Chhindwara districts of Madhya Pradesh, it is a Dharwarian formation. It is rich in copper pyrite and magniferous rocks.
6. **Damuda Series:** Lying in the state of Jharkhand and West Bengal, the Damuda Series is rich in coal deposits. The Raniganj, Jharia, Bokaro, Dhanbad, Daltenganj and Karanpur coal mines lie in this series.
7. **Iron Series**: Lying along the border of Jharkhand and Odisha, this series is rich in iron ore deposits. The iron ore is of high grade haematite which is supplied to the iron and steel plants of Jamshedpur, Rourkela, Bokaro and Durgapur.
8. **Kaldagi Series**: Lying in the northern parts of Karnataka in the Raichur District, the Kaldagi Series is rich in gold and precious stones.
9. **Khondolite Series:** It occupies a large area in the Eastern Ghats from the northern extremity to the valley of Krishna. It is famous for charnokite stones and gneisses.
10. **Panchet Series**: Lies on the border of Jharkhand and West Bengal. It is rich in coal and metallic minerals.
10. **Rialo Series:** Also known as Delhi Series, it extends from Delhi (Majnu-Ka-Tila) to Alwar. The famous Makrana marble is obtained from this series.
11. **Sakoli Series**: Stretching over Jabalpur and Rewa Districts, this series belongs to the Dharwar System. It is rich in mica, dolomite, schist and marble.
12. **Sausar Series**: This series stretches over Nagpur and Bhandara districts of Maharashtra and Chhindwara District of Madhya Pradesh. It is rich in mica, marble and building materials.
13. **Talcher Series**: Lying in Odisha, this series is rich in coal deposits. It belongs to the Gondwana formation.

Faults: A surface along which a rock body has broken/fractured and has been displaced is known as a fault. Some of the important faults of India are given below:

1. **Main Central Thrust**: This fault separates the Greater Himalayas from the Lesser Himalayas **(Fig. 10.4).**
2. **Main Boundary Fault**: This fault separates the Shiwaliks from the Lesser Himalayas **(Fig. 10.4).**
2. **Himalayan Front Fault (HFF):** This fault separates the Great Plains of India from the Shiwaliks **(Fig. 10.4)**.
3. **Great Boundary Fault**: It separates the Vindhayan System from the Aravalli mountain system **(Fig. 10.4)**.
4. **Dauki Fault**: It lies to the south of Meghalaya, separating the plains of Bangladesh from the Plateau of Meghalaya **(Fig. 10.4).**

Drainage of India

Drainage may refer either to natural drainage of the land-surface or to the system of land-drainage introduced by human activity. Natural drainage of the land-surface is organised in drainage basins. Drainage basins are those areas in which water is concentrated and flows into the drainage network. The drainage system of India may be divided into the Peninsular Drainage, and the Extra-Peninsular Drainage or the Himalayan Drainage System.

The Himalayan Drainage System or the Extra-Peninsular Drainage

The Himalayan drainage system comprises all the international rivers of India, i.e. the Indus, the Ganga, and the Brahmaputra. Most of these rivers and their major tributaries are perennial in character, obtaining their water from the glaciers, springs and rains. These rivers are in

their youthful stage carving out a number of erosional landforms like waterfalls, cataracts, rapids, gorges, steepsided valleys, alluvial fans and river terraces.

In Himalayas, these rivers are highly tortuous, but in plains they display a strong meandering tendency and shift their courses frequently. The regimes of these rivers exhibit wide seasonal fluctuations, causing devastating floods, especially during the season of general rains. The Himalayan rivers have great socio-economic and cultural importance in the life of the Indian people. The water of the Himalayan rivers is utilised for irrigation, industries, hydel-power generation, navigation and domestic purposes.

The Peninsular Drainage System

The drainage of the Peninsular India is much older than that of the Himalayan drainage system. They are mostly seasonal. Their erosional and carrying capacity is low. Their channels are more defined and are close to the base level.

Major Drainage Basins of India

The area of land drained by a river and its tributaries is known as drainage basin. It is synonymous with river basin. On the basis of the area drained, the river basins of India may be classified into the following three categories **(Fig. 10.5)**:

(i) **Large River Basins**: River basins with catchment area of more than 20,000 sq km.

(ii) **Medium River Basins**: Area between 2,000 and 20,000 sq. km.

(iii) **Minor River Basins**: Area less than 2,000 sq km.

India has one hundred and thirteen river basins, out of which 14 are large, 44 medium and 55 minor basins.

The major river basins of India in descending of the area: (i) the Ganga, (ii) Indus, (iii) Godavari,(iv) Krishna, (v) Brahmaputra, (vi) Mahanadi, (vii) Narmada, (viii) Kaveri, (ix) Tapi, (x) Pennar, (xi) Brahmani, (xii) Mahi, and (xiii) Subarnrekha.

***Table 10.5:** Major River Basins of India*

River Basin	*Basin Area**	*Percentage Area*	*Annual Discharge (m^3/km^2)*	*%*
Ganga	861,404	26.2	468,700	25.2
Indus	321,284	9.8	79,500	4.3
Godavari	312,812	9.5	118,000	6.4
Krishna	258,948	7.9	62,800	3.4
Brahmaputra	258,008	7.8	627,000	33.8
Mahanadi	141,589	4.3	66,640	3.6
Narmada	98,795	3.0	54,600	2.9
Kaveri	87,900	2.7	20,950	1.1
Tapi	65,150	2.0	17,982	0.9
Pennar	55,213	1.7	3,238	0.2
Brahmani	39,033	1.2	18,310	1.0
Mahi	34,481	1.0	11,800	0.6
Subarnrekha	19,296	0.6	7,940	0.4
Sabarmati	21,895	0.7	3,800	0.2
Medium and Minor Rivers	711,833	23.6	-	16.0
Total	328,76,97	100.00	1,561,170	100.00

**Area means basin area in India*

Source: *S.P. Das Gupta, 1989.*

Fig. 10.3 – Main peaks

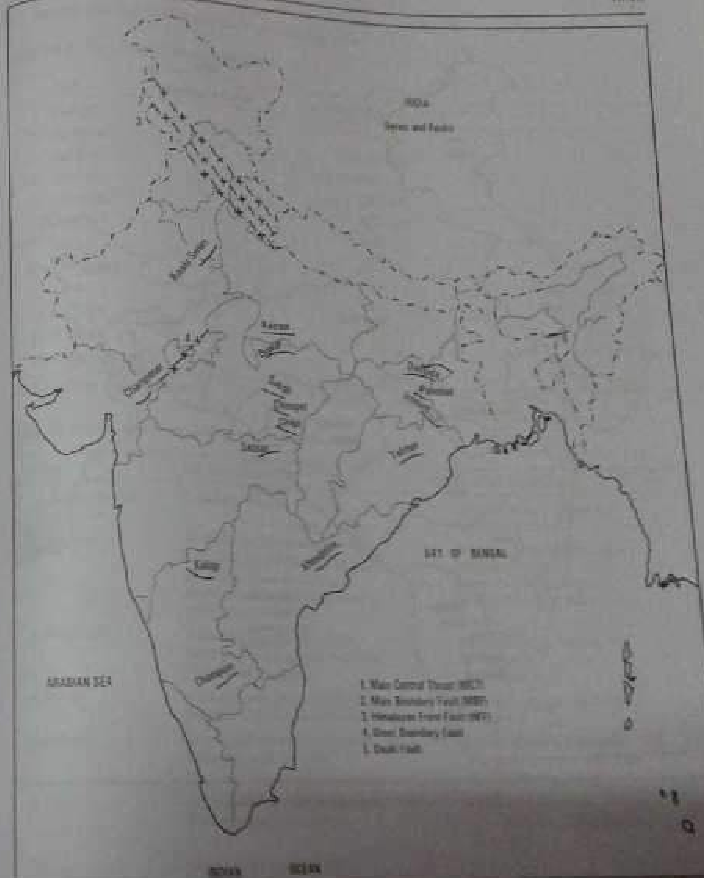


Fig. 10.4 – Main ranges and faults

Fig. 10.5 : Major drainage basins of India

The longest rivers of India have been given in Fig. 10.6.

Table 10.6: *The Longest Rivers of India*

River	Length of the River (km)
1. Ganga*	2525 km
2. Godavari	1465 km
3. Krishna	1400 km
4. Yamuna	1370 km
5. Narmada	1312 km
6. Ghaghra	1080 km
7. Satluj*	1050 km
8. Mahanadi	858 km
9. Kaveri	805 km
10. Son	780 km
11. Kosi	730 km
12. Brahmaputra*	725 km

*Length of the river in India

Table 10.7: *Rivers of India and their Main Tributaries*

River	Left Bank Tributary	Right Bank Tributary
1. Brahmaputra	Subansiri, Manas	Lohit, Dihang, Disang, Kalang (Fig. 10.6).
2. Ganga	Alaknanda, Ramganga, Gomti, Kali (Sardaa), Sarju, Rapti, Ghagra (Karnali), Gandak, Trishuli, Burhi-Gandak, Bagmati, Kosi, Mahananda.	Yamuna, Son, Rihand, Ajay, Punpun, Phalgu, Damodar, Rupnarayan, Sitai, Haldi (Fig. 10.6)
3. Godavari	Sabari, Indravati, Paranhita Wainganga, Penganga, Wardha, Purna and Dudhana	Manjira, Tirna, Manar, Kinnarsani (Fig. 10.6)
4. Indus	Zaskar, Suru, Dras, Krishnganga, Jhelum, Chenab, Ravi, Beas, Satluj	Shyok, Nubra, Gilgit, etc (Fig. 10.6).
5. Kaveri	Herangi, Hemavati, Lokpavni, Shimsha, and Akravati	Lakshmitirtha, Kabani, Suvarnavati, Bhavani, and Amravati (Fig. 10.6)
6. Krishna	Muneru, Musi, Hallia, Bhima, Panchganga, Dudhganga,	Koyna, Malprabha, Ghataprabha, Tunghbadra (Fig. 10.6)
7. Luni	Bandi, Sukri, Jawai, Sukri	
8. Mahanadi	Jb, Mand, Hasdeo, Sheonath	Ong, Jonk, Tel
9. Narmada	Burhner, Sanjar, Shar, Shakkar, Tawa and Kundi	Hiran, Barna, Kolar (Fig. 10.6)
10. Satluj		Parechhu, Spiti, Beas

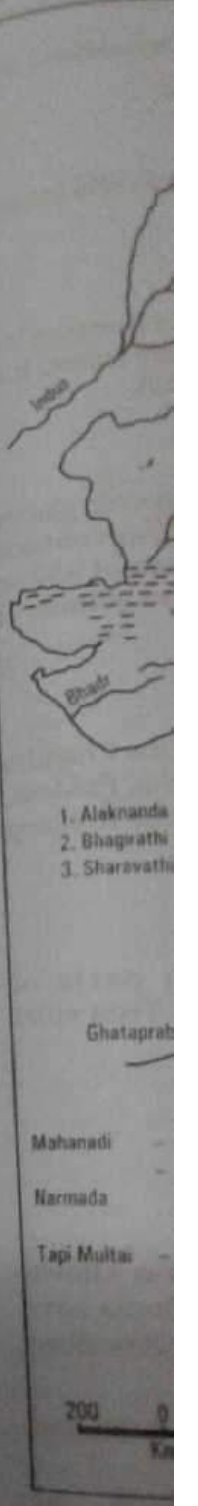
11. Tapi	Sipra, Kapra, Khursi, Mona, Purna, Girna, Panjhra	Betul, Patki, Suki, More, Arunavati, Gomai **(Fig. 10.6)**
12. Yamuna	Tons, Hindan	Chambal, Banas, Sind, Betwa, Dhansan, Ken

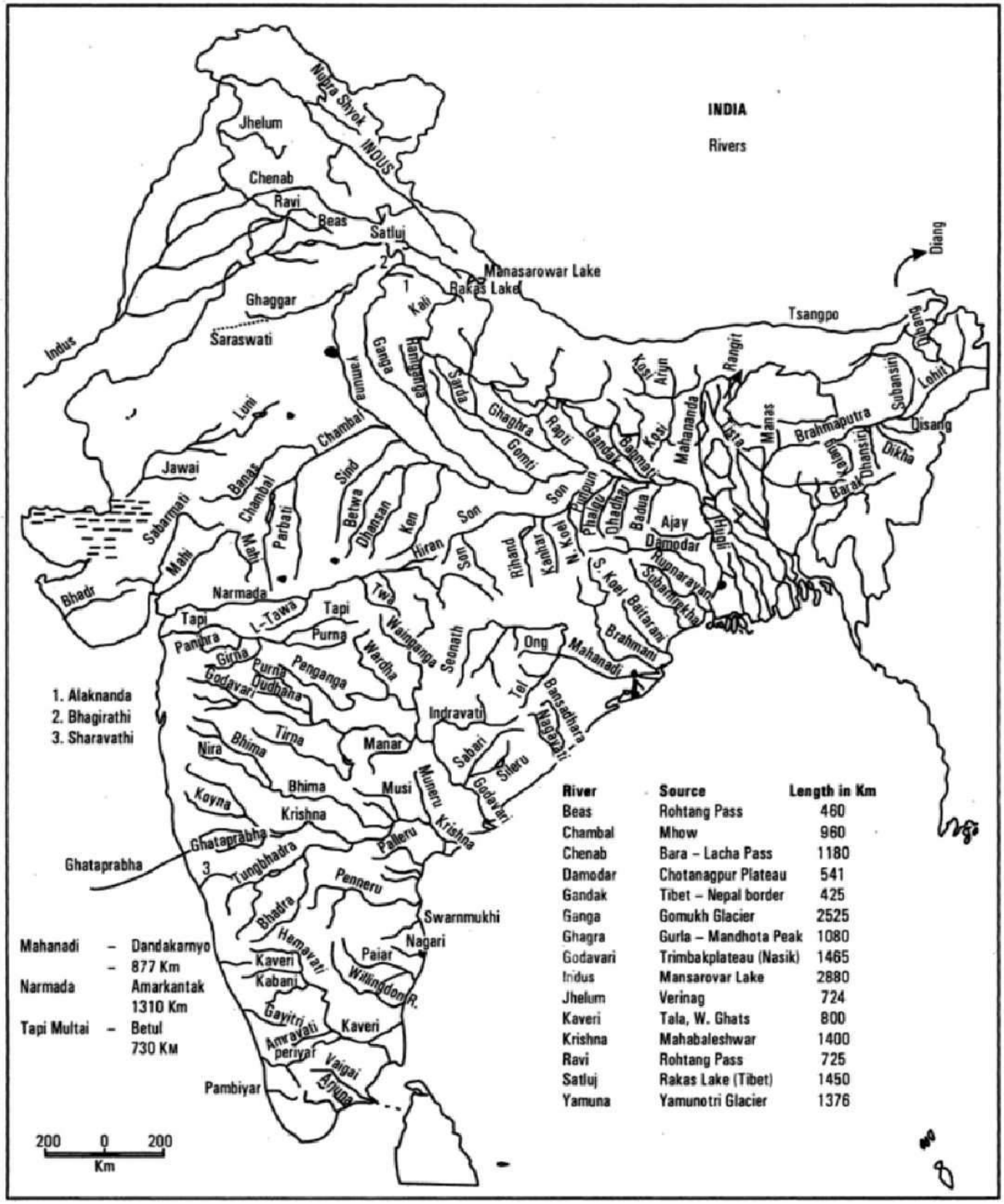
Table 10.8: *Facts about the Peninsular Rivers of India.*

River	*Source*	*Length (km)*	*Area Drained (sq km)*	*Volume of Average Annual Flow (million cubic)*	*Main tributaries*
1. Mahanadi	Dandakarnya near Sihawa in Raipur District of Chhattisgarh	857	141,600	67,000	Ib, Mand, Hasdo, Seonath, Ong, Jonk, and Tel
2. Godavari	Trimbak Plateau near Nashik in Maharashtra	1465	312,812	105,000	Manjra, Mula, Penganga, Wardha, Wainganga, Indravati, Sabari, Pranhita
3. Krishna	Near Mahabaleshwar	1400	258,948	67,670	Koyna, Ghataprabha, Malprabha, Bhima, Tungbhadra, Musi, Muneru
4. Kaveri	Taal Kaveri (W.Ghats)	800	87,900	20,950	Herangi, Hemavati, Lokpavni, Shimsha, Arkavati, Lakshmanatirath, Kabani, Suvanavati, Bhavani, and Amravati
5. Narmada	Amarkantak Plateau	1310	98,796	40,700	Hiran, Orsang, Barna, Kolar, Burhner, Banjar, Shar, Shakhar, Tawa, Kundi
6. Tapi	Multai in Betul Distt (M.P.)	730	65,145	17,980	Purna, Betul, Patkai, Ganjal, Dhatranj, Bokad, and Amravati

Main Glaciers of Indian Himalayas

Glacier is a mass of ice formed from compacted, recrystallized snow that is thick enough to flow plastically. There are nearly 15,000 glaciers in the Himalayas lying between the two syntaxial bends of the Hindukush-Karakoram Ranges (Pamir) and the Eastern Himalaya-Patkai-Bum Ranges (Arunachal Pradesh). They are of different sizes from the giants of more than 60 km to small ones only 2 to 5 km long. Almost 33,000 sq km or 17 per cent of the Himalayas is snow covered, out of which the Karakoram Range alone covers 16,000 sq. km. of ice. The snow-line is 4200 m above the sea level in the Eastern Himalayas which descends to 4000 m in the Karakoram Range. Moreover, the snowline on the Great Himalayan Ranges is at a lower





River	Source	Length in Km
Beas	Rohtang Pass	460
Chambal	Mhow	960
Chenab	Bara – Lacha Pass	1180
Damodar	Chotanagpur Plateau	541
Gandak	Tibet – Nepal border	425
Ganga	Gomukh Glacier	2525
Ghagra	Gurla – Mandhota Peak	1080
Godavari	Trimbakplateau (Nasik)	1465
Indus	Mansarovar Lake	2880
Jhelum	Verinag	724
Kaveri	Tala, W. Ghats	800
Krishna	Mahabaleshwar	1400
Ravi	Rohtang Pass	725
Satluj	Rakas Lake (Tibet)	1450
Yamuna	Yamunotri Glacier	1376

Fig. 10.6 – Rivers and their tributaries

a lower elevation on the southern slopes than that of the northern slopes. The reason is that the southern slopes receive much greater rainfall and are also much steeper than the northern which are more gentle and much drier. Some of the important glaciers of Himalayas have been described briefly in the following **(Fig. 10.7)**

Biafo Glacier

Located in the Braldoh Valley in Karakoram, the Biafo glacier is about 59 km in length. It is the fourth longest glacier outside the polar region. Its snout occurs at an elevation of 5128 m.**(Fig. 10.7).**

Chongo Lungma Glacier

Having a length of 50 km, it is situated in the Rakaposhi Range of the Karakoram. Flowing towards the east, it terminates at an altitude of 2075 m above the sea level **(Fig. 10.7).**

Gangotri Glacier or Gaumukh Glacier

It is the source of the sacred Ganga. It is about 30 km long. The snout of this glacier lies at an altitude of 3880 m above the sea level **(Fig. 10.7).**

Gasherbrum Glacier

Situated in the Karakoram Range, it is 21 km in length. The snout of this glacier is about 4345 m above the sea level **(Fig. 10.7).**

Hispar Glacier

Having a length of 62 km, it lies in the Karakoram Range. It is the third longest glacier outside the Polar region. It flows southward and its snout is at an elevation of 3000 m **(Fig. 10.7).**

Kanchenjunga Glacier

It is 21 km long. The source of Kangchen a tributary of the Kosi river lies in this glacier **(Fig. 10.7).**

Kangto Glacier (7089 m)

It is located in the western parts of Arunachal Pradesh.

Mana Glacier

Situated along the border of Uttarakhand and Tibet, it is 18 km long.

Milam Glacier

Having a length of 20 km, it is the second longest glacier in Kumaun **(Fig. 10.7).**

Pindari Glacier

In the Trishul-Nanda Devi area of Kumaun lies the Pindari glacier. Having an easy access, it is of great tourist attraction **(Fig. 10.7).**

Siachin Glacier (5753 m)

Occupying the Nubra Valley, the Siachin glacier is 75 km in length. It is the largest glacier outside the polar region. It covers an area of 450 sq km. The snout of the glacier is at an altitude of 3705 m **(Fig. 10.7).**

Sonapani Glacier

Having a length of 18 km, it lies in the Chandra Valley (Pir-Panjal Range) of Himachal Pradesh. It rises from about 4000 m below the Rohtang Pass.

Zemu Glacier (4750 m)

Located in the north-eastern parts of Kanchenjunga, it is the source of Tista river **(Fig. 10.7).**

Major Passes of India

Pass

A route over or through mountains is known as a 'pass'. The important passes of India have been shown in **Fig. 10.8.** and briefly described in the following:

Aghil Pass: Lies between Ladakh (J & K) and Sinkiang (China).

Balcha Dhura: Connecting Uttarakhand with Tibet (China).

Banihal Pass (Jawahar Tunnel): This pass connects Banihal Town (Doda District) and

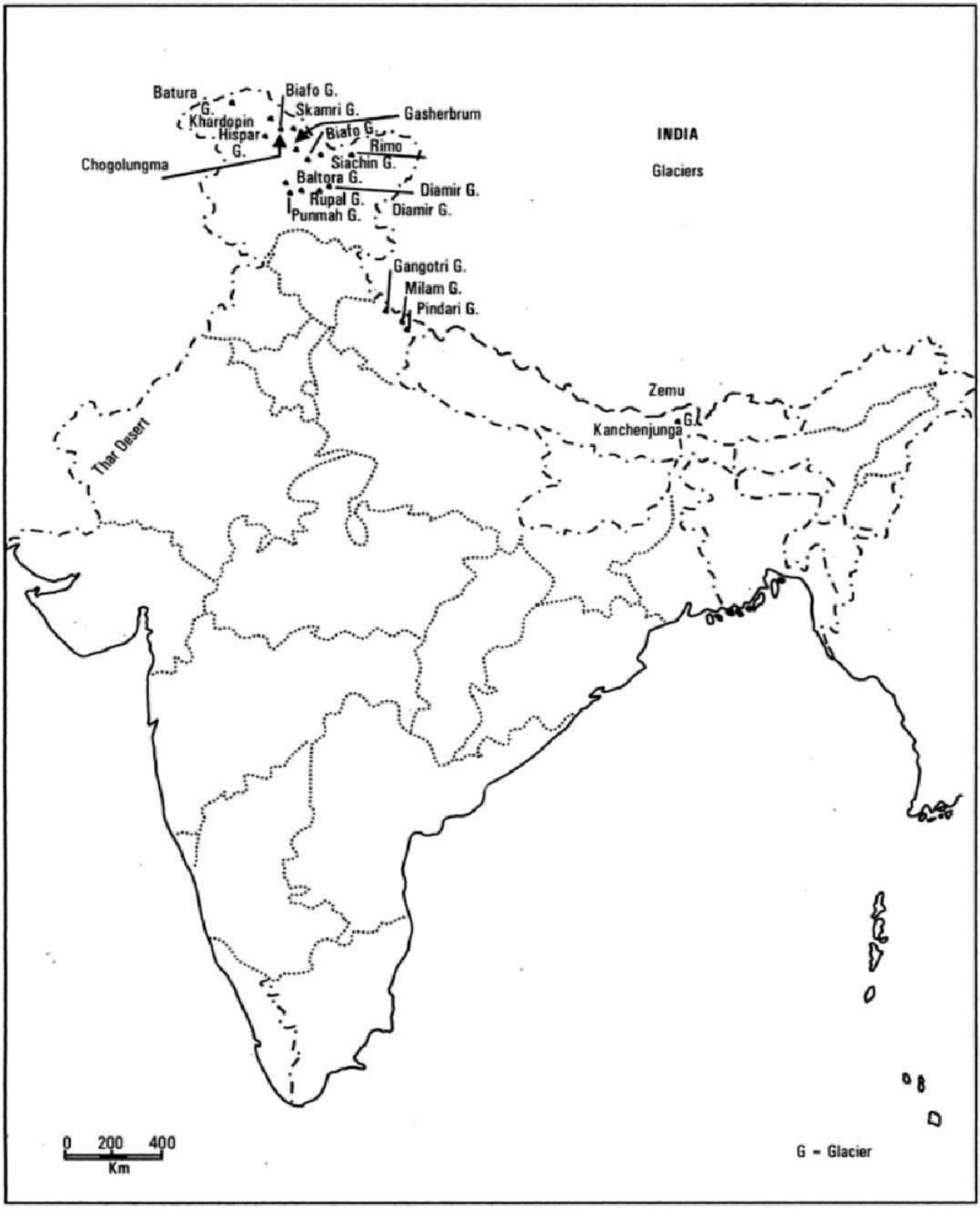


Fig.10. 7 – Main glaciers of India

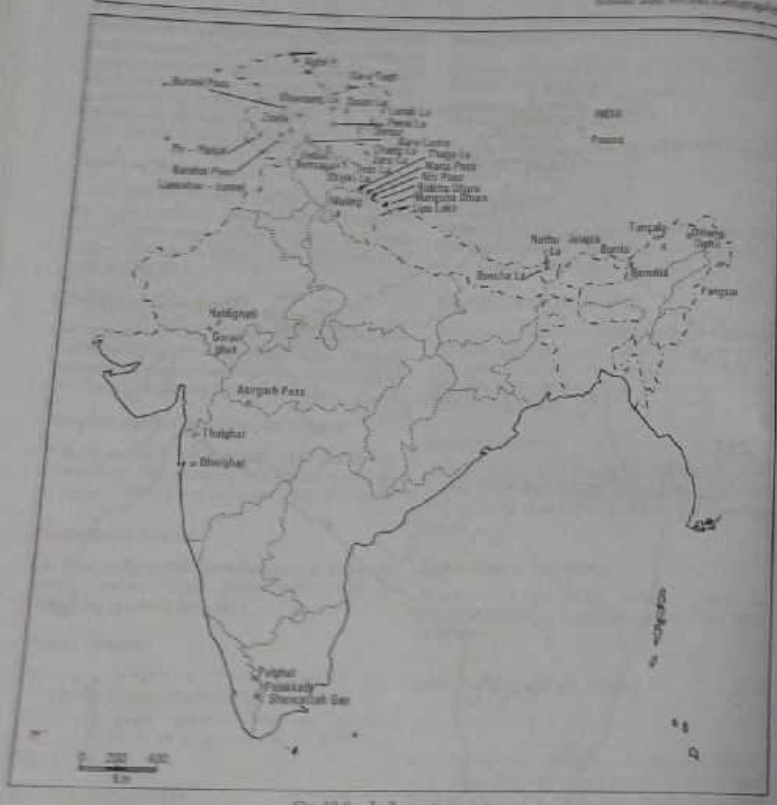


Fig 10.8 – India main passes

Qazigund Town of Anantnag (Kashmir Division).

