Chapter 5

Natural Vegetation and National Parks

INTRODUCTION

Natural vegetation of India reflects a state of perfect harmony with the relief and climatic conditions of the subcontinent. In fact, this correspondence is so perfect that if one superimposes the two maps showing the annual rainfall and the altitude above the mean sea level, one can easily infer the types of vegetation that will be found in each major region of the country.

The present vegetal cover has a long history. According to Palaeo-botanists, most of our Himalayan and peninsular areas are covered with indigenous or endemic flora, while the Indo-Gangetic Plain and the Thar desert contain plant species that have come generally from outside. Here, the plant species are exotic and have migrated from the Trans-Himalayan areas (Tibet and China). This natural vegetation is classified as boreal. Plants which have come from the adjacent tropical regions are known as palaeo-tropical. Those plants which came from north Africa have influenced the vegetation of the arid and semi-arid regions, such as the Thar, as well as a good deal of the Great Plains of India. Those immigrating from Indo-Malaysia have influenced the vegetal cover of the hilly regions of north-eastern India. This process of the immigration of uninvited plant species is not only continuous, but has actually become more marked with the increase in communication with other lands, both by sea and air. Some of the exotic varieties are troublesome weeds. They thrive under conditions of tropical sun with abundant moisture, multiply rapidly and spread out as there are no 'natural' enemies to curb them in the new habitat. In course of time, their eradication becomes difficult; they invade the land and reduce the area for other uses, prevent the growth of plants which are economically important and become a hazard to public health by indirectly helping the spread of several diseases. We can cite two striking examples: lantana (*Lantana camara varauyleata Mold*) and water hyacinth (*Eichhornia crassipes Solms*).

Both were brought into India as decorative garden plants; the former having now spread out in forests and pasture lands, and the latter choking up our rivers, lakes and ponds so much so, as to earn its nickname 'terror of Bengal' because of its phenomenal growth in that region. It is spreading to almost all water sources, ponds and canals in the rest of the country.

It may be ascertained from the above description that much of our natural vegetal cover is not that natural, except perhaps in the inaccessible parts of the Himalayas and the interior of the

Thar desert. A considerable part of it has been replaced or destroyed as a result of human occupancy of the land. Much of the plant cover is in a degraded condition, that is, low in quality and content. What we usually designate as 'natural' vegetation now refers to a plant community that has been left undisturbed over a long time, so as to allow individual species to adjust themselves to geo-climatic conditions, as far as possible.

FLORISTIC REGIONS OF INDIA

Depending on the geo-climatic conditions, the flora of India differs from region to region and altitude to altitude. In 1937, C.C. Calder identified eight floristic regions of India (**Fig. 5.1**). These floristic regions are:

1. The Eastern Himalayan Region
2. The North-Western Himalayan Region
3. The Assam Region
4. The Gangetic Plain
5. The Indus Plain
6. The Deccan Region
7. The Malabar Region
8. Andaman and Nicobar Islands

1. The Eastern Himalayan Region

Stretching over the hilly regions of Sikkim, West Bengal and Arunachal Pradesh, this is an undulating and mountainous region, recording over 200 cm of average annual rainfall. This region has over 4000 species of plants which vary from tropical to temperate and Alpine. The main trees of this floristic region are sal, oak, chestnut, magnolia, pyrus, bamboo, silver fir, pine, birch, rhododendrons, and alpine grasses.

2.The North-Western Himalayan Region

The Western Himalayan Floristic region stretches over Jammu and Kashmir, Himachal Pradesh and Uttarakhand. This region records relatively less rainfall and temperatures. The effect of altitude is quite visible on the vegetation of Western Himalayas. Here again, one finds the sub-tropical (up to 1525 m), temperate (1525m to 3650 m) and Alpine vegetation from 3650 m to 4575 metres. In the sub-montane region the main vegetation is sal, semul, and savanna type. Among the temperate vegetation are chir (pine), oak, deodar, alder, birch, and conifers. At higher altitudes, trees are replaced by alpine pastures and trees like juniper, silver fir, birch, and larch are seen.

3. The Assam Region

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

4. The Gangetic Plain

The flora of the Gangetic plain has been substantially transformed by human activities and cultivation of crops. The vegetation type, however, ranges between the semi-arid shrubs of the Aravalli region

to evergreen mangroves of the Sundarban Delta. Sal and Arjun of the Tarai region of Bihar and West Bengal are the representative species of the primordial vegetation. The vegetation of Uttar Pradesh is mainly dry deciduous type which changes to moist deciduous type, in Bihar and West Bengal. Sheesham, neem, mahuwa, jamun, acacia, ber, bel, etc. are the examples of this type of vegetation. In addition to these, there are numerous types of grasses found in the Gangetic Plain.

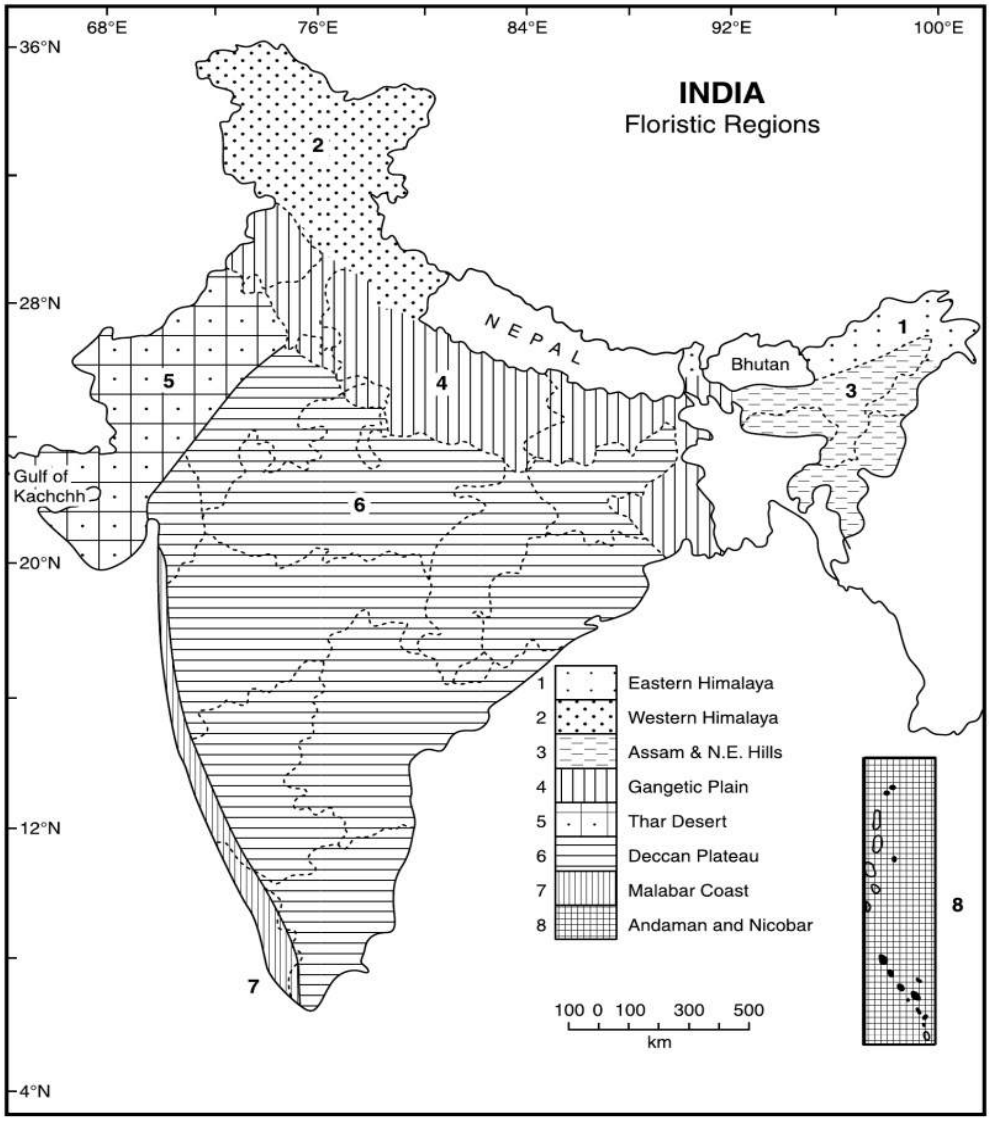

Fig. 5.1 Floristic Regions

5. The Indus Plain

This floristic region spreads over Punjab, Haryana, Rajasthan, west of the Aravallis, Kuchchh, and north-western parts of Gujarat. In this region the average annual rainfall is less than 75 cm . Consequently, its vegetation is of the type which can bear the arid and severe drought conditions. Acacias, cacti, wild-palms, khejra, and palas, etc. are the main trees of this region. During the rainy season, numerous grasses develop which wither during the dry season.

6. The Deccan Region

This region covers the greater parts of Peninsular India. This region has teak, tendu, sal, palm, and thorny shrubs.

7. The Malabar Region

This region stretches all along the western coast from the Gulf of Khambat (Cambay) to Cape Camorin (Kanniyakumari). Here, the vegetation type ranges from moist tropical evergreen to broad leafed mixed and monsoon deciduous type. The Nilgiri Hills show temperate forests at higher altitudes. The region also contains several species of plants of the Malay origin.

8. Andaman and Nicobar

The Andaman and Nicobar Islands are covered by the equatorial evergreen forests of heavy wood.

SPATIAL DISTRIBUTION OF FORESTS IN INDIA

The total geographical area of India is 32,87,263 sq km, of which about 6,75,500 sq km—equal to 22.50 per cent—is under forests. According to the National Forest Policy (1952) about 33 per cent of the geographical area should be under forest. However, the existing forest area is much below the desired level. The areas under forest cover in India have been shown in **Fig. 5.2**. It may be observed from **Fig. 5.2** that the Himalayan mountains, Bhabhar and Tarai, Western Ghats, Eastern Ghats, Bundelkhand, Baghelkhand, Chotanagpur Plateau, North-eastern Hills, Nilgiris, and the hills of Peninsular India are the main areas of Indian forests. Unfortunately, about 5 to 6 per cent of the total forest area of the country is under the category of degraded forests.

The forest area in India is much below the world average of 34.5 per cent and that of Brazil (57 per cent), Sweden (58 per cent), USA (42 per cent), Germany (41 per cent), and Canada (36 per cent). Similarly, the per head forest area in India is only 0.07 hectare as against the world average of 1.10 hectares, Canada at 23 hectares, Brazil 8.6 hectares, Australia 5 hectares, Sweden 4 hectares, and USA 3.5 hectares per head of population.

Table 5.1 *The Region-wise Distribution of Forests in India*

Geographical region	*% of total forest area of India*
1. Himalayan Region	18.00
2. The Great Plains of India	5.00
3. Peninsular Plateau and Hills	57.00
4. Western-Ghats and Coastal Plains	10.00
5. Eastern-Ghats and Eastern Coastal Plains	10.00
Total	**100.00**

It may be observed from Table 5.2 that the largest forest area lies in Peninsular India accounting for 57 per cent of the total forest area of India. The Himalayan region has the second largest forest area having 18 per cent of the forest area of the country. The Eastern and Western Ghats have 10 per cent each, while the Gangetic-Plains have only 5 per cent of the forest area of the country.

