Transitions to Sustainable Forest Management and Rehabilitation in Asia–Pacific Region – India

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CONTENTS

1	**BRIEF PROFILE OF INDIA**		**1**
1.1	Introduction		1
1.2	Polity and Governance		1
	1.2.1	Historical Perspective	1
	1.2.2	After Independence	2
1.3	Geography and Climate		3
	1.3.1	Geography	3
	1.3.2	Climate	4
	1.3.3	Geology and Soil	5
	1.3.4	Diverse Climatic Regions	5
1.4	Flora and Fauna		8
	1.4.1	Biodiversity Hotspots	9
	1.4.2	Floral Diversity	9
	1.4.3	Faunal Diversity	10
	1.4.4	Bio-Geographical Zones	11
1.5	Land Use Classification		12
	1.5.1	Current Land Utilization	13
	1.5.2	Land Use Pattern in India	14
	1.5.3	Land Use Change in India after 1950	15
1.6	Land Tenure Arrangement		16
	1.6.1	Ryotwari System	16
	1.6.2	Zamidari System	16
	1.6.3	Mahalwari System	16
1.7	Gross Domestic Product and other Economical Factors		17
	1.7.1	Agricultural Production	19
	1.7.2	Agricultural Productivity	20
	1.7.3	Livestock Population	20
1.8	Population and other Social Factors		21
	1.8.1	Population Growth	21
	1.8.2	Rural Population and Migration to Urban Areas	22
	1.8.3	Population Density	22
	1.8.4	Literacy Rate	22
	1.8.5	Life Expectancy	23
1.9	Environmental Concerns in India		24
1.10	Conclusion		27
2	**FORESTS AND FORESTRY IN INDIA**		**28**
2.1	Extent of Forests and their Classification in India		28
2.2	Forest Classification and Forest Types of India		29
2.3	Historical Background		31
	2.3.1	The Forest Charter of 1855	32
	2.3.2	The Indian Forest Act, 1865 (amended in 1878)	33
	2.3.3	The First Forest Policy of 1894	33
	2.3.4	The Indian Forest Act of 1927	33
2.4	The Forest Governance in Independent India		34
	2.4.1	The Forest Policy of 1952	34
	2.4.2	The National Commission on Agriculture and its Interim Report in 1972	34
	2.4.3	Wildlife (Protection) Act 1972 and its Implementation	35
	2.4.4	Forest Conservation Act, 1980	35
	2.4.5	National Forest Policy of 1988	35
	2.4.6	Joint Forest Management Circular of 1990	35
	2.4.7	Panchayat (Extension to Scheduled Areas) Act (or PESA), 1996 (PESA Act 1996)	35
	2.4.8	Forest Rights Act 2006	36
2.5	Forestry Administration in India		36
2.6	Scientific Management of Forests in India		37

2.7	Development of Forest Resources : Schemes and Funding		38
	2.7.1	Social Forestry	38
	2.7.2	National Afforestation Programme (NAP)	38
	2.7.3	Preservation of Wildlife and Forest Biodiversity	39
	2.7.4	Integrated Development of Wildlife Habitats	39
	2.7.5	Project Tiger	39
	2.7.6	Project Elephant	39
	2.7.7	National Rural Emplyment Guarantee Act (NREGA)	40
	2.7.8	Compensatory Afforestation Fund Management and Planning Authority (CAMPA)	40
	2.7.9	Green India Mission (GIM)	40
2.8	Extraction of Forest Products from Indian forests		41
	2.8.1	Production and Consumption of Timber	41
	2.8.2	Consumption and Production of Fuelwood	42
	2.8.3	Non-Wood Forest Products (NWFP)	43
	2.8.4	Resin	43
	2.8.5	Bamboo	43
2.9	Forest Product Processing and Marketing		44
2.10	Economic Aspects of Forests in India		44
	2.10.1	Valuation of Benefits of Forests	44
	2.10.2	Economic Contribution to GDP	46
2.11	Social Contribution of Forests in India		46
2.12	Import of Wood		48
2.13	Conclusion		49
3	**HISTORICAL REVIEW OF FOREST COVER CHANGE AND THEIR DRIVERS IN INDIA**		**50**
3.1	Introduction		50
3.2	Forests as Land Use		51
3.3	Forest Cover Assessment and Historical Trend		52
3.4	Forest Cover Changes of Recent Past by Forest Survey of India		53
3.5	Variation and Discrepancy in data on Forest Cover by FAO and FSI		81
3.6	Forest Cover Change at national level		81
3.7	Density Class		82
3.8	Conclusion		84
4	**FOREST TRANSITION IN INDIA AND ITS MAJOR DRIVERS**		**85**
4.1	Introduction		85
4.2	Forest Transition		85
4.3	Drivers to Forest Deforestation and Degradation		86
	4.3.1	People's Dependence on Forests	89
	4.3.2	Shifting Cultivation	89
	4.3.3	Forest Fire and Other Natural Calamities	91
4.4	Key points leading to Afforestation and Forest Rehabilitation		91
	4.4.1	Forest Plantations	91
	4.4.2	Demand and Supply of Wood: Farm Forestry and Agroforestry	94
	4.4.3	Joint Forest Management and Rehabilitation	96
4.5	Key legal and policy milestones leading to Conservation and Sustainable management of forests in India		97
4.6	Conclusion		100
5	**UNDERSTANDING FOREST TRANSITION IN INDIA**		**101**
5.1	Introduction		101
5.2	The Historical Dynamics of Transition		101
	5.2.1	Stages of Development and Forest Transition in India	102
5.3	The Environmental Kuznets Curve (EKC) and Forest Transition in India		104
5.4	Policy and Legal Historical Framework		105
5.5	Economic Parameters		106
5.6	Social Parameters		109
5.7	Econometric Analysis		110

5.8 A Comprehensive Forest Transition Cluster Model for India 111
5.9 Conclusion 116

6 FORESTS AND FOREST TRANSITION IN FUTURE 117
6.1 Introduction 117
6.2 Forests 117
6.3 Climate Change and Forest Sector as Potential Mitigation Option 119
6.4 Forest Transition in Future 120
6.5 Possible Paradigm Shifts in Forest Management and Associated Policy Shifts and their Implementation 121
6.6 Conclusion 124

REFERENCES 125

APPENDIX 130

1 BRIEF PROFILE ABOUT INDIA

1.1 Introduction

India is a democratic republic with unique culture and old traditions of wise use of natural resources as embodied in the hymn about mother earth in Atharvaveda –"What of thee I dig out let that quickly grow over let me not hit thy vitals". India is known for its rich natural resources and large rural population who are intrinsically close to traditional values. It has rich biodiversity, diverse climate and varied land use pattern. India, the seventh largest country in area with 2.4% (328.72 mil ha) of the geographic area of the world, accounts for 1.8 % of world forests, but contributes 17.5 % (1210 Million) of world population. The population density of the country is 382 persons per Km^2 approximately (Census of India 2011). There is high demand for, and huge pressure on land and forest resources. The strength and resilience of the diversified forest resources of India can be ascribed to favourable and varied climatic and geological conditions as evident from 35 agro-meteorological regions, 15 agro-climatic zones, 20 agro-ecological regions and 10 bio-geographical zones, the country has been classified on the basis of diverse climatic conditions, topography, soil types etc.

1.2 Polity and Governance

Polity and governance has been quite supportive towards management and rehabilitation of forests in India. A brief profile of historical and present day polity and governance is given in this section so as to familiarize the readers with Indian conditions. The supportive role played for rehabilitation of Indian forests will be explained in subsequent chapters.

1.2.1 Historical Perspective

The process of development of civilization began in India much before the migration of the Aryans, which took place between 1500 and 2500 BC. The Indus valley civilizations of Mohenjodaro, Harappa and Channudaro in Sindh, Punjab and Rajputana (the territory extending on either side of the international line dividing present day Pakistan and India) dates back to between 4000 and 5000 BC in north India. There is also evidence of a thriving Dravidian civilization existing deep in the south about 2000 BC. The relics of the Dravidian civilization still exist. They were the tribal communities of central and south India. The Aryans were semi-nomadic, pastoral people who first settled down in Punjab and later moved eastwards and spread all over the Gangetic plains. Being lovers of nature, Aryans worshipped the sun, the water, the fire, etc. There were six religious books, namely The Vedas (Rig Veda, Sama Veda, Yajur Veda, Artharva Veda), The Upanishads, The Brahmanas, The Aranayakas, Manu Smriti and The Puranas of the Aryans which reveal their beliefs, customs, culture, social life, philosophy, political framework, science and medicine etc. Before Chandra Gupta Maurya established a relatively big empire about 300 BC the territory in the country was divided among various rulers whose reigns extended to small geographical units. They were far too occupied fighting wars against each other, to evolve any pattern of resource management in their kingdoms. Kautilya , also known as Chanakya, a monister of Chandragupta, wrote the Arthashastra, a treatise on statecraft. Megasthenes was a Greek ambassador to Chandrgupta, court who wrote the Indica detailing the Maurya dynasty. Then came the Golden Age of ancient India under the Gupta dynasty and the Gupta Empire was known for peace and prosperity. The Gupta Empire ended in 673 AD, and the country reverted back to the situation, which prevailed prior to the establishment of the Maurya kingdom. The country was again, divided into small states which perpetually fought with each other. The political instability caused by the local conflicts was aggravated by repeated Muslim invasions from the west and it prevailed in the country for over nine centuries that elapsed between the fall of the Gupta dynasty in the later years of the seventh century and the consolidation of the Mughal Empire by Akbar about the close of the sixteenth century. Invasion by Nadir Shah, a Persian king in 1739 broke up the Mughal Empire and the East India Company taking full advantage of the situation first captured Bihar and Bengal by 1764 and India came under the direct governance of the Crown of England in 1858. In accordance with the Indian Independence act, 1947, enacted by British Parliament, India was partitioned into India and Pakistan on 15 August 1947.

1.2.2 After Independence

The constituent assembly adopted the new Constitution of India on 26 November 1949 and the written Constitution is in force since 26 January 1950 onwards, to secure to all its citizens justice, social, economic and political; liberty of thought, expression, belief, faith, and worship; equality of status and of opportunity; and to promote among all fraternity assuring the dignity of the individual and the unity and integrity of the Nation. As per the constitution, India, a Union of States, comprising 29 states and 6 union territories (Table 1.1), is proclaimed a Sovereign Socialist Secular Democratic Republic with federal form of government like United States and Westminster-style parliamentary system. However, the federal government in India has greater power in relation to its states, which is similar to that in the British parliamentary system.

Table 1.1. The States in Union of India and their basic Statistics at 2012.

State or Union territory	Capital	Geo. Area (GA) mil ha	Population	Population density	Representation		Forest Area as % of GA
					Lok sabha	Rajya sabha	
Andhra Pradesh	Hyderabad	27.51	84,665,533	308	42	18	23.20
Arunachal Pradesh	Itanagar	8.37	1,382611	17	2	1	61.55
Assam	Dispur	7.84	31,169,272	397	14	7	34.21
Bihar	Patna	9.42	103,804,637	1,102	40	15	6.87
Chhattisgarh	Raipur	13.52	25,540,196	189	11	5	44.21
Goa	Panaji	0.37	1,457,723	394	2	1	33.06
Gujarat	Gandhinagar	19.60	60,383,628	308	26	11	9.66
Haryana	Chandigarh	4.42	25,353,081	573	10	5	3.53
Himachal Pradesh	Shimla	5.57	6,856,509	123	4	3	66.52
Jammu & Kashmir	Srinagar	22.22	12,548,926	56	6	4	9.10
Jharkhand	Ranchi	7.97	32,966,238	414	14	6	29.61
Karnataka	Bengaluru	19.18	61,130,704	319	28	12	19.96
Kerala	Thiruvananthapuram	3.89	33,387,677	859	20	9	28.99
Madhya Pradesh	Bhopal	30.82	72,597,565	236	29	11	30.72
Maharashtra	Mumbai	30.77	112,372,972	365	48	18	20.13
Manipur	Imphal	2.23	2,721,756	122	2	1	78.01
Meghalaya	Shillong	2.24	2,964,007	132	2	1	42.34
Mizoram	Aizawl	2.11	1,091,014	52	1	1	79.30
Nagaland	Kohima	1.66	1,980,602	119	1	1	55.62
Odisha	Bhubaneswar	15.57	41,947,358	269	21	10	37.34
Punjab	Chandigarh	5.04	27,704,236	550	13	7	6.12
Rajasthan	Jaipur	34.22	68,621,012	201	25	10	9.54
Sikkim	Gangtok	0.71	607,688	86	1	1	82.31
Tamil Nadu	Chennai	13.01	72,138,958	555	39	18	17.59
Tripura	Agartala	1.05	3,671,032	350	2	1	60.02
Uttar Pradesh	Lucknow	24.10	199,581,477	828	81	31	6.88
Uttarakhand	Dehradun	5.35	10,116,752	189	5	3	64.79
West Bengal	Kolkata	8.88	91,347,736	1030	42	16	13.38
A & N Islands	Port Blair	0.83	379,944	46	1	-	86.93
Chandigarh	Chandigarh	0.01	1,054,686	9,252	1	5	29.82
Dadar & Nagar Haveli	Silvassa	0.05	342,853	491	1	-	41.55
Delhi	Delhi	0.15	16,753,235	9,340	7	3	5.73
Daman & Diu	Daman	0.01	242,911	112	1	-	7.38
Lakshadweep	Kavaratti	0.003	64,429	2,013	1	-	0.00
Puducherry	Puducherry	0.05	1,244,464	2,598	1	1	2.71

The national government has the power to dismiss state governments under specific constitutional clauses or in case no majority party or coalition is able to form a government. The central government can also impose direct federal rule known as president's rule (or central rule). The central government exercises its broad administrative powers in the name of the President, whose duties are largely ceremonial. The president and vice president are elected indirectly for 5-year terms by a special electoral college. The vice president assumes the office of president in case of the death or resignation of the incumbent president. India's bicameral parliament consists of the Rajya Sabha (Council of States) and the Lok Sabha (House of the People). Members of Lok sabha are elected directly by the voters of the each constituency under universal adult franchise. Membership of Rajya Sabha is limited to 250 members, 12 of whom are nominated by the President of India for their contributions to art, literature, science, and social services and the remainder of the body is elected by the state and union territorial legislatures. Real national executive power is centred in the Council of Ministers, led by the Prime Minister. The President appoints the Prime Minister, who is designated by legislators of the political party or coalition commanding a majority in Lok Sabha (House of the People). The President then appoints subordinate ministers on the advice of the Prime Minister. In reality, the President has no discretion on the question of whom to appoint as Prime Minister except when no political party or coalition of parties gains a majority in the Lok Sabha. Once the Prime Minister has been appointed, the President has no discretion on any other matter whatsoever, including the appointment of ministers. Similarly, states in India have their own elected governments, whereas Union Territories are governed by an administrator appointed by the president. The states' chief ministers are responsible to the state legislatures in the same way the prime minister is responsible to parliament. Each state has a presidentially appointed governor who may assume certain broad powers when directed by the central government. The central government exerts greater control over the union territories than over the States, although some territories have gained more power to administer their own affairs. Local state governments in India have less autonomy compared to their counterparts in the United States.

The constitution provides for directive principles of state policy which are “fundamentals in governance of the country” and it is the duty of the government to apply these principles in making laws. The constitution also provides for organization of village panchayats to enable them to function as units of self-government under Panchayati Raj System. It also contains provision for separation of judiciary and the executive; protection of national monuments; promotion of justice on a basis of equal opportunity; protection and improvement of environment and safeguarding of forest and wildlife of the country and promotion of international peace and security. Both the Union (Federal) and State (Provincial) houses of legislation have well defined and exclusive powers over subjects enumerated in the constitution. There are certain subjects in concurrent list which are controlled by the Union (Federal) and State (Provincial) houses and or governments. Till 1976, the subject of forests was in the state list and it was transferred to the concurrent list by the constitutional amendment to ensure uniform policy and management in the country.

1.3 Geography and Climate

The geographical and climatic conditions are described in subsequent sub sections which are self explanatory to present the uniqueness of Indian subcontinent and diverse conditions prevailing in different parts of the country. Geography and climate together constitute conditions for existence of different forest types in India, which are described in next chapter.

1.3.1 Geography

India is situated in the northern hemisphere between 8°4' and 37°6' N latitude and 68°7' and 97°25' E longitude measuring 3,214 km from north to south and 2,933 km from east to west. It has a land frontier of 15,200 km and a coastline of 7,517 km. The northern frontiers of India are defined largely by the Himalayan mountain range, where the country borders China, Bhutan, and Nepal. Its western border with Pakistan lies in the Punjab Plain and the Thar Desert. On the south, India projects into and is bounded by the Indian Ocean – in particular, by the Arabian Sea on the southwest and the Bay of Bengal on the southeast. The Palk Strait and Gulf of Mannar separate India from Sri Lanka to its immediate southeast, and the Maldives are some 400 kilometres to the southwest. India's Andaman and Nicobar Islands, some 1,200 km southeast of the mainland, share maritime borders with Burma, Thailand and Indonesia. In the far northeast, the deeply forested mountainous regions of the Chin Hills

and Kachin Hills, separate India from Burma. On the east, its border with Bangladesh is largely defined by the Khasi Hills and Mizo Hills.

1.3.2 Climate

Predominately a country of tropical zone, India exhibits a variety of climatic conditions. India can be categorized into four major topographic zones viz.

1. The mighty and sprawling 2400 km long Himalayan Mountain ranges in the north with alpine deserts, permanent glaciers (sources of numerous perennial rivers), large tracts of coniferous and broad - leaved forests and fertile valleys.
2. South of the Himalayas is the flat and fertile basin of Indo-Gangetic plains from Brahmaputra in the east to Indus in the west intervened in the middle by vast Gangetic delta which is also most densely populated portion of the country.
3. The Great Thar Desert in the West consists of areas from the States of Rajasthan, Gujarat, Haryana and Punjab.
4. The Highland of Deccan Plateau in the South covered by hill ranges of Eastern and Western Ghats and also by a long coast line of Bay of Bengal, Indian Ocean and Arabian sea.

The Himalayan region itself exhibits a whole range of climates from tropical or sub tropical at the base of foot hills to the alpine or arctic conditions prevailing at the higher altitude. The summer in the dry and centre of the country is extremely severe when compared to the heavy rainfall areas near the southern tip of the peninsula or of Andaman & Nicobar Islands in the Bay of Bengal, which are close to the equator. There is hardly any distribution between summer and winter in these southern most areas of the country as the climate is mild and equable throughout the year. There are four distinct and well marked seasons in the mainland.

- Winter season from December – February
- Summer season spanning four months from March–June
- South West monsoon season from July– September
- The post monsoon season during October – November

The Table 1.2 gives the monthly minimum, maximum and average temperature along with average rainfall of India.

Table 1.2. Average Temperature and Rainfall of India.

	Temperature (°C)			Average Rainfall
Month	**Minimum**	**Maximum**	**Average**	**(mm)**
January	7	21	14	25
February	10	24	17	22
March	15	30	23	17
April	21	36	29	7
May	27	41	34	8
June	29	40	35	65
July	27	35	31	211
August	26	34	30	173
September	25	34	30	150
October	19	33	26	31
November	12	29	21	1
December	8	23	15.5	5

Source: http://www.india.climatemps.com/

Most of the precipitation (80%) in the country is received through South-West monsoon. India receives one and half times of the world's average rainfall per sq. km of area. There is great variation in precipitation among different regions of the country. There are regions of heavy rainfall with precipitation of over 2500 mm in Western Ghats in the south, Himalayas in the north and sub-montane areas of West Bengal, Arunachal Pradesh, Assam and Meghalaya in the east. The winds blowing over the Arabian Sea in the west cause heavy precipitation along the Western Ghats. But the air currents

sweeping for about 1600 km over the hot plains of west and North-West are unable to shed their moisture till they hit the Himalayas. Hence, there is a prevailing desert condition in the north western part, i.e. Rajasthan, part of Gujarat, Haryana and Punjab where the annual rainfall may be as low as 100 mm.

Temperature also greatly varies in the diverse land mass owing to its variegated physical features. Altitudinal variations, humidity and proximity to sea shore exert a greater influence on the range of temperatures than the effect of mere nearness to the equator. The temperatures may go up to 49°C in the deserts approximately around 26°N latitude while in Kerala and Andaman Nicobar islands which are much closer to the equator the temperatures rarely goes above 35°C.

Frost is the peculiar feature of the western Gangetic plain of the sub Himalayan region limiting the extension of frost tender forest species (e.g. Teak) snowfall in the Himalayas is, again, a dominant feature in the siliviculture of some trees (e.g. Deodar). The diurnal range of temperature as well as the annual range exerts great influence on vegetation. Similarly snowfall, humidity, number of rainy days, presence of clouds, the play of seasonal hot dry winds, slope, aspect, explosion and shelter– all have an importance in the distribution of species and forest types.

1.3.3 Geology and Soil

Consistent with its geological and geographical diversity, India has a wide range of soils, specific to each locality. Peninsular India is an ancient land mass which owes its present features to denudation and weathering over long ages. Deccan Trap which occupies some 25.9 mil ha of considerable importance as a geological feature. Covering an extensive region of the Deccan peninsula this underlying trap (or basaltic lava) has given rise to the typical black soil commonly known as black cotton soil, which is made up of fine clay with high content of minerals. It swells up when wet and on drying, exposes large cracks. Red soils are of wide occurrence in Peninsular India, especially in areas occupied by granitic rocks, the particular shade of red being dependent on the extent of diffusion of their iron content. There is a vast chunk of desert soil in the western part of the country which is less suitable or not suitable at all for agriculture. The Himalayan range on the other hand is a region of comparatively young age with a steep and rugged terrain and a network of youthful and torrential streams and rivers which are still actively eroding their courses. The great Ganga – Brahmaputra Plain is located between the two large geological features i.e. the Deccan Peninsula and the Great Himalayas. The soils of these plains are composed of sediments of silt and sand deposited by the strong network of perennial river systems. This, however, is too simple a division of the main geological region of this great sub-continent. Each big tract of the country has its own sub regions which have uniform characteristics amongst themselves and support unique natural vegetation which are easily distinguishable from others. A typical example from Himalayan foot hills in North supporting moist deciduous *Shorea robusta* (Sal) forests is mentioned as under:

1. The Shivalik system of hills of coarse sand stone and clay forming the foothills of the Himalayan range
2. The Bhabhar tract which fringes the foot hills and is an accumulation of coarse and porous materials like boulders, shingle etc., through which rain and river water rapidly drains down.
3. The Terai belt, occurring at lower elevation with alluvial soil where water that seeps into Bhabhar emerges out with a force, occasionally creating artesian wells.

These sub-regions support different forest sub types such as moist siwalik sal, moist bhabar sal and moist terai sal forests.

1.3.4 Diverse Climatic Regions

Diverse climatic conditions prevailing in the country present different agro-climatic zones and agro-ecological zones. A brief description is presented below to appreciate the diverse climatic conditions supporting varied vegetations in different parts of the country.

1.3.4.1 Agro–Climatic Regions

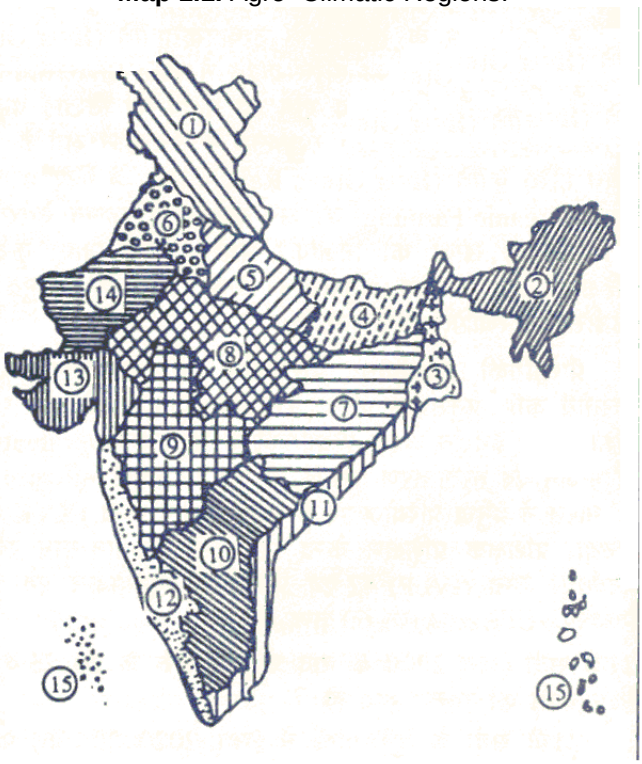
India has been divided into 15 agro-climatic zones on the basis of climate, in combination with soil and other factors that affect the agriculture in the region. This classification was developed in 1979 by the Indian Council of Agricultural Research (ICAR) through the National Agricultural Research Project (NARP). These are given in Table 1.3.

Table 1.3. Agro-Climatic Regions of India.

	Agro-Climatic Region		Agro-Climatic Region
1.	Western Himalayan Region	2.	Eastern Himalayan Region
3.	Lower Gangetic Plains Region	4.	Middle Gangetic Plains Region
5.	Upper Gangetic Plain Region	6.	Trans Gangetic Plains Region
7.	Eastern Plateau and Hill Region	8.	Central Plateau and Hill Region
9.	Western Plateau and Hill Region	10.	Southern Plateau and Hill Region
11.	East Coast Plains and Hill Region	12.	West Coast Plains and Ghat Region
13.	Gujarat Plains and Ghat Region	14.	Western Dry Region
15.	Island Region		

Source: Databook 2008, ISARI

Map 1.1. Agro–Climatic Regions.



Source: Planning Commission

1.3.4.2 Agro–Ecological Regions

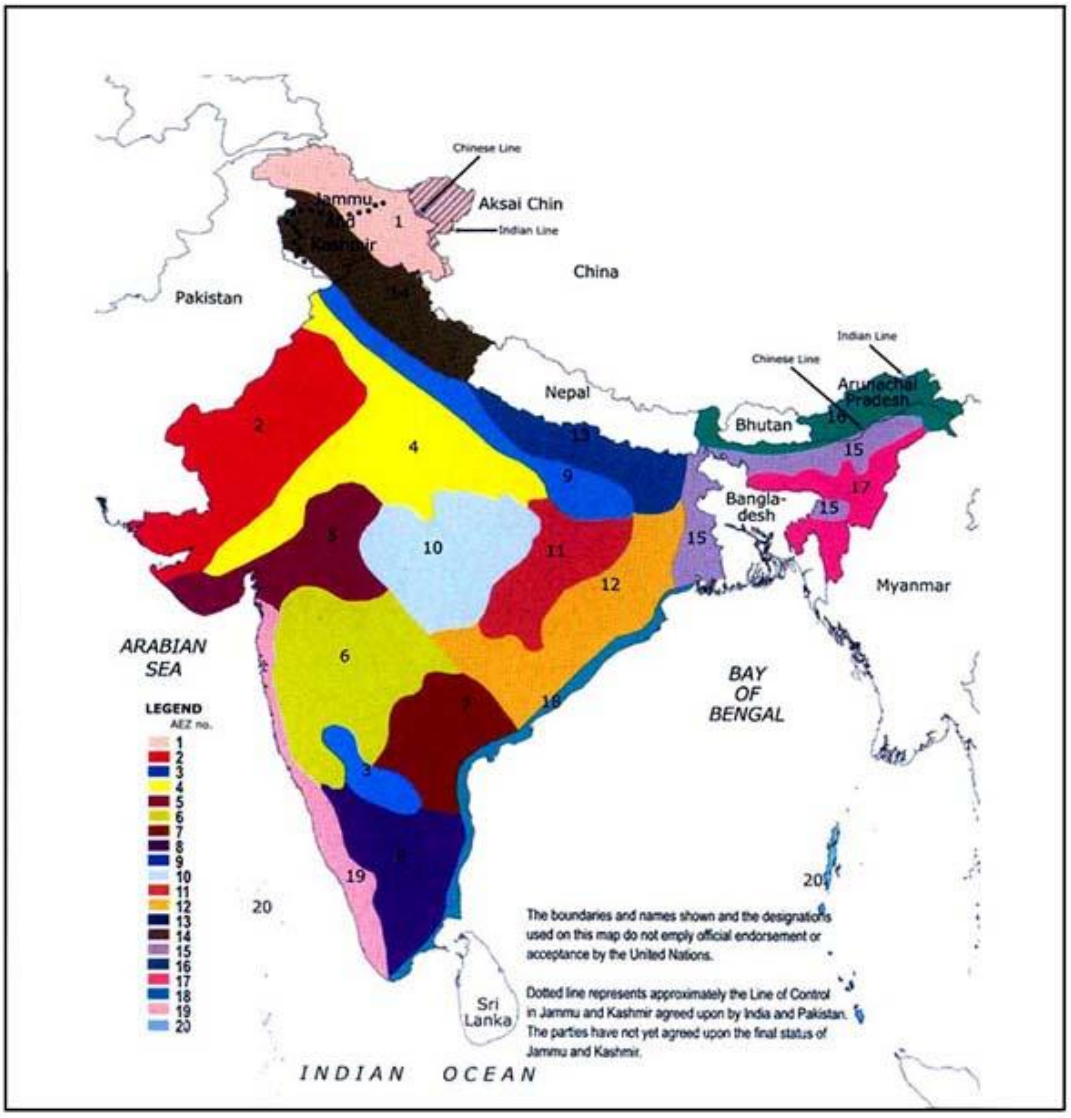
The country has also been categorised into 20 Agro-Ecological Regions on a 1:4 million scale map, based on the "Bio-climate" parameters (rainfall, temperature, vegetation, potential evapo-transpiration), "Length of the Growing Period" (LGP) parameters (rainfall, potential evapo-transpiration, soil storage) and "Soil or Landscape." parameters (soils and physiography) by National Bureau of Soil Science and Land Use Planning (NBSS&LUP). The mapping and classification of the various parts of the country for generation of agro-ecological regions involved the superimposition of four base maps, namely physiography, soils, bio-climate and length of growing period and have been used for resource planning at national level. These agro-ecological regions are given in Table 1.4.

Table 1.4. Agro–Ecological Regions of India.

	Agro–Ecological Regions		**Agro–Ecological Regions**
1	Cold arid eco-region with shallow skeletal soils	2	Hot arid eco-region with desert and saline soils
3	Hot arid eco-region with red and black soils	4	Hot semi-arid eco-region with alluvium-derived soils
5	Hot semi-arid eco-region with medium and deep black soils	6	Hot semi-arid eco-region with shallow and medium (dominant) black soils
7	Hot semi-arid eco-region with red and black soils	8	Hot semi-arid eco-region with red loamy soils
9	Hot sub-humid (dry) eco-region with alluvium-derived soils	10	Hot sub-humid eco-region with red and black soils
11	Hot sub-humid eco-region with red and yellow soils	12	Hot sub-humid eco-region with red and lateritic soils
13	Hot sub-humid (moist) eco-region with alluvium-derived soils	14	Warm sub-humid to humid with inclusion of per humid eco-region with brown forest and podzolic soils
15	Hot sub-humid (moist) to humid (inclusion of per humid) eco-regions with alluvial-derived soils	16	Warm per humid eco-region with brown and red hill soils
17	Warm per humid eco-region with red and lateritic soils	18	Hot sub-humid to semi-arid eco-region with coastal alluvium-derived soils
19	Hot humid per humid eco-region with red, lateritic and alluvium-derived soils	20	Hot humid / per humid island eco-region with red loamy and sandy soils

Source: Databook 2012, ISARI

Map 1.2. Agro–Ecological Regions of India.



Source: Sehgal *et al*. 1992.

1.4 Flora and Fauna

The unique bio-geographical location of India which happens to be at the confluence of three major realms i.e. Eurasian, Afro-tropical and Indo-Malayan with a varied edaphic, climatic and topographic conditions and years of geological stability have resulted in a wide range of ecosystems and habitats such as forests, grasslands, wetlands, deserts, and coastal and marine ecosystem supporting a very large variety of floral and faunal elements. The changing conceptualisation of forests has been largely shaped by greater recognition of its values as repositories of biodiversity at various taxonomic levels. The ecological and ecosystem services provided by the forest biodiversity has influenced and guided the management of forests towards sustainability to a great extent.

India ranks among the top ten species-rich nations of the world. Although India is connected by land with a number of continents with distinct floral elements, it has a large proportion of endemic flora. Its rich heritage of biological diversity, has so far documented over 91 200 species of animals and 45 500 species of plants in its ten bio-geographic regions. India is one of the recognized mega diversity countries of the world. Comparative account of India's position on species diversity is shown in Table 1.5.

Table 1.5. Position of species biodiversity in India.

Group	Estimated number of species	Rank amongst Mega diverse countries
Higher plants	18664	IX
Mammals	390	VII
Birds	458	IX
Reptiles	521	V
Amphibian	231	IX
Fishes	5749	I

Source: Fourth National Report of National Biodiversity Authority (NBA), MoEF-2009

1.4.1 Biodiversity Hotspots

Of the 34 globally identified biodiversity hotspots, India harbours three, i.e., Eastern Himalaya, Indo-Burma and Western Ghats & Sri Lanka. The main attributes of these hotspots are given in Table 1.6.

Table 1.6. Attributes of Indian biodiversity hotspots.

	Attributes	Hotspots		
		Eastern Himalaya	Indo–Burma	W. Ghats & Srilanka
1	Hotspot original extent (km^2)	741 706	2 373 057	189 611
2	Hotspot vegetation remaining (km^2)	185 427	118 653	43 611
3	Endemic plant species	3,160	7,000	3,049
4	Endemic threatened birds	8	18	10
5	Endemic threatened mammals	4	25	14
6	Endemic threatened amphibians	4	35	87
7	Extinct species*	0	1	20
8	Human population density (people/km^2)	123	134	261
9	Area protected (km^2)	112 578	235 758	26 130
10	Area protected (km^2) in categories I-IV**	77 739	132 283	21 259

*Recorded extinction since 1500, **Categories I-IV afford higher levels of protection
Source: Fourth National Report of NBA, MoEF-2009

1.4.2 Floral Diversity

In terms of plant diversity, India ranks tenth in the world and fourth in Asia. With over 45 500 plant species, India represents nearly 11% of the world's known floral diversity. As elsewhere in the world, many organisms especially in lower groups such as bacteria, fungi, algae, lichens and bryophytes are yet to be described and remote geographical areas are to be comprehensively explored. India has about 17,527 species of Angiosperms. (More than 7% of the world's known flowering plants) in 247 families and 2984 genera. Gymnosperms are represented by about 67 species and Pteridophytes are about 1200 species under 204 genera. Bryophytes represented by 2500 species are the second largest group of green plants in India distributed largely in Eastern Himalaya, North-eastern India, Western Himalaya and the Western Ghats. Lichens, representing symbiotic association of fungi and algae, constitute a dominant component of epiphytic and saxicolous vegetation, and comprise 2223 species in 283 genera and 72 families. India has 14 500 species of fungi in 2300 genera and 250 families with maximum diversity in the Western Ghats followed by the eastern Himalayas and the western Himalayas. Algae are represented by over 7 175 species in 666 genera which are found in a variety of habitats ranging from aquatic (both fresh water and marine) to terrestrial. The richness of Indian plant species as compared to the world is shown in Table 1.7.

Table 1.7. Number of species in major groups of flora.

Plant groups	No. of species described		% of India to the world	Number of species endemic to India	% of endemic species to the total
	India	World			
Virus/Bacteria	850	8,050	10.6	--	--
Algae	7175	40,000	17.9	1925	26.8
Fungi	14,500	72,000	20.1	3500	24.0
Lichens	2223	13,500	16.4	527	23.7
Bryophytes	2500	14500	17.2	629	25.1
Pteridophytes	1,200	10,000	12.0	193	16.0
Gymnosperms	67	650	10.3	7	14.9
Angiosperms	17,527	2,50,000	7.0	6200	35.3

Source: Botanical Survey of India 2009.

1.4.3 Faunal Diversity

While representing 30% of total global flora India is not far behind representing a large range of 91,364 faunal species, 7.31% of global fauna (Forest Sector Report India 2010). Various species of birds, insects, and diverse varieties of mammals, fish, amphibians and reptiles are also found in the Indian subcontinent. As per an estimate of the numbers of species by group in India based on Alfred, 1998 is given in Table 1.8.

Table 1.8. Faunal Diversity.

Taxonomic Group	World species	Indian species	% in India
PROTISTA			
Protozoa	31 250	2577	8.24
Total (Protista)	31 250	2577	8.24
ANIMALIA			
Mesozoa	71	10	14.08
Porifera	4562	486	10.65
Cnidaria	9916	842	8.49
Ctenophora	100	12	12
Platyhelminthes	17 500	1622	9.27
Nemertinea	600		
Rotifera	2500	330	13.2
Gastrotricha	3000	100	3.33
Kinorhyncha	100	10	10
Nematoda	30 000	2850	9.5
Nematomorpha	250		
Acanthocephala	800	229	28.62
Sipuncula	145	35	24.14
Mollusca	66 535	5070	7.62
Echiura	127	43	33.86
Annelida	12 700	840	6.61
Onychophora	100	1	1
Arthropoda	987 949	68 389	6.9
Crustacea	35 534	2934	8.26
Insecta	853 000	53 400	6.83
Arachnida	73 440		7.9
Pycnogonida	600		2.67
Pauropoda	360		
Chilopoda	3000	100	3.33
Diplopoda	7500	162	2.16
Symphyla	120	4	3.33

Merostomata	4	2	50
Phoronida	11	3	27.27
Bryozoa (Ectoprocta)	4000	200	5
Endoprocta	60	10	16.66
Brachiopoda	300	3	1
Pogonophora	80		
Praipulida	8		
Pentastomida	70		
Chaetognatha	111	30	27.02
Tardigrada	514	30	5.83
Echinodermata	6223	765	12.29
Hemichordata	120	12	10
Chordata	48 451	4952	10.22
Protochordata (Cephalochordata+Urochordata)	2106	119	5.65
Pisces	21 723	2546	11.72
Amphibia	5150	209	4.06
Reptilia	5817	456	7.84
Aves	9026	1232	13.66
Mammalia	4629	390	8.42
Total (Animalia)	1 196 903	868 741	7.25
Grand Total (Protosticta+Animalia)	1 228 153	871 318	7.09

Source: Alfred1998

1.4.4 Bio–Geographical Zones

With the kind of floral and faunal diversity present in Indian ecosystems, Wildlife Institute of India, Dehradun classified India into 10 bio-geographic zones. The name and %age of geographical area covered by these zones are given in Table 1.9.

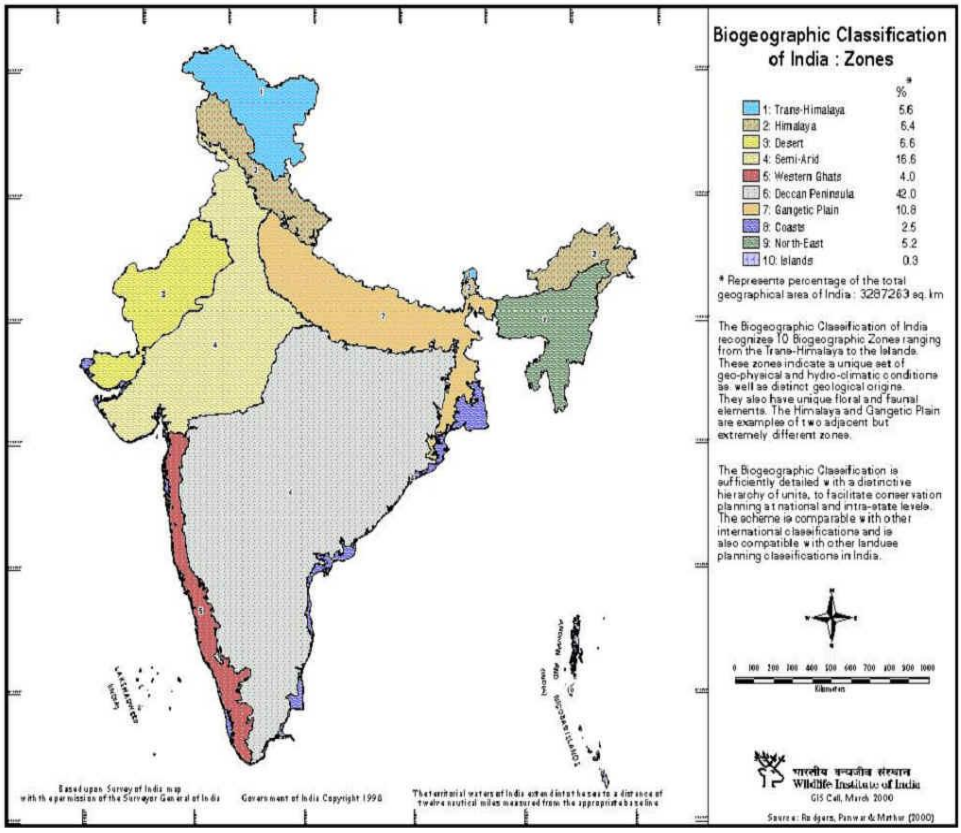
Table 1.9. Bio-Geographic Zones of India.

Bio-Geographic Zones	%	Bio-Geographic Zones	%
Trans- Himalayan zone	5.6	Himalayan zone	6.4
Indian Desert zone	6.5	Semi- Arid zone	16.6
Western ghat	4.0	Deccan Peninsula	41.9
Gangetic plains	10.8	The country extensive coasts	2.6
North East zone	5.2	Island zone	0.3

Source: Wildlife Institute of India

Of all the zones, Deccan Peninsula is the largest and Island zone is the smallest in extent while, North East and Island zone are known for their wide ranging variety of endemic flora & fauna. Similarly, other bio-geographic regions such as, Trans Himalaya, Himalayas, Desert, Semi Arid, Western Ghats, Deccan Peninsula, Gangetic plains, and Coasts are well-known for their distinct and diversified floral and faunal elements. The kind of diversity that is represented by these different regions of India is rarely found elsewhere on the globe. Proving true, its synonym- 'Asian sub Continent' , India can boast of the presence of a variegated physical features like plateaus, dense forests, mountains, rivers both perennial and seasonal, islands, deserts, archipelagos, river plains, swamplands etc. The floral wealth of the country varies from Alpine to temperate thorn, from thick tropical forests to temperate woods, from deciduous to evergreen, from desert scrubs to rain forests.

Map 1.3. Bio geographical zones of India.



1.5 Land Use Classification

Statistics of land utilization in India are based on two methods, one on actual land records and second method employs the estimates based on sample survey.

Till 1949-50, the land area in India was classified into five categories (Table 1.10) known as the five-fold land-utilisation classification. This fivefold land utilisation classification was however, a very broad outline of land-use in the country and was not found adequate enough to meet the needs of agricultural planning in the country. The states (provinces) were also finding it difficult to present comparable data according to this classification, owing to the lack of uniformity in the definition and scope of classification covered by these five broad categories. To remove the non-comparability and to break up the broad categories into smaller constituents for better comprehension, the Technical Committee on Co-ordination of Agricultural Statistics set up by the Ministry of Food and Agriculture, Government of India, recommended a nine-fold land-use classification replacing the old five-fold classification. Table 1.10 describes how the five old classifications were regrouped into nine new classifications.

Table 1.10. Old and New Land Use Classifications of India.

Old classification	**New Classification**
Forests	Forests
Area not available for cultivation	Land put to non agricultural uses (includes area for residences and industry, infrastructure)
	Barren and un-culturable land
Other cultivated land, excluding current fallows	Permanent pastures and other grazing lands
	Miscellaneous tree crops and groves, not included in the net area sown
	Culturable waste
Fallow lands	Fallow land, other than current fallows
	Current fallows
Net area sown	Net area sown

Source: Handbook of Agriculture 1980

Agriculture is the largest land use category in India, followed by forests. **Forests include all lands classed as forest under any legal enactment dealing with forests or administered as forests, whether state owned or private, and whether wooded or maintained as potential forest land.** The area of crops raised in the forests and grazing lands or the area open for grazing within the forests should remain included under the forest area. **Land under non-agricultural use** included all lands occupied by buildings, roads and railways or under water, e.g. rivers and canals, and other lands put to uses other than agricultural. **Barren and unculturable land** covers all barren and unculturable lands, including mountains, deserts, etc. which cannot be brought under cultivation, except at a high cost, whether such land is in isolated blocks or within cultivated holdings. **Permanent pastures and other grazing land** cover all grazing lands whether they are permanent pastures or meadows or not. Village commons and grazing lands are included under this category. **Miscellaneous tree crops and groves, not included in the net area sown** include all cultivable land which is not included under the net area sown, but is put to some agricultural use. Lands under casuarinas trees, thatching grass, bamboo bushes and other groves for fuel, etc. which are not included under 'orchards' are classed under this category. **Culturable wastelands** category includes all lands available for cultivation, whether taken up for cultivation or not taken up for cultivation once, but not cultivated during the current years and the last five years or more in succession. Such lands may be either fallow or covered with shrubs and jungles which are not put to any use. They may be assessed or un-assessed and may lie in isolated blocks or within cultivate holdings. Land once cultivated, but not cultivated for five years in succession, shall also be included in this category after five years. **Current fallow land** class comprises cropped areas which are kept fallow during the current years only. For example, if any seedling area is not cropped again in the same year, it may be treated as current fallow. **Other fallow land or Fallow lands other than Current Fallow** category includes all lands which were taken up for cultivation but are temporarily out of cultivation for a period of not less than one year and not more than five years. The reason for keeping such lands fallow may be Poverty of the cultivators, inadequate supply of water, malicious climate, silting of canals and rivers or un-remunerative nature of farming.

1.5.1 Current Land Utilization

Out of the total geographical area of 328.73 mil ha , the reporting area for Land Utilisation Statistics i.e., the land, for which the data on classification of land-use is known, is 305.69 mil ha (Table 1.11). Reporting area of the country is considerable and no other large country is as fortunate as India in this regard. Nearly half of the reporting area is covered under Agricultural Land Use (46.24%) followed by area under Forest (22.78%). The other land use categories include land Not Available for Cultivation (14.17%), Other Uncultivated land excluding Fallow Land (8.67%) and Fallow Lands (8.13%).

Table 1.11. Current Land Use Classification of India.

Classification	2008-09	%
Reporting Area for Land Utilisation Statistics	305.69	100.00
Forest*	69.63	22.78
Area Under Non-agricultural Uses	26.31	8.61
Barren and Un-culturable Land	17.02	5.57
Permanent Pasture and other Grazing Land	10.34	3.38
Land under Miscellaneous Tree Crops & Groves not included in Net Area Sown	3.40	1.11
Culturable Waste Land	12.76	4.17
Fallow Lands other than Current Fallows	10.32	3.38
Current Fallows	14.54	4.76
Net Area Sown	141.36	46.24

Source: Agricultural Statistics at a Glance 2011

***** all lands classed as forest under any legal enactment dealing with forests or administered as forests, whether state owned or private, and whether wooded or maintained as potential forest land.

1.5.2 Land Use Pattern in India

Land use pattern in India relates to the physical characteristics of land, the institutional and other resources' framework like labour, capital and other factors associated with the economic development. In other words, the existing land use pattern in different regions in India has been evolved as the result of the action and interaction of the various factors, such as the physical characteristics of land, the institutional framework, the structure of other resources available and the location of the region in relation to other aspects of economic development, e.g. those related to transport as well as to industry and trade.

In British India, the land use pattern was not consistent in most of the classes. The area under forest and fallow land has increased from 1900-01 to 1920-21, but decreased in the next decade (Table 1.12). There was uneven trend for area not available for cultivation, and culturable waste other than fallow. However, the irrigated area has consistently increased from 1900-01 to 1930-31.

Table 1.12. Land use Pattern in British India.

Classification of area	1900-01	1910-11	1920-21	1930-31
Area by professional survey (Mil ha)	219.4956	247.4324	248.4904	267.738
Area Under forest	12.08%	13.03%	14.20%	13.14%
Area not available for cultivation	25.24%	24.25%	22.78%	21.93%
Culturable waste other than fallow	19.09%	18.61%	18.49%	23.01%
Fallow land	7.69%	7.59%	9.88%	7.41%
Net area cropped	35.92%	36.06%	34.17%	34.23%

Source: Agricultural Statistics of India 1921,1937, 1941.

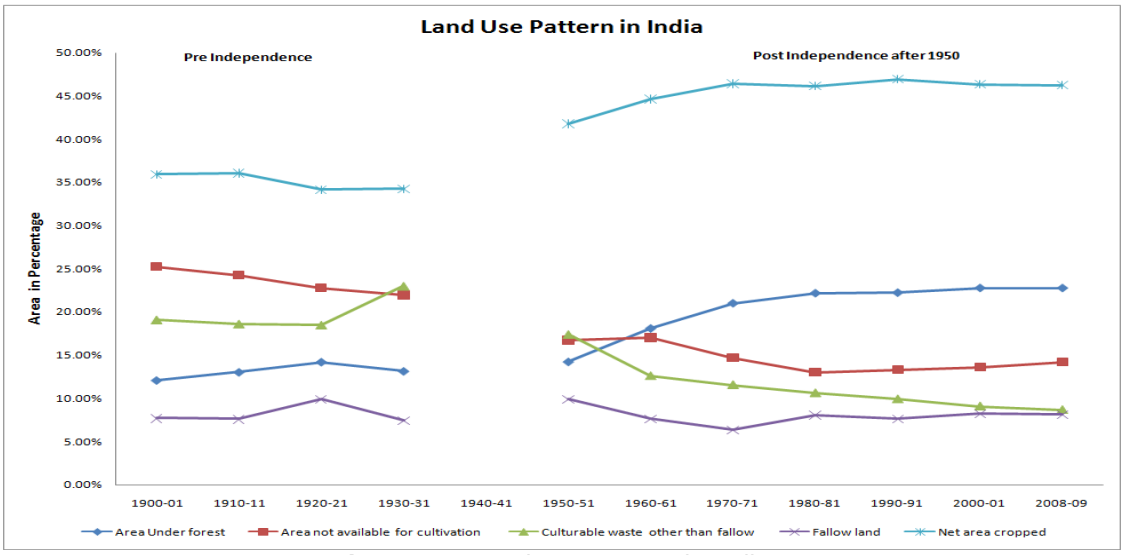


Figure 1.1. Land Use pattern in India.

After the independence, the forest area has consistently increased during the last six decades from 14.24 % in 1950-51 to 18.11% in 1960-61 and further to 22.78 % in 2008-09 as more and more land brought under legal enactment dealing with forests or administered as forests. Land under agriculture i.e. net sown area has consistently increased after independence, which was stagnant in the pre independence era. Other cultivated land and waste land have decreasing trend after independence. However, Fallow Lands have uneven pattern as given in Table 1.13.

Table 1.13. Land Use Pattern in India after Independence.

Classification	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2008-09
Reporting Area for Land Utilisation Statistics (mil ha)	284.32	298.46	303.75	304.16	304.86	305.18	305.69
Forests*	14.24%	18.11%	21.01%	22.18%	22.24%	22.78%	22.78%
Area not available for cultivation	16.71%	17.00%	14.69%	13.01%	13.28%	13.59%	14.17%
Other cultivated land, excluding current fallows	17.39%	12.61%	11.57%	10.62%	9.91%	9.09%	8.67%
Fallow lands	9.89%	7.65%	6.36%	8.07%	7.66%	8.21%	8.13%
Net area sown	41.77%	44.63%	46.37%	46.12%	46.91%	46.32%	46.24%

Source: Agricultural Statistics at a Glance 2011
***** all lands classed as forest under any legal enactment dealing with forests or administered as forests, whether state owned or private, and whether wooded or maintained as potential forest land.