Baralacha La: Between Kyelan and Leh (Ladakh).

Bhorghat: Between Mumbai and Nasik (Maharashtra).

Bomdila Pass: Between Tezpur (Assam) and Tawang (Arunachal Pradesh).

Bum La: Between Arunachal Pradesh and Ursang (Tibet–China).

Chang La: Between Ladakh (J & K) and Tibet (China).

Diphu Pass: Between Arunachal Pradesh and Myanmar.

Gyaranghat: Between Udaipur and Sirohi (Aravallis–Rajasthan).

Jelep La: Between Gangtok (Sikkim–India) and Lhasa (Tibet–China).

Karakoram Pass: Between Ladakh (J & K) and Sinkiang (China).

Khardungla Pass: Between Leh and Siachin glaciers through Nubra Valley.

Lipu Lekh Pass: Between Uttarakhand and Tibet (China).

Mana Pass: Between Uttarakhand and Tibet (China).

Nathu La: Between Sikkim (India) and Tibet (China) entry to Chumbi Valley.

Niti Pass: Between Uttarakhand and Tibet (China).

Palghat: Between Palakkad and Coimbatore (Tamil Nadu).

Shenkottai: Between Kollam (Kerala) and Madurai (Tamil Nadu).

Shipki La: Between Himachal Pradesh (India) and Tibet (China) through the Sutluj Gorge.

Thaga La: Between Himachal Pradesh and Tibet (China).

Sea Beaches

The portion of the coastline where an accumulation of sediment is in motion. In other words, it is a deposit of wave-washed sediment along a coast between the landward limit of wave action and the outermost breakers. Some of the important sea-beaches of India have been shown in **Fig. 10.9** and the names are given in **Table 10.9**.

Table 10.9: Sea Beaches of India

	State/Union Territory	Sea Beaches
1.	Andhra Pradesh	Bheemunipatnam, Manginapudi Beach, Mypadu Beach, Rishikonda Beach, Vodarevu Beach.
2.	Goa	Anjuna Beach, Agonda Beach, Arambol Beach, Colva Beach, Dona Paula Beach, Vagator Beach.
3.	Gujarat	Beyt, Dwarka, Chorwad, Gopnath, Mandvi, Nani-Bandar, Somnath, Veraval.
4.	Karnataka	Karwar, Kudle, Malpe, Maravanta, Murdeshwar, Om, Paramboor, Ullal.
5.	Kerala	Alleppey, Bekal, Cherai, Kappad, Kollam, Kovalam, Lighthouse, Rockshelm, Samudra, Shanmugamugham, Thirumullavaram, Varkala, Veli, Vypeen and Gunda Islands.
6.	Lakshadweep	Bangram, Kadamat,Kavaratti, Minicoy.
7.	Maharashtra	Alibagh, Bassien, Boisi, Chowpatty, Dhanu, Ganpatipule, Harihashwar, Manori, Janjeera, Juhu, Kihim, Malvan, Mandva, Marve, Murad, Shrivardhan, Sindhudurg, Valneshwar, Versova,Vijaidurg.
8.	Odisha	Bolighai, Chandipur, Chatrapur, Ghirmatha, Gopalpur, Konarak, Paradeeep, Puri.
9.	Andaman and Nicobar Islands	Chariya Tapu, Wandoor, Corbyn Cove, Ramanada Island, Mahabalipuram, Mandapam, Neil Island, Sacharangapanmam.

10.	Puducherry	Beaches of Puducherry
11.	Tamil Nadu	Cuvelong, Manna, Pichavaram, Pulicat, Vattikinal
12.	West Bengal	Digha, Frazergani, Ganga Sagar, Shankarpur
13.	Daman	Devaka Beach, Jayopore Beach
15.	Diu	Chikratiih, Jallandhar, Nagoa

Lakes

Lakes are the static bodies of water that are surrounded by land on all sides. They vary in size and depth. Caspian Sea is the largest lake in the world followed by the Superior (North America), and Victoria (Africa). In India Chilka Lake is the largest salt water lake, while the Wular is the largset fresh water lake. The important lakes of India have been shown in **Fig. 10.10**, while **Table 10.10** gives their location.

Table 10.10: Lakes of India

	Lake	*State*
1.	Asthamudi (Lagoon)	Kerala
2.	Bhimtal	Uttarakhand
3.	Chilka (Lagoon)	Odisha
4.	Dal Lake	Kashmir (J & K)
5.	Kolleru	Andhra Pradesh
6.	Loktak	Manipur
7.	Lonar	Maharashtra
8.	Naini Tal	Uttarakhand
9.	Nakki Lake	Rajasthan
10.	Nizam Sagar	Hyderabad (Andhra Pradesh)
11.	Parashuram Kund	Arunachal Pradesh
12.	Pong Morari	Ladakh (J & K)
13.	Pulicat	Andhra Pradesh
14.	Pushkar Lake	Rajasthan
15.	Salt Lake	Kolkata
16.	Sambhar Lake	Rajasthan
17.	Tso Moriari	Ladakh (J & K)
18.	Udaipur Lake (Panchola)	Rajasthan
19.	Upper and Lower Lakes	Bhopal (Madhya Pradesh)
20.	Vembnad Kayal (Lagoon)	Kerala
21.	Wular Lake	Kashmir (J & K)

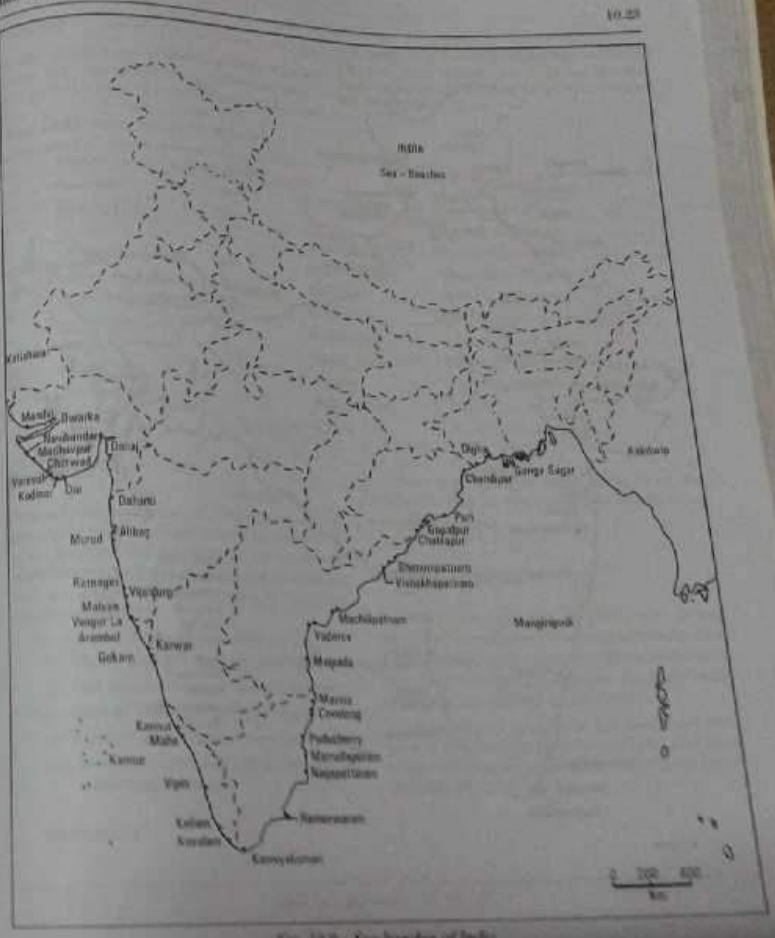


Fig. 10.9 – Sea-beaches of India

Fig. 10.10 – Main lakes of India

Waterfall

A site on the long profile of a river where water falls almost vertically. Waterfalls may be found at a band of more resistant rock, at a nick point, or where deposition has occurred. There are many waterfalls in India. Some of the important waterfalls of India have been shown in **Fig. 10.11 (Table 10.11)**.

Table 10.11: Major Waterfalls of India

	Waterfall	Height (metres)	River	State
1.	Barehipani	399	Buchabalanga	Mayurbhanj (Odisha)
2.	Barkana Falls	259	Sita	Shimoga (Karnataka)
3.	Jog Falls	253	Sharavati	Shimoga (Karnataka)
4.	Khandadhar Falls	244	Kotapani Nala	Sundargarh (Odisha)
5.	Vantawng Falls	229	Lau River	Serchhip (Mizoram)
6.	Magod Falls	198	Bedti River	Uttar Kannada (Karnataka)
7.	Lodh Falls	143	Budha River	Latehar (Jharkhand)
8.	Chachai	130	Bihad	Madhya Pradesh
9.	Bundla	100	Bundla	Kangra (Himachal Pradesh)
10.	Hundru Falls	99	Subernrekha	Ranchi (Jharkhand)
11.	Teerathgarh	91	Kagra	Bastar (Chhattisgarh)

Monsoon

Derived from the Arabic word *mausim*, meaning season, the term originally referred to the winds of the Arabian Sea which blow for about six months from the north-east and for six months from the south-west. The seasons in India are divisible as under:

1. The season of the north-east monsoon:
   (i) Winter season – January and February
   (ii) Hot weather season – March to May
2. The season of the south-west monsoon:
   (i) Season of general rains – June-September
   (ii) Post-monsoon season or season of retreating monsoon.

Over most parts of India the bulk of the rainfall comes in the season of south-west monsoon.

Natural Vegetation

In theory, the grouping of plants which has developed in an area without human interference is known as natural vegetation. Most landscapes have been changed by humans through forest clearance, agriculture, and industry.

It is argued that there are relatively few areas truly natural vegetation left. The area under different types of forest have been given in **Table 10.12**.

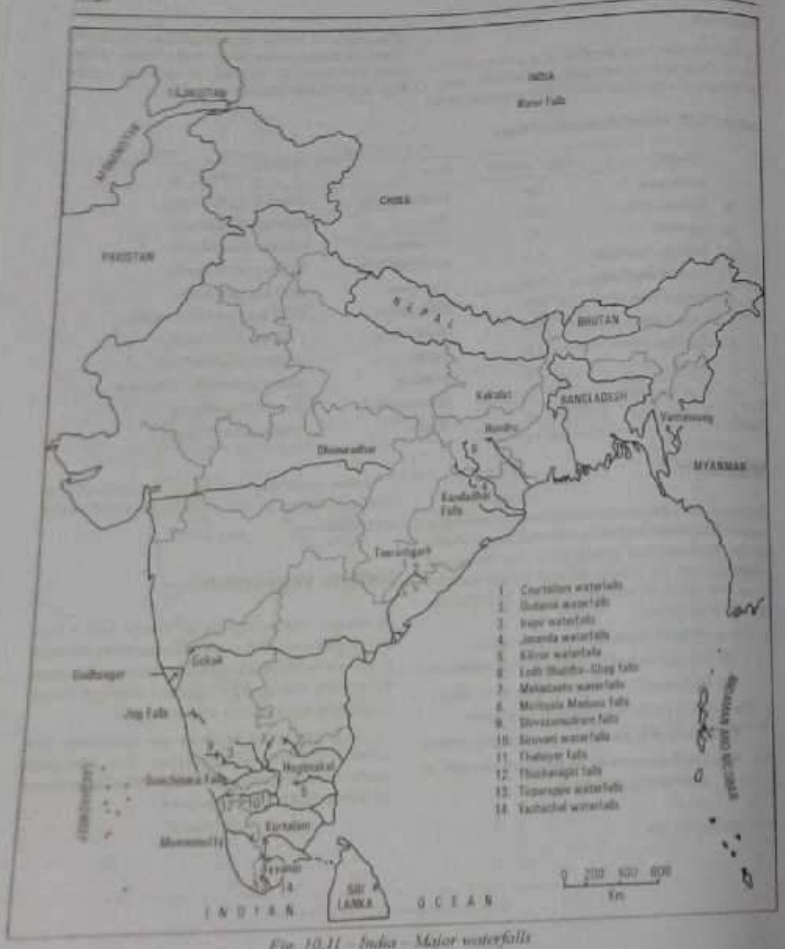


Fig. 10.11 – India – Major waterfalls

Table 10.12: *India – Area Under Forests*

	Forest Type	Area (million hectares)	Percentage of Total Area
1.	Tropical Moist Deciduous	23.680	37.0
2.	Tropical Dry Deciduous	18.304	28.6
3.	Tropical Wet Evergreen	5.120	8.0
4.	Sub-Tropical Moist Hill (pines)	4.224	6.6
5.	Tropical Semi-evergreen	2.624	4.1
6.	Montane Wet Temperate	2.304	3.6
7.	Himalayan Moist Temperate	2.176	3.4
8.	Tropical Thorny Forests	1.664	2.6
9.	Subtropical Dry Evergreen	1.600	2.5
10.	Alpine	1.344	2.1
11.	Littoral and Swamps	0.384	0.6
12.	Subtropical Broad-Leaved	0.256	0.4
13.	Himalayan Dry Temperate	0.192	0.3
14.	Tropical Dry Evergreen	0.128	0.2
	Total	**64.000**	**100.00**

The percentage share of forests in the different geographical regions of India has been given in **Table 10.13**.

Table 10.13: *India – Geographical Distribution of Forest*

	Region	Percentage of Total Forest Area of India
1.	Peninsular Plateau and Hills	57.50
2.	Himalayan region	18.00
3.	Western Ghats and Western Coastal Plains	10.50
4.	Eastern Ghats and Eastern Coastal Plains	9.50
5.	The Great Plains of India	5.00
	Total	**100.00**

Biosphere Reserves

Multi-purpose protected areas to preserve genetic diversity in representative ecosystem. The boundaries of a biosphere are fixed by legislation. Tourism normally not permissible. Research and educational activities are promoted and properly managed. The biosphere reserves of India have been shown in **Fig. 10.12**.The names of the states where these biosphere reserves are located are given in **Table 10.14**.

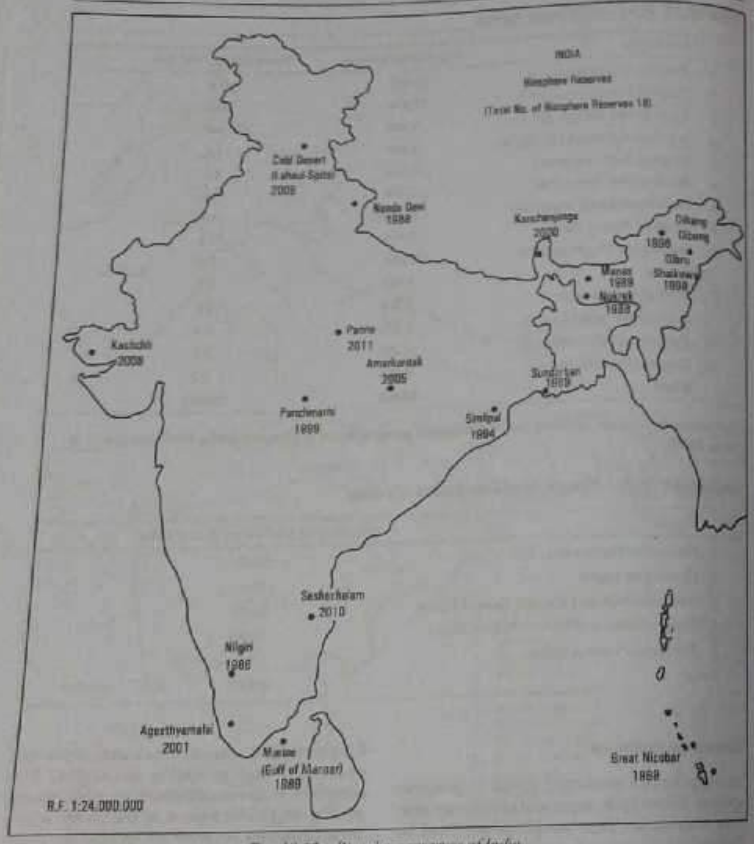


Fig. 10.12 – Biosphere reserves of India

***Table 10.14**: Biosphere Reserves of India*

Biosphere Reserve	State
1. Agasthyamalai	Kerala
2. Amarkantak	Madhya Pradesh
3. Dibang-Dibang	Arunachal Pradesh
4. Dibru-Shaikowa	Assam
5. Great Nicobar	Andaman and Nicobar Islands
6. Kachchh	Gujarat
7. Manas	Assam
8. Marine (Gulf of Mannar)	Tamil Nadu
9. Nandadevi	Uttarakhand
10. Nilgiri	Tamil Nadu
11. Nokrek	Garo Hills (Meghalaya)
12. Panchmarhi	Madhya Pradesh
13. Similipal	Odisha
14. Sundarban	West Bengal
15. Cold Desert (Lahaul-Spiti)	Himachal Pradesh
16. Seshachalam	Andhra Pradesh
17. Kanchenjunga	Sikkim
18. Panna	Madhya Pradesh

National Park

A reserved area meant for preserving its natural vegetation, wildlife, natural beauty and ethnic culture. It is the habitat for some particular wild animals.

Its boundaries are fixed by legislation. While tourism is permissible, research and scientific management are lacking in Indian national parks. The national parks, bird sanctuaries and tiger reserves of India have been shown in **Fig. 10.13**, while **Table 10.15** gives their names and the states they are located in.

Sanctuary

A reserved area meant for preservation and development of endangered species. Generally species-oriented such as citrus, pitcher plant, etc. Boundaries are not fixed. Limited biotic interference. Tourism is permissible, but research and scientific management are lacking in Indian sanctuaries.

***Table 10.15**: National Parks, Tiger Reserves and Bird Sanctuaries*

State/Union Territory	Reserve	Status	Specialities
1. Andhra Pradesh	(i) Kolleru	Bird Sanctuary	
	(ii) Nagarjuna Sagar	National Park	Tiger Reserve
2. Arunachal Pradesh	Nam Dhapa	National Park	Tiger Reserve
	Pakhui Nameri		Tiger Reserve
3. Assam	(i) Kaziranga	National Park	Habitat of endangered Rhinoceros
	(ii) Manas (Barpeta Distt.)	National Park	Tiger Reserve

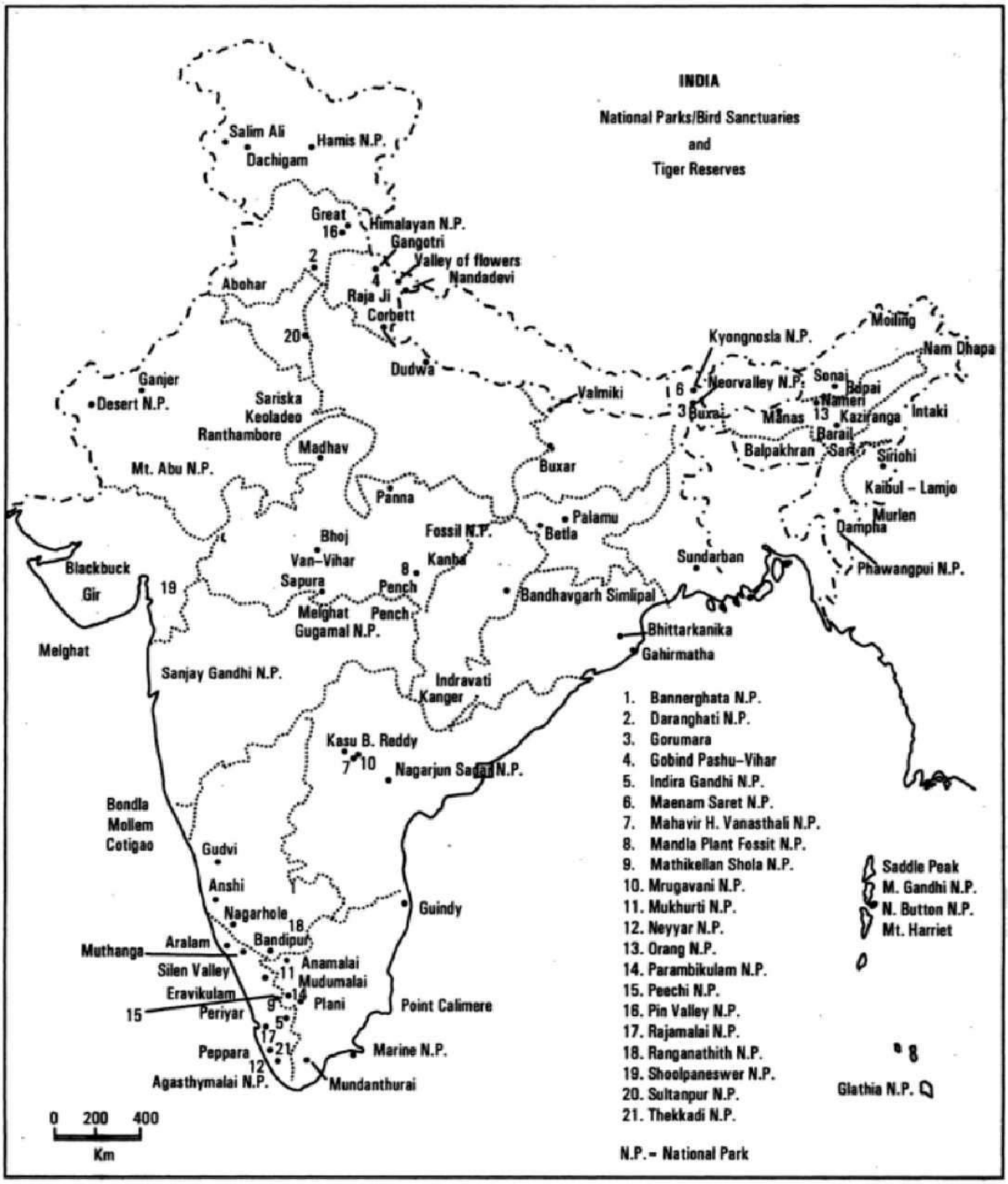
4. Bihar	(i) Buxar	National Park	Tiger Reserve
	(ii) Valmiki	National Park	Tiger Reserve
5. Chhattisgarh	Indravati	National Park	Tiger Reserve
6. Goa	(i) Mahavir	National Park	-
	(ii) Mollem	National Park	
7. Gujarat	(i) Gir	National Park	Tiger Reserve (Asiatic Lions)
	(ii) Valvadar (Bhavnagar)	National Park	
	(iii) Rann of Kachchh	Wildlife Sanctuary	Indian Wild Ass Sanctuary
8. Haryana	Sultanpur Lake	Birds Sanctuary	-
9. Himachal Pradesh	(i) Great Himalayan National Park	National Park	
	(ii) Kugati	Wildlife Sanctuary	
10. Jammu & Kashmir	(i) Dachigam (Srinagar)	National Park	Kashmiri Stag
	(ii) Hamis (J & K)	National Park	
11. Jharkhand	(i) Betla	National Park	-
	(ii) Palamau (Daltenganj)	National Park	Tiger Reserve
12. Karnataka	(i) Bandipur	National Park	Tiger Reserve
	(ii) Bannregatta(Bengaluru)	National Park	-
	(iii) Bhadra	National Park	Tiger Reserve
	(iv) Nagarhole (Kodau)	National Park	
13. Kerala	(i) Eravikulam-Rajamalai (Idukki Distt.)	National Park	-
	(ii) Periyar (Idukki)	National Park	Wild Elephents and Tiger Reserve
	(iii) Silent Valley	National Park	
14. Madhya Pradesh	(i) Bandhavagarh (Shahdol Distt.)	National Park	Tiger Reserve
	(ii) Bori-Satpura	National Park	Tiger Reserve
	(iii) Kanha(Mandla & Balaghat)	National Park	Tiger Reserve
	(iv) Panna Tiger Reserve	Wild Life Sanctuary	Tiger Reserve
	(v) Pench	Wild Life Sancturay	Tiger Reserve
	(vi) Shivpuri (Madhav)		
	(vii) Tadoba (Chandrapur)	National Park	-
15. Maharashtra	(i) Borivli (Greater Mumbai)	National Park	-
	(ii) Melghat (Amravati Distt.)	Tiger Reserves	Tiger Reserve
	(iii) Nawegaon (Bhandara)	National Park	-
	(iv) Pench (Nagpur)	National Park	-
	(v) Tadoba Andharai	Wild Life Sancturay	Tiger Reserve
16. Manipur	Kaibul Lamjao (Churachandpur)	National Park	-

17. Meghalaya	Balpakhran (Garo Hills)	National Park	-
18. Mizoram	Dampha	National Park	Tiger Reserve
19. Nagaland	Intaki	National Park	-
20. Odisha	(i) Gahirmatha	Wildlife Sanctuary	Sea turtles (Olive Ridley)
	(ii) Nandankanan	National Park	Habitat-White Tigers
	(iii) Simlipal (Mayurbhanj	Wild Life Sanctuary	Tiger Reserve
21. Punjab	(i) Abohar	Wild Life Sanctuary	-
22. Rajasthan	(i) Keoladeo Ghana (Bharatpur Distt)	National Park, Bird Sanctuary	Bird Sanctuary
	(ii) Ranthambore (S. Madhopur)	Wildlife Reserve National Park	Tiger Reserve
	(iii) Sariska (Alwar Distt.)	National Park	Tiger Reserve
23. Sikkim	Kanchenjunga	National Park	-
24. Tamil Nadu	(i) Guindy	National Park	-
	(ii) Kalakad Mundanthurai	-	Tiger Reserve
	(iii) Mudumalai (Nilgiri)	National Park	-
25.Uttarakhand	(i) Jim Corbett (Nainital)	National Park	Tiger Reserve
	(ii) Nanda Devi	National Park	Bioshphere Reserve
	(iii) Valley of Flowers	National Park	-
26.Uttar Pradesh	Dudwa (Distt.Kheri)	National Park	Tiger Reserve
27.West Bengal	(i) Buxa	Wildlife Sanctuary	Tiger Reserve
	(ii) Sundarbans (24-Parganas)	Wildlife Sanctuary	Tiger Reserve (Bengal Tigers)
Union Territories			
Andaman and Nicorbar Islands	(i) Mount Harrier (ii) Saddle Peak	National Park National Park	Biosphere Reserve