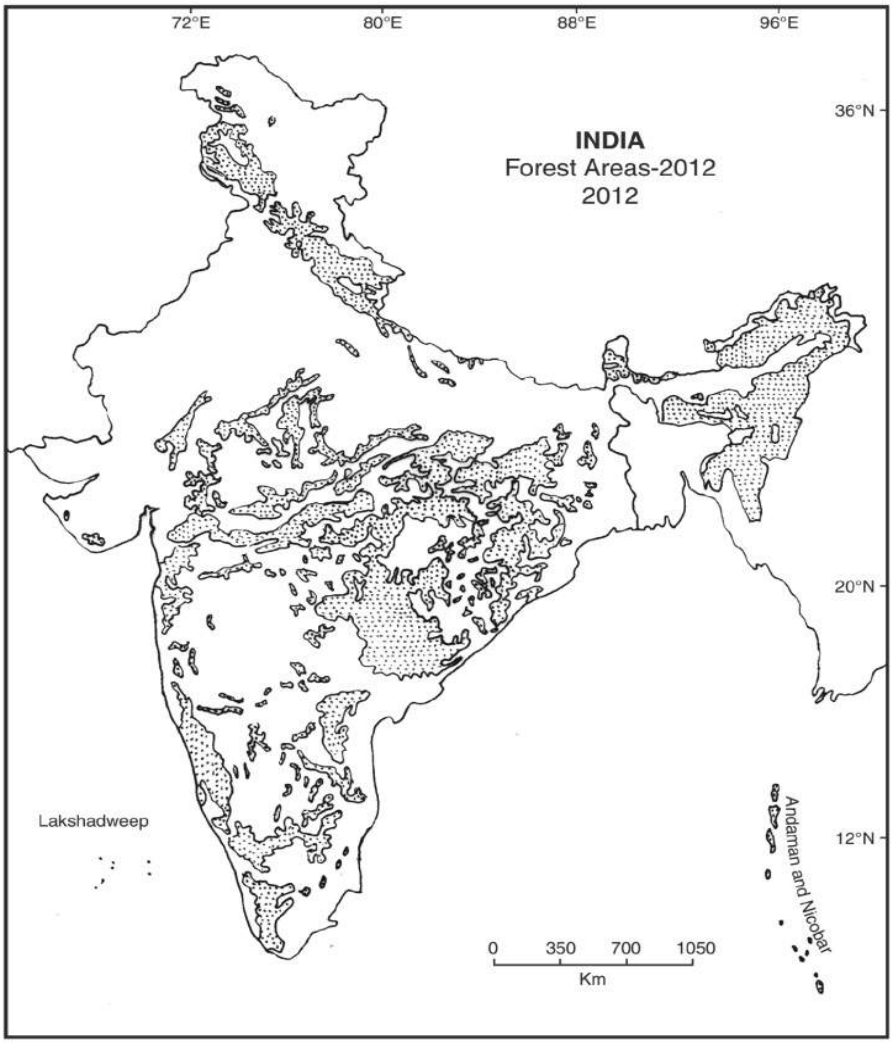

Fig. 5.2 Forest Areas (2012)

Table 5.2 *India—Statewise-Distribution of Forest*

State/Union Territory	*Geographical area*	*Total Forest Area*	*Percentage of forest area to geographical area*
State			
Andhra Pradesh	275069	44637	16.23
Arunachal Pradesh	83743	68045	81.25
Assam	78438	27714	35.33
Bihar	94163	5720	6.07
Chhattisgarh	135191	56448	41.75
Goa	3702	2095	56.59
Gujarat	196022	15152	7.73
Haryana	44212	1754	3.97
Himachal Pradesh	55673	14360	25.79
Jammu & Kashmir	222236	21237	9.56
Jharkhand	79714	22637	28.40
Karnataka	191791	36991	19.29
Kerala	38863	15560	40.04
Madhya Pradesh	308245	77265	25.07
Maharashtra	307713	47482	15.43
Manipur	22327	16926	75.81
Meghalaya	22429	15584	69.48
Mizoram	21081	17494	82.98
Nagaland	16579	13345	80.49
Odisha	155707	48838	31.37
Punjab	50362	2432	4.82
Rajasthan	342239	16367	4.78
Sikkim	7096	3193	44.99
Tamil Nadu	130058	21482	16.52
Tripura	10486	7065	67.38
Uttarakhand	53483	23938	44.76
Uttar Pradesh	240928	13746	5.71
West Bengal	88752	10693	12.05
Union Territories			
Andaman & Nicobar Islands	8249	6930	84.01
Chandigarh	114	9	7.89
Dadra & Nagar Haveli	491	219	44.60
Daman & Diu	112	6	5.36
Delhi	1483	111	7.48
Lakshadweep	32	27	84.38
Poducherry	480	36	7.50
India	**3287263**	**675538**	**22.50**

Source: ***India 2005, Govt. of India Publication***, New Delhi

An examination of Table 5.2 shows that Madhya Pradesh with 77,265 sq km has the largest area under forests in India, followed by Arunachal Pradesh with 68,045 sq km and Chhattisgarh

with 56,448 sq. km. The rank of Odisha and Maharashtra are fourth and fifth respectively. With only 1754 sq. km, Haryana has the lowest area under forest among the states of India.

In terms of percentage, Mizoram with 83 per cent of its area under forest holds the first rank, followed by Arunachal Pradesh at 81 per cent and Nagaland at 80.50 per cent. The percentage of forest area in Meghalaya and Tripura are 69 and 67 per cent respectively. The lowest percentage of forest area is in Haryana (3.97 per cent) followed by Rajasthan (4.78 per cent) and Punjab (4.8 per cent). In general, the hilly and mountainous states have more percentage of area under forest while the forest cover in the states with plains is almost insignificant.

CLASSIFICATION OF FORESTS

The forests of India have been classified in a number of ways.

A. On the basis of **administration**, the forests have been classified into the following three categories:

1. **Reserved Forests:** These forests are under the direct supervision of the government and no public entry is allowed for collection of timber or grazing of cattle. About 53 per cent of the total forest area falls in this category.
2. **Protected Forests:** These forests are looked after by the government, but the local people are allowed to collect fuel-wood/timber and graze their cattle without causing serious damage to the forests. These forests occupy about 29 per cent of the total forest area of the country.
3. **Unclassified Forests:** The unclassified forests are those in which there is no restriction on the cutting of trees and grazing of cattle. About 18 per cent of the total forest area of the country falls under this category.

B. In the **Constitution of India**, forests have been classified under the following categories:

1. **State Forests:** These are under the full control of the government (State/Central) and include almost all the important forest areas of the country. They constitute about 94 per cent of the total forest area of the country.
2. **Commercial Forests:** These forests are owned and administered by the local bodies (municipal corporations, municipal boards, town areas, district boards, and village-panchayats). They occupy about 5 per cent of the total forest area of the country.
3. **Private Forests:** These are under private ownership and cover slightly more than one per cent of the total forest area of the country.

C. On the basis of **merchantability**, Indian forests may be grouped under two categories:

1. **Merchantable:** which are accessible. About 82 per cent of the total forest area belongs to this category.
2. **Non-Merchantable:** These are not accessible being situated in high mountainous areas with inaccessible topographical features. About 18 per cent of the total forest area (especially conifers) of the country fall in this category.

D. Based on Composition: Based on composition and types of leaves, Indian forests fall into two broad groups:

1. **Conifer Forests**: These are temperate forests occupying about 6.50 per cent of the total forest area of the country.
2. **Broad-leaf Forests**: These are tropical and subtropical monsoon forests. About 94 per cent of the country's forests belong to this category. They are found in the plains, plateau, and mountainous areas of the country.

E. Based on Exploitability: On the basis of exploitability, the Indian forests may be classified into:

1. **Exploitable Forests:** These forests contribute 58 per cent of the total forest area of the country.
2. **Potentially Exploitable**: These forests are reserved to be utilised in future. These forests cover about 22 per cent of the total forest area of the country.
3. **Other Forests:** These forests also cover about 20 per cent of the total forest area of the country. There is no restriction on their exploitation.

F. On the basis of Average Annual Rainfall: On the basis of average annual rainfall, Indian forests have been classified by L.D. Stamp into the following four categories (**Table 5.3**)**:**

Table 5.3 *India—Classification of Forests on the basis of Rainfall Distribution*

Vegetation Type	*Average Annual Rainfall (cm)*	*Zone*
1. Evergreen forests	Above 200	Humid
2. Monsoon forests	100–200	Semi-Humid
3. Dry forests	50–100	Dry
4. Desert forests	Below 50	Very Dry (deserts)

The natural vegetation of India has been shown in **Fig. 5.3**.

The Indian forests were also classified by H.G. Champion (1936) into eleven categories. The main categories according to this classification are as under:

1. **Tropical Evergreen:** These forests are mainly found in the areas recording over 150 cm of average annual rainfall where the temperature varies between 25°C to 27°C. North-East India, parts of Western Ghats, the Andaman and Nicobar, upper Assam, lower slopes of Eastern Himalayas, Odisha, along the foot-hills of Himalayas, Bhabhar and Tarai regions (**Fig. 5.3**)**.** In the areas where the average annual rainfall is more than 250 cm, the forests are dense; composed of tall trees (45 m) epiphytes, parasites, lianas and rattans so as to look like a green carpet when viewed from above. Trees have multi-storeyed structures with good canopies. These trees do not shed their leaves annually and are hence evergreen. The floor lacks grasses because of deep shade. There are, however, canes, palms, bamboos, ferns, and climbers which make passage difficult. The important species of these forests are white cedar, toon, dhup, palaquinum, mesua, collophyllum, hopea, and canes, gurjan, chaplas, agor, muli, and bamboo. Due to poor accessibility these forests have not been properly exploited.

   In areas where rainfall varies between 200 to 250 cm and the mean monthly temperature varies between 24°C to 27°C , the evergreen forests degenerate into semi-evergreen forests. These forests are found along the Western Ghats, upper Assam, slopes of the Himalayas, and Odisha. The important varieties include aini, semul, gutel, mundane, hopea, kadam, irul, rosewood, laurel, haldu, kanju, holloch, champa, and mesua.
2. **The Tropical Moist Deciduous**: These are typical monsoon forests with teak (*Tectona grandis*) and sal (*Shorea robusta*) as the dominant species. They form the natural vegetation all over the country where the average annual rainfall ranges between 100–200 cm. The tropical moist deciduous forests are found in Sahyadris, the north-eastern parts of the peninsula and along the foothills of the Himalayas (**Fig. 5.3**)**.** These forests on the whole have gregarious species. The typical landscape consists of tall teak trees with sal, bamboos, and shrubs growing

fairly close together to form thickets. Both teak and sal are economically important and so are the Sandalwood (*Santalum album)* Shisham (*Dalbergia sissoo*), Hurra (*Terminalia chebula*), and Khair (*Acacia catechu*).