1.5.3 Land Use Change in India after 1950

The table 1.14 gives the trend of the land use since 1950. The forests in the year 1950-51 were 40.48 mil ha which consistently increased during the last six decades and reached to 69.63 mil ha during the year 2008-09. The area under non agricultural use was 9.36 mil ha in the year 1950-51, which increased to 26.31 during the year 2008-09. The barren and un-cultivable land along with land under miscellaneous tree crops consistently decreased from 38.16 mil ha in 1950-51 to 17.02 mil ha in 2008-09 and 19.83 mil ha to 3.4 mil ha respectively. The cultivable wasteland also decreased consistently. The land use pattern of fallow lands and current fallow were not uniform.

Table 1.14. Land Use Change in India after 1950.

Classification	1950-51	1960-61	1970-71	1980-81	1990-91	2000-01	2008-09
Forest*	40.48	54.05	63.83	67.46	67.81	69.53	69.63
Area Under Non-agricultural Uses	9.36	14.84	16.48	19.6	21.09	23.89	26.31
Barren & Un-culturable Land Permanent Pasture & other	38.16	35.91	28.13	19.96	19.39	17.59	17.02
Grazing Land	6.68	13.97	13.26	11.99	11.4	10.67	10.34
Land under Miscellaneous Tree Crops & Groves not included in Net Area Sown	19.83	4.46	4.37	3.58	3.82	3.44	3.4
Culturable Waste Land	22.94	19.21	17.5	16.74	15	13.63	12.76
Fallow Lands other than Current Fallows	17.45	11.18	8.73	9.72	9.66	10.29	10.32
Current Fallows	10.68	11.64	10.6	14.83	13.7	14.78	14.54
Net Area Sown	118.75	133.2	140.86	140.29	143	141.36	141.36

Source: Agricultural Statistics at a Glance 2011, Ministry of Agriculture
***** all lands classed as forest under any legal enactment dealing with forests or administered as forests, whether state owned or private, and whether wooded or maintained as potential forest land.

1.6 Land Tenure Arrangement

Land tenure is an important part of social, political and economic structures. It is multi-dimensional, bringing into play social, technical, economic, institutional, legal and political aspects that are often ignored but must be taken into account. Land tenure is the relationship, whether legally or customarily defined, among people, as individuals or groups, with respect to land. (For convenience, “land” is used here to include other natural resources such as water and trees). Land tenure is an institution, i.e., rules invented by societies to regulate behaviour. In simple terms, land tenure systems determine who can use what resources for how long, and under what conditions.

There is little understanding available on land records and tenure system prior to Muslim rule in India. The land belonged to "King" and the property rights of individuals were not specified. "The native law of India has ordinarily recognized agricultural land as being crown property" (Smith 1924).

The Arthasashtra (Kautilya) has historical evidence of the cultivator being able to sell and alienate his land. But it also states of the right of the king to replace him in his holding if he fails to pay the rent. The Mughals organised that land revenue system following the footholds of Sher Shah Suri. They found the principal structure of agrarian base well established. Akbar introduced the Mansabdari system and tied the system, with land revenue collections. A compendium of land records was prepared through collection of data from the field and entered in a register. The Mughals were keen to expand cultivated area and extended special concessions to the cultivators for bringing new areas under cultivation. The authorities were vigilant to expand the cultivated land, in no case the cultivated land should be permitted for degradation into fallow lands. The British inherited the institutional form of agrarian system from the Mughals. The British superimposed a system over the existing pattern in tune with British customs and laws relating land. Broadly three principal types of land revenue system were introduced in British India. The basic characteristic of each system was the attempt to incorporate elements of the preceding agrarian structure. The three broad land revenue systems introduced by the British are 1. Ryotwari System, 2. Zamindari System and 3. Mahalwari System.

1.6.1 Ryotwari System

The Ryotwari system was introduced in Madras Presidency in 1792 and in Bombay Presidency in 1817-18. This system recognized the proprietary right of the peasant on land and resembled the revenue system of the Mughal to a great extent. The Ryotwari system covered nearly 38% of the cultivated area in India.

1.6.2 Zamidari System

The Zamindari system was introduced in early British period. The Permanent settlement Act was passed in 1793 and was first introduced in Bengal to ensure the revenue receipt of the british colonial power, where a Zamindar was declared the proprietor of land on condition of fixed revenue payments to the British regime. The peasants were turned into tenant farmers and deprived of the land title including other rights and privileges enjoyed during the Mughal period. The Zamindars collected the rents of land through different intermediate collectors. This revenue system accounted for 57% of cultivated area in the country.

1.6.3 Mahalwari System

The Mahalwari system was introduced between 1840 and 1850. In this system the entire village constituted revenue settlement as collective unit. The peasants paid the revenue share of whole village in proportion according to their individual holdings. The System was not extensive and included only 5 % of the cultivated land in India. Of the three systems the Rywotari resembled the Mughal revenue system, wherein the proprietary rights of the cultivators had been recognized.

The British land policy which lasted 150 years as well as the consequences of economic changes and the drastic population growth led to a complete change in the land tenure system in India. Whereas, formerly, the cultivators possessed the right of use and the government the right to impose taxes, now the rights in land were split into many pieces. In this process, not only did a large number of cultivators lose their valid land rights and fell in status to unprotected tenants and labourers. At the same time, the tax collectors became landlords and large landowners.

The abuses of the zamindari system attracted attention during the struggle for independence, and in the period immediately following Independence, as the country's new leaders turned their attention toward land reforms. The injustices practiced by zamindars, coupled with their support of the British colonial administration, fuelled the political will to undermine or eliminate intermediary rights to land.

The Indian Constitution grants exclusive authority to the state governments to enact land tenure legislation. By the end of the 1950s, almost all states had enacted legislation aimed at abolishing intermediary interests upon the payment of compensation. The laws to abolish intermediary interests brought an estimated 20 to 25 million erstwhile tenants into a direct relationship with the State. In addition to the social and political gains of beneficiaries, the abolition of intermediaries brought large areas of cultivable wasteland, forests, and abadi land (house plots and other land in villages) under state ownership. The legislation to abolish intermediaries reduced the multiplicity of legal land tenures that previously existed and thus simplified and clarified land tenure law and it also either reduced or entirely extinguished the feudal nature of agrarian relationships in many parts of India. The abolition of most intermediary tenures brought the whole of India under a uniform tenurial system (albeit with some local variation) within the first decade after Independence

1.7 Gross Domestic Product and other Economical Factors

At present, India is one of the fastest growing economies of the world. The economic growth of the country has been characterized by static agriculture economy (in fact, a small decline) and stagnant per capita income as per Table 1.15 during 1900 to 1950.

Table 1.15. Agricultural stagnation in India during 1900–1950 at 1948–49 prices.

Year	Population (Millions)	National Income (US$ in 0.182 Million)		Per Capita income (US$)
		Total	Agriculture	
1900-01	232	5109	3976	4.00
1910-11	247	6241	4433	4.60
1920-21	251	6469	3807	4.71
1930-31	276	7684	4598	5.05
1940-41	315	8646	4534	5.00
1950-51	359	8850	4405	4.47

Source: Mukherji1962.

After the independence, the gross domestic product (GDP) of US$ 1767.10 million during 1950-51 at factor cost at current price rose to US$ 3002.18 million in the year 1960–61. Due to subsequent and consistent increase in the GDP, the present GDP at factor cost at current price is US$ 1328543million. According to statistics in Table 1.16, the GDP per capita during 1950–1980 grew by 1.5% and with liberalization of economy grew to 3.8% in 1990–91.

Table 1.16. Growth of economy and agricultural area expansion.

Year	Population (millions)	Economic Trends		Agricultural Land Use		
		Real GDP Growth (%)	GDP / Capita (%)	Net area sown (Million ha)	Area irrigated (%)	Yield of Food Grain (kg/ha
1950–51	361	3.7	1.5	118.75	18.1	536
1960–61	439			133.20	19.1	710
1971–72	548			140.27	24.1	872
1981–82	683			140.00	29.7	1023
1990–91	843	5.9	3.8	143.00	35.1	1380
2000–01	1027	6.2	4.4	141.63	43.4	1626
2010–11	1210	7.2		141.36	46.2	1921

Source: National Agricultural Statistical Handbook 2000, 2005 and 2011, GOI

Just after the independence, the growth of gross domestic product of India was slow in the initial three decades that is from 1950-51 to 1980-81, in the next two decades from 1980–81 to 2000–01, the

growth of gross domestic product of India was higher than the previous decades. in the last decade, from 2000–01 to 2010–11, the growth of gross domestic product of India was very fast as compared to the last five decades.

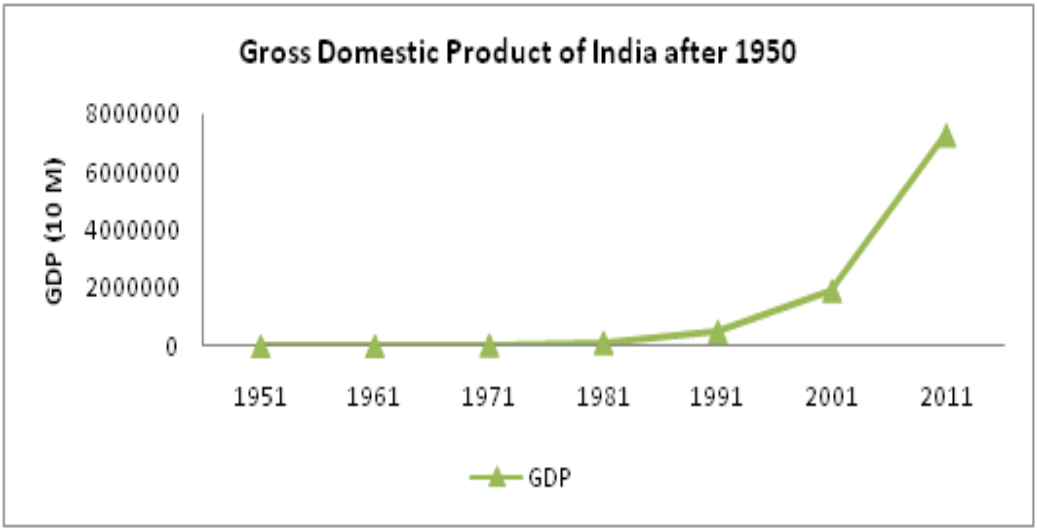


Figure 1.2. Gross Domestic Product of India after 1950.

The contributions of the agriculture and allied sector, industry sector, and services sector in India GDP also underwent significant changes over time. The long term growth rate of the agriculture sector (over the last 60 years) has been 2.7 %. It was 2.3 % between 1950–51 and 1980–81 and 3.1 % during 1980–81 to 2011–12. Growth in the industry sector increased from 5.2 % in the earlier period to 6.4 % between 1980–81 and 2011–12. Similarly growth in the services sector was 4.4 % and 7.8 % respectively during these two sub-periods. During the current financial year, the maximum contribution to the GDP in Indian economy is from service sector, which is approximately 57.79 % (Economic Survey, 2012), industry (27.8 %) and then followed by agriculture (14.5 %). Out of a total share of 14.5 % in GDP in 2010-11, agriculture alone accounted for 12.3 %, followed by forestry and logging at 1.4 %, and fishing at 0.7 %. The changes in relative shares of these sectors in GDP are shown in the Table 1.17.

Table 1.17. GDP and share of other sectors.

Year	GDP at factor cost (10 Million)	GDP(Ag.) %	GDP(Ind.) %	GDP(Ser.) %
1950–51	9719	53.10	16.60	30.30
1960–61	16512	48.70	20.50	30.80
1970–71	42981	42.30	24.00	33.80
1980–81	132520	36.10	25.90	38.00
1990–91	515032	29.60	27.70	42.70
2000–01	1925017	22.30	27.30	50.40
2010–11	7306990	14.50	27.80	57.70

Source: Economic Survey 2012

Between 1950–51 and 1980–81, the industrial sector registered a higher growth rate than the services sector. Since then, the growth was very marginal. . The share of the industry sector in GDP increased by around 9.30 % from 16.6% to 25.9% during the period from 1950–51 to 1980–81. The share of the services sector increased from 30.3% in 1950–51 to 38% in 1980–81. It started growing rapidly thereafter and this phenomenon became more pronounced in the 1990s. Consequently, since 1980–81, the share of the industry sector has remained in the range of 26 to 28 % of GDP, while the entire decline in share of agriculture has been balanced by an increase in share of the services sector. Thus, the resilience of the economy to shocks owes to the services sector which has the largest share and most consistent growth performance.

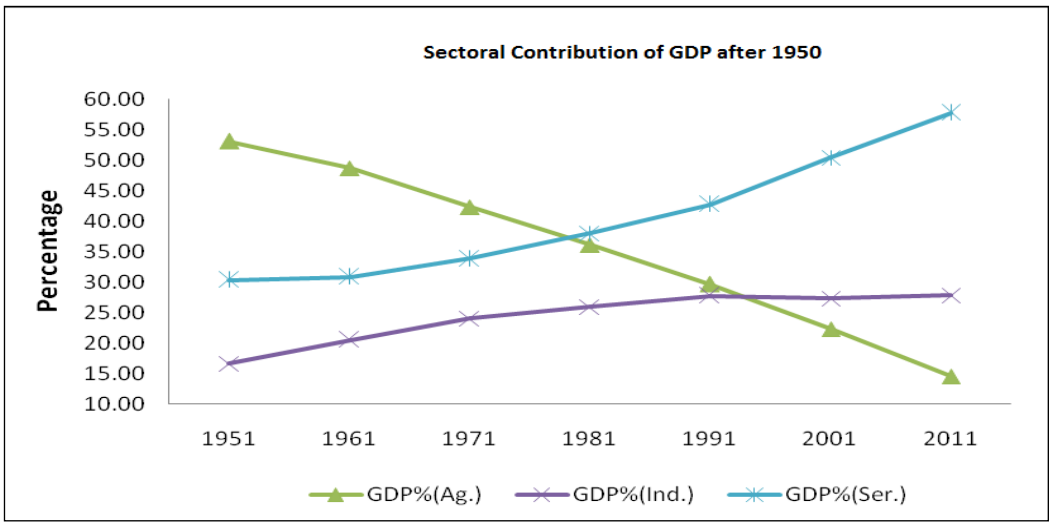


Figure1.3. Sectoral Contribution of GDP after 1950.

1.7.1 Agricultural Production

Agriculture plays an essential role in the process of economic development of the country. Agriculture not only provides food to the nation, but also generates employment, provides savings, contributes to market of industrial goods and earns foreign exchange. Agricultural development is an integral part of overall economic development. Agriculture was the main source of national income and occupation at the time of Independence in India. Agriculture and allied activities contributed nearly 50% to India's national income. The total agricultural production was 50.82 mil tonnes (MT) in 1950–51, which increased to 129.59 MT in 1980-81. The agricultural production increased approximately double in the next 30 years, i.e. 241.57 MT in the year 2010–11. After 65 years of Independence, the share of agriculture in total national income declined from 50% in 1950–51 to 14.5% in 2010–11. But even today more than 60 % of workforce is engaged in agriculture. In spite of this, an important feature of agriculture that is to be noted is that growth of other sectors and overall economy depends on the performance of agriculture to a considerable extent. Because of these reasons agriculture continues to be the dominant sector in Indian Economy.

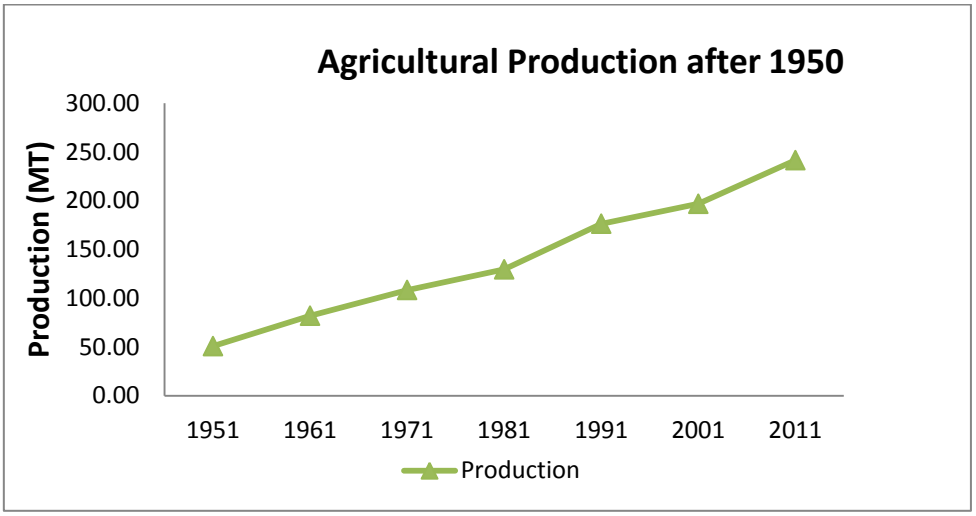


Figure 1.4. Agricultural Production after 1950.

1.7.2 Agricultural Productivity

The productivity of agriculture has witnessed a consistent increase since independence in India. The country was dependent on agricultural imports for almost two decades after independence. The mid 1960s was the beginning of a turning point in Indian agriculture as the production of rice and wheat grew at 28.0% and 23.6 %, respectively, during 1967–68 while their yields during the same year grew at 19.6 % and 24.4 %, respectively. The development of high-yielding variety (HYV) of seeds in mid 1960s and the subsequent use of the fertiliser-pesticides-irrigation package, better seeds, improved irrigation and education of farmers led to quantum jumps in the productivity. India has experienced considerable changes in the crop mix, yield and production since the inception of the Green Revolution. The Green Revolution phase displayed a high yield growth per unit of input. The first post-Green Revolution phase (from late-1960s to mid-1980s) was marked by the continued growth in returns from land through the intensification in use of chemical inputs and machine labour (Kumar and Mittal, 2006). The second post-Green Revolution phase (beginning the mid-1980s) was characterized by high input-use and decelerating productivity growth. It calls for an examination of the issues related to the trends in agricultural productivity, particularly with reference to individual crops in recent years.

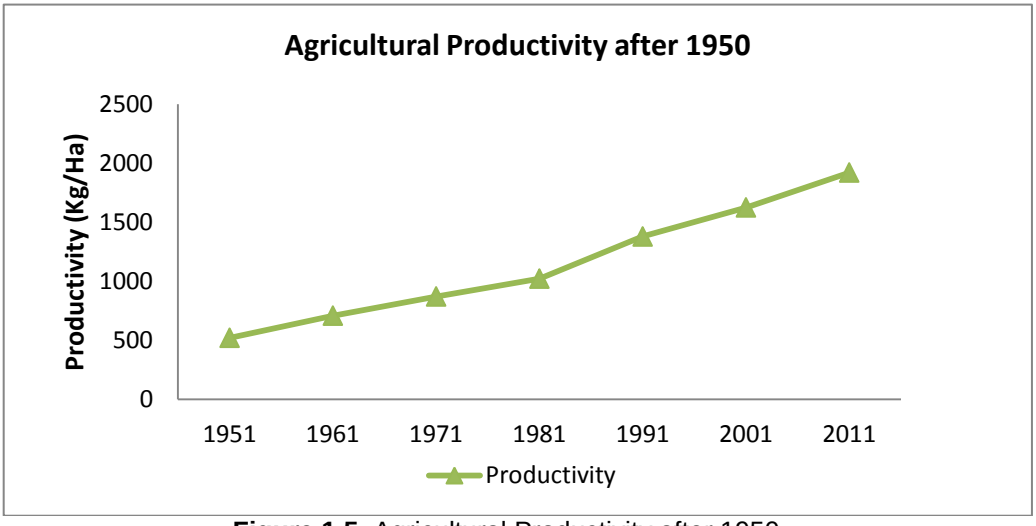


Figure 1.5. Agricultural Productivity after 1950.

1.7.3 Livestock Population

Human and livestock populations have both grown considerably in India since after independence. Livestock population includes cattle, goats, buffaloes and sheep etc but excludes poultry and dogs. Between 1961 and 1997, cattle, goats, buffaloes and sheep numbers increased by 195%, 98%, 80% and 41% respectively. Tremendous increase occurred in numbers of chicken which rose by 400% and pigs increased in number by 200%. Relationships between human and animal population growth, livestock production methods are complex according to Templeton and Scherr (1997). Nevertheless, in India between 1961 and 1997, the annual population growth rates of livestock were 2.44%. Livestock numbers grew at a faster rate than human population in India in the period 1961-1997. Populations of all major types of livestock have risen steadily in recent years except for chickens, the population of which rose dramatically in the late 1980s and early 1990s.

The livestock sector contributes about 6.8% to GDP and employs 8 % of the labour force. The contribution of livestock sub sector of agricultural GDP has increased impressively in the last few decades from less than 15% in 1970s to over 33 % in 2002 (FAO 2005).

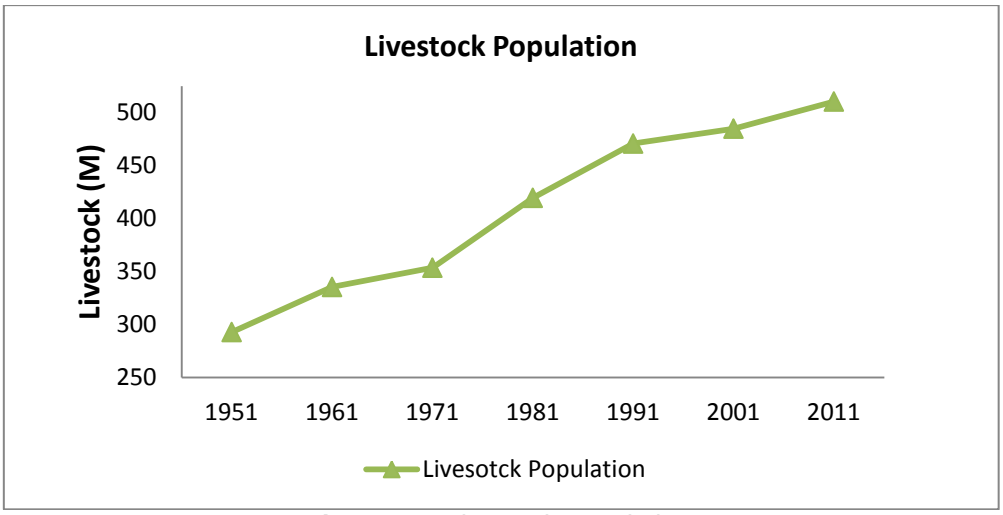


Figure 1.6. Livestock Population.

1.8 Population and Other Social Factors

India is the second most populous country in the world after China with over 1.210.2 million people (2011 census), i.e. 16 % of the world's population on 2.4% of the globe's land area. After Independence, an increasing trend of the growth rate of India's population was observed which increased from 13.3% during the 1951 to 24.7% during the year 1981 in the three decades (Table 1.18). But after 1981, the growth rate has decreased to 17.64 % during the year 2011 in the next three decades. India was the first country in the world to launch a national programme in 1952, emphasizing family planning to the extent necessary for reducing birth rates "to stabilize the population at a level consistent with the requirement of national economy".

Table 1.18. Trend of Indian Population after 1951.

Year	1951	1961	1971	1981	1991	2001	2011
Total	361.1	439.2	548.2	683.3	846.4	1028.7	1210.2
Urban	62.5	78.9	109.2	159.4	217.5	286.1	377.2
Rural	298.6	360.3	439	523.9	628.9	742.6	833
Growth rate	13.3	21.6	24.8	24.7	23.9	21.5	17.64
Urban%	17.31%	17.96%	19.92%	23.33%	25.70%	27.81%	31.17%
Rural%	82.69%	82.04%	80.08%	76.67%	74.30%	72.19%	68.83%

Source: Registrar General & Census Commissioner, India

1.8.1 Population Growth

The growth in Indian population has been rapid since Independence, which had important implications for social and economic development and quality of life of the people. It is well known that a population growing at a rate of 2% per year doubles itself in a period of about 35 years The average annual population growth rate in the country over the fifty-year period between 1951 and 2001 has been slightly more than 2% per year. There are only five states in India – Andhra Pradesh, Tamil Nadu, Orissa, Kerala and Punjab - where the average annual population growth rate during the period 1951–2001 has been less than 2% per year with slowest growth of population recorded in Tamil Nadu (Chaurasia 2011). By contrast, the average annual population growth rate has been very close to 3% per year in the smaller states and Union Territories of the country. The population of the country more than doubled from 361 million in 1951 to 763 million in 1986. During the decade 1951–61, around 78 million people were added to the population of the country. This number increased to almost 183 million between 1991 and 2001 despite a marginal slow down in population growth rate.

Between 1911 and 1920, the birth and death rates were virtually equal, about forty eight births and forty eight deaths per thousand populations. The increasing impact of curative and preventive medicine (especially mass inoculations) brought a steady decline in the death rate. By the mid-1990s, the estimated birth rate had fallen to twenty-eight per thousand, and the estimated death rate had fallen to ten per thousand. Clearly, the future configuration of India's population (indeed the future of India itself) depends on what happens to the birth rate. The decrease in the birth rate in India has been slower than the decrease in the total fertility rate because of the young age structure of the Indian population (Chaurasia and Gulati 2008).

1.8.2 Rural Population and Migration to Urban Areas

The rural population was approximately 82.7% during the year 1951 but thereafter, a decreasing trend in the rural population has been observed due to migration to the urban areas. During the interval of 30 years, the rural population decreased to 76.6% in 1981, which further decreased to 68.8% in 2011. The level of urbanization increased from 27.81% in the 2001 Census to 31.16% in the 2011 Census, while the proportion of rural population declined from 72.19% to 68.84%. The slowing down of the overall growth rate of population is due to the sharp decline in the growth rate in rural areas, while the growth rate in urban areas remains almost the same. It was seen in the past that the population is shifting from rural to urban due to number of factors.

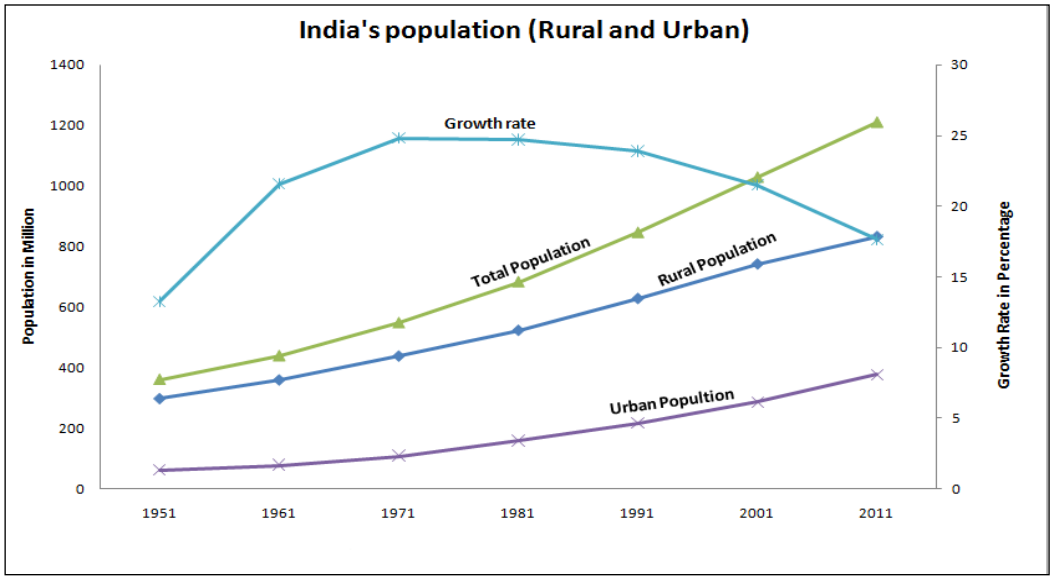


Figure 1.7. India's Population (Rural and Urban).

1.8.3 Population Density

Due to high population growth rate, the density has increased consistently since independence. During the year 1950–51, the population density was 117 people/km^2, which increased up to 216 during the year 1980–81 and rose up to 364 during the year 2010–11.

Population growth in the years between 1950 and 1970 centred around areas of new irrigation projects, areas subject to refugee resettlement, and regions of urban expansion. Areas where population did not increase at a rate approaching the national average were those facing the most severe economic hardships, overpopulated rural areas, and regions with low levels of urbanization.

1.8.4 Literacy Rate

Literacy in India is key factor for socio-economic progress. Literacy rate in India grew to 74.04% in 2010-11 from 18% at the end of the British rule in 1947. Although this was a greater than six fold improvement, the level is well below the world average literacy rate of 84%. India currently has the largest illiterate population of any nation on earth. Despite government programs, India's literacy rate increased only sluggishly. The 2011 census, however, indicated a 2001–2011 decadal literacy growth of 9.2%, which is the slower than the growth seen during the previous decade. There is a gender

disparity in the literacy rate in India, the literacy rate for men was 82.14% and 65.46% for women during 2011.

The literacy rate recorded an increase of 12.60% from 1991 to 2001, the highest increase in any one decade. An encouraging feature is that the growth rate of literacy has been higher in case of females at 14.87% than for males at 11.72% during this decade. The rate of growth of literacy in the decade ending 2001 has been higher in the rural areas, at 14.75% as compared to the 7.2% increase in urban areas. Despite these improvements literacy in urban areas was 80.3% and that in rural areas 59.4%.

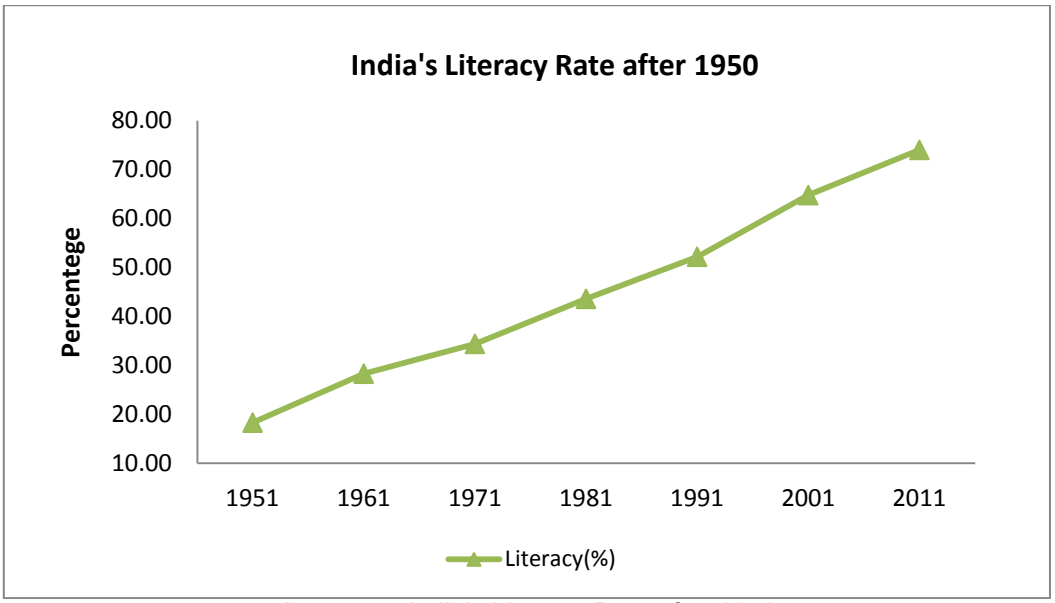


Figure 1.8. India's Literacy Rate after 1950.

1.8.5 Life Expectancy

Life expectancy at birth is one of the best-known measures of a population's health status and overall status of the healthcare sector. Life expectancy and overall health of Indians has improved consistently to 62.6 for males and 64.2 for females since Independence (Ministry of Health & Family Welfare). Post-independence India's most noteworthy achievement, in the public health arena, has been the decrease in death rates (mortality). In 1951 the at-birth life expectancy was around 37years which increased to nearly 65 years by 2011. In terms of infant mortality, there has been improvement between 1951 and 2000, such that the number of deaths in the youngest age group has fallen to 70 from 146 per thousand. Similar trends were observed from 2001 to 2006 with regards to maternal mortality, that is, 254 rather than 301 maternal deaths per 100,000 births. However, in both instances the total number of women and young children dying in India – partially due to the population growth – continues to be among the highest in the world.

India has a long way to go before it matches average life expectancy with other Asian countries. According to CIA-The World Fact book, China has the highest life expectancy at 78.32, Malaysia 74.20, Sri Lanka 72.40, Indonesia 70.70, and Pakistan 65.50. India has shot up to 62.6 years for males and 64.2 years for females in 2006, as per the report released by the World Health Organization.

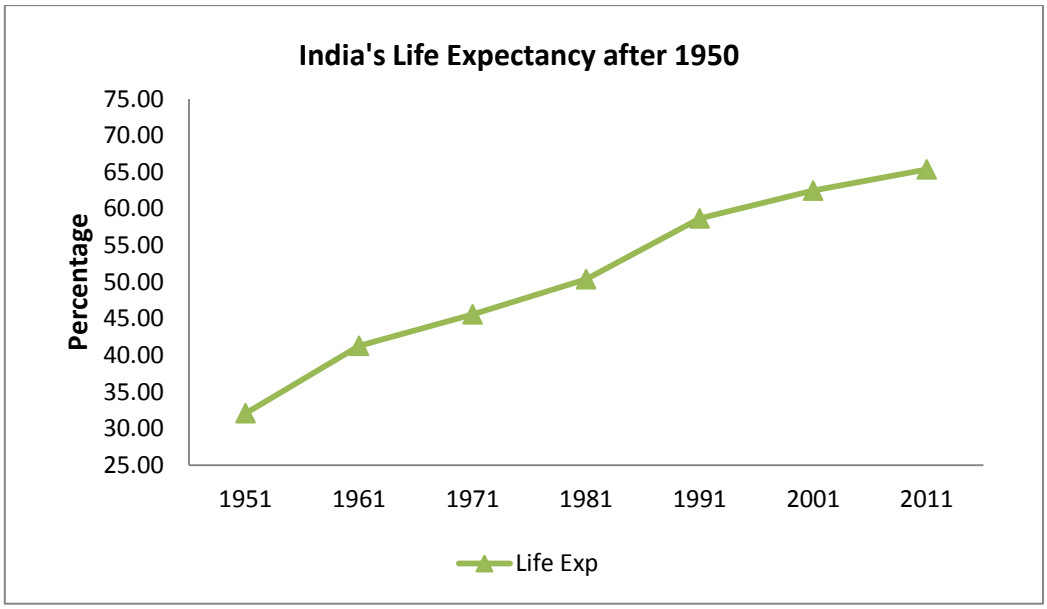


Figure 1.9. India's Life Expectancy after 1950.

1.9 Environmental Concerns in India

India with developing economy has gained its pace of industrial development, rapid urbanisation, extensive exploitation of natural resources, harnessing of energy and other developments causing direct and indirect impacts upon the environment. The problem has further been aggravated with the rapid growth of the population in post independence era, where population grew from 350.0 million in the year 1947 to 1220 million in the year 2012. India is the second most populous country in the world after China. The population of India is almost equal to the combined population of USA, Indonesia, Brazil, Pakistan, Bangladesh and Japan put together. India represents almost 17.5 % of the world's population, which means one out of six people on this planet live in India. The huge population has put tremendous pressure on the every components of the environment whether it be air, water, land or forests. Poverty level of the country has been limiting factor for the eradication of pollution. When the global concern on environment started and the countries from all over the world assembled together for the first time to discuss the serious issue of environment at Stockholm in 1972, Indian Prime Ministry Indira Gandhi rightly stressed and pointed out poverty as the most serious polluter saying "Poverty is the worst polluter. If you are poor, you live in the most polluted world. The sanitation is poor, the drinking water is poor, the housing is poor, the air you breathe is poor. Everything is polluted. Poverty is the worst polluter"

India at present witnesses the serious issues of pollution in urban as well as rural areas. The various types, causes and sources attributed for the problem of pollution in India in present day contexts includes:

1. Industrial pollution
2. Vehicular emissions
3. Noise pollution
4. Urbanisation
5. Overexploitation of ground water and its contamination
6. River pollution
7. Pollution of inland water
8. Pollution of Indian coasts
9. Arsenic, Flouride, Iron and Nitrate contamination in drinking water in few states
10. Municipal solid wastes including plastic wastes
11. Biomedical and hospital wastes
12. Hazardous wastes
13. Nuclear wastes
14. Electronic wastes
15. Biodiversity loss, deforestation and forest degradation
16. Invasion of alien species

17. Excessive use of fertilizers
18. Land degradation
19. Mining and over exploitation of natural resources
20. Health and sanitation

Indian government has taken adequate majors to control the problem of pollution by enforcing and implementing laws from time to time and has been signatory to major international conventions and treaties to participate significantly in controlling the global issues of pollution.

The constitution of India itself is committed for the protection of the environment. Indian Constitution – Article 48a directs the states to make endeavour for protection and improvement of the environment and for safeguarding the forest and wildlife of the country. Article 51–A (G) says that it shall be the duty of every citizen of India to protect and improve the natural environment including forests, lakes, rivers and wildlife and to have compassion for living creatures.

There is separate ministry, **Ministry of Environment & Forests (MoEF),** to look after the issues related to environmental concern in India. MoEF looks after the planning, promotion, co-ordination and overseeing the implementation of India's environmental and forestry policies and programmes. The primary concerns of MoEF are implementation of policies and programmes relating to conservation of the country's natural resources including its lakes and rivers, its biodiversity, forests and wildlife, ensuring the welfare of animals, and the prevention and abatement of pollution. While implementing these policies and programmes, the Ministry is guided by the principle of sustainable development and enhancement of human well-being. The Ministry also serves as the nodal agency in the country for the United Nations Environment Programme (UNEP), South Asia Co-operative Environment Programme (SACEP), International Centre for Integrated Mountain Development (ICIMOD) and for the follow-up of the United Nations Conference on Environment and Development (UNCED). The Ministry is also entrusted with issues relating to multilateral bodies such as the Commission on Sustainable Development (CSD), Global Environment Facility (GEF) and of regional bodies like Economic and Social Council for Asia and Pacific (ESCAP) and South Asian Association for Regional Co-operation (SAARC) on matters pertaining to the environment.

A separate statutory body **Central Pollution Control Board (CPCB)** has also been created to look after the protection of the environment which provides technical services to the MoEF to promote cleanliness of streams and water bodies in different areas of the states by prevention and control of water pollution, to improve the quality of air and to prevent, control or abate the overall environment of the country by implementing various environment related regulations time to time. Some of the important environment acts and policies existing in India to safeguard the environment are:

1. Indian forest act 1927
2. The wild life (protection) act 1972
3. The water (prevention and control of pollution) act 1974
4. The forest (conservation act) 1980
5. The air (prevention and control of pollution) act 1981
6. The environment (protection) act 1986
7. National forest policy 1988
8. The motor vehicle act 1988
9. The hazardous wastes (management and handling) rules 1989
10. The manufacture, storage and import of hazardous chemical rules 1989
11. The rules for the manufacture, use, import, export and storage of hazardous micro-organisms/genetically engineered organisms or cells 1989
12. The chemical accidents (emergency planning, preparedness and response) rules 1996
13. The biomedical wastes (management and handling) rules 1998
14. The plastic manufacture, sales and usage rules 1999
15. The noise pollution (regulation and control) rules 2000
16. The ozone depleting substances (regulation and control) rules 2000
17. The municipal solid wastes (management and handling) rules 2000
18. The batteries (management and handling) rules 2001
19. The biological diversity act 2002
20. National green tribunal act 2010

Problem of air pollution in the cities has increased with the growing number of vehicles run on diesel. The concentration of PM_{10} and $PM_{2.5}$ has been found to be more than the safety level in many of the cities in India. Global Burden of Disease (GBD) report (2012) states that particulate air pollution is now just three places behind indoor air pollution, which is the second highest killer in India. Outdoor air pollution has become the fifth largest killer in India after high blood pressure, indoor air pollution, tobacco smoking, and poor nutrition. GBD report is a world-wide initiative involving the World Health Organization which tracks deaths and illnesses from all causes across the world every 10 years. The report says that in 2010, about 620 000 premature deaths occurred in India from air pollution related diseases. In India, air pollution is the seventh leading cause behind the loss of about 18 million healthy years of life due to illness. It comes after indoor air pollution, tobacco smoking, high blood pressure, childhood underweight, low nutritional status, and alcohol use.

Main reasons of outdoor air pollution in India are – emissions from vehicles, thermal power plants, industries and refineries. The problem of indoor air pollution in rural and urban slums has also immerged as a major concern. Vehicle emissions are responsible for 70% of the country's air pollution. The major problem with government efforts to safeguard the environment has been enforcement at the local level and not with lack of appropriate laws. Introduction of vehicles run on CNG although limited the level of particulate matters in the cities like Delhi and other cities where it was introduced but at the same time it has now been questioned for being environment friendly. CPCB report (2011) says CNG is not without environmental drawbacks. Burning CNG has the highest rates of potentially hazardous carbonyl emissions. The study also made a case for regulating CNG and other fuels for methane emissions. Study reports that retrofitted CNG car engines emit 30% more methane than original CNG engines. Almost all CNG car engines in India are retrofitted. The major cities facing the problem of air pollution at worst are Kolkata, Delhi, Mumbai and Chennai.

India's environmental problems are further exacerbated by its heavy reliance on coal for power generation. More than 80% of energy is produced from coal, a fuel that emits a high amount of carbon and greenhouse gases. Growing needs of bricks with the fast escalating pace of infrastructure development in India has been an additional source of pollution. The exhaust from the kilns mixes with diesel emissions and other fumes to form vast brown smog/cloud. Rice crop yields in southern India are falling as brown clouds block out more and more sunlight. One of the seven wonders of world, Taj Mahal, has also witnessed the ill effects of air pollution, where the brilliant white colour has slowly been fading to dull yellowish because of the reaction of its white marbles with the acidic fumes of nearby refineries.

Number of water bodies in India is slowly becoming unfit for human use. River Ganga, lifeline of northern India is facing a serious problem of pollution due to unchecked dumping of pollutants in its streams. Major reservoirs on the upper catchment of the river have reduced the amount of water, reducing water volume of the stream and in turn have caused increase in the concentration of the pollutants. Another most threatened river in India facing water pollution is river Yamuna which looks just as the flowing sewer in the national capital Delhi. Ground water is the major source for the survival of the population in India upon which majority of the population is dependent for drinking and domestic purposes. Coastal areas of the India faces severe salinity problem because of the inherent ground water salinity and intrusion of the sea water. In certain areas problem of upcoming of saline water has also been reported due to overexploitation of ground water. The problems of increased concentration of flouride, arsenic, iron, nitrates and heavy metals have also been reported in many parts of the country.

Pollution due to mining has been identified as one of the worst sources because of the several unmanaged and illegal mining operations going on in the country. There are adequate laws already existing in the countries but the willingness to abide by it and its proper implementation by the stakeholders has been lacking which requires immediate majors to be taken to control its ill effects and sustainable growth of the country. In the realm of facing different environmental problems, apart from enacting its own indigenous laws to protect environment, India has always volunteered to be a party to most of the international treaties and convention to contribute significantly in the protection of environment at global level. Some of the important international treaties/conventions to which India is a party are:

- International convention on regulation of whaling 1946
- Ramsar Convention on Wetlands of International Importance 1971
- Convention on International Trade in Endangered Species (CITES) 1973
- Convention for conservation of Antarctic marine living resources 1980
- Basal convention on the control of trans-boundary movements of hazardous wastes and their disposal 1992
- Vienna convention for the Protection of the Ozone layer 1985
- Montreal protocol on substances that deplete the Ozone layer 1987
- United Nations Convention on Climate Change (UNFCCC) 1994
- Convention on Biological Diversity (CBD) 1994
- UN convention to combat desertification 1994
- Kyoto protocol 1997
- Stockholm convention on persistent organic pollutants 2001
- Reduced Emissions from Deforestation and forest Degradation (REDD) 2005

1.10 Conclusion

The economic and social profile of India presented in this chapter gives a vivid description of all relevant parameters tracing the trend from the past also. The country has passed through different phases of economic growth characterized by different economic and social indicators. The growth of gross domestic product of India was slow in the initial three decades that is from 1950–51 to 1980–81 in comparison to the decades from 1980–81 to 2010–11. Out of the total share of 14.5% in GDP in 2010–11, agriculture alone accounted for 12.3% followed by forestry and logging at 1.4%. The rural population of the country was approximately 82.7% during 1950-51, which decreased to 68.8 % in 2010–11 due to migration to the urban areas. The level urbanization recorded on an increased from 27.81% in 2001 to 31.16% in 2011 census. Moreover, literacy rate in India grew to 74.04% in 2010–11 from 12% at the end of British rule in 1947. The rate of growth of literacy in the decade ending 2001 has been higher 14.75% in rural areas as compared to the 7.2% increase in urban areas. Improvements literacy in urban areas was 80.3% and that in rural areas 59.4%. In 1951 the at-birth life expectancy was found 37 years which increased to nearly 65 years by 2011. However the environment condition in the country continues to deteriorate in general whereas the forests have shown remarkable improvement and transition towards sustainable forest management and rehabilitation.

The history of management of forests since 1855, various forest acts, land marks in forest policy, regulation and governance, and scientific management of forests in the country is described in the next chapter. The continuous increase in forest cover is described in details in Chapter III. The Chapters IV and V present how the state of forests has been shaped by these socio-economic conditions of the country in general and special efforts made by the all three organs-executive, legislative and judiciary of the government.

2 FORESTS AND FORESTRY IN INDIA

2.1 Extent of Forests and their Classification in India

The term Forest area generally refers to all the geographic areas recorded as 'Forest' in any government records in India for the purpose of land use classification. The Indian Forest Act, 1927 does not define the forests, and the legal extent of forests depends upon the process of notifications. Hon. Supreme Court of India has taken a view regarding extending purview of the Forest Conservation Act, 1980 to all the areas falling in the "dictionary meaning" of forests irrespective of ownership and control (1996), which is read as, "an extensive natural tract of land covered with trees and undergrowth, sometimes intermixed with pastures". Legally recorded forest areas are largely categorised as Reserved Forest (RF) and Protected Forest (PF) notified under the provisions of Indian Forest Act 1927. The act also provided for a third designation of forests in its constitution called the Village Forests. As of today, an area notified as forests in any act or recorded as forests in any government record continues to be defined as forests provided their ecological functions are maintained. The extent of State/UT wise recorded Forest Area is given as under in the Table 2.1.

Table 2.1. Recorded Forest Area of states of India (area in mil ha).

State	Geo. Area (GA)	Recorded Forest Area	Reserve forest	Protected Forest
Andhra Pradesh	27.507	6.381	5.048	1.237
Arunachal Pradesh	8.374	5.154	1.055	0.953
Assam	7.844	2.683	1.786	0
Bihar	9.416	0.647	0.069	0.578
Chhattisgarh	13.519	5.977	2.578	2.404
Delhi	0.148	0.009	0.008	0.001
Goa	0.370	0.122	0.025	0.085
Gujarat	19.602	1.893	1.412	0.048
Haryana	4.421	0.156	0.025	0.116
Himachal Pradesh	5.567	3.703	0.190	3.313
Jammu & Kashmir	22.224	2.023	1.764	0.255
Jharkhand	7.971	2.361	0.439	1.919
Karnataka	19.179	3.828	2.869	0.393
Kerala	3.886	1.127	1.112	0.014
Madhya Pradesh	30.825	9.469	6.189	3.110
Maharashtra	30.771	6.194	4.923	0.820
Manipur	2.233	1.742	0.147	0.417
Meghalaya	2.243	0.950	0.111	0.001
Mizoram	2.108	1.672	0.791	0.357
Nagaland	1.658	0.922	0.009	0.051
Orissa	15.571	5.814	2.633	1.553
Punjab	5.036	0.306	0.004	0.114
Rajasthan	34.224	3.264	1.245	1.742
Sikkim	0.710	0.584	0.545	0.039
Tamil Nadu	13.006	2.288	1.939	0.218
Tripura	1.049	0.629	0.418	0
Uttar Pradesh	24.093	1.658	1.166	0.142
Uttarakhand	5.348	3.465	2.464	0.989
West Bengal	8.875	1.188	0.705	0.377
A & N Islands	0.825	0.717	0.561	0.156
Chandigarh	0.011	0.003	0.003	0.000
Dadar & NagarHaveli	0.049	0.020	0.020	0.001
Daman & Diu	0.011	0.001	0	0
Lakshadweep	0.003	0	0	0
Puducherry	0.048	0.001	0	0
Total	**328.726**	**76.951**	**42.254**	**21.398**

Source: SFR –India 2010

2.2 Forest Classification and Forest Types of India

The two famous foresters of India, Champion and Seth after traversing the country's forests and studying them in depth, classified India's forests into 16 broad categories (type groups), which were further divided into 200 types on the basis of climate, topography and soil described in previous chapter and includes tropical, sub-tropical, temperate, dry and moist deciduous as well as wet evergreen forests. The forest classification of Champion and Seth is given in Table 2.2.

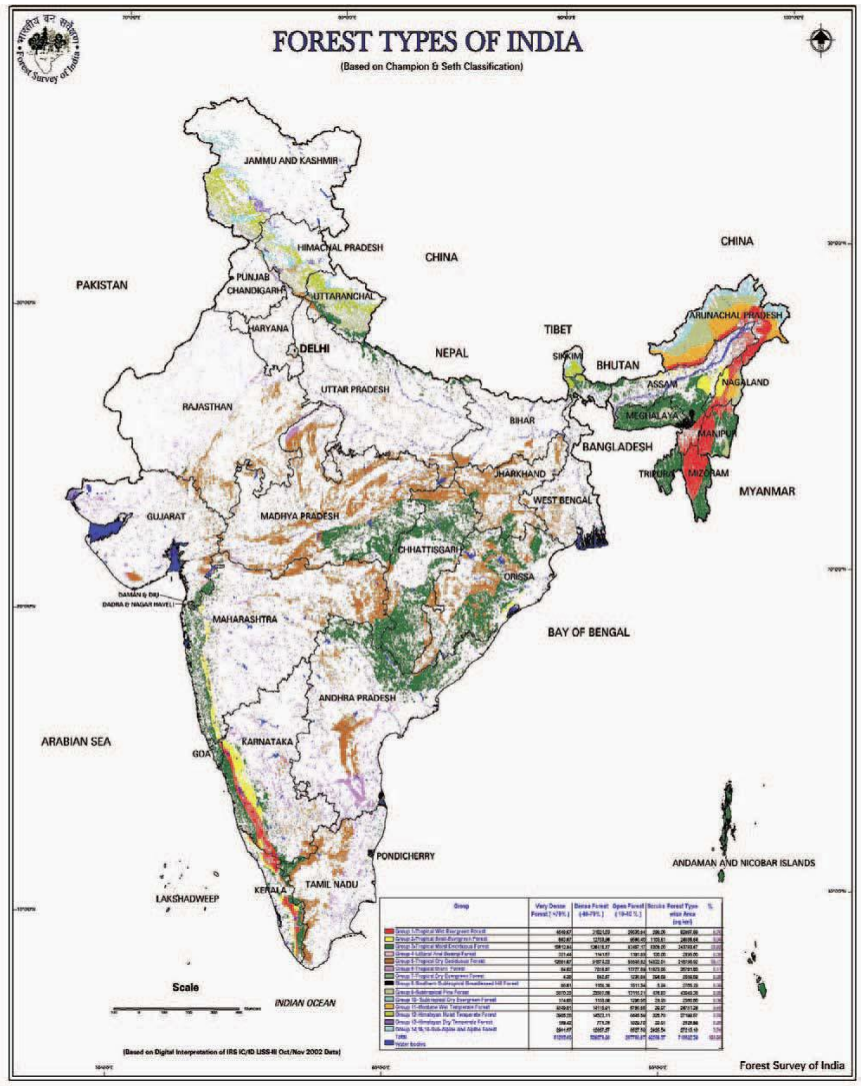


Figure 2.1. Forest Types of India.