Project Tiger

It is a centrally sponsored project which was launched in February 1992 to provide financial and technical support to major tiger bearing states in the country for the protection of tigers, their habitat and corridors. The project is being implemented in 13 states, namely: Andhra Pradesh, Arunachal Pradesh, Assam, Jharkhand, Karnataka, Kerala, Meghalaya, Nagaland, Odisha, Tamil Nadu, Uttarakhand, Uttar Pradesh and West Bengal. The main tiger reserves in India under the project tigers are **(Fig. 10.13).**

1. Anamalai – Parambikulam (Tamil Nadu)
2. Barail-Saifung (Assam and Meghalaya)
3. Dalma Wildlife Sanctuary (Jharkhand)
4. Kameng-Sonitpur (Arunachal Pradesh and Assam)
5. Kaziranga-Karbelong-Intaki (Assam and Nagaland)
6. Nilambur-Silent Valley (Kerala and Tamil Nadu)
7. Periyar-Madurai (Tamil Nadu)
8. Rajaji-Corbett (Uttarakhand)



Fog. 10.13 – National parks, bird sanctuaries and tiger reserves of India

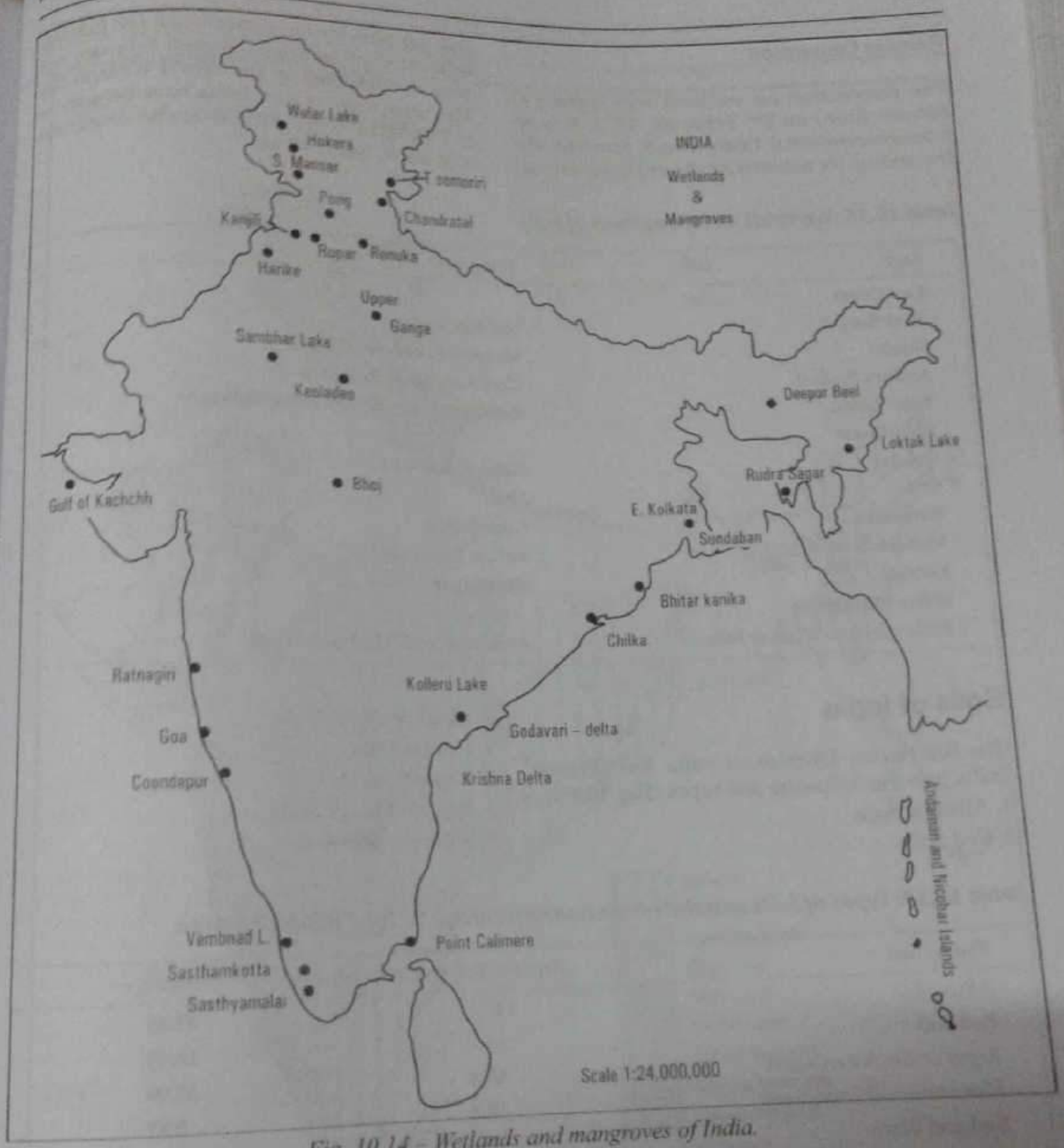


Fig. 10.14 – Wetlands and mangroves of India.

Crocodile Projects

The Crocodile Project in India was initiated in 1975. The main objective of the project was to conserve and protect crocodiles of India from extinction.

The *Gahirmatha* (Odisha) is one of crocodile projects **(Fig. 10.13)**. A Crocodile Bank has been established at Chennai to conserve and protect the natural habitat of the crocodiles.

Ramsar Convention

The convention on wetland was signed at Ramsar (Iran) on 2nd February, 1971. It is an inter-governmental treaty which provides the framework for national action and international co-operation for the conservation and judicious utilisation of wetlands. Second February each year is celebrated as the World Wetland Day.The main wetlands of India have been shown in **Fig. 10.14**, while their statewise distribution is given in **Table 10.16**.

Table 10.16: Wetlands and Mangroves of India

State	*Mangrove*
East Coast	
West Bengal	Sundarban
Odisha	Mahanadi, Bhaitarakanika
Andhra Pradesh	Godavari, Krishna deltas
Tamil Nadu	Pichvaram, Muthupet, Point Calimere
West Coast	
Gujarat	Gulf of Kachchh
Goa	Goa
Karnataka	Coondapur
Maharashtra	Achar, Ratnagiri
Kerala	Vambanad
Other Mangroves	
Andaman and Nicobar Islands	Andaman and Nicobar Islands

Soils of India

The Soil Survey Division of India has divided India into the following soil types **(Fig. 10.15)**:

1. Alluvial Soils
2. Red Soils
3. Black Soils or *Regur*
4. Desert Soils
5. Lateritic Soils
6. Red and Black Soils
7. Submontane Soils

Table 10.17: Types of Soils and their Area and Percentage to Total Reporting Area.

Type of Soil	*Area (million hectares)*	*Percentage*
Alluvial	143.1	43.36
Red Soil	61.0	18.49
Regur or Black earth-soil	49.8	15.09
Mountain Soil Desert soil	18.2	5.51
Red and Black	17.8	5.40
Desert Soil	14.6	4.42
Lateritic Soil	12.2	3.70
Other Soils	13.3	4.03
Total	330.0	100.00

Source: Chatterji, S.P., 1973 & 1986.

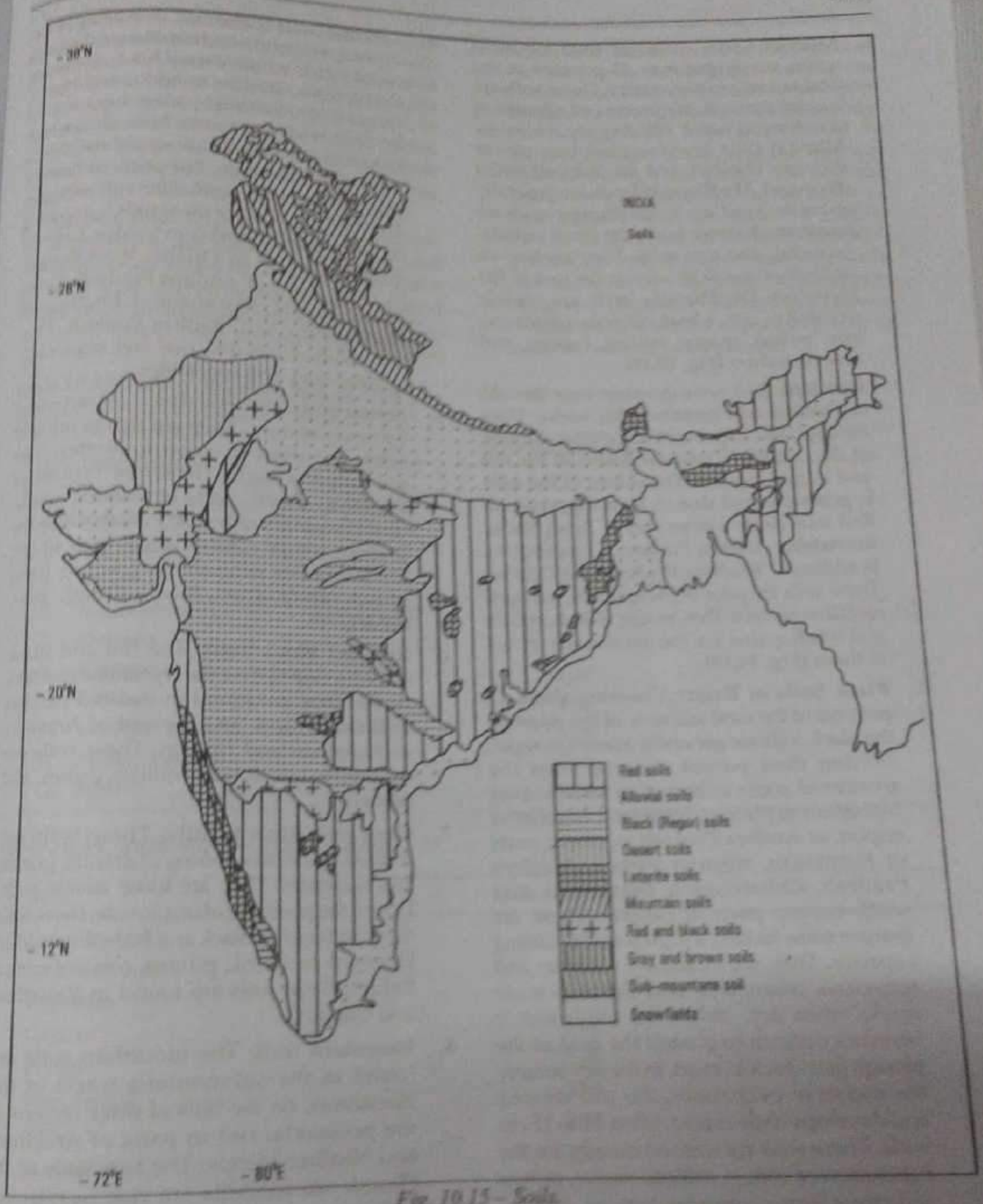


Fig. 10.15 – Soils

1. **Alluvial Soils**: Alluvial soils are most fertile, occupying over 43 per cent of the total soil area of the country. These soils are formed through the process of deposition of sediments (sand, silt, clay, etc.) in layers. Alluvial soils are classified into newer alluvium (Khadar) and the older alluvium (Bhangar). The Bhangar lands are generally above the flood levels. The Bhangar lands are however, characterised with Bhurs (winds-deposits), and kar soils. They are known as Bhabhar and Tarai soils at the foot of the Shivaliks. The Bhangar lands are mainly devoted to rice, wheat, oilseeds, sugarcane, jute, pulses, maize, millets, fodder, and horticulture fruits (**Fig. 10.15**).

2. **Red Soil**: Red soils develop over the old crystalline and metamorphic rocks. They occupy over 18 per cent of the total soil area of the country. These are found in the hot and humid regions. The colour of the soils is generally red due to high iron content. Red soils cover a large part of Tamil Nadu, Karnataka, Andhra Pradesh, Chhattisgarh, Jharkhand, Madhya Pradesh and Odisha. These soils are poor in phosphorus, nitrogen and lime content. Rice, maize, millets, pulses and small grains are the main crops grown on them (**Fig. 10.15**).

3. **Black Soils or Regur**: Covering about 15 per cent of the total soil area of the country, the black soils are generally known as regur. Getting their parent material from the weathered rocks of lava, they stretch over Maharashtra plateau, Telengana, Rayalseema region, of Andhra Pradesh, northern parts of Karnataka, western parts of Madhya Pradesh, Chhattisgarh, Jharkhand, and south-western parts of Gujarat. These are mature soils, having a high water retaining capacity. They are extremely compact and generally when wet, and develop wide cracks when dry. When the soil is wet, it becomes difficult to plough the field as the plough gets stuck around, in the dry season, the moisture evaporates, the soil shrinks and develops wide cracks, after this it can easily be ploughed without much effort. These soils are utilised mainly for the cultivation of cotton, millets, oilseeds, pulses and rice, wheat, tobacco, etc.

4. **Lateritic Soils (Latosols)**: The name of the lateritic soils has been derived from the Latin word *later* which means brick. These are the typical soils of the monsoon and humid tropical or equatorial zones characterised by deep weathered layer from silica which has been leached. These soils are rich in iron and aluminium, but poor in humus, phosphorous, potassium, lime and nitrogen. The reddish colour of these soils is imparted by the iron and aluminium residue. Lateritic soils are found in Orissa, West Bengal, in some parts of Andhra Pradesh, Tamil Nadu, Kerala, Jharkhand, Chhattisgarh, Maharashtra, and Madhya Pradesh. They are mainly devoted to rice, ragi, sugarcane, cashew nuts, and vegetables.

5. **Desert Soils**: Desert soils are characterised by sandy texture. They are rich in mineral salts, but poor in organic matter. The pH value is high. These are typical of Rajasthan desert, parts of Gujarat, south-west Haryana, south-west Punjab where the average annual rainfall is less than 40 cm. These soils are generally devoted to *bajra*, pulses (green-gram, black- gram) *guar*, fodder, etc.

6. **Red and Black Soils**: The red and black soils developed over the crystalline and lava rocks. They are found in isolated patches in Bundelkhand, and the east of Aravallis in Rajasthan and Gujarat. These soils are devoted to maize, bajra, millets, pulses, and oilseeds.

7. **Grey and Brown Soils**: These soils are formed by the weathering of granite, gneiss, and quartzite. They are loose friable soils. Due to the presence of iron-oxide, these soils vary from red to black and brown in colour. Devoted to *bajra*, pulses, oilseeds, and fodder. These soils are found in Rajasthan and Gujarat.

8. **Mountain Soil**: The mountain soils are found in the sub-mountane tracts of the Himalayas, on the hills of lower regions of the peninsula, and in parts of Jharkhand and Chhattisgarh. The new soils of the Himalayan mountains are rich in nitrogen and organic matter, in valleys they are rich in silt, clay, sand, and boulder gravel. According to geologists, during the Pleistocene Period, the entire valley of Kashmir was under water. Subsequently, the Baramullah Gorge was created by the endogenetic forces, and the lake was drained through this gorge. The deposits left as the process are known as karewas. The karewa soils are devoted mainly to the cultivation of saffron, almond, walnut, apricot, apple and peach orchards. The karewas of Pampur, Pulwama and Kuligam (Kashmir Valley) are famous for the cultivation of superior quality of saffron, walnut, and almond.

of Jammu & Kashmir, Himachal Pradesh, Uttrakhand, and Sikkim, brown podzol soils are found. Alpine meadow soils are located at further higher altitudes. Mountain soils having a good vegetative cover are rich in organic matter, but their base-status varies, depending on the degree of leaching. These soils are generally devoted to maize, pulses, oilseeds and fodder.

9. **Karewa Soils**: Karewas are the lacustrine deposits in the Valley of Kashmir and Bhaderwah Valley of the Jammu Division of J & K. Karewas are the flat topped mounds that border the Kashmir Valley on all sides. They are composed of fine

Table 10.18: India – Salinity Affected Area

	State/Union Territory	Area (lakh hectares)
1.	Uttar Pradesh	12.95
2.	Punjab	12.25
3.	Gujarat	12.14
4.	West Bengal	8.50
5.	Rajasthan	7.29
6.	Maharashtra	5.34
7.	Haryana	5.26
8.	Karnataka	4.04
9.	Odisha	4.04
10.	Madhya Pradesh	2.24
11.	Andhra Pradesh	0.42
12.	Bihar	0.04

Table 10.19: India—Ravine Affected Areas

State	Area (lakh hectares)
Uttar Pradesh	12.30
Madhya Pradesh	6.97
Rajasthan	4.52
Gujarat	4.00
Punjab	1.28
West Bengal	1.04
Bihar	0.65
Tamil Nadu	0.58
Maharashtra	0.28

Water Resources of India

Water is our most precious resource. It is, however, limited and unequally distributed. India has only 4% of water resources of the world, while it has to support about 17% of the world population and over 15% the livestock. The average annual precipitation is the main source of water in the country, is estimated to be of the order of 4000 Billion Cubic Metres (BCM). The estimated precipitation during the monsoon season (June-September) is 3000 BCM or 75% of the annual precipitation. With the rapid growth of population, industrialisation and urbanisation, the demand for water is increasing at a faster pace. The Ministry of Water Resources lays down policies and programmes for the development, regulation and judicious utilisation of water resources. The average annual water availability of the country is assessed as 1869 billion cubic metres (BCM). Of this, total utilisable water resource is assessed as 1123 BCM, surface water 690 BCM and groundwater 433 BCM.

Irrigation

Indian agriculture is often been called as *"a gamble on monsoon"*. In the areas of high variability of rainfall, the availability of irrigation can make the cultivation of crops more reliable and sustainable. In fact, irrigation is vital for realising full potential of agricultural sector. Efficient utilisation of our water resources, therefore, assumes great significance. Drought is an annual phenomenon in some parts of the country. The delayed arrival of monsoon often reduces the agricultural returns. Moreover, the winter crops are largely dependent on irrigation. To solve all these problems, irrigation is needed. From time immemorial irrigation has been practiced in India, and now it ranks first in the world in terms of total irrigated area. The main irrigation sources and the areas irrigated by them are given in **Fig. 10.16.**

Canals

Canals are one of the oldest and most important sources of irrigation in India. Canal irrigation is, however, largely confined to the Great Plains of India (Punjab, Haryana, Uttar Pradesh, Uttarakhand, Rajasthan, Bihar and West Bengal), and the fertile plains of India (Andhra Pradesh, Karnataka, Madhya Pradseh, Odisha, and Tamil Nadu). The Bari Doab Canal, Bhakhra Canal, Indira Gandhi Canal, Eastern and Western Yamuna Canals, The Ganga Canal, Agra and Sharda Canals are some of the important irrigation systems of India. The canal irrigation has transformed certain areas of the Thar Desert into fertile green areas in the Indira Gandhi Canal Command Area.

Table 10.20: Area under Canal irrigation of the Selected States

State	Net Area under canal irrigation (thousand hectares)	Percentage of canal irrigated area to net irrigated area of the state	Percentage of canal irrigated area in the state of total irrigated area of India
1. Uttar Pradesh	3090	25.42	21.33
2. Andhra Pradesh	1650	36.42	10.83
3. Haryana	1475	49.89	9.68
4. Rajasthan	1355	27.59	8.90
5. Bihar	1135	31.34	7.45
6. Maharashtra	1050	35.38	6.89
7. Karnataka	975	36.55	6.40
8. Odisha	875	24.38	5.74
9. Tamil Nadu	830	28.81	5.44
10. Madhya Pradesh	825	19.49	5.41
11. Chhattisgarh	800	68.90	4.25
12. Punjab	675	18.76	4.43
13. Gujarat	495	16.52	3.25
Total	15,230	29.24	100.00

Source: Statistical Abstracts of India 2003.

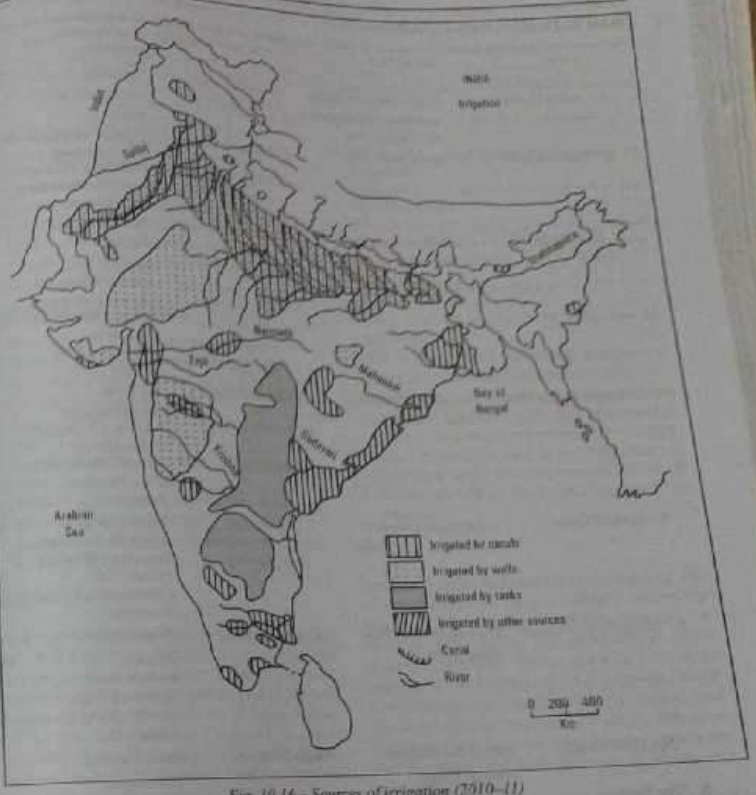


Fig. 10.16 – Sources of irrigation (2010–11)

Table 10.21: Major Canals of India

	Canal	Source/Year	Area under Command	Distrits under Irrigation
1.	Indira Gandhi Canal	Harike Barrage (Satluj and Beas rivers) started 31st March, 1958	8.6 million hectares	Rajasthan. It does not irrigate in Punjab.
2.	Bhakra Canal	Satluj River, 1954	1.5 million hectares	Punjab, Haryana and Rajasthan, Ludhiana, Patiala, Sangrur, Jalandhar, and Firozpur
3.	Sharda Canal	Banbasa, near India-Nepal border. Opened in 1928	8 lakh hectares	Bareilly, Kheri, Pilibhit, Shahjahanpur, Hardoi, Lucknow, Unnao, Pratapgarh, Sitapur, Sultanpur, Barabanki, Allahabad, Rai-Bareilly
4.	Upper Ganga Canal	Kankhal (Hardwar), 1954	7 lakh hectares	Hardwar, Muzaffarnagar, Meerut, Ghaziabad, Bulandshahr, Aligarh, Mathura, Etah, Mainpuri, Kanpur
5.	Sirhind Canal	Rupnagar (Ropar)	7 lakh hectares	Patiala, Sangrur, Bhatinda, Ludhiana, Ferozepur (Punjab), Hissar, Sirsa, Fatehabad (Haryana)
6.	Lower Ganga Canal	Narora (Bulandshahr District), 1878	4.6 lakh hectares	Bulandshahr, Aligarh, Farrukhabad, Mainpuri, Etah, Etawah, Kanpur, Allahabad
7.	Bist Doab Canal	Part of the Bhakra-Nangal Project	7 lakh hectares	Jalandhar and Hoshiarpur
8.	The Western Yamuna Canal	Tajewala (Feroz Tughlaq)	4 lakh hectares	Ambala, Kurukshetra, Karnal, Panipat, Rohtak, Hissar, Sirsa, Faridabad, and Jind
9.	Upper Bari-Doab Canal	Madhopur (Pathankot), Ravi-River, 1859	3.5 lakh hectares	Gurdaspur and Amritsar

10. Tawa Canal	Tawa Barrage	3 lakh hectares	Hoshingabad
11. Eastern Yamuna Canal	Faizabad (Saharanpur), 1831	2 lakh hectares	Saharanpur, Muzaffarnagar, Meerut, Baghpat, Ghaziabad
12. Mettur Canal	Metture Dam	1.2 lakh hectares	Salem, Tiruchirapalli

Merits of Canal Irrigation

1. Canals are a perennial source of irrigation.
2. Canals are a cheap source of irrigation.
3. Canals carry a lot of sediments which enrich the fertility of the irrigated fields.
4. Canals make agriculture sustainable.
5. Canals help in the control of floods during the rainy season.

Demerits of Canal Irrigation

1. Overuse and misuse of canal water.
2. Over irrigation leads to water logging.
3. Excessive irrigation leads to rise in underground water table.
4. Many canals over flow during the rainy season.
5. Canal irrigation is possible only in the plain areas.
6. Water-logged areas become the breeding grounds for mosquitoes.
7. In the semi-arid areas canal irrigation lead to the problem of *usar (kallar)* formation.

Wells and Tubewells

Wells and tubewells irrigate the largest cropped area of the country. About 54 per cent of the total irrigated area is under tubewell and well irrigation. Tubewell irrigation is extensively developed in Northern Plains of India. About 95% of the tubewells are located in Uttar Pradesh, Punjab, Haryana, Gujarat, Bihar, Madhya Pradesh, Maharshtra, Andhra Pradesh, Karnataka, West Bengal and Odisha.

Merits of Tubewell Irrigation

1. Tubewells can be installed in a short period of time.
2. Tubewells can be installed at convenient places by the government and farmers.
3. Tubewells can be installed at low cost.
4. Tubewell is an independent source of irrigation.
5. Tubewells can be used as and when the necessity arises.
6. The tubewell water contains several minerals and salts (e.g. nitrate, sulphate, etc) which enhance the fertility of soil.

Demerits of Tubewell Irrigation

1. Only limited area can be irrigated by tubewells.
2. The underground watertable diminishes, especially during the summer season.
3. In the case of failure of monsoon, the underground watertable falls and enough water is not available for irrigation of crops.
4. Since tubewells and pumping sets are operated with electricity and diesel, it is considered as an expensive mode of irrigation.