3. **The Tropical Thorny Forests:** The tropical thorny forest is a degraded version of the moist deciduous forest. They are found in the average annual rainfall varies between 75 and 100 cm and the average annual temperature between 16°C and 22.5°C. These forests are found in peninsular India, Rajasthan, Haryana, Punjab, western Uttar Pradesh, Kachchh, Madhya Pradesh and the foothills of the Himalayas **(Fig. 5.3).** The important trees of these forests are acacia, wild-palms, euphorbias, jhad, tamarix, khair, kokko, dhaman, erunjha, cacti, kanju, and palas.
4. **The Subtropical Montane Forests**: These forests are found in areas where the average annual rainfall varies between 100 to 200 cm and the temperature varies between 15° and 22°C. These forests are found in the north-western Himalayas (except in Ladakh and Kashmir), Himachal Pradesh, Uttarakhand, Sikkim, Arunachal Pradesh and on the slopes of north-eastern hill states **(Fig. 5.3).** Chir (pine) is the main tree but broad leaved trees are also found in these areas. Oak, jamun, and rhododendron are the other varieties in these forests.
5. **The Dry Deciduous Forests:** These forests are found in areas where the average annual rainfall ranges between 100–150 cm. These forests are characterised by closed and rather uneven canopies. Enough light reaches the ground to permit the growth of grasses and climbers. Acacia, jamun, modesta, and pistacia are the main trees. Grasses and shrubs appear during the season of general rains.
6. **The Himalayan Moist Forests**: These forests are found in Jammu and Kashmir, Himachal Pradesh, Uttarakhand, and northern hilly parts of North Bengal **(Fig. 5.3).** The wet temperate type is found in a belt where the altitude varies between 1000 and 2000 metres. They occur largely as bands of crested dark green landscape of coniferous varieties. The important varieties are oak, chestnut, chir, sal, shrubs, and nutritious grasses.
7. **The Himalayan Dry Temperate Forests:** These forests are found in Jammu and Kashmir, Lahul, Chamba, Kinnaur (Himachal Pradesh), and Sikkim **(Fig. 5.3)**. These are predominantly coniferous forests with shrubs. The important varieties of trees are deodar, oak, chilgoza, ash, maple, olive, mulberry, willow, celtis, and parrotia.
8. **Montane Wet Temperate Forests:** These forests are found in the entire Himalayas from Jammu and Kashmir to Arunachal Pradesh between the altitudes of 1500 m to 3500 m where the temperature varies between 12°C to 15°C, and the mean annual rainfall is between 100 to 250 cm. Oak, fir, spruce *Picea*, deodar, (*Cedrus deodara*), magnolia *(Magnolia glandifora*) celtis, chestnut, cedar (*Chamaecyparis*) and maple, spruce, deodar, silver-fir (*Abies alba)*, kail, and yew are found here. These forests also contain scrubs, creepers, and ferns. The woods of these forests are durable. At higher altitudes above 3500m, are the alpine pastures known as **Margs** in Kashmir and **Bugyals** in Uttarkhand.
9. **Alpine and Sub-alpine Forests:** The Alpine forests are found all along the Himalayas at altitudes ranging between 2500 to 3500 metres. These areas are characterised with short dwarf conifers and lush green nutritious grasses during the summer season. The trees found in the zone are kail, spruce, yew, firs, birch, honeysuckle, artemesia, potentilla, and small scrubs.
10. **Desert Vegetation:** The desert vegetation is confined to the west of Aravallis in the states of Rajasthan and northern Gujarat **(Fig. 5.3).** The average annual rainfall in this zone is

less than 50 cm, the diurnal and annual range of temperature are high. Acacia, cacti, jhar and khejra, kanju, and wild palms are the main trees of the desert.

11. **Tidal (Mangrove):** These forests are found along the coastal areas of the Bay of Bengal in the states of West Bengal, Odisha, Andhra Pradesh, and Tamil Nadu, and along the coastal areas of Kachchh, Kathiwar, and Gulf of Khambat. Their main concentration is found in areas where tides are frequent. The mangrove which attains a height up to 30 metres is the most important tree. It is utilised for fuel. The famous delta of Sundarban is covered by the

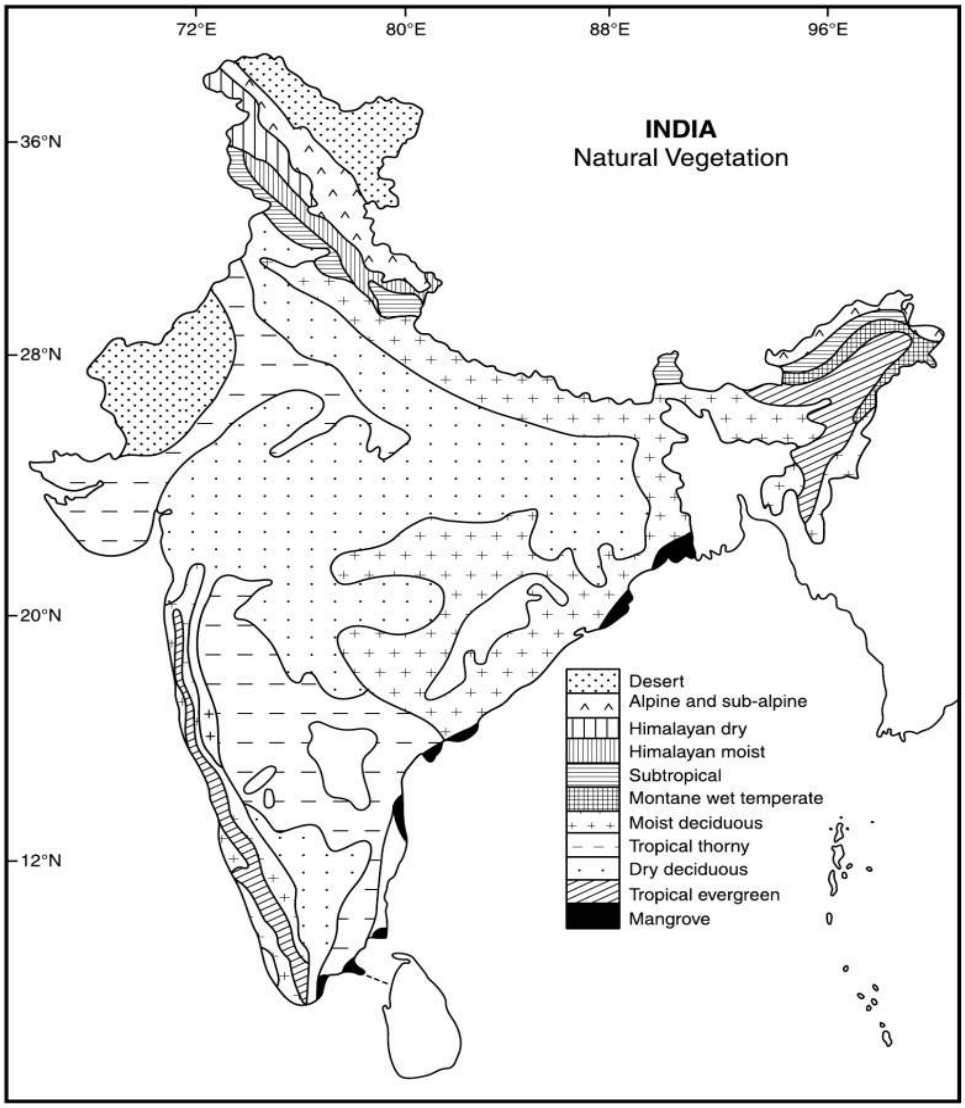

Fig. 5.3 Natural Vegetation—2012

Sundri (*Heritiera minor*) trees which supply hard durable timber for construction and boat making. Here, higher grounds support screw-pines (*Pennanus spp.*). Palms occupy creeks, and epiphytes are predominant all over the region **(Fig. 5.3).**

The percentage share of the different categories of forests have been given in the **Table 5.4**.

Table 5.4 *Percentage Share of Different Types of Forests (2001)*

Type of Forest	*Per cent (Total Forest Area)*
1. Tropical Moist Deciduous	37.0
2. Tropical Dry Deciduous	28.8
3. Tropical Evergreen	12.1
4. Subtropical	9.5
5. Montane Wet Temperate	7.0
6. Alpine and Sub-alpine	2.9
7. Tropical Thorny	2.6
8. Mangrove	0.06

Source: ***Oxford School Atlas***, 2004.

It may be seen from Table 5.4 that tropical moist deciduous forests cover 37 per cent of the total forest area of the country followed by the tropical dry deciduous at 28.8 per cent. The tropical evergreen forests occupy 12.1 per cent and the subtropical 9.5 per cent. The rest of the forest area is under montane wet temperate (7.0 per cent) and alpine and sub-alpine (2.9 per cent). The tropical thorny forest occupy about 2.6 per cent and about 0.06 per cent is under mangrove vegetation.

IMPORTANT SPECIES OF TREES AND THEIR UTILITY

On the basis of type of species and utility, the trees of India may be classified under the following categories:

1. Woods from Evergreen Forests.
2. Woods from Monsoon Forests.
3. Woods from Subtropical (Himalayan Forests).

1. Woods from the Evergreen Forests

The main trees from the evergreen forests are:

(i) Rosewood

It grows well along the slopes of the Western Ghats (Tamil Nadu, Karnataka, and Kerala) and in some parts of Andhra Pradesh, Odisha, Jharkhand, and Chhattisgarh. The wood from these forests is hard and fine-grained, dark purple in colour, widely used in the manufacture of furniture, floor boards, and ornamental plyboards.

(ii) Gurjan

It occurs in the evergreen forests of Assam, West Bengal, and Andaman and Nicobar Islands. The wood is dull reddish to brown in colour. It is extensively used for internal construction work of houses. It is also used for packing cases, tea boxes, flooring, and wagons.

(iii) Telsur or Irupu

It is mainly found in West Bengal, Kerala, Karnataka, Maharashtra, and Andaman and Nicobar Islands. Its wood is very hard, strong and durable which are largely used for the manufacturing of boats, bridges, piles, masts, carts, and railway sleepers.

(iv) Toon

It is obtained from the foothills of the Himalayas. Although its wood is not very hard, it is durable. It is used for making tea boxes, toys and furniture.

(v) Ebony (Diospyros Ebenum)

It is found in the dry evergreen forests of Karnataka, Kerala, Tamil Nadu, Malabar Coast, Goa, and Maharashtra. Its wood is lightly yellowish-grey and often streaked with black. The heartwood (inner core) is jet black, rarely with brown golden streaks. It has a metallic lusture when smoothed. It is one of the most valuable woods as it is resistant to attack by insects. It is used for ornamental carving and decoration. It is also used for veneers, musical instruments, sports goods, piano keys, and caskets.

(vi) Chaplas

The *chapla* forests mainly occur in north-east India and the Western Ghats. Its timber is strong and durable and hence, is in great demand for ship-building, furniture-making, and packing boxes.

(vii) Nahar

It is found in Assam and the Malabar coast. The wood is fairly strong and durable. Its wood is used for railway sleepers, piles, and boats.

(viii) Poon

It is found in the Western Ghats, Kerala, Nilgiri, and Tamil Nadu. Its wood is very hard, can be easily seasoned and is mainly used as structural timber for house making.