Table 2.2. Major Forest Types of India.

Major Forest Group	**Temperature range in zone occupied by the major forest types**	
	Mean annual temperature (degree Celsius)	**Mean January Winter temperature (degree Celsius)**
Tropical	>24	> 8; no frost
Sub-tropical	17 to 24	10 to 18; frost but not severe
Temperate	7 to 17	1 to 10; pronounced, frost and some snow
Alpine	<7	<1; severe frost with snow

Tropical forests		
Forest Type	**Characteristics**	**Major tree species**
Tropical Wet Evergreen Forest (Two subgroups)	Dense tall forest, 45 m or more, entirely evergreen or nearly so, no species occurs gregariously. No individual species forms more than 1% of the upper canopy.	*Dipterocarpus*, *Artocarpus*, *Hopea dysoxylum*, *Mesua*, Cane and Bamboo.
Semi-Evergreen Forest (two sub-groups)	Dominants include deciduous species but evergreens predominate. the canopy is typically less dense than the true evergreen.	*Dipterocarpus*, *Artocarpus*, *Terminalia*, *Albizzia*, *Hopea*, etc. Cane and Bamboo.
Moist Deciduous Forest (three sub-groups)	Dominants mainly deciduous but sub-dominant and lower canopy largely evergreen. Canopy rarely dense and even but over 25 m high.	*Tectona* (Teak) in south, *Shorea* (Sal) in north, *Albizzia*, *Terminalia*, *Lagerstroemia*, *Anogeissus*, *Pterocarpus*, *Dalbergia* and bamboo.
Littoral and Swamp Forest (five sub-groups)	Mangroves, mainly evergreen, varying density and height, but always associated with wetness.	*Casuarina*, *Heriteiora*, *Bruguiera*, *Syzygium*, *Myristica*, *Rhyzophora* and Palm.
Sub- Tropical Forests		
Dry deciduous Forest (two sub-groups)	Entirely deciduous or nearly so. Top canopy rather light rarely over 25 m high, usually 8-20 m.	*Tectona* (Teak) in south, *Shorea* in north, *Anogeissus*, *Dalbergia*, *Terminalia*, *Madhuca*, *Acacia*, *Diospyros*, etc. and grasses.
Thorn Forest (two sub-groups)	Deciduous with low thorny trees. Canopy more or less broken height under 10 m.	*Prospis*, *Acacia*, *Zizyphus*, *Calotropis*, *Salvadora* and *Euphorbia*, etc.
Dry Evergreen Forest	Hardleaved evergreen trees predominant with some deciduous emergents, often dense, but usually under 20 m high.	*Memicylon*, *Mimusops*, etc.
Subtropical Broadleaved Hill Forest (two sub-groups)	Broadleaved, largely evergreen high forest.	*Calophyllum*, *Cinnamomum*, *Castanopsis*, *Ficus*, *Schima* and *Michelia*, etc.
Subtropical Pine Forest	Pine association predominate.	*Pinus roxburghii* (in west), *P. Kesiya* and *Pinus insularis* (in east).
Subtropical Dry Evergreen Forest	Low xerophytic forest and scrub	*Olea cuspidata* and *Acacia modesta*, *Dononea*, etc.

Temperate Forests		
Montane Wet Temperate Forest (two sub-groups)	Evergreen forest without conifers.	*Ternostroemia* and *Michelia* in southern hills and *Quercus* (oak), *Acer*, *Alnus* and *Machilus* in Himalayas.
Himalayan Moist Temperate Forest	Open Coniferous mainly oak and conifers.	*Cedrus deodara*, *Abies pindrow* (fir) *Quercus* (oak), *Picea smithiana* (Spruce), etc.
Himalayan Dry Temperate Forest (two sub-groups)	Open coniferous forest with sparse xerophytic under growth.	*Pinus wallichiana*, *Pinus gerardiana*, *Ilex*, *Quercus harix*, *Betula*, *Salix* spp. etc.
Alpine Forests		
Sub Alpine Forest	Stunted deciduous or evergreen forest, usually in close formation, with or without conifers.	*Picea smithiana*, *Abies spectabilis* in west, and *Abies densa* and *Betula utilis* in east, *Rhododendron* spp. etc.
Moist Alpine Scrub	Low often dense scrub.	*Betula utilis*, *Rhododendron*, *Juniperus* and *Betula* spp. etc.
Dry Alpine Scrub	Xerophytic scrub in open formation.	*Juniperus communis* and *Juniperus wallichiana* in west and *Juniperus recurva* in east. Also some *Salix* and *Hyricaria* spp.

Source: Champion and Seth 1968

2.3 Historical Background

Hunting/gathering societies characterized by low density and usually nomadic populations are those that harvest the bounty of the natural environment in order to meet their basic needs. The aboriginal (tribal) people, who resided in different parts of India, were an example of hunter/gatherer society. The forests provided their basic needs like wood for fuel, game, nuts and berries for food. With the advent of tools and agricultural implements which made it easier to clear forests and plough heavy soils, forests were cleared for agriculture and grain crops flourished. Low–density nomadic populations were transformed to a higher-density agrarian and commerce-based population by expansion of agriculture. The relationship to the land and to forests changed and the idea of land ownership started to take hold.

Gradually a feudal society emerged with the nobility, royalty or the heads of religious institutions owning the forests. Before Chandra Gupta Maurya established a relatively big empire about **300 BC** the territory in the country was divided among various feudal lords whose reign extended to small geographical units. They were far too occupied fighting wars against each other, to evolve any pattern of resource management in their kingdoms. However, the forests were used in several ways. Peasants were allowed to occupy and clear the forests for cultivation and to collect firewood for fuel while the trees were harvested and the timber used for various purposes of construction. Forest management in this era was mainly for sport and recreation and could be better labelled as “game management”. This ancient period was marked by destruction of forests due to wars rather than any attempt for their conservation. Virtually every war took a toll on large tracts of forest. Chanakya, the wily and famous Prime Minister to Chandra Gupta Maurya, realized the need to establish a forest administration. He not only appointed a Superintendent of Forest, but also classified the forests on a functional basis. The following pattern of functional classification of forests was evolved during this period.

1. **Forests set apart for the study of religion,**
2. **Forests reserved for the supply of forest produce,**
3. **Forests set apart for the grazing of royal elephants,**
4. **Forests reserved for hunting by the Royalty,**
5. **Forests open to public for hunting**.

Following the decline of the Mauryan Empire, India became fragmented, with various parts ruled by numerous kingdoms for the next 1,500 years. This period is generally known as the classical period of Indian history since it is estimated that India had the largest economy of the ancient and medieval world, up to the 18th century. Forests supplied the timber for various temples, palaces and other buildings belonging to aristocrats of society at that time. **Teak, Deodar, Sal and Shisham** may have been the first commercial trees and were harvested as early as 4000 B.C. The Mughals (1526–1756) made no attempts towards forest conservation. Perhaps, they did not even realize the need. Though forests shrank steadily in size on account of felling made for cultivations, they still produced much more than the people required. If the Mughal rulers took no steps to conserve forests, the early British administrators did worse. The Mughals were only indifferent to forests but the early British administrators exploited the Indian forests to secure big supplies of teak and other timber for their navy; to obtain timber for local construction; to fell and export the scented sandalwood to various European countries; and to allow free development of agriculture by clearing forests. They did not consider even regulating the felling in forests, let alone make any efforts to conserve the resource. It is, indeed, ironical that the first officer, Captain Watson was appointed as a Conservator of Forests in November, 1806 and was assigned the duties of procuring maximum quantities of Indian timber for building the ships for the British Navy. Watson plundered rather than conserved the forests in Travancore and Malabar. The first regular Conservator of Forests was appointed in Bombay in 1847 and in Madras state of India in 1856. The foundation of organized forest administration was laid with the establishment of Imperial Forest Department in 1864 under Dr. Dietrich Brandis and legal measures, notably the 1865 Forest Act was promulgated to confer powers to the newly constituted Forest departments. It provided for the creation of separate categories of forest: 'reserved' and 'protected'. The reserved forests may be defined as an area notified under the provisions of Indian Forest Act or the State Forest Acts having full degree of protection and all activities are prohibited unless permitted, whereas protected area may be defined as an area notified under the provisions of Indian Forest Act or the State Forest Acts having limited degree of protection and all the activities are permitted unless prohibited. Concepts of working plans[1] and management units as Divisions and Circles emerged for scientific management of state owned forests and a separate forest department was set up in each province and by 1917 the post of Chief Conservator of Forests was also created in major provinces.

One of the major factors which contributed to a substantial loss in forest area and its conversion to agriculture during British era was loss of occupation of artisans who could not compete with imported goods from England. India became an importer of finished goods and exporter of raw materials. Consequently, more land was required for agriculture by these people and as a result, forests were cleared in India by landless rural. The forests in India were at different stages of development and their use was dominated by three assumptions viz.

1. Natural resources are inexhaustible,
2. There is an abundance of resources in an unclaimed state,
3. Hard work to convert wilderness into a cultivated or managed state should be rewarded.

There was little concern of conservation for future generations. The years after the Royal proclamation in 1858 were marked by massive felling of forests for railway sleepers. If the needs of the Royal Navy destroyed the forests in the early years of the British administration, the requirement for the local railways ruined the forests in the middle years of the foreign rule (Lal 1989).

With this historical background, the landmarks in forest policy, regulation and governance evolved during British India are described in brief to bring out clear picture prevalent in the field of forestry till India became independent in 1947.

2.3.1 The Forest Charter of 1855

Public policy making is generally a reflection of the dominant economic and strategic requirement of the current ruling regimes. In second half of the 19th century the British rulers started consolidating their foothold in India and planned for vast network of roads, rails and other physical infrastructure.

[1] Working Plans are used for scientific management of forests. They are useful for evaluating the status of forest resource of a division, assessing the impact of past management practices and deciding about suitable management interventions for future.

With the growing significance of forests as a source of revenue and strategic requirement of timber for the expanding railway network, the Forest Charter in 1855 was attempted by the British India Government towards forest governance. The Forest Charter of 1855 decisively changed the status of wasteland into government property, reversing the previous *laissez-faire* (or sometimes laisser-faire meaning "let them do as they will") policy in matters of land. This was a key intellectual revolution at that time, extending the private concept of absolute property from the individual to the State while greatly expanding British authority over land and people of India. It is also held that the Charter was issued to support modern scientific forestry methods and conservation in the face indiscriminate felling and potential long term environmental effects of deforestation (100 Years of Indian Forestry, 1861-1961, Vol. II).

2.3.2 The Indian Forest Act 1865 (amended in 1878)

The British began extending their control over forests in India after legislating acts – the Indian Forest Act of 1865 and 1878. The Indian Forest Act, 1865, empowered the government for notification of any land covered with trees as state forest provided the existing rights of individuals and communities were settled in a process. This initial act was superseded by a more inclusive piece of legislation, the Indian Forest Act of 1878, which was particularly aimed at removing the ambiguity about the 'absolute proprietary right of the State'. The new act was designed to facilitate strict State control over forest resources and sought to remove all concessions and 'rights' that were not explicitly granted by the State. In this way, the informal and centuries-old system of privileges that existed between rural communities and the government, were actually rescinded.

According to the 1878 Forest Act, three types of forest were designated; **Reserved, Protected, and Village**. Reserved Forests were deemed the most commercially valuable and amenable to sustained exploitation. Overall state control of reserved forests was sought, which involved either relinquishment or transferral of claims and rights. Protected Forests were similarly state controlled, but some concessions were granted, conditional to the reservation of commercial tree species, when these became valuable. Protected Forests could also be closed to fuel wood collection and grazing, whenever it was deemed necessary to do so. As timber demand of British Empire increased, it was noticed that the limited control of the State was inadequate and many Protected Forests were re-designated as Reserved Forests. Provisions were also made for village forests for the management and local use of the community.

2.3.3 The First Forest Policy of 1894

In 1894, Brandis a German forester and the first Inspector General of Forests in India concluded that the "frontier was closed". Forests were not inexhaustible anymore. Thus the Indian conservation movement was started under the leadership of Brandis, who wrote the first forest policy of India in 1894. The sole objective of the policy was the maintenance of adequate forests for revenue collection and to serve agricultural interests more directly. The forests of India were classed under following headings:

1. Forests, the preservation of which was essential on climatic or physical grounds such as hill slopes,
2. Forests which afforded a supply of valuable timbers for commercial purposes,
3. Minor forests to be managed mainly in the interests of the population of the tract which obtained its forest requirement from the source,
4. Pasture forests[2]

The management resulting from the policy was directed towards promoting the general well-being of the country, meeting the needs of local people and to maximize the revenue collection. However the First World War resulted in over exploitation of the forests for timber.

2.3.4 The Indian Forest Act of 1927

Indian Forest Act 1927 embodied all the major provisions of the earlier Indian Forest Act and other Provincial Acts with the objective of managing government forests in India and laid the foundation of

[2] Lands, available for grazing of domestic animals in or adjoining forests.

legal forestry in modern times. It extended to consolidate the law relating to the transit of forest produce and the duty imposable on timber and other forest produce. The classification of forests as reserved, protected and village forests continued and detailed procedure for their notification and regulation was provided in the Act. The reserved forests were exclusively meant for the Imperial use whereas protected forests recognised the rights and concessions enjoyed by the local people. Though the enactment aimed to ease the realization of Imperial interests, it was a very far sighted approach and has been serving the purpose of forest regulation and management in India till date. Provincial governments have undertaken various amendments from time to time to make the act more suitable to local governance and issues (Govt. of India Act 1935). Uttarakhand, has a unique institution for Community Forest Management in the form of Van Panchayat created under the provision of Section 28 of the Indian Forest Act 1927 and governed by the Uttarakhand Panchayati Van Rules 2005. This unique institution has been in existence and has successfully been managing village forest since early 1930, with technical guidance of the Forest Department

2.4 The Forest Governance in Independent India

After independence there were many political initiatives and the contemporary princely states were either constituted into states of India or merged into adjoining states creating a new Republic of India. With the abolition of 'Zamindari System[3]', large private forest areas were taken over by the state government by their legislative enactments. Consequently these acts of consolidation of forest areas led to an increase in notified forest area from 40.48 mil ha in 1950-51to 66.80 mil ha in 1976–77.

2.4.1 The Forest Policy of 1952

The Forest Policy of 1952 was enunciated by the Government of India in view of far reaching development in the economic and political fields. The policy recommended bringing 33% of the total land area of the country under the forest cover, a proportion of 20% to be attained in the plains and 60% in the mountainous regions, for ensuring a balanced and complementary land use system for ecological security. It also recognized the protective and productive functions of forests and underlined the importance of their protection, and contribution in watershed management, wildlife conservation as well as their role in improving soil fertility and agricultural productivity with continued emphasis on contributing maximum annual revenue. To facilitate fixing of priorities in management, the policy indicated the following functional classification of forests:

1. *Protected forests*: those forests which must be preserved or created for physical and climatic considerations.
2. *National forests*: those which have to be maintained and managed to meet the needs of defence, communications, industry and other general purposes of public importance.
3. *Village forests*: those which have to be maintained to provide firewood, small timber and other forest produce for local requirements and to provide grazing for cattle.
4. *Tree lands*: those areas which though outside the scope of forest management are essential for the amelioration of the climatic and physical conditions of the country.

Even though no operational guidelines were issued and the functional classification was seldom adhered to, the policy advocacy for the extension forestry to meet the growing needs of the local populace laid the foundation of social forestry in India in 1970s.

2.4.2 The National Commission on Agriculture and its Interim Report in 1972

The National Commission on Agriculture in its interim report in 1972 emphasized production forestry (man-made forests) and recommended creation of Forest Development Corporations for enhancing the investment through bank financing and raising of large scale plantations through social forestry. The report of the commission was instrumental in promoting large scale social forestry programmes in India. Further, the subject "Forest" was shifted to the Concurrent list of the Constitution from the State list by the 42nd amendment of the Constitution in 1976. Subsequently, a Central Act "Forest Conservation Act 1980" was enacted to control the diversion of forest land for non-forestry purposes. In January 1985, the subject of Forestry and Wildlife was shifted from the Ministry of Agriculture to

[3] A landholder in British colonial India responsible for collecting and paying to the government the taxes on the land under his jurisdiction

Ministry of Environment and Forests, an independent new ministry created in the Central Government to prioritise emerging issues of forestry and wildlife.

2.4.3 Wildlife (Protection) Act 1972 and its Implementation

The Wildlife Protection Act 1972 enacted in 1972 by the Government of India provides protection to wild animals, birds and plants and for matters connected therewith or ancillary or incidental thereto with a view to ensure ecological and environmental security of the country.

Among other reforms, the Act not only established schedules of protected plants and animals but hunting and harvesting was also largely outlawed. The Act made provisions for appointment of regulatory authorities such as the Director of Wildlife Preservation with the Central Government and Chief Wildlife Warden and other officers with the State Governments for implementation of the Act. The National Board for Wildlife was constituted under the chairmanship of Prime Minister of India for framing policies and advising the Central and State Governments on the ways and means of promoting wildlife conservation and effectively controlling poaching and illegal trade of wildlife and its products.

2.4.4 Forest Conservation Act 1980

In order to exercise control on the diversion of forests by the State Governments, the Government of India enacted a Central Act called Forest (Conservation) Act, which came into force on the 25th October, 1980. Under the provisions of this Act, prior approval of the Central Government is essential for diversion of forestlands for non-forestry purposes of mankind development like construction of roads and dams, mining, transmission lines, defence purposes, etc.

2.4.5 National Forest Policy of 1988

A new National Forest Policy was promulgated in 1988. It marked a major departure from the 1952 policy by laying prime emphasis on environmental stability and conservation of forests, while meeting the domestic requirements of fuel wood, fodder, minor forest produce and construction timber for rural and tribal population and their participation in protection and management of forests. Forests were no longer source of revenue to finance the development activities. Conservation of natural heritage in the country by preserving natural forests with their vast variety of flora and fauna, which represents the remarkable biological diversity and genetic resource of the country, has also been emphasized.

2.4.6 Joint Forest Management Circular of 1990

Participatory arrangements have existed in Indian forestry for several years in some form or other. However it got formalized with the issuance of a circular from the Ministry of Environment and Forests in June 1990, which provided to the state governments a framework for involvement of village communities in protection, regeneration and development of degraded forests situated in the vicinity of the villages. Joint Forest Management (JFM) has been in operation for about 20 years and adopted by all States. The total number of JFM Committees in the country now are 112, 896 and the forest area brought under their ambit is 24.6 mil ha, till March 2010. (FSR- India 2010)

2.4.7 Panchayat (Extension to Scheduled Areas) (or PESA)Act 1996 (PESA Act 1996)

Village level democracy became a real prospect for India in 1992 with the 73rd amendment to the Constitution, which mandated that resources, responsibility and decision making be entrusted to the lowest unit of the governance, the Gram Sabha or the Village Assembly. A three tier structure of local self government was envisaged under this amendment. In January 1957, the Government of India passed an act to examine the working of the Community Development Programme (1952). The Act aimed to provide a three tier system of Panchayati Raj for all States having a population of over 2 mil, to hold Panchayat elections regularly every 5 years, to provide reservation of seats for scheduled castes, scheduled tribes and women; to appoint a State Finance Commission to make recommendations as regards to the financial powers of the Panchayats and to constitute a District Planning Committee to prepare a development plan draft for the district. The three tier system of Panchayati Raj consists: Village-level Panchayats; Block-level Panchayats and District-level Panchayats.

Since the existing laws did not automatically cover the scheduled areas, the PESA Act was enacted on 24 December 1996 to enable Tribal Self Rule in these areas. The Act extended the provisions of Panchayats to the tribal areas of nine states that have Fifth Schedule Areas[4]. Most of the north-eastern states under Sixth Schedule Areas (where autonomous councils exist) are not covered by PESA, as these states have their own Autonomous Councils for governance. The PESA Act gives governance powers to the tribal community and recognizes its traditional community rights over local natural resources. It not only accepts the validity of "customary law, social and religious practices, and traditional management practices of community resources", but also directs the state governments not to make any law which is inconsistent with these.

2.4.8 Forest Rights Act 2006

The Scheduled Tribes and Other Traditional Forest Dwellers (Recognition of Forest Rights) Act 2006 is a result of the protracted struggle by the marginal and tribal communities of our country to assert their rights over the forestland over which they were traditionally dependent. This Act is crucial to the rights of Millions of tribal people and other forest dwellers in different parts of our country as it provides for the restitution of deprived forest rights across India, including both individual rights to cultivated land in forestland and community rights over common property resources. The notification of rules for the implementation of the Forest Rights Act 2006 on 1 Jan 2008, paved the way to undo the 'historic injustice' done to the tribal people and other forest dwellers.

2.5 Forestry Administration in India

The forest sector of the country is administered broadly at two levels a) at the Union Government level by the Ministry of Environment and Forests and b) at the State/UTs level by the Forest Departments (FD). The Union Ministry of Environment and Forests is largely responsible for framing national policies and laws. It also provides financial support for research activities, national surveys, training to officials and over all monitoring of the forests sector. On the other hand major responsibility to protect, conserve, manage, administer and develop forests and wildlife lies with state governments/UTs in their respective jurisdictions. For the purpose of administration each State Forest Department has, in general, two main wings, territorial forests and wildlife, each headed by a Principal Chief Conservator of Forests. Many states have named the department as Forest and Wildlife Department or Environment and Forest Department. All the senior positions of the department are manned by Indian Forest Service (IFS) officers recruited by Union Public Service Commission. Depending upon the size, these wings are further divided into Circles and each Circle into Divisions. Forest Divisions forms the basic unit of forest administration and management, which mostly correspond to Civil Districts of the state administration. The divisions are divided into Ranges under the charge of Range Forest Officers and each Range into Sections/Blocks and Beats under Foresters/Forest Guards for undertaking all field operations. The structure from the top up to Range level is almost uniform in all the State Forest Departments (SFD). The Principal Chief Conservator of Forests (PCCF) heads the forest department in the State.

The wildlife wing is generally responsible for management and protection of Protected Areas, National Parks, Wildlife Sanctuaries, Zoological Parks and other wildlife activities. In many cases officers heading territorial divisions also have the responsibility to manage wildlife in their territory. On the recommendation of National Commission on Agriculture (NCA), many State Governments in India established Forest Development Corporations (FDCs) to work on commercial lines by raising industrial plantations to enhance the production of forest produce, to restore the productivity of degraded forest areas, to harvest and undertake trade of timber and Non-Timber Forest Products (NTFPs), to own and run forest based industries, to provide support to farmers for marketing their forest produce and to provide consultancy in raising bio-aesthetic plantations etc. At present such corporations exist in 22 states and in one union territory.

[4]The Indian Constitution is supposed to protect tribal interests, especially tribal autonomy and their rights over land, through Fifth and Sixth Schedules. Scheduled Areas of Article 244(1) are notified as per the Fifth Schedule and Tribal Areas of Article 244(2) are notified as per the Sixth Schedule.

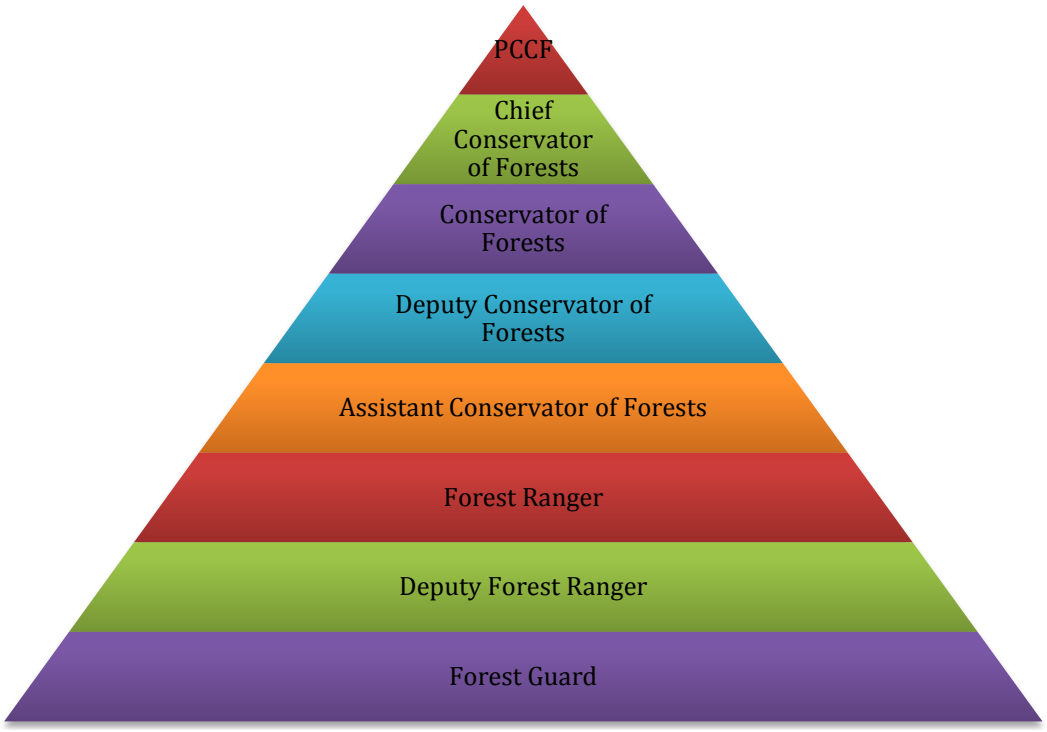


Figure 2.2. Hierarchical level of forest administration.

2.6 Scientific Management of Forests in India

Sustained yield and scientific forest management, had not been widely applied in the management of forests in India, However with passage of time these management principles were now seen as a way to increase production and make a profit. The market incentives for forest management provided a powerful force and forestry became a profitable enterprise. In India, the era of scientific management of forest began with the appointment of Dietrich Brandis, as the Inspector General of Forests in 1864. However, the first recorded action to improve and rehabilitate the forests in the country was observed in 1842, when Conolly, the then Collector of Malabar, assisted by an Indian, Chathu Menon, a Sub-Conservator of Forest, raised the pioneer Teak plantations at Nilumbur. The plantations were highly successful, and over the years became world famous. Conolly's efforts made the British rulers (the Directors of the East India Company) recognize the need to improve the forests of south India.

Dietrich Brandis for the first time estimated the existing growing stock in the forest with respect to their size-classes by introducing Linear Valuation Survey. The rates of growth of teak were estimated by extensive ring counting. He also propounded the fundamental principle that the first class trees (trees over a prescribed diameter) to be taken up for felling in a given year should be restricted to the growing stock of the second class trees that will eventually replace them in that year. He used this principle in all subsequent working plan strategies. Though Brandis initiated the preparation of Working Plan for selected valuable forests, the progress was very slow and only 0.0282 mil ha forests owned by the government was covered under the scientific management.

But in 1884, the diligent efforts of Sir Wilhelm Schlich, Inspector General of Forests, resulted in a country wide unified approach towards the preparation of Working Plans and scientific management of forests as per prescriptions of working plan. The experience so gained in the past led W. E. D'arcy (1895) to bring out his treatise "Preparation of Forest Working-Plans in India", which provided guidelines for systematic working plan preparations. From 1906, the work of execution of working plans was entrusted to the Superintendent of Working Plans stationed at Forest Research Institute, Dehradun and the working plans were now based on research carried out here. Working Plan Officers based their prescriptions on more definite information about the silvicultural characters of most of the important tree species, techniques of obtaining their regeneration and their probable response to the main silvicultural treatments. So far as working plans were concerned, the central control was once again lost in 1935. With the subject of "Forestry" which was managed by the Federal Government until then, being transferred to the "Provincial List" by the Government of India Act 1935, felling of forests was carried out in total disregard to the working plan prescriptions.

After India became independent in 1947, the forest department undertook big drives to recover substantial areas under the working plans. For the next half a century, the Provincial/State Governments adopted their own Provincial Working Plan Code as per regional requirements in different states of the country. However with the intervention of the Supreme Court of India, it has been further clarified that all working/management plans have to be approved by the Central government on account of forests being brought on the Concurrent list. Therefore, Ministry of Environment and Forests (MoEF), Govt. of India adopted a uniform code namely National Working Plan Code 2004, for the preparation of working plans and the management of forests under the prescriptions of a working plan/scheme for all forests of the country.

In recent years there has been paradigm shift in the policy and approach to the forestry sector both nationally and internationally. The focus has shifted from timber harvesting to environmental stability, biodiversity monitoring and management, restoration of ecological balance of the disturbed areas, protective functions of the forest resource and other socio-economic benefits based on Non Wood Forest Products (NWFP). The concept of sustainability in forest management thus implies not only to sustainability of productive functions but also to environmental functions (e.g. soil and water conservation) and socio-economic benefits (e.g. meeting livelihood and basic needs of forest dwellers and other forest dependent communities). Therefore, provisions have been made to integrate the aspects of forest management which are considered important for assessing the sustainability, accompanied by a set of related quantitative, qualitative or descriptive attributes which when measured or assessed periodically would indicate the direction of change for each aspect of sustainable management of forests. It has also been recognized that climate change phenomenon seriously affects and alters the distribution, type, composition, quality and mitigation potential of forests especially in the realm of anthropogenic stressors. Involvement of forest fringe communities in protection and management of forest resources through micro-plans and eco-development plans has become imperative and must find linkages in the working plan. Working plan preparations also need to capitalise on the gains of technological advancements like remote sensing, GIS, GPS, computational and analytical systems at hand for real time monitoring of forest dynamics.

2.7 Development of Forest Resources: Schemes and Funding

Protection and conservation of forests which are also the habitat for wildlife is a major objective of the financial resources allocation by the government. The ultimate aim is to increase forest cover in the country and improve its quality.

2.7.1 Social Forestry

Externally Aided Projects (EAP) in forestry sector on a substantially large scale started during late 1970s to augment the financial resource mainly for expanding the forest and tree resource through Social Forestry programmes. These programmes were implemented with aid from different funding agencies like the World Bank, the Swedish International Development Agency (SIDA), the United States Agency for International Development (US AID) and Canadian International Development Agency (CIDA).

The funds from all the funding agencies amounting to US$ 309.10 million over the years was used to raise forest plantations of 2.572 mil ha mostly in non-forest lands along roads, rail and canal sides, on barren common lands, panchayat and institutional lands (MoEF 2004). The fund was also used for raising nurseries for distributing seedlings to people, often free of cost, for planting in their own farm lands, bunds, homesteads, institutional areas etc. The projects cover a wide range of issues of the forest sector, broadly including livelihood promotion, afforestation, forest management, institutional strengthening, protection and conservation of biodiversity of forests etc. The plantations raised have played a significant role not only in substantially increasing the forest cover of the country (including forest component of Trees Outside Forests) but also in meeting the ever growing timber needs of the country.

2.7.2 National Afforestation Programme (NAP)

National Afforestation Programme has been initiated by the Government of India with the objective of increasing the forest cover of the country and rehabilitating degraded forests through peoples'

participation. The implementation of this programme is through a two tier set up i.e. (1) Forest Development Agency (FDA) and (2) Joint Forest Management Committee (JFMC). FDA is an autonomous federation of all the registered JFMCs in a forest division. A good blend of entry point activities beneficial to village communities with forestry development activities is made to facilitate easy acceptance of the schemes by the village communities. In the initial year of its launch there were only 47 FDAs with a financial outlay of US$ 8.64 million. Gradually the growth of FDAs has increased and by 2009-10, 800 FDAs and 42,5335 JFMCs had been constituted under this programme. A total of US$ 424.91 million has been spent under NAP between 2001-02 to 2009-10, achieving afforestation on about 1.69 mil ha.

2.7.3 Preservation of Wildlife and Forest Biodiversity

The National Forest Policy 1952 provided for setting up of sanctuaries and national parks for preservation of wildlife. The enactment of the Wildlife (Protection) Act 1972, launch of Project Tiger in 1973, Project Elephant in 1992, and the Biological Diversity Act 2002 are other milestones in the conservation history of the country. Indian ivory is banned and India is a member of the Convention on International Trade in Endangered Species of Wild Fauna and Flora. The Wildlife Institute of India, Central Zoo Authority (CZA), the Tiger Conservation Authority, and National Wildlife Crime Control Bureau support the States in their responsibility towards conservation of wildlife and biodiversity.

The public forests dedicated to the protection of wildlife habitats include 102 national parks and 515 wildlife sanctuaries. The total area of 16.12 mil ha, which is about 4.90% of the geographical area of the country covering about 20% of the total forests, is maintained under this protected area network (FSR-India 2010). Scientific assessments of biodiversity of fauna, flora, and microorganisms for these areas have been undertaken.

In the context of the policy and planning on wildlife conservation in India a National Wildlife Action Plan (2002-2016) was adopted. The MoEF also provides technical and financial support is provided to the State/ UT Governments broadly under three Centrally Sponsored Schemes (CSS) namely (i) Integrated Development of Wildlife Habitat (ii) Project Tiger and (iii) Project Elephant for strengthening wildlife managment.

2.7.4 Integrated Development of Wildlife Habitats

This scheme provides financial and technical assistance to the states/UTs for improving the habitats of protected areas (102 National Parks, 515 Wildlife Sanctuaries, 47 Conservation Reserves and 4 Community Reserves), infrastructure development, eco development activities, anti poaching activities, research, training, capacity building and wildlife census etc.

The Centrally Sponsored Schemes (CSS) like 'Development of National Parks and Wildlife Sanctuaries' provide assistance to the States for conservation activities in the wildlife areas. MoEF has prioritized the Protected Areas (PAs) on the basis of their conservation value.

2.7.5 Project Tiger

The period of five decades after independence saw the depletion of tiger population of the country resulting in the introspection through the Tiger Task Force. The recommendations of the Tiger Task Force were considered relevant for not only protected area management but also for general forest management, which has resulted in the constitution of the Tiger Conservation Authority and Wildlife Crime Control Bureau at the Centre. The Directorate of Wildlife Preservation with a network in major ports of import/export has been reinforced with National Wildlife Crime Control Bureau for strengthening wildlife management. Critical activities such as identification of areas feasible for relocation and inclusive protection strategies remain to be worked on. Out of about 1500 villages in tiger reserves, only 80 have been relocated so far including nine during the Tenth Plan period (FSR-India 2010).

2.7.6 Project Elephant

The aim of Project Elephant is long-term conservation of viable elephant populations in the larger landscapes through strengthening or creation of corridors. Not enough attention has been paid to

reduce human–wildlife conflicts. Much of the activities have been short-term responses to conflict situations. With increasing population, wild elephants are observed to be increasing their range by dispersing into new areas.

The project focuses on strategies for strengthening and developing elephant movement corridors. It also explores the possibility of relocation from the areas with the potential of restoration of habitats. For the captive elephant population, a complete database for monitoring the status of health and productivity is being prepared.

2.7.7 National Rural Employment Guarantee Act (NREGA)

The (Mahatma Gandhi) National Rural Employment Guarantee Act (NREGA) was notified in September 2005 by the Government of India to enhance livelihood security of households in rural areas of the country, by providing at least one hundred days of guaranteed wage employment in a financial year to every household whose adult members volunteer to do unskilled manual work. The activities under the scheme *inter alia* include water conservation and water harvesting, drought proofing including afforestation and tree plantations, irrigation canals, renovation of traditional water bodies and land development. State Forest Departments have been intensively involved in this mega programme and have received funds for implementation of the NREGA where they are undertaking the activities which improve ecological stability and forest resource, besides enhancing livelihood security of the rural households.

A shelf of afforestation/ eco-restoration programmes will be generated for village communities for implementation under this Act. Necessary institutional initiatives include notification of afforestation as one of the activities, and dovetailing afforestation programmes with the NREGA programme. Apart from enrichment activity for forests, afforestation/eco-restoration helps in sustaining the livelihood of the rural poor. Developing multipurpose resources in underproductive forest or non-forest areas is an important component of this employment generation programme.

2.7.8 Compensatory Afforestation Fund Management and Planning Authority (CAMPA)

While considering the proposals for diversion of forest lands for non-forestry purposes under Forest (Conservation) Act 1980, MoEF generally levies cost of compensatory afforestation in equivalent non forest lands offered by the user agencies or in degraded forest land. Net present value of the land allowed to be diverted is also realized from the user agency. The funds thus accrued are made available by the respective States for identified compensatory afforestation and other forest development activities. The Supreme Court had, however, observed that the funds were not appropriated to the implementing authorities. It, therefore, directed the Central Government in 2002 to constitute an authority for management of the funds received from the user agencies and their exclusive and prompt utilization for the intended purpose. The MoEF notified the constitution of CAMPA on 23 April 2004, for management and use of this fund for forest development. It is understood that presently an amount of about US$ 909.10 million (FSR–India 2010) is available with CAMPA for utilization in forest conservation activities.

2.7.9 Green India Mission (GIM)

The Green India Mission (GIM) is one of the eight missions under the National Action Plan on Climate Change (NAPCC). The Mission aims to respond to the likely climate change impacts by a combination of adaptation and mitigation measures that help enhance carbon sinks in forests and other ecosystems. The overarching objective of GIM is to increase forest/ tree cover in 5 mil ha of land, and improve quality of forest cover in another 5 mil ha, thus together help in improving ecosystem services from 10 mil ha of lands, and increase forest based livelihood income of about 3 million forest dependent households. The mission proposes to take a holistic view of greening by restoring ecosystems and habitat diversity, enhancing biodiversity, and not merely focusing on tree plantations to meet carbon sequestration targets, and realizing carbon benefits as co-benefits, and treating forest and non-forest lands simultaneously in a given bio-physical unit such as landscape/sub-landscape/sub-watershed, etc. and addressing the drivers of degradation through crosscutting interventions and convergence with other programmes.

2.8 Extraction of Forest Products from Indian Forests

The uncontrolled and wasteful logging, illegal felling and excessive fuel wood collection are among the major direct causes of deforestation and degradation. State owned forest departments are the custodians of national forest resources controlling all forest related activities including protection and management of forest. However the task of extraction of timber and other forest produce was out sourced to private traders and contractors till late 70s right from pre-independence era.

On the recommendations of the National Commission on Agriculture (NCA 1972) on 'Production of Man-made Forests', many State Governments in India established Forest Development Corporations (FDCs). The FDCs raise industrial plantations to enhance the production of forest produce, restore the productivity of degraded forest areas, harvest and undertake trade of timber and Non-Timber Forest Products (NTFPs). The FDCs are registered bodies under the Companies Act, or any such similar Act, with a memorandum and articles of association of the company which can mobilize finance through banks etc.

2.8.1 Production and Consumption of Timber

In India, until 1970s the natural forests remained the main source of timber. The total production of timber from forests was about 10 mil m^3 per year although the country's requirement was estimated to be about 15 mil cu m (NCA 1972). Part of the requirement was met by harvesting trees from private lands outside forests. Timber production from government forests gradually declined with increasing restrictions imposed by Central Government (Figure 2.3). Ban was imposed on clear felling of forests and as well as green felling of trees above 1000 m (amsl) in hills. The new National Forest Policy 1988 also laid emphasis on conservation of forests and biodiversity, and discouraged production of timber from natural forest for industries. The annual production of timber from forests had declined to about 4 mil cu m by 1990.

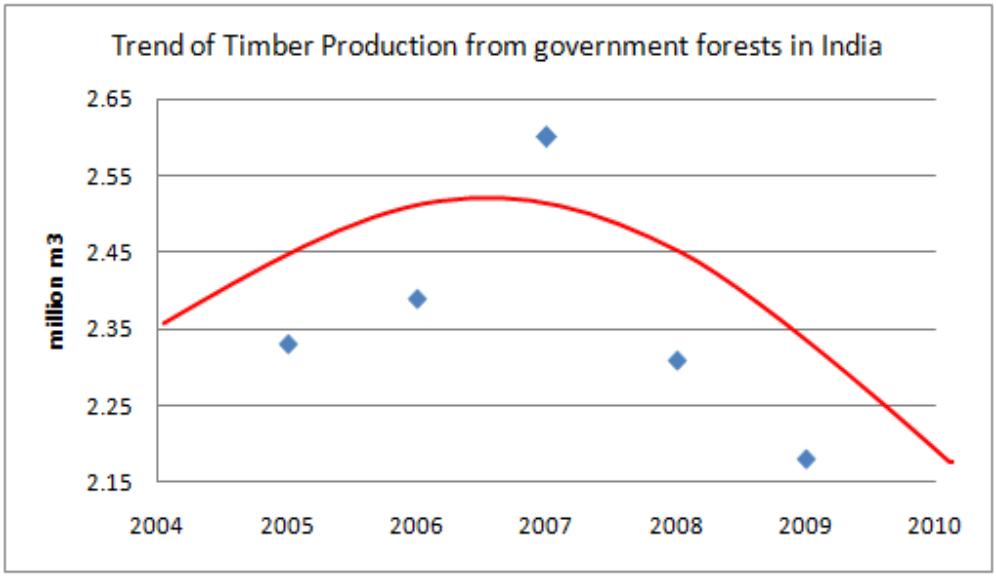


Figure 2.3. Trend of timber production from government forests in India.

Source: FSR- India 2010

The Supreme Court of India in its interim order stopped all activities in the forests in some states in December 1996, and banned felling of trees in two areas of Arunachal Pradesh. In a subsequent final order of 15 January 1998 applicable throughout the country, the apex court ordered that without prior approval of the Central Government, felling of trees would not take place except in accordance with the Working Plans of the area prepared by the State Government and approved by the Central Government. Some of the states which were harvesting timber without Working Plans especially of North-East India were the worst hit. There was virtually no production of timber in Arunachal Pradesh for about four years till the Working Plans of few divisions were approved by the Central Government. The trend of production of timber in Arunachal Pradesh (Figure 2.4) is quite revealing. The production of timber in other states was also adversely affected and the total annual production of timber from

government forests declined to about 2 mil cu m. Approximately 60% of the timber produced from natural forests in the country is carried out by government owned Forest Development Corporations.

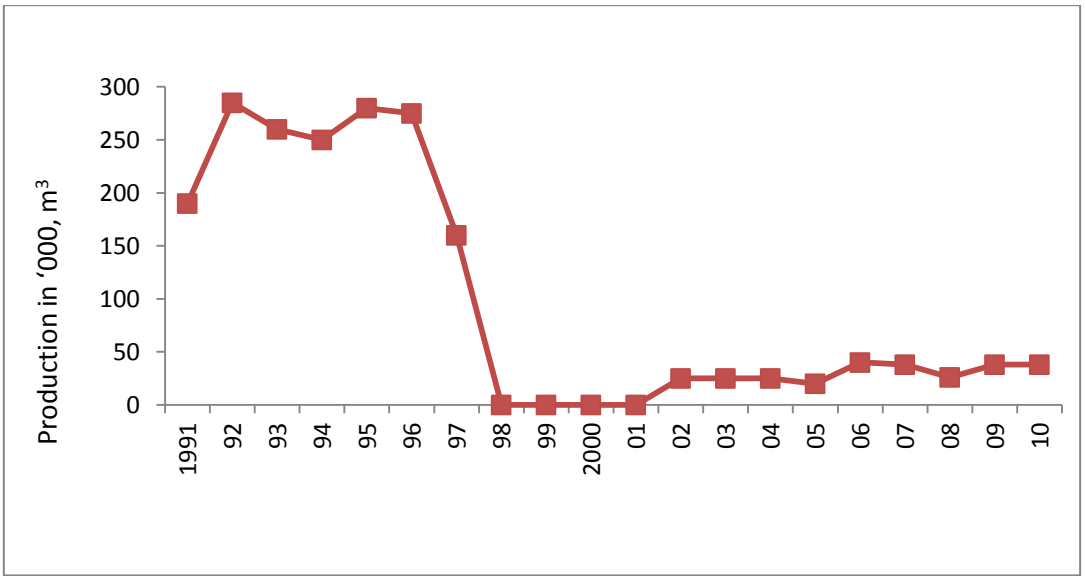


Figure 2.4. Trend of timber production in Arunachal Pradesh before and after the 1998 decision of the Supreme Court of India.

Source: FSR-India 2010

The annual production of wood in 2010 is estimated to be 3.175 mil cu m from the forests (excluding trees outside forests) in the country (ISFR 2011). Most of the wood produced in the country comes from TOF grown in private lands under agro-forestry, along the roads, canal, homesteads etc. Based on the growing stock of TOF and average rotation of the tree species, the annual potential production of wood from TOF has been estimated by the Forest Survey of India (ISFR 2011) to be 42.77 mil cu m in the country.

The estimated consumption of logs in wood based industries is 22.90 mil cu m by sawmills and that by plywood and veneer industrial units is estimated to be 19.90 mil cu m in 2010. Quantity of wood used in house construction, furniture and agriculture implements are estimated to be 340.17, 58.42, 21.59 mil cu m respectively (IFSR 2011). To calculate the annual consumption, the life span of wood for construction is taken as 20 years, household furniture as 15 years, industrial furniture as 10 years and agricultural implements as 5 years, the total annual consumption was calculated as 33.61 mil cu m (IFSR 2011).

2.8.2 Consumption and Production of Fuelwood

Majority of Indian population lives in rural areas where insufficient supply of comparatively expensive fuels like fossil fuels forces people to depend for their energy needs, on traditional practice of burning fuelwood. Though the largest use of wood in India is in the form of fuel, its production, supply, distribution and consumption have remained in the informal sector mainly because collection of firewood as head load by people dependent on forests is traditionally allowed as part of privileges or rights. The Forest Survey of India has found that 23.38% of the population still uses fuelwood and chips for domestic energy and the total quantity of fuelwood used every year in the country was estimated to be 216.421 mil tonnes for the year 2010. On the basis of analysis of data on free collection of fuel-wood, Neelkanthan (1999) found that only 20% of the total fuelwood produced in India comes from forests and rest from different sources. Treating this estimate as the best, the consumption of fuelwood from forests has been estimated to be 58.75 mil tonnes (ISFR 2011) and remaining coming from farmland, community land, homestead, roadside, canal side and other wastelands. It is also estimated that the recorded annual production of fuelwood from the forests is 1.232 mil tonnes and annual availability of fuelwood from Trees Outside Trees (TOF) is 19.254 mil tonnes (ISFR 2011).

2.8.3 Non–Wood Forest Products (NWFP)

Traditionally Non-Timber Forest Products (NTFP) or Non-Wood Forest Products (NWFP) have been known as 'minor forest produce' (MFP) because their volume and value compared to timber was recognized as minor in the national economy, although they have significant influence on local incomes and livelihoods. There are more than 800 types of NWFPs harvested in India however reliable harvest data is available only for a few. The enactment of Panchayats (Extension to Schedule Areas) Act, 1996, commonly known as PESA, has brought significant changes in policy relating to management and trade of NWFP as the ownership right of NWFP has been bestowed on the Gram Sabha.

In some parts of the country, harvest/collection, processing and trade of NWFPs like *tendu* leaves is done by the State Federations. The leaves obtained from Tendu tree (*Diospyros melanoxylon* Roxb.) are considered the most suitable for *bidi* industry (country made cigarettes) on account of their ease of rolling as *bidi* wrapper, texture, flavour and workability. The tree species is found in dry deciduous forests covering almost the entire Indian peninsula, and is harvested on commercial scale in many States. The bags, thus packed and cured, can be stored till their use in *bidi* manufacture.

The collection of *tendu* leaves is done involving local people through primary Forest Produce Societies, and the Federation additionally transfers the net profit to the these Societies, retaining a small proportion for overheads, development of NWFP and infrastructure. The Societies finally distribute the profits to the primary collectors. Other NTFPs which are most commonly harvested in many states are fodder grass, *Citronella* grass, *Bhabhar* grass, cane, thatch leaf, seeds of Sal, *Karanj*, *Mahua*, fruits of *Aonla*, Tamarind, *Harra*, *Bahera*, gum, lac, wax, honey, cinnamon, broom, *agarbati* stick and a large number of medicinal plants.

2.8.4 Resin

Crude resin is a thick, sticky fluid obtained by tapping the living pine tree. Resin is the source for producing rosin and turpentine which have wide utility in making soap, paper, paint, varnish, pharmaceuticals etc. In India the principal species tapped for resin production is *Pinus roxburghii* known as *Chir* or *Chil* which grows in the northern hilly region, mainly in Himachal Pradesh, Jammu and Kashmir, Uttarakhand and Arunachal Pradesh. A small quantity of resin is also produced from Blue Pine (*Pinus wallichiana*), which grows at higher elevations in these states. The tapping of the pine tree begins when it attains the diameter of about 30 cm at 50–60 years age. Average production of resin per blaze in a year is about 4 kg. The production of the resin harvested in India during 2009-10 was about 28,000 tonnes having market value INR 1080 million. Details of production and value of five years 2005-10 are given in Table 2.3. It is observed that the total annual production has gradually declined because of various policies of nature conservation.

Table 2.3. Annual production and value of resin for 2005–06 to 2009–10.
(Weight in 100 tonnes, Value in US$ 0.182 million).

	2005–06	2006–07	2007–08	2008–09	2009–10
Weight	337.40	338.22	320.81	291.96	279.61
Value	87.90	108.74	81.99	84.24	108.48

Source: FSR- India 2010.

2.8.5 Bamboo

Bamboo is considered poor man's timber in India probably owing to it being a versatile natural resource and extensively used NWFP for making variety of household products besides construction of dwelling units. Besides forests, it also grows in private farms, lands and in homesteads. Total bamboo bearing area of the country has been estimated at 13.96 mil ha (ISFR 2011). Arunachal Pradesh has the maximum bamboo bearing area of the country, followed by MP, Maharashtra, and Orissa. Average annual production of bamboo in India and their market value is 821 300 MT and is valued at US$ 76.34 million (FSR-India 2010).