Tanks

Tank irrigation is generally practiced in the eastern part of the Deccan Plateau where the topography is suitable for erecting dams across small rivulets and for the collection of water in artificial lakes.

Tanks are found in large number in the districts of Chengalpattu, North Arcot, South Arcot in Tamil Nadu, Nellore and Warangal districts in Andhra Pradesh. The other states where it is prevalent to lesser extent are Odisha, West Bengal, Uttar Pradesh, Karnataka and Maharashtra.

Drip Irrigation

In this method the application of water is precise but slow as discrete drops, continuous drops, tiny streams of miniature sprays through mechanical devices. Drip irrigation has the advantages of water saving and more suitable to poor soils, no soil erosion and improves the efficiency of fertilizers.

Irrigation Potential

With sustained and systematic development, irrigation potential has increased from 22.6 million hectares in 1951 to 87.8 million hectares in 2010. Since April 1978, irrigation projects have been classified on the basis of their command area:

Major: More than 10,000 hectares
Medium: 2000-10,000 hectares
Minor: Less than 2000 hectares.

Minor irrigation projects are widely distributed and they provide instant and reliable sources of irrigation to the farmers. Ground water development which forms bulk of the minor irrigation programme is implemented primarily through the individual and co-operative efforts. According to a recent study conducted by the World Bank about 20% of the 40 million hectare of irrigated agricultural land in India is reported to suffer from a water-logging and salinity problem which have reduced the yield of crops substantially.

Expansion of irrigation facilities, along with consolidation of the existing systems, has been the main part of the core strategy for increasing production of food with sustainable and systematic development of irrigation gains.

The irrigation potential through major, medium and minor irrigation projects has increased from 22.6 million hectares (mha) in 1951 to 103 mha at the end of the tenth plan.

National Water Resource Policy-2002

The National Water Resource Policy, 2002 lays emphasis on the integrated water resources development and management. The main points of this policy are:

1. Optimal and sustainable utilisation of the available surface and ground water.
2. Creation of well developed information system.
3. Water conservation and demand management.
4. Quantity and quality aspects as well as environmental consideration.
5. Involvement of beneficiaries and stakeholders in the project of planning and participatory approach in water resources management.
6. Adequate training and research.
7. Resettlement and rehabilitation aspect of project affected persons.
8. The policy encourages the Private Sector Participation in placing development and management of water resources projects for diverse uses, wherever feasible with a view to introducing innovative ideas generating financial resources.
9. Introducing corporate management and improving service efficiency and judicious distribution.
10. Introducing accountability of the water users.

Table 10.22: India–General Land Use, 2005-06

	Land Category	Area (million hectares)	Percentage of the Total Geographical Area
1.	Total geographical area	328.75	
2.	Total reporting area for land use	306.25	93.20
3.	Area under forests	69.00	22.55
4.	Area not available for cultivation		
	(i) Area put to non-agricultural uses	23.25	7.61
	(ii) Barren and uncultivable land	19.18	6.25

	(b) Land under tree crops and groves	3.62	1.18
	(c) Culturable waste	13.83	4.52
6.	Fallow land		
	(i) Current fallow	14.80	4.83
	(ii) Other fallow	10.11	3.30
7.	Net sown area	141.23	46.15
8.	Area sown more than once	48.51	32.60
9.	Total or gross cropped area	189.74	
10.	Area under irrigation	78.00	55.30

Source: Statistical Abstracts of India, 2005-06.

***Table 10.23:** Size of Holdings*

	Category of Holding	*Area (hectares)*	*Percentage of Holdings*
1.	Marginal	Below one	50.6
2.	Small	1-2	20.0
3.	Semi-medium	2-4	15.2
4.	Medium	4-10	11.3
5.	Large	Above 10	04.0

Source: Statistical Abstracts of India, 2005-06.

***Table 10.24:** Average Size of Holdings in Selected States of India*

	State	*Size of Holdings*
1.	Rajasthan	4.00
2.	Punjab	3.45
3.	Gujarat	2.85
4.	Madhya Pradesh	2.75
5.	Haryana	2.45
6.	Maharashtra	2.40
7.	Karnataka	2.15
8.	Andhra Pradesh	1.50
9.	Odisha	1.30
10.	Himachal Pradesh	1.15
11.	Assam	1.15
12.	Tamil Nadu	1.00
13.	West Bengal	0.80
14.	Jammu & Kashmir	0.75
15.	Uttar Pradesh	0.72
16.	Bihar	0.70
17.	Kerala	0.30
India		**1.50**

Source: Statistical Abstracts of India-2005-06.

Table10.25: *Cropping Seasons in India*

Cropping Season	Major Crops Cultivated in Northern States	Major Crops Cultivated in Southern States
Kharif (June-September)	Rice, cotton, bajra, maize, jowar, tur, black-gram, green gram,	Rice, maize, ragi, jowar, groundnut
Rabi (October-March/April)	Wheat, gram, barley, mustard, rapeseed, lentil (masoor), peas, green-fodder (Barseem)	Rice, maize, ragi, groundnut, gram
Zaid (April-June)	Vegetables, cucumber, melons, fodder	Rice, vegetables, fodder

Dryland Farming

Dry-land farming is the cultivation of crops in areas where the source of water to crops is only rainfall and the average annual rainfall varies between 40 -70 cm. and the annual variability of rainfall is between 20 to 60 per cent. According to the experts of agriculture, this amount of rainfall is sufficient to grow a number of crops, but its distribution is very erratic and most of the time precipitation is less than the rate of evapotranspiration. In fact, more than 80 per cent of the rainfall is recorded in only 10-15 days. In India about 62 per cent of the net cultivated area is under dry-land and rain-fed cultivation which contribute about 40 per cent of the total production of India. The salient features of dry-land farming and rain-fed agriculture has been given in **Table-10.26**.

Table10.26: *Dry-land and Rain-fed Agriculture*

Salient Features	Dry-land Cultivation	Rain-fed Cultivation
1. Rainfall	<70 cm	> 70 cm
2. Moisture availability to crop	shortage	Adequate
3. Growing season	< 200 days	>200 days
4. Cropping system	Single crop or intercropping	Inter-cropping or double—cropping
5 Constraints	Wind and water erosion	Water erosion
6. Regions	Arid and semi-arid as well as upland of sub-humid/humid regions	Humid and sub-humid regions

The area under irrigated and rain-fed conditions has been given in **Table-10.27**

Table10.27: *Area under irrigated and rain-fed conditions in India*

Class	Area (in million ha)	Percentage of total arable land
Total arable	143.0	100.00
Dry-land	54.3	37.9
rain-fed*	65.3	45.5
Irrigated	43.4	30.3

*Includes flood prone area of 15 million hectares

Problems of Crop Production in Dry-land Farming: Following are the main problems of dry-farming cultivation. Consequently, crop failures are quite common.

1. **Inadequate and Uneven Distribution of Rainfall:** As stated above, the rainfall in the dry-farming areas is low and highly variable which results in uncertain crop yields.
2. **Late Onset and Early Cessation of Rains:** When the arrival of summer monsoon is late, the sowings of crops are delayed resulting in poor yields. Times, the rains may cease very early in the season exposing the crop to drought during flowering and maturity stages which reduces the crop yields considerably.
3. **Prolonged Dry Spells During the Crop Period:** Long breaks in the rainy season is an important feature of Indian Monsoon. These intervening dry spells when prolonged during crop period reduces crop growth and yield and when unduly prolonged, crops fail.
4. **Low Moisture Retention Capacity:** The crops raised on coarse textured soils like sandy or red soil. Loss of rain water occurs as runoff due to undulating land and shallow soils.
5. **Low Fertility of Soils:** Dry land are not only thirsty, but hungry too. Soil fertility has to be increased, but there is limited scope for extensive use of chemical fertilizers due to lack of adequate soil moisture.

Strategy for Sustainable Dry Farming

In the dry land farming the yield of crops per unit area is low. In order to enhance the crop yield, the important drought management practices include selection of suitable crops and cropping systems, tillage, seeds and sowing, nutrient management, rain-water management, weed management, pest management and harvesting and storage.

(i) **Moisture Conservation:** Moisture conservation is the key of successful crop production in dry-land areas. Deep and repeated ploughing and pulverization of soil enables preservation of a large amount of moisture, uniform soil structure, enhanced root growth and extraction of soil moisture from deeper soil layers.

(ii) **Choice of Crops:** Short duration crops and varieties with deep rooted system and drought tolerance are better adapted to dry-land farming. Among the cereals barley has better moisture extraction power than wheat.

(iii) **Early Sowing:** Early sowing of crops is advisable as it helps in (i) better moisture conservation, (ii) longer growing season and avoidance of pests and diseases.

(iv) **Optimum Plant Population:** Maintenance of optimum plant population is a must for getting good results. The plant population for the rabi (Winter season) should be less as compared to that of the kharif (Summer Season) crops.

(v) **Intercropping**: In areas of dry land farming inter-cropping is being recommended and practiced. In such areas, at least one of the component crops succeeds in drought years and there is every chance to get two crops in good rainfall years. The different intercropping systems followed in different regions of the country based soil, rainfall, market price and marketing facilities. Intercropping systems are subject to change due to change in market price of component crops. The dominant intercropping systems are: (i) groundnut +pigeon-pea, (ii) sorghum +pigeon-pea, (iii) groundnut +castor, (iv) finger-millet +pigeon-pea, (v) wheat + gram, (vii) cotton + gram, (viii) millets + black-gram, (ix) pearl-millet+ green gram, etc.

(vi) **Nutrient Management**: Rain-fed soils are more deficient than irrigated soils in nutrient because of their poor organic matter status. According to the experts of agriculture, compared to all other nutrients, response of crops to N fertilizers has been maximum.

(vii) **Weed Management**: Weed density is generally low under dry land conditions than under irrigated condition. Several generations of weeds occur under irrigated conditions due to continuous availability of water. Limited number of generation of weeds occurs due to shorter period of water availability. However, weed management is equally important under dry land conditions as weeds compete for soil moisture. Weed if not properly controlled can take away as much as 30 per cent moisture and nutrients leading to substantial reduction in yields.

(viii) **Pest Management**: Important pests on crops are weather bound and they can be avoided through proper scheduling of their sowing time. Early sowing facilitates vigorous seedling growth which can withstand the adverse effects of pests.

(ix) **Water Harvesting**: Water harvesting can be defined as collection and conservation of excess rain water directly in-situ or in construction reservoir for the use of crop production.

(x) **Integrated Dry Land Technology**: The application of single technology to dry region is generally incapable of giving desired results. The adaptation of all related technologies as an integrated dry land technology can provide a synergistic effect and can improve the productivity in dry farming regions.

(xi) **Mulches**: About 60 to 75 per cent of the rainfall is lost through evaporation. These evaporations can be reduced by applying mulches. Mulch is any material applied on the soil surface to check evaporation and improve soil water. Application of mulches results in additional benefits like soil conservation, moderation of temperature, reduction in soil fertility, weed control and improvement of soil structure.

The mulches may be of different types as (i) soil-mulch or dust-mulch, (ii) stubble mulch, (iii)straw-mulch, and vertical mulching-breaking of hard pans to improve root penetration and water percolation.

(xi) **Selection of Proper Crop Varieties for Dry-land Farming**: In the dry farming regions, crops have to be selected with suitable crop duration to coincide with the length of the growing season. However, if the monsoon turns to be extra-ordinary good, opportunity is lost if only short duration crops are sown. Farmers with economic strength and motivation for high profits with some amount of risk can go for crops of long duration. The long duration crops with flexibility are more suitable. For example, pearl-millet and sorghum can be rationed if monsoon extends. Sunflower can be introduced for higher profits with certain amount of risk.A crop or variety intended for dry land farming should have (a) deep and extensive root system, thereby a better moisture extraction capacity, (b) low transpiration rate and (c)shorter duration of growth. Some recommended varieties of crops for dryland farming are as under:

Jowar (millets)	CSH1, CSH-2, CSH4
Bajra (Pearl –millet)	HB-1,HB-3, NHB-5,
Wheat	C-306, K-65, K-68
Barley	Jyoti, Karan -4, Karan-15, Karan-19
Moong (Green-gram)	T-44, Jawahar-45
Urad (Black-gram)	T-9, Mash-2
Gram	RS-10, T-1, T-3
Mustard	Pusa-Barani

Rajora, R., 1988, Integrated Watershed Management, Jaipur, Rajasthan Publications.

Sankara Reddy, G.H. and T. Yellamanda Reddy, Principles of Agronomy, Kalyani Publishers.

Contract Farming

Contract farming is a method of farming based on the optimisation of profit from agriculture. In the contract farming a company enters into a written contract with the farmer/farmers with the following objectives.

(i) To produce a given volume of product of specified quality. The product will be purchased by the company on an agreed price. In other words, marketing enters into contract with production. The company after making the purchase, freezes, dehydrates and starts canning operation. Sometimes the company enters into contracts with the co-operative societies.

(ii) In contract farming the main crops grown are vegetables, fruits, flowers and poultry.

Merits of Contract Farming

The farmers gain certain advantages, given below:

(i) The sale of their products is assured.

(ii) They earn higher price than the price in the open market.

(iii) The capital requirements of the farmers are reduced as the contract often agreed for advance payment.

(iv) Very often the companies also provide specialised knowledge and expertise.

Demerits of Contract Farming

(i) If a farmer has produced quality product, he may get a higher price in the open market than that offered by the contract.

(ii) The farmer acts mechanically and loses his independent status.

(iii) The bargaining power is tilted in favour of companies as financially they are more powerful.

(iv) The farmer becomes an economic man which may not be in accordance to his traditional mode of life. In fact, Indian farmers are generally practice agriculture for satisfaction as a mode of life.

Natural Hazards

A hazard is an unexpected threat to humans and/or their property. By this definition, the Indian monsoon is not a hazard, but its failure is. The most frequent occurring hazards are climatic (i) drought, floods, cyclones, ice, snow, and fog, (ii) tectonic: earthquakes, volcanoes, and tsunami, (iii) mass movement: land slides, land creep, rock-fall, and avalanches.

Some geographers distinguish between environmental hazards, but others stress that human activity plays a part in the development of most hazards. Some of the important natural hazards which create havoc in India have been described briefly in the following:

Drought

Drought has been defined differently by different geographers. A long, continuous period of dry weather is known as drought. The Meteorological Department of India defined drought as a period of at least 22 consecutive days recording less than 0.25 cm of rainfall. This definition however, does not apply to the whole of India. In areas like Mawsynram and Cherrapunji (1187 cm) even one week recording less than 0.25 mm may be considered as a drought period. In India drought is often associated with the failure of monsoon, especially in the years of El-Nino like that of 1982, 1968, and 2009. In a drought year, the vegetation, crops, and surface and underground water tables are adversely

affected. An agricultural drought is a period of four consecutive weeks with half or less than half of the normal rainfall or with a weekly rainfall of 2.5 cm or less during the period from mid-May to mid-October, when about 80 per cent of country's sowing area is under *kharif* crops. On an average, one in every five years is a drought year in India, while in western Rajasthan every two out of five years are drought years. The drought prone areas of India have been shown in Fig. 10.17 and discussed below:

1. **The Arid and Semi-arid Areas of Rajasthan**. There is a contiguous region covering Thar Desert, northern parts of Gujarat, south-western parts of Haryana and Punjab and parts of the Agra Division of Uttar Pradesh which is drought prone area of India. The average annual rainfall in this region varies between 15 and 25 cm and the variability of rainfall between 20 to 60 per cent.
2. **The Rainshadow Areas of Western Ghats**. This is the area lying to the east of the Western Ghats, covering the greater parts of Maharashtra, northern parts of Andhra Pradesh, Karnataka, and Tamil Nadu. The average annual rainfall in this region is also less than 75 cm, while the variability of rainfall is more than 30 per cent.
3. **Other Drought Prone Areas**. There are isolated tracts in Odisha, Purulia district of West Bengal, parts of Jharkhand, Chhattisgarh, Baghelkhand (Madhya Pradesh), Bundelkhand (Uttar Pradesh), Ladakh (J&K), and Madurai and Coimbatore (Tamil Nadu) which are often adversely affected by droughts.

Some of the important droughts in India occurred during the recent years are given below:

1963 – 64 – Bihar and West Bengal
1965 – 66 – Maharashtra
1966 – 67 – Odisha
1982 – 83 – Haryana and Rajasthan
1987 – 88 – Rajasthan and Gujarat
1999 – 07 – Bolangir and Kalahandi (Odisha)
2009 – Greater parts of India

Drought Management

The Government of India has paid enough attention to the drought affected areas. Prior to 1987, the government used to provide relief to the drought affected people by providing employment and distribution of food grains through Public Distribution System (PDS). The consequent drought relief expenditure imposed a serious strain on public finances as huge amounts had to be diverted from development for undertaking relief projects. In some states like Rajasthan, the drought relief outlay exceeded the developmental outlays. Now, the drought relief approach has been adopted in which emphasis is given to water conservation and rain water harvesting.

Floods

A high water level along a river channel or on a coast that leads to inundation of land which is not normally submerged. River floods which involve inundation of the floodplain may be caused by: (i) precipitation, (ii) collapse of dams, (iii) drainage of ice-dammed lakes, (iv) high tides, and (v) storm surges.

In India, due to erratic and heavy seasonal rainfall during the monsoon months many of the areas are adversely affected by floods. The intensity of floods, however, varies from region to region and month to month. The National Flood Commission of India has estimated that about 40 million hectare of land (1/8 of the geographical area) of the country, is prone to recurring floods. Along with heavy drainage, the Ganga-Brahmaputra drainage system brings down large volume of sediments that cause aggradation of river beds and seasonal overflows. Crops and other properties in the flood plain suffer heavy damages. An annual flood is a serious problem in some parts of the country, particularly in Andhra Pradesh, Assam, Bihar, Gujarat, Odisha, Tamil Nadu, Uttar Pradesh and West Bengal. It is estimated that losses from the annual floods amount to Rs. 2305 million, causing suffering to 50 million people, affecting 10 million hectares of cropped land.

Cyclones (Tropical)

Tropical cyclones occurring in the of Bay Bengal and the Arabian Sea are natural hazards. They

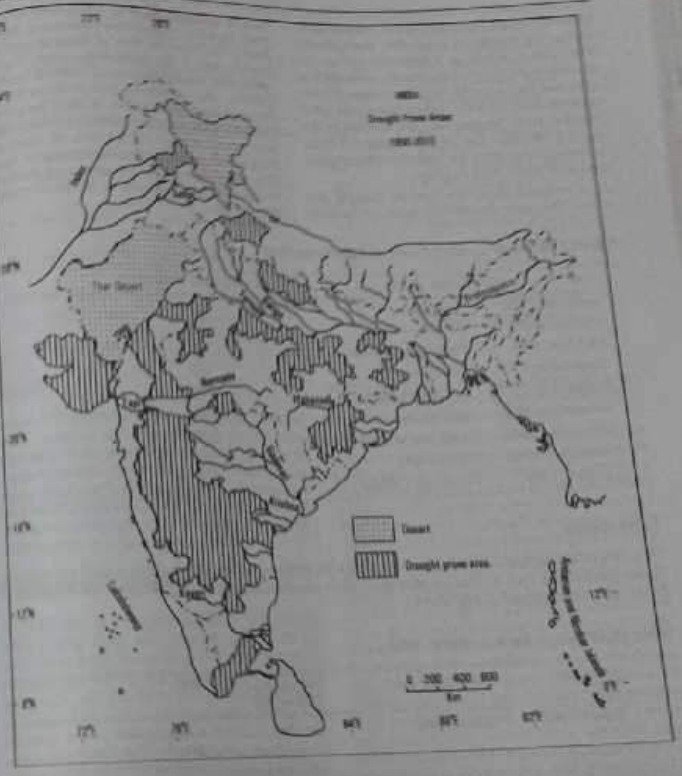


Fig. 10.17 - Drought prone areas (1950–2010)

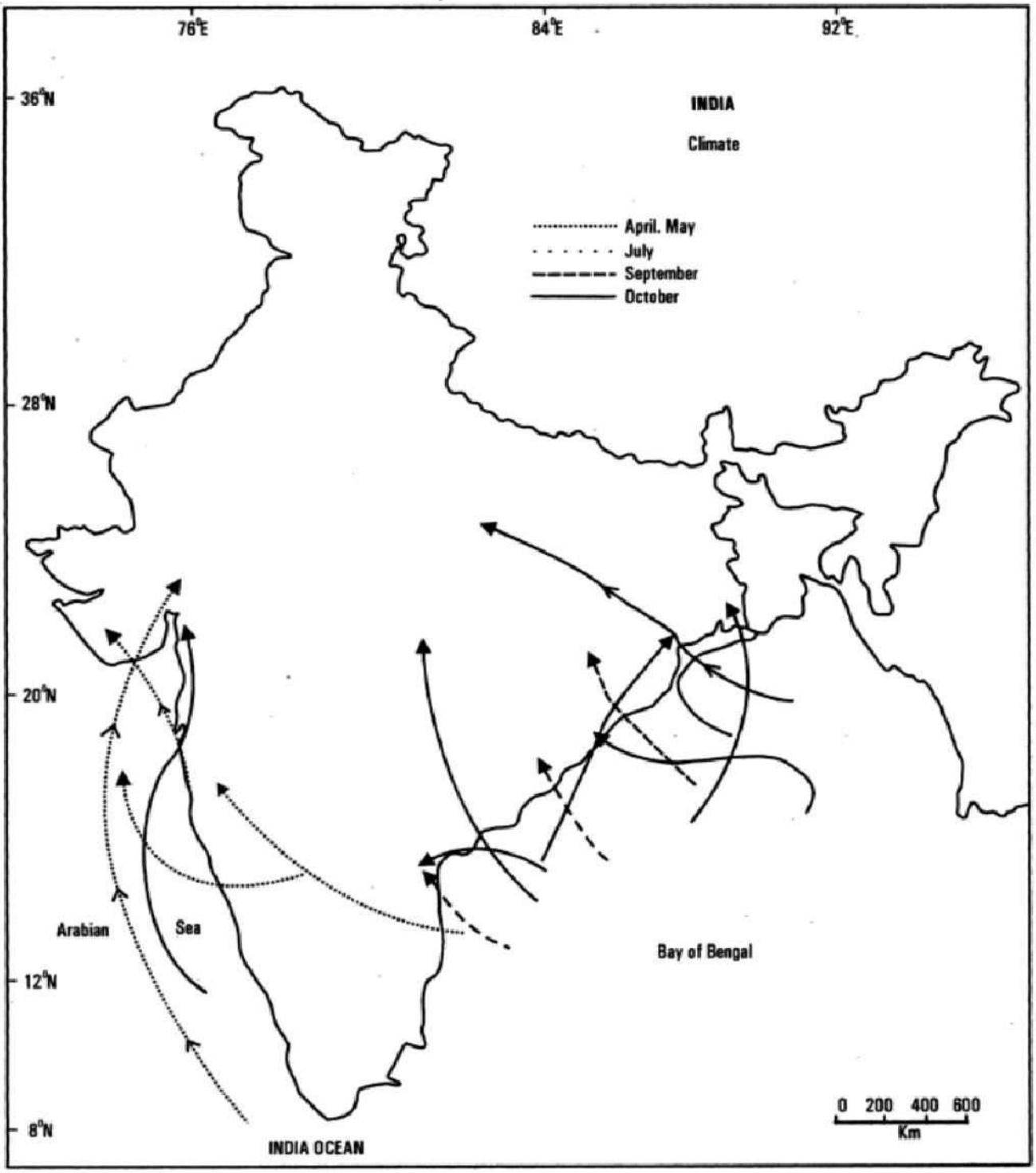


Fig. 10.18 – Cyclones

Power Resources

The socio-economic development of a country is largely controlled by the availability of power and energy resources. The main power resources of India are coal, petroleum, natural gas, and electricity. In recent years, the development of nonconventional sources of energy is getting increasing attention of the planners. Generation of nuclear power is being geared up to contribute significantly to the over-all availability of energy.

Electricity

Electricity is a clean source of energy. It is generated from water, coal, mineral oil, natural gas, wind, sea-waves, tides, thermal springs, and atomic minerals. Electricity is relatively cheap, transportable, pollution free, and renewable. Because of these advantages it is becoming increasingly popular.

The per capita consumption of electricity is often considered as an indicator of socio-economic development. In India, the per capita consumption of electricity is about 350 kWh which is much below the per capita consumption in the world, i.e. 1000 kWh and USA 7000 kWh.

The total installed capacity of electricity by different sources was only 2.3 thousand MW in 1950-51 which rose to 150 thousand in 2005-06. The highest installed capacity is that of thermal power, accounting for 63 per cent of the installed capacity.

***Table 10.28**: India–Installed Capacity of Electricity (in thousand MW)*

Year	*Hydro*	*Thermal*	*Nuclear*	*Others*	*Grand Total*
1950-51	0.6	1.1	-	0.6	2.3
1960-61	1.9	2.7	-	1.0	5.6
1970-71	6.4	8.0	0.4	1.6	16.3
1980-81	11.8	17.6	0.9	3.1	33.3
1990.91	18.8	45.8	1.5	8.6	74.7
2000.01	25.0	76.0	2.9	15.2	119.1
2005.06	35.0	95.0	2.8	17.2	150.0

Source: The Economic Survey, 2006-07.

Coal: The major coal deposits of India have been shown in **Fig. 10.20.**

***Table 10.29**: Coal Deposits in India (Statewise)*

State	*Total Deposits (million tonnes)*	*Percentage of the Total Coal Deposits*
1. Jharkhand	72,565	28.93
2. Odisha	61,684	24.59
3. Chhattisgarh	40,865	17.09
4. West Bengal	27,495	10.96
5. Madhya Pradesh	19,672	7.34
6. Andhra Pradesh	17,595	7.02
7. Maharashtra	8,635	3.44
8. Uttar Pradesh	1135	0.45
9. Meghalaya	469	0.20
9. Assam	385	0.15

10. Bihar	178	0.07
11. Arunachal Pradesh	95	0.02
12. Nagaland	22	0.01
Total	**250,795**	**100.00**

Source: Statistical Abstracts of India, 2006-2007.