2. Woods of the Monsoon Forests

The main trees of the monsoon forests are as under:

(i) Sal (Shorea Robusta)

It occurs in the sub-Himalayan region from Kangra (Himachal Pradesh) to Darrang (Assam), Meghalaya and the northern parts of Tamil Nadu. Its wood is very heavy, hard and durable. It is much in demand for piles, doors, beams, planking and railway sleepers. Sal forests occupy 11.6 lakh hectares, accounting for about 16 per cent of the total forest area of the country.

(ii) Teak (Tectona Grandis)

Teak is the most popular tree of the monsoon climate found mainly in Chhattisgarh, Jharkhand, Madhya Pradesh, Odisha, the foothills of Himalayas, Tamil Nadu, Karnataka, Kerala, and the western and eastern Ghats, and Banswara (Rajasthan). Its wood is moderately hard, duarable, easy to work and takes a good polish. It is an expensive timber used for doors, cupboards, and furniture. Teak forests cover about 9 million hectares of the total forest area of the country.

(iii) Shisham (Dalbergia Sissoo)

It occurs throughout the Himalayas from Jammu to Assam up to an altitude of 1500 m. It grows extensively in Punjab, Haryana, Uttarakhand, Uttar Pradesh, Bihar, and West Bengal. On account

of its great strength, elasticity and durability, its wood is mainly used in furniture making, musical instruments, and agricultural equipments.

(iv) Haldu

It is found all over the monsoon area. Its wood is hard, durable, and light in colour. It is used for toy making and wood carving.

(v) Palas

It occurs mainly in Chotanagpur Plateau, Chhattisgarh, and south-eastern parts of Rajasthan. Its leaves are used for rearing shellac worms.

(vi) Arjun

It is also an important tree of monsoon forests which is used for the making of agricultural equipments and bullock carts.

(vii) Mahua (Madhuca Indica)

It is largely found in Madhya Pradesh, Chhattisgarh Bundelkhand (U.P), Jharkhand, Bihar, Gujarat, Maharashtra, Uttarakhand, and south-eastern parts of Rajasthan. Its fruits are used for the extraction of oil and flowers for wine making.

(viii) Semul

It is widely found in Assam, Bihar, and Tamil Nadu. Its timber is soft and white and is used for toy making, packing cases, match boxes, and plywood. Its fruits yield soft fibre for pillows and *lihafs.*

(ix) Mulberry

It grows widely in monsoon areas. Its wood is soft and durable, used mainly for the manufacture of sports goods (hockey, cricket bats, tennis rackets, badminton and squash rackets, and cricket stumps).

(x) Jamun (Syzygium cumini)

It is a large tree of monsoon region. Its timber is moderately strong and used for the construction of houses and furniture. Its fruits are highly beneficial in controlling diabetes and high blood pressure.

3. Woods from the High Altitudinal Forests of the Himalayas

The main woods of the Himalayan forests are deodar, chir (pine), blue-pine, silver fir, spruce, walnut, white willow, Indian birch, and cypress.

(i) Chir (Pinus Longifolia)

Chir occurs in the Himalayas between 900 m and 1800 m, from Jammu to Arunachal Pradesh. The wood is light and reddish brown in colour and is moderately hard. It is used for furniture, for making tea-boxes, match industry, and railway sleepers. It yields resins, gums, and turpentine oils.

(ii) Deodar (Cedrus Deodara)

It grows in the north-western Himalayas in the states of Jammu and Kashmir, Himachal Pradesh, and Uttarakhand, between the heights of 1500 m and 2500 m. Its wood is of light brown to yellow

colour. Its wood is very sturdy and duarable. It is also an easy timber to saw and work to smooth finish. The timber is used for construction-work, and for railway sleepers. It is also suitable for beams, floor-boards, ports, doors, window frames, light furniture, and shingles.

(iii) Blue-Pine (Pinus Excelsa)

It grows along the entire length of the Himalayas from Chumbi Valley to Sikkim between the elevation of 1800 m and 3600 m. The wood is pink in colour, moderately hard and of good quality. It is used for making doors, windows, furniture, and railway sleepers. It also yields resins and turpentine.

(iv) Silver-fir (Abies)

It is found in the north-western and north-eastern Himalayas between 2200 m and 3000 m. The food is soft but not very durable. It is mostly used for planking, packing boxes, containers, wood-pulp, paper, and match sticks.

(v) Spruce (Picea Mithiana)

It is found in the western Himalayas between 2100 m and 3600 m. Its soft white wood is used for construction of houses, railway sleepers, cabinets, packing, and pulp making.

(vi) Walnut (Juglans Regia)

It is found in Kashmir, Himachal Pradesh, Uttarakhand, and Khasi hills. It is a relatively light wood on which work can be done easily and the finish is fine and attractive. Once dried it does not shrink, swell or split. The wood is used for musical instruments, gun-butts, and cabinet works.

(vii) White Willow (Salix Alba)

It is a small tree found in north-western Himalayas including the Kashmir Valley. Its twigs are used for making baskets. The wood is used for making cricket bats and other sports goods.

(viii) Indian Birch

It is obtained from the higher slopes of the Himalayas. The wood is grayish in colour, even textured and straight grained. It is largely used for the making of furniture, plywood, and radio cabinets.

(ix) Cypress

It mostly occurs in Uttarakhand, Himachal Pradesh and Jammu & Kashmir. Its wood is durable and used for making furniture.

FOREST PRODUCTS AND THEIR UTILITY

In addition to fuel-wood, timber, and charcoal, the forests provide a number of other products. These include bamboos, canes, tendu leaves, grasses, oils, lac, resins, gums, medicinal herbs, tanning material, dyes, honey, bees wax, ivory, vegetables, fruits, roots, and tubers.

1. Bamboo

Bamboo is found in most of the monsoon regions where the average annual rainfall is more than 150 cm. Some of the bambooes may attain a height of 30 m. It is used for a variety of purposes—basket making, roofing, and thatching, construction, paper, and pulp making. In India more than 100 varieties of bamboos are found. According to the Planning Commission bamboo occupies

100,210 sq km of the forest area of the country with an annual production of four million tonnes. Different types of decorative items such as flower pots, trays, vases, caskets, and even ornaments are made of bamboo in states like Mizoram, Nagaland, Meghalaya, Manipur, and Tripura. Bamboo also finds a place in cultural activities of the Mizo people, i.e. Cherraw (bamboo) dance.

2. Canes

Canes grow in moist and wet forests in Assam, Kerala, Karnataka, West Bengal, Gujarat, Uttarakhand, Himachal Pradesh and Jammu and Kashmir states. It is used mainly for making strings, ropes, mats, bags, and baskets.

3. Tendu

The leaves of tendu are obtained from the forests of Chhattisgarh, Jharkhand, Odisha, Madhya Pradesh, south-east Rajasthan, and Andhra Pradesh. Tendu leaves are used for *bidi*-making.

4. Grasses

A large variety of grasses are found in the Indian forests. Some of the important grasses are *Sabai* (sub-Himalayan Tarai tracts), elephant-grass (Assam), spear-grass, *ulla*, and *panni* grasses, etc. *Khus-Khus* grass (Bharatpur, and Sawai-Madhopur, Rajasthan) is used for making cooling screens during summer season. *Rosha, lemon*, and ginger-grasses yield medicinal and perfumed oils.

5. Oils

The raw materials for a number of perfumes and oils are also obtained from the herbs, plants, and trees. Some of them are camphor, clove, ylang, cinnamon-oil, cypress-oil, eucalyptus-oil, jasmine-oil, khus-oil, lavender-oil, lemon-grass-oil, mint-oil, sandalwood-oil, patchouli-oil, turpentine oil, nutmeg-oil, and champaca-oil.

6. Medicinal Herbs and Plants

A number of medicinal plants, herbs and trees are found in Indian forests. The leaves, stems, flowers, fruits, barks, roots, and seeds of different plants and scrubs are used as raw materials for the manufacture of a number of medicines. Some of the important herbs used for medicines are aconite, Keera-jari (insect herb), celery, belladone, colocynth, sarasaparilla, jalap, leadwort, chitraka, serpentine, and liquorice. The root of serpentine is an antidote for snake and insect bite. Barks of mountain ebony, Indian oak, quinine, Spanish-cherry, bay-berry, lodh-tree, Indian-red-wood, ashoka, arjuna, and Indian barberry have medicinal value. The stem of ephedrine, white sandal-wood, catechu, and long needle-pine are also of great medicinal importance. Leaves of vasaka, Indian aloe, poison-bulb, fever-nut, life-plant, swallow wart, Indian-penny-word, Tasmanian blue-gum, physic-nut, holy-basil, betel, pepper, and typlophora yield different drugs. Similarly, flowers of saffron, iron-wood, violet and fruits of bel, fish-berry, purging-cassia, coriander, cumin, fennel, emblic, opium, long-pepper, black and white pepper, belleric, myrobalan, ammi and solanum are used in medicine making. Keera-jari (insect herb) known as cordyceps sinensis is highly valued as a tremendous energy booster which cost about Rs. 2.5 lakh per kg.

7. Shellac

It is secreted by an insect called *Kerria lacca* which feed on the saps of host trees like palas, peepal, kusum, sissoo, kul, gular, siras, and banyan. These trees are extensively found in the Gangetic

plains, Madhya Pradesh, Chhattisgarh, Jharkhand, Maharashtra and Assam. India has a monopoly in lac production in the world. It is used for dyeing silk, making bangles, paints, munitions, fire-works, gramophone records, sealing wax, electrical insulation material, shoe-dressing, plastic-moulding, spirit , baking enamels, and anti-moulding compository for ships.

8. Resins

Resin is the exudation of paints belonging to phaneorogamic families. It is a yellowish solid, insoluble in water, but soluble in alcohol. In the conifer pine forests of the Himalayan region, resin is collected on commercial scale. The resin is used for soap, and sizing paper and cloth. It is also used in the manufacture of sealing wax, linoleum, lubricating compounds, paints, and several kinds of inks.

9. Gums

Gum is obtained from acacia, carob, mesquite, kateera-gum. These are used as adhesives in printing and finishing textiles, in the paint and candy industries, and drugs.

10. Tannins and Dyes

Tannins are used for coagulating the protein in hides and skins, so that resistant leather can be produced. Lighter vegetable tannins dominate in the production of leather. Tannins are obtained from the bark of mangrove, sundri trees, wattle, avaram, sumac, arjun, Indian almond, jujube, Cuddapah-almond, hog-plum, chestnut, and leaves of smoke trees.

The dyes are coloured compounds. On being fixed to fabrics, they do not wash out with soap and water or fade on exposure to light. About 150 dye yielding plants are available in Indian forests, but only a few have been utilised so far.

11. Katha

Katha is extracted from the inner wood of *khair* tree which is largely grown in Uttarakhand, Uttar Pradesh, Himachal Pradesh, Madhya Pradesh, Chhattisgarh, Jharkhand, Gujarat, and Bihar. Its important factories are at Bareilly (U.P.) and Shivpuri (M.P.).

12. Fruits and Vegetables

The fruits and vegetables obtained from the forests are jamun, bel, ber, gular, jack-fruit, amla, tamarind, khirni, karonda, khajur, and chilgoza. Chinch, munga, chkoora, arvi, ratalu, kanhi, akana, kirchi, jarungi, sua, saijan, saidu, mushrooms, and guchchhi are obtained as vegetables.