2.9 Forest Product Processing and Marketing

Forest based industries are developed to encourage intensive utilization of available wood resources; enhance value addition on resources through its processing, create more employment and increase the contribution of forestry to national income. Forest based industries can help regional and rural development. Through backward and forward linkages they can generate considerable employment and income. Forest based small scale industries are part of the early stages of development in many rural areas and play important social and economic roles. They supply some of the basic needs of the community like charcoal for households/industrial energy and timber for housing. The inter industry linkages of forest products are significant, through their usage in successive stages of manufacturing/ processing to produce consumer goods of everyday use. The overall attributable contribution of primary forest products is thus considerably larger than their direct value. Primary and integrated wood processing industries produce a large number of products including sawn wood, veneer, plywood, other panel products, wood pulp/paper, parquet, shingles, toys, bobbins, sports goods, boats, carts, music instruments and pencils. The actual number of units involved in wood based processing is not available, however the timber produced in the country is consumed mainly by three categories of wood based industries, i.e. saw mills, paper mills, and plywood and veneer industries, all in the private sector. Saw milling industry (55731 in number, ISFR 2011) is the largest consumer of timber with estimated potential consumption of about 37 mil m^3 and the number of persons employed in these units was estimated as 0.27 million. In plywood, veneer and composite wood category, there are 62 large and medium-sized mills and over 3,000 small scale industries with consumption potential of 26.53 mil m^3 logs and 0.18 million persons are estimated to be employed in these units. The total number of paper and pulp mills in India is around 660, out of which only 25 mills are wood and bamboo based and the rest are agro and recycled fibre based. The demand of raw material for forest based paper mills in 2010 was estimated to be about 9 mil tons. Many large wood based paper mills like ITC, JK Paper Mills, Ballarpur Paper Mills have entered into arrangement with local farmers for growing trees in their farm land to supply raw material for their mills. The farmers are provided financial and technical assistance.

2.10 Economic Aspects of Forests in India

Traditionally, timber has been the most important and valuable product of the forests. Part of the requirement was met by harvesting trees from private lands outside forests. To meet their increasing demands, the wood-based industries augment their requirement by importing wood and promote plantations of high yielding genetically improved variety of tree species outside forests in farmer's lands as well as raise their own captive plantations. Many State Governments have established their own Forest Development Corporations to carry out commercial operations related to forestry sector. In Arunachal Pradesh and Andaman & Nicobar Island, the FDC was established to supplement forest departments in harvesting and marketing of timber. In Haryana and Punjab, FDC's were created to support farmers growing trees by providing reasonable price for their trees, besides supporting forest department in harvesting and marketing of timber. In Andhra Pradesh, Chhattisgarh, Madhya Pradesh and Maharashtra, the FDCs are harvesting and marketing timber only in the limited forest area leased to them where they raise commercially valuable tree species. Thus timber production from government forests has gradually declined with increasing restriction imposed by Central Government on felling of trees during 1980s for biodiversity conservation and bringing more areas under Protected Area network. Ban has been imposed on clear felling of forests and as well as green felling of trees above 1000 m sea level in Himalayas.

2.10.1 Valuation of Benefits of Forests

Ecosystems function and services have been classified in a number of ways by various groups. The economic value of an ecosystem good or service consist of both, use and non use values. It may be consumptive e.g. timber or non consumptive bird watching. Non use values can be substantial but are difficult to quantify. Valuation can be used as an important tool for decision making at the level of policy formulation. There have been several studies in India on valuation of goods and services from forest Lal (1990) was probably the first person to compile at the national level followed by Kumar (2004) who estimated the value of ecological services at US$ 1880 million per year. Few workers have estimated the value of goods and services at state level e.g. Himachal Pradesh (Verma 1999), Maharashtra (Haripriya 2000), Himalayan forest (Singh 2007). Few studies are available on valuation of protected areas e.g. Borivali (Hadkar *et al.* 1997), Dudhwa (Sharma 2006), Corbett (Badola *et al.*

2010). There are also studies on individual groups of goods and services such as NWFPs (Markandya 1993), biodiversity conservation (Ninan and Jyothis 2005), recreation (Manoharan 1996, Chopra 1998, Chaudhary 2006), carbon sequestration (Singh and Das 2008). All these studies have used different methodologies hence there is a huge variation in the results. Recently Bahuguna and Bisht (2013) estimated the economic value of goods and services of the forests of India as under.

2.10.1.1 Direct Benefits

Timber

Timber is one of the major forest products accounted also for estimation of the contribution of forestry sector to the GDP. The average annual timber production from the forests is approximately 2.4 mil cu m (FSR-India 2010) translating into a monetary value of US$ 1309.10million at an average market price of US$ 545.45 per cu m. The total value of timber extracted annually from forest is estimated at US $ 2,582.82 million annually (1 US$=INR 55). Trees Outside of Forest have a potential to produce 42.77 mil cu m of timber annually and its value in monetary terms come to around US$ 11,665.54 million. The total contribution of timber from forestry sector is estimated at US$ 14,246.36 million per year.

Fuelwood

Fuelwood is a predominant source of energy in rural India. According to an estimate of National Sample Survey Organization (NSSO) 261 mil cu m of fuelwood is consumed in the country each year, including wood used by households, restaurants and also for cremation. FSI (ISFR 2011) estimated that approximately 853.88 million persons in the country used fuelwood as a source of energy of which 199.63 million (23.38%) used fuelwood collected from forests. The total quantity of fuelwood used annually in the country was 216.42 mil tonnes per annum of which 58.75 mil tonnes came from forests, and its market value was estimated at US$ 3,738.63 million.

Fodder

Forests are major source of feed and fodder for livestock for forest dependent communities in India. The total fodder consuming livestock population of the country has been estimated at 518.6 million. FSI (ISFR 2011), estimated that 38.49% of these cattle i.e. 199.6 million cattle are partially or fully dependent on forest for feed or grazing. Currently, economic contribution of forestry sector for fodder/grazing is estimated at US$ 1619.45 million per year. However taking ISFR (2011) figures of Adult Cattle Units (ACU) into account and by multiplying it with the lowest value of fodder consumed by an ACU from forest @ US$ 0.58/-day (Pandey 2010), the total contribution of fodder/grazing from forest is estimated at US$ 18348.22 million per year.

Other Non Wood Forest Products

Forests provide a wide range of NWFPs such as fruits, nuts, pods, bark, gums and resins, medicinal plants, rhizomes etc. Nearly 27% of the total population of the country, comprising of around 275 million rural people, depend on NWFPs for at least part of their sustenance and cash livelihoods (Malhotra and Bhattacharya 2010, Bhattacharya and Hayat 2009). Around 89 million tribals living mainly in forest fringe areas of the country have a higher dependence on NWFPs (Bisht and Singsit 2011). NWFP accounts for 68% of the export from forestry sector. Planning Commission of India has proposed to spend around US$ 1181.82 million during the 12th Plan for this sector (Planning Commission 2011). In addition to this, NWFP sector creates about 10 million work days annually in the country and by multiplying it with the average wage rate of US$ 3.64 per day, the economic value of the work days generated by this sector is estimated at US$ 36.36million annually. The total value of NWFPs was estimated at US$ 14 727.27 million per year (ICFRE 2007).

2.10.1.2. Indirect Benefits of Forests (Ecosystem Services)

Forests are very important ecosystems delivering benefits that go beyond the supply of direct benefits like timber, fuel wood fodder, food, bamboo, NWFPs to provide carbon sequestration, climate amelioration, prevention of soil erosion and landslides, water retention and water supply , biological control, pollination, recreation value etc. The valuation of services is very difficult to assess due to lack of suitable methodologies. However different people have tried to evaluate these indirect benefits of forests. Das (1979) was probably the first to estimate the monetary value of a tree at US$ 193,250. From 1995–2005 carbon stocks store in forest are estimated to have increased from 6245 mil tonnes to 6622 mil tonnes thereby registering an annual increment of 37.68 mil tonnes of carbon or 138.15 mil tonnes of CO_2 equivalent (Kishwan *et al.* 2009). Verma (1999) estimated value of watershed function for Himalayan forest of Himachal Pradesh @ US$ 94 000/ha/year.

As per the estimation by Bahuguna and Bisht (2013), the indirect benefits in the form of various ecosystem services derived from the country's forests are valued at US$ 71220.39 million. Prevention of soil erosion and landslide is the most valued service followed by climate amelioration and then by water conservation (Table 2.4).

Table 2.4. Estimates of Goods and Services from forests in India.

Items	Value (US$ 0.182 Million)	Share(%)
Fodder	100 915.20	14.48
NTFPs	81 000.00	11.62
Timber	78 335.00	11.24
Bamboos	24 298.25	3.49
Fuel wood	20 562.50	2.951
Indirect Benefits	-	-
Prevention of soil erosion and landslides	149 360.18	21.43
Climate amelioration	69 991.58	10.04
Water retention and water supply	61 960.50	8.89
Pollination	54 694.02	7.85
Recreation values	30 771.32	4.42
Food and water security	18 050.21	2.59
Carbon sequestration	5 969.42	0.857
Biological control	960.00	0.14

Source: Bahuguna and Bisht 2013

2.10.2 Economic Contribution to GDP

Forestry sector occupies an important place in India's economy in terms of its contribution to Gross Domestic Product (GDP), employment and livelihood of poor people. Besides, it plays an important role in meeting the requirements of forest dependent communities for food, fuel, fodder, timber and other forest produce. The total production of timber from forests was about 10 mil m^3 per year although the country's requirement was estimated to be about 15 mil m^3 (NCA 1972). The average annual growth in GDP of forestry sector during 1950–2006 was 0.9% against growth in overall GDP of 4.6%. The GDP estimates for the forestry sector was US$ 5285.27 million for the year 2007–08, which was 0.67% of the total GDP of the country. The main share (about 83%) was attributed to fuel-wood. The contribution of Tree Outside Forest (TOF) was about US$ 6181.82 million.

2.11 Social Contribution of Forests in India

Forests provide a range of goods and services, which are vital for the rural economy and the subsistence of the most disadvantaged sections of people in India. A rural poor family depends on the forests for many of its subsistence needs. In fact one of the objectives of the National Forest Policy is to meet the bonafide needs of the communities from forest produce. The Joint Forest Management programme in India was also launched with the above objectives as one of its main aim. The JFM programme works on the 'Care and Share' principle whereby the villagers are given the rights to collect certain forest products free of cost and certain other forest products at concessional rates. The Joint Forest Management is therefore making the difference in the life of the poorest of the poor of the country, who live in the remote and unapproachable places and are generally deprived of the regular developmental schemes. Based on the data provided by 15 states on quantified benefits accruing to the villagers through collection of fuel wood, fodder, NWFPs and other produce, the annual benefit per JFMC works to US$ 0.004545 million and the annual monetary values of the forest products per family come to US$ 35.34 (ICFRE 2011). In 15 states alone the annual benefits amounting to US$ 350.55 million are assessed to flow to the beneficiaries, who most often are the most vulnerable and deprived sections of our society (Table 2.5).

Table 2.5. Data provided by 15 states on quantified benefits accruing to the villagers.

	State	JFM Committees (No)	Total No. of families	Benefits in US$ (Million)				
				Fuel wood	Fodder	NTFP	Others	Total
1.	Andhra Pradesh	7718	1 438 000	1.85929	0.39618	1.27369	1.63158	5.16075
2.	Arunachal Pradesh	1013	33 048	3.42465	16.7236	0.21436	0.08045	20.4431
3.	Chhattisgarh	7887	1 117 000	26.1818	43.6364	169.182	1.45455	2422.27
4.	Haryana	2487	66 036	0.172	0.14269	0.03815	0.00049	0.35333
5.	Jharkhand	9926	429 796	15.6	NA	5.68	NA	21.28
6.	Karnataka	3848	272 805	2.96105	NA	NA	2.75531	5.71636
7.	Madhya Pradesh	15 228	1 700 000	NA	NA	NA	5.16711	5.16545
8.	Maharashtra	12 665	2 709 000	1.67205	0.21387	0.04633	0.00531	1.93756
9.	Meghalaya	285	39 210	0.125	0.04476	0.01422	1.09091	0.19489
10.	Nagaland	951	159 587	1.22727	0	0.03636	0	1.26364
11.	Punjab	1224	91 850	0.02182	0.03636	0.07273	0.00909	0.16364
12.	Rajasthan	5316	571 051	NA	0.88811	0.13684	0.23182	1.26085
13.	Tripura	920	79 445	8.13091	1.38545	0.87818	0.30909	10.7036
14.	Uttar Pradesh	3426	706 050	2.09458	1.43851	0.09151	0.09676	3.72136
15.	West Bengal	4368	505 149	18.1818	5.45455	9.09091	0	32.7273
	Total	**77 262**	**9 918 027**	**81.676**	**70.36**	**186.76**	**11.757**	**350.55**

Source: ICFRE 2011

The employment opportunities created in the forestry works and projects are very important to the landless poor as the employment opportunities in the rural areas are often limited. The forestry works often provide the subsistence to these poor sections during lean times. The data on the annual employment generated under JFM project was furnished by 21 states and is compiled in the Table 2.6.

Table 2.6. Annual Employment Generated Under JFM.

	State	No. of JFMC	Total No. of families	Annual Employment Generated in Man-days (in'000)
1.	Andhra Pradesh	7718	1 438 000	1,00,000
2.	Arunachal Pradesh	1013	330 482	2,640
3.	Assam	1184	52 499	4,880
4.	Bihar	682	211 674	4,720
5.	Chhattisgarh	7887	1 117 000	70,000
6.	Gujarat	2195	417 032	1,82,760
7.	Haryana	2487	66 036	7,050
8.	Himachal Pradesh	1023	263 024	2,700
9.	Jharkhand	9926	429 796	8,600
10.	Karnataka	3848	272 805	74,900
11.	Kerala	576	78 501	4,000
12.	Maharashtra	12 665	2 709 000	91,370
13.	Manipur	665	24 102	6,430
14.	Meghalaya	285	39 210	16,040
15.	Nagaland	951	159 587	2,600
16.	Punjab	1224	91850	8000
17.	Rajasthan	5316	571 051	51,350
18.	Tamilnadu	3487	482 269	16,990
19.	Tripura	920	79 445	39000
20.	Uttar Pradesh	3426	706 050	17,230
21.	West Bengal	4386	505 149	38,460
	Total	**71 864**	**9 747 128**	**749 720**

Source: ICFRE 2011

In these 21 states, where the data is available, employment for 749.72 million man-days has been generated annually. The employment generation helps in the poverty alleviation efforts of the nation.

2.12 Import of Wood

In view of increasing emphasis on conservation of forest, the Government of India took a policy initiative and liberalized the import of wood and wood products in 1996 to reduce the demand supply gap by bringing them under Open General License (OGL) category. Since then the import of wood and wood products has been steadily increasing, which is shown in Figure 2.5.

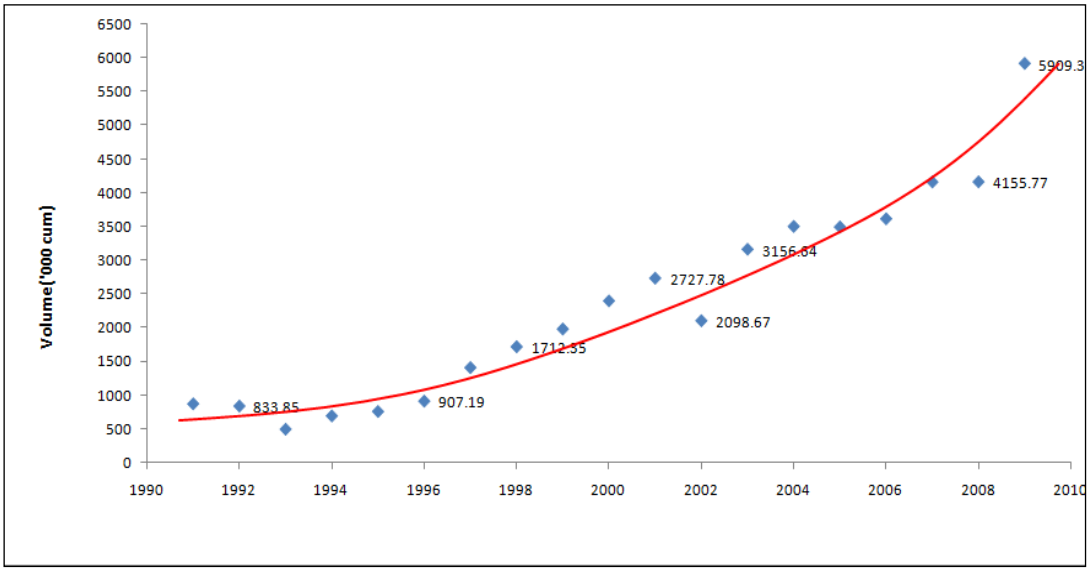


Figure 2.5. Import of wood and wood products in India during 1991-2010.
Source: FSR-India 2010

Detailed quantity of import of wood in different form (round log, sawn wood, plywood and veneer) is given in Table 2.7. It can be seen that import of wood has continuously increased in the last two decades except for a slight dip in 2002–03. There was a sudden increase in the import by 60% in 1997-98 after economic liberalization. The current level of import of wood is about 6 mil m^3 of which round logs alone constitute more than 93%. Though wood is imported from about 100 countries, six countries namely Malaysia, Myanmar, New Zealand, Ghana, Ivory Coast, and Gabon constitute bulk of the import. About 80% of the imported wood during 2006–10, was from these countries. Teak constitutes an important timber species and forms about 15% of the total annual imported volume. Most of the import of teak is from Myanmar, Ivory Coast, Ghana, Ecuador, Costa Rica and Benin. The value of the imported wood and wood products has gradually increased from US$ 604 million in 2003–04 to US$ 1397.82 million in 2009–10

Table 2.7. Import of Wood and Major Wood Products (in Million US$) in India.

Year	Wood in logs	Sawn Wood	Plywood	Veneer & plywood sheets	Particle/Fibre Board	Total wood &wood products
2002-03	328.19	6.73	2.55	2.75	15.10	362.56
2003-04	557.83	10.19	3.46	2.92	21.83	604.00
2004-05	679.46	10.93	4.19	4.01	28.73	740.92
2005-06	669.47	16.73	6.55	8.91	43.83	759.64
2006-07	748.02	18.73	10.37	11.64	56.01	880.73
2007-08	857.65	18.73	20.74	13.46	75.65	1033.65
2008-09	935.28	26.20	23.47	16.74	72.37	1138.93
2009-10	1169.28	40.00	28.37	18.74	74.38	1397.82

Source: FSR-India 2010

India's forest-based secondary industry encompasses a wide range of small, medium and large scale firms that process wood into a variety of products for the domestic market. With the improvement of

productivity, net supply of wood products may improve. However, the principles of SFM and fair trade practices including eco-labelling of wood products might limit the wood supply from natural forests. In these circumstances, wood from trees outside forests, mostly agro-forestry, will become the main source of raw material for industries. It is also likely that wood processing units will modernize and improve their efficiency to meet the growing demands for house construction and furniture industry, infrastructure and other industrial requirements. These developments are likely to support new processing technologies creating demand for small sized, lower quality wood that could be produced in short rotation in farms and on common land.

2.13 Conclusion

This chapter has depicted the historical perspective along with recent initiatives in policy and managements of forests in the country. A long tradition of forest management in India has (ISFR 2011) contributed towards the stability and increase of forest cover which are described in the next chapter. Social and economic aspects relating to the forests have also been dealt at length so as to help in understanding the transition of Indian forests towards sustainable management and rehabilitation.

3 HISTORICAL REVIEW OF FOREST COVER CHANGE IN INDIA

3.1 Introduction

As the civilization prospered and population increased, the relationship between humankind and forests including their degradation has changed. It is a known fact that low density nomadic populations were transformed into a high density agrarian and commerce based population. This revolution spread across the South Asia as well as in India as people followed the new agricultural technologies. Forests were cleared for agriculture to feed the growing population. Formation of villages, towns and then cities further accelerated the process. Moreover the requirement of timber and woods increased progressively by the urban based civilizations. Forests got its commercial value in the form of timber, and teak, deodar, sal and shisham were identified as the first commercial trees. Forests continued to be used for the sustenance of the local increasing population and supply of timber for the local needs till the arrival of Europeans. With the advancement of the technology and improved transportation, emergence of market economy along with industrial revolution, timber became a commercial commodity globally and was key to maintenance of sea power.

Since conservation efforts were taking hold in Europe, Britain was faced with an alarming position in its ability to supply the wood needed for new warships. Therefore, during the early British period, strategic and commercial exploitation of forests for the large scale supply of timber immensely depleted the forests of India. The local economy of the native people was altered by the same pattern of settlement and agriculture that had occurred in Europe. However there was a significant difference in the rate at which the transformation occurred in Europe and India. Changes in the relationship and use of forest that had occurred over 25000 years in Europe happened over a period of mere 150 years in India. The landscape and its peoples were swept up in a tidal wave of progress (Merchant 1989).

Settlement first occurred in the eastern India (Bengal) where early immigrants eked out an existence through a semi-subsistence form of agriculture. Forests were cleared and lands cultivated. Exports of important items such as tea, indigo and cotton grown on lands captured by the East India Company to England prevailed in exchange for goods, not available in India. More important strategically than these products was the use of teak and other timber for ship building. Teak timber was superior to hardwoods for use in ships and England's hardwood species were rare and did not grow to a size sufficient for larger ships. Trees of adequate dimensions were no longer readily available from German and Russian forests due to extensive harvesting in the accessible areas. Besides this, timber from the Baltic countries was becoming increasingly more expensive and its supply unreliable due to the imposition of taxes and the threat of naval blockades preventing their import. England was strongly motivated to obtain its own supply and looked to India and Asia for the supply of hardwoods for ship building (Williams 1989). The only interest of the early British administrators in the Indian forests was to secure big supplies of teak and other timber for the Royal Navy. Forests continued to be depleted for obtaining and exporting large quantities of Indian timber for use by the British Navy and scented sandalwood to various European countries. There were no regulation on felling for supplying timber for local construction and clearing forests to allow free development of agriculture. Local demand for timber stimulated the establishment of a domestic saw milling industry during the 18th and 19th centuries. Many small mills were tied to land clearing as timber industry developed hand in hand with the expansion of agriculture in India and South Asia. These were small speculative enterprises located not more than 8 or 9.6 km from the logging sites. The wood from the cleared forests were used to build the fast growing towns, for fence posts and fuel (Williams 1989).

The landscape changed very quickly and the native population was irrevocably impacted. The idea of land ownership was introduced and the land became enclosed, literally, by fences and much of the forest was replaced by cultivated land. The forests of the agrarian era were no longer used for food, shelter or as home of spirits. They were instead: land for agriculture; timber for buildings; fuel to heat dwellings and energy for industry; ships for war and trading ships and places of sport for the wealthy. Alarmed by speed at which the Indian forests were disappearing and concerned about the diminishing supply of hard woods, England passed the Indian Forest Acts (1865, 1878, 1927), which brought more and more forests under the control of government.

3.2 Forests as Land Use

The forests as per legal notification under the Indian Forest Acts or administered as forests, whether state owned or private, as a category in land use classification showed continuous increase in British India after 1900 and this trend continued for more than 100 years 2008-09 when forests as a category of land use classification exist as 22.78% of geographical area of the country with 69.63 mil ha as shown in Table 1.11 and Figure 1.1 of Chapter I. This indicates that legal regulations were used to bring more and more area under the control of government as forest land. During British rule in India, the main objective was to obtain the sustained supply of timber from Indian forests and more and more productive areas were brought under the government ownership by notification under the provisions of India Forest Acts of 1864 and 1927. However, not much effort was made for the conservation of forests and the forests continued to be cleared to meet the claims of cultivation and demand of commercial timber. In independent India, the new forest policy (1952) aimed at bringing and maintaining at least one-third of the geographical area of the country under forests. All the forest land under the control of the private as well as local landlords was notified as forests by way of abolition of proprietary rights over forest and their acquisition by states. Even land areas potentially fit for forestry were brought under the provision of Indian Forest Acts to makeup the national deficiency. This phase of forest consolidation continued for nearly two decades after independence. However, the forest lands suitable for agricultural use continued to be diverted during this phase.

In the year 1994, Richards and Flint defined eight land use categories as (1) Net cultivated area, (2) Settled/built-up area, (3) Forest/woodland, (4) Interrupted woods, (5) Grass/shrub complex, 6) Barren/sparsely vegetated, (7) Wetlands (non- forested and forested), (8) Surface water. They collected and analyzed the data for forest cover for India for the period of 1880–1980 using land use trends with respect to forest/woodland, interrupted woods and forested wetlands. The forest cover followed a decreasing trend between 1880 and 1980 (Richards and Flint 1994). In the year 1880, the forest cover was 32.12% of the geographical area, which decreased to 29.65% by 1920; and it came down to 25.82% by 1950. After another two decades i.e. in 1970, the forest cover further came down to 23.24%, which again went down to 20.20% in the year 1980. Though, the forest cover data given by Richards and Flint was for hundred years, it was limited to different time periods of varying intervals i.e. 1880, 1920, 1950, 1970, and 1980.

Table 3.1. Forest Land Use Trend of 100 Years.

Years	**1880**	**1920**	**1950**	**1970**	**1980**
Forest Cover* (mil ha)	102.7	94.8	82.5	74.3	64.6
%	32.12	29.65	25.82	23.24	20.20

Source: Richards and Flint 1994, * forest cover is based on forest vegetation areas land use.

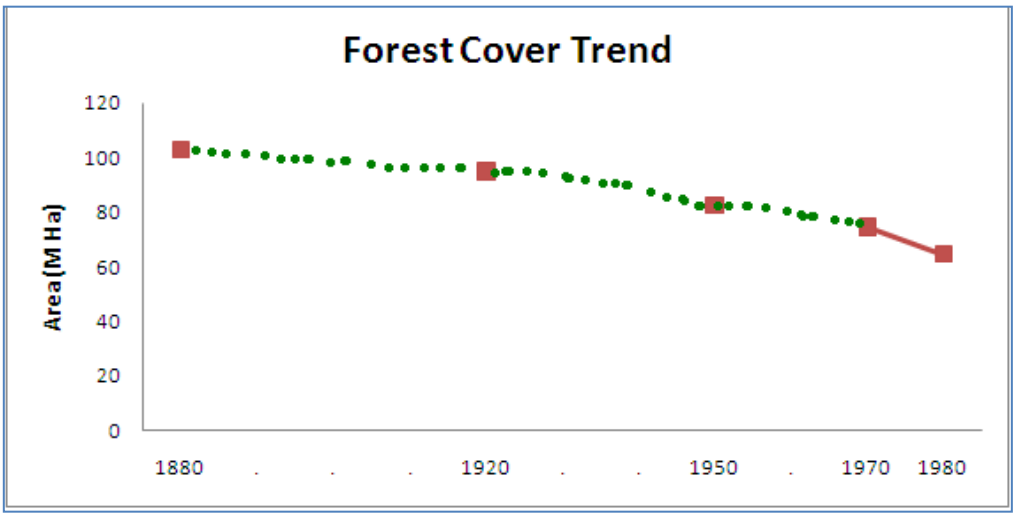


Figure 3.1. Forest Land Use Trend.

3.3 Forest Cover Assessment and Historical Trend

The most concerted effort at assessment of forest cover was first made in 1980 under the FAO/UNEP Tropical Forest Resources Assessment Project within the framework of the Global Environment Monitoring System (GEMS) to assess the present situation and evolution of tropical forest resources qualitatively and quantitatively. The study also aimed at determining the methodology and the means needed for the continuous updating of this first assessment. The lack of recent and consistent data at national level on the areas of forest formations in India and some other countries prompted the FAO to decide on the interpretation of LANDSAT imagery from 1972 to 1978 for forest cover for these countries (FAO Corporate Document Repository). The forest cover, as interpreted by FAO at global level in this project was any vegetated area of given size with a canopy density of more than 10%. The Forest Survey of India also adopted this definition for assessments of forest cover in India.

The forest cover in India was actually depleting and was estimated to be 57.23 mil ha (17.19%) under the FAO/UNEP Project on the interpretation of LANDSAT imagery from 1972 to 1978 (FAO Corporate Document Repository). FAO under Forest Resource Assessment (FRA) in 2000 estimated the forest area and area change over time. These estimates were based on a comprehensive analysis of the latest forest inventory data available for each country. To support the country findings a systematic pan-tropical remote sensing survey provided estimates at the regional and pan-tropical levels. A detailed study of forest plantations was included in the analysis. A number of qualitative studies were carried out to enrich the knowledge on forest area change. This was the most comprehensive survey of forest area and area change at the global level to date. The rate of net change in forest cover was slightly lower in the 1990s compared to the 1980s, due to a higher estimated rate of forest expansion in the 1990s worldwide. Country studies point at land use rights as a common main determinant behind land use change (deforestation), and the remote sensing survey indicated that direct conversions of forests to permanent agriculture were more prominent than shifting agriculture in forest change processes. FAO's series of Forest Resource Assessments (FRA) have increased both, the availability and quality of internationally comparable data on the situation of forests globally. Based on FAO 2010, recent forest trend in India is shown in the Table 3.2.

Table 3.2. Forest Cover Trend of last Two Decades in India.

Years	**1990**	**2000**	**2005**	**2010**
Forest Cover (mil ha)	63.9	67.6	67.7	68.4
%	19.45	19.89	20.59	20.82

Source: FAO, 2010

To estimate the size of the land transfer from forest to agriculture, a model study was made in 1990 by the FAO/UN Forest Resources Assessment Project, which indicated the deforestation to be of the order of 14 mil ha during 1901-1950 in India. The forest cover further declined to 57.3 mil ha from 75.8 mil ha during 1950 to 1980 (Singh 2011). Singh (2011) also pointed out that these estimates do not include the area under shifting cultivation, which is approximately 7 mil ha. These estimates are equivalent to FSI estimates if areas under shifting cultivation are included in the FAO (1993) model figure. Figure 3.2 gives the simulated historical trend of forest cover loss during 1900-1990 for India (FAO 1993).

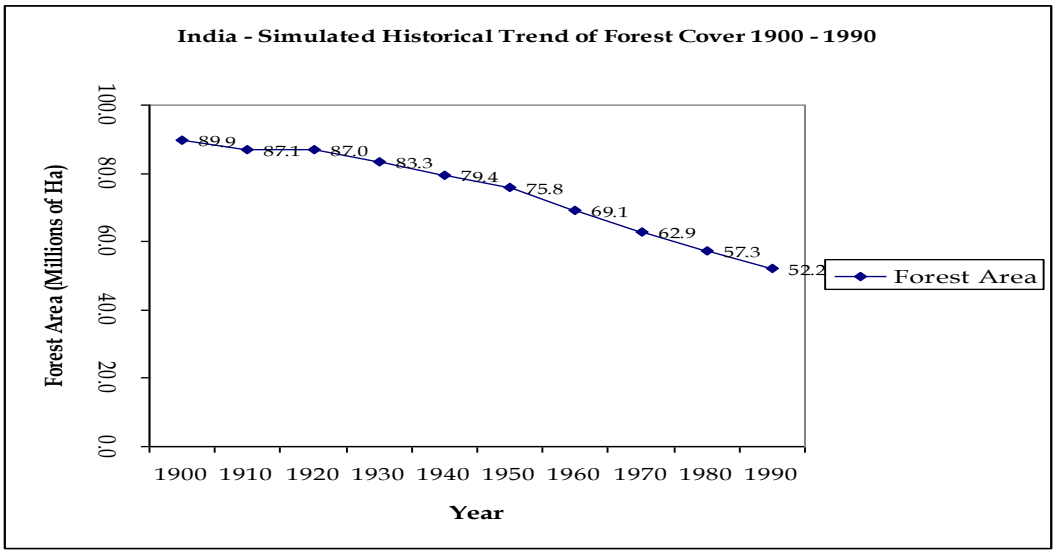


Figure 3.2. Simulated Historical trend of Forest Cover 1900-1990.

Source: Singh 2011

3.4 Forest Cover changes of recent Past by Forest Survey of India

Apart from the global effort at forest cover mapping under FAO/UN Forest Resource Assessment series, the first ever forest cover mapping in India was carried out using LANDSAT imageries pertaining to period 1981–83 at 1:1 million scale. The results of this assessment were published in the first "State Of Forest Report 1987". Since after the first SFR publication, there has been continuous improvement in the remote sensing satellite technology, method of interpretation, and classification schemes as mentioned in the Table 3.3.

Table 3.3. Forest Cover Mapping Over the Years.

Cycle of Assessment	Year	Data Period	Sensor	Resolution	Scale	Minimumm appable area (ha)	Mode of interpretation
1.	1987	1981-83	MANDSAT-MSS	80 m	1:1 Million	400	Visual
2.	1989	1985-87	LANDSAT-TM	30 m	1:250,000	25	Visual
3.	1991	1987-89	LANDSAT-TM	30 m	1:250,000	25	Visual
4.	1993	1989-91	LANDSAT-TM	30 m	1:250,000	25	Visual
5.	1995	1991-93	IRS-1B LISSII	36.25 m	1:250,000	25	Visual & Digital
6.	1997	1993-95	IRS-1B LISSII	36.25 m	1:250,000	25	Visual & Digital
7.	1999	1996-98	IRS-1C/1D LISS III	23.5 m	1:250,000	25	Visual & Digital
8.	2001	2000	IRS-1C/1D LISS III	23.5 m	1:50,000	1	Digital
9.	2003	2002	IRS-1C LISS III	23.5 m	1:50,000	1	Digital
10.	2005	2004	IRS-1D LISS III	23.5 m	1:50,000	1	Digital
11.	2009	2006	IRS-P6-LISS III	23.5 m	1:50,000	1	Digital
12.	2011	2008-09	IRS-P6-LISS III & IRS-P6 AWiFS	23.5 m 56 m	1:50,000	1	Digital

Source: ISFR 2009

Policy makers and planners wanted to use these successive assessments as a time series to look at the long-term trend in the forest cover. However, there has been a significant change in technology and methodology since 1999, due to which the comparison of different assessments of forest cover was not possible. Subsequently, an attempt was made to reduce (normalize) the effects of technology and methodology changes. The estimates of the real change in the forest cover were made although with its own limitations. The results can only be taken as best approximation. Therefore, these assessments (Table 3.4) present a difficulty as far as possibility of comparison is concerned, but these do provide reliability in tracing the trend (Figure 3.4) in the forest cover change in the country.

Table 3.4. Time series of forest cover of India showing the transformation with respect to methodology changes for making the area figure comparable (area in mil ha).

SFR year	Data Period	Forest cover (as reported in SFR)	Smoothened forest cover (using moving average of three)	Forest cover corrected for change in scale	Forest cover corrected for change in scale and inclusion of small patches	Forest cover corrected for change in scale, inclusion of small patches and vector approach
1987	1981-1983	64.08	**			
1989	1985-1987	63.88	63.96	62.30	65.04	66.28
1991	1987-1989	63.94	63.92	62.26	64.99	66.23
1993	1989-1991	63.94	63.92	62.26	64.99	66.23
1995	1991-1993	63.89	63.72	62.06	64.79	66.02
1997	1993-1995	63.34	63.65	61.99	64.72	**65.95**
1999	1996-1998	63.73	64.15	62.48	65.23	66.47
2001	1999-2000	65.39	65.64			66.88
2003	2001-2002	67.78	67.39			68.67
2005	2003-2004	69.02	68.63	*	*	69.01
2009	2005-2006	69.09	**			**69.09**
2011	2008-2009	69.20				**69.20**

* not required, ** gap due to moving average
Source: ISFR 2009, 2011

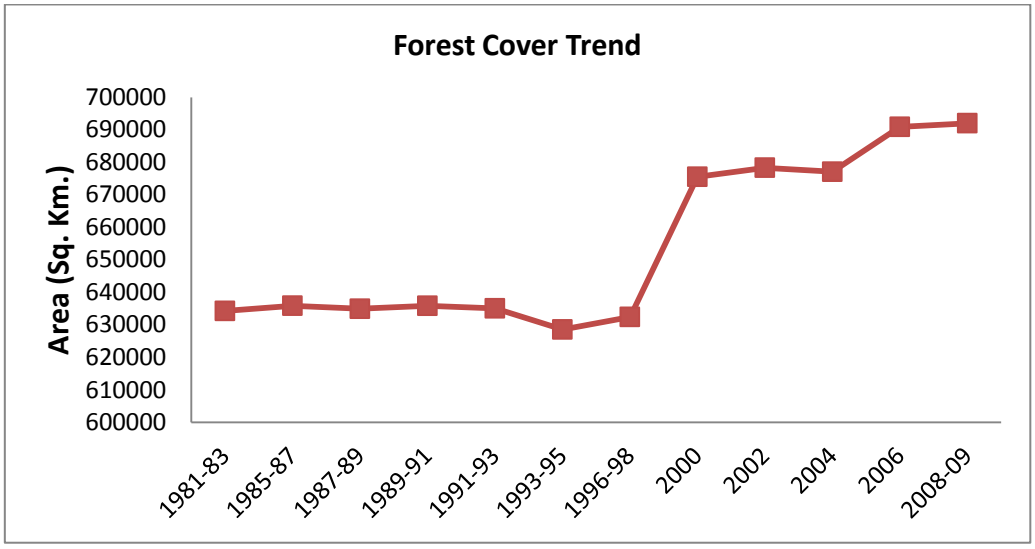


Figure. 3.4. Forest Cover Trend for India.
Source: ISFR 2011

Though the recent trends in the forest cover of different states of India as available from FSI data are given below along with a brief description of the state, the detailed state wise analysis for the trend would require detailed studies. However as a case study, state of Haryana has been covered for detailed analysis.

3.4.1 Andhra Pradesh

Andhra Pradesh is the fourth largest state of India covering a geographical area of 27.51 mil ha which is 8.37% of total area of country it lies between 12^0 37' N to 19^0 55'N latitude and 76^0 45' E to 84^0 46'E longitude. The state has three distinct physiological regions. The population of the state is 84.67 million which 7% of the country's population. The proportion of rural and urban population is 66.51% and 33.49% respectively. The population density is 308 persons per sq km.

Figure 3.4.1 shows that the forest cover consistently decreased till 2005 from 1987 then increasing onwards till today. The forest cover was 5.01mil ha in during the year 1997 which decreased to 4.45 mil ha during 2005 which further increased to 4.64 mil ha.

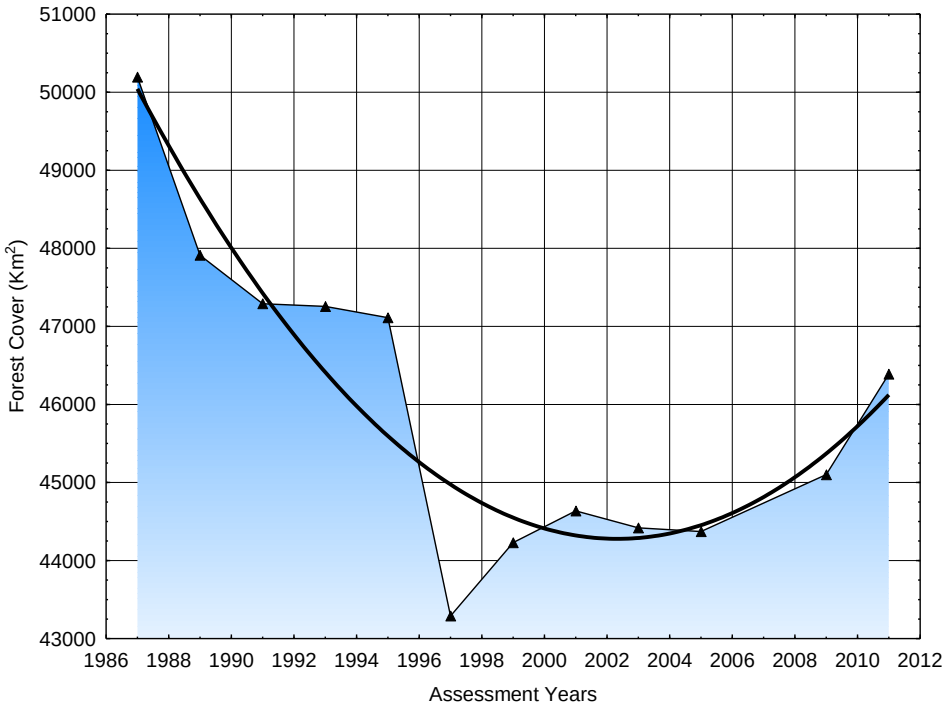


Figure 3.4.1. Graph of forest cover – Andhra Pradesh.

3.4.2 Arunachal Pradesh

Arunachal Pradesh is the largest state in the North-Eastern region of the country, sharing international boundaries with Bhutan, China, Tibet and Myanmar. It lies between 26^0 29' N to 29^0 30'N latitude and 91^0 30' E to 97^0 30'E longitude. It covers the geographical area of 8.37mil ha which is 2.54% of the total area of the country. The state has temperate climate in northern part and warm humid in southern part. The average annual rainfall ranges from 2000mm to 8000mm and the temperature from sub – zero to 31^0. The population of the state is 1.38 million which constitute 0.11% of the country's population. The proportion of rural and urban population is 77.33% and 22.67% respectively. The population density is 17 persons per sq km.

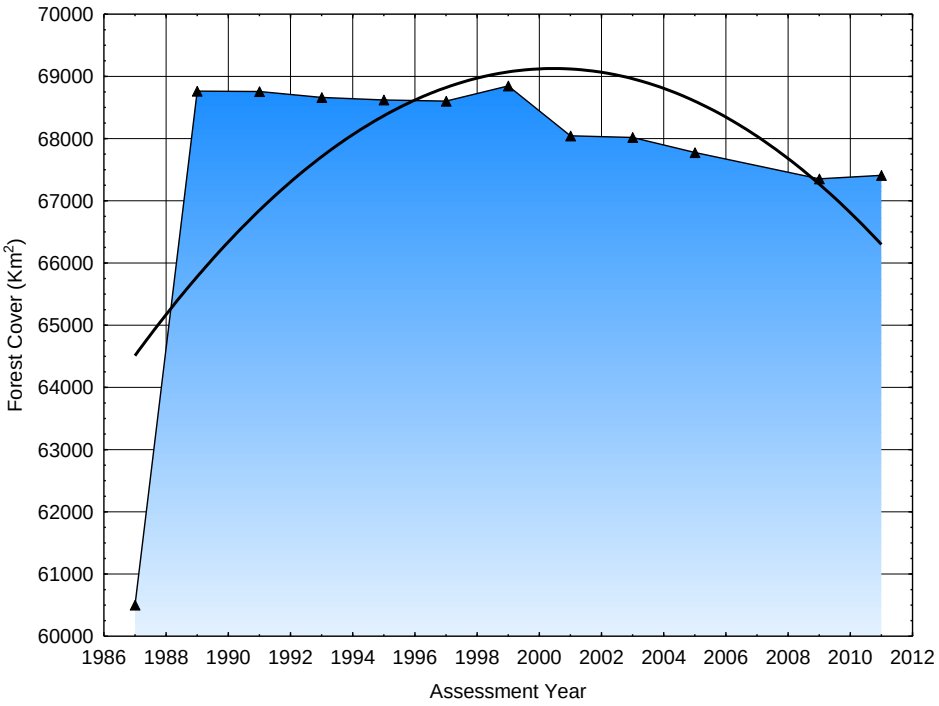


Figure. 3.4.2. Graph of forest cover – Arunachal Pradesh.

In Figure. 3.4.2 the forests cover consistently increased from 1987 to 1999 and then continuously decreasing till today. The forest cover was 6.05 mil ha during the year 1987 which increased to 6.88 mil ha during 1999 and then decreased to 6.74 mil ha in 2011.

3.4.3 Assam

Assam is situated in the middle of the north – eastern part of India and sharing international boundaries with Bhutan and Bhutan along with west Bengal and six north eastern states. It covers the geographical area of 7.84 mil ha which is 2.39% of the total area of the country. It is situated between 24^0 07' N to 28^0 00'N latitude and 89^0 42' E to 96^0 02'E longitude. The state has sub-tropical climate with temperature ranging from 5^0 to 32^0 and mean annual rainfall varying from 1500mm to 3750mm. The population of the state is 31.17 million. The proportion of rural and urban population is 85.92% and 14.08% respectively. The population density is 397 persons per sq km.

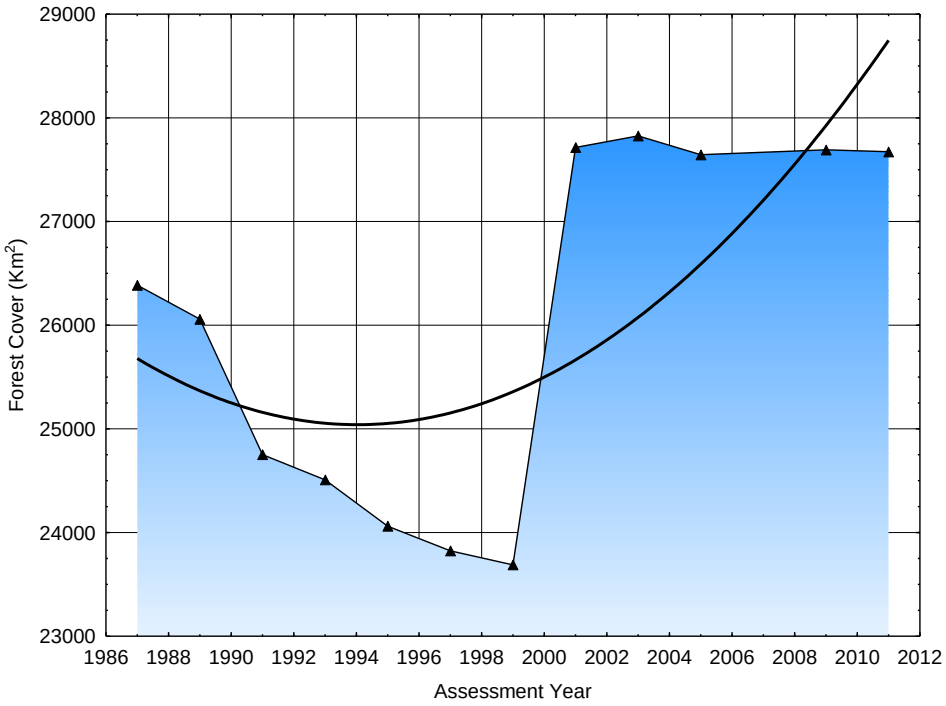


Figure. 3.4.3. Graph of forest cover – Assam.

Figure 3.4.3 shows that the forest cover decreased consistently from 1987 to 1999 and then immediately shoot-up in 2001 and was constant till today. The forest cover was 2.64 mil ha during the year 1987 which increased to 2.37 mil ha during 1999 and then immediately increased to 2.77 mil ha in 2001 and then continued to be same till today.

3.4.4 Bihar

Bihar is situated in the eastern part of India and sharing international boundaries with Nepal. It covers the geographical area of 9.42 mil ha which is 2.86% of the total area of the country. It is situated between 24^0 16' N to 27^0 45'N latitude and 83^0 16' E to 88^0 30'E longitude. Bihar is a part of Gangetic Plains and is drained by two major rivers Ganga and Gandak. The state has mean annual temperature ranging from 20^0 c to 28^0 c and annual rainfall varying from 1000mm to 2000 mm. The population of the state is 103.80 million, which is 8.58% of the total population of the country. The proportion of rural and urban population is 88.70% and 11.30% respectively. The population density is 1102 persons per sq km.

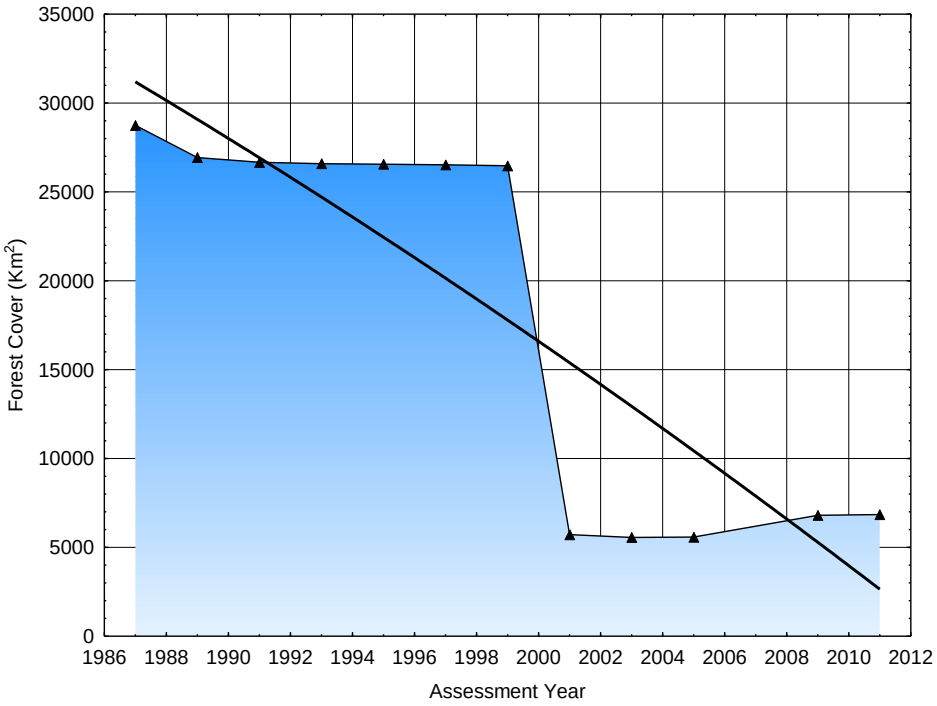


Figure 3.4.4. Graph of forest cover – Bihar.

Figure 3.4.4 shows slight decrease during first two years, the forest cover was almost constant from 1987 to 2001, then because of the formation state from the state of Bihar in 2001, the forest cover decrease and was constant during the next decade. The current forest cover is 0.68 mil ha in 2011.

3.4.5 Chhattisgarh

Chhattisgarh lies 17^0 47' N to 24^0 06'N latitude and 80^0 15' E to 84^0 E longitude. The geographical area of the state is 13.51 mil ha which is 4.1% of the total area of the country. The state is rich in forest and mineral resources. The annual rainfall varying from 1100mm to 1700mm and temperature ranges from 11^0 to 47^0. The population of the state is 25.54 million which is 2.11% of the country's population. The proportion of rural and urban population is 76.76% and 23.24% respectively. The population density is 189 persons per sq km.

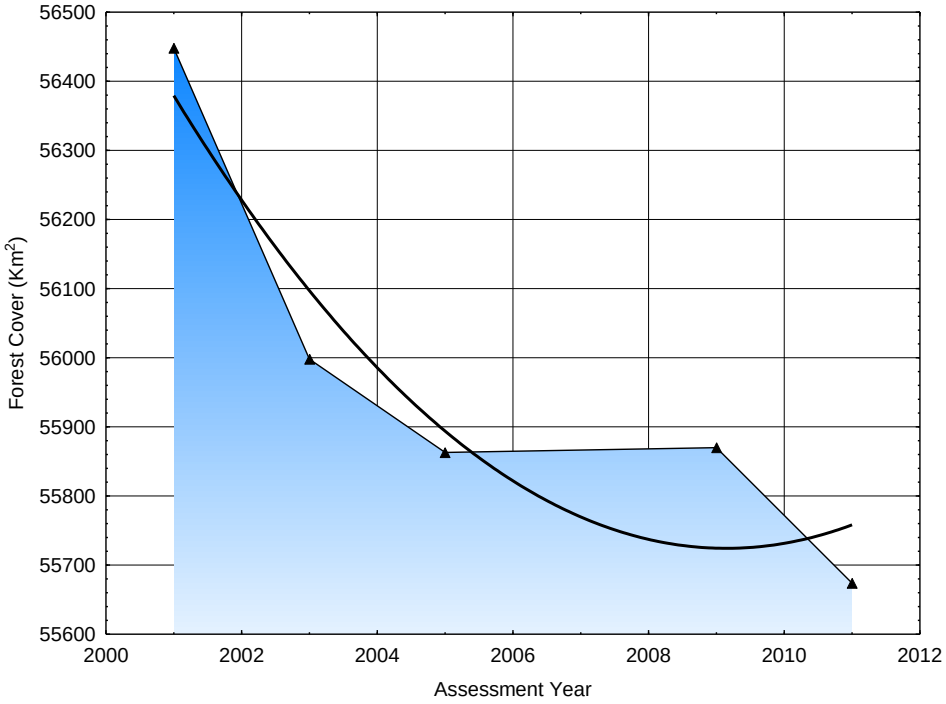


Figure 3.4.5. Graph of forest cover – Chhattisgarh.