Petroleum

Petroleun is an important source of energy. Crude oil is obtained from the sedimentary rocks. The statewise production of petroleum has been shown in **Fig. 10.21 (Table 10.30).**

***Table 10.30:** Crude Oil Production in India*

State/Region	*Production (thousand tonnes)*	*Percentage to the Total Production*
1. Mumbai High	22.10	65.00
2. Gujarat	06.00	17.65
3. Assam	05.10	15.00
4. Andhra Pradesh	00.39	1.15
5. Tamil Nadu	00.37	1.10
6. Arunachal Pradesh	00.04	0.10
Total (All India)	**34.00**	**100.00**

Source: Statistical Abstracts of India 2007.

Natural Gas

Natural gas is obtained from the oil-wells. Being lighter, it overlies the oil pool and is required to be taken out first at the time of drilling oil-well. Natural gas is mainly utilised in the manufacturing of chemical fertilizers, thermal power plants, heating of industries and fuel (cooking gas).

The exploration of natural gas is being done by the Oil and Natural Gas Commission. According to one estimate, India has a total natural gas reserve of about 450 billion cubic meters. Out of the total reserves, about 75 per cent lies in the Bassein and Bombay High, about 12 percent in Gujarat, 7 per cent in Andhra Pradesh and 6 percent in Assam. Natural gas is also found in the Barmer and Jaisalmer Districts of Rajasthan, Kangra Districts of Himachal Pradesh, and Firozepur District of Punjab. The trend of natural gas production has been shown in **Table 10.31.**

***Table 10.31:** India–Trend in Natural Gas Production (2009)*

Year	*Production (million cubic meters)*
1960-61	17
1970-71	76
1980-81	200
1990-91	12,870
2000-01	20,920
2005-06	25,750

Source: Statistical Abstracts, India, *2006-07.*

(2 cm) of rainfall may fall in a few minutes. At the occurrence of a cloudburst loss of property and human life is frequent which may take the shape of disaster and catastrophe. The Uttarakhand cloudburst on 16th June, 2013 is an example of large scale destruction of human life and economic structure.

Because of the amount of rainfall involved, a cloudburst can be quite dangerous, especially if it persists for several hours. Flashflood is common with cloudburst, and in areas with arroyos, and gullies are quickly filled with water, sweeping away any people and animals which might be in the region. Flooding can also render streets unusable, and in extreme cases it can shut down entire city (like Kedarnath, Rambara, Gaurikund, etc.) as people struggle to cope with the influx of water. The Uttarakhand cloudburst known as Himalayan Tsunami of 16th June, 2013 is an example of one of the worst cloudburst disasters in the recent history of India.

Often, these rainstorms appear in the summer season. In the farming communities, they are sometimes welcomed, as a cloudburst can irrigate the withering crops very thoroughly. Most people try to avoid being caught out in the weather. Drowning have also been linked with cloudbursts, even without widespread flooding, because people can become disoriented when caught outside in severe weather. The extremes of rainfall in cloudbursts have been given in the Table 10.30

Table 10.30: Extremes of Rainfall in Cloudbursts

Duration	Rainfall	Location	Date
1 minute	38.10 mm (1.5 inches)	Basse-Terre, Guadeloupe (West Indies)	26 November, 1970
15 minutes	198.12 mm (7.9 inches)	Plumb Point, Jamaica	12th May, 1916
1 hour	250 mm (9.84 inches)	Leh, Ladakh, India	August 5, 2010
10 hours	940 mm (37 inches)	Mumbai, India	July 26, 2005
24 hours	2299 mm (90.49 inches)	Cherrapunji, India	January, 1966

In the Indian subcontinent, a cloudburst usually occurs when a thunderstorm (called monsoon clouds) stalls southward, from the Bay of Bengal or Arabian Sea across the plains, then on to the Himalaya and bursts, bringing rainfall as high as 75 millimeters per hour.

Table 10.31: Cloudburst Damage in India in recent past

Year	Place of cloudburst	Deaths
August, 1998	Guwahati (Assam)	800
July, 1970	Alaknanda Basin (Uttarakhand)	500
18th August, 1997	Chirgaon-Shimla District (H.P.)	115
August, 17, 1998	Malpa Village, Kumaun Division (Uttarakhand)	250
July 26, 2004	Mumbai cloudburst	>5000
August 6, 2010	Leh-Ladakh (J &K)	>1000
June 16, 2013	Kedarnath cloudburst (Uttarakhand)	Several thousands

Cloudburst in Uttarakhand

Uttarakhand the "abode of gods" with its magnificent snow-covered peaks, prestinue forests and awe inspiring rivers is a sacred place in Indian culture. Millions of pilgrims and tourists visit the state of Uttarakhand every year, especially during the summer season. Despite all these attractions, the state of Uttarakhand has a highly vulnerable ecosphere. There are sudden cloudburst, flashfloods, landslides, rock-fall, soil-creep and mass-wasting. The cloudburst of 16th June, 2013 has been termed by the experts as the 'Himalayan Tsunami' (Fig.10.19-a).

The pace at which snow melt moves can be affected by the volume of rain and ground conditions. As the turbulent rivers of Uttarakhand moved downwards on steep slopes, they carried more weathered material and the water gained speed and volume, rapidly increasing the levels downstream. It led to the flash flood and became an unparalleled disaster in the modern history of the state. In the words of a poet "Tabahi ka Manzar Dukhon ki Kahani; Pahadon pe Barsa Pahadon ka Pani".

This cloudburst resulted into enormous loss of life, property and infrastructure. With National Highways damaged at several places, bridges washed away, electricity and phone networks down, hotels and motels destroyed, towns and rural settlements buried and numerous ravaged places marooned. The Uttarakhand cloudburst

Fig. 10. 19-a Cloudburst Region of Uttarakhand (16th June, 2013)

affected about 48,000 sq km of Bhagirathi, Alaknanda rivers and their tributaries. The worst affected was the Mandakni River Basin in which the Kedarnath-shacine, Rambara, Caunkund and Guptkashi towns were devastated. According to official figures, the number of villages affected by the flash flood was 3978, roads damaged 1636 km, worth Rs. 500 crore; cost of resorting drinking water network RS.100 crore; damage to hydro-power projects about 150-200 crore.

According to the experts of environment, ecology the disaster might have been waiting to happen. The illegal constructions on the hills, the exponential growth of rickety structures that serve as hotels which are sordidly maintained, the lackadaisical attitude towards warning the natural catastrophes are largely responsible for the disaster of Uttarakhand. In fact the disaster was man made. The main anthropogenic causes of disaster are given below:

1. The development and extension of roads and the National Highways NH-58-Mana Pass, NH-108-Gangotri-Angar, NH-109-Guptkashi-Kedarnath; etc have disturbed the ecology and the highly fragile ecosystems of the region.
2. Heavy pressure of cultural activities and tourists: To accommodate the tourists, there is tremendous growth of urban settlements, hotels, hill resorts, camping-sites and business-houses in the vulnerable hilly areas.
3. Deforestation: Large scale deforestation has taken place in the young folded mountains of the lesser and outer Siwaliks.
4. Construction of dams and multi-purpose projects: Several projects in the form of Tehri Dam, Koteswar, dam, Maneri-Bhali Hydel Project, Loharinga-Pala Hydel Project, Srinagar Project, Asi-Ganga Project and Vishnu-Prayag Project. The reservoirs of these projects have disturbed the isostatic equilibrium in the Himalayan region leading to frequent earthquakes and landslides.
5. The ambitious plan of the government of Uttarakhand to convert the state into 'Urja-Pradesh' (Energy Province), and the leading 'tourist region' of India.

Cloudburst Management

Cloudburst is a natural disaster that cause great damage to life and property. Some of the steps that can help in reducing the damage to life and property in the affected areas are given below:

1. Based on scientific data, there should be delineation of eco-sensitive zones.
2. The maximum and minimum discharge of water of all the rivers and their tributaries should be ascertained and the people should be made aware about the possible discharge of the rivers.
3. Better and effective system of weather forecasting and dissemination of weather related information are imperative to mitigate the disasters like cloudburst.
4. There should be proper site selection and planning of the rural and urban settlements.
5. There is an urgent need for a comprehensive renewal and relook at construction techniques of roads, houses, factories and other structures.
6. Blasting of rocks for the construction of roads should be stopped or minimized.
7. There should be strict regulation of tourism.
8. Uncontrolled traffic jams and increased environmental pollution play havoc in the fragile ecosystems of the Himalayas. They should be checked and mitigated.
9. Human resource required to tackle the natural disaster should be strengthened.
10. The post-cloud-burst operations include quick action to rescue of stranded people buried under thick cover of debris to evacuate them to safer places. Immediate medical help be provided to survivors.
11. The Sant Samaj (religious community) should work as a pressure group to check the construction of multi-story buildings, hotels, Dharamsalas and Sarais.
12. The state government should take strict and effective action against the encroachment around the shrines in the form of make shift shops, Dhabas and temporary shelters.

If these steps are taken together, the consequent damage to life and property, infrastructure, ecology and environment can be reduced substantially.

Power Resources

The socio-economic development of a country is largely controlled by the availability of power and energy resources. The main power resources of India are coal, petroleum, natural gas, and electricity. In recent years, the development of non-conventional sources of energy is getting increasing attention of the planners. Generation of nuclear power is being geared up to contribute significantly to the over-all availability of energy.

Electricity

Electricity is a clean source of energy. It is generated from water, coal, mineral oil, natural gas, wind, sea-waves, tides, thermal springs, and atomic minerals. Electricity is relatively cheap, transportable, pollution free, and renewable. Because of these advantages it is becoming increasingly popular.

The per capita consumption of electricity is often considered as an indicator of socio-economic development. In India, the per capita consumption of electricity is about 350 kWh which is much below the per capita consumption in the world, i.e. 1600 kWh and U.S.A. 7000 kWh.

The total installed capacity of electricity by different sources was only 2.3 thousand MW in 1950-51 which rose to 150 thousand in 2005-06. The highest installed capacity is that of thermal power, accounting for 63 per cent of the installed capacity.

Table 10.32: India–Installed Capacity of Electricity (in thousand MW)

Year	Hydro	Thermal	Nuclear	Others	Grand Total
1950-51	0.6	1.1	–	0.6	2.3
1960-61	1.9	2.7	–	1.0	5.6
1970-71	6.4	8.0	0.4	1.4	16.3
1980-81	11.8	17.6	0.9	3.1	33.5
1990-91	18.8	45.8	1.5	8.6	74.7
2000-01	25.0	76.0	2.9	15.2	129.1
2005-06	35.0	91.0	2.8	17.2	150.0

Source: The Economic Survey, 2006-07.

Coal. The major coal deposits of India have been shown in **Fig. 10.20**.

Table 10.33: Coal Deposits in India (Statewise)

State	Total Deposits (million tonnes)	Percentage of the Total Coal Deposits
1. Jharkhand	72,568	28.99
2. Odisha	53,684	24.59
3. Chhattisgarh	40,865	17.09
4. West Bengal	27,495	10.96
5. Madhya Pradesh	19,672	7.54
6. Andhra Pradesh	12,595	7.02
7. Maharashtra	8,655	3.44
8. Uttar Pradesh	1558	0.45
9. Meghalaya	609	0.28
9. Assam	385	0.15
10. Bihar	179	0.07

11. Arunachal Pradesh	98	0.03
12. Nagaland	22	0.01
Total	**250.788**	**100.00**

Source: Statistical Abstracts of India 2006-2007.

Petroleum

Petroleum is an important source of energy. Crude oil is obtained from the sedimentary rocks. The statewise production of petroleum has been shown in **Fig. 10.21 (Table 10.34)**.

Table 10.34: *Crude Oil Production in India*

State/Region	*Production (thousand tonnes)*	*Percentage to the Total Production*
1. Mumbai High	22.10	65.00
2. Gujarat	06.00	17.65
3. Assam	05.10	15.00
4. Andhra Pradesh	00.39	1.15
5. Tamil Nadu	00.37	1.10
6. Arunachal Pradesh	00.04	0.10
Total (All India)	**34.00**	**100.00**

Source: Statistical Abstracts of India 2007.

Natural Gas

Natural gas is obtained from the oil-wells. Being lighter, it overlies the oil pool and is required to be taken out first at the time of drilling oil-well. Natural gas is mainly utilised in the manufacturing of chemical fertilizers, thermal power plants, heating of industries and fuel (cooking gas).

The exploration of natural gas is being done by the Oil and Natural Gas Commission.

According to one estimate, India has a total natural gas reserve of about 450 billion cubic meters. Out of the total reserves, about 75 per cent lies in the Bassein and Bombay High, about 12 percent in Gujarat, 7 per cent in Andhra Pradesh and 6 percent in Assam. Natural gas is also found in the Barmer and Jaisalmer Districts of Rajasthan, Kangra Districts of Himachal Pradesh, and Firozepur District of Punjab. The trend of natural gas production has been shown in **Table 10.35**.

Table 10.35: *India–Trend in Natural Gas Production (2009)*

Year	*Production (million cubic meters)*
1960-61	17
1970-71	76
1980-81	200
1990-91	12,870
2000-01	20,920
2005-06	25,750

Source: Statistical Abstracts, India, 2006-07.

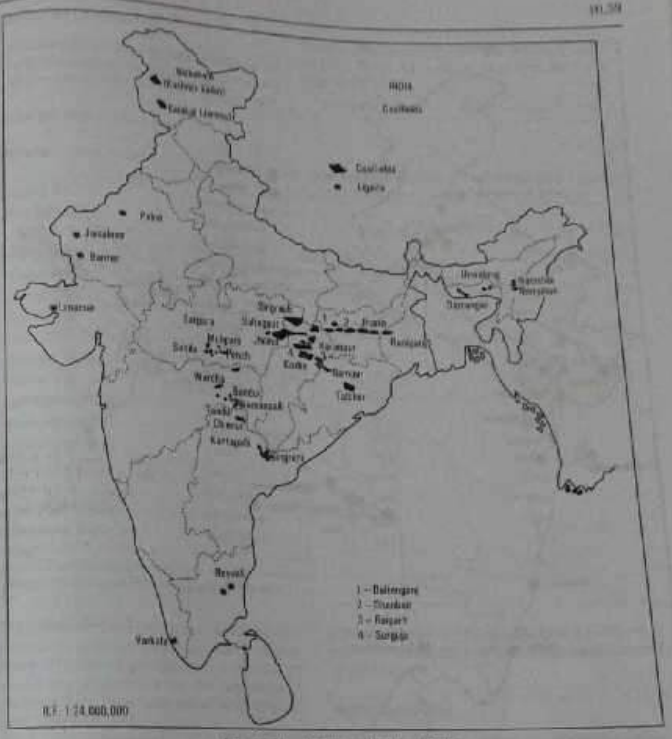


Fig. 10.20 – Major coalfields of India

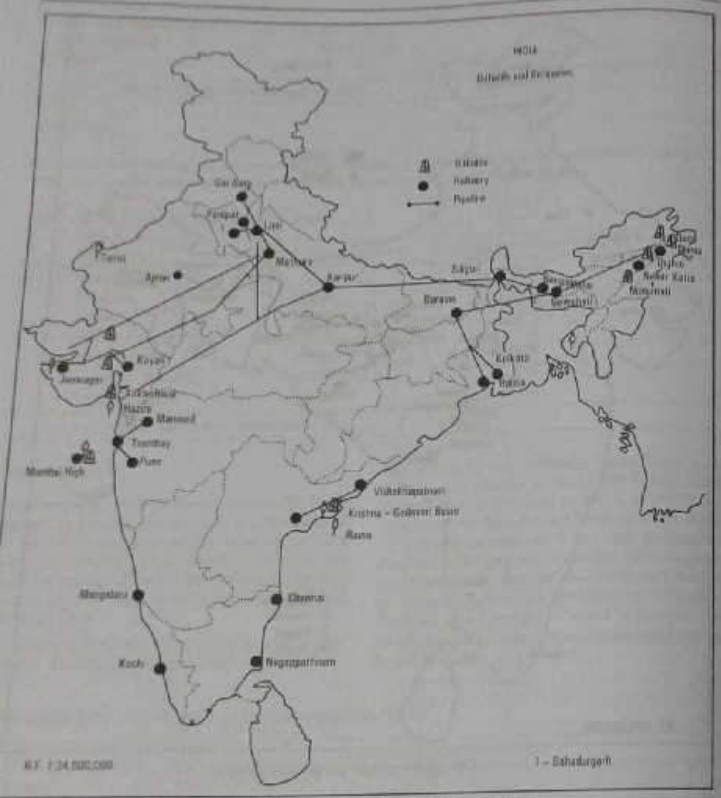


Fig. 10.21 – Oilfields and petroleum refineries of India

Oil Refineries of India

The oil refineries are the processing factories of crude oil. The impurities from the crude oil are removed to obtain petroleum, diesel, kerosene, bitumen, and aviation fuel. The main refineries of India are given in **Table 10.36** and shown in **Fig. 10.21**.

***Table 10.36:** Refineries of India*

Refinery	State	Commissioned in year	Capacity (lakh tonnes per year)
Digboi, IOC	Assam	1901	5.0
Trombay, HPCL	Maharashtra	1954	55.0
Trombay, BPCL	Maharashtra	1955	60.0
Vishakhapatnam, HPCAL	Andhra Pradesh	1957	45.0
Nunamati, IOC	Assam	1962	8.5
Barauni, IOC	Bihar	1964	33.5
Koyali, IOC	Gujarat	1965	95.0
Kochi, CRL	Kerala	1966	45.0
Chennai, MRL	Tamil Nadu	1969	56.0
Haldia, IOC	West Bengal	1975	27.5
Bongaigaon, BRPL	Assam	1979	13.5
Mathura, IOC	Uttar Pradesh	1982	75.0
Numaligarh, IOC	Assam	1999	30.0
Jamnagar, RP	Gujarat	1999	270.0
Kamal, IOC	Haryana	1998	60.0
Mangalore, HPCL	Karnataka	1998	30.0
Panagundi, IOC	Tamil Nadu	1999	9.0
Total			**913.5**

Source: Statistical Abstract of India, 2006-07

India is, however, not self-reliant in the matter of petroleum and petroleum products. Heavy quantity of crude-oil, petroleum and petroleum products are imported from the countries of South-West Asia, especially from Saudi Arabia, Kuwait, Iran and UAE.

The generation of electricity was started in India in 1898 when the Darjeeling Hydel Power Project was commissioned.

The first thermal power plant was installed in Kolkata in 1899. Subsequently, the Mettur Project in Tamil Nadu and Sivasamudram Project in Karnataka were commissioned. The National Thermal Power Corporation (NTPC) was established in 1975. A number of thermal power stations were established in different parts of the country to meet the growing demand of electricity.

Hydro Electricity

India is one of the leading producers of hydro-electricity in the world. At present, there are 115 hydel power projects in operation in the country. Most of the hydel projects are located in the hilly and mountainous areas of the country. The major hydro-electric power projects have been shown in **Fig. 10.22**, while their statewise distribution is given in **Table 10.37**.

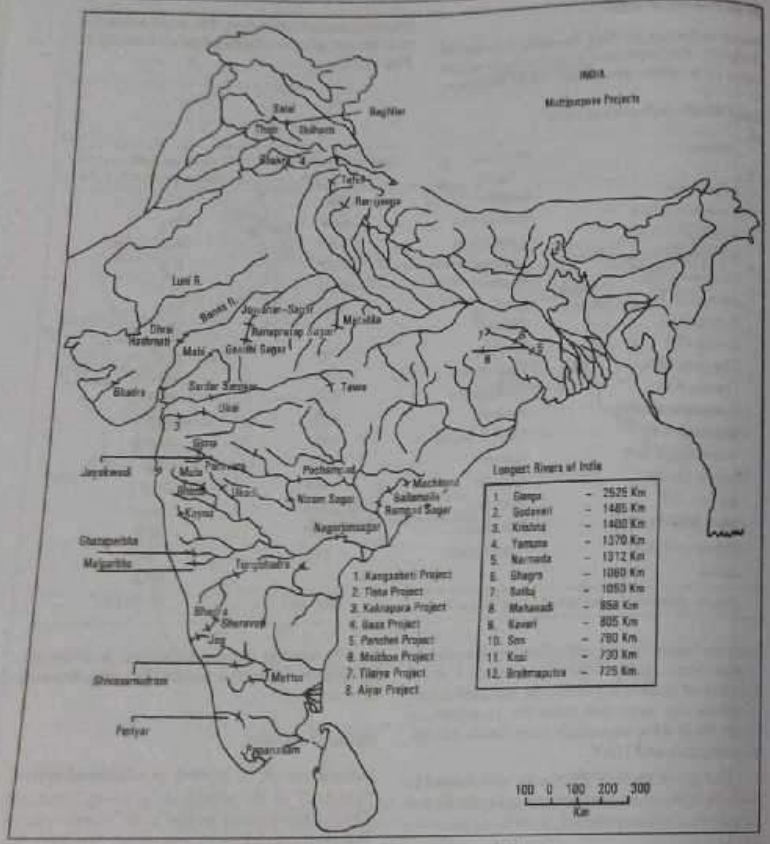


Fig. 10.22 Multipurpose projects of India

Multipurpose Projects

Some of the important multipurpose projects of India are as under:

1. D.V.C. (Damodar Valley Corporation)
2. Mayurakshi Project in Jharkhand and West Bengal
3. Kangsabati Project in Bankura district of West Bengal
4. Tista Valley Project in West Bengal
5. Nagarjun Sagar Project in Andhra Pradesh
6. Tungbhadra Project in Andhra Pradesh and Karnataka
7. Pochampad Project in Andhra Pradesh
8. Kakrapara Project in Gujarat
9. Ukai Project in Gujarat
10. Mahi Project in Gujarat
11. Bhadra Project in Gujarat
12. Upper Krishna Project in Karnataka
13. Ghataprabha Valley Development Project in Karnataka
14. Malaprabha Project in Karnataka
15. Tawa Project in Hoshingabad district (Madhya Pradesh)
16. C.V.D. Project on the Chambal River
17. Bhima Project on Pavna River in Pune and Sholapur districts of Maharashtra
18. Hirakud Project in Odisha
19. Tawakwadi Project in Maharashtra
20. Bhakra Nangal Project in Himachal Pradesh/ Punjab
21. Beas Project in Himachal Pradesh
22. Parambikulam Alliyar Project in Tamil Nadu
23. Indira Gandhi Canal in Punjab and Rajasthan
24. Gandak Project on the Gandak River, Bihar
25. Rihand Project in Uttar Pradesh
26. Kosi Project in Bihar
27. Sabarmati Project in Gujarat
28. Panam Project in Panchmahal District of Gujarat
29. Kanjan Project in Gujarat
30. Maharadi Reservoir in Madhya Pradesh
31. Hasdeo Bango and Bargi Projects in Madhya Pradesh
32. Sarda-Sahayak and Ramganga Project in Uttarakhand
33. Ukadi, Krishna and Upper Penganga Project in Maharashtra
34. Thein Project in Punjab

Table 10.37: Statewise Main Hydro-Electric Power Projects

	State	Names of Hydro-electric Power Plants
1.	Andhra Pradesh	Machkund, Nagarjun Sagar, Nizam Sagar, Sileru, Srisailem
2.	Bihar	Kosi
3.	Gujarat	Bhadra (Kathiawad), Hathmati (Sabarmati), Ukai (Tapi)
4.	Jammu & Kashmir	Dool Hasti, Baghliar, Salal (Chenab), Lower Jhelum
5.	Jharkhand	Maithon, Panchat, Tilaiya (all under Damodar Valley Corporation)
6.	Karnataka	Bhadra, Krishnarajsagar, Mahatma-Gandhi (Jog Falls), Munirabad, Saravati, Sivasamudram (Kaveri)
7.	Kerala	Iddukki (Periyar), Kallada, Kuttiadidy, Pallivasal, Parmbikulam, Periyar, Poringal, Pomniar, Sabarigiri
8.	Madhya Pradesh	Jawaharsagar and Pratapsagar Pallivasal, (Chambal), Tawa (Narmada)
9.	Maharshtra	Bhula, Bhatnagar (Beed), Girnar, Khopali, Koyna, Purna, Paithen, Vaitarna
10.	North-Eastern States	Dikhu, Doyan (Nagaland), Gomuti (Tripura), Kopali (Assam), Khandong and Kyrdemkulai (Meghalaya), Loktak (Manipur), Ranganadi (Arunachal Pradesh), Sirlui and

	Barabi (Mizoram)
11. Odisha	Hirakud (Maharadi), Balimela, Bengal (Brahmani), Indravati
12. Punjab and Himachal Pradesh	Bhakra-Nangal (Sutlej), Dehar (Beas), Giri-Bata, Binwa, Chamera, Pong, Siul, Bassi, Bhabhanagar
13. Rajasthan	Rana Pratap Sagar (Chambal)
14. Tamil Nadu	Mettur, Periyar, Aliayar, Kodayar, Moyar, Papnesam, Suruliyar
15. Uttarakhand	Tehri-Dam, Koteshwar-Dam (Bhagirathi)
16. Uttar Pradesh	Rihand, Ramganga, Chibro (Tons)
17. West Bengal	Panchet

Thermal Electricity

Coal and lignite based thermal power stations contribute about 60 per cent of the total electricity generated in India. Some of the important thermal power stations of India are Patratu, Barauni and Muzaffarpur in Bihar, Talcher (Odisha), Titagarh, Mulajore, Cossipore, Durgapur, Bandel, Santaldih, Gouripur, Disergarh, Kolaghat, Farakka in West Bengal; Ahmadebad, Dhuravan, Gandhinagar, Kawas, Gandgar, Sabarmati, Ukai and Uttaran, Gujarat; Satpura, Korba (M.P.); Ballarshah, Bhusawal, Chola, Koradi, Khaparkheda, Nasik, Paras, and Parli in Maharashtra **(Fig. 10.23)**.

In northern India thermal power plants are located Rajghat in Delhi, Faridabad, Panipat and Surajpur in Haryana, Chenani and Kalakot in Jammu and Kashmir, Bhatinda, in Punjab, Obra, Harduagang, Renusagar, Panki (Kanpur), Dadri, Rihand, and Singrauli in Uttar Pradesh. In southern India thermal power plants are located at Kothagudam, Vijaiwada, Ramagundam, Nellore, Ennore, Tuticorin, and Basin- Bridge (Tamil Nadu); Raichur (Karnataka) and Kochi (Kerala). Moreover, gas turbine projects are located at Kamrup, Chandrapur, Bongaigaon, and Lakwa. Waste heat recovery plants are located at Namrup, and Lower Burpani.