13. Valuable Things

In addition to the given benefits from forests, the collection of ivory, honey, bees wax, hides, horns, and furs is also done from the forests.

14. Grazing Grounds

Forests are the grazing grounds for domesticated animals and the abode for over 30,000 species of plants, animals, and micro-organisms.

15. Forests and Climate

Climate, temperature, and precipitation are also directly affected by the presence or absence of forests. It is said that larger the area under forests, greater is the amount of precipitation.

PROBLEMS OF INDIAN FORESTRY

The specific problems of Indian forestry are the following:

1. Low Forest cover

(i) The forest cover in India is only 22.50 per cent as against the world average of about 35 per cent. The overall desired forest area as recommended in the National Forest Policy of India 1952, should be 33 per cent (25 per cent in plains and 60 per cent in hilly regions) of the total geographical area of the country. This percentage is missing in almost all the states and UTs except Andaman and Nicobar, Assam, Goa, Kerala, Meghalaya, Sikkim, Uttrakhand, Mizoram, Arunachal Pradesh, Nagaland, Manipur and Lakshadweep. The states of Haryana, Punjab, and Rajasthan have less than 5 per cent of their areas under forest. India has 99 National Parks, 513 wild-life sanctuaries and 18 Biosphere Reserves.
(ii) Most of the forests of India are not gregarious which creates problems in their exploitation. Teak, sal, bamboo, pines, oak, deodar, fir, spruce and larch are, however, exceptions.
(iii) About 40 per cent of the total forest area in not easily accessible.
(iv) In about 50 per cent of the total forest area, tribals have been given the rights of free grazing and cutting fuel-wood and timber for their personal consumption. This right is often misused.
(v) The felling of trees is still primitive and indigenous in most of the forests. This damages the ecosystem, leads to more soil erosion and delays the regeneration of forests.
(vi) There is inadequate trained personnel in forestry. Much of the energy of the available man-power is used in the protection and conservation of forests instead of their regeneration.
(vii) There is inadequate protection against forest fire, insects, pests and plant diseases.
(viii) The shifting cultivation in the wet mountainous regions of the country is another serious problem of the Indian forests.
(ix) According to the data published by the new environmentalists, India is losing 135 hectare forest daily (12th June-2013, Hindu, Delhi ed.)

2. Open Grazing

Extensive damage to the Indian forests is being done by the grazing of cattle, sheep and goats, especially in the hilly and mountainous areas, by the local people. Nomadic tribes like Bakarwals, Bhutias, Gaddis, Gujjars, and Lepchas, practicing transhumance (seasonal migration) damage the forest ecosystems.

3. Shifting Cultivation

Tribals in the areas where rainfall is more than 100 cm generally practice shifting cultivation (*Jhuming*) in the hilly and mountainous areas. The increasing pressure of population has reduced the Jhum Cycle to only five years in many parts of Nagaland, Meghalaya, Mizoram, Manipur, and Tripura. Consequently, the forests do not have sufficient time to regenerate.

4. Growing Demand for Agricultural Land

With the tremendous increase in population during the last 65 years, the demand for cereals and agricultural raw materials has increased significantly. Consequently, the forest area has been brought under cultivation leading to a continuous shrinkage of the forest area.

5. Urbanisation and Industrialisation

Fast urbanisation and industrialisation in the forest and hilly areas is also an important cause of forest degradation. The size of cities like Shimla, Mussoorie, Dehra-Dun, Nainital, Ranikhet, Chamba, Dalhousie, Darjeeling etc. has increased over ten times during the last thirty years. There has been rapid expansion of roads in the Himalayas and other forest areas as a result of which the valuable forests have been exposed to tourists and pleasure-seekers.

6. Construction of Multi-Purpose Projects

The construction of reservoirs of big dams like Bhakra-Nangal, Rihand, Hirakud, Tehri, Koteshwar, Salal, Dulhasti, Sardar-Sarovar, etc. has resulted in the submergence of large forest tracts.

7. Commercial Activities

Commercial activities like resin extraction, mining, quarrying, oil-extraction, plantation, orchard development have also led to large-scale deforestation. Unfortunately, paper mills, and saw-factories have been located in the forests areas which accelerate the process of deforestation.

THE NATIONAL FOREST POLICY

India is one of the very few countries of the world where forest policy is in operation since 1894. In 1952 and 1988, revisions were made in the forest policy of 1894. The National Forest Policy of 1952 recommended that the country should aim at a coverage of one-third of the total land area under forest (60 per cent in hilly and mountainous areas, and 25 per cent in the plains). It has suggested the extension of tree-lands on river/canal banks, roads, railways, culturable waste and in such areas which are not suitable for cultivation.

The National Forest Policy 1952 classified the forests of the country into four categories:

(i) **Protected forests** essential for physical and climatic needs.
(ii) **National forests** to be utilised for the economic needs of the country.
(iii) **Village forests** to meet the fuel and domestic needs of villages and neighbouring towns.
(iv) **Tree lands**. The policy envisaged the annual organisation of *Van-Mahotsava* and tree plantation week in the month of July/August.

The National Forest Policy 1952 lays emphasis on :

(i) Weaning the tribal people by persuasion to desist from shifting cultivation.
(ii) Implementation of forest laws more effectively.
(iii) To provide adequate facilities for the management of forest resources.
(iv) To control grazing of cattle, sheep and goats in forest areas.
(v) Providing fuel-wood to rural areas.
(vi) To improve the availability of timber wood for industrial purposes.
(vii) To increase the area under social forestry.
(viii) To promote research in forestry.

The National Forest Policy 1988

The main emphasis of the National Forest Policy 1988 is on the protection, conservation, regeneration and development of forests. The main points of the National Forest Policy 1988 are:

(a) Maintenance of environmental stability through the preservation and restoration of ecological balance.
(b) Conservation of forests as a national heritage with vast varieties of flora and fauna.
(c) Control of soil erosion and denudation in catchment areas of rivers, lakes and reservoirs.
(d) Check on the extension of sand-dunes in desert areas of Rajasthan and along sea-coasts.
(e) Substantial increase in forest cover through massive afforestation and social forestry programmes.
(f) To meet the needs of fuel-wood, fodder and minor forest products for the rural and tribal people.
(g) Augment the productivity of the forests to meet national needs.
(h) Encouragement of efficient utilisation of forest produce and optimum substitution of wood.
(i) Steps to create massive movement of people with the involvement of women folk to achieve these objectives and to minimise pressure on existing forests.
(j) Involvement of people in forest management under joint forest management.

SOCIAL FORESTRY

Social forestry refers to the forests (trees) planted by the people of a society. It has been defined as '*the forestry of the people, for the people by the people*'. The significance of social forestry has been emphasised in the National Forest Policy 1952 and 1988. The main objective of social forestry is to reduce pressure on traditional forests by plantation of fuel-wood, fodder, timber, and grasses. The two types of social forestry include:

Agro-forestry which includes community forestry and agro-forestry (commercial and non-commercial farm forestry).

Objectives

(i) To meet the need for fuel wood, small timber, bamboo, fodder and other minor forest produce on sustainable basis. (ii) To release cow dung as manure for increasing agricultural production, (iii) To provide gainful employment opportunities to the rural population, (iv) To develop cottage industries, (v) To provide efficient soil and water conservation, (vi) To provide efficient soil and water conservation, (vii) to improve aesthetic value of an area and to meet the recreational needs of the population.

Community Forestry

Community forestry is a part of social forestry. It involves the raising of trees on community lands with the set objective to provide benefits to the community as a whole. Although the plants and seedlings are provided by the forest departments, the protection of planted trees is primarily the responsibility of the community as a whole.

India has performed superbly in community forestry and stands only next to China in this respect. The states in which community forestry is a big success are Gujarat, Haryana, Himachal Pradesh, Karnataka, Kerala, Odisha, Punjab, Rajasthan, Tamil Nadu, Uttarakhand, and Uttar Pradesh.

Agro-Forestry

Agro-forestry is a sustainable management for land that increases overall production, combines agricultural crops, tree crops, forest plants and animals simultaneously and applies management practices that are compatible with cultural patterns of local population.

Agro-forestry is a type of social forestry in which individual farmer undertakes tree-farming and grows fodder plants, grasses and legumes on his own land. In agro-forestry, trees (forest) are considered as a crop and they (trees) become a part of crop combinations.

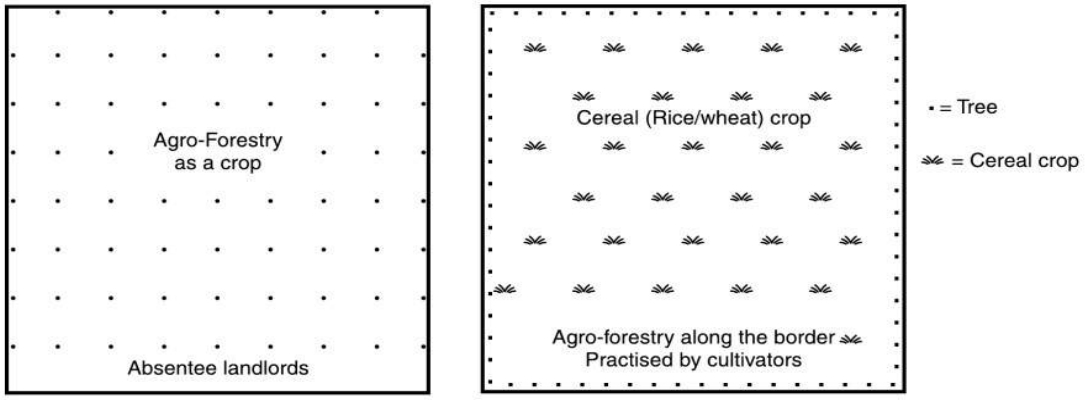

Fig. 5.4 Patterns of Agro-Forestry

There is an increasing number of farmers who plant trees either along the boundaries or in the whole field/farm as a crop (**Fig. 5.4**). In fact, in the Northern Plains of India, trees are planted by most of the farmers irrespective of the size of their holdings, but the large farmers and absentee landlords put part of their holdings or total agriculture area under tree crops.

Under agro-forestry, a farmer generally uses his degraded or useful land to plant trees for domestic use or commercial use. Such land may be his own or obtained on lease under social forestry programme.

Agro-forestry involves both the big and the small farmers. It fetches additional income to farmers, improves their income and thereby, their standard of living, and provide them employment during lean agricultural seasons. These trees are normally harvested after 6 to 10 years from the date of plantation, depending on the needs and requirements of the farmer. The main advantages of agro-forestry are:

(i) The absentee landlords go for agro-forestry to retain title of the land and to increase their income.
(ii) To manage the agricultural land even without the availability of family labour.
(iii) To ensure better land use.
(iv) To generate employment.
(v) To conserve soil moisture.
(vi) To meet the needs of fuel-wood, fodder and timber.
(vii) To protect the arable land from winds and water erosion.