Figure 3.4.5 shows that the forest cover in the state decreased consistently from since 2001 from 5.64 mil ha to 5.57 mil ha (2011), which is 4.18% of the states geographical area.

3.4.6 Goa

Goa is located on the west coast nestled between Maharashtra and Karnataka and popular tourist destination of the country. It lies 14^0 53' N to 15^0 40'N latitude and 73^0 40' E to 74^0 21'. It is a tiny state with a geographical area of 0.37 mil ha constituting 0.11% of the total area of the country. The falls under two physiographic zones i.e. Western Ghats and coastal plains. The mean temperature in the state varies from 16^0 C to 37^0 C and the average rainfall is 3790 mm. The population of the state is 1.46 million which is 0.12% of the country's population. The proportion of rural and urban population is 37.83% and 62.17% respectively. The population density is 394 persons per sq km.

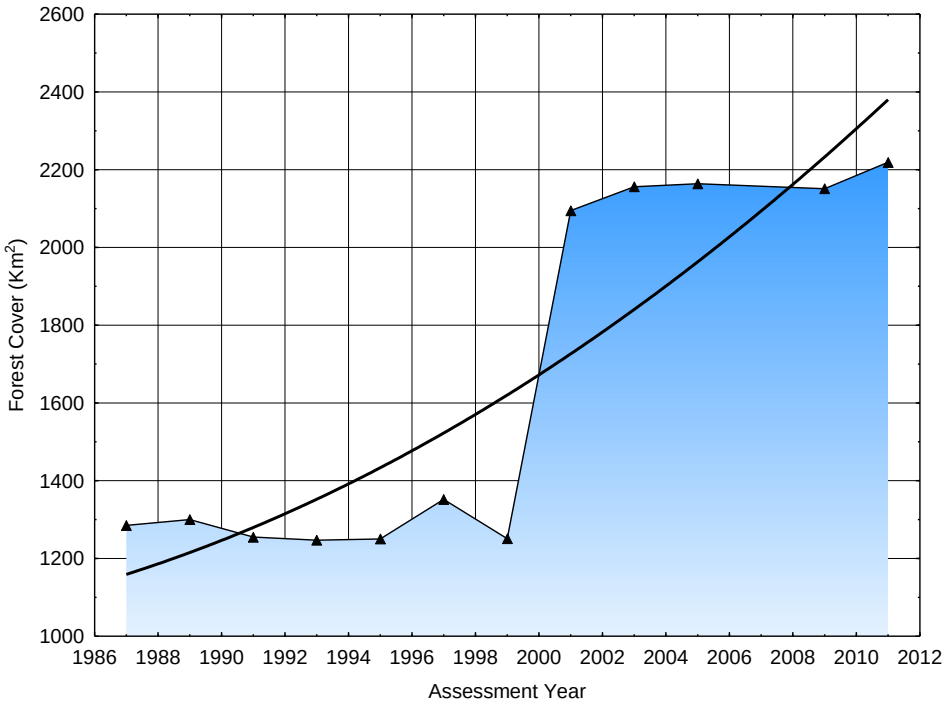


Figure 3.4.6. Graph of forest cover – Goa.

In Figure 3.4.6, the forest cover was approximately constant from 1987 (0.13 mil ha) to 1999 (0.12 mil ha) and then immediately increased to 0.21 mil ha in 2001. The forest cover is slightly increased up to 0.22 mil ha in 2011.

3.4.7 Gujarat

Gujarat situated on the western coast of the country having the longest coast line. The state lies between 20^0 07' N to 24^0 43'N latitude and 68^0 10' E to 74^0 29' E longitude. The geographical area of the state is 19.60 mil ha constituting 5.96% of the total area of the country. The climate of the state is moderate with mean temperature ranging from 25^0 to 27.5^0C and the average annual rainfall is 800mm to 1000mm. The population of the state is 60.38 million which is 4.99% of the country's population. The proportion of rural and urban population is 57.42% and 42.58% respectively. The population density is 308 persons per sq km.

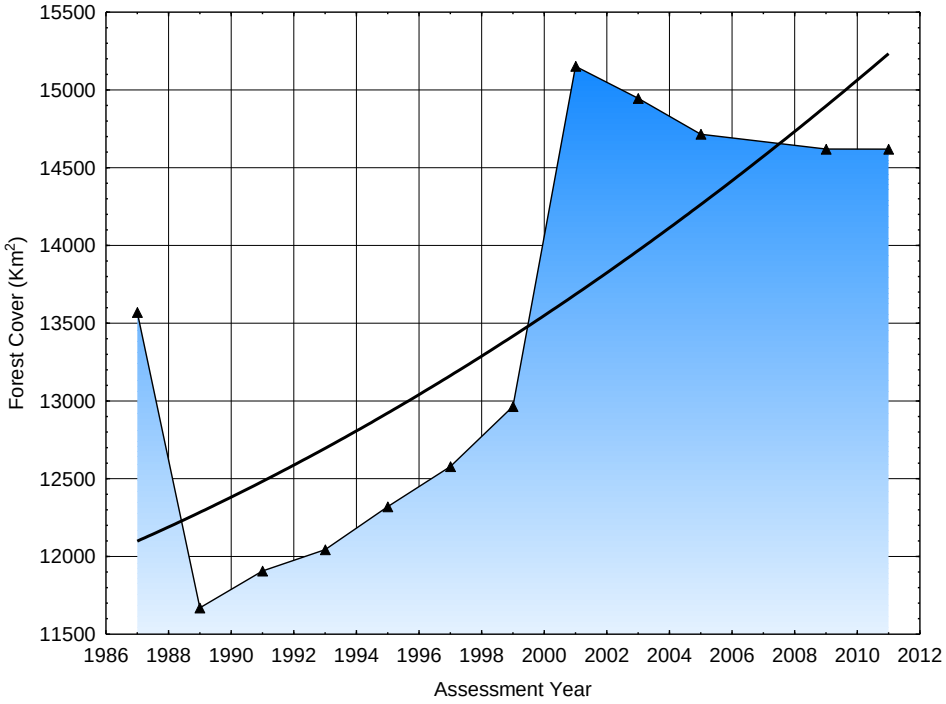


Figure 3.4.7. Graph of forest cover – Gujarat.

In Figure 3.4.7, the forest cover decreased rapidly from 1.36 mil ha (1987) to 1.17 mil ha (1989) and then consistently increased to 1.51 mil ha (2001). The forest cover further decreased 1.47 mil ha in the current year (2011).

3.4.8 Himachal Pradesh

Himachal Pradesh, predominantly a mountainous state in the western Himalayas has a geographical area of 55673 km^2. It is located between 30^0 22' N to 33^0 12'N latitude and 75^0 45' E to 79^0 04' E longitude. The altitude of the state varies from 350 m to 6975 m above mean sea level. The state has three distinct regions, viz. The Shivaliks with altitude up-to 1500 m, middle Himalayan region lies between 1500 m to 3000 m and Himadris higher than 3000 m. About one-third of the state is permanently under a snow, glaciers and cold deserts which do not support tree growth. The average annual rainfall is about 1800mm. The temperature varies from sub-zeros to 35^0 C. The population of the state is 6.86 million which is 0.57% of the country's population. The proportion of rural and urban population is 89.96% and 10.04% respectively. The population density is 123 persons per sq km.

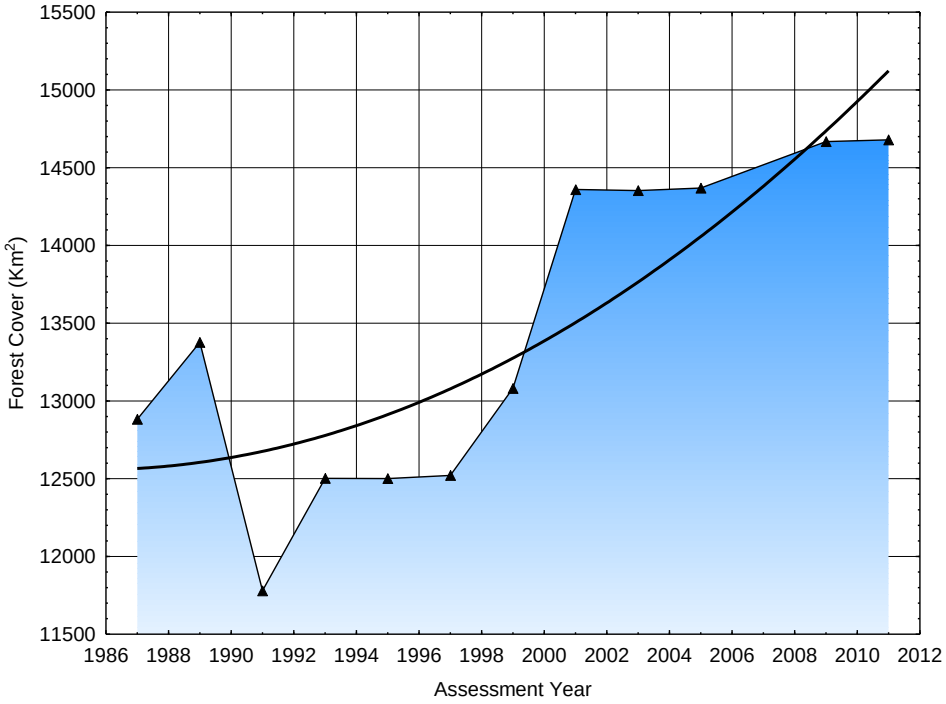


Figure 3.4.8. Graph of forest cover – Himachal Pradesh.

Figure 3.4.8 shows that the overall forest cover is in the increasing trend since 1987 to 2011 with slight alterations. The forest cover decreased from 1987 to 1991 and then continuously increased till today. The forest cover was 1.29 mil ha in 1987 and is 1.47 mil ha in 2011.

3.4.9 Jammu and Kashmir

Jammu and Kashmir comprises of three regions; Kashmir valley, Laddakh and Jammu. The state lies between 32^0 17' N to 37^0 05'N latitude and 72^0 31' E to 80^0 20' E longitude. The state is situated in the extreme north of the country and shares international boundaries with Pakistan, Afghanistan and China. Its geographical area is 22.22 mil ha. The annual rainfall is 600 mm to 800 mm and the temperature ranges from subzero to 40^0C. The population of the state is 12.55 million, which is 1.04% of the country's population. The proportion of rural and urban population is 72.79% and 27.21% respectively. The population density is 56 persons per sq km.

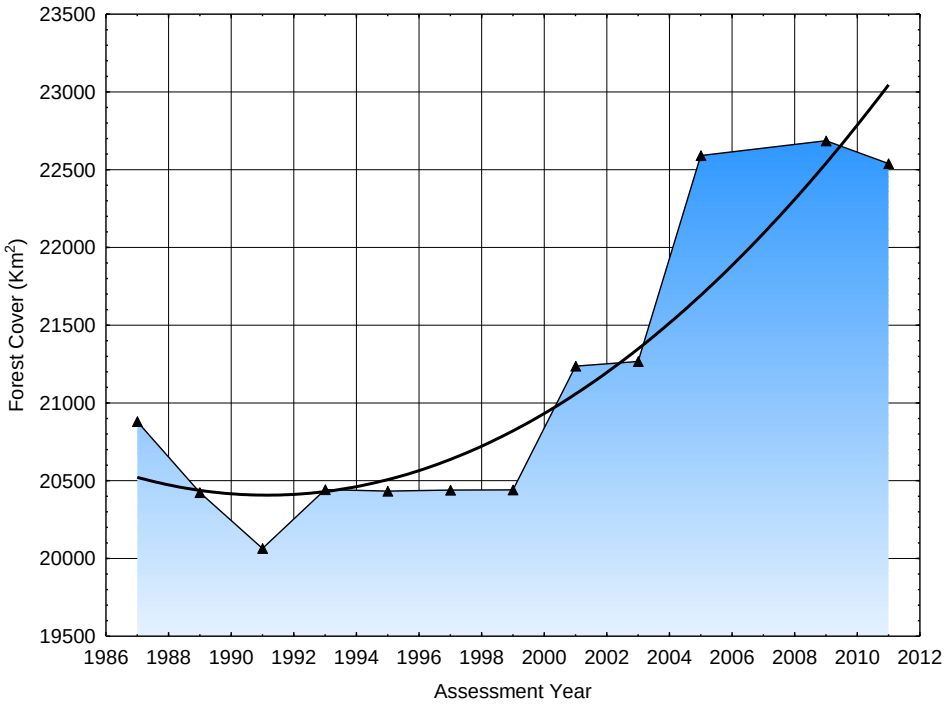


Figure 3.4.9. Graph of forest cover – Jammu and Kashmir.

In Figure 3.4.9, there was overall increasing trend since 1987 to 2011 in the forest cover with slight alterations. However, there was a sudden increase from 2003 to 2005. The forest cover increased from 2.09 mil ha in 1987 to 2.25 mil ha in 2011.

3.4.10 Jharkhand

Jharkhand is one of the most prolific mineral producing states of the country. Its geographical area is 7.98 mil ha, which is 2.42% of the total geographical area of the country. The state lies between 22^0 00' N to 24^0 37'N latitude and 83^0 15' E to 87^0 01' E longitude. The important rivers of the state are Sone, Keol and Damodar. It has a tropical climate with annual rainfall of about 900 mm. The temperature varies from 4^0 to 47^0 C. The population of the state is 32.97 million, which is 2.72% of the country's population. The proportion of rural and urban population is 75.95% and 24.05% respectively. The population density is 414 persons per sq km.

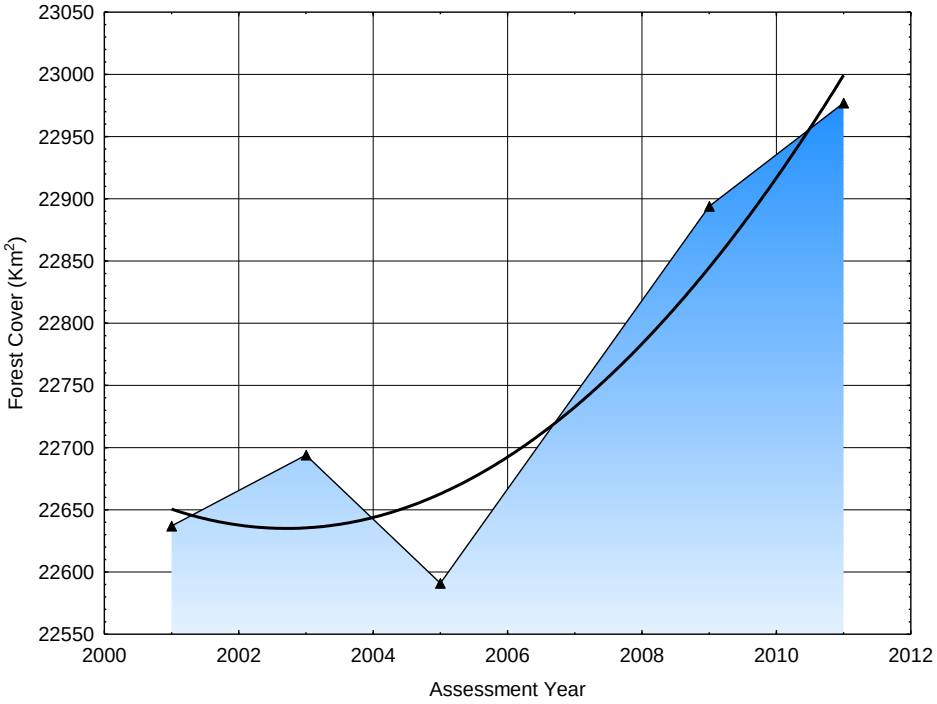


Figure 3.4.10. Graph of forest cover – Jharkhand.

Figure 3.4.10 shows that after the formation of the new state in 2001, the forest cover increased in the last ten years. The current forest cover of the state is 2.30 mil ha and it was 2.26 mil ha when the state was formed.

3.4.11 Karnataka

Karnataka is the southern peninsular states of the country covering the geographical area of 19.18 mil ha, which is 5.83% of the total area of the country. The state lies between 11^0 30' N to 18^0 25'N latitude and 74^0 10' E to 78^0 35' E longitude. It has the coastline of approximately 400 km^2 along the Arabian Sea. The annual rainfall is 2000 mm to 3200 mm in Western Ghats and between 400 mm to 500 mm in northern and north-eastern parts. The average temperature of summer and winter ranges from 26^0 to 36^0C and 14^0 to 25^0 C respectively. The population of the state is 61.13 million, which is 5.05% of the country's population. The proportion of rural and urban population is 61.43% and 38.57% respectively. The population density is 319 persons per sq km.

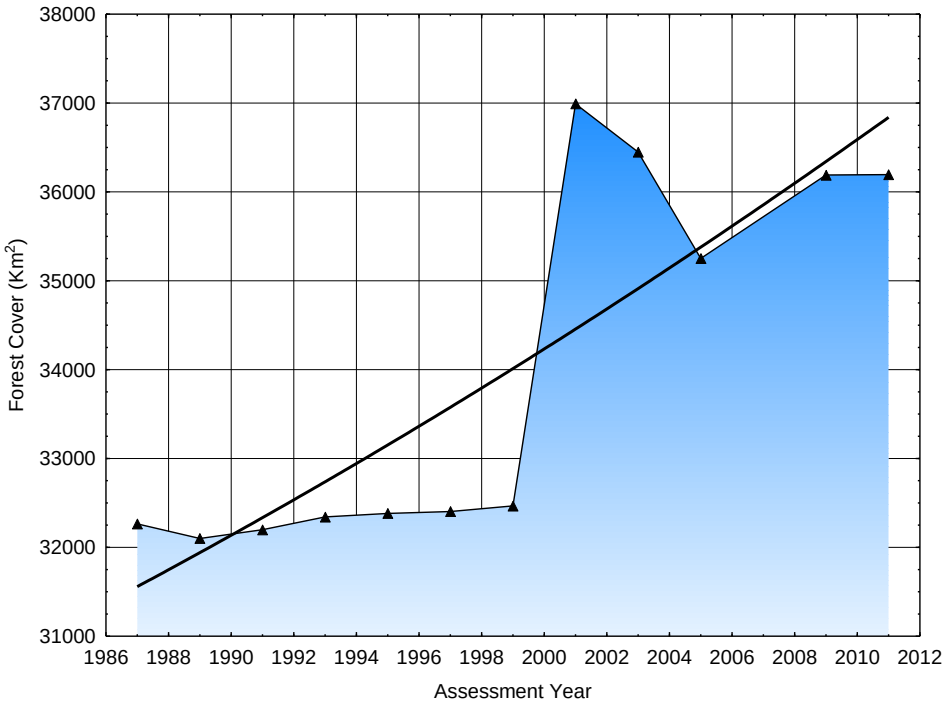


Figure 3.4.11. Graph of forest cover – Karnataka.

Figure 3.4.11 indicates that the forest cover increased from 6.22 mil ha in 1987 to 36194 in 2011. The forest cover rapidly increased from 3.25 mil ha to 3.70 mil ha in just two years i.e. 1999 to 2001. Thereafter, there was slight decrease in the forest cover.

3.4.12 Kerala

Kerala is a coastal state situated in southern most part of India along with Arabian Sea. The geographical area of the state is 3.89 mil ha. The state lies between 8^0 17' N to 12^0 47'N latitude and 74^0 52' E to 77^0 24' E longitude. The state has coastal, midland and highland zones. The state is situated in the humid tropical belt, along with high rainfall and humidity. The annual rainfall varies from 1520 mm to 4075 mm and the temperature ranges from 19.8^0 to 36.7^0C. The population of the state is 33.39 million, which is 2.76% of the country's population. The proportion of rural and urban population is 52.28% and 47.72% respectively. The population density is 859 persons per sq km.

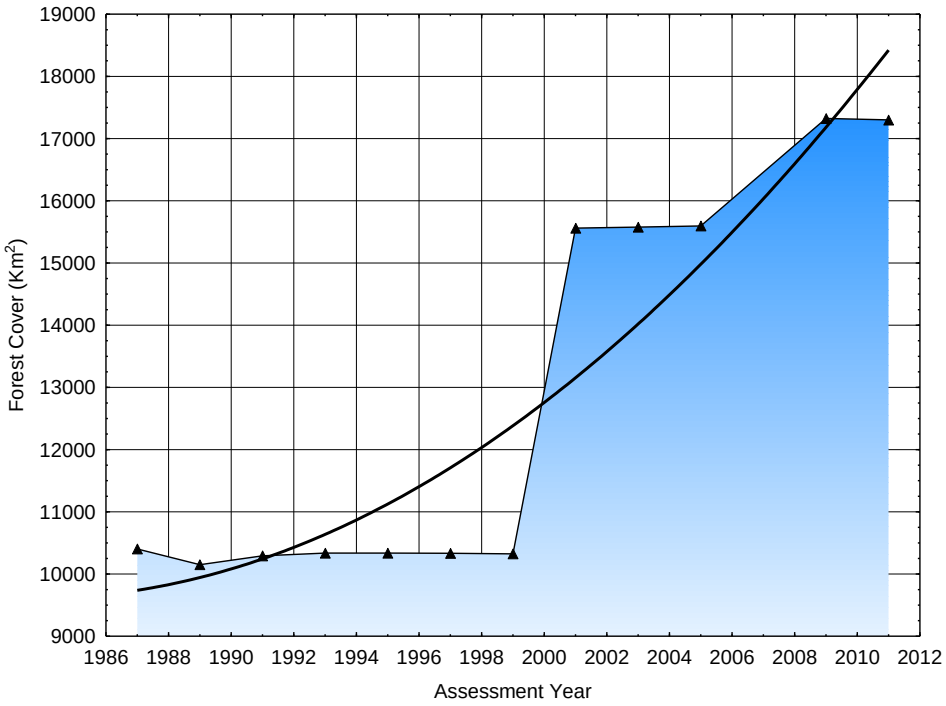


Figure 3.4.12. Graph of forest cover – Kerala.

In Figure 3.4.12 the forest cover was almost uniform from 1987 to 2001. After that, there was a huge rise in cover from 1.03 mil ha to 1.56 in just two years. Thereafter, there was slow growth in forest cover. At present, the forest cover is 1.73 mil ha.

3.4.13 Madhya Pradesh

Madhya Pradesh is the second largest state of the country after Rajasthan. It covers the geographical area as 30.82 mil ha, which is 9.38% of the total geographical area of the country. The state is situated between 21^0 17' N to 26^0 52'N latitude and 74^0 08' E to 82^0 49' E longitude. The annual rainfall varies from 800 mm to 1800 mm and the annual temperature ranges from 22.5^0 to 25^0C. The population of the state is 72.6 million, which is 6% of the country's population. The proportion of rural and urban population is 72.37% and 27.63% respectively. The population density is 236 persons per sq km.

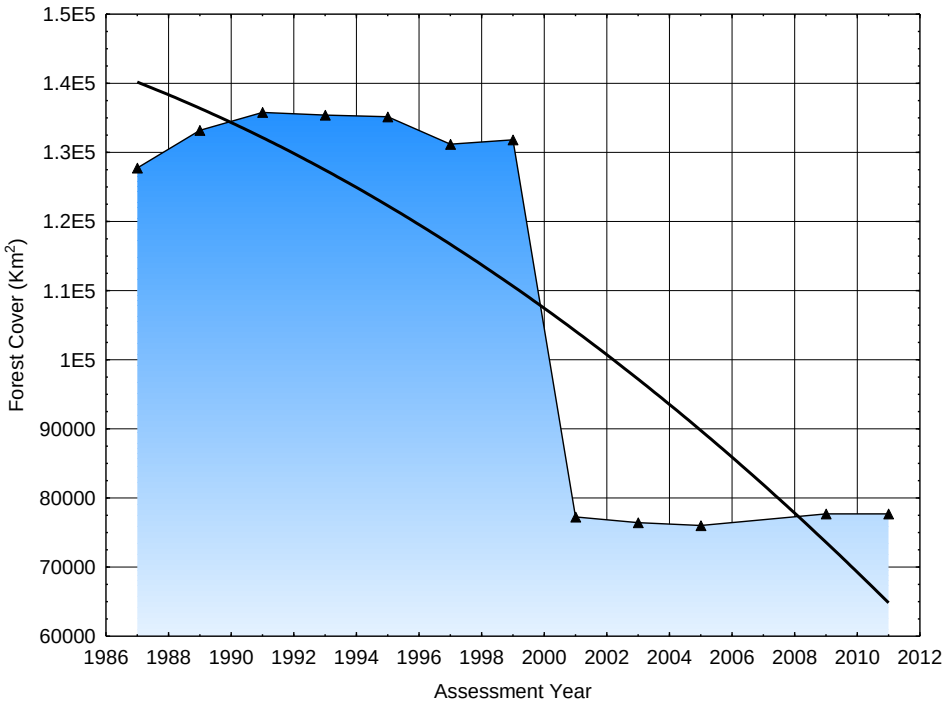


Figure 3.4.13. Graph of forest cover – Madhya Pradesh.

Figure 3.4.13 shows that the forest cover consistently increased with slow speed. However, due to division of the state in 2011, the forest cover decreased. The forest cover decreased from 13.18 to 7.72 mil ha. The present forest cover is 7.77 mil ha.

3.4.14 Maharashtra

Maharashtra has three distinct regions namely Deccan Plateau, Western Ghats and Coastal planes. It covers the geographical area as 30.77 mil ha, which is 9.36% of the total geographical area of the country. It is situated between 15^0 35' N to 22^0 02'N latitude and 72^0 36' E to 80^0 54' E longitude. The annual rainfall varies from 1600 mm to 2000 mm and the annual temperature ranges from 25^0 to 27.5^0C. The population of the state is 112.37 million, which is 9.29% of the country's population. The proportion of rural and urban population is 54.77% and 45.23% respectively. The population density is 366 persons per sq km.

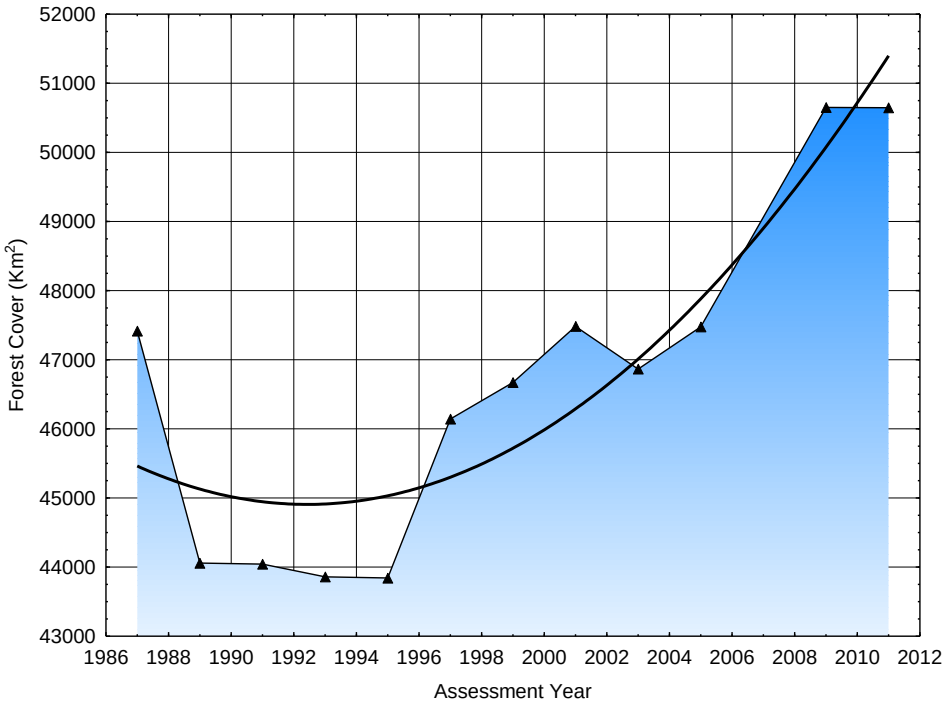


Figure 3.4.14. Graph of forest cover – Maharashtra.

Figure 3.4.14 indicates that after the decrease in forest cover from 1987 to 1989, it was uniform for the next six years and then after, it consistently increased till today. The forest cover reached from 4.74 mil ha to 5.06 mil ha.

3.4.15 Manipur

Manipur is one of the hilly states of north eastern part of India, which covers the geographical area as 2.23 mil ha, which is 0.68% of the total geographical area of the country. It shares the international boundary with Myanmar and lies between 23^0 50' N to 25^0 42'N latitude and 92^0 59' E to 94^0 46' E longitude.

The annual temperature ranges from 14.5^0 to 38^0C. The annual rainfall varies from 1250 mm to 2700 mm. November to February are the dry months. The population of the state is 2.72 million, which is 0.22% of the country's population. The proportion of rural and urban population is 69.79% and 30.21% respectively. The population density is 122 persons per sq km.

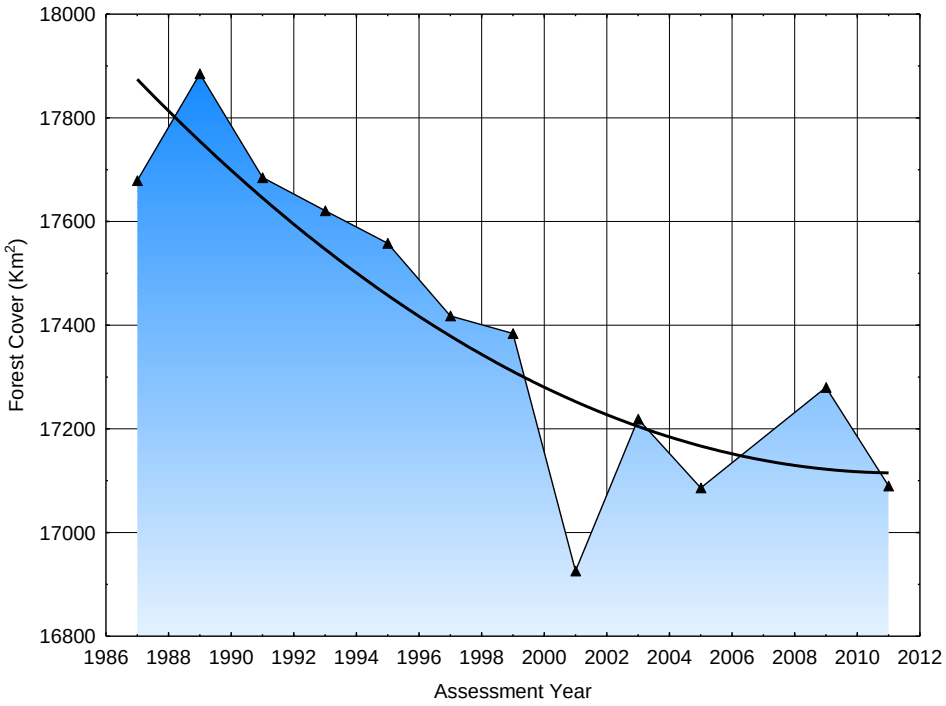


Figure 3.4.15. Graph of forest cover – Manipur.

Figure 3.4.15 shows the forest cover decreased consistently since 1987. The forest cover reached from 1.78 mil ha to 1.71 mil ha.

3.4.16 Meghalaya

Meghalaya is one of the hilly states of north eastern part of India, which covers the geographical area as 2.24 mil ha. It lies between 24^0 58' N to 26^0 07'N latitude and 89^0 48' E to 92^0 51' E longitude. Cherrapunjee and Mawsynram are located in the state has the highest rainfall spot of the world. The state has most of its land covered by hilly interspersed with gorges and small valleys with elevation ranging between 150 m to 1950 m. The western part of the state is warmer with mean temperature ranging from 12^0 to 33^0C. The central upland is relatively cooler with mean temperature ranging from 2^0 to 24^0C. The annual rainfall varies from 4000 mm to 11400 mm. The population of the state is 2.96 million, which is 0.24% of the country's population. The proportion of rural and urban population is 79.92% and 20.08% respectively. The population density is 132 persons per sq km.

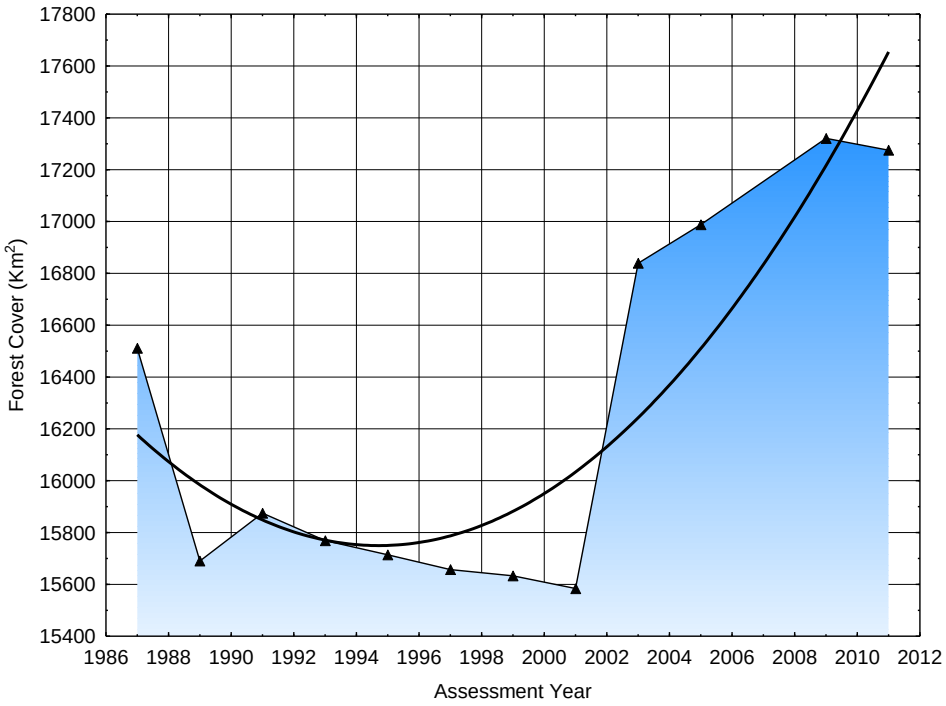


Figure 3.4.16. Graph of forest cover – Meghalaya.

Figure 3.4.16 shows that the forest cover consistently decreased since 1987 up to 2001 from 1.65 mil ha to 1.56 mil ha, then suddenly increased to 1.68 mil ha in 2003. At present, the forest cover is 1.72 mil ha.

3.4.17 Mizoram

Mizoram is situated in the north eastern part of India and shares the international border of Bangladesh in west and Myanmar in east and south. The state covers the geographical area as 2.11 mil ha , which is 0.64% of the total geographical area of the country. It lies between 21^0 56' N to 24^0 31'N latitude and 92^0 16' E to 93^0 26' E longitude. The average elevation of the state ranges between 500 m to 800 m with maximum reaching 2157 m in Blue Mountain. The state has a climate ranging from moist tropical to moist sub tropical, not very warm in summer and not very cold in winter. During winter, the temperature ranges from 11^0 to 24^0 C and in summer, it varies from 18^0 c to 29^0 C. the entire area is under the regular influence of monsoons. The population of the state is 1.09 million, which is 0.09% of the country's population. The proportion of rural and urban population is 48.49% and 51.51% respectively. The population density is 52 persons per sq km.

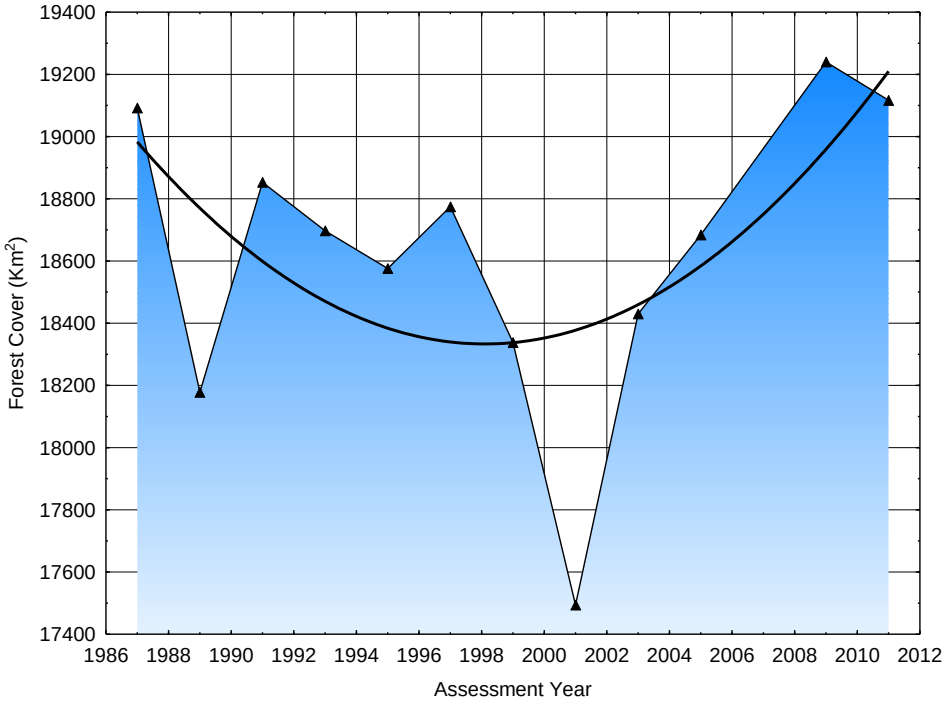


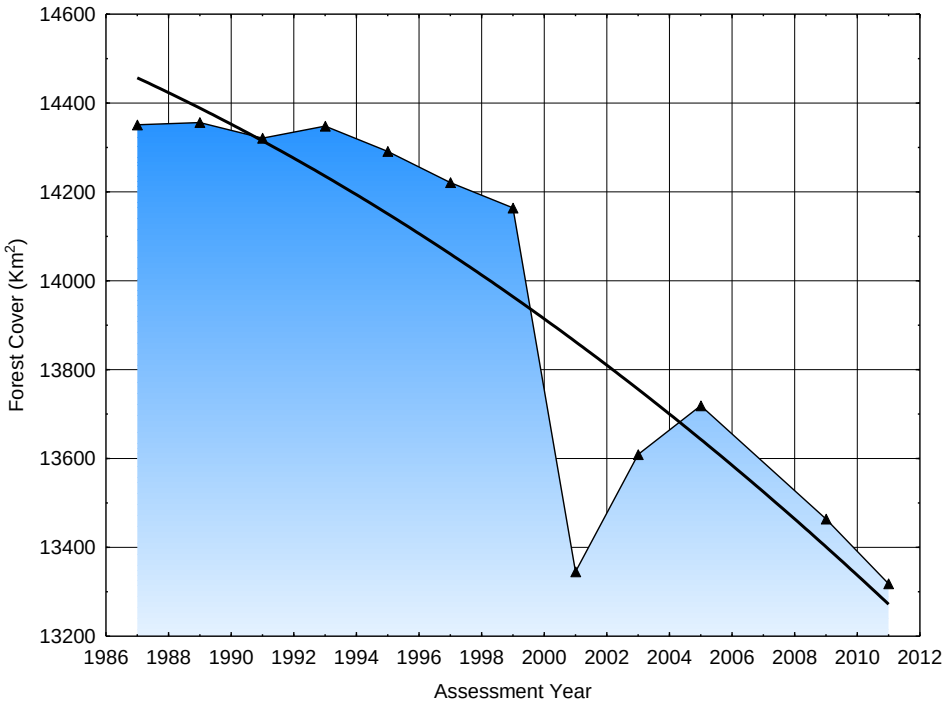
Figure 3.4.17. Graph of forest cover – Mizoram.

Figure 3.4.17 shows that the change of forest cover was not consistently in the last 25-30 years. The forest cover decreased to 1.74 mil ha in 2001. The current status of forest cover is 1.91 mil ha.

3.4.18 Nagaland

Nagaland is situated in the north eastern part of India sharing the international border of Myanmar. The state has 1.66 mil ha as the geographical area. It lies between 25^0 10' N to 27^0 04'N latitude and 93^0 15' E to 93^0 26' E longitude. Nagaland consists of narrow strip of hilly area running northeast to southwest.

The altitude of the state ranges between 194 m to 3826 m. The summer temperature ranges from 15^0 to 30^0 C and winter temperatures varies from 4^0 to 25^0 C. The annual rainfall in the state is 2000 mm. The population of the state is 1.98 million, which is 0.16% of the country's population. The proportion of rural and urban population is 71.03% and 28.97% respectively. The population density is 119 persons per sq km.



3.4.18. Graph of forest cover – Nagaland.

In Figure 3.4.18, the forest cover consistently decreased during the last 25-30 years. The forest cover decreased to 1.33 mil ha in 2001, then increase to 1.37 mil ha and then further decreased to 1.33 mil ha in 2011.

3.4.19 Odissa

Odissa is situated on the east coast of the country having 15.57 mil ha as the geographical area, which constitutes 4.47% of the total geographical area of the country. It lies between 17^0 47' N to 22^0 34'N latitude and 81^0 22' E to 87^0 29' E longitude. The state is rich in mineral resources including coal, iron, bauxite, chromite and nickel. The annual rainfall in the state varies from 1200 mm to 1600 mm and mean annual temperature ranges from 25^0 to 27.5^0 C. The population of the state is 41.95 million, which is 3.47% of the country's population. The proportion of rural and urban population is 83.32% and 16.68% respectively. The population density is 269 persons per sq km.

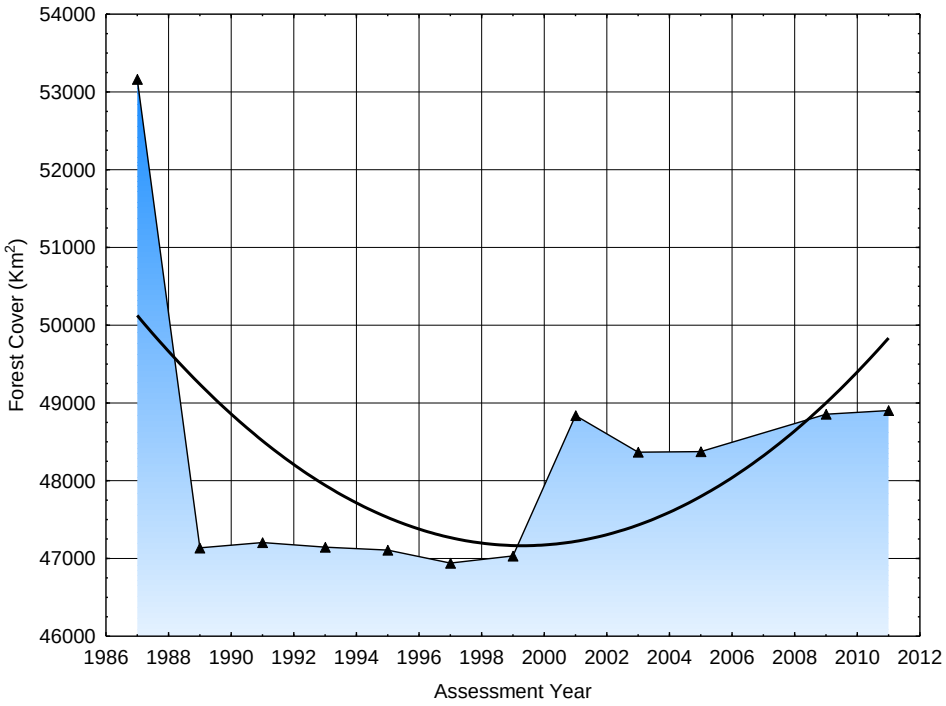


Figure 3.4.19. Graph of forest cover – Odissa.

Figure 3.4.19 indicates that the forest cover decreased from 5.32 mil ha to 4.71 mil ha in just two years during 1987-1989. It was constant in the next years and further increased. The current forest cover is 4.89 mil ha.

3.4.20 Punjab

Punjab is situated on the north western part of the country is known as grain ball of India having the geographical area as 5.04 mil ha. It lies between 290 33' N to 320 32'N latitude and 730 53' E to 760 56' E longitude. it shares the international border with Pakistan. The state has sub-tropical climate with hot summers and cold winters. The minimum temperature in winter falls to 00 c and maximum in summer touches to 470 C.

The annual rainfall in the state varies from 480 mm to 960 mm in hilly regions. The population of the state is 27.7 million, which is 2.29% of the country's population. The proportion of rural and urban population is 62.51% and 37.49% respectively. The population density is 550 persons per sq km.

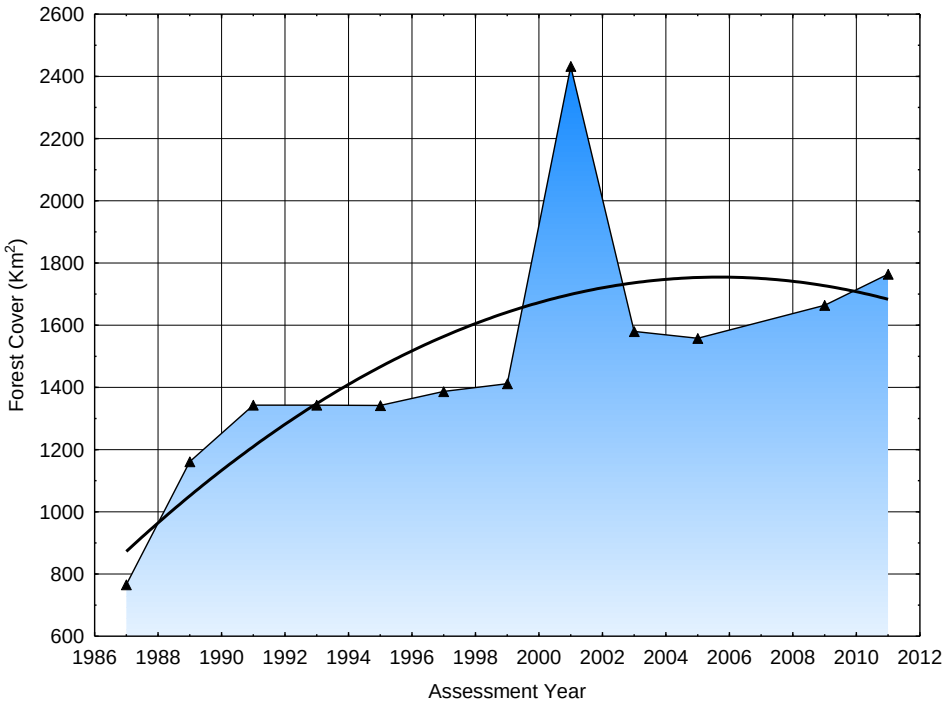


Figure 3.4.20. Graph of forest cover – Punjab.

Figure 3.4.20 shows that the forest cover consistently increased during last 25-30 years. The forest cover reached to 1.76 mil ha in 2011 from 77 mil ha in 1987. It touched the maximum of 2.43 mil ha in 2001.

3.4.21 Rajasthan

Rajasthan is the largest state in area of the country sharing the international border with Pakistan. Its geographical area is 34.22 mil ha, which is 10.41% of the total geographical area of the country. It lies between 230 04' N to 300 11'N latitude and 690 29' E to 780 17 E longitude.

The temperature ranges from sub zero to 500 C. The annual rainfall in the state varies from 480 mm to 750 mm. The population of the state is 68.62 million, which is 5.67% of the country's population. The proportion of rural and urban population is 75.11% and 24.89% respectively. The population density is 201 persons per sq km.

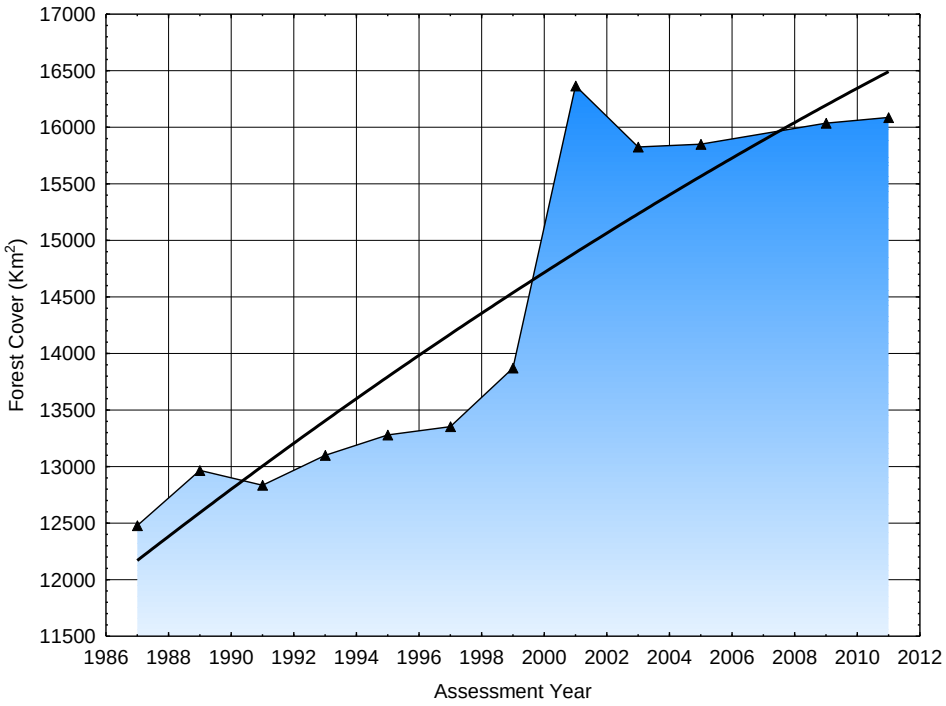


Figure 3.4.21. Graph of forest cover – Rajasthan.

Figure 3.4.21 shows that the forest cover consistently increased during last 25-30 years. The forest cover reached from 1.25 mil ha in 1987 to 16.09 mil ha in 2011. It touched the maximum of 1.64 mil ha in 2001.

3.4.22 Sikkim

Sikkim lies in the north east of India. Its geographical area is 7.1 mil ha, which is 0.22% of the total geographical area of the country. It lies between 270 04' N to 270 07'N latitude and 880 00' E to 880 55' E longitude. The climate ranges from subtropical to high alpine. Kanchenjunga, the world's third highest peak is located on the border of Sikkim with Nepal.

The temperature ranges from sub zero in winter to 280 C during summer. The annual rainfall in the state varies from 2700 mm to 3200 mm. The population of the state is 0.61 million, which is 0.05% of the country's population. The proportion of rural and urban population is 75.03% and 24.97% respectively. The population density is 86 persons per sq km.