Table 10.38: Thermal Power Plants

States	*Thermal Power Station*
1. Andhra Pradesh	Bhadrachalam, Kothagudem, Manuguru, Nellore, Ramagundam, Vijaiwada
2. Assam	Bongaigaon, Chandrapur, Namrup
3. Bihar	Barauni, Kahalgaon
4. Chhattisgarh	Korba
5. Delhi	Badarpur, Indraprastha, Rajghat
6. Gujarat	Ahmadebad, Banas, Dhuvaran, Gandhisagar, Kachchh, Kandla, Mahiva, Porbandar, Sabarmati, Shahpur, Sikka, Ukai, Utaran, Wanskhobri
7. Haryana	Faridabad, Panipat, Yamunanagar
8. Jammu & Kashmir	Kalakot
9. Jharkhand	Bokaro, Chandrapur, Subernrekha
10. Madhya Pradesh	Amarkantak, Satpura, Vindhyachal
11. Maharashtra	Ballarshah, Bhusaval, Chandrapur, Chola, Dabhol, Khapar-Kheda, Koradi, Nasik, Paras, Parli, Trombay, Uran
12. Punjab	Bhatinda, Rupnagar
13. Rajasthan	Anta, Banswara, Kota, Palana, Sawai-Madhopur

14. Odisha	Balimela, Talcher
15. Tamil Nadu	Ennore, Mettur, Neyveli, Tuticorin
16. Uttar Pradesh	Bahraich, Dadri, Ghaziabad, Gorakhpur, Harduaganj, Jawaharpur, Kanpur, Mau, Moradabad, Obra, Panki, Paricha, Singrauli, Tanakla
17. West Bengal	Bishnum, Bandel, Durgapur, Farakka, Gouripur, Kalaghat, Kolkata, Maithakhand, Santaldih, Titagarh

Bhakra-Nangal Project on the Sutlej in Himachal/Punjab; Dehar (Beas) in Mandi District, Bhabhanagar in Kinnaur District, Nathpa-Jhakri, Bassi, Baira-Siul and Chamera (H.P.); Lower Jhelum, Dool-Hasti, Baghliar, and Salal on Chenab River in Jammu and Kashmir; Ranapratap Sagar and Jawahar Sagar on Chambal, Tehri-Dam and Koteshwar Dam on Bhagirathi (Uttarakhand). Khodri, Chibro on Tons are important plants in northern India.

Plants of southern India are Lower Sileru, Upper Sileru, Machkunda in Andhra Pradesh and Odisha; Nizam-Sagar, Nagarjunsagar and Srisalam (Krishna), Tungbhadra Dam of Andhra Pradesh, Saravati, Kalinadi, Mahatma Gandhi (Jog-Falls), Bhadra, Shivasamudram (Kaveri), Shimashpura, Munirabad and Lingnamakki of Karnataka; Iddikki (Periyar), Sabarigiri, Kuttiady, Sholayar, Sengulam, Neriammangalam, Parambi-Kulam Aliyar, Kallada, Pallivasal, Poringal and Ponniar of Kerala; Pykara, Mettur, Kodayar, Sholayar, Aliyar, Moyar, Sakarpathy, Suruliyar and Papanasam of Tamil Nadu.

Plants of north-east India include Dikhu, Doyang, (Nagaland), Gomati (Tripura), Loktak (Manipur), Khandong and Kyrdemkulai (Meghalaya), Kopili (Assam), Serlui and Barabi (Mizoram). Ranganadi (Arunachal Pradesh). Damodar Valley Corporation, the first multipurpose river valley project is having an installed capacity of 2146 mw, comprising of 1920 mw thermal, 144 mw hydel and 82 mw electricity generated by gas turbines.

Nuclear Power

India has rich deposits of uranium and thorium, the fuel used in the generation of nuclear power. The atomic energy institution at Trombay (Bhabha Atomic Research Centre) was established in 1954 and the Nuclear Power Corporation of India was established in 1987 to implement the nuclear power generation programme for commercial lines.

The first nuclear power plant with a capacity of 320 mw was set up at Tarapur (Maharashtra). Subsequently, the Rawatbhata Atomic Plant (300 mw) near Kota was set up in 1969 which was followed by the establishment of Narora-U.P. (1989), Kaiga (Karnataka), and Kakrapara in Gujarat in 1993 **(Fig. 10.24)**.

The new sites for nuclear power plants are Bergi or Chutka (M.P.), Haripur (W.Bengal), Kawada (Andhra Pradesh), Kudankulam (TamilNadu), Kumharia (Haryana) and Mithi-Verdi-Kathiawad (Gujarat) **(Fig. 10.24)**.

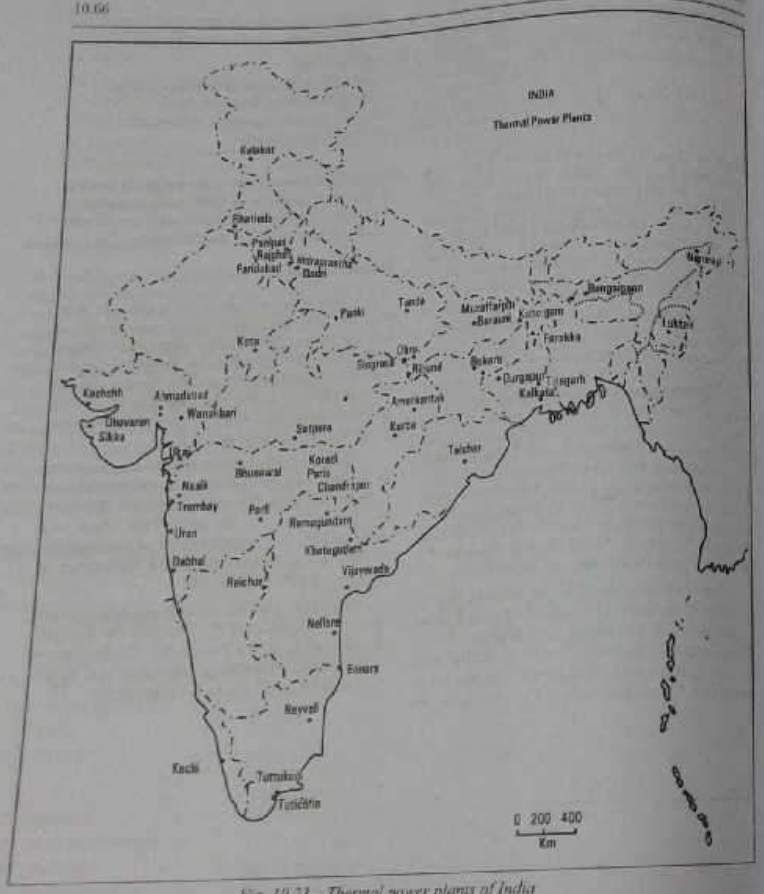


Fig. 10.23 – Thermal power plants of India

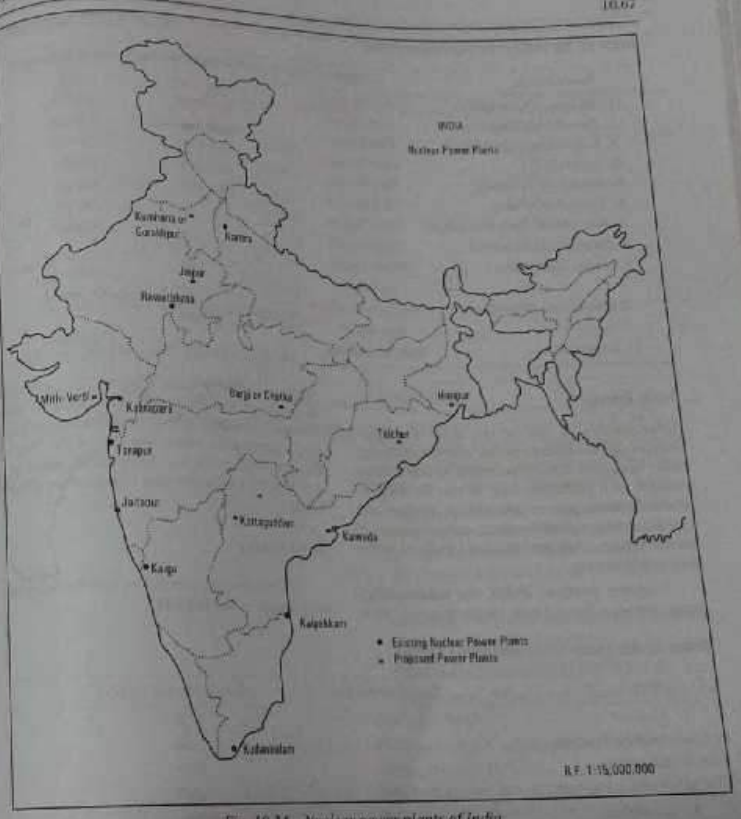


Fig. 10.24 – Nuclear power plants of India

Table 10.39: *India–Nuclear Power Plants*

Power Station	Unit	Year of Commissioning	Capacity (mw)
1. Tarapur (Maharashtra)	First Second	1969 1970	160
2. Rawatbhata (Rajasthan)	First Second	1972 1981	200 200
3. Kalpakkam (Tamil Nadu)	First Second	1984 1986	235 235
4. Narora(U.P.)	First Second	1989 1991	235 235
5. Kakrapara (Gujarat)	First Second	1993 1995	235 235
6. Kaiga (Karnataka)	First Second	1993 1995	235 235
7. Rawatbhata, Kota (Rajasthan)	Third Fourth		235 235
8. Tarapur (Maharashtra)	Third Fourth		500 500
9. Kaiga (Karnataka)	Third, Fourth and Fifth		235 (each)
10. Kawathbata (Rajasthan)	Sixth, Seventh and Eighth		500 (each)
11. Kundakulam	First and Second		1000 (each)

Solar Energy

Solar energy is one of the most important sources of non-conventional sources of energy. Solar energy is non-exhaustible, space-heating, reliable and pollution free. It can be used for water heaters, power generation devices, air-conditioning, space heating, development of pisci-culture, and multifarious uses of water and refrigeration.

In many parts of India, the solar energy programmes have been implemented. One such example is Rural Energy Co-operative at Sagar Island in Sundarban Delta of West Bengal. Similar programmes have been implemented in other islands of the Bay of Bengal, the district of Jodhpur (Rajasthan), Kalyanpur (Aligarh) and Coimbatore (Tamil Nadu).

Wind Energy

The statewise potential of wind energy has been given in **Table 10.40.**

Table 10.40: *India–Statewise Wind Energy*

State	Total Potential (mw)	Technical Potential (mw)
1. Gujarat	9675	1730
2. Andhra Pradesh	8275	1550
3. Karnataka	6620	1025
4. Madhya Pradesh	5500	1200
5. Rajasthan	5400	0885
6. Tamil Nadu	3050	1700
7. Others	6675	4725
Total	**45195**	**12835**

It may be seen from **Table 10.36** *that Gujarat has the highest wind energy potential followed by* Andhra Pradesh, Karnataka, Madhya Pradesh, Rajasthan and Tamil Nadu.

Mineral Resources

Table 10.41: *Leading Iron Ore Producing States of India*

State	Production (Thousand tonnes)	Percentage of the Total Production in the Country
1. Karnataka	25,565	24.90
2. Odisha	22,560	21.98
3. Chhattisgarh	20,455	19.92
4. Goa	18,400	17.92
5. Jharkhand	14,685	14.32
6. Others	975	0.96
Total	**102,640**	**100.00**

Source: Statistical Abstracts of India, 2006–2007.

Table 10.42: *Iron Ore Deposits of India*

State	Quality	Mining Centres
1. Karnataka	Magnetite (high grade)	*Kemmangundi* (Baba-Budan Hills-Chikmagalur District), *Sandur* and *Hospet* (Bellary District), Chitradurga, Dharwar, Shimoga, Tumkur, Uttar Kannad.
2. Odisha	Haematite	Cuttack, Kendujhar, Koraput, *Barabil-Koira* Valley, *Badampahar* (Mayurbhanj), Sambalpur, Kandaihar (Sundargarh), Daitri Hill along the boundary of Kendujhar and Cuttack.
3. Chhattisgarh	Haematite	Bailadila, Dalli-Rajhara (Durg), Bilaspur, Jagdalpur, Raigarh, Surguja.
4. Goa		Pirna-Adolpale-Asnora (North Goa).
5. Jharkhand		Singhbhum, Noamandi, Santhal Pargana, Hazaribagh.
6. Others	Sederite, Limonite	Anantapur, Cuddapah, Guntur, Khammam, Kurnool, Nellore (Andhra Pradesh), Bhavnagar, Junagarh, Vadodra (Gujarat); Kangra, Mandi (Himachal Pradesh) Chandrapur, Ratnagiri, Sindhudurg (Maharashtra); Alwar, Bhilwara, Bundi, Jaipur, Udaipur (Rajasthan), Almora, Garhwal, Nainital (Uttarakhand), Mirzapur (Uttar Pradesh) Birbhum, Burdwan, Darjeeling (West Bengal).

Table 10.43: *Manganese – Leading Producing States of India* **(Fig. 10.26)**

State	Production (thousand tonnes)	Percentage of the Total Production of the Country	Major Mining Districts/Centres
1. Odisha	715	38.55	Bolangir, Kalahandi, Koraput, Sambalpur, Sundargarh
2. Maharashtra	429	22.91	Bhandara, Nagpur, Ratnagiri
3. Madhya Pradesh	365	19.68	Balaghat and Chhindwara
4. Karnataka	245	13.20	Bellary, Chitradurga, Shimoga, Tumkur, Uttara Kannad
5. Andhra Pradesh	85	4.58	Cuddapah, Guntur, Srikakulam, Vizianagram, Vishakhapatnam
6. Others	20	1.08	Goa, Panchmahal and Vadodra (Gujarat), Dhanbad, Singhbhum (Jharkhand) Udaipur (**Rajasthan**)
Total (All India)	**1855**	**100.00**	

Source: Statistical Abstracts of India 2007 – 2008.

Table 10.44: *Copper–Leading Producing States of India* **(Fig. 10.26)**

State	Production (thousand tonnes)	Percentage of the Total Production of India	Major Mining Districts/Centres
1. Madhya Pradesh	89	55.97	Malanjkhand (Balaghat), Badgaon (Betul)
2. Rajasthan	65	40.80	Ajmer, Bhilwada, Chittorgarh, Dungarpur, Jaipur, Khetri (Jhunjhunu), Pali, Sikar, Singhana Sirohi
3. Jharkhand	05	03.34	Hazaribagh, Santhal Pargana
Total (All India)	159	100.00	

Source: Statistical Abstracts 2007 – 2008.

Table 10.45: *Bauxite–Leading Producing States of India* **(Fig. 10.27)**

State	Production (thousand tonnes)	Percentage of the Total Production of India	Major Mining Districts/Centres
1. Odisha	4904	50.16	Bolangir, Kalahandi, Koraput, Sundergarh, Sambalpur
2. Gujarat	1547	15.82	Amreli, Bhavnagar, Jamnagar, Junagarh, Kachchh
3. Jharkhand	1161	11.87	Dumka, Lohardaga, Palamu, Ranchi
4. Maharashtra	964	9.87	Kolhapur, Pune, Ratnagiri, Satara, Thane
5. Chhattisgarh	501	5.18	Amarkantak-Pathar, Bilaspur, Durg, Raigarh, and Surguja
6. Tamil Nadu	268	2.74	Madurai, Nilgiri, and Salem
7. Madhya Pradesh	230	2.35	Balaghat, Katni, Jabalpur, Maikal range, Mandla, Shahdol
8. Others	99	1.01	Andhra Pradesh, Goa, Jammu & Kashmir, and Kerala
Total (All India)	**9772**	**100.00**	

Source: Statistical Abstracts, 2007 – 08.

Table 10.46: *Mica – Leading Producing States of India*

State	Production (thousand tonnes)	Percentage of the Total Production of India	Major Mining Districts/Centres
1. Andhra Pradesh	910	71.15	Khammam, Krishna, Nellore, Vishakhapatnam, and West Godavari
2. Rajasthan	205	16.03	Ajmer, Bhilwara, Dungarpur, Sikar, Tonk, Udaipur
3. Jharkhand	148	11.57	Dhanbad, Giridih, Hazaribagh, Koderma, Ranchi, Singhbhum
4. Bihar	16	01.25	Bhagalpur, Gaya, Munger
Total (All India)	**1279**	**100.00**	

Source: Statistical Abstracts of India 2007-08.

Table 10.47: *Limestone – Leading Producing States of India*

State	Production (thousand tonnes)	Percentage of the Total Production of India	Major Mining Districts/Centres
1. Rajasthan	240	16.15	Ajmer, Alwar, Bikaner, Chittaurgarh, Dungarpur, Kota, Nagaur, Pali
2. Madhya Pradesh	238	16.01	Betul, Damoh, Jabalpur, Rewa, Satna, Sagar
3. Andhra Pradesh	235	15.81	Cuddapah, Guntur, Kurnool, Krishna, Nalgonda, Warangal
4. Gujarat	160	10.77	Amreli, Junagarh, Kheda, Surat
5. Chhattisgarh	140	09.42	Bastar, Bilaspur, Durg, Raigarh, Raipur
6. Tamil Nadu	138	09.29	Coimbatore, Madurai, Salem, Thanjavur
7. Karnataka	125	08.41	Bijapur, Gulbarga, Shimoga
8. Maharashtra	090	06.06	Chandrapur, Naded, Ahmadnagar, Yavatmal
9. Himachal Pradesh	068	04.58	Bilaspur, Chamba, Kangra
10. Odisha	025	01.68	Kalahandi, Sambalpur, Sundergarh

11. Others	027	01.82	Dehra Dun, Mussoorie, Darjeeling, Jammu, Mahendergarh, Mirzapur
Total (All India)	**1486**	**100.00**	

***Table 10.48:** Dolomite – Leading Producing States of India*

State	*Production (Thousand Tonnes)*	*Percentage of the Total Production of India*	*Major Mining Districts/Centres*
1. Odisha	1075	28.71	Cangapur, Koraput, Sambalpur, Sudargarh
2. Chhattisgarh	1025	27.38	Bastar, Bilaspur, Durg, Raigarh
3. Andhra Pradesh	687	18.35	Anantapur, Kurnool, Khammam
4. Jharkhand	295	07.88	Chaibasa, Palamu, Singhbhum
5. Rajasthan	215	05.74	Ajmer, Alwar, Bhilwara, Jaipur, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, Sawai Madhopur, Sikar, and Udaipur
6. Karnataka	212	05.66	Belgaum, Bijapur, Chitradurga, Mysore, Uttar Kannad, and Tumkur
Others	235	06.28	Arunachal Pradesh, Haryana, Himachal Pradesh, Maharashtra, Tamil Nadu, Uttarakhand, Uttar Pradesh, and West Bengal
Total (All India)	**3744**	**100.00**	

Source: Statistical Abstracts, 2007–08

Cotton Textile Industry

Cotton textile is one of the largest industries of India in terms of output, employment and foreign exchange. Its share in the industrial production is 14 per cent. Moreover, it provides 10 per cent of the excise collection, 18 per cent of employment in the industrial sector, 20 per cent of the country's total export and 4 per cent of the GDP. India enjoyed the monopoly in the production of textile goods from 1500 B.C. to 1500 A.D. Indian cotton and silk products were in great demand all over the world. The arrival of the British in India, however, led to the downfall of Indian textile manufacturing.

The first textile mill in India was established by C.N. Dewar at Mumbai, in 1854. This industry expanded fast in the ending parts of the 19th century and in the 20th century. At present India is one of the leading producers and exporter of cotton goods. The distribution of cotton textiles have been shown in **Fig. 10.29**, while the statewise production has been given in **Table 10.49**.

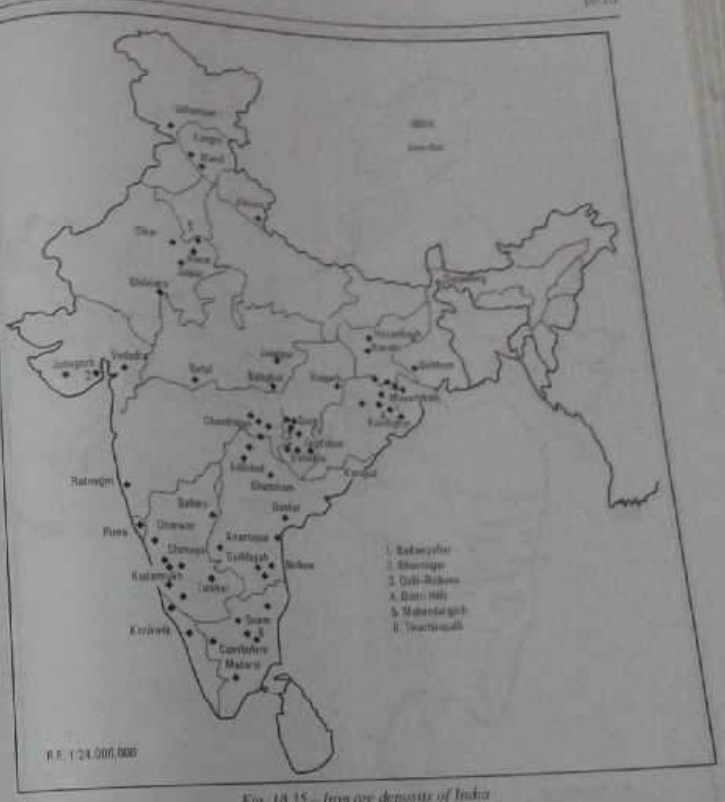


Fig. 10.25 – Iron ore deposits of India

Fig. 10.26 – Main copper and manganese deposits of India

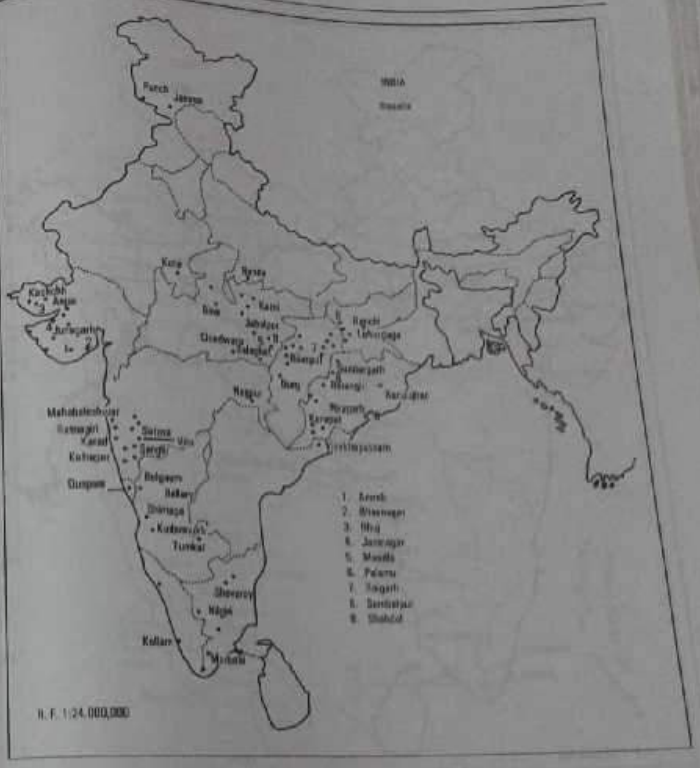


Fig. 10.27 – Bauxite deposits of India

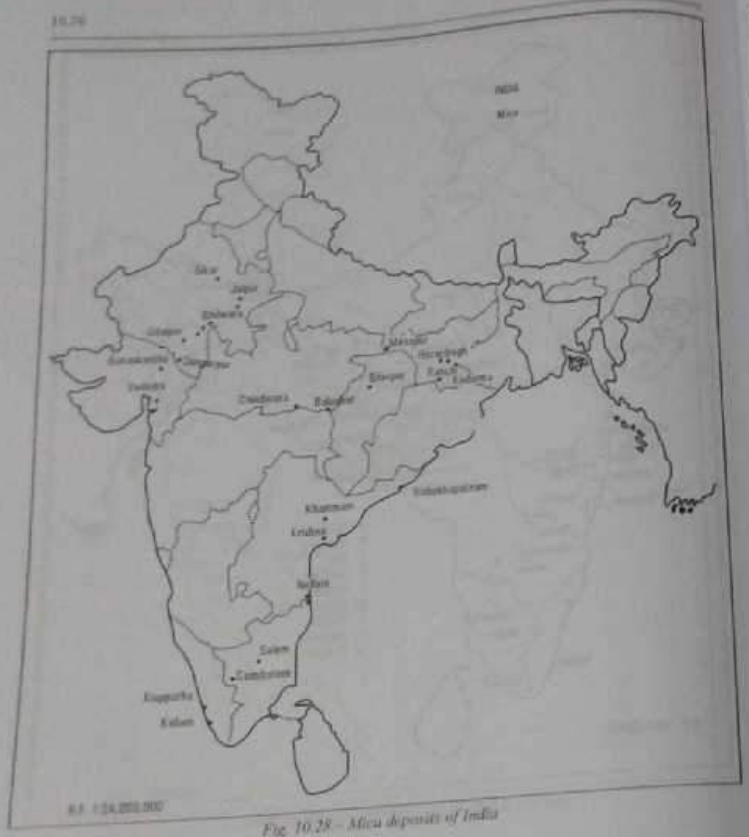


Fig. 10.28 – Mica deposits of India

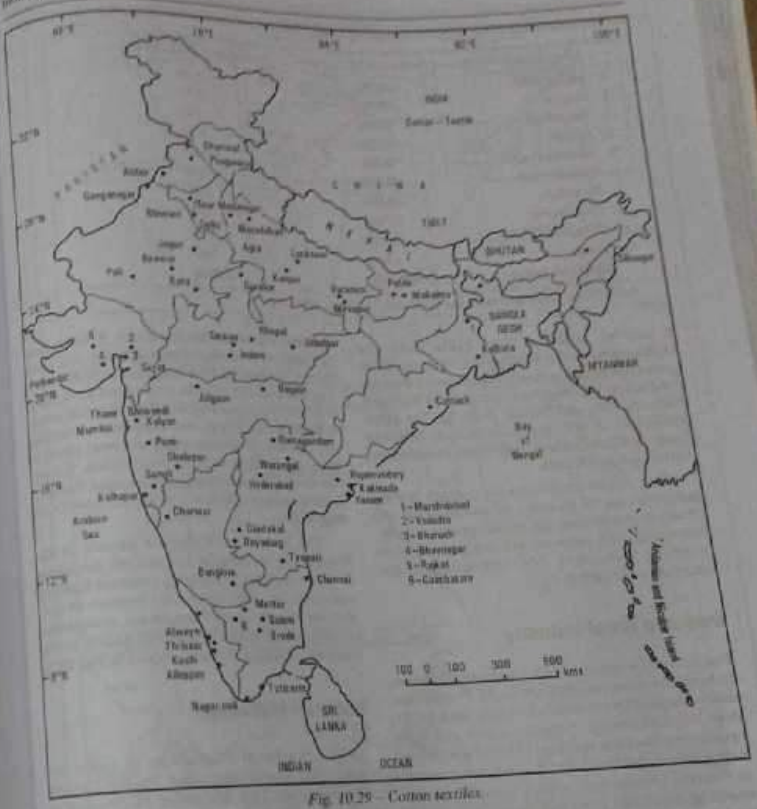


Fig. 10.29 – Cotton textiles

Table 10.49: India–Statewise Production of Cotton Cloth

State/Union Territories	Production (sq. metres)	Percentage of All India Production
1. Maharashtra	403,550	38.99
2. Gujarat	355,745	34.54
3. Tamil Nadu	65,850	6.40
4. Punjab	56,850	5.53
5. Madhya Pradesh	48,500	4.70
6. Uttar Pradesh	32,850	3.20
7. Rajasthan	26,880	2.80
8. Puducherry	25,250	2.45
9. Karnataka	8,500	0.82
10. Kerala	6,800	0.67
Total (All India)	**10,29,825**	**100.00**

Source: Data compiled from the Statistical Abstracts, 2007 – 08.