Despite numerous material and geo-climatic benefits, agro-forestry has some adverse effects on agricultural land. Some of its shortcomings are given below:

(i) The market-oriented trees are preferred which damage the ecosystem. Instead of poplar and eucalyptus, the farmers should go for the plantation of Neem, Mahua, Karanj, Arjun, and acacia.
(ii) Fuelwood and fodder trees are generally neglected.
(iii) The exotic varieties planted by the farmers in the form of agro-forestry are soil-moisture and water exhaustive. Consequently, the underground water-table is adversely affected.
(iv) The land under agro-forestry becomes unproductive as the roots of trees become so dense that their digging and removal to bring the land under cultivation becomes very difficult unless heavy investment is made in the digging and removing of roots.
(v) In the fields along which trees have been planted, the productivity per unit area decreases, as at least in about two metres from the trees the moisture content in the soil is significantly reduced.
(vi) The trees become the habitat of many pests and diseases, adversely affecting the crops.
(vii) Unscientific method of spacing of trees, reduces the growth and mass of the trees.

In brief, Agro-forestry is a system of agricultural land utilisation which not only provides fuel-wood, fodder, and grasses, but helps in the promotion of forests and their conservation. The Indian Council of Agricultural Research and the Forestry Department jointly undertake agro-forestry research in order to develop suitable systems of land management which involves integration of silviculture, with horticulture, agriculture and animal husbandry. Agro-forestry thus integrates agri-silviculture, silvi-pastoral system, and medicinal plants culture. Under agro-forestry, a farmer generally uses his degraded or useful land to plant trees for his domestic use or for commercial use.

Agro-forestry has become very popular in Andhra Pradesh, Bihar, Gujarat, Haryana, Karnataka, Kerala, Punjab, Rajasthan, Uttarakhand, and Uttar Pradesh. The main species of trees planted by farmers in their fields are eucalyptus, poplar and casuarinas. The wood of these forests is used mainly for fuel-wood, plywood, paper and pulp manufacturing, and match industries.

Agro-forestry has benefited the big farmers more than the marginal and small farmers. Many of the absentee land-lords plant commercial trees in their agricultural land-holdings to save their land from dispossession. Thus, the agricultural labourers are thrown out of employment. The diversion of good agricultural land from cereal and commercial crops may create the problem of scarcity of food stuffs and industrial raw material. The programme, therefore, needs a new strategy and reorientation to achieve its real objectives.

EXISTING POSITION OF FOREST ECOSYSTEMS

The continuing exploitation of our forest resources has damaged the forest ecosystem almost beyond repair. The depletion of forest cover is due to expansion of agriculture, habitat destruction, over-exploitation, pollution, toxic imbalances in community structure, epedemics, floods, droughts and cyclones. As a consequence of the denudation of hill slopes, soil erosion and recurrent floods have emerged as major problems. According to one estimate by the National Remote Sensing Agency, India has been losing about 1.3 million hectares of forest cover every year. This is an alarming rate indeed. It is now generally realised that forests are life sustaining agents. They play a vital role in maintaining the ecological balance. The recent concern for environment has resulted

in rethinking on these issues. Looking at the present state of our forest resources and their degradation, it is imperative to utilise them in a judicious manner, so that they may be regenerated in a short time to make them sustainable.

FOREST CONSERVATION

The utility of forests, their social relevance and climatic importance have been discussed in the preceding paras. The conservation of forest resources is imperative for our survival. Some of the steps which can go a long way in making forests healthy and sustainable are as under:

(i) *Afforestation:* There should be massive afforestation programmes with main emphasis being on the production of fuel-wood, timber, grasses, and small trees to cover up degraded and denuded lands.
(ii) Plantation of trees along the roads, railway lines, rivers, and canal banks, and along lakes and ponds.
(iii) Development of Green-belts in the urban areas and plantation of trees on community lands.
(iv) Plantation of community forests on *Gram-Sabha* lands.
(v) Villagers should be given loans at easy interest rates to revive degraded forest.
(vi) Encroachment of agriculture in forests should be made punishable.
(vii) The customary rights and concessions like grazing, collection of fuel-wood and fodder from forests by the local people should not be allowed to exceed the carrying capacity of the forests.
(viii) Rural population should be provided alternate sources of fuel-wood and wood-based products.
(ix) The development projects including mining and industrial activities should be so planned to cause minimum damage to forest ecosystems.
(x) Mining contracts should have an obligatory clause of reforestation when the process of mining is over.
(xi) Industries should adopt anti-pollution devices and must develop and compensate the forest loss by new plantation.
(xii) Tribal and local people should be directly involved in the protection, regeneration, and management of forests.
(xiii) Shifting cultivation should be gradually replaced by terraced farming and orchards development and silviculture.
(xiv) Scientific methods should be adopted to check and contain forest fires. There should be strict control in issuing license for the establishment of industries in forest areas.
(xv) There should be more research on forestry in agricultural universities, for which facilities and funds should be provided by the Central and State governments. Forestry should be made an important part of the course structures in schools, colleges and universities.
(xvi) There should be arrangements to protect the forests from pests and diseases for which trimming and spraying of the trees should be a regular practice.
(xvii) There should be perfect co-ordination between the forest department and other departments of the government for effective and judicious utilisation of forests and their conservation.
(xviii) People should be encouraged to participate in the *Van-Mahotsav* and should be made aware about the *Chipko Movement.*

(xix) There is a need to change our outlook towards forests. A forest should not be treated as a perennial resource and a source of revenue only. The planning and conservation of forests is not only the duty of the government, but also all the citizens of the country.

(xx) There should be special audio-visual programmes, demonstrations, seminars and workshops to develop awareness among the people about the social relevance of forests.

The Indian Council of Forestry Research and Education (ICFRE) was created in 1987 under the Ministry of Environment and Forests. The following forestry research institutes are working under the Indian Council of Forestry Research and education:

(i) Forest Research Institute, Dehra Dun.
(ii) The Central Arid Zone Research Institute, Jodhpur.
(iii) The Institute of Rain and Moist Deciduous Forests, Jorhat.
(iv) The Institute of Wood Science and Technology, Bangalore.
(v) The Tropical Forestry Research Institute, Jabalpur.
(vi) The Institute of Forest Genetics and Tree Breeding, Coimbatore.
(vii) The Temperate Forest Research Centre, Shimla.
(viii) The Centre for Forest Productivity, Ranchi.
(ix) The Centre for Social Forestry and Environment, Allahabad.

WILDLIFE

India has a great diversity in its geo-climatic environment. This diversity of environment provides natural habitats for wild animals, birds and insects. Out of the world's total of about 15 lakh species of animals, India has 81,251 or (6.7 per cent). According to S.H. Prater (1934), India can be divided into six zoo-geographic regions. India has 350 different mammals, 1200 species of birds, 453 species of reptiles, and 45000 plant species. Moreover, India has 50,000 known species of insects, including 13,000 butterflies and moths. They are: (i) The Himalayan region (ii) The Northern Plains, (iii) The Thar Desert, (iv) The Peninsular Plateau, (v) The Malabar Coast, and (vi) The Nilgiri.

Under the pressure of a fast increasing population and heavy demand of food and industrial raw material, the forest cover of India has shrunk substantially. Moreover, the density of trees in the forests is very low as compared to the forests of other countries. Consequently, the natural habitat of wild animals are disappearing. The growing trade of furs of big cats and tiger bones has diminished their number. There is increasing demand of rhino-horns and deer musk which are used in medicines and aromatic substances. Moreover, due to the continuous hunting of wild animals and illegal poaching, the number of wild animals is decreasing day by day. Some of the species are on the verge of extinction. Asiatic lion, clouded leopard, tiger, musk-deer, rhinoceros, great Indian bustard, Nilgiri langur, python and vultures are the species in danger.

In order to conserve wildlife, the Government of India passed the Wildlife Protection Act in 1972. Large tracts in various parts of the country covering 1.56 lakh sq km—4.75% of the total area of the country—were declared as national parks, sanctuaries and biosphere reserves. At present, the number of national parks and sanctuaries has gone up to 89 and 490 respectively.

To increase the number of animals classified under endangered species, Project Tiger (1973), Crocodile Breeding Project (1975), Rhinoceros Project (1987), Snow-leopard Project, and Project Elephant (1988) have been launched.

National Park: A national park is a relatively large area of one or several ecosystems that are not being materially altered by human exploitation and occupation. Here, plant and animal species, geomorphological sites and habitats for special scientific education and recreation are preserved. The National Parks of India have been plotted in **Fig. 5.5** and some of the important national parks have been described in the following section:

Wildlife Sanctuary: Similar to a national park, a wildlife sanctuary is dedicated to protect wildlife and particular species. In a sanctuary, human activities are allowed, but in a national park human interference is totally prohibited.

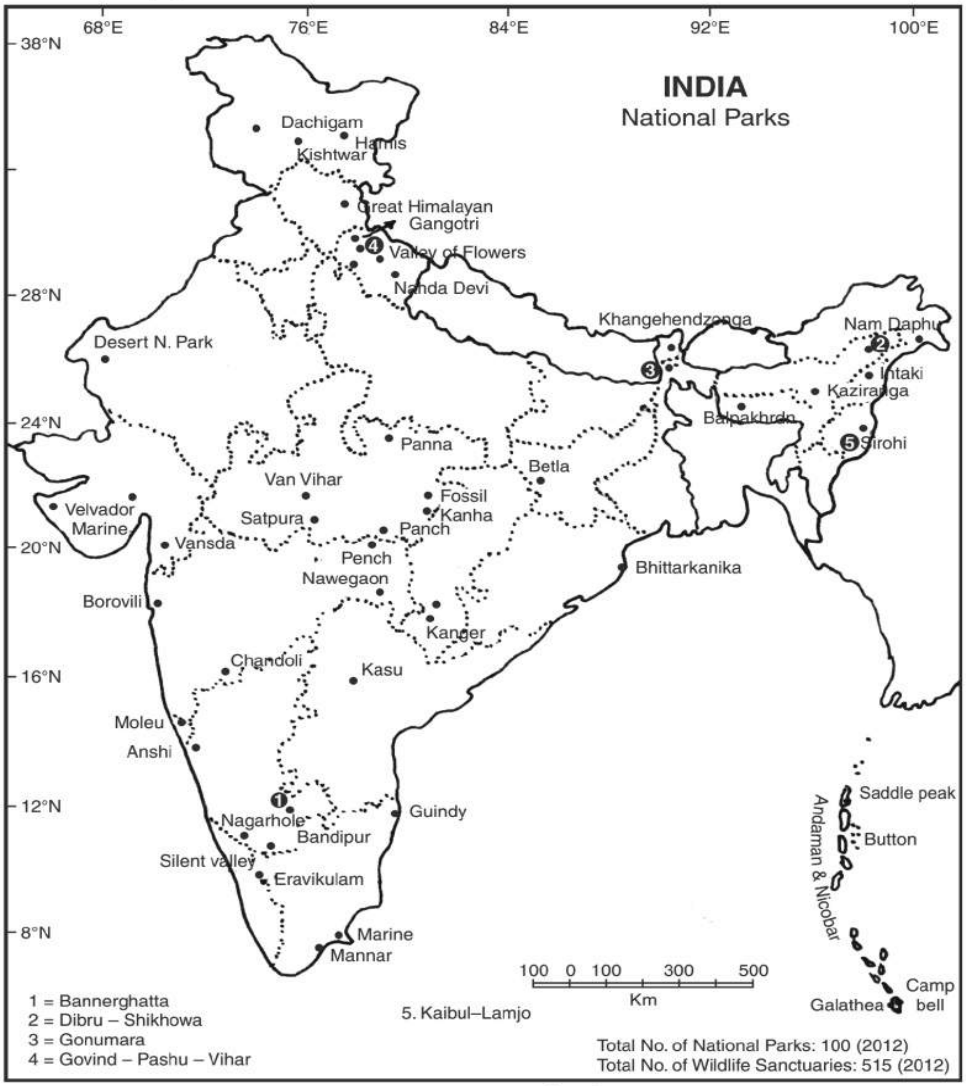

Fig. 5.5 National Parks

Tiger Reserves: Some of the important Tiger Reserves of India have been discussed in the subsequent pages. Their geographical distribution has been shown in **Fig. 5.6.**