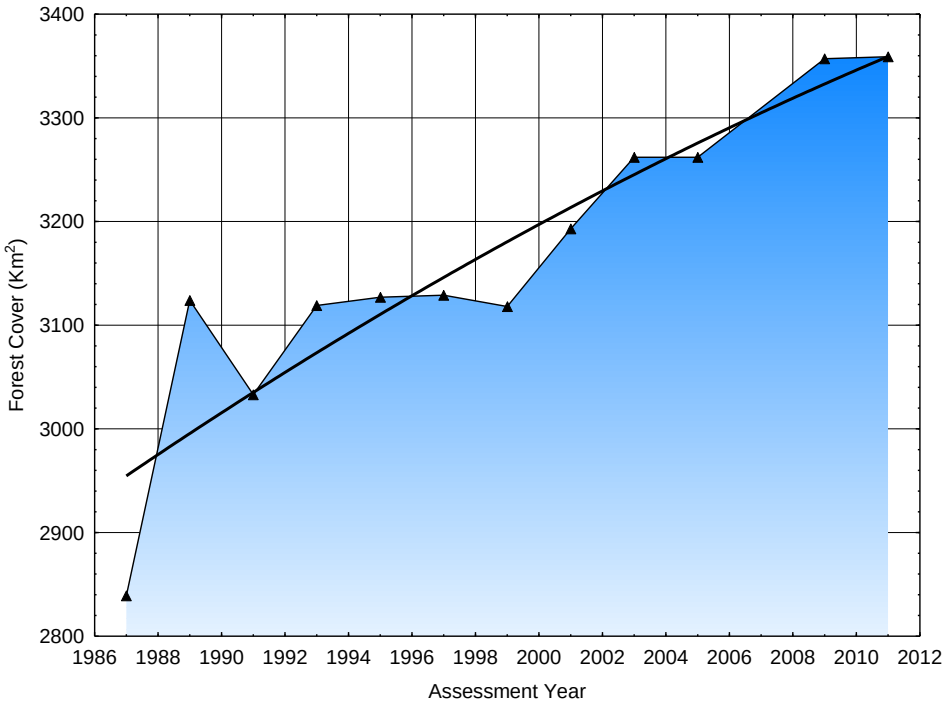


Figure 3.4.22. Graph of forest cover – Sikkim.

Figure 3.4.22 shows that the forest cover consistently increased during last 25-30 years. The forest cover reached from 2.83 mil ha in 1987 to 3.36 mil ha in 2011.

3.4.23 Tamil Nadu

Tamil Nadu is located in the southernmost part of the country. It has the geographical area of 13.01 mil ha , which is 3.96% of the total geographical area of the country. It lies between 080 05' N to 130 35'N latitude and 760 15' E to 800 20' E longitude. The south west monsoon feeds the plateau and the retreating north east monsoon brings rain to the east coast.

The temperature in the state ranges 20 C in the hills to 450 C in other areas. The annual rainfall in the state varies from 925 mm to 1170 mm. The population of the state is 72.14 million, which is 5.96% of the country's population. The proportion of rural and urban population is 51.55% and 48.45% respectively. The population density is 555 persons per sq km.

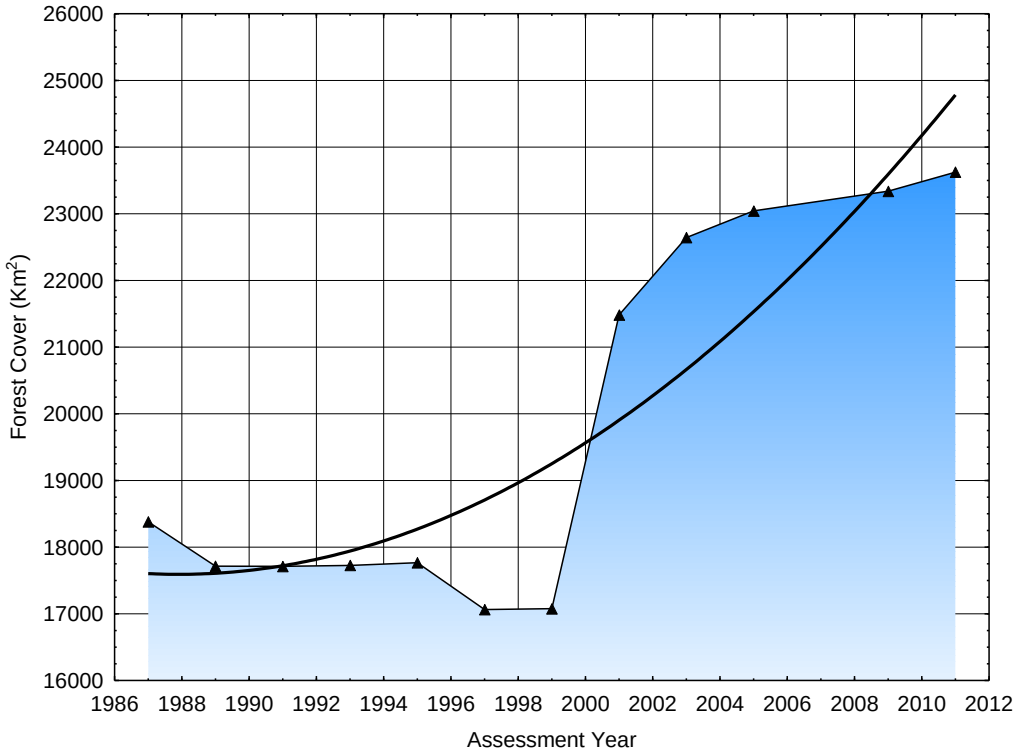


Figure 3.4.23. Graph of forest cover – Tamil Nadu.

Figure 3.4.23 shows that the forest cover slightly decreased during 1987 to 1999, then immediately increased in the next two years and continued to increase till today. The forest cover reached from 1.84 mil ha in 1987 to 2.36 mil ha in 2011.

3.4.24 Tripura

Tripura is located in the north eastern part of the country and sharing the international border with Bangladesh from three sides. The geographical area of the state is 1.05 mil ha , which is 0.32% of the total geographical area of the country. It lies between 220 57' N to 240 33'N latitude and 910 10' E to 800 20' E longitude. The climate ranges from moist to humid.

The temperature in the state ranges 210 to 380 C in summer and 40 to 330 C in winter. The annual rainfall in the state varies from 2250 mm to 2500 mm. The population of the state is 3.67 million, which is 0.30% of the country's population. The proportion of rural and urban population is 73.82% and 26.18% respectively. The population density is 350 persons per sq km.

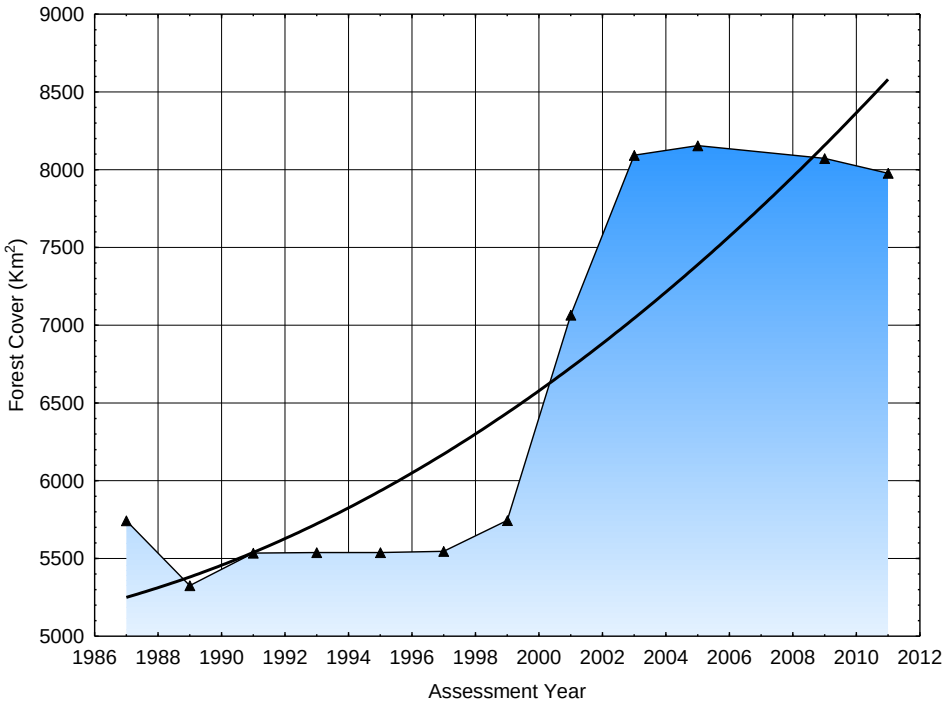


Figure 3.4.24. Graph of forest cover – Tripura.

In Figure 3.4.24, the forest cover was almost constant during 1987 to 1999, then immediately increased in the next 6-7 years from 0.57 mil ha (1999) to 0.82 mil ha (2005) and continued to decrease slightly till today. The current forest cover is 0.80 mil ha.

3.4.25 Uttar Pradesh

Uttar Pradesh is the most populous state of the country having the geographical area of the state is 24.09 mil ha which is 7.3% of the total geographical area of the country. The state is sharing the international border with Nepal. It lies between 23^0 52' N to 30^0 24'N latitude and 77^0 05' E to 84^0 38' E longitude.

The annual rainfall in the state varies from 1000 mm to 1200 mm and the temperature in the state ranges from 5^0 C during the winters to 45^0 C during summer. The population of the state is 199.58 million, which is 16.49% of the country's population. The proportion of rural and urban population is 77.72% and 22.28% respectively. The population density is 828 persons per sq km.

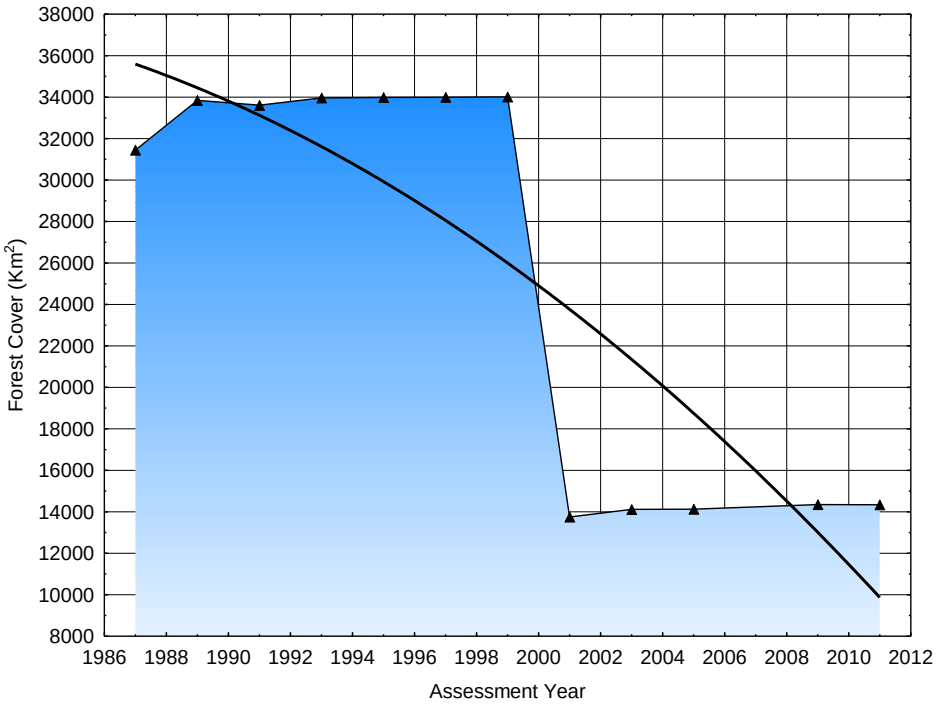


Figure 3.4.25. Graph of forest cover – Uttar Pradesh.

Figure 3.4.25 shows that there is slight increase in the first two years, the forest cover was almost constant from 1987 to 2001, then due to the formation of a new state from the state of Uttar Pradesh in 2001, the forest cover decrease and was constant during the next decade. The current forest cover is 1.43 mil ha in 2011.

3.4.26 Uttarakhand

Uttarakhand is situated in the northern India, where the Ganga and Yamuna river originates. The geographical area of the state is 5.35 mil ha which is 1.63% of the total geographical area of the country. The state is sharing the international border with Nepal and China. It lies between 28^0 43' N to 31^0 28'N latitude and 77^0 34' E to 81^0 03' E longitude. The state has temperate climate except in the plains area where the climate is tropical.

The annual rainfall in the state is 1200 mm to1500 mm. The temperature in the state ranges from subzero to 43^0 C. The population of the state is 10.12 million, which is 0.84% of the country's population. The proportion of rural and urban population is 69.45% and 30.55% respectively. The population density is 189 persons per sq km.

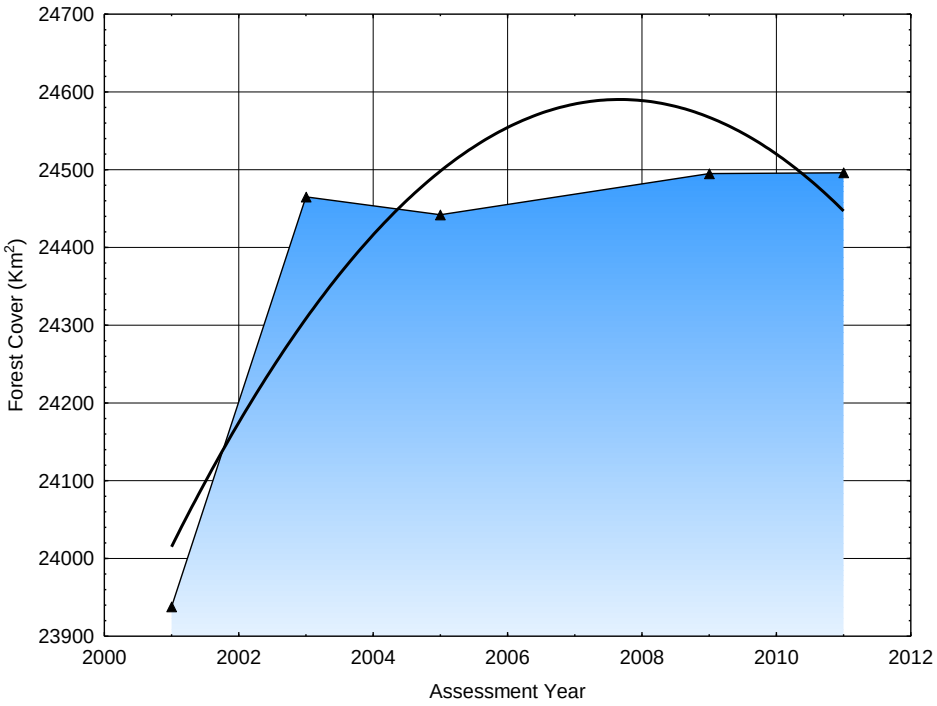


Figure 3.4.26 Graph of forest cover – Uttarakhand.

In Figure 3.4.26, after the formation of the new state in 2001, the forest cover consistently increased during the last ten years. The forest cover of the state was 2.39 mil ha in 2001 and reached to 2.45 mil ha in 2011.

3.4.27 West Bengal

West Bengal is situated in the eastern part of the country and sharing the international border with Bangladesh, Nepal and Bhutan. The geographical area of the state is 8.87 mil ha , which is 2.7% of the total geographical area of the country. It lies between 21^0 20' N to 27^0 32'N latitude and 85^0 50' E to 89^0 52' E longitude. The state has a diverse climate, varying from moist tropical in the southeast to dry tropical in the southwest and from subtropical to temperate in the mountains in the north.

The annual rainfall in the state varies from 900 mm in southwest to 5000 mm in the northern parts of the state. The temperature in the state ranges subzero in the hills during the winters to 46^0 c in southern parts during summer. The population of the state is 91.35 million, which is 7.55% of the country's population. The proportion of rural and urban population is 68.11% and 31.89% respectively. The population density is 1029 persons per sq km.

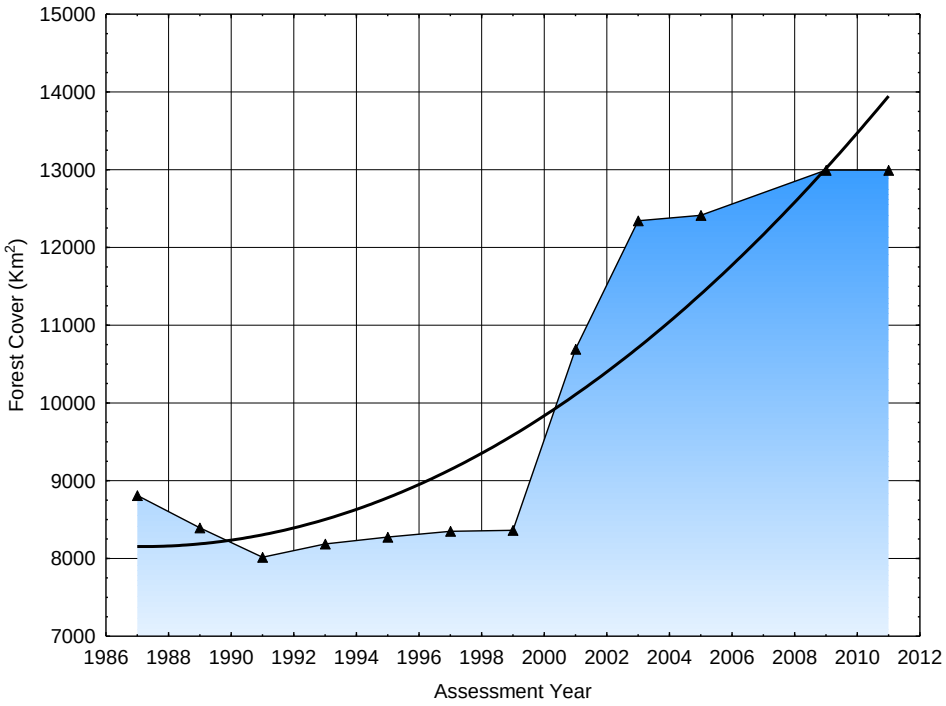


Figure 3.4.27. Graph of forest cover – West Bengal.

In Figure 3.4.27 shows that the forest cover was almost constant during 1987 to 1999, then immediately increased in the next four years from 0.84 mil ha (1999) to 1.23 mil ha (2003) and continued to increase slightly till today. The current forest cover is 1.30 mil ha.

3.5 Variation and Discrepancy in data on Forest Cover by FAO and FSI

The variation and discrepancy in data on forest cover by different agencies is due to the variation in classifications and definitions of forest cover. The national definition of forest cover by FSI deviates from the present FRA definition (FAO) of forest cover namely, the minimum area of forest cover is 1 ha for FSI instead of 0.5 ha for the FAO. The other factors for the discrepancy in data on forest cover may be due to the inclusion of mangroves and "Inland Water Bodies".

Due to the difference in the classification and definition, the figures published by FAO, do not tally with the figures reported by FSI, India. Forest cover assessment of India by the FAO in 1990 used the data of SFR 1989, where the total reported forest cover was 63.880 mil ha. As per FAO's classification, forest areas affected by shifting cultivation even once in the past are recorded under the category of "forest fallow" even if such areas presently support forest vegetation (close or open), whereas in the FSI's classification, the present status of the forest cover is taken into account. The latest data of the existing forest area affected by the shifting cultivation was not available in 1990. Using old estimates of 1975, 1981 and 1984, FAO worked out the total area affected by shifting cultivation as 11.515 mil ha and classified it as "forest fallow". As a result, the forest area of the country reflected in 1990 report of FAO was reduced to 52.365 mil ha. This has been the basic reason for the difference in the area of forest cover as assessed by the FSI and FAO.

3.6 Forest Cover Change at national level

Based on the discussion made in preceding Sections 3.3 and 3.4; FAO's simulated decadal data on forest cover are being relied upon for the period of 1900-1970 and forest cover data on for the period of 1980-2010 are taken from the national forest cover assessment made by Forest Survey of India (Table 3.5).

Table 3.5. Decadal Forest Cover Trend.

Years	1900	1910	1920	1930	1940	1950	1960	1970	1980	1990	2000	2010
Forest Cover (mil ha)	89.9	87.1	87	83.3	79.4	75.8	69.1	62.9	64.1	66.33	66.88	69.2

Source: FAO and FSI

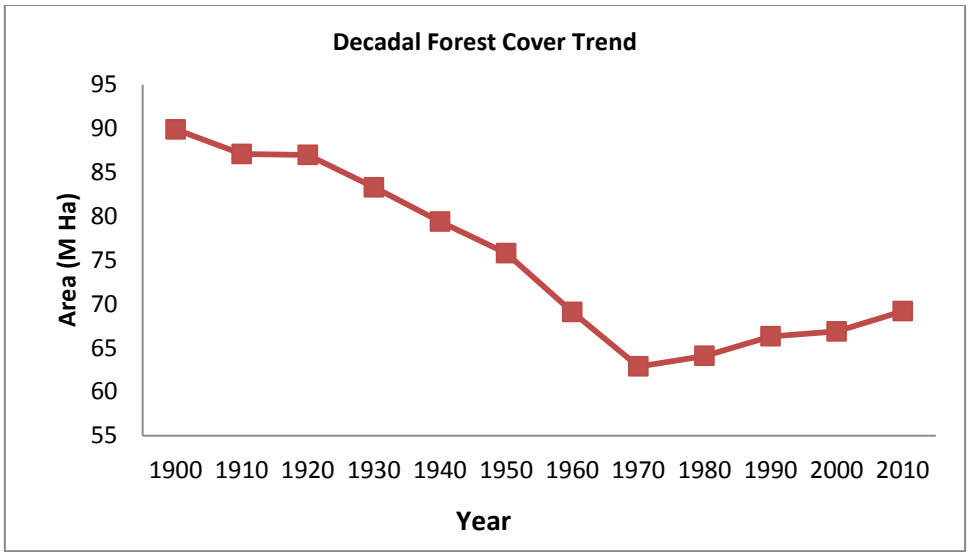


Figure 3.5. Decadal Forest Cover Trend.

The FSI has been carrying out the assessment of forest cover for the country since 1980. Forest cover mapping is carried out regularly on a biennial basis. India is one of the few countries to have a robust mechanism for periodic assessment and monitoring of its forest resources. Forest cover includes all lands of more than one hectare in area with a tree canopy density of more than 10%. Data of forest cover assessments for the periods 1981–83, 1989–91, 1999–2000 and 2008–09 were used for decadal data of 1980, 1990, 2000 and 2010 respectively.

3.7 Density Class

According to the Forest Survey of India, dense forest may be defined as all forest lands with tree canopy density of 40% and above; and open forest as all lands with tree canopy density between 10% to 40%, where as scrub as degraded forest lands with canopy density less than 10%. According to the State of Forest Report of 1991 and 2011 of FSI, Dehradun, there has been an increase in the dense forest (1.9199 mil ha) and open forest (3.7890 mil ha) along with mangrove forest (0.0418 mil ha). The changes in forest cover between the two assessment periods reflect the actual change on the ground during the intervention period. These changes can be attributed to either management interventions such as harvesting of short rotational plantations, clearances in encroached areas, biotic pressures, shifting cultivation practices etc.

There is continuous improvement in the quality of forest in India, as evident from the table below. There has been a continuous decrease in the scrub forest, which has canopy density less than 10%. In the year 2003, the dense forest was redefined and classed into 2 more categories i.e. Very Dense Forest (VDF) and Moderately Dense Forest (MDF). Very dense forest is defined as all lands with tree canopy density of 70 % and above; and moderately dense forest as all lands with tree canopy density from 40% to 70%. The graphical representation has been made for dense, which includes very dense forest and moderately dense forest, open and scrub forests Table 3.6.

Table 3.6. Biennial Forest Density Data.

Year	VDF	MDF	Dense (VDF+MDF)	OF	Scrub
1987	357,686	0	357686	276,583	76,796
1989	378,470	0	378470	257,409	76,796
1991	385,008	0	385008	249,930	59641
1993	385,576	0	385576	250,275	58,943
1995	385,756	0	385756	249,311	60,528
1997	367,260	0	367260	261,310	57,211
1999	377,358	0	377358	255,064	51,896
2001	416,809	0	416809	258,729	47,318
2003	51,285	3,39,279	390564	287,769	40,269
2005	54,569	3,32,647	387216	289,872	38,475
2007	83,510	3,19,012	402522	288,377	41,525
2011	83,471	3,20,736	404207	287,820	42,177

Source: ISFR 2009,2011

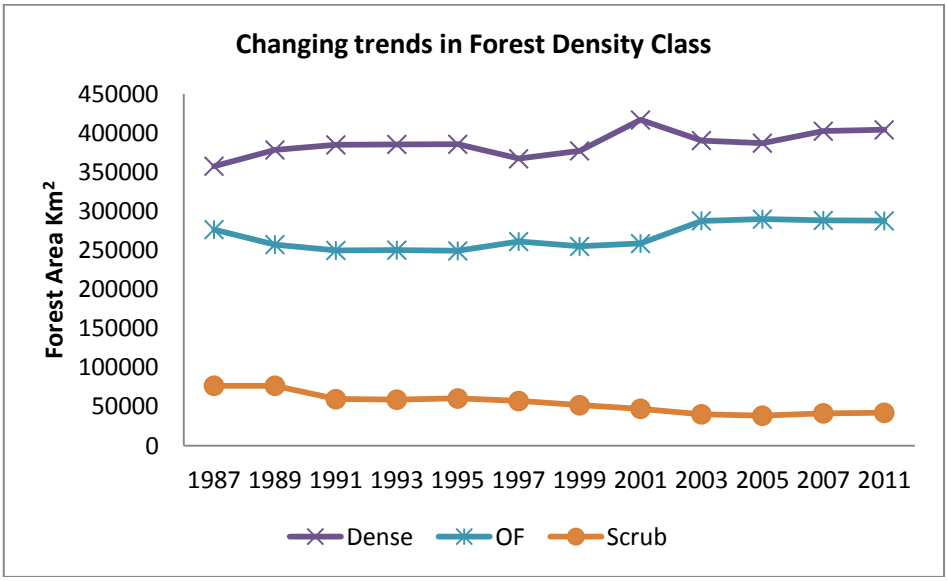


Figure 3.6. Changing Trend in Forest Density Class.
Source: ISFR 2011

3.8 Conclusion

As the civilization prospered and population increased, the relationship between humankind and forests including their degradation of the forests has changed. Forests were cleared for agriculture to feed the growing population. Apart from the global effort at forest cover mapping under FAO/UN Forest Resource Assessment series, the first ever forest cover mapping in India was carried out using LANDSAT imageries pertaining to period 1981-83 at 1:1 million scale. The forest cover followed a decreasing trend between 1880 and 1980. FSI is carrying out the assessment of forest cover for the country since 1980. Forest cover mapping is being carried out regularly on biennial basis. Data of forest cover assessment for the periods 1981-83, 1989-91, 1999-2000 and 2008-09 were used for decadal data of 1980, 1990, 2000 and 2010 respectively. The variation and discrepancy in data on forest cover by different agencies is due to the variation in classifications and definitions of forest cover. The national definition of forest cover by FSI is the minimum area of forest cover is 1 ha instead of 0.5 for FAO. The FAO used the data of SFR 1989, where the total reported forest cover was 63.880 mil ha. In 2010, FAO has used the past data of FSI to project the forest cover for forest resource assessment report. Beyond forest cover, density class, growing stock volume and forest carbon are also important attributes of forests to understand the rate and pattern of their depletion and degradation in the country.

4 FOREST TRANSITION IN INDIA AND ITS MAJOR DRIVERS

4.1 Introduction

Status of development and welfare are the crucial factors in determining forest loss. The requirement for income and economic growth results in a growing demand for agricultural and forest derived products. The early stage of development is marked by an increasing rate of deforestation. Increase in the incomes too accelerates the rate of deforestation and a great decline in forest cover takes place; but at incomes beyond a certain level, the rate of deforestation reduces; then the trend reverses and a slow increase in forest cover takes place. The term "forest transition" was coined by Alexander Mather to describe this general trend that the stocks of forests follow on the path of economic development in any society. Forest transitions occur at various scales from a sub-region within a country to several countries within a large geographical region (Rudel *et al*. 2005). The attributes of forest situation and transition can be forest cover, forest density, growing stock, forest carbon, improvement of ecosystem services depending upon the availability of the data and the context of study. Except for forest cover, there is a lack of reliable time series data for the other attributes of forest situation.

Forest transition is generally studied from the curve drawn using time series data on forest cover (Figure 4.1). In the general forest transition curve, two features of forest transition namely deforestation and reforestation are depicted. Average decline rate in the proportion of forested land during the first phase (from the origin to T1, point of inflection) is given by slope of deforestation curve and the subsequent recovery rate in the proportion of forested land during the later phase (from T1 to the present time) is estimated from slope of reforestation curve.. This ratio of loss v/s gain was approximately 2 to 1 and characterized national forest cover trends between 1948 and 1990 in all the countries that reported to FAO during that period (Rudel *et al.* 2005). The point of inflection, T1, where gains in secondary forests finally begin to exceed losses in old growth forests (primary forests) often does not occur until the amount of primary forests has reduced to very low levels (Rudel 1998).

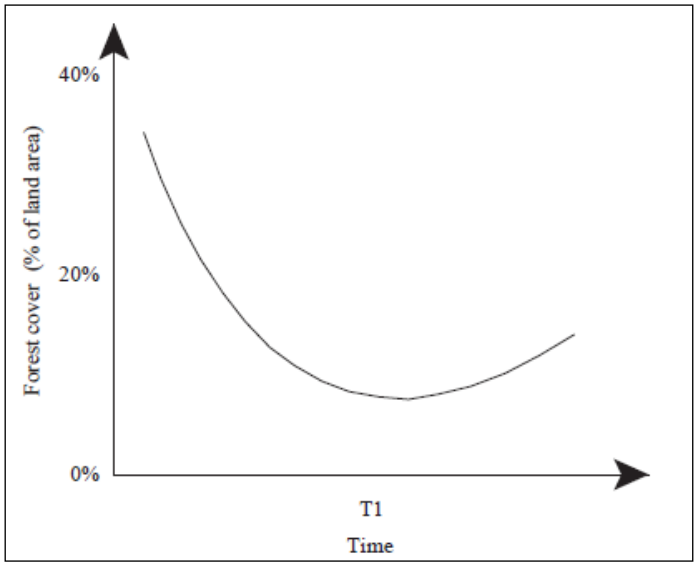


Figure 4.1. Forest Transition Curve.
Source: Rudel *et al*. 2005.

4.2 Forest Transition

Data availability is a major constraint in the analysis of forest transitions worldwide and the construction of reliable curves of forest area against time, therefore, is difficult. The Forest Resources Assessment series data from FAO provides sufficient indication that the net loss of forests in many Asian countries persisting for many decades has now been halted to pave the way for the net gain in forest cover in recent years. For India, the simulated forest cover data as prepared by FAO for the period 1900 to 1980 and FSI forest cover data after 1980 can be used to construct the transition curve since it is the only reliable data available on forest cover as described in Chapter III. Therefore the

forest transition curve for India (Figure 4.2.) is given as the curve of best fit, using decadal time series data on forest cover (Table 3.4).

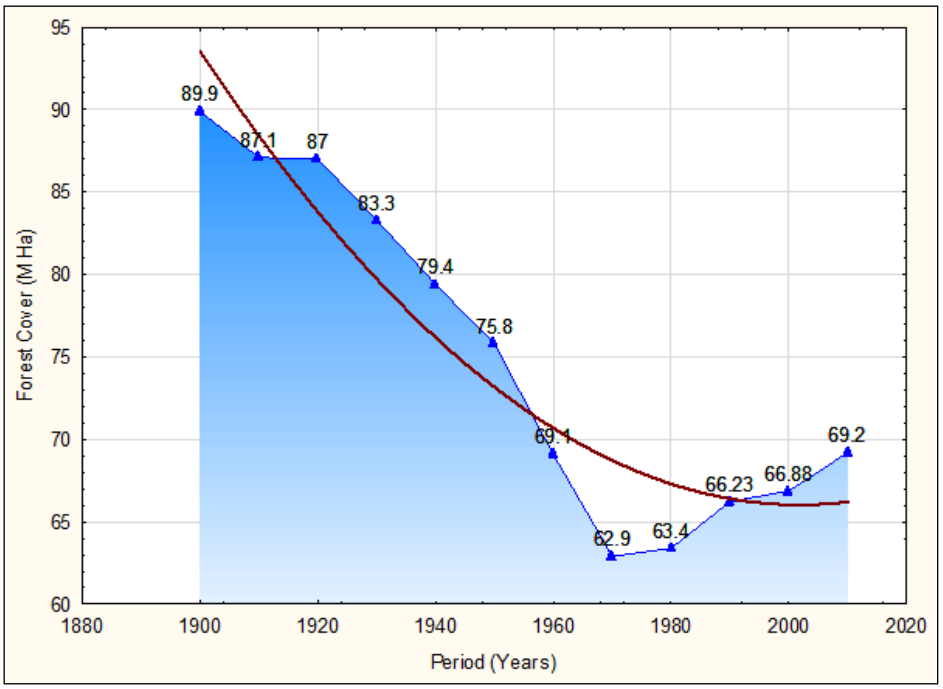


Figure 4.2. Forest Transition Curve for India.

The forest situation curve in terms of forest cover is the net result of such aspects as deforestation, degradation of forests, conservation of forests, sustainable management of forests, afforestation and rehabilitation of forests; all happening on different scales during different stages of economic development in India. Each stage is generally characterized by dominance of one aspect over the others. Deforestation dominated the first phase of forest transition curve as has been the general trend in all forest transitions but the historical events associated with the advent of colonial rule accelerated the deforestation process. From the land use pattern (Table 1.12), this deforestation is attributed to agricultural expansion and other infrastructural projects. However, India's agricultural area stabilized by 1970 due to intensification of agriculture. Finally government regulations in the form of the Forest Conservation Act of 1980 and the subsequent intervention of the Supreme Court of India checked the undue diversion of forest land for non-agricultural development purpose. Moreover, forest degradation is directly related to the dependence of local people on the forests and the outcome of the forest management regime especially in a historical perspective. The forest conservation aspect showed dominance as a result of policy interventions (in the form of National Forest Policy 1988 and Joint Forest Management Circular of 1990 for rehabilitation of degraded forests) by the Government of India and the legal interventions made by the Supreme Court of India for the sustainable management of forests. The effects of large scale afforestation and rehabilitation programmes of the state and central government today contribute substantially towards the increasing forest cover trends in the country while forest degradation still poses one of the greatest challenges for forestry in India. There are other indirect drivers to forest cover change, which include general economic development, urban population growth, an economy becoming more and more dependent on secondary and tertiary sectors, land abandonment, import substitution of forest products, policy and legal regulations, and change in attitude towards forests, which are discussed in the next chapter.

4.3 Drivers to Forest Deforestation and Degradation

Forest degradation is usually associated with a reduction in vegetative cover, especially trees. There are exceptions, however, such as the 'empty forest syndrome' brought on by excessive hunting and/or the high-grading of commercially valuable timber species (FAO 2009). Thus, deforestation is an extreme case of degradation, as it temporarily reduces the density of vegetation cover to zero (Grainger 1993). Consequently, vegetation degradation in forests may be attributable to either the temporary or permanent changes in structure, density (canopy closure, stock quality, tree density,

biomass density and fragmentation), and species composition, which is not the case in deforestation. The truth is that forests get degraded due to biophysical, socioeconomic and political disturbances manifested in drought, fire, insect pest attack, pollution, defoliation, perverse incentives, political instability and other natural and anthropogenic hazards (Grainger 1996). Perceptions of forest degradation are many and varied, depending on the driver of degradation and the goods or services of most interest. Natural and human-induced degradation are often interdependent, since human actions can affect the vulnerability of a forest to degradation from natural causes (e.g. reduced stocking due to harvesting can lead to increased sensitivity to wind damage), while natural damage can also lead to increased human-induced disturbance (e.g. natural forest fire can lead to encroachment by shifting cultivators) and the deforestation of steeply sloping land can lead to widespread, severe erosion. Distinguishing between natural and human-induced causes may be difficult when abiotic and biotic factors are triggered by changes in weather patterns (perhaps as a result of human-induced climate change) that lead to a greater frequency, scale and impact of forest degradation.

Throughout the world, forests have had historical similarities. Forests were plentiful while the population was small and their subsistence needs minimal. Forests were cleared for cultivation with onset of settled habitation from nomadic existence. Low–density nomadic populations were transformed to a higher-density agrarian and commerce-based population by expansion of agriculture. Richards and Flint (1994) attributed the large scale deforestation to large scale clearance of forestlands for agriculture, overexploitation of the surviving forests in agricultural areas due to increasing population and livestock exacerbated the status of forests. However, the historical background of Indian forests clearly establishes that the early British administration destroyed Indian forests to secure big supplies of teak and other timber for their navy and the requirement for railways in India ruined forests during the middle of colonial rule (Lal 1989). Forest regulations and policies during the British Empire only helped to make rich forests in the country into government property and alienated the people from access to these forests for their routine needs. Consequently, all concessions and rights that were not explicitly granted by the state were withdrawn, paving the way to facilitate absolute control of the state over forest resources. Moreover, the objectives advocated in the first forest policy of 1894 could not be implemented in all categories of forestlands and its implementation was limited to supply of valuable timber for their imperial strategic interests and commercial purposes. Some of the efforts made under the scientific management of forests under the concept of sustained supply of timber, could not make a mark on the overall condition of forests in the country and the subsequent two world wars further deteriorated the forests of India due to over exploitation of timber. In the initial stages of economic growth, forests mainly served as a land bank for subsistence agriculture and for providing fuel wood, fodder and grazing.

The new forest policy of 1952 recognized the functional classification of forests as protected forests for environmental consideration; national forests for strategic requirement of defence, communications and industry; village forests for local needs; and tree lands for extension forestry to meet the growing needs of the people. It also recommended bringing 33% of the total land area of the country under the forest cover. Legally more and more areas were brought under notified forestlands and forest consolidation took place in first two decades after independence. Though, the extent of forests as land use showed continuous increase due to notification of wilderness into the category of legal forest (Figure 1.4), status of forests in terms of forest cover in the country showed continuous decline. In 1950-51 the recorded forest area was 40.48 mil has. It increased to 66.80 mil ha in 1976-77 and 76.52 mil ha in 1996, i.e. an increase of 36.04 mil ha (NFAP–India 1999). However, the intervening period witnessed large scale felling by the private owners to get maximum returns before surrendering ownership. Forests being on the provincial/state list (Section 2.5) under the separation of powers between the provincial and central governments continued to be diverted recklessly for all non-forestry purposes. Large scale development activities were initiated, immediately after independence, leading to rapid industrialization (including paper, plywood, saw milling), expansion of railways, network of highways and other roads, construction activities, river valley projects, expansion of agriculture etc. claiming large areas of forests (nearly 4.13 mil ha) till 1976. Forests were thus considered as a land bank for meeting the land needs for other purposes and a resource for earning revenue to support other development activity.

However, there was a remarkable change in the approach of the central government towards sustainable development and environmental conservation in India after the 1972 Stockholm Conference on Environment. The federal (central) government with the amendment in the constitutional provision under the separation of powers brought forests on the concurrent list in 1976,

wherein the central act would prevail over the provisions of any state act on the subject of forests. Later, the Forest Conservation Act was enacted in 1980 and the diversion of forestland and related deforestation could occur only with the concurrence of the central government. It is important to mention that prior to the enactment of the Forest Conservation Act 1980, the diversion of forestland for non-forestry purposes during 25 years (1951–1976) was 4.13 mil ha about 60% of which was for agricultural purposes (FSR–India 2010) . Before the Act came into force, the annual diversion was 165200 ha, which has been reduced to 36,560 ha. Often, forestland transfer took place without properly analyzing the comparative benefits and costs of alternative uses. The forest land diverted for non-forestry uses before and after the enactment of the Act is depicted (Figures 4.3 and 4.4). About 32.5% (36 8432 ha) of the total diverted forest land in post act period has been for the regularization of encroachment[5]. Maximum regularization had happened during the period 1990 to 2001. The average annual diversion of forest land would be about 24 700 ha for the development purposes after excluding the diversion for regularization of encroachment.

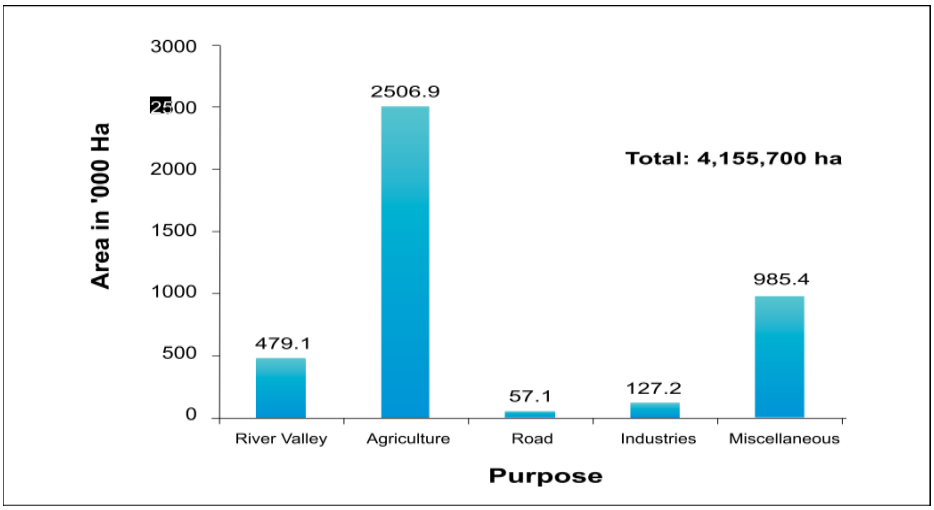


Figure 4.3. Forest land diverted for different purpose during 1951–1976.

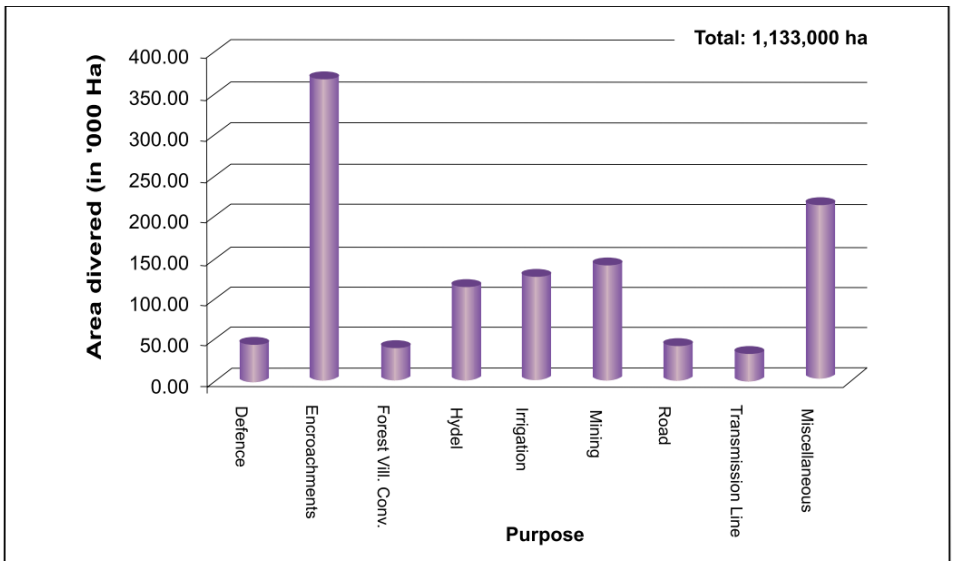


Figure 4.4. Forest land diverted for different purpose during 1980–2011.

Note: Miscellaneous purpose includes dispensary, disputed settlement claims, drinking water, railways, rehabilitation, school, thermal, village electricity and wind power

[5] Any activity that is not forestry related and found done inside reserved forests even under exigencies is to be treated as illegal. Any cultivation, cropping, settlement, etc. found done or carried out in reserved forests, could be termed as encroachment.

In independent India, drivers of forest deforestation and degradation fall into two categories- first, those which are planned and projected in accordance with policies, legal framework and management plans, etc, and second, those which are spontaneous, beyond government and management control (MoEF 2012). Developmental works and projected use, such as road and railway construction, coal, iron and other mining activities, hydro-electric power and irrigation projects, industrial requirements, expansion of cities and towns are categorised as Planned Drivers. Routine local unsustainable practices not covered in official management plans such as uncontrolled felling, fuel wood and small timber collection, NTFP extraction, unregulated livestock grazing, fodder collection etc. lead to forest degradation and in some cases do lead to deforestation. They are linked to livelihoods of local people and people's participation in the management of forest through Joint Forest Management has contributed towards the control of these degradations and rehabilitation of forests. Natural disturbances, such as forest fires, insect attack, disease outbreak, forest dieback etc. along with unauthorized activities such as encroachment of forest land for agriculture and housing, illegal mining operations, etc. are examples of unplanned drivers. Further, shifting cultivation in parts of India owing to socio-economic and cultural linkage has also contributed towards forest degradation.

The mitigation measures for forest degradation and deforestation revolve around forest management and plantation on degraded land (Grainger 1990), besides many other management interventions. Moreover, minimizing the impacts of planned or controlled drivers is possible by introducing appropriate policy instruments and management options including effective legal framework and site specific mitigation measures. However, the challenge lies in addressing and managing the unplanned or uncontrolled drivers and activities, which are mainly a direct outcome of local people's dependence on the adjoining forest areas to meet their livelihood needs of fuel wood, grazing, fodder, and food supplements, and to a very small extent on the illegal activities within forests.

4.3.1 People's Dependence on Forests

Forests in India are heavily burdened to meet the subsistence needs of the people living in the vicinity of the forests. Therefore, acting on the recommendations of the interim report (1972) of National Commission on Agriculture on Production of Man-made Forests, externally aided projects were started on a large scale in late 1970s for expanding the forest and tree resource through social forestry programmes. The fund was used to raise forest plantations on 2.572 mil ha, mostly in non-forest lands along road, rail and canal side, on barren common lands, panchayat lands and institutional land (MoEF 2004). The fund was also used for raising nurseries for distributing seedlings to people, often free of cost for planting in their own farmlands, bunds, homesteads etc. However, people's dependence on forests to meet their livelihood needs of small timber, fuel-wood, grazing and fodder continues to be a major factor in determining the condition of the forests in the country. The consumption of fuel wood from forests has been estimated to be 58.75 mil tonnes annually while the annual production of fuel wood from the forests is 1.23 mil tonnes and annual availability of fuel-wood from TOF is 19.25 mil tonnes (ISFR 2011). Thus rest of the consumption is considered to be met by unregulated or uncontrolled removal of fuel wood from the forests. Fuel wood collection for household energy significantly contributes to pressure on forests and adds to the rate of forest degradation and deforestation. The annual consumption of wood for household purposes is estimated to be another 48.0 mil cu m. Similarly FSI also estimated the equivalent number of fodder consuming livestock fully dependent on forests to be 86.4 million. This results in overgrazing and over extraction of green fodder, leading to forest degradation through damages to regeneration and compaction of soil (NFAP 1999).

There are large number of guesstimate on the numbers of forest dependent people in India. Based on Lynch and Taibot (1995), FAO (1998) report estimated 275 million people directly dependent on forest resources and 100 millions are living inside the forests. Even the report by different source of Fisher and Veer, 1997 shows forest dependent people in the range of 250–300 million and people living in forests at 100 million.

4.3.2 Shifting Cultivation

Shifting cultivation or *jhum* cultivation is an agricultural land use where forest land use is converted to agriculture land use temporarily and these activities repeated in a cyclical fashion over the years. Such cultivation not only affects the forest cover but also reduces its productivity and increases soil erosion.

As per the report of the National Commission on Agriculture (1976), 492,000 tribal families of the north-east region are involved in *jhum* cultivation and the total area affected by this practice is 2,694,000 ha. A recent study based on satellite data carried out by the Assam Remote Sensing Application Center (ASTC Council 1996) shows that in the Karbi Anglong District of Assam, area currently under *jhumming* has increased from 13,583 ha (1.3% of total geographical area) in 1986-87 to 69125 ha (6.62% of total geographical area) in 1993–94. The corresponding figures for the North Cachar Hills district in Assam are 22,807 ha (4.67% of total geographical area) and 69,447 ha (14.21% of geographical area) in 1986-87 and 1993-94 respectively.

The practice of shifting cultivation in its original form was not harmful and was rather considered to be useful. Least disturbance to soil, natural fertility build up of soil, mixed cropping on slopes under purely rainy conditions were some of its merits. When the system emerged there was no population pressure and the cycle of rotation was 10 to 20 years or above, thus leaving enough time for the soil to revive. Due to increase in population, and non-availability of land, the *jhum* cultivation cycle nowadays has reduced to 3-6 years, thus resulting into large scale damage not only to the forests but also to forest soils leading to deforestation and denudation of hill slopes.

The Table 4.1 gives the status of shifting cultivation in North East India. Maximum area under shifting cultivation is in Manipur, followed by Arunachal Pradesh, Assam, Mizoram, Meghalaya, Tripura and Nagaland.

Table 4.1. Status of Shifting Cultivation in North East India.

State	**Annual area under shifting cultivation (ha)**
Arunachal Pradesh	70,000
Assam	69,600
Manipur	90,000
Meghalaya	53,000
Nagaland	19,000
Tripura	22,300
Mizoram	63,000

Source: ISFR 2003

Table 4.2 shows that the practice of shifting cultivation in North-Eastern region of India had affected and reduced forest cover to an extent of 0.5476 mil ha during the years 2001–03. Maximum effect due shifting cultivation was in Nagaland followed by Arunachal Pradesh, Manipur, Mizoram, etc.

Table 4.2: Forest cover affected due to shifting cultivation.

State	**Decrease in forest cover (mil ha)**
Arunachal Pradesh	0.0925
Assam	0.0609
Manipur	0.0855
Meghalaya	0.0684
Mizoram	0.0687
Nagaland	0.1332
Tripura	0.0384
Total	**0.5476**

Source: ISFR 2003

The graph below gives the trend of forest cover of North-Eastern region of India since 1989, based on the estimates generated by the FSI. Loss in forest cover in the North-Eastern states has been mainly due to shifting cultivation. Nagaland exhibits the maximum and most consistent loss of forest cover, followed by Arunachal Pradesh as the second most affected state in the region with regard to loss of forest cover due to shifting cultivation. Manipur has also been affected consistently over the years due to shifting cultivation. In the State of Assam, other factors have contributed to reduction in the forest cover like extension of encroachment in some areas.

Based on the task force of Government of India report, more than 3.0 mil ha of land in India is under shifting cultivation. Shifting cultivation is also practised in Odisha, where it is known as the *podu* cultivation. About 0.5298 mil ha area annually is under this primitive agriculture practice. About 150 000 tribal families are engaged in *podu* cultivation.