It may be observed from **Table 10.49** that Maharashtra is the leading producer of cotton goods contributing about 39 per cent of the total production, followed by Gujarat (34.54 %), Tamil Nadu (6.4%), and Punjab (5.53 %). The other producers of cotton goods include Madhya Pradesh, Uttar Pradesh, Rajasthan, Puducherry, Karnataka and Kerala.

The main problems of cotton textile industries are (i) shortage of raw material, (ii) Obsolete machinery, (iii) erratic power supply, (iv) strikes and lockouts, (v) competition with synthetic fibres, and (vi) competition in the international market.

Iron and Steel Industry

Iron and steel is one of the oldest industries of India. Its history is more than 4000 years old. The famous iron pillar near Qutab Minar is dating back to 350 A.D. The first attempt to produce iron and steel on modern lines was made in 1830 at Porto Nova near Chennai (Madras). But it was not successful as charcoal was the main source of energy for the smelting of iron ore. The real progress in iron and steel industry was made in 1907 when J.N. Tata established the iron-smelting factory at Sakchi (former name of Jamshedpur). Tremendous progress in the iron and steel industry was made during the Second Five Year Plan (1956-61) when the Government of India established steel plants at Bhilai, Durgapur and Rourkela in collaboration with the Soviet, British, and German governments respectively. The other important steel plants of India are located at Bhadravati, Salem, Bokaro, Paradwip, Vishakhaputnam, Vijainagar, Burnpur, Kalinganagar, Daitre Gopalpur, and Dolvi (**Fig. 10.30**).

The Damodar Valley is known as the Rhur Basin of India. It has several complexes of iron and steel, smelting, machine-building and fertilizer industries. The location of coal, iron-ore mines, copper limestone, manganese, chromite and major industrial places in the Damodar Valley have been shown in **Fig. 10.31**.

National Highways

The National Highways in India are developed and maintained by the Central Government. The National Highways of India have been shown in **Fig. 10.32**, while **Table 10.50** gives the main cities on the different National Highways.

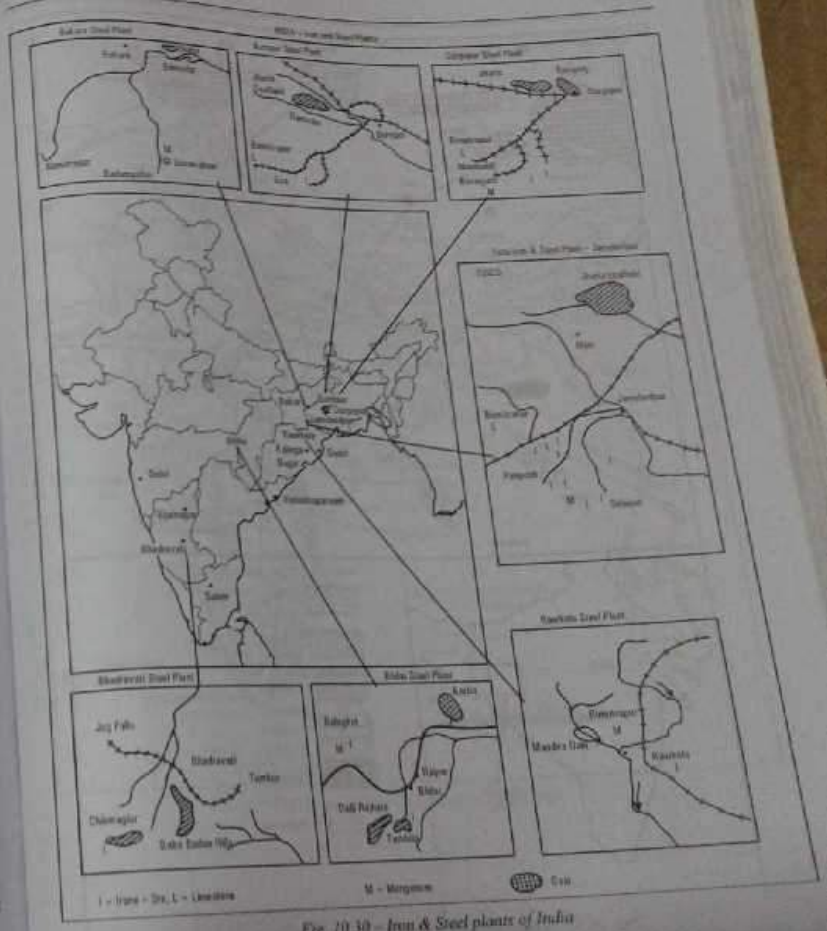


Fig. 10.30 – Iron & Steel plants of India

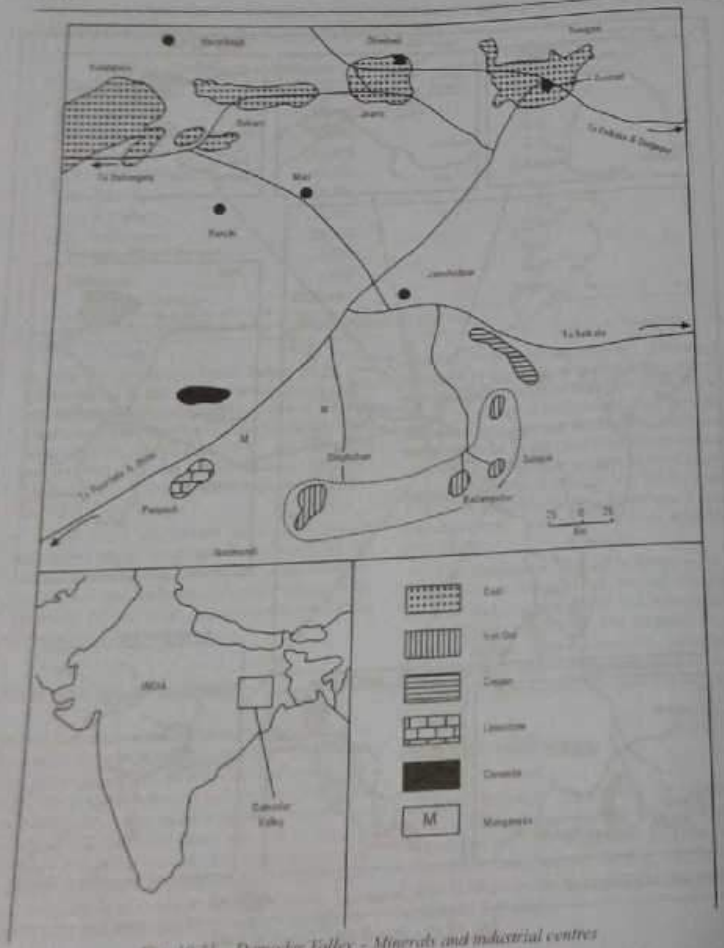


Fig. 10.31 – Damodar Valley – Minerals and industrial centres

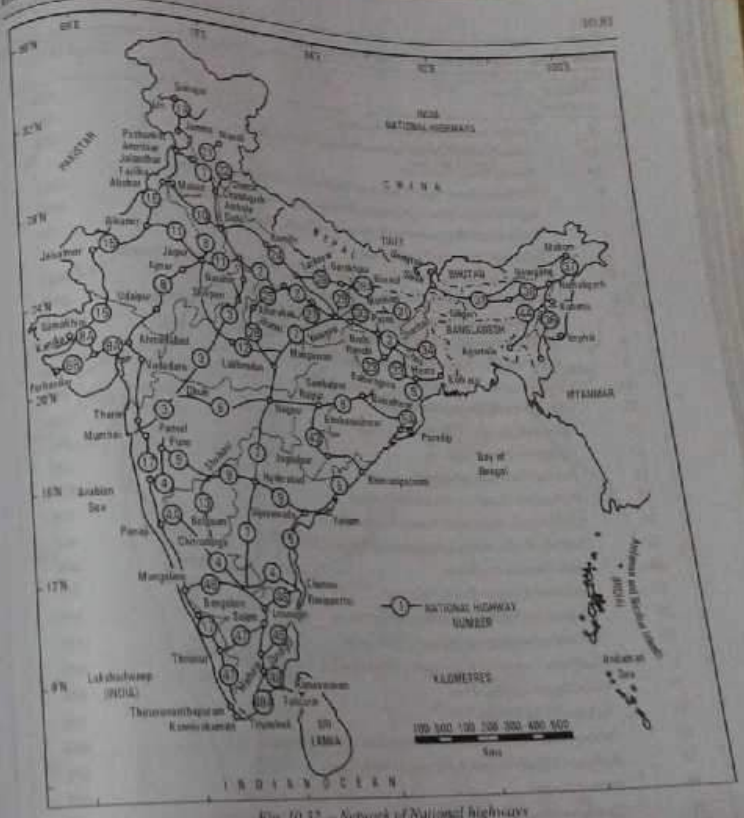


Fig. 10.32 – Network of National highways

Table 10.50: Important National Highways of India

National Highway	Route	Length in km
1	Delhi-Ambala-Jalandhar-Amritsar	456
1A	Jalandhar-Madhopur-Jammu-Srinagar-Baramulla-Uri	663
1B	Batote, Yoda, Kishtwar	274
2	Delhi-Mathura-Agra-Kanpur-Allahabad-Varanasi-Barh-Kolkata	1161
3	Agra-Gwalior-Shivpuri-Indore-Dhulia-Nasik-Thane-Mumbai	1553
4	Thane-Pune-Belgaum-Hubli-Bangalore-Ranipet-Chennai	151
4A	Belgaum-Anmode-Poona-Panaji	
5	Baharagora-Cuttack-Bhubaneshwar-Vishakhapatnam-Vijaywada-Chennai	1645
6	Dhule-Nagpur-Raipur-Sambalpur-Baharagora-Kolkata	2369
7	Varanasi-Rewa-Jabalpur-Nagpur-Hyderabad-Bangalore-Madurai-Kanniyakumari	1428
8	Delhi-Jaipur-Ajmer-Udaipur-Ahmadabad-Vadodra-Mumbai	791
9	Pune-Solapur-Hyderabad-Vijaywada	403
10	Delhi-Fazilka	702
11	Agra-Bharatpur-Jaipur-Bikaner	890
12	Jabalpur-Bhopal-Kota-Bundi-Jaipur	491
13	Solapur-Chitradurga	456
14	Beawar-Sirohi-Radhanpur	1526
15	Pathankot-Bhatinda-Bikaner-Jaisalmer	323
21	Chandigarh-Rupnagar-Mandi-Kullu-Manali	402
22	Ambala-Kalka-Shimla-Narkanda-Rampur-Chini	438
24	Delhi-Bareilly-Lucknow	379
25	Lucknow-Kanpur-Jhansi-Shivpuri	570
28	Barauni-Muzaffarpur-Gorakhpur-Lucknow	1123
31	Bakhtiyarpur-Siliguri-Nalbari-Amingaon	680
37	Goalpara-Guwahati-Kamargaon-Sadiya Ghat	436
39	Numaligarh-Imphal Palel	560
43	Raipur-Vizianagram	640
47	Salem-Coimbatore-Thiruvananthapuram-Kanniyakumari	850
52	Balhara-Charali-Tezpur-Lakhimpur-Sekhoaghat	560
54	Silchar-Aizawl	285
56	Lucknow-Varanasi	

Golden Quadrilateral (GQ): The National Highways Development Project (NHDP) launched a massive programme in 1999 known as Golden Quadrilateral **(Fig. 10.33)**. The length of the different sectors has been given in **Table 10.51**.

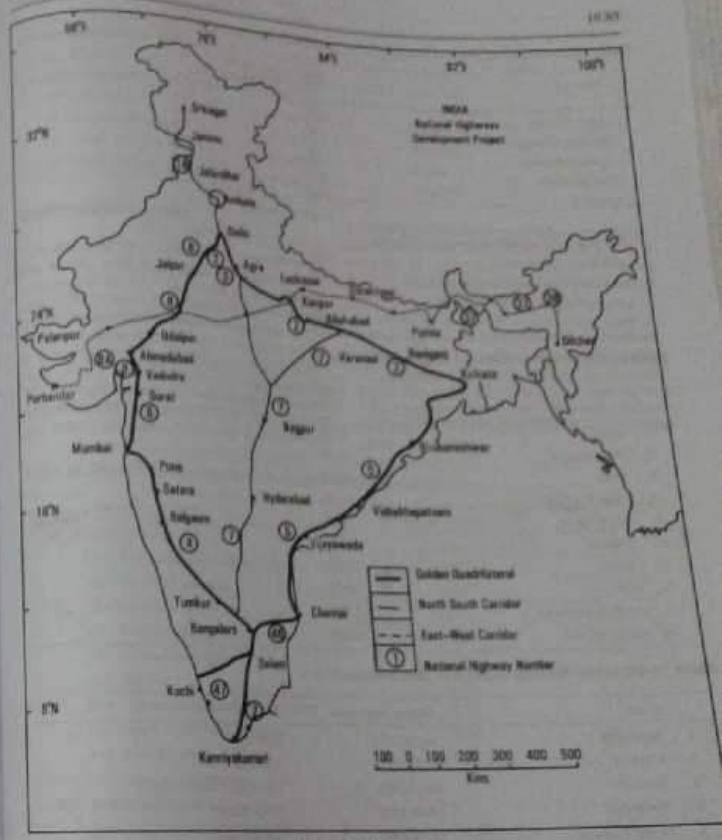


Fig. 10.33 - Golden Quadrilateral

Table 10.51: *Length of Various Sections of the Golden Quadrilateral*

Name	Length of sides of the Golden Quadrilateral in km
Delhi-Mumbai	1419
Mumbai-Chennai	1290
Chennai-Kolkata	1684
Kolkata-Delhi	1453
Total	**5846**
	Length of Corridor
North-South Corridor, connecting Srinagar with Kanniyakumari	4000
East-West Corridor connecting Silchar with Porbandar	3000
Total	**7000**

Table 10.52: *Length of Railways in some of the States*

	State	Length of Railway (in km per 1000 sq km)
1.	Punjab	42.78
2.	West Bengal	41.85
3.	Bihar	30.82
4.	Uttar Pradesh	30.20
5.	Tamil Nadu	29.96
6.	Gujarat	28.73
7.	Assam	27.38
8.	Goa	20.72
9.	Andhra Pradesh	17.39
10.	Maharashtra	17.20

Table 10.53: *Indian Railway Zones and their Headquarters*

	Zone	Date of Formation	Headquarters
1.	Southern	14.04.1951	Chennai
2.	Central	05.11.1951	Mumbai (CST)
3.	Western	05.11.1951	Mumbai (Church Gate)
4.	Northern	14.04.1952	New Delhi
5.	North-Eastern	14.04.1952	Gorakhpur
6.	South-Eastern	01.08.1955	Kolkata
7.	Eastern	01.08.1955	Kolkata
8.	North-Eastern Frontier	15.01.1958	Maligaon (Guwahati)

9.	South Central	02.10.1966	Secunderabad
10.	East Central	05.10.2002	Hajipur
11.	North-Western	01.10.2002	Jaipur
12.	East Coast	01.04.2003	Bhubaneshwar
13.	North Central	01.04.2003	Allahabad
14.	South-East Central	01.04.2005	Bilaspur
15.	South Western	01.04.2006	Hubli
16.	West Central	01.04.2003	Jabalpur

International Trade

The developed and wealthy countries of the world, with their aggressive market-led economies as well as access to productive new technologies and international markets, dominate the world economic system. At the other extreme, many of the countries of the developing world are locked in a cycle of national debt, rising population and unemployment. The state-managed economies of the former communist bloc began to be dismantled during the 1990s. At present, China and India are emerging as the major economic powers in the international trade. World trade acts as a stimulus to national economies, encouraging growth. Over the last three decades, as heavy industries have declined

services-banking, insurance, tourism, airlines, and shipping have taken an increasingly large share of world trade. Manufactured articles now account for nearly two thirds of world trade; raw materials and food make up less than a quarter of the total. The major exports and imports of India have been given in **Tables 10.54 and 10.55**.

Table 10.54 : *India – Commodity Composition of Exports (2006-07)*

	Commodity Group	Percentage Share 2006-07
I.	Primary Products	15.40
	(i) Agriculture and allied	10.20
	(ii) Ores and minerals	05.20
II.	Manufactured Goods	65.70
	(i) Engineering goods	20.70
	(ii) Gems and jewellery	15.10
	(iii) Textiles	14.50
	(iv) Chemicals and related products	11.80
	(v) Leather and leather goods	02.60
	(vi) Handicrafts excluding hand made carpets	01.20
III.	Petroleum-crude and products including coal	11.50
IV.	Others	07.40
	Total	**100.00**

Table 10.55: *India – Imports of Principal Commodities (2006-07)*

	Commodity	Percentage Share
1.	Petroleum, crude-oil and petroleum products	33.70
2.	Capital goods	12.10
3.	Electronic goods	09.40
4.	Gold and silver	08.60
5.	Chemicals	05.50
6.	Pearls, precious and semi-precious stones	04.10
7.	Metal scrap	03.90
8.	Coke coal, and briquettes	02.40
9.	Edible oils	01.30
10.	Professional instruments and optical goods	01.30
11.	Other commodities	17.70
	Total	**100.00**

Salient Features of India's International Trade: (i) Unfavourable Balance of Trade, (ii) More export of manufactured goods, (iii) world-wide trade, (iv) about 96 per cent of the trade is carried by sea route, (v) increasing import of raw material, (vi) increasing import of capital goods like metals, electrical and non-electrical machinery, transport equipments chemicals and new technology, (vii) low position in international trade.

REFERENCES

Bharucha, J.P., 1998, ***Vegetation of India,*** Oxford University Press.

Das Gupta, S.P., 1989, **'India's Water Resource Potential'** *Man and Ecology* School of Fundamental Research, Calcutta.

DEshpande, C.D., 1982, ***India–A Regional Interpretation,*** New Delhi, Northern Book Centre.

Husain, M., 2008, ***Geography of India,*** Tata McGraw Hill's.

Joshi, H.L.,1990, ***Industrial Geography of India,*** Jaipur, Rawat Publications.

Learmonth, A.T.A., 1964, ***The Vegetation of Indian Subcontinent,*** Canberra.

Muthiah, S.A., 1987, ***A Social and Economic Atlas of India,*** New Delhi, Oxford University Press.

NATMO, ***Irrigation Atlas of India,*** 2nd ed., Kolkata.

India 2010, Publication Division Ministry of Information and Broadcasting, Govt. of India.

Tiwari, R.C.,2004, ***Geography of India,*** Allahabad, Paryag Pustak Bhawan.

Wadia, N.D.N.,1994, ***Minerals of India,*** National Book Trust.

Mineral Resources

***Table 10.37:** Leading Iron Ore Producing States of India*

State	*Production (thousand tonnes)*	*Percentage of the Total Production in the Country*
1. Karnataka	25,565	24.90
2. Odisha	22,560	21.98
3. Chhattisgarh	20,455	19.92
4. Goa	18,400	17.92
5. Jharkhand	14,685	14.32
6. Others	975	0.96
Total	**102,640**	**100.00**

Source: Statistical Abstracts of India, 2006-2007.

***Table 10.38:** Iron-Ore Deposits of India*

State	*Quality*	*Mining Centres*
1. Karnataka	Magnetite (high grade)	*Kemmangundi* (Baba-Budan Hills-Chikmagalur District), *Sandur* and *Hosepet* (Bellary District), Chitradurga, Dharwar, Shimoga, Tumkur, Uttar Kannad.
2. Odisha	Haematite	Cuttack, Kendujhar, Koraput, *Barabil-Koira* Valley, *Badampahar* (Mayurbhanj), Sambalpur, *Kandadhar* (Sundargarh), Daitri Hill along the boundary of Kendujhar and Cuttack.
3. Chhattisgarh	Haematite	Bailadila, Dalli-Rajhara (Durg), Bilaspur, Jagdalpur, Raigarh, Surguja.
4. Goa		Pirna-Adolpale-Asnora (North Goa).
5. Jharkhand		Singhbhum, Noamandi, Santhal Pargana, Hazaribagh.
6. Others	Sederite, Limonite	Anantapur, Cuddapah, Guntur, Khammam, Kurnool, Nellore (Andhra Pradesh), Bhavnagar, Junagarh, Vadodra (Gujarat): Kangra, Mandi (Himachal Pradesh) Chandrapur, Ratnagiri, Sindhudurg (Maharashtra): Alwar, Bhilwara, Bundi, Jaipur, Udaipur (Rajasthan), Almora, Garhwal, Nainital (Uttarakhand), Mirzapur (Uttar Pradesh) Birbhum, Burdwan, Darjeeling (West Bengal).

Table 10.39: Manganese – Leading Producing States of India (Fig. 10.26)

State	Production (thousand tonnes)	Percentage of the Total Production of the Country	Major Mining Districts/Centres
1. Odisha	715	38.55	Bolangir, Kalahandi, Koraput, Sambalpur, Sundargarh
2. Maharashtra	425	22.91	Bhandara, Nagpur, Ratnagiri
3. Madhya Pradesh	365	19.68	Balaghat and Chhindwara
4. Karnataka	245	13.20	Bellary, Chitradurga, Shimoga, Tumkur, Uttari-Kannad
5. Andhra Pradesh	85	4.58	Cuddapah, Guntur, Srikakulam, Vijainagram, Vishakhapatnam
6. Others	20	1.08	Goa, Panchmahal and Vadodra (Gujarat), Dhanbad, Singhbhum (Jharkhand) Udaipur (Rajasthan)
Total (All India)	**1855**	**100.00**	

Source: Statistical Abstracts of India 2007 – *2008.*

Table 10.40: Copper–Leading Producing States of India (Fig. 10.26)

State	Production (thousand tonnes)	Percentage of the Total Production of India	Major Mining Districts/Centres
1. Madhya Pradesh	89	55.97	Malanjkhand (Balaghat), Badgaon (Betul)
2. Rajasthan	65	40.80	Ajmer, Bhilwada, Chittorgarh Dungarpur, Jaipur, Khetri (Jhunjhunu), Pali, Sikar, Singhana Sirohi
3. Jharkhand	05	03.14	Hazaribagh, Santhal Pargana
Total (All India)	159	100.00	

Source: Statistical Abstracts 2007 – 2008.

Table 10.41: Bauxite–Leading Producing States of India (Fig. 10.27)

State	Production (thousand tonnes)	Percentage of the Total Production of India	Major Mining Districts/Centres
1. Odisha	4904	50.16	Bolangir, Kalahandi, Koraput, Sundergarh, Sambalpur
2. Gujarat	1547	15.82	Amreli, Bhavnagar, Jamnagar, Junagarh, Kachchh
3. Jharkhand	1161	11.87	Dumka, Lohardaga, Palamu, Ranchi

4.	Maharashtra	964	9.87	Kolhapur, Pune, Ratnagiri, Satara, Thane
5.	Chhattisgarh	604	6.18	Amarkantak-Pathar, Bilaspur, Durg, Raigarh, and Sarguja
6.	Tamil Nadu	268	2.74	Madurai, Nilgiri, and Salem
7.	Madhya Pradesh	230	2.35	Balaghat, Katni, Jabalpur, Maikal range, Mandla, Shahdol
8.	Others	99	1.01	Andhra Pradesh, Goa, Jammu & Kashmir, and Kerala
	Total (All India)	**9777**	**100.00**	

Source: Statistical Abstracts, 2007 – 08.

***Table 10.42:** Mica – Leading Producing States of India*

	State	*Production (thousand tonnes)*	*Percentage of the Total Production of India*	*Major Mining Districts/Centres*
1.	Andhra Pradesh	910	71.15	Khammam, Krishna, Nellore, Vishakhapatnam, and West Godavari
2.	Rajasthan	205	16.03	Ajmer, Bhilwara, Dungarpur, Sikar, Tonk, Udaipur
3.	Jharkhand	148	11.57	Dhanbad, Giridih, Hazaribagh, Kodarma, Ranchi, Singhbhum
4.	Bihar	16	01.25	Bhagalpur, Gaya, Munger
	Total (All India)	**1279**	**100.00**	

Source: Statistical Abstracts of India 2007–08.