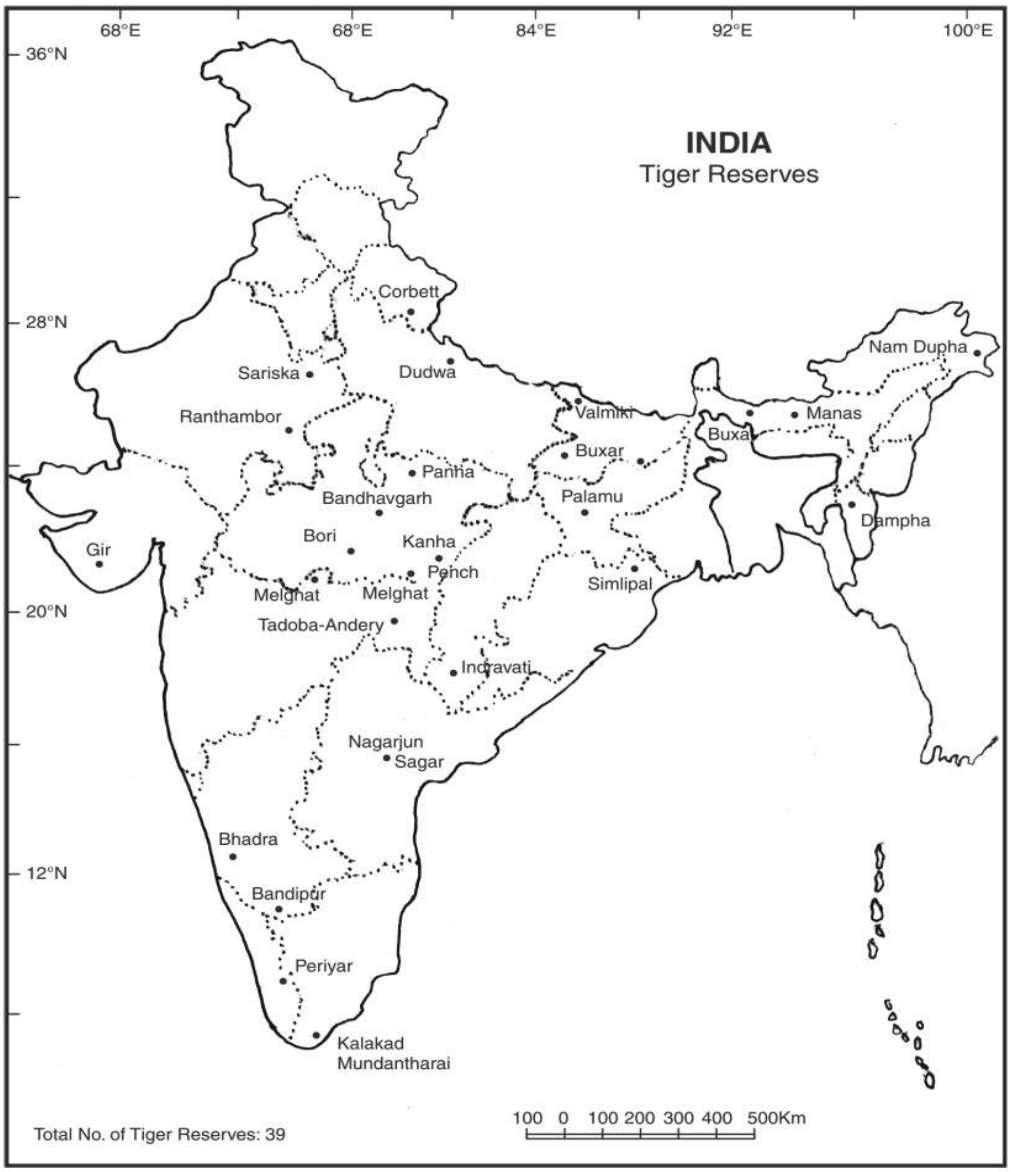

Fig. 5.6 Tiger Reserves

Biosphere Reserves

Biosphere reserves are areas of terrestrial and coastal ecosystems which are internationally recognised within the framework of UNESCO's *'Man and Biosphere (MAB) Programme'*. These reserves are required to meet a minimal set of criteria and adhere to a minimal set of conditions before being admitted to the *World Network of Biosphere Reserves* designated by the UNESCO. These reserves are rich in biological and cultural diversity and encompass unique features of exceptionally pristine nature. The scheme is a pioneering effort at pursuing the increasing difficult yet urgent task of conserving ecological diversity under mounting pressures.

The main objectives for the delineation of biosphere reserves are:

1. To conserve biological and cultural diversity and integrity of plants animals, birds, reptiles, micro-organisms and unique features of pristine nature.
2. To promote research on ecological conservation and other environmental aspects, and
3. To provide facilities for education, research, awareness and training.

The Biosphere Reserves Programme was initiated in India in 1986 and till date, 18 sites have been designated as Biosphere Reserves (BR) in different parts of the country. The names of the biosphere reserves of India have been given in **Table 5.1** and their locations have been shown in **Fig. 5.7.**

Table 5.5 *Biosphere Reserves of India*

	Biosphere Reserve	*Geographical Area in sq km*	*States*
1.	Nilgiri	5520	Tamil Nadu, Kerala, Kamataka
2.	Nanada Devi	5861	Uttarkhand
3.	Nokrek	0820	Meghalaya
4.	Manas	2837	Assam
5.	Sundarban	9630	West Bengal
6.	Gulf of Mannar	10,500	Tamil Nadu coast
7.	Great Nicobar	0885	Andaman and Nicobar Islands
8.	Simlipal	4,374	Odisha
9.	Dibru-Saikhowa	0765	Arunachal Pradesh
10.	Dehang-Debang	0512	Arunachal Pradesh
11.	Kangchendzonga	2620	Sikkim (Kanchenjunga)
12.	Panchmarhi	4928	Madhya Pradesh
13.	Agasthymalai	3500	Kerala
14.	Achanakmar Amarkantak	38351	Madhya Pradesh
15.	Kachchh	12,454	Gujarat
16.	Cold Desert	7555	Lahaul-Spiti and ladakh
17.	Sheshachalam	4500	Andhra Pradesh
18.	Panna	4100	Madhya Pradesh
	Total	1,19,712	

The programme was initiated in 1986 and till date, 18 sites have been designated as Biosphere Reserves in different parts of the country. Out of the 18 biosphere reserves, seven biosphere reserves have been included in the World Network of Biosphere Reserves so far. These 7 include: Sundarban, Gulf of Mannar, Nilgiri, Nanda Devi, Panchmarhi, Simlipal and Nokrek.

These biosphere reserves include:

1. Nilgiri, 2. Nokrek, 3. Nanda Devi, 4. Sundraban, 5. Gulf of Mannar, 6. Manas, 7. Great Nicobar, 8. Simlipal, 9. Dibru-Saikhova, 10. Dehang-Dibang, 11. Panchmarhi, 12. Kanchanjunga, 13. Agasthamalai, 14. Achanakamar, 15. Great Rann of Kachchh, 16. Cold Desert (Pin-Valley-H.P.), 17. Seshachalam (Andhra Pradesh), 18. Panna (M.P.).

Seven out of the 18 biosphere reserves are a part of the World Network of Biosphere Reserves, based on the UNESCO Man and Biosphere Programme List. Their names are: 1. Nilgiri, 2. Sundarban, 3. Gulf of Mannar, 4. Nanda Devi, 5. Kokrek, 6. Panchmarhi, and 7. Simplipal.

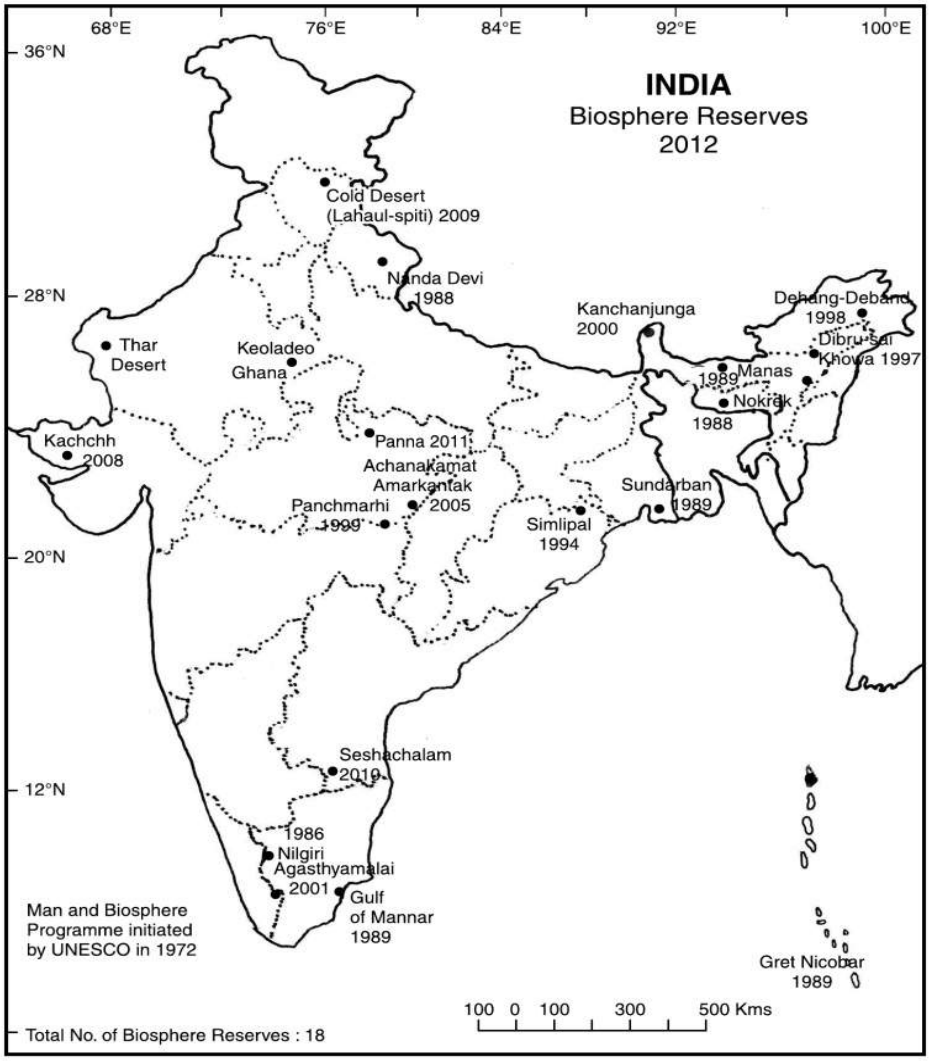

Fig. 5.7 Biosphere Reserves

MANGROVES

Mangroves are large flowering shrubs or trees that grow in dense thickest forests along muddy or silty tropical coasts. According to the latest assessment mangrove covers 4639 sq. km or 0.14 per cent of the geographical area of the country. The government of India has identified 28 mangrove areas. The statewise distribution of mangroves has been given in Table: 5.6.