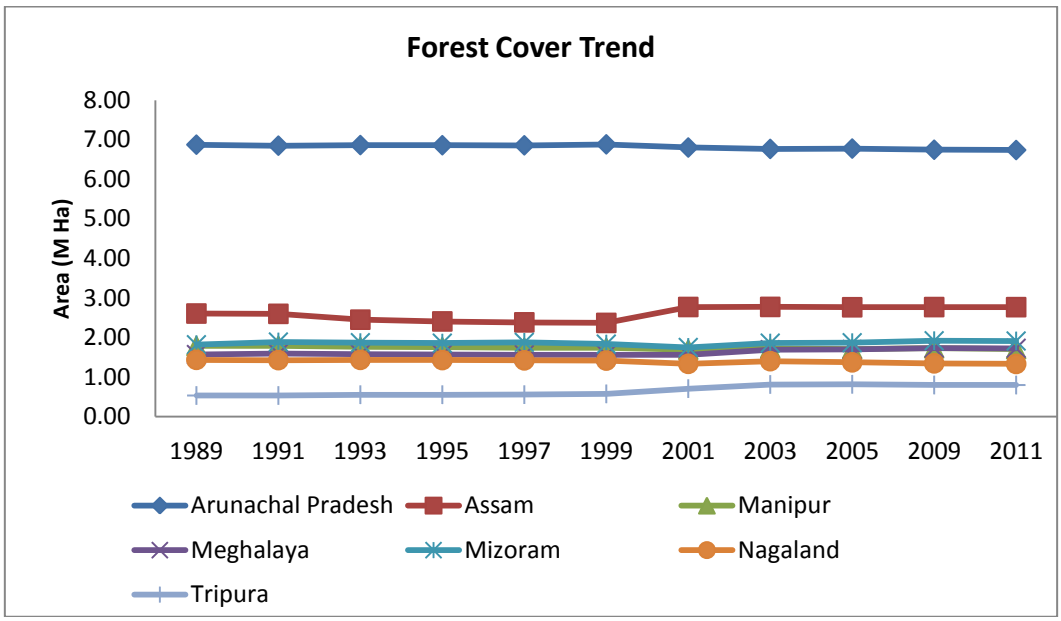


Figure 4.5. Status of shifting cultivation in North East India.

4.3.3 Forest Fire and Other Natural Calamities

In India, forest fire is a widespread and recurring phenomenon and causes extensive damage to forests. The fires are almost entirely attributed to burning by people. People light fire in forests for variety of reasons: to encourage a fresh flush of fodder for livestock grazing, to facilitate collection of fuel wood and non wood forest products (NWFP) like *bidi* leaf and to practice shifting cultivation. Sometimes fires are set in the forests as a form of protest against restrictive policies of the government and also by accident and carelessness of the people. Fire scorches are often seen in the s*al* (*Shorea robusta)*, teak (*Tectona grandis)* and chir (*Pinus roxburghii)* forests. The 'ground forest fires' are most common in India. It destroys the herbs, shrubs, lower vegetation as well as the organic matter in dry deciduous forests. The normal fire season in India is from January to mid-June and the peak season lies in the months of March and April.

FSI has estimated that about 2.94 mil ha forests or 3.69% of the recorded forest area, are annually affected by mild to heavy ground fire of which 1.64 mil ha is affected by moderate to heavy fire. The states of Andhra Pradesh, Himachal Pradesh, Karnataka, Odisha and Uttarakhand are more seriously affected and in Arunachal Pradesh, Chhattisgarh, Jharkhand, Madhya Pradesh, Maharashtra, Odisha, Rajasthan and West Bengal, the incidences of mild fires are more. Forest fires in Meghalaya, Manipur, Mizoram, Nagaland and Odisha are more on account of *jhumming* cultivation. Based on the recurrence of fires, it has been further estimated that about 1.29% of the total forest area is prone to heavy fires, 6.25% to moderate fires and 45.27% to mild fires. Along with incidents of fire, deforestation is also caused by other natural disasters like drought, floods, earthquakes, cyclone, heat and cold waves, etc.

4.4 Key points leading to Afforestation and Forest Rehabilitation

4.4.1 Forest Plantations

The earliest attempt at raising forest plantations in India was the teak plantation of Nilambur, in Kerala around 1840. The adopted system involved clear felling of natural forest followed by plantation. Later, this system of forest plantation was adopted elsewhere in India and continued, though on a small scale, for high value species like teak (*Tectona grandis*), rosewood (*Dalbegia latifolia*), mahogany

(*Swietenia mahagoni*), sal (*Shorea robusta*), deodar (*Cedrus deodara*), chir pine (*Pinus roxburghii*), etc. This trend of forest plantation continued until the concept of social forestry on the recommendations of National Commission on Agriculture emerged in late 1970s. India then embarked upon large scale **social forestry** programme with the aim of producing fuelwood, fodder, small timber and other products from the plantations on wastelands, degraded forests, private marginal lands, village common lands and agricultural farms to meet the increasing needs of rural communities with support from external agencies.

Another key aspect leading to an increase in forest plantations was to meet the growing needs of the processing industries. Following the recommendations of the National Commission on Agriculture (1972), these demands were met by establishing industrial plantations on forest lands on commercial terms to be managed by Forest Development Corporations registered under the Company's Acts of the country. Forest plantations under a system of clear felling followed by artificial regeneration were disallowed after the enactment of Forest Conservation Act of 1980. Later, the National Forest Policy (1988) altered the strategy of the government in respect of supplies of raw materials from government forests to wood based industries. The policy specifically provided that as far as possible, a forest-based industry should raise the raw material needed for meeting its own requirements

In the first three decades after Independence i.e. 1950-80, the total plantation was 3.54 M Ha with an investment of Rs. 2,400 million, while in the Sixth Five Year Plan (1980–85) alone, the 4.64 M Ha of plantation was raised with an investment of Rs 9,260 million. This substantial increase was due to internationally aided social forestry projects. During the Seventh Five Year Plan (1985-90), plantation was undertaken on 8.86 M Ha with an investment of Rs. 25,868 million, which was almost double of the previous plan with substantial addition from poverty alleviation programmes of rural development schemes. Due to climatic variability different species were planted in different parts of the country. Plantations were established outside forest reserves on wasteland owned by the governments and communities and on private lands. It was estimated that 5.94 mil ha of public lands were covered under block plantation and 2.92 mil ha were covered in private areas. The survival percentage varied considerably. During the Eighth Five Year Plan (1992–1997), 7.95 mil ha area was afforested, the drop in the achievement compared to last plan period is attributed to the removal of practice of earmarking certain percentage of funds for afforestation under rural poverty alleviation schemes. Only 0.75 and 1.15 mil ha lands were afforested during 1990-91 and 1991–92 respectively due to the termination of many externally funded projects and paucity of funds. During the Ninth Five Year Plan (1997–2002), a flagship programme of the central government under the name of National Afforestation Programme (NAP) was launched to institutionalise people's participation in project formulation and implementation. The Forest Development Agency as an autonomous federation of Joint Forest Management committees registered under the Societies Act 1860 is the implementing agency at the divisional level. Large scale plantation continued with onset of NAP and support from the Twenty Point Programme (TPP). The overall impact of forest plantation may be interpreted from Figure 4.8. Forest plantations achievement during the Ninth Five Year Plan (1997–2002) improved to 8.05 mil ha and 7.6 mil ha during the Tenth Five Year Plan (2002-2007). These include all government sector schemes.

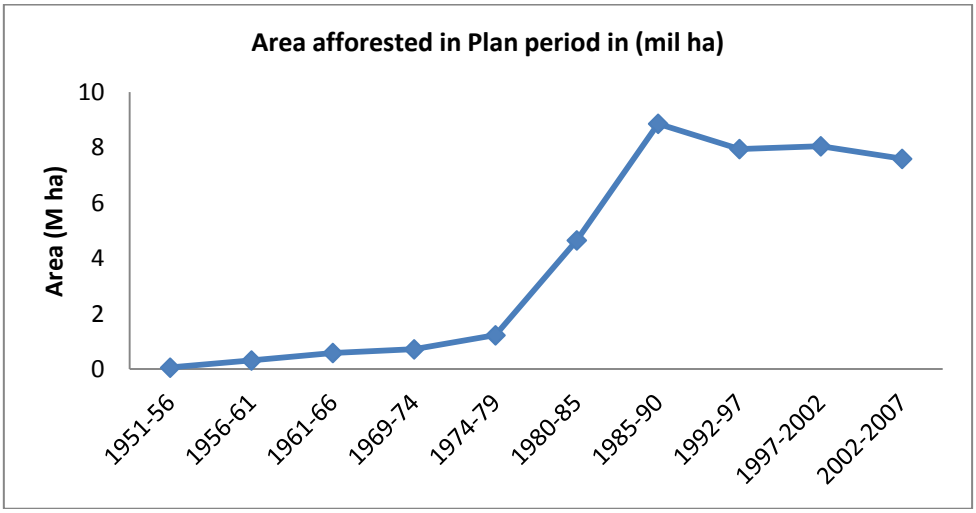


Figure 4.6. Trend of Forest Plantation in India of National Five Year Plans.

Table 4.3. Forest Plantation in India during National Five Year Plans.

Five Year Plans	Forest Plantation (M Ha)
1951-56	0.052
1956-61	0.311
1961-66	0.583
1969-74	0.714
1974-79	1.221
1980-85	4.56
1986-90	8.863
1992-97	7.95
1997-2002	8.05
2002-07	7.596

Source: FSR–India 2010, MoEF.

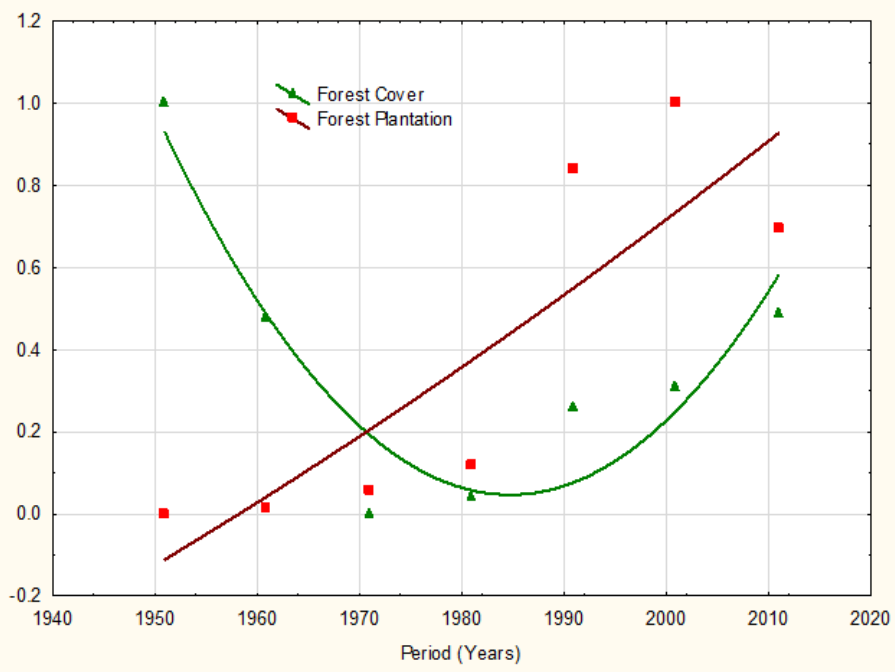


Figure 4.7. Increase in Forest Cover due to forest plantations.

In the 20-Point Programme (TPP) which is a package of Social Sector Schemes, the Government of India declared tree planting a priority in 1982. The progress of tree plantation raised in blocks was reported in hectares where as those planted in linear and scattered form or distributed to public, by number of seedlings, which were finally converted into 'notional' area using a norm of 2000 seedlings equal to one hectare. It is to be noted that about 35% to 40% of total area of annual plantations are actually ascribed to notional area equivalent of seedlings distributed. After the creation of the National Afforestation and Eco-development Board (NAEB) in 1992 under the Ministry of Environment and Forests, the reporting from plantation agencies (States/UTs) has two components, area of block plantations and number of seedlings. The current reporting of plantations in India continues to have these two components. After the creation of NAEB, the afforestation activities within the forest land are carried out by the forest departments of States/UTs and are monitored by NAEB, whereas tree planting outside forest lands is done by other departments and monitored by Ministry of Rural Development under the 20-Point Programme (TPP). The TPP was restructured again in 2006 in conformity with the priorities of the government as contained in the National Common Minimum Programme (NCMP). The restructured Programme is called Twenty Point Programme – 2006 (TPP–2006). The physical target of tree plantation under TPP-2006 is fixed by the Ministry of Environment and Forests in consultation with the States/UTs. The States/UTs are required to furnish progress reports to the Ministry of Statistics and Programme Implementation (MoSPI) which compiles the progress on a monthly basis and puts it on the website. The ministry also rates the performance of the States/UTs on the basis of norms set by it. In addition to State Forest Departments, the physical achievements/contribution to the tree planting target comes from other departments like Rural

Development, Urban Development, Horticulture, Public Works Department, Industries etc. The annual tree plantation under TPP inclusive of plantation by state forest departments (SFDs) is depicted (Figure 4.6).

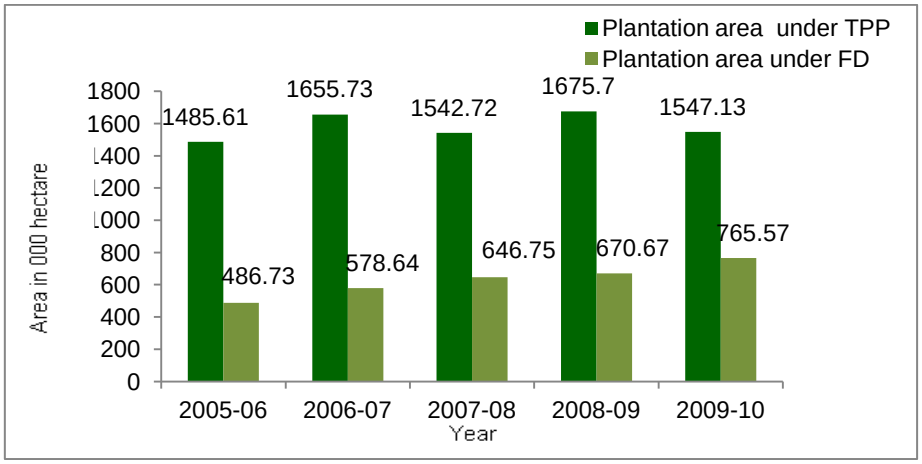


Figure 4.8. Tree plantations raised under 20– Point Programme inclusive of plantations by State Forest Departments.
Source: FSR-India 2010

4.4.2 Demand and Supply of Wood: Farm forestry and Agro forestry

The trees grown outside forests in homesteads, farmlands, agricultural lands and other public lands in various models of agro-forestry, farm forestry and social forestry contribute significantly to the total timber and fuelwood production in India. It is estimated that about 60 mil cu m of wood from the TOF (Trees Outside Forests) are being managed on 6–7 years rotation and the remaining about 74 mil cu m on longer rotation of 30–35 years (Dogra 2006). At the national level, most of the wood supply is estimated to come from plantations and social and farm forestry (Table 4.4).

Table 4.4. Demand and Supply of Wood (10^6 cu m).

Particulars	**1985**	**1996**	**2001**	**2006**	**2011**
Wood demand for domestic furniture, agriculture, industries	50	64	73	82	91
Output from Forests (state owned)	24	12	12	12	3
Output from plantation, production, social, farm forestry(private owned)		41	47	53	43
Deficit	26	11	14	17	45

Sources: Dogra 2006, MoEF 2007 and FSR-India 2011.

This scarcity in the supply position is motivating the industries and the farmers to go for farm forestry and agro forestry. The northern Gangetic plains of Haryana, Punjab and Western Uttar Pradesh have undertaken agro-forestry on large scale. The absentee landowners are carry out block plantation since they have moved to urban areas and are employed in the service sector. Other farmers practise line planting along with the agricultural crops. The preferred species in these areas are Eucalyptus, Poplar and Melia, all short duration wood species. They are used as raw materials for wood based panel products and veneer sheets. A detailed analysis of demand and supply of wood paper mills done by Indian Paper and Pulp Technical Association is presented below which clearly establishes that the scarcity of wood due to policy interventions lead to large scale farm forestry outside the recorded forests in India. Agroforestry also became very popular in such regions of the country. The state of Andhra Pradesh has four mega pulp and paper units and has become a wood surplus state in India. Andhra Pradesh has brought in legislation wherein Eucalyptus, Casuarina and Leucaena wood is declared as agricultural produce and marketed through agricultural market committee. Pulpwood from social forestry in the districts viz., Prakasham and Krishna in Andhra Pradesh meet the wood demand of mills not only of Andhra Pradesh but also of mills located in Karnataka, Maharashtra, Gujarat, Orissa, Uttar Pradesh, Uttarakhand and Madhya Pradesh. The plantation efforts have led to a net increase of 0.0939 mil ha in forest cover in five years time including 0.3 mil ha in non forest areas and nearly 400,000 ha in trees outside forests

4.4.2.1 Wood requirement and generation by paper mills through farm forestry

The wood based paper mills in India continue to face challenges with forest-based raw material. Pulp and paper industry consumes 3% of total national requirement of wood while, the major consumption being fuel wood (89.5%) and timber (7.5%). The annual pulp production is 3.03 mil tonnes from 10 mil tonnes of wood agro-residue and waste paper. Nearly 20% of wood is procured from government sources while 80% is from agro farm forestry sources. The bamboo and wood requirement is 0.82 and 9.27 mil tonnes per annum respectively (Table 4.5).

Table 4.5. Wood requirement and generation by paper mills through farm forestry.

Sr. No.	Company	Wood Pulp (t)	Wood requirement			Area Planted (ha)	Estimated Wood Generation (t) @60t/ha
			Bamboo	Wood	Total		
1.	ITC Ltd.	300000	0	1125000	1125000	140989	8459340
2.	Tamil Nadu New Print Ltd.	280000	0	400000	400000	34542	2072620
3.	Century P&P Ltd.	280000	168750	958125	1126875	2340	140400
4.	JK Corp (Orissa)	220000	50000	850000	900000	59974	3598440
5.	JK Corp (Gujarat)	55000	80000	126250	206250		
6.	Orient Paper Mill Ltd.	80000	167000	173000	340000	33043	1982580
7.	Star Paper Mill Ltd.	70000	100000	180000	280000	72740	4364400
8.	Mysore Paper Mil*	60000	0	225000	225000	27500	1650000
9.	Sirpur Paper Mill Ltd	120000	0	375000	375000	30921	1855260
10.	BILT Ballarpur/Asthi	220000	200000	175000	375000	36055	2163300
11.	BILT Sewa	100000	40000	335000	375000		
12.	BILT Yamunanagar	100000	0	375000	375000		
13.	BILT Kamalapur	100000	0	375000	375000		
14.	BILT Chowdwar (Not Operational)	0	0	0	0		
15.	Seshasai P&B Ltd*	160000	0	400000	400000	18534	1112040
16.	Andhra Pradesh Paper Mill Ltd.	220000	18000	800000	818000	124040	7442400
17.	Circar Paper Mill *	0	0	5000	5000	0	0
18.	West Coast Paper Mill Ltd	280000	0	900000	900000	44260	2655600
19.	Rama News Print*	0	0	0	0	0	0
20.	HNL Kottayam	80000	0	300000	300000	32000	1920000
21.	HNL Naogaon	100000	0	375000	375000		
22.	HNL Kachar	100000	0	375000	375000		
23.	HNL Kachar	20000	0	75000	75000		
24.	Nepa Paper Mill*	0	0	50000	50000	0	0
25.	Yash Paper Mill*	5000	0	16500	16500	150	9000
26.	Delta Paper Mill*	80000	0	300000	300000	0	0
27.	Emami Paper Mill*	0	0	0	0	5	300
	Total	3030000	823750	9268875	10092625	657093	39425680

Source: Kulkarni 2013, and Indian Paper and Pulp Technical Association

The strategy adopted by the industry to meet the ever growing demand of wood on a sustainable basis is to obtain wood from social and farm forestry plantations. Over a period of 23 years the paper industry has promoted nearly 657 093 ha plantations which is estimated to produce 39.42 mil tonnes of wood and 60 tonnes per ha yield. However, if we consider last five years plantations of Eucalyptus, Casuarina, Leucaena and Acacia, it is 300,000 ha which can produce 18 mil tonnes of wood. At the felling cycle of 4 years, the wood production annually is 4.5 mil tonnes. The current level of planting by the paper mills is around 50,000 ha per annum, apart from the industrial efforts, farmers on their own are raising plantations. In recent years several private Eucalyptus clonal nurseries have sprung up and an additional 20,000 ha area every year is planted. This is adding to the general availability of wood to the industry. Hence, the industries wood demand of 10 mil tonnes annually is somehow met through farm forestry plantations.

4.4.3 Joint Forest Management and Rehabilitation

Joint Forest Management (JFM) is the relationship between the two major stake holders—village communities and the forest department, and mediated in most cases by a Non Government Organisation (NGO). The forest department sets the objectives of forest management under the JFM programme with the participation of village communities, while the management responsibilities and benefits from the forest are expected to be shared by the village communities and the forest department.

In 1920s itself, management of forests by Van Panchayats in the hills of Uttar Pradesh (presently, Uttarakhand) was started. The participatory management regime involves the Government and local communities for regeneration of degraded forests through effective protection, sharing of produce and improving the livelihood opportunities of forest dependent communities. The forest department initiated a pilot project in Arabari village of West Bengal during 1971–72. The programme covered an area of over 1,270 ha of degraded forests involving 618 families in 11 villages. This joint initiative rehabilitated the forests and thus became an example to be emulated. Its phenomenal success, led the MoEF to propagate a policy circular in 1990 in pursuance of the National Forest Policy of 1988, which recognized the need to involve local people in forest management. However, the progress of JFM was slow in initial years as many policies, technical and institutional issues cropped up in the field. Till 1998, 4 mil ha of forest in 17 states were under JFM.

Various policy directives have been issued on JFM by the MoEF to create a people's movement and encourage participation in the management of forests. The chronological review of different policy directives and its main features are as follows

Policy Directive	Main Features
The Circular (first) Concerning JFM, 1990	Involvement of village communities and NGOs in regeneration of degraded forests; Benefits of people's participation should go to the village communities
JFM Cell Creation Notification, 1998	Cell created for monitoring impact of JFM being carried out by state governments
Standing Committee Notification, 1988	Advise on all operational aspects of JFM for expansion of JFM to non-forest areas
Terms of Reference Notification, 1999	Sharing of experiences of JFM implementation as each state has passed its own resolution on JFM; Monitoring of JFM programmes
Notification for JFM Network, 2000	Creation of 'JFM Network' at the national level to act as regular mechanism for consultation between various agencies involved in JFM; Representatives from all the stakeholders Guidelines for Strengthening
Guidelines for Strengthening JFM, 2000, 2002	Present latest JFM policy directives and broad framework for implementation of JFM; Measures such as legal support for JFM Committees, promotion of women's participation, and conflict resolution; Memorandum of Understanding between forest department and JFM Committees outlining short- and long-term roles and responsibilities, and pattern of sharing of usufructs; Capacity building for management of non-timber forest products for providing remunerative prices for users.
Operational Guidelines for Tenth Five Year Plan, 2002–2007	Formulation of National Afforestation Programme to encourage participatory approach to sustainable forest development; Implementation of centrally sponsored afforestation schemes via a two-tier system consisting of Forest Development Agencies and JFM Committees; Transfer of funds to JFM Committees through Forest Development Agencies

Source: Balooni *et al.* 2009

The area under JFM and number of committees involved provides some indication about the level of participation of local people in the management of forest resources. The level of satisfaction with benefit sharing mechanisms is an important component and indicates whether the arrangements in place require adaptations or not. Under the National Afforestation Programmes (NAP) various afforestation schemes were raised to increase the area under plantations. By 2009–10, 800 Forest Development Agencies (FDAs) (Figure 4.8) and 42,535 JFM Committees had been constituted. The involvement of JFM committees and corresponding area under JFM is shown (Table 4.6 and Figure 4.7)

Table 4.6. JFM Committees and Area under JFM in India.

Year	No. of JFM committees	Area under JFM (ha)
2000*	36130	1,02,48,586
2006†	1,11,926	2,67,38,267
2011#	1,18,213	2,29,38,814

Source: *JFM cell MoEF, † FSR-India 2010, # Proceedings of National workshop on JFM, FRI 2011

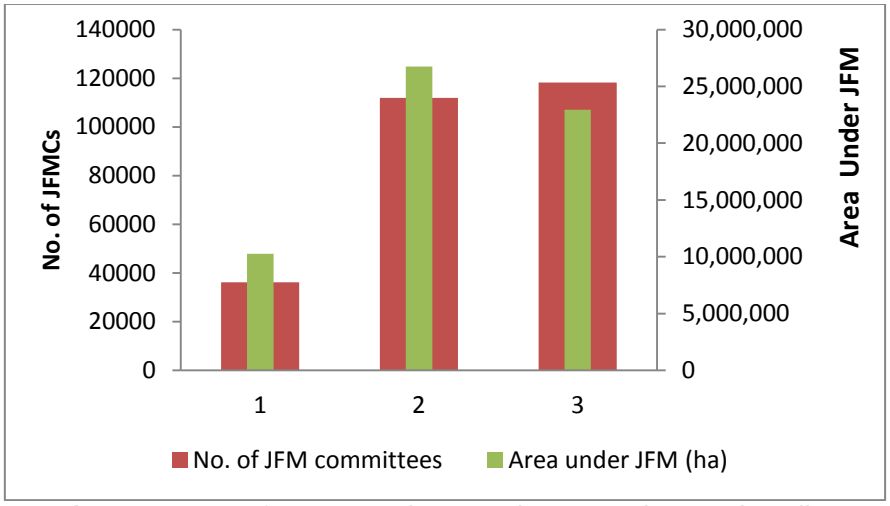


Figure 4.9. No. of JFM committees and areas under JFM in India.

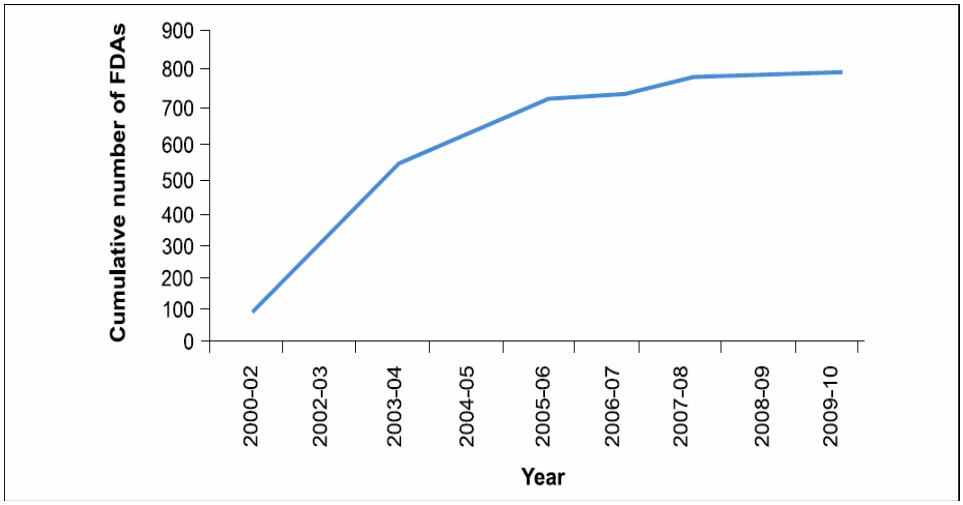


Figure 4.10. Formation of Forest Development Agencies.

4.5 Key legal and policy milestones leading to Conservation and Sustainable management of forests in India

Though the Forest Conservation Act of 1980 and National Forest Policy of 1988 are considered to have contributed substantially towards the conservation of forests in India, the beginning of Indian conservation movement was made under the leadership of Dietrich Brandis in 1894, who rightly concluded that the "frontier was closed" and forests were not inexhaustible. The Indian Forest Act of 1927 gave protection to the forests from the locals, but forests continued to be exploited for strategic

and commercial purposes. The National Forest Policy of 1952 did set the target of having one third of the geographical area under forests, but no operational guidelines were issued and the functional classification was seldom adhered to. Thus forests continued to serve as the source for financing economic development programmes of the country. The inadequacy of the National Forest Policy was felt as over the years and forests suffered serious depletion after being treated solely as a revenue earning resource. Also, the diversion of forest lands to non-forest uses was allowed to continue without compensatory afforestation and essential environmental safeguards. However, since Independence, progressive and effective steps taken by the Government of India and the State governments for the protection, preservation and management of the forest and wildlife wealth of the country (NFAP–India 1999) are summarised below:

1. The Constitution of India provides guidelines for protection of forests and wildlife. The Directive Principles of state policy has assigned duties for the states and citizens through Articles 48-A and 51-A (g) which envisage that the State shall endeavour to protect and improve the environment and to safeguard the forests and wildlife of the country and the citizens are to protect and improve the natural environment including forest, lakes, rivers and wildlife and to have compassion for living creatures.
2. The National Forest Policy of 1952, the first after Independence laid down that one third of the land area of the country should be under forest cover for ensuring a balanced and complementary land use system. It introduced the fundamental concept of self sustenance for meeting local and national needs and advocated extension forestry. It provided for the management and control of private forests, containment of shifting cultivation, creation of village forests etc. However, it had a bias towards timber yield and revenue generation by replacement of inferior species by valuable commercial species and did not lay emphasis on sustainable management of non-wood forest products. It proposed classification of forests in functional terms, i.e. protected forests, forests for national use, village forests and tree lands. However, it did not lay much emphasis on the involvement of the people in management and protection of forests.
3. In 1966; the Indian Forest Service was revived to ensure coordinated professional management of forests.
4. National Commission on Agriculture in its interim report in 1972 advocated social forestry for meeting the local needs of people thus shifting the demands from the existing forests.
5. In 1976, the subject 'Forest' was transferred from the State List to the Concurrent List of the Constitution of India to ensure uniform policy and management.
6. The Forest Conservation Act enacted in 1980, was later amended in 1988. It provides that areas recorded as forests in government records cannot be transferred for non-forestry use without the prior approval of the Government of India. Moreover, this diversion now requires compensatory afforestation on an equivalent area of non forest land or double the area on degraded forest lands.
7. A separate Ministry of Environment and Forests was created in the Union Government in 1985 and the forest wing from the Ministry of Agriculture was transferred to the new ministry.
8. In 1988, a new forest policy was enunciated which laid special emphasis on conserving the natural heritage, preserving flora and fauna, meeting fuel wood, fodder, non-wood forest produce and small timber requirements of the rural and tribal population, and increasing forest area and productivity to meet local and national needs. This is to be achieved through a massive people's movement for afforestation and protection with the involvement, especially of women, and encouraging forest based industries develop direct linkages with the rural people for their raw material requirements. The national goal of the policy is to have a minimum of one-third (two third in hills) of the total land area of the country under forest or tree cover.
9. In the field of wildlife conservation, there were various specific Acts in the states prior to independence. However, the National Forest Policy (1952) focussed on the need for protecting wild animals through setting up of sanctuaries and national parks. Subsequently, a national wildlife policy was adopted by the Indian Board of Wildlife in 1970 leading to the enactment of the Wildlife (Protection) Act of 1972, amended in 1991. The Directorate of Wildlife was established at the centre and also in the states and special projects to protect the Tiger, Crocodile, Elephant, Rhinoceros, Asiatic Lion, etc. were launched. The Wildlife Institute of India (WII) was established in 1982, the National Wildlife Action Plan was adopted in 1983 and the protected area network increased from 115 sanctuaries and national parks in 1972 to 80 national parks and 441 sanctuaries covering 14.8 mil ha. in 1996. Presently, the Protected Area (PA) network consists of 102 National Parks, 515 Wildlife Sanctuaries (WLS), 47 Conservation

Reserves and 4 Community Reserves covering the forests of 16.12 M ha with relatively large populations of the target species and associated ecological components (FSR-India 2010).

10. *Joint Forest Management*: The Joint Forest Management Circular of 1990, flowing from the Forest Policy of 1988, is said to be the turning point in arresting the degradation of forests and has paved the way for the restoration of large degraded forest areas of the country. People had been alienated after the notification of forest areas as government forests under the provisions of Indian Forest Acts during the colonial period. This changed the face of Indian forestry and people started protecting the forests. Different states provided for different sharing mechanisms for benefits accruing from the forests.
11. Since Independence, the Indian Forest Act of 1927 was amended by various state governments to suit their requirements.
12. In view of increasing emphasis on conservation of forests, the Government of India took a policy initiative and liberalized the import of wood and wood products in 1996 to reduce the demand supply gap by bringing them under Open General License (OGL) category. Since then the import of wood and wood products has been steadily increasing.
13. Bhopal-India Process: It was an Indian initiative undertaken in 1998 to develop a practical and indigenous mechanism for monitoring Sustainable Management of Forests (SFM) in the country .
14. The Biological Diversity Act 2002 was enacted to provide for conservation of biological diversity, sustainable use of its components and fair and equitable sharing of the benefits arising out of the use of biological resources, knowledge and for matters connected therewith or incidental thereto.
15. National Working Plan Code 2004 was applied uniformly throughout the country for preparation of management (working) plans for forests applying the principles of sustained yield and assured regenerations.

As a consequence of the policy and enactment of Forest Conservation Act, 1980: (i) presently there is a ban on felling of trees in all forests over an altitude of 1000 m; (ii) high priority has been given for raising fuel wood and leaf fodder producing trees in the government forests almost to the exclusion of raising industrial trees; (iii) industrial wood production has been restricted to only on farm lands or on waste lands; (iv) a ban on all operations in national parks and sanctuaries have been imposed; and (v) stoppage of green felling in forests in some states leading to drastic reduction in wood yield.

Forest management in the country has been guided by operational plans, known as Working Plans, for every forest division, generally for a period of 10 years. As has been explained under Scientific Management of Forests in India in Chapter II, India has more than 100 years of scientific forests management. Before the order of the Supreme Court, state governments used to sanction the operational plans with respect to the forests. In order to enforce the provisions of Forest Conservation Act, 1980, the Supreme Court of India in 1996 passed an order making it mandatory to get the sanction of the central government before taking up any felling of trees in the forests. As explained under Section 2.7 some of the states which were harvesting timber without Working Plans especially of North East India were the worst affected and production of timber from these states declined substantially. At the same time the central government came up with a National Working Plan Code 2004 and applied the principles of sustained yield and regeneration more rigorously in sanctioning the provisions related to felling in the forests. The focus has shifted from timber harvesting to environmental stability, biodiversity monitoring and management, restoration of ecological balance of the disturbed areas, protective functions of the forest resource and other socio-economic benefits based on Non-Wood Forest Products (NWFP). The concept of sustainability in forest management thus implies not only sustainability of productive functions but also environmental functions (e.g. soil and water conservation) and socio-economic benefits (e.g. meeting livelihood and basic needs of forest dwellers and other forest dependent communities). In order to integrate the aspects of forest management which are considered important for assessing sustainability, accompanied by a set of related quantitative, qualitative or descriptive attributes which when measured or assessed periodically indicate the direction of change for each aspect of sustainable management of forests; an agreeable framework for Sustainable Management of Forests was developed under Bhopal-India Process and is being incorporated in the National Working Plan Code of India currently under revision.

4.6 Conclusion

Forest transitions provide a picture of the status of forests and may change the way governments size up their woodland resources in future. The simulated forest cover data for India as prepared by FAO for the period 1900 to 1980 and FSI forest cover data after 1980 are the only reliable data available on forest cover. The forest situation curve in terms of forest cover is the net result of such aspects as deforestation, degradation of forests, conservation of forests, sustainable management of forests, afforestation and rehabilitation of forests; all happening on different scales in different stages of economic development in India. The historical relationship between social and economic development and forest cover reflects an idea about forest transition which are analysed in detail in the next chapter.

5 UNDERSTANDING FOREST TRANSITION IN INDIA

5.1 Introduction

Forest transition is used to describe the empirical regularity in the conditions of the forests as societies/nations undergo economic development, industrialization and urbanization (Mather 1990, Mather 1992, Walker 1993) in historical perspective. It is evident that the modernization, urbanization and economic development have a complex relationship with the rate of deforestation. The phenomenon of the forest transition is explained in terms of an environmental Kuznets curve by Culas (2012), Southworth *et al.* (2010), Mather (2007), Rudel *et al.* (2005) and Goldewijk *et al.* (2004), which follows an economic developmental pathway. Rudel *et al.* (2005) also used forest product as a scarcity pathway to explain forest transition. Culas (2012) has even analyzed alternative development paths for forest cover changes and forest transition for the REDD policy in the context of climate change initiatives under United Nations Framework Convention on Climate Change. The environmental Kuznets curve hypothesis is also applied with respect to the trend of deforestation and socio-economic factors responsible for forest transition in India. However these factors and associated changes interact in a complex and intertwined manner and therefore are not able to present the complete picture. The relationship between deforestation and income, and associated policy and institutional factors is not straightforward (Arrow *et al*. 1995). Since the management of forests in most developing economies is under public ownership, it has been suggested that the EKC relationship is linked with various socio-political institutions, structural factors, and historical processes (Arrow *et al*. 1995). Furthermore, it has been explained in detail and established that forestry in India has a long history of the existence of legal and policy instruments (Sections 2.3, 2.4 and 4.5) addressing forests and the use of their usufructs. Thus forest transition must depict the picture of forest situation in such a way that it changes the way governments look at their forest resources in future. Hence, after discussing various pathways, a comprehensive cluster model is proposed, keeping in view of availability of information of the parameters which explains forest transition in India.

5.2 The Historical Dynamics of Transition

Historians and political economists have studied the evolution of society by analyzing changes based primarily on socio-economic structures (Cox 1986). Therefore, the transition of Indian forests from deforestation to reforestation and subsequently sustainable management needs to be traced in a historical perspective through several stages involved in the development of nation. By stepping back from the “noise” of current events, one can distinguish geographic and historically specific patterns (Braudel 1969) and the interaction of a variety of forces that have shaped and have been shaped themselves (by the use of forests) over the long term. This broader perspective would, it is hoped, would lead to a deeper understanding of what transition to sustainability means for Indian forestry in vogue today and in the future.

Development stages relate to particular socio-economic structures – subsistence, feudal, colonial, national, globalization – and in each stage the use and view of forests as well as relationship to the land differs. These stages are: (1) hunting/gathering; (2) agrarian; (3) industrial/scientific/market; (4) globalization. However different stages occur gradually and forests have been affected at different rates historically and geographically in the world. Agriculture brought about changes in the landscape, which in turn, affected the use of land and its relationship with forests. The forests of the agrarian era provided land for agriculture; timber for buildings; fuel to household consumption and places of sport for the wealthy. However, with the onset of the industrial and scientific revolution and the emergence of market economy in Western Europe, the forests as a resource dominated the development stage as strategic and commercial interests of the colonial powers and also provided timber for ships, wood for energy. Later timber was replaced by steel in 1862 and charcoal by coal as the main source of fuel for industry. Consequently, almost overnight forests lost their strategic importance and demand for forest products decreased, at least temporarily. However the advancement of technology and improved transportation led to increased deforestation probably due to easier access to forests, due to roads and machines. For example the steam engine was key to the industrial revolution and influenced the forest industry as steam-driven sawmills made it possible to saw much large quantities of timber more efficiently. Furthermore, the building of roads and railways opened up forests and enabled the easy and cost effective transportation of timber from areas, previously inaccessible. Moreover, the industrial revolution created new wealth, which in turn triggered new demands for forest products. Thus, wood was no longer needed for ships or charcoal but was in great demand as home building materials and

pulp and paper for a growing and advanced population. The fusion of rationale and atomistic thinking, application of scientific principles, technological developments, scarcity of wood, and the emergence of the market renewed the importance of forests for colonial powers, which looked for the resources outside their native country.

5.2.1 Stages of Development and Forest Transition in India

Meanwhile in India, at the turn of the last century, societies still remained at the agrarian stage under the colonial rule of British. This period was characterized by a static agriculture economy (Table 1.15). Forest use was dominated by three assumptions: natural resources are inexhaustible; abundance of resources in an unclaimed state; and hard work to convert wilderness into a cultivated or managed state should be rewarded in the short term. The model study, made by FAO Forest Resources 1990 Assessment Project indicated deforestation to be of the order of 14 mil ha during 1901-1950 (Figure 3.2).

After independence, this trend of clearing forests for agriculture continued for more than two decades while the country embarked upon a phase of planned development and learning from the scientific, industrial and market oriented development happening elsewhere. The forest cover is estimated to have decreased from 75.8 mil ha in 1950's to 62.9 mil in 1970's (Table 3.5). All agricultural expansion did not happen at the expense of forests since the country already had resolved to have 1/3 of geographical areas under forests. The area under agriculture expanded by 22 mil ha during 1950-1970 (Table 1.13) and almost stabilized between 1970 and 1980 with the advent of green revolution with technological innovation in agriculture and ban on transfer of forestlands to non-forestry use. The agricultural productivity grew to 872kg/ha (1971-72) from 522 kg/ha (1951-52) in two decades and further to 1626 kg/ha in 2000-01 and 1921kg/ha in 2010-11 due agricultural intensification (Table 1.6). Increased productivity eased the pressure from forests, though there had been expansion of area under shifting cultivation as explained under Section 4.3.2.

As explained earlier under Section 1.6, the growth of the economy showed steady improvement during 1950–1980 and the role of the agriculture sector gradually declined indicating the growth of industrial and service sector (Table 1.17). Between 1950–51 and 1980–81, the industrial sector registered a higher growth rate than the services sector. However the growth rate of service sector overtook the growth of the industry sector during 1970-1980 and this became more pronounced in the 1990s. Therefore the period of 1950-1980 may be considered as the period of slow and steady economic growth dominated by agrarian growth. This phase did contribute towards the deforestation since the agricultural sector was still in the expansion phase. This may not be attributable to population growth factor since the growth of population in this phase was lower than that of the succeeding phases i.e. beyond 1980's. The transition curve is explained in terms of socio-economic stages of development (Figure 5.1). The Table 5.1 shows the comparative dominance of factors during different phase of development.

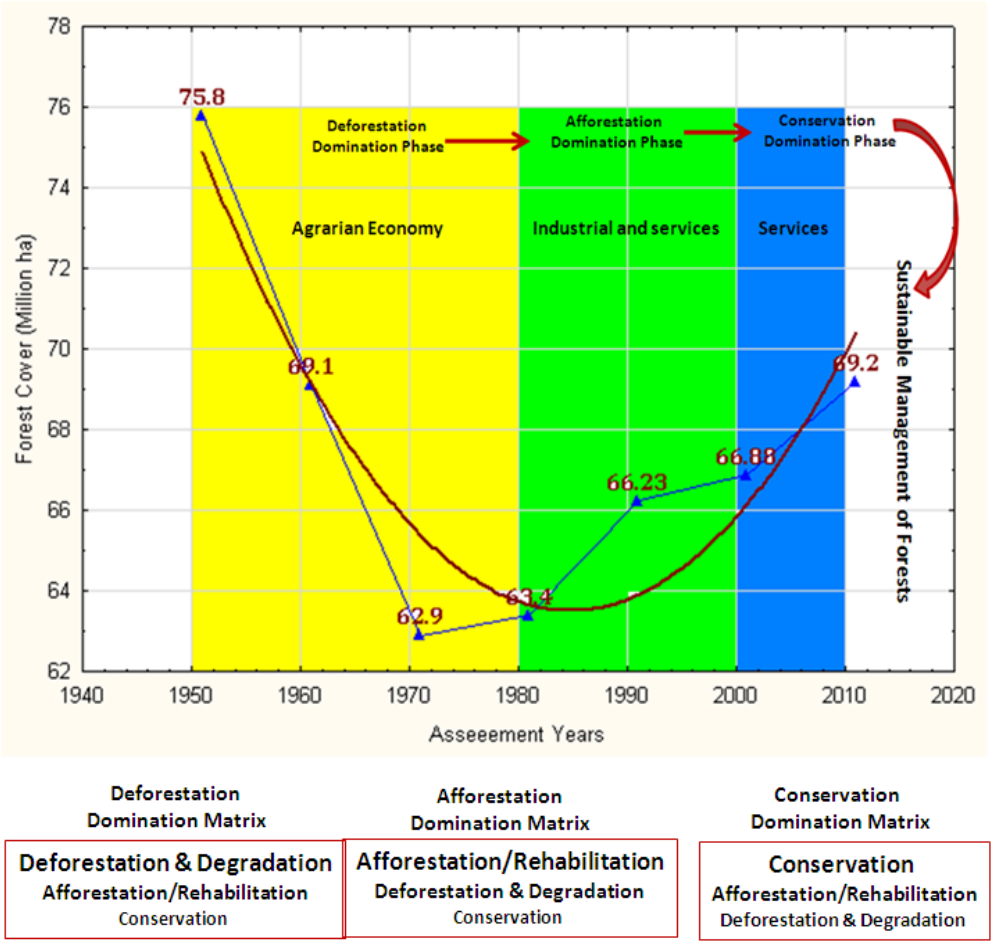


Figure 5.1. Socio-economic stages of development.

Table 5.1. Comparative dominance chart of factors during different phase of development.

Socio-economic parameters	Phase I	Phase II	Phase II
Forest Acts and Policies	High	Higher	Higher
Notified Forest lands	Medium	Medium	low
Watershed management programmes	Low	Medium	High
Awareness	Low	Medium	High
Timber Import	Low	Medium	High
Forest Plantations	Low	Medium	High
Population Growth	Medium	High	High
Land availability for plantation	High	High	Medium
success rate of plantation	High	Medium	Low
Land Transfer	High	Medium	Low
Agricultural expansion	High	Low	Reverse
Shifting Cultivation	Low	Medium	High
Special plantation drives	Low	Medium	High
International focus	Medium	High	High

The period beyond 1980 may be considered to be dominated by service sector, easing pressure on land based activity and being characterized by migration of rural population to urban areas (Table 1.18). However, the share of the industry sector has remained in the range of 24 to 28 % of GDP since 1970–71, while the entire decline in share of agriculture has been balanced by an increase in share of the services sector. The percentage of urban population showed increased growth during 1971–1981. Similar growth in the level of urbanization did occur from 27.81 % to 31.16 % for the period 2001–2011, while the proportion of rural population declined from 72.19 % to 68.84 %. The period between

1980-2000 can be considered as the take off period of the Indian economy (Singh 2011). This phase (beyond 1980) of development is marked by stabilization of forests and some recovery due to the emphasis on social forestry outside the traditional forest areas to cater to the needs of people such as fuelwood, fodder and small timber. More than that, the international focus on forests also contributed to concerted support from the government in the form of policy, legislation, programmes, organization and funds. There was a definitive shift in the national preference towards the environmental functions of forests over economic functions as is evident from a number of reinforcing developments which have been discussed in Section 4.5.

The period beyond 2000 can be described as the stage of globalization of Indian economy with the adoption of liberalization policy in 1991 (Bhasin 2005). For the period 2000-2010, GDP per capita increased from 429 US$ to 762 US$ and is expected to reach 1538 US$ by 2020(Table 5.2). The service sector has become the major dominating sector with its share crossing the milestone of 50%. The migration of rural population to the urban areas is taking place at increased rate and it is expected that 38% of Indian population will be urban by 2020.

Table 5.1. Socio-economic trends during 2000-2020.

Year	Population		Urbanization Trends	GDP / Capita (All)	GDP / Capita Lowest (10%)
	Billions	No/ha	(%)	US$	US$
2000	1.01	307	28	429	159
2010	1.16	357	32	762	282
2020	1.30	405	38	1538	569

Sources: Singh, 2011

On the social front, literacy rates for the country as a whole increased from 18.33% in 1951 to 74.04% in 2011, which helped in building public opinion towards environmental issues in general and forestry in particular. In 1951, the at-birth life expectancy was around 37 years which increased to nearly 65 years by 2011. In terms of infant mortality, there has been an improvement between 1951 and 2000, such that the number of deaths in the youngest age group has fallen to 70 from 146 per 1000 (Figure 1.9).

Based on all the trends on socio-economic aspects of India, it can be concluded that India had a predominantly agrarian economy during 1950-80, characterized by agrarian economic growth. This phase of economic growth is marked by deforestation primarily due to agricultural expansion and demand of lands for infrastructural development. The economy expanded exponentially after 1980 (Figure 1.2) and the demand for land for non-agricultural purposes rose. However, legal intervention in the form of Forest Conservation Act, 1980 regulated the diversion of forest lands for non-forestry purposes and subsequently the Act also provided for compensatory afforestation, which compensated for diversion of area. The report of the National Commission on Agriculture opened new frontiers of social forestry and large areas were brought under forest cover. The Joint Forest Management resolution (1990) of the central government gave further impetus to the rehabilitation of degraded forests (Section 4.4). Therefore the period of 1980–2000 can be said to be dominated by afforestation and rehabilitation on account of factors shown in Figure 5.3. The intervention of the Supreme Court of India further provided the impetus to the conservation of forests in India in the subsequent period beyond 2000 when the economy is booming and India can afford to import the timber to meet its domestic demands. Farmers and industries are adopting agro-forestry and farm forestry on economic terms driven by forest product scarcity. On the whole, forest transition in India is a result of a combination of social, economic, legal and policy, and technical changes that occurred during the period 1952–2012.

5.3 The Environmental Kuznets Curve (EKC) and Forest Transition in India

The environmental Kuznets curve (EKC) suggests that the relationship between a country's economic development in terms of GDP/capita and its environmental degradation follows an inverse-U relationship. In other words, as the level of economic development increases beyond a certain point in a country, its rate of environmental degradation stabilizes and finally starts to go down. The state of environmental degradation is represented by deforestation in terms of forests cover as used by Culas (2012). The negative forest cover change represents deforestation while positive forest cover change signifies re-forestation. Deforestation is at an increasing rate during the early stage of the

development, which leads to forest transition. An increase in the per capita income accelerates deforestation, but at incomes beyond a certain level, the deforestation reduces. High income can reduce pressure on forest if there is demand for the protection of forest. The income per capita associated with economic development, can be considered to give a plausible explanation for the transition of forests for developing country like India provided the tunnelling aspect of the curve due to policy, legislation and socio-political institutions is factored into the hypothesis (Figure 5.2). The tunnelling aspect is due to the existing and planned policy and legal interventions and the rapid growth of the economy during the 1990's and beyond – the post liberalization phase of the Indian economy. However the reversal of forest cover loss is happening at very low income, which makes the hypothesis implausible.

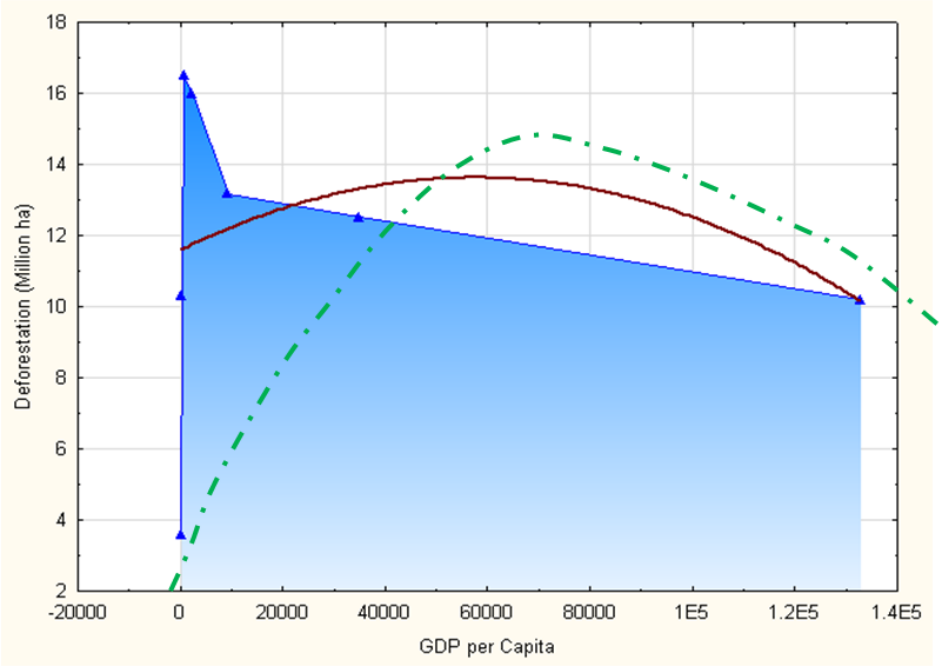


Figure 5.2. Conventional Environmental Kuznet Curve in Indian condition.