***Table 10.43:** Limestone – Leading Producing States of India*

	State	*Production (thousand tonnes)*	*Percentage of the Total Production of India*	*Major Mining Districts/Centres*
1.	Rajasthan	240	16.15	Ajmer, Alwar, Bikaner, Chittaurgarh, Dungarpur, Kota, Nagaur, Pali
2.	Madhya Pradesh	238	16.01	Betul, Damoh, Jabalpur, Rewa, Satna, Sagar
3.	Andhra Pradesh	235	15.81	Cuddapah, Guntur, Kurnool, Krishna, Nalgonda, Warangal
4.	Gujarat	160	10.77	Amreli, Junagarh, Kheda, Surat
5.	Chhattisgarh	140	09.42	Bastar, Bilaspur, Durg, Raigarh, Raipur
6.	Tamil Nadu	138	09.29	Coimbatore, Madurai, Salem, Thanjavur
7.	Karnataka	125	08.41	Bijapur, Gulbarga, Shimoga

8. Maharashtra	090	06.06	Chandrapur, Naded, Ahmadnagar, Yavatmal
9. Himachal Pradesh	068	04.58	Bilaspur,Chamba,Kangra
10. Odisha	025	01.68	Kalahandi, Sambalpur, Sundergarh
11. Others	027	01.82	Dehra Dun, Mussoorie, Darjeeling, Jammu, Mahendergarh, Mirzapur
Total (All India)	**1486**	**100.00**	

***Table 10.44:** Dolomite – Leading Producing States of India*

State	*Production (thousand tonnes)*	*Percentage of the Total Production of India*	*Major Mining Districts/Centres*
1. Odisha	1075	28.71	Gangapur, Koraput, Sambalpur, Sudargarh
2. Chhattisgarh	1025	27.38	Bastar, Bilaspur, Durg, Raigarh
3. Andhra Pradesh	687	18.35	Anantapur, Kurnool, Khammam
4. Jharkhand	295	07.88	Chaibasa, Palamu, Singhbhum
5. Rajasthan	215	05.74	Ajmer, Alwar, Bhilwara, Jaipur, Jaisalmer, Jhunjhunu, Jodhpur, Nagaur, Pali, Sawai Madhopur, Sikar, and Udaipur
6. Karnataka	212	05.66	Belgaum, Bijapur, Chitradurga, Mysore, Uttar-Kannad, and Tumkur
Others	235	06.28	Arunachal Pradesh, Haryana, Himachal Pradesh, Maharashtra, Tamil Nadu, Uttarakhand, Uttar Pradesh, and West Bengal
Total (All India)	**3744**	**100.00**	

Source: Statistical Abstracts, 2007–08.

Cotton Textile Industry

Cotton textile is one of the largest industries of India in terms of output, employment and foreign exchange. Its share in the industrial production is 14 per cent. Moreover, it provides 10 per cent of the excise collection, 18 per cent of employment in the industrial sector, 20 per cent of the country's total export and 4 per cent of the GDP. India enjoyed the monopoly in the production of textile goods from 1500 B.C. to 1500 A.D. Indian cotton and silk products were in great demand all over the world. The arrival of the British in India, however, led to the downfall of Indian textile manufacturing.

The first textile mill in India was established by C.N. Dewar at Mumbai, in 1854. This industry expanded fast in the ending parts of the 19th century and in the 20th century. At present India is one of the leading producers and exporter of cotton goods. The distribution of cotton textiles have been shown in **Fig. 10.29**, while the statewise production has been given in **Table 10.45**.

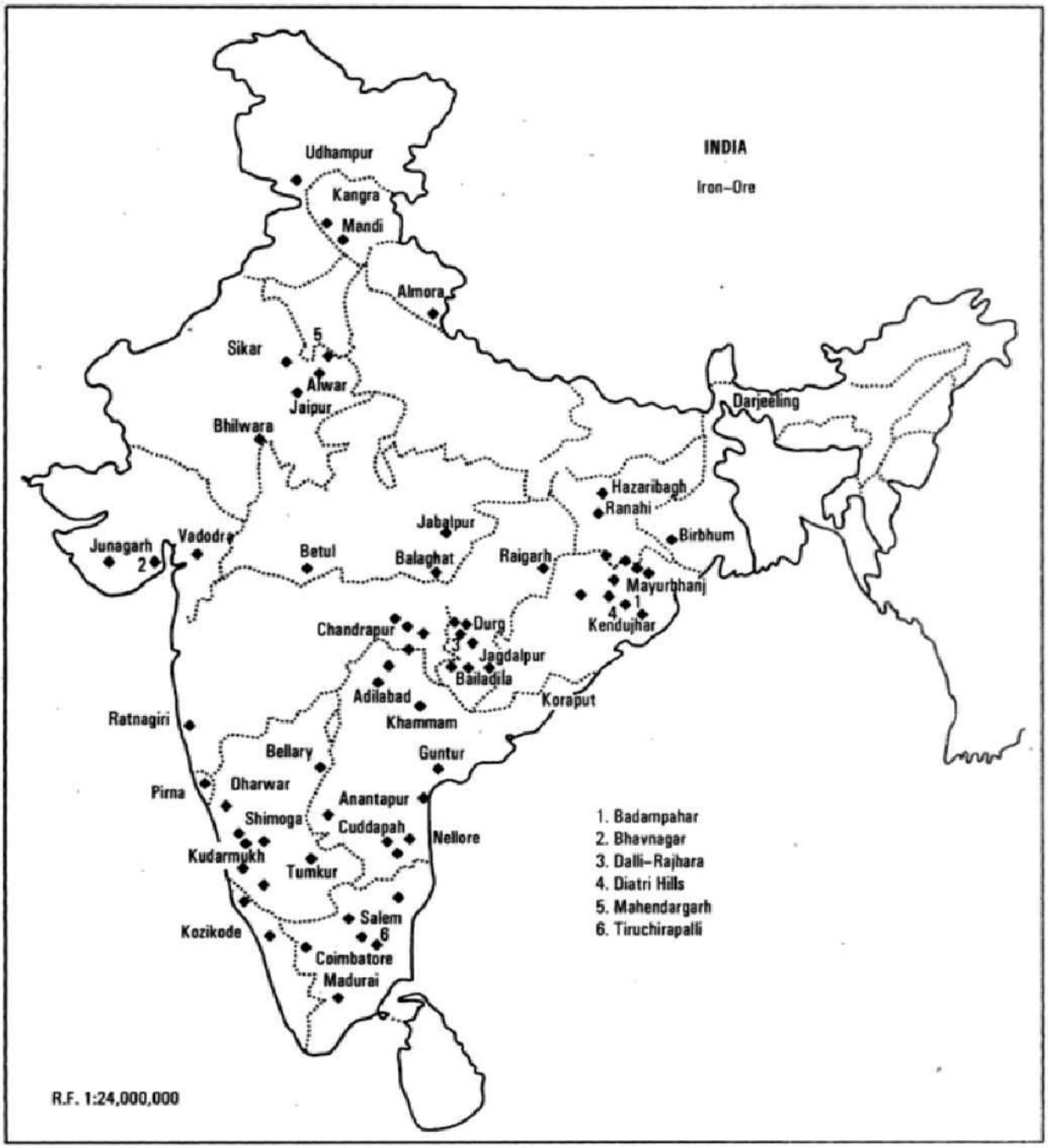


Fig. 10.25 – Iron ore deposits of India

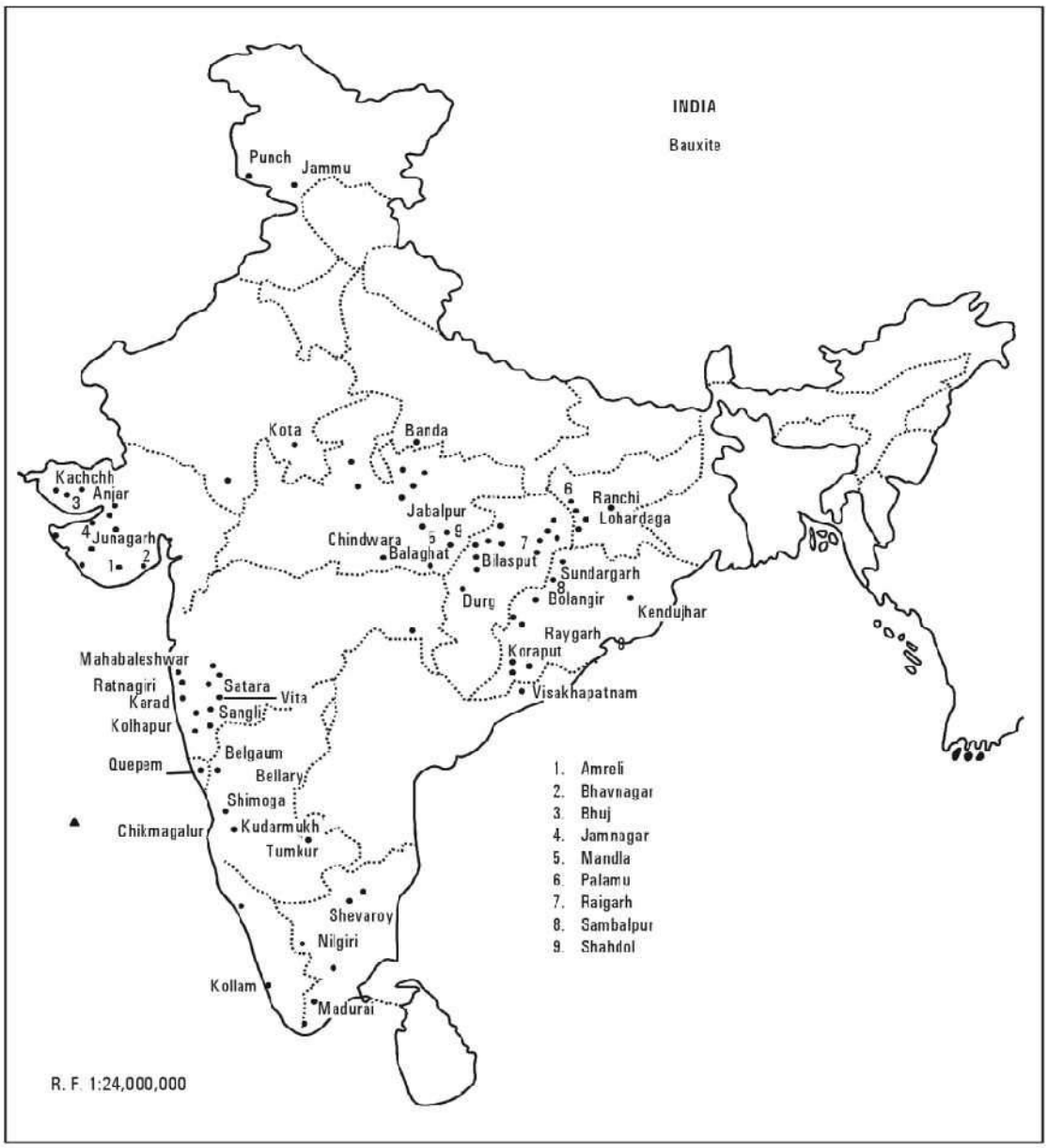


Fig. 10.27 – Bauxite deposits of India

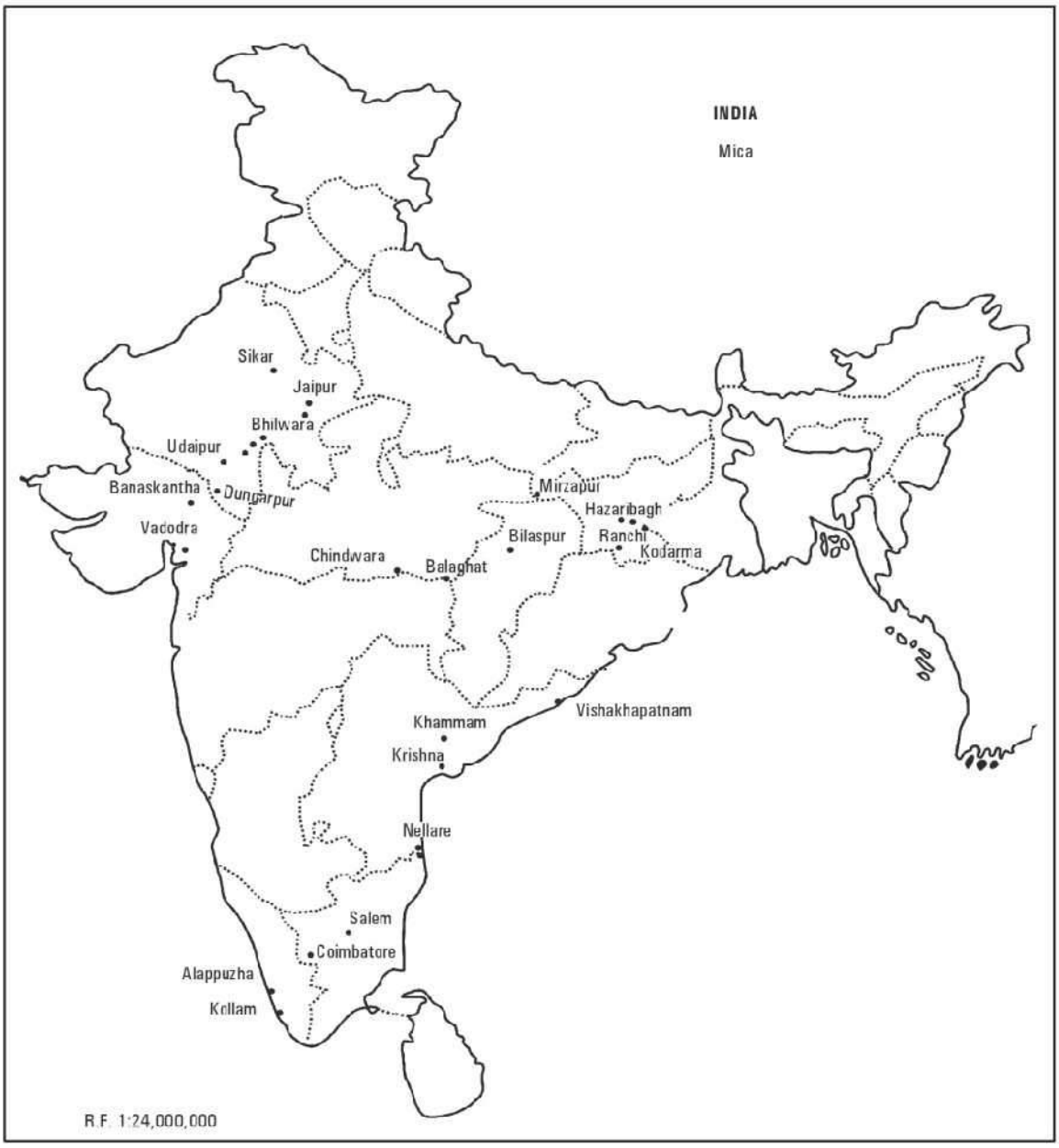


Fig. 10.28 – Mica deposits of India

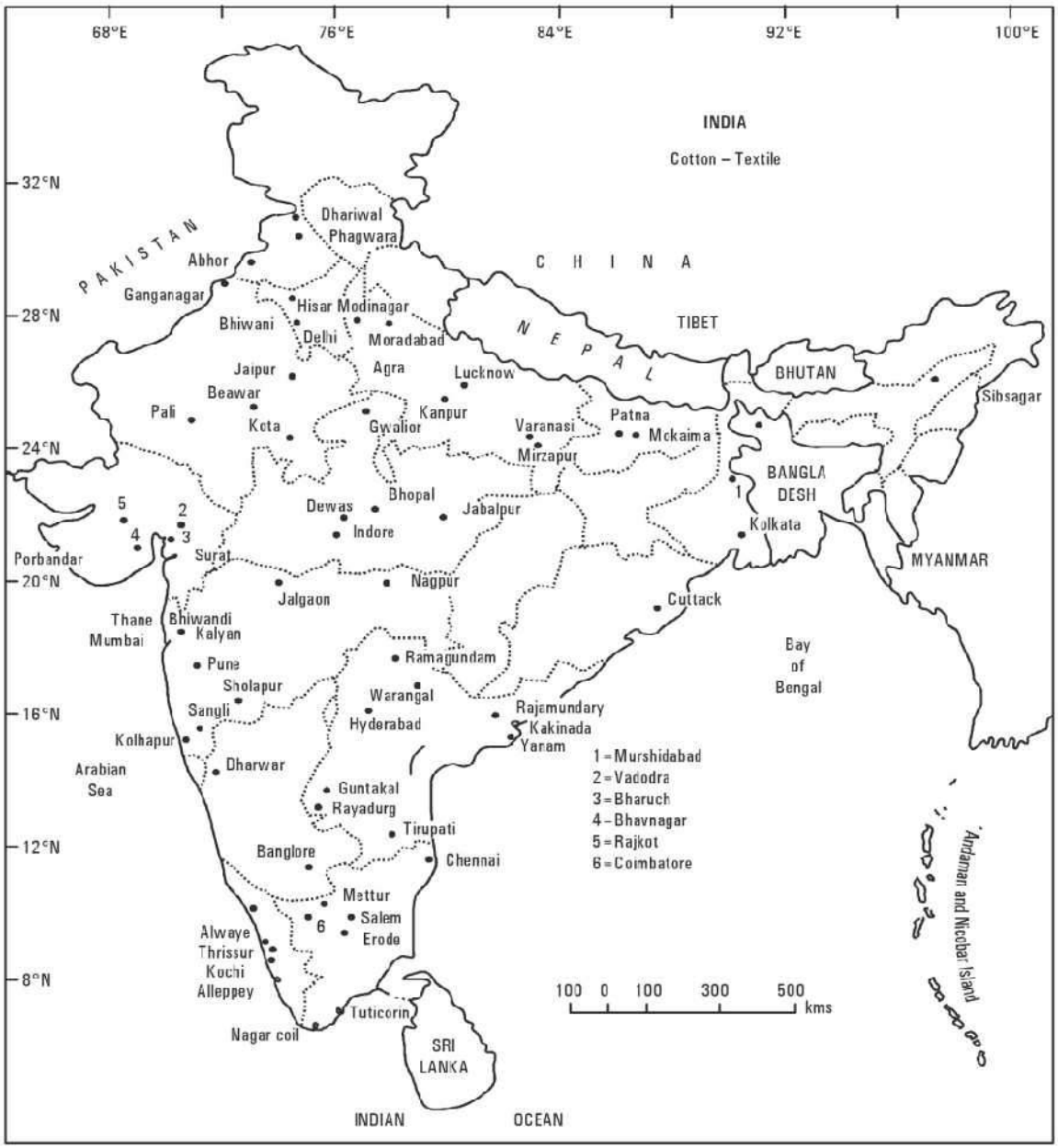


Fig. 10.29 – Cotton iextile

Table 10.45: *India–Statewise Production of Cotton Cloth*

	State/Union Territories	*Production (sq. metres)*	*Percentage of All India Production*
1.	Maharashtra	400,550	38.89
2.	Gujarat	355,745	34.54
3.	Tamil Nadu	65,850	6.40
4.	Punjab	56,850	5.53
5.	Madhya Pradesh	48,500	4.70
6.	Uttar Pradesh	32,850	3.20
7.	Rajasthan	28,880	2.80
8.	Puducherry	25,250	2.45
9.	Karnataka	8,500	0.82
10.	Kerala	6,850	0.67
	Total (All India)	**10,29,825**	**100.00**

Source: Data computed from the Statistical Abstracts, 2007 – 08.

It may be observed from **Table 10.45** that Maharashtra is the leading producer of cotton goods contributing about 39 per cent of the total production, followed by Gujarat (34.54 %), Tamil Nadu (6.4%), and Punjab (5.53 %). The other producers of cotton goods include Madhya Pradesh, Uttar Pradesh, Rajasthan, Puducherry, Karnataka and Kerala.

The main problems of cotton textile industries are (i) shortage of raw material, (ii) Obsolete machinery, (iii) erratic power supply, (iv) strikes and lockouts, (v) competition with synthetic fibres, and (vi) competition in the international market.

Iron and Steel Industry

Iron and steel is one of the oldest industries of India. Its history is more than 4000 years old. The famous iron pillar near Qutab Minar is dating back to 350 A.D. The first attempt to produce iron and steel on modern lines was made in 1830 at Porto Nova near Chennai (Madras). But it was not successful as charcoal was the main source of energy for the smelting of iron ore. The real progress in iron and steel industry was made in 1907 when J.N. Tata established the iron-smelting factory at Sakchi (former name of Jamshedpur). Tremendous progress in the iron and steel industry was made during the Second Five Year Plan (1956-61) when the Government of India established steel plants at Bhilai, Durgapur and Rourkela in collaboration with the Soviet, British, and German governments, respectively. The other important steel industries of India are located at Bhadravati, Salem, Vishakhapatnam, Vijainagar, Kalinganagar, Daitre and Dolvi **(Fig. 10.30)**.

The Damodar Valley is known as the Rhur Basin of India. It has several complexes of iron and steel, smelting, machine-building and fertilizer industries. The location of coal, iron-ore mines, copper limestone, manganese, chromite and major industrial places in the Damodar Valley have been shown in **Fig. 10.31**.

National Highways

The National Highways in India are developed and maintained by the Central Government. The National Highways of India have been shown in **Fig. 10.32**, while **Table 10.46** gives the main cities on the different National Highways.

***Table 10.46**: Important National Highways of India*

National Highway	*Route*	*Length in km*
1	Delhi-Ambala-Jalandhar-Amritsar	456
1A	Jalandhar-Madhopur-Jammu-Srinagar-Baramulla-Uri	663
1B	Batote, Toda, Kishtwar,	274
2	Delhi-Mathura-Agra-Kanpur-Allahabad-Varanasi-Barh-Kolkata	
3	Agra-Gwalior-Shivpuri-Indore-Dhulia-Nasik-Thane-Mumbai	1161
4	Thane-Pune-Belgaum-Hubli-Bangalore-Ranipet-Chennai	1533
4A	Belgaum-Anmode-Ponda-Panaji	153
5	Bahargagora-Cuttack-Bhubaneshwar-Vishakhapatnam-Vijaiwada-Chennai	
6	Dhule-Nagpur-Raipur-Sambalpur-Baharagora-Kolkata	1645
7	Varanasi-Rewa-Jabalpur-Nagpur-Hyderabad-Bangalore-Madurai-Kanniyakumari	2369
8	Delhi-Jaipur-Ajmer-Udaipur-Ahmadabad-Vadodra-Mumbai	1428
9	Pune-Solapur-Hyderabad-Vijaiwada	791
10	Delhi-Fazilka	403
11	Agra-Bharatpur-Jaipur-Bikaner	582
12	Jabalpur-Bhopal-Kota-Bundi-Jaipur	890
13	Solapur-Chitradurga	491
14	Beawar-Sirohi-Radhanpur	450
15	Pathankot-Bhatinda-Bikaner-Jaisalmer	1526
21	Chandigarh-Rupnagar-Mandi-Kullu-Manali	323
22	Ambala-Kalka-Shimla-Narkanda-Rampur-Chini	462
24	Delhi-Bareilly-Lucknow	438
25	Lucknow-Kanpur-Jhansi-Shivpuri	319
28	Barauni-Muzaffarpur-Gorakhpur-Lucknow	570
31	Bakhtiyarpur-Siliguri-Nalbari-Aminagaon	1125
37	Goalpara-Guwahati-Kamargaon-Saikhoa Ghat	680
39	Numiligarh-Imphal-Palel	436
43	Raipur-Vizianagram	560
47	Salem-Coimbatore-Thiruvananthapuram-Kanniyakumari	640
52	Baihata-Charali-Tezpur-Lakhimpur-Sekhoaghat	850
54	Silchar-Aizawl	560
56	Lucknow-Varanasi	285

Golden Quadrilateral (GQ): The National Highways Development Project (NHDP) launched a massive programme in 1999 known as Golden Quadrilateral **(Fig. 10.33)**. The length of the different sectors has been given in **Table 10.47**.

Table 10.47: *Length of Various Sections of the Golden Quadrilateral*

Name	*Length of sides of the Golden Quadrilateral in km*
Delhi-Mumbai	1419
Mumbai-Chennai	1290
Chennai-Kolkata	1684
Kolkata-Delhi	1453
Total	**5846**
	Length of Corridor
North-South Corridor, connecting Srinagar with Kanniyakumari	4000
East-West Corridor connecting Silchar with Porbandar	3300
Total	**7300**

Table 10.48: *Length of Railways in some of the States*

	State	*Length of Railway (in km per 1000 aq km)*
1.	Punjab	42.78
2.	West Bengal	41.85
3.	Bihar	30.82
4.	Uttar Pradesh	30.20
5.	Tamil Nadu	29.96
6.	Gujarat	28.73
7.	Assam	27.58
8.	Goa	20.72
9.	Andhra Pradesh	17.39
10.	Maharashtra	17.00

Table 10.49: *Indian Railway Zones and their Headquarters*

	Zone	*Date of Formation*	*Headquarters*
1.	Southern	14.04.1951	Chennai
2.	Central	05.11.1951	Mumbai (CST)
3.	Western	05.11.1951	Mumbai (Church Gate)
4.	Northern	14.04.1952	New Delhi
5.	North-Eastern	14.04.1952	Gorakhpur
6.	South-Eastern	01.08.1955	Kolkata
7.	Eastern	01.08.1955	Kolkata

8.	North-Eastern Frontier	15.01.1958	Maligaon (Guwahati)
9.	South Central	02.10.1966	Secundrabad
10.	East Central	01.10.2002	Hajipur
11.	North-Western	01.10.2002	Jaipur
12.	East Coast	01.04.2003	Bhubaneshwar
13.	North Central	01.04.2003	Allahabad
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***Table 10.50** : India – Commodity Composition of Exports (2006-07)*

	Commodity Group	*Percentage Share 2006-07*
I.	Primary Products	15.40
	(i) Agriculture and allied	10.20
	(ii) Ores and minerals	05.20
II.	Manufactured Goods	65.70
	(i) Engineering goods	20.70
	(ii) Gems and jewellery	15.10
	(iii) Textiles	14.50
	(iv) Chemicals and related products	11.60
	(v) Leather and leather goods	02.60
	(vi) Handicrafts including hand-made carpets	01.20
III	Petroleum-crude and products including coal	11.50
IV.	Others	07.40
	Total	**100.00**