Table 5.6 *Mangroves in India*

S.No.	*Mangrove*	*State/Union Territory*
1.	Bhitarkanika	Odisha
2.	Coondapur	Kamataka
3.	Goa	Goa
4.	Godavari Delta	Andhra Pradesh
5.	Gulf of Kachchh	Gujarat
6.	Krishna Delta	Andhra Pradesh
7.	Loringa	Andhra Pradesh
8.	Mahanadi Delta	Odisha
9.	North Andaman and Nicobar	Andman & Nicobar Islands
10.	Piahavaram	Tamil Nadu
11.	Point Collimere	Tamil Nadu
12.	Sundarban	West Bengal

Source: India 2012

Coral Reefs

The four major coral reef areas identified for intensive conservation and management are: (i) Gulf of Mannar, (ii) Gulf of Kachchh, (iii) Lakshdweep, and (iv) Andaman and Nicobar Islands.

Wetlands (Ramsar Convention)

The convention on wetlands (Ramsar-lran, 1971) - called the 'Ramsar Convention' is an intergovernmental treaty that embodies the commitment of its member countries to maintain the ecological character of their wetlands of international importance and to plan for the 'wise-use' or sustainable use.

Any wetland to be declared a wetland of international importance should support vulnerable, endangered or threatened species and attract more than 20.00 water birds.

In India, the scheme on conservation and management of wetlands was initiated in 1987. Over the years, based on the recommendations of National Wetlands Committee 115 wetlands have been identified for conservation under the programme. The main wetlands which have been included in the Ramsar List are given in Table.5.7.

Table 5.7 *India-Wetlands included in Ramsan List*

SI.No.	*Name*	*Area (Km^2)*
1.	Ashtamudi Wetland, Kerala (19 08/02)	614
2.	Bhitarkanika Mangroves, Odisha (19/08/02)	650
3.	Bhoj Wetland, Madhya Pradesh (19/08/02)	32
4.	Chandeital Wetland, Himachal Pradesh (08/11/05)	49
5.	Chilika Lake, Odisha (01/10,81)	1165
6.	Deepor Beel, Assam (19/08/02)	40
7.	East Calcutta Wetlands, West Bengal (19/08/02)	125
8.	Harike Lake, Punjab (23/03/90)	41
9.	Hokera Wetland, Jammu and Kashmir (08/11/05)	13.75
10.	Kanjli, Punjab (22/01/02)	1.83
11.	Keoladeo National Park, Rajasthan (01/10/81)	28.73
12.	Kolleru Lake, Andhra Pradesh (19/08/02)	901
13.	Loktak Lake, Manipur (23/03/90)	266
14.	Point Calimere Wildlife and Bird Sanctuary, Tamil Nadu (19/08/02)	385
15.	Pong Dam Lake, Himachal Pradesh (19/08/02)	156.62
16.	Renuka Wetland, Himachal Pradesh (08/11/05)	2
17.	Ropar, Punjab (22/01/02)	13.65
18.	Rudrasagar Lake, Tripura (08/11/05)	2.4
19.	Sambhar Lake, Rajasthan (23/03/90)	240
20.	Sasthamkotta Lake, Kerala (19/08/02)	3.73
21.	Surinsar –Mansar Lakes, Jammu and Kashmir (08/T1/05)	3.5
22.	Tsomoriri, Jammu and Kashmir (19/08/02)	120
23.	Upper Ganga River (Brijghat to Narora Stretch), Uttar Pradesh (08/11/05)	265.9
24.	Vembanad-Kol Wetland, Kerala (19/08/02)	1512.5
25.	Wular Lake, Jammu and Kashmir (23/03/90)	189

Strategy for the Conservation of Wildlife

The following steps can go a long way in the conservation of wildlife:

(i) Hunting should be strictly prohibited in the national parks, sanctuaries, tiger reserves and biosphere reserves.

(ii) Poachers and herdsmen should not be allowed to enter the reserved parks and sanctuaries.

(iii) More national parks and wildlife sanctuaries should be established.

(iv) The existing national parks and sanctuaries should be further developed by providing more infrastructural facilities.
(v) Captive breeding of wildlife should be encouraged.
(vi) Adequate medical facilities should be provided in the national parks and sanctuaries for the treatment of wildlife.
(vii) Conducive habitat and environment should be created for living and breeding in the national parks and sanctuaries.
(viii) Seminars, conferences, workshops and exhibitions should be organised in national parks and sanctuaries to improve general awareness among caretakers about wildlife.
(ix) All the degraded forest land should be taken up for afforestation.
(x) The marginal lands that are not suitable for crop production should be brought under social forestry to increase the ecosystems and habitats for wildlife.

WESTERN GHATS: A WORLD HERITAGE SITE

Western Ghats has been included in the UNESCO World Heritage List in the meeting of the World Heritage Committee held at St. Petersburg in Russia on 1st July, 2012.

The Western Ghats has "outstanding examples representing significant ongoing ecological and biological processes in the evolution and development of terrestrial, freshwater, coastal and marine ecosystems and communities of plants and animals. It is also the most significant natural habitat for in-situ conservation of biological diversity, including those containing threatened species of outstanding universal value from the point of view of science and conservation. Apart from the World Heritage Site, it is one of the eight hottest **hot spots** of biological diversity in the world.

The Western Ghats or the Sahyadri is a mountain ranee sec *'re western* see of the Peninsular India. It separates the Deccan Plateau from the narrow coastal plain along the Arabian Sea **(Fig.5.8).**

The Western Ghats starts south of the Tapi river in Gujarat and runs about 1600 km through the states of Maharashtra, Goa, Karnataka, Tamil Nadu and Kerala ending at Kanniyakumari, at the southern tip of India.

The main peaks of the Western Ghats are: Anaimudi (2695m), Doddabetta (2636m), Mukurthi (2554m), Kodaikanal (2133m), Bababudangiri (1895m), Kudremukh (1894m), Agasthymalai (1866m), Pushpagiri (1712m), Kalsubai (1646m), and Salher (1567m). The important hill stations of Ooty (2500m) and Kodaikanal (2285m) are also located in the Western Ghats.

The area has 5000 species of flowering plants, 139 mammal species, 508 bird species and 179 amphibian species. According to one estimate 325 globally threatened species occur in the Western Ghats.

The Western Ghats are covered with the tropical and subtropical forests that provide food and natural habitats for the native tribal people. The area is ecologically sensitive to development. The Government of India has established many protected areas including 2 biosphere reserves, 13 national parks and several wildlife sanctuaries to protect specific endangered species. The Nilgiri Biosphere Reserve (5500 sq.km) of the evergreen forests of Nagarhole, the Bandipur National Park covered with deciduous forest, the Mudumalai National Park and the Mukurthi National Park in the states of Kerala and Tamil Nadu are the other important protected areas. A judicious use of resources and conservation practices can improve the resilience characteristics of the ecosystems of this important world heritage site.

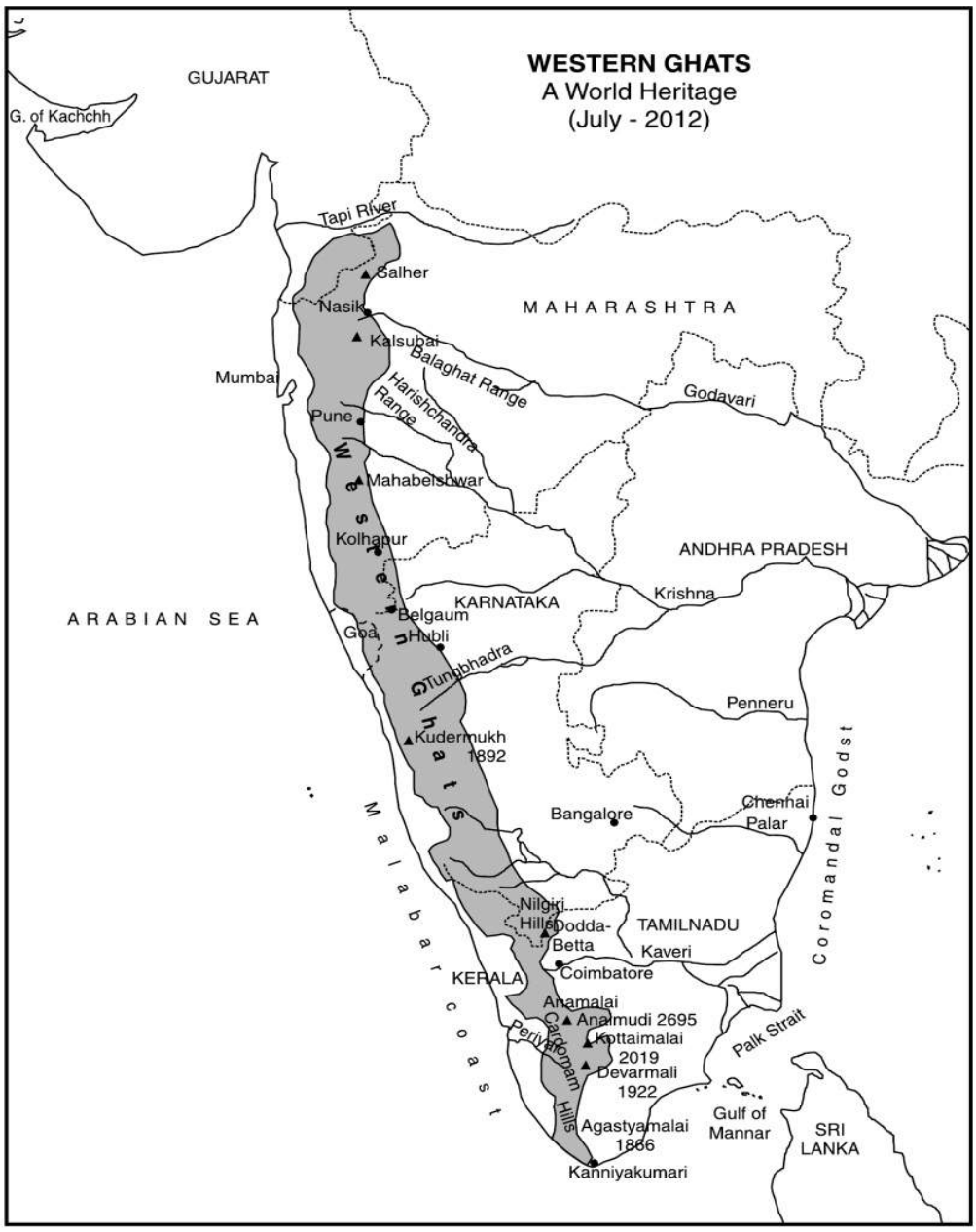

Fig. 5.8 Western Ghats: A World Heritage Site (UNESCO)

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