5.4 Policy and Legal Historical Framework

The profession of forestry is at the cross roads today. The burgeoning interest in conservation forestry in the 1980s that stemmed from increased global environmental awareness and international publicity for natural resource issues has been globalized, the stakeholders have multiplied and long held beliefs of foresters have been called into question. In 1992, the United Nations Conference on Environment and Development (UNCED) provided as its primary achievement, a formal and comprehensive endorsement of the principle of sustainable development. The Conference also adopted, along with Agenda 2, a Statement of Principles for a global consensus on the Management, Conservation and Sustainable Development of Forests and Intergovernmental Forum on Forests Commission on Sustainable Development; the Convention of Biological Diversity; the Framework Convention on Climate Change and associated Kyoto Protocol, and Convention on International Trade on Endangered Species. All these events have brought forestry on the international agenda. Therefore forest officials face increased internal and external pressure for periodic monitoring and reporting of state of forests at the national level. The Forest Survey of India publishes biennially a report on the status of forest. This report clearly shows the extent of forests in different parts of India and includes data to the level of district administration unit.

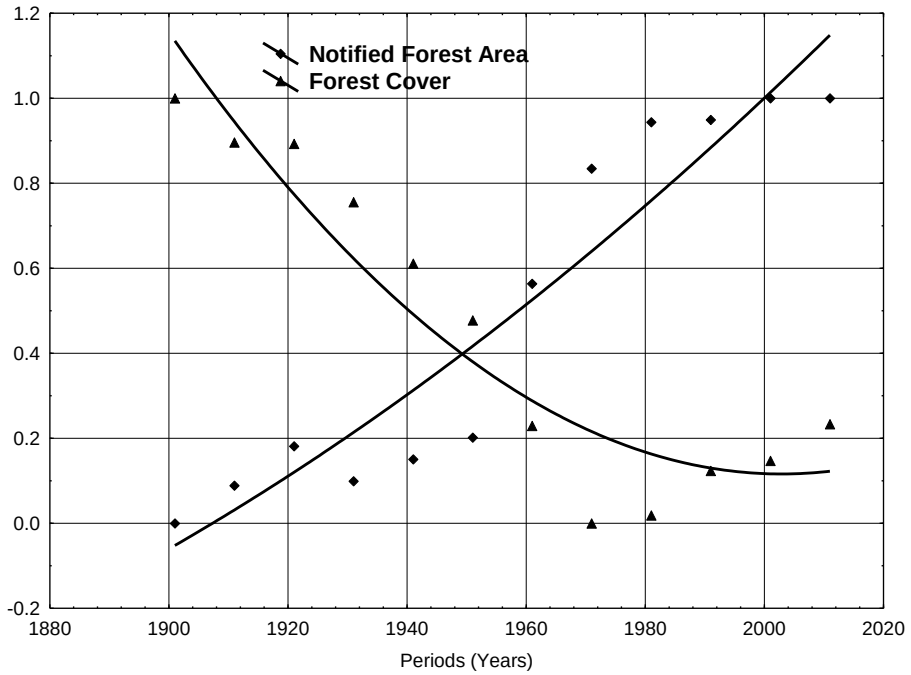


Figure 5.3. Policy and Legal Historical Framework.

Forestry in India has a historical perspective with respect to legal and policy support (Section 4.5). Even during the agrarian stage of development, when agriculture expansion was taking place, forests continued to be notified as reserved or protected forests and brought under the scientific management (Figure 5.3) Agricultural expansion did cause loss to forest cover but all agricultural expansion had not occurred at the expense of forest cover. Active support for the sector from the all the three pillars of democratic setup in the country namely legislature in the form of constitutional amendment to bring forests on the concurrent list and enactment of Forest Conservation Act; executive body (government) in the form of forest policy of 1988 , JFM resolution of 1990 and other programmes like 20-Point Programme (TPP); and the judicial pronouncement of the Supreme Court of India, brought attitudinal change towards the forests in the country. The Godavarman Judgment (T N Godavarman Thirumulkpad vs. Union of India, AIR 1997, SC 1228) put a complete ban on felling in any states without prior permission from the Union government, because of which there has been severe shortage of raw material for wood based industries leading to their closure. Further, the establishment of Green Tribunals (special courts) for adjudicating on the disputes arising from the actions on part of any party on matters related to environmental and forest conservation aspects, is another milestone in encouraging the public participation in the conservation and management of natural resources.

5.5 Economic Parameters

A relation with the time series data of forest cover change and economic parameters like GDP; GDP per capita; share of agriculture, industries and service sector in GDP; agricultural production and its productivity; livestock population is discussed below.

Gross Domestic Products and GDP per Capita: National income (GDP) of the country was slow during the early period of the independence. Rate of deforestation was high when the national incomes were low; however, the rate of deforestation started to decline as national incomes increased subsequently. The graph clearly shows that due to inconsistency in the growth of GDP and GDP per capita, the deforestation rate is poorly explained (Figures 5.4 A, 5.4 B).

Share of service sector, agriculture and industries in GDP: During 1950, the contribution of service sector to GDP was 30.3 %, which increased to 42.7 % in four decades and further increased to 57.7 % in just two decades. At the early stage, the deforestation rate was more as compared to the later stage and after 1990, higher contribution and steep increment in the service sector decreased the pressure on forest resulting in low deforestation (Figure 5.4 D). The share of agriculture in GDP is negatively related with the rate of deforestation. The share of agriculture in GDP consistently decreased during the last six decades. But, after 1990, there was a steep decline in agriculture's share to GDP and

corresponding decrease in the deforestation rate. Industrial development was one of the main focus for sustaining the economic growth rates. India has committed to developing state-of-the-art industrial complexes for facilitating growth and improving quality of life. Land is the foremost requirement for growth and development of the industry sector. The diversion rate of forests for development has been inevitable in recent decades. Dependence on forests in areas with forests in the vicinity is also expected to be influenced accordingly. Industrial development is expected to have a special focus on the small and medium enterprise sector. There was not much variation observed in the share of industry to GDP.

Agricultural production and productivity: Due to continuous increase in the agricultural production and its productivity during the last century, the deforestation rate increased and then after certain threshold (1970-80), it started to decline. In rural India, the majority of the population still has agriculture as the primary occupation till today and agriculture is the best indicated sector to promote rural economic growth. In the vicinity of larger urban areas, irrigated agricultural lands are being converted. Increasing area under irrigation being a priority of the agriculture sector, inclusion of more rainfed areas under irrigation is expected to offset the loss of irrigated farmlands. The corresponding fall in net area is also being offset by increasing use of wastelands, technological advances and increasing investment in suitable production systems in rainfed areas. Thus, while agricultural developments put pressure on forestry in terms of area, they can also reduce pressure on forests for products; the area supporting perennial tree-based systems could only add to green cover (Figures 5.4 and 5.4F).

Livestock production: The population of livestock has doubled in the last six decades (Figure 5.4C). However, the deforestation rate increased and then started to decline, which may be because alternate sources of food for livestock are being produced, also because of a consistent increase in agricultural production and productivity.

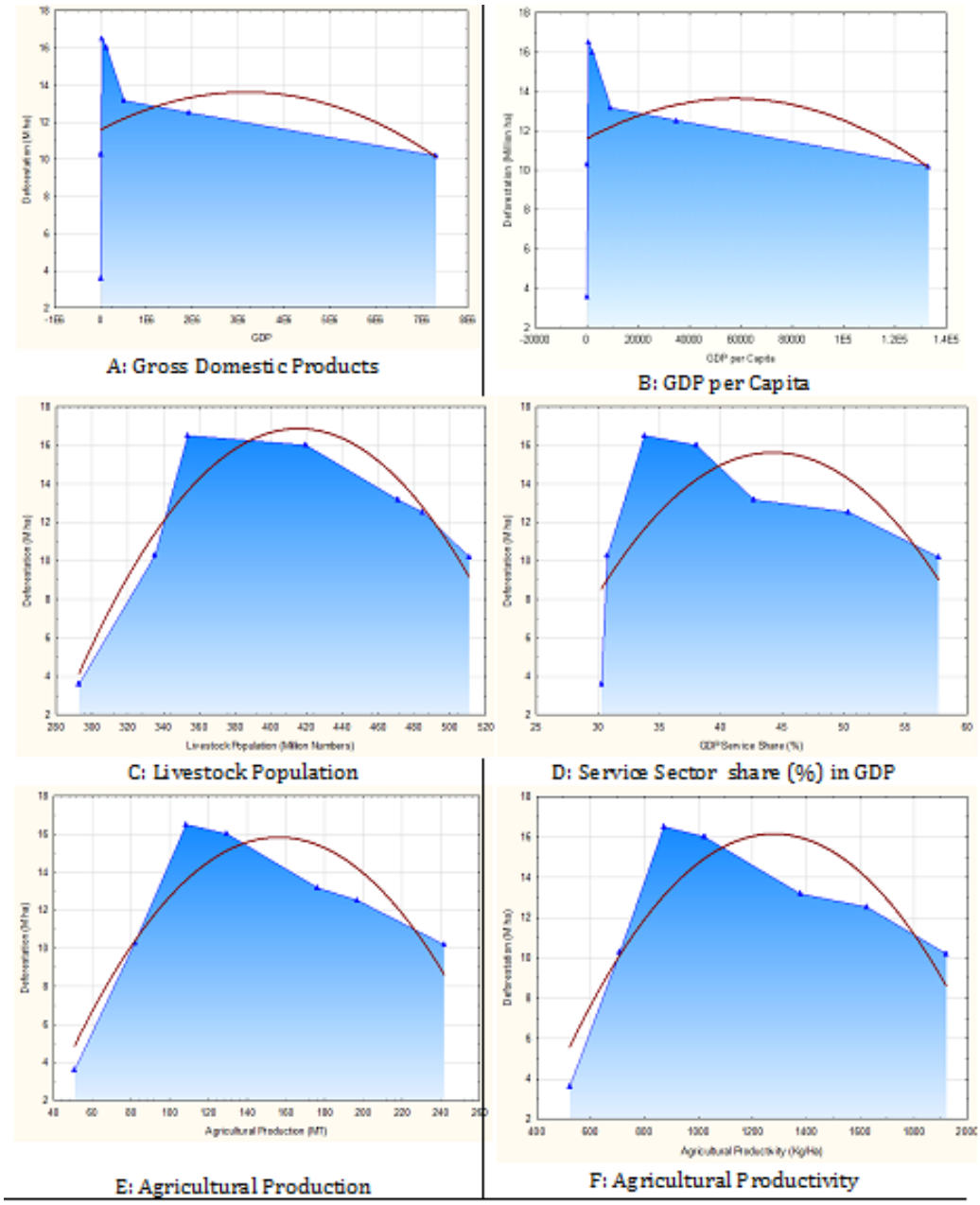


Figure 5.4. Economic parameters.

The contribution of economic development to forest transition was again obscured due to destruction of forests under colonial rule for strategic and commercial purposes. In the initial period of development, the economy was dominantly agrarian and forests were cleared for cultivation. However forest regulation and policy interventions helped the forests, and agricultural expansion did not happen at the cost of forests entirely. In a planned economy as prevalent in India, government intervention plays a crucial role in determining forest transition. Economics demand that more forest products are available to the growing middle class. However the demands may be met from imports if sufficient conditions do not exist in the country for growing more forests. Agro-forestry in North Gangetic plains of Haryana, Punjab, Uttarakhand and Uttar Pradesh may be considered as the response to the forest product scarcity hypothesis, where farmers are integrating tree farming in agricultural practices for diversification of income. On the other hand, farmers are moving out of the agricultural land with low productivity as in state of Jharkhand, making land available for re-forestation.

Table 5.3. Land Use Classification (Agriculture) for the state of Jharkhand.

Agricultural land Classes	2005	2011
Fallow Lands other than Current Fallows	783	962
Current Fallows	1244	1394
Net Area Sown	1769	1504

Source: ISFR 2005, 2009

5.6 Social Parameters

Forest cover is correlated with a number of parameters, which lead to deforestation. These parameters are passive or permissive drivers rather than active drivers. Growth in national population and affluence do not necessarily mean continued deforestation, while the cluster of economic, social, political and technological trends associated with 'development' can apparently facilitate reforestation. The parameters like population, urbanization, literacy rate, etc. are social drivers which lead to forest transition.

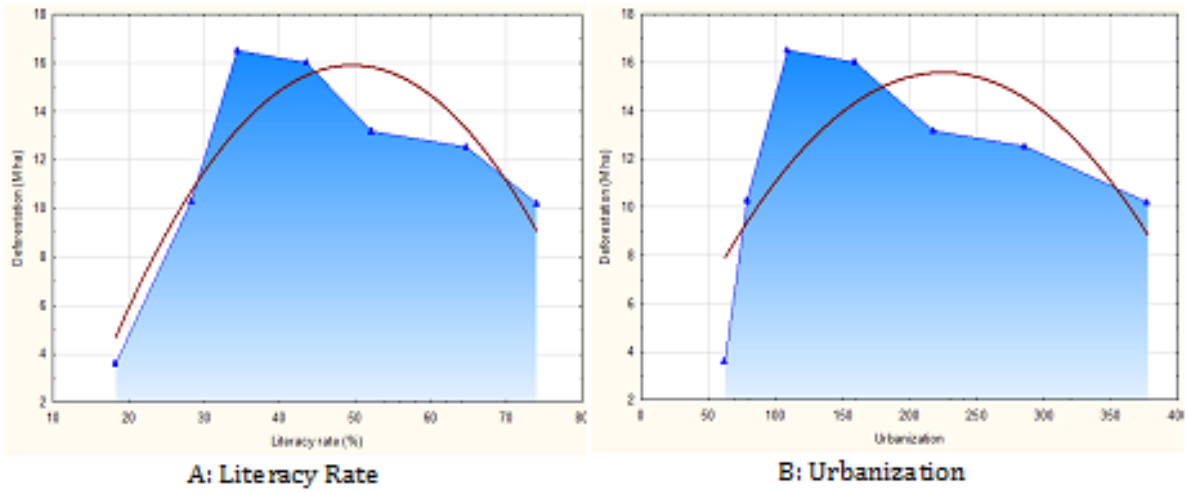


Figure 5.5. Social parameters.

Population growth: Population growth had played the key role in the decline of forests, but the relationship between population and forests in (and after) the transition is poorly understood (Mather *et al.* 1999). The rate of deforestation and the population growth were directly related during the early to mid 20th century (as explained in earlier chapters). From them, the direct relation became an inverse relationship after 1980. The pressure of population growth increases deforestation because of the ever increasing demand for forest products. Furthermore, a growing population results in abundant labour that will affect the labour market by pushing down wage rates and results in high unemployment rate, which may further increase pressures on forests. A change in population growth trend might exert pressure on forests (especially through the expansion of arable area). Thus stabilisation and expansion of forest cover could be linked to a demographic transition, and a scarcity of forest goods and (ecosystem) services.

Urbanization: Urbanization is one of the major forces for forest cover change. The shift from rural to urban lifestyles reduces the reliance on local resources. The rates of migration of rural population to the urban areas have consistently increased over the decades, which reduced the pressure on forests consistently. The rural population decreased from 82.7% to 68.8% during the last six decades (Figure 5.5 B). Fuelwood is the dominant source for traditional biofuels, which was reduced drastically in the last few decades. The rural to urban mobility is attributable to increasing jobs in service sector (Figure 1.8). According to the 2001 census, 285 million people (27.8%) lived in 5,161 towns. Further, 37% of the 285 million live in 35 metropolitan cities today, compared to 19% in 1951. The projection for the urban population by 2020/2021 indicates a corresponding size of 433 million of urban population. The estimated requirement for housing in urban areas in 2002 was about 22.44 million dwelling units. This was estimated to be around 24.71 million by 2007 and 26.3 million by 2012. Therefore, the trend can be taken as an indicator of the growth in the requirement for structural material and accessories in the housing sector. Therefore it is difficult to explain transition in terms of urbanisation only.

Literacy rate: The literacy rate of the country consistently increased from 18.3% in 1951 to 74% in the year 2011. Regular knowledge gain and awareness about forests by the population helped in understanding the environment and ecosystem of the forest, which led to a decline in the rate of deforestation (Figure 5.5 A).

The social parameters have an impact on forest transition in India provided, they are leading to change in the use of forest products and recognition of the environmental and ecological functions of the forests. They appreciably contribute towards building public opinion for the conservation and management of forests which ultimately leads to policy, legal, administrative and financial support to the forestry sector.

5.7 Econometric Analysis

The relationship between socio-economic variables and deforestation along with forest cover is analysed using simple and multiple non linear regression models. The general empirical non linear model (Barbier and Burgess 2002, Gomes and Braga 2008, Santos *et al.* 2008) used in the study was as:

$$Y = \alpha + \beta_1 X + \beta_2 X^2 + \sum_{k}^{p} \beta_k Z_k + \varepsilon$$

where

Y = deforestation rate or forest cover
X = GDP per capita
Z_k= Socio-economic parameters (GDP per capita, literacy rate, agricultural area, agricultural productivity, forest plantations, urbanization, etc.)
ε = random error

Model 1: Empirical model of forest cover (FC) with GDP per capita (GDPP)

$$FC = 129.204 - 15.779 * (\ln(GDPP)) + 0.952 * (\ln((GDPP))^2$$

The overall model is significant and the value of R^2 (57%) is high, which explains that overall explanatory power of the model is satisfactory. Based on the model, 57% variability is explained by the variable which seems to be considerable keep in view of the nature of the dependent variable, which is influenced by other explanatory variable. The R^2 value suggests that GDP per capita explains variation in forest cover.

Model 2: Empirical model of forest cover (FC) with GDP per capita (GDPP) and agricultural area (AA)

$$FC = 129.204 - 0.247 * AA - 8.05 * (\ln(GDPP)) + 0.514 * (\ln((GDPP))^2$$

The overall model is significant and the value of R^2 (67%) is high, which explains that overall explanatory power of the model is satisfactory. Based on the model, 67% variability is explained by the variable which seems to be considerable keep in view of the nature of the dependent variable, which is influenced by other explanatory variable. The R^2 value suggests that GDP per capita explains variation in forest cover.

Model 3: Empirical model of deforestation rate (Def) with GDP per capita (GDPP)

$$Def = -12.36 + 2.69 * (\ln(GDPP)) - 0.141 * (\ln((GDPP))^2$$

The overall model is significant and the value of R^2 (79%) is significantly high, which explains that overall explanatory power of the model is satisfactory. 79% variability in the model is explained by the variable which seems to be considerable keep in view of the nature of the dependent variable, which is influenced by other explanatory variable. The R^2 value suggests that GDP per capita explains variation in deforestation rate.

Model 4: Empirical model of deforestation (Def) with GDP per capita (GDPP) and agricultural area (AA)

$$Def = -9.97 + 0.077 * AA + 0.000071 * (GDPP) - 1.033E - 9 * (GDPP)^2$$

The overall model is significant and the value of R^2 (69%) is high, which explains that overall explanatory power of the model is satisfactory. 69% variability in the model is explained by the variable which seems to be considerable keep in view of the nature of the dependent variable, which is influenced by other explanatory variable. The R^2 value suggests that GDP per capita explains variation in deforestation rate.

Model 5: Empirical model of Deforestation (Def) with GDP per capita (GDPP) and agricultural productivity (AP)

$$Def = -17.22 - 0.0069 * AP + 4.23 * (\ln(GDPP)) - 0.131 * (\ln((GDPP))^2$$

The overall model is significant and the value of R^2 (91%) is sufficiently high, which explains that overall explanatory power of the model is satisfactory. Based on the model, 91% variability in the model is explained by the variable which seems to be considerable keep in view of the nature of the dependent variable, which is influenced by other explanatory variable. The R^2 value suggests that GDP per capita explains variation in deforestation rate.

As the theory of EKC suggests that coefficient of GDP per capita is positive whereas the coefficient of quadratic GDP per capita term is negative, which holds good in all the above established econometric models.

The analysis was done for the socio-economic parameters like GDP per capita, agricultural area, agricultural productivity, urbanization, forest plantations, agricultural production, literacy rate, etc., it was found that GDP per capita, and agricultural area/ agricultural productivity found to be significant to the forest cover and the rate of deforestation, whereas the other parameters are non significant.

The model explains that

- The results are consistent with the basic concept of EKC hypothesis.
- The positive GDP per capita and negative quadratic GDP per capita was observed in all the models which confirm the EKC relationship for deforestation of natural forests.
- Model 2 indicates that the expansion of agricultural area was at the expense of forests.
- The non significance of other socio-economic parameters provides evidence that forest cover and rate of deforestation are not governed by these parameters directly, but they may have some casual relationship with the deforestation rate or forest cover.

5.8 A Comprehensive Forest Transition Cluster Model for India

All socio-economic parameters acting together may provide a better explanation for forest transition happening in India (Figure 5.6). Even these factors interact with each other providing a coupling complexity. Therefore all changes associated with transition of forests, are grouped into five major categories of changes (Figure 5.7). These categories include; changes in attitude towards forests; changes in usage of forest products; changes in interface between forests and other macro systems; changes in forestry and forest management practices and changes in formal evaluation and social scrutiny mechanisms. It must be noted that even these categories interact with each other in a complex and intertwined manner forming a cluster, which is termed as “transition cluster”. Notably, some of the factors within each category may overlap across categories. Therefore, these categories are not mutually exclusive.

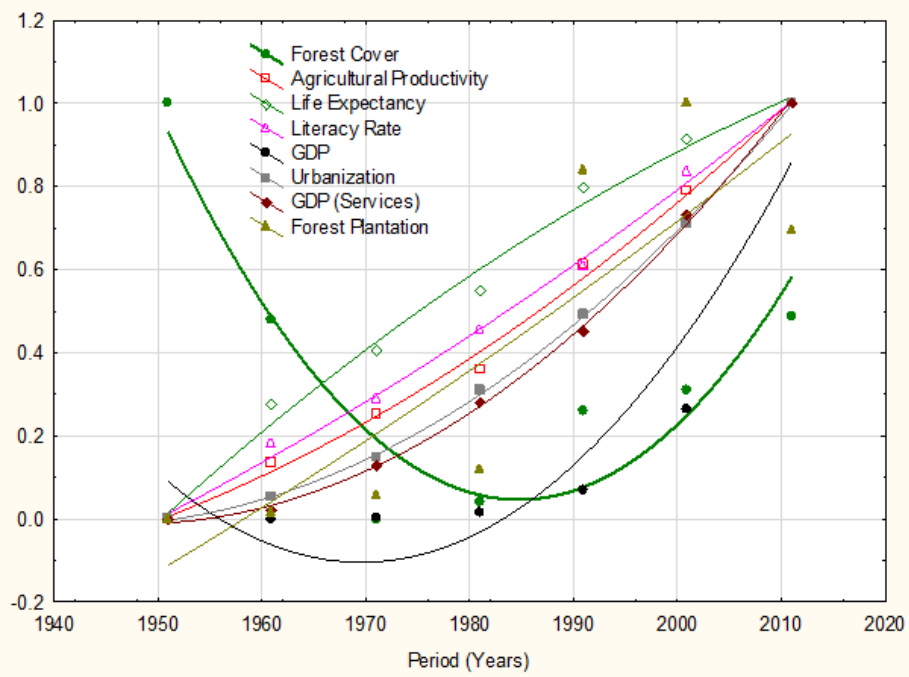


Figure5.6. Forest Transition in Comprehensive Framework of Socio-economic parameters.

Figure 5.7. Forest Transition Cluster Model for India.

Changes in Attitude toward Forests

With the advent of industrial age accompanied by scientific temperament and thinking and advancement of market economy, the inexhaustibility of forests as natural resource was questioned. This led to policy level interventions to augment forest resources in the form of the First Forest Policy of 1894. In the Pre-independence era it was guided by the strategic and commercial interests of the British. However, after independence, the constitutional provisions with regards to directive principles for guiding governance in the India were the results of emerging thoughts on sustainable development. The international externalities in forms of instruments also facilitated in formulation of national policy and enactment of forest acts.

At the social level, an evolution of education system has paralleled changes in the approach towards forests by introducing new courses in environment and ecology and by diffusing environmental awareness courses across other disciplines. Literacy rate in India also grew to almost 75% from 12% which prevailed at the end of the British rule in 1947. Societal awareness about environment is greatly attributable to general economic development of the country as a whole since high income has generated demand for the protection of forest.

The contributions of agriculture and allied sectors, industry sector, and services sector to the overall economy also underwent significant changes overtime. Due to availability of employment in these sectors, there is not much pressure on forestlands for expansion of agriculture, which was witnessed when the economy was primarily agrarian. The only exception is the livelihood needs of forest dwellers as provided in the Forest Rights Act 2006. Rural to urban movement (Figure 1.12) has also resulted in reduced pressure on agriculture and wasteland that, in turn, has reduced pressure on forest land and also positively contributed to the availability of land for re-forestation and natural regeneration.

In last two decades the JFM programme has also rejuvenated the interest of local people in forest protection and management. Forests worked under JFM regime have also contributed significantly towards the economic wellbeing of the people through increased availability of forest resources, creation of employment opportunities and better flow of ecosystem services. Presently JFM activities in 29 states are carried out through 118 213 JFM committees, managing 22.94 mil ha of forest (29.8% of the recorded forest area of the country). In most of the Indian states the representation of women is up to 33% in the JFM executive committees. This attitudinal change at the grass root level towards forests has led to a drastic decline in organised illegal activities. Forest Development Agencies were also formed in almost all forest divisions to function as a federation of JFM committees (Figure 4.8).

Changes in Usage of Forest Products

Several developments in the recent past have changed society's usage of forest—especially of wood products, thereby changing the pressure on forests. Most notably, a dramatic increase in both affordability and availability of foreign goods (such as furniture) has helped alleviate pressure on local production and, in turn, on local forests. This change was triggered by three policy interventions.

1. The Forest Conservation Act 1980, the National Forest Policy of 1988 and National Forest Commission 2003 are the umbrella legislation and framework for forest conservation and management. Under these acts, rules and policy, the supply of raw material to wood based industries is phased out from forests. They envisage the wood based industries to encourage agro-forestry for raising plantation to meet the raw material demand.

2. The Supreme Court of India imposing a ban on green felling and also on felling in areas beyond an elevation of 1000 m constricted local harvesting and supply but provided an opportunity for forestry outside forests:

Large numbers of wood and non wood products are sourced from the forests. During the period 1900-1970, the natural forests remained the main source of timber. The total production of timber from forests was about 10 mil m^3 per year although the country's requirement was estimated to be about 15 mil m^3 (NCA 1972). The major part of the requirement was met by harvesting trees from private lands outside forests. Recent studies have indicated a reversal of trends. The actual annual production of timber in India is estimated to be 3.175 mil m^3 from forests (ISFR 2011). Most of the timber produced in the country comes from TOF grown in private lands under agro-forestry, along roads, canals, homesteads etc. Based on the growing stock of TOF and average rotation of the tree species, the annual potential production of timber from TOF has been estimated by the Forest Survey of India (ISFR 2011) to be 42.77 mil m^3 in the country. In terms of forest product scarcity pathway, forestry outside forests is bound to flourish in India for meet the demands gap (Table 4.4) as explained in section 4.4.3.

3. Timber Import Liberalization

Prior to independence, India's foreign trade was typical of a colonial and agricultural economy. A progressive change in import policy took place in 1957 to safeguard the interests of the nation. The Open General License (OGL) was discontinued, instead, limited quotas in respect of essential

commodities were granted to importers on the basis of their actual imports. In the late 1970's and early 1980's, the trade regime was based on a complex system of licensing. Consequently, the import licences were based on two major criteria, the principle of essentiality and the principle of indigenous non availability (Bhat 2011). The import of forest products in 1970–71 was INR 714.289 million and in 1980-81 was INR 2323.620 million. A major program of economic reform (liberalization) was introduced in 1991, with emphasis on external sectors such as foreign trade, export-import policy, tariff policy, current account management, capital account dynamics, foreign exchange reserves, exchange rate policies, external debt and aid, foreign direct investment and foreign portfolio investment (Bhasin 2005). Tariffs were reduced from an average of 71% in 1993 to 35% in 1997, however, the tariff structure remained complex and escalation remained high in several industries, notably in paper and paper products, printing and publication, wood and wood products etc.

The Government of India took a policy initiative and liberalized the import of wood and wood products in 1996 to reduce the demand supply gap by bringing them under Open General License (OGL) category and also to facilitate conservation of forests. Since then the import of wood and wood products has been steadily increasing. The import of wood has continuously increased in the last two decades except for a slight dip in 2002-03. There was a sudden increase in the import by 60% in 1997-98 after liberalization policy. The current level of import of wood is about 6 mil m^3 of which round logs alone constitute more than 93%. Though wood is imported from about 100 countries, six countries namely Malaysia, Myanmar, New Zealand, Ghana, Ivory Coast and Gabon constitute the bulk of the import. About 80% of the imported wood during 2006-10, was from these countries. Teak constitutes an important timber species and forms about 15% of the total annual imported volume. Most of the import of teak is from Myanmar, Ivory Coast, Ghana, Ecuador, Costa Rica and Benin. The value of the imported wood and wood products has gradually increased from Rs. 33,220 million in 2003-04 to 76,880 million in 2009-10.

Additionally, local wood manufacturers have adopted better technologies and have increased their material use efficiency. In the last twenty years, wood has also been substituted by plastic and other material, such as high density boards. This product substitution is also likely to have alleviated pressure from natural forests leading to eventual reduction in overall deforestation.

Changes in Interface between Forests and Other Macro Systems

Different macro-systems within a society interact and influence each other. In agrarian era, forests and agriculture were at the crossroad. With the advent of market dominated era, all the macro-economic systems interact with each other and inter-sectoral boundaries have become more porous. During the last three decades, forest products industry including the paper sector has shown appreciation for environmental issues, primarily driven through global supply chains. Legal systems have also changed significantly both through policy changes (e.g., new legislations to stop deforestation) and changes in legal infrastructure (e.g., creation of Green Tribunal). Improved knowledge and understanding on issues related to forestry and environment also paralleled changes in other macro-systems. The 20-Point Programme (TPP) specifically prioritised afforestation and tree planting and all rural employment generation programmes had certain percentage earmarked for afforestation. Lateral funding for afforestation activities also came in a large scale from other sectors such as Railways, National Highway Authority, Armed Forces, etc. Integration of plantation with farming activities has given birth to farm and agro-forestry models that have become very popular during last three decades in many parts of India, especially in the northern states of Haryana, Punjab, Uttarakhand, Gujarat, and Bihar etc. Estimates are that 90% of the wood used in India is produced in tree outside forests (TOF) and only 10% come from natural forests.

Changes in Forestry and Forest Management Practices

India has one of the oldest organized forest sectors in the world. In 1864, the Forest Conservator in the Presidency of Madras was instituted. Subsequently, forest policies were formulated and the forest service was initiated. There was little concern or regard for future generations and by the time the 19th century came to a close, the cost of this short-term focused and unregulated development started to become evident. In 1894, Brandis, the first Inspector General of Forests concluded that the "frontier was closed". Forests were not inexhaustible, most of the natural resources had been appropriated and benefits concentrated in the hands of speculators and large corporations. Many people now saw the need to transform extractive forest management to sustained yield and there was increasing political support for forest conservation.

The Indian conservation movement, under the leadership of Brandis, had three roots; efficiency, equity and aesthetics. The proponents of efficiency wanted to manage forests by scientific and economic principles to maximize yield while those supporting equity wanted to insure the benefits from resource management were shared as widely as possible. Those advocating aesthetics wanted to preserve the natural landscape from the ruin of development.

These three streams of the conservation movement struggled for dominance with the efficiency supporters being the most successful, at least for the first half of the 20th century. The scientific sustained yield forest management of Europe, aimed at maximizing yield, was politically supportable because its philosophy was consistent with the capitalist-based private-enterprise economy. Regulation and control of short-term market fluctuations were viewed as positive reforms that would make capitalism work better over the long term and as needed to ensure social objectives of community stability. Long-term investment was justified by maintaining or increasing short-term harvest levels given the promise of higher yields from the superior managed forests of the future. The European emphasis on increasing productivity and efficiency, fit with entrepreneurialism and free enterprise, while the assurance of forests for future generations satisfied the proponents of conservation. Sustained yield was introduced to India and the rest of south Asia by European-trained foresters including Brandis. The Imperial forest reserves expanded and were managed objectively by an elite corps of scientifically-trained experts within the colonial bureaucracy. Conservation was interpreted and applied via forest management as "wise use". With several modifications, this interpretation and ethic is still applied and taught in forestry schools today in India.

The equity stream of the conservation movement was the least successful as redistribution of benefits has always been viewed negatively in the neo-liberalist politics of modern society. The aesthetic movement, however, did make some gains and continues to influence and enhance the application of "wise-use" forest management.

The aesthetic stream of the conservation movement was not prompted by loss of economic benefit as was the efficiency stream. Those concerned for aesthetics were deeply offended by the disappearance of the Indian landscape, which had been transformed by its extremely rapid development. Many had a genuine concern for the loss and sufferings of the forest dwellers, who were later intentionally brought into the main stream. Moreover, the landscape in India was transformed very, very quickly compared a similar transformation in Europe. It outraged their sense of aesthetic and sparked a movement to preserve India's natural and beautiful heritage.

The preservation movement was most successful when the political and economic cost was low. Gains were made when the demand for natural resources was low and the movement lost power after WW II when industrial development dominated. The movement gained new momentum in the 1960s and 70s with the combining of the new science of ecology with concerns for aesthetics. This gave the preservation movement an objective and scientific rationale and today the preservation of old growth forest is argued based on ecological reasons such as its contribution to global biodiversity as well as for spiritual, cultural and aesthetic reasons.

Although wise-use dominated, sustained yield was enhanced by the preservation movement and increased demand from the forest for other uses. During the 1960s, 70s and 80s, it evolved from considering the production of timber to the production of other resources in an attempt to manage the forest to satisfy all demands. Large scale forest plantation has contributed towards conservation and sustainable management of forest (Figure 5.8). If timber production could be managed in way as to protect and ensure aesthetic, recreation and water values, for example, less land would need to be preserved and total output of all values could be maximized. Preservation for "single use" was considered an inefficient use of land in a period of increasing demand. In 1968, sustained yield was defined in Indian law as "sustained-yield of the several products and services, means the achievement and maintenance in perpetuity of high-level annual or regular periodic output of the various renewable resources without impairment of the productivity of the land". Production was still emphasized but the concept of sustained yield had broadened to include all outputs from the forest as well as the maintenance of the land's biological productivity.

Forest management was redefined under the Indian Forest Policy of 1988 to become "resource management". Interdisciplinary teams of trained experts brought sectoral research and goals to the

planning table. A great deal of effort was extended to quantify resource impacts and interactions between resources. Analytical tools (mathematical models, benefit/cost analyses, geographic information systems) were applied to determine land use under an objective of maximizing economic efficiency. Consensus decision-making was employed to resolve conflict. Rational planning processes supported by data and science were used to manage natural resources. However, many of these planning processes were less than successful and erupted into conflict, civil disobedience and legal battles. The root of the conflict was not incomplete data or process problems (although these contribute to the conflict) but fundamental differences in the ethics of the two streams of the conservation movement: "wise-use" with forests as short-term economic utility to humans on one hand and the ethic of "preservation" with forests as having intrinsic value and role in planetary regulation on the other. The Supreme Court judgment in 1996, which redefined the scope of the Forest Conservation Act 1980, suspended tree felling across the country unless prescribed in government approved working plans and sought to radically reorient the licensing and functioning of the forest-based industries in the forest rich north east., clearly established the supremacy of the conservation movement in India. The sustainable management of the forests has been the way of life now in India.

This change has also been brought about by 'environmental issues' moving beyond national boundaries and becoming global concerns. Countries today are globally interdependent both economically and environmentally. Individual countries are no longer able to take action on their own as it may place them at a competitive disadvantage. A global solution and strategy is required and is in the interests of all countries. The UNCED conference in Brazil in June 1992 was a start in developing just such a strategy.

Changes in Formal Evaluation and Social Scrutiny of Forest Management and Protection
The 20 Point Programme is a selection of Plan schemes and is in essence, a commitment to achieve certain selected targets and objectives with respect to alleviation of poverty and providing better living conditions to the people. The Programme is encompassed within the Annual Plan and Five Year Plan of the States/UTs and Central Ministries and allows for the formulation of a 20 Point Programme for the Centre and each of the States/UTs based on the approved Annual Plan. Protection of environment is one of the components of the programme. Since its launch in 1975, forest related issues such as protection of forests; plantation activities etc are monitored under this programme by the government at the field level.

Civil society pressure and increased media attention on forestry issues have intensified public scrutiny of forest protection. Emphasis on stakeholder engagement process and transparency in information dissemination has facilitated increasing public participation in forest management decisions.

Worldwide, public and private forestry is becoming increasingly complex, visible and contentious. Forestry is no longer the sole province of foresters but is now a high-profile issue of concern to society at large. Reduced public trust in the profession is evident in the rise of regulation, litigation, public initiatives, licensing and certification of practices and products. The appropriate response to increased public scrutiny is to demonstrate that all forestry management options, actions and policies are soundly based on those biological, quantitative, managerial and social sciences that underpin the field.

5.9 Conclusion

The forests of the agrarian era provided land for agriculture, timber for agriculture, timber for building, fuel to house hold consumption and places of sport for the wealthy. The industrial revolution created new wealth which in turn triggered new demands of forest products. The period of 1950–70 contribute towards the deforestation since the agricultural sector was in the expansion phase. The socio-economic parameters associated with economic development, are considered to give a plausible explanation for the transition of forests in India. The economic parameters related to forest transition such as GDP, agricultural production and productivity, livestock population etc. described in details.

A comprehensive forest transition cluster model for India is developed, with the component of viz; changes in attitude toward forests, changes in usage of forest products, changes in interface between forests management practices and changes in formal evaluation and social security mechanism. In the policy and legal framework, active support for the sector in the form of act programmes and the judicial pronouncement of, the supreme court of India, brought attitudinal change towards the forests in the country.

6 FORESTS AND FOREST TRANSITION IN FUTURE

6.1 Introduction

India's rapid economic growth is expected to impose demands on its natural resources — directly or indirectly. Therefore, the associated expansion of manufacturing sector would create a direct demand on natural resources for their utility in the manufacturing process. On the other hand, issues like consequent increase in the demand of power and energy; need for infrastructure support; among others put further demands on natural resources via their direct utility or competing demands on land that support their existence. Therefore, focused attention is required in looking at multipronged options for ensuring economic growth at the local levels that imparts confidence in the need and viability of the conservation efforts while maintaining a steady level of economic development. In the backdrop of a rapidly growing economy; high rates of migration from rural to urban areas; stark imbalance in regional development; and growing economic aspirations of the populace, there is a need to look for options that ensure that development is not at the cost of destruction of natural resources. A vision of national economy 2000-2020 (GOI 2006), Table 5.1 presents socio-economic situations whereas per capita GDP is expected to almost quadruple during 2000-20. It will be accompanied by an increase in urban population from 28% in 2000 to 38% in 2020, which will have a higher level of income. However the economic wellbeing of forest fringe communities would not improve to a similar position and they would continue to use the forests as the sources for subsistence and for income. In succeeding sections, the future potential scenario of forests is postulated in brief followed by probable trend and forest transition.

6.2 Forests

It is estimated that the livelihood of 70 million tribal and 200 million non-tribal rural people is dependent on forests (MoEF 2007). Apart from fulfilling their subsistence needs, forests provide them with employment and monetary income. Nearly 173,000 villages (about 28% of the total in India) are located along the forest fringe (FSI 1999). Forests support, grazing of nearly 60% of the livestock (270 million out of about 450 million) and firewood to most of the nearby villages for self-consumption and sale (Singh 2011). Chauhan *et al.,* (2008) provides an estimate of Timber and Non-timber Forest Products contribution to national GDP (Figure 6.1). Timber revenues rose from less than INR 5 billion in 1980 to over INR 20 billion by the end of 2000. The NTFP contribution followed that of timber very closely and exceeded timber towards the end of 2000. The NTFP export has been growing between 5–15% annually (average 11%); the state revenue from non-timber resources has crossed levels to that fetched by timber.

The large-scale dependence exerts pressure on forests, leading to **t**heir unsustainable exploitation and eventual degradation, as indicated by the trends in the recent past.The demand for forest product in the form of timber, fuel or fodder can be expected to only rise in the future. The largest demand for wood in Asia and the Pacific is for fuel wood (more than 70% of the forest produce), but increase in income levels may result in a shift towards industrial wood products (sawn timber, wood panels, and paper). The total industrial demand of wood in India in terms of Round Wood Equivalent (RWE) was estimated at 58 mil m^3 with a deficit of the order of 29 mil m^3 and 91 mil m^3 with a deficit of the order of 45 mil m^3 in the year 2000 and 2010 respectively. The projected demand is expected to reach 153 mil m^3 in the year 2020 (MoEF, 2007). The import of wood registered a four-fold increase during the last decade (Table 2.7). Given that the Indian wood-based industry already depends on imports for their raw materials, the projected demand-pull is only likely to further exacerbate the situation. It is worthwhile to investigate if the growing demand of raw material by forest industries can be used as an opportunity to accelerate economic development in the remote regions and the north-eastern states of the country in particular. Moreover, by the end of the millennium, agro-forestry was producing more industrial and non-industrial wood than forestry sector. Further, it also improves the productivity of the farm environment and provides additional income and employment in the rural areas.

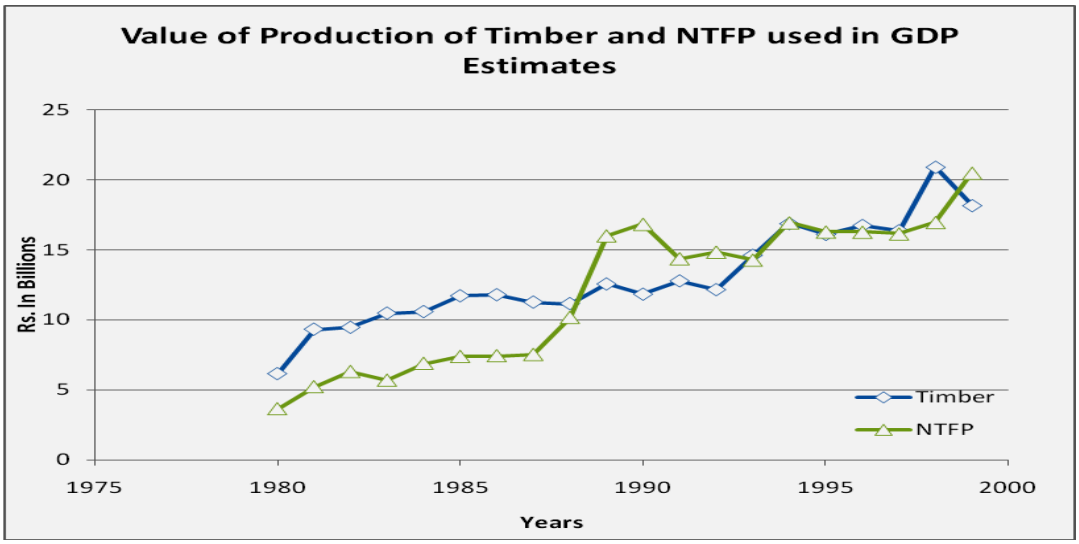


Figure 6.1. NTFP & timber in GDP estimates.
Source: Chauhan *et al.,* 2008

Cultivation of medicinal plants is another promising area for investment in view of the steadily growing international demand, which exceeded US$ 12.5 billion in 1994 and US$ 30 billion in 2000, with annual growth rates averaging 5% to 15% (Singh, 2008). Besides forest products, the importance of forests and forest cover – for conservation of biodiversity; conservation of *adivasi* (tribal) culture and livelihood; as carbon sinks; for water and soil conservation; and so on are being recognised in a bigger way.

A joint study carried out by Technology Information, Forecasting and Assessment Council (TIFAC) and The International Institute for Applied Systems Analysis (IIASA) under India-IIASA programme in 2008 clearly shows the rapid and fundamental changes are taking place in the forest systems of India towards a more comprehensive and multiple use of forestry as given in table 6.2. (Singh, 2011). With the growth of urban population and service sector in expanding economy, societal recognition and preference for environmental functions of the forests will increase and role of forests will be valued more for ecosystem service than forest product.

With increasing concern on loss of natural biodiversity and ecological importance of natural forests for watershed, soil and fertility services, ecotourism and carbon sequestration, payment for ecological services; there will be a dramatic increase in the creation of plantation forests in the nation. These plantation forests will be largely driven probably by a shift in local policies and through workable financial and institutional arrangements. The main species planted will be short-rotation, fast-growing eucalyptus, poplar and casuarinas etc. and long term species such as pines, rubber, and teak. Most of such plantations will be raised on agricultural lands in the form of agro forestry and other areas located outside the traditional (legally notified) forest reserves and industrial farms; and will qualify as TOF (Trees Outside Forest). Further, wood produced from TOF and value-added products will offer a great opportunity for employment generation, income generation, and alleviating pressures from natural forests. This will possibly have a positive effect on the stability and increase in forest cover in India in the coming decades.

Table 6.2. The changing priorities in the forestry sector production in India.

S. N.	Forest Functions	Changing Importance of Forest Functions	
		1980	2010
A.	Production of Goods		
1.	Industrial/farm forestry	High	High (Cost limitation of land tenure)
2.	Agro-forestry	Limited	Very High
3.	Non Timber Forest Products	Medium	Very High
4.	Fuel wood	Very High	Very High
5.	Fodder and Grazing	Very High	Very High
B.	Production of Services		
6.	Climate change	Almost Unknown	Very High
7.	Watershed services	Medium	Very high
8.	Protected Areas	Medium	High
9.	Biological Diversity	Limited	Very High
10.	Eco-tourism	Limited	Medium

6.3 Climate Change and Forest Sector as Potential Mitigation Option

Forest ecosystems in India are already subjected to socio-economic pressures leading to forest degradation and loss, with adverse impacts on the livelihoods of the forest-dependent communities. Climate change will be an additional pressure on forest ecosystems and the impacts of climate change on forest ecosystems are likely to be long-term and irreversible. However, forests provide an excellent opportunity for reducing atmospheric greenhouse gases especially carbon dioxide, responsible for global warming and climate change.

During the last few decades, national policies aimed at conservation and sustainable management of forests have transformed India's forests into a net sink of CO_2. Carbon stocks stored in Indian forests have increased from 6244.78 (1995) to 6621.55 (2005) mil tonnes (MT) (Table 6.3) with an annual increment of 37.68 MT of carbon ≅ 138.15 MT of CO_2 (Kishwan *et al.,* 2009). This amount of carbon sequestration will still be adequate to mitigate emissions even when these will be on the increase due to the accelerated development process. Estimates show that the continued removals by the forests would still be able to offset 6.53% and 4.87% of the projected annual emissions in 2010 and 2020 respectively in the business as usual scenario. It was estimated that emissions in 2010 and 2020 will respectively be 45% and 95% higher than those in 2000.

Table 6.3. Carbon in India's Forests (Mil Tonnes).

Carbon	1995	2005	Incremental Change
In Biomass	2692.474	2865.739	173.265
In Soil	3552.304	3755.811	203.507
Total	6244.778	6621.550	376.772

Source: Based on Kishwan *et al.,* 2009

Apart from the above trend, the Green India Mission (GIM) as part of the 'National Action Plan on Climate Change' (NAPCC) becomes operational, the capability of the forestry sector to contribute in GHG removal would be further enhanced. The overarching objective of GIM is to increase forest/ tree cover in 5 mil ha of land, and improve quality of forest cover in another 5 mil ha of lands, and thus together help in improving ecosystem services from 10 mil ha of lands, and increase forest based livelihood income of about 3 million forest dependent households. The mission proposes to take a holistic view of greening by restoring ecosystems and habitat diversity, enhancing biodiversity, and not merely focusing on tree plantations to meet carbon sequestration targets, and realizing carbon benefits as co-benefits, and treating forest and non-forest lands simultaneously in a given bio-physical unit such as landscape/sub-landscape/sub-watershed, etc. and addressing the drivers of degradation through crosscutting interventions and convergence with other programs. Afforestation and reforestation of 10 mil ha of degraded land covered under the GIM with participation of Joint Forest Management Committees (JFMCs) would be able to add another 30 MT of carbon ≅ 110 MT of CO_2 by 2020 based on Kishwan *et al.,* 2009. Annual addition of 10 MT of biomass due to operationalization

of the GIM would increase the annual emissions removal capability of the forests from 4.87% to 5.38% of the corresponding projected emissions in 2020. Even if half (5 MT) of the annual biomass increment (10 MT) is removed annually on a sustainable basis from 2025 onwards, the emission removal capability of forestry sector would still be able to offset every year 5.12% of the 2020 level emissions.

6.4 Forest Transition in Future

The assessment of forest cover in India by the Forest Survey of India (FSI), based on remote sensing data pertaining to 2008-2009, works out to be 21.05% of the geographical area of the country. This includes all lands comprising area of one hectare and more, with a tree canopy density of more than 10%, irrespective of their land use and ownership. However, there are many small patches of trees which are less than 1.0 ha in extent such as trees in village woodlots, homestead, urban areas, scattered trees, trees along roads, canals, railway lines, trees in block and linear formation with area less than 1.0 hectare, that are excluded from the forest cover due to technical limitations of minimum map able area being one hectare. After 2001, FSI started the tree cover assessment for areas less than 1.0 hectare in extent having trees. This tree cover assessment by FSI works out to be 2.48% in 2001, 3.04% in 2003, 2.79% in 2005, 2.82 in 2009 and 2.76% in 2011 of geographical area of the country. These tree cover data only signifies that the pattern of scattered trees in the country has not changed and for the purpose of monitoring forest situation, the forest cover trend is more relevant as the methodology adopted by FSI.

The trend of forest cover in recent years available from the biennial assessment by FSI, is explained in detail in the Chapter III. Forest transition (as discussed in Chapter IV) in India will follow the trend established in last three decades in the business as usual scenario. It has been seen that there are no socio-economic or social factors, which are reversing the trend. As explained earlier, there will be a continuous increase in demand for forest products and the forest scarcity pathway will encourage more and more plantations. More and more farmers will take advantage of agroforestry to diversify income from the forests. More lands will be available for plantations due to abandonment of agricultural areas due to low productivity, absentee landownership due to urban migration and land use adjustment to land quality. Respect and demand for ecosystem services will increase among the growing urban population with high income and concern for the environment. Policy and regulation framework for forestry will further improve and give impetus to enhancement of forestry outside forests for bridging the supply demands of forest products. Therefore taking the time trend factor into account, it is projected that the forest cover will increase to 71.34 mil ha in 2020. This approach has also been taken by Ravindranath *et al.*, 2006 to project the forest cover of India in 2030 to be 72.19 mil ha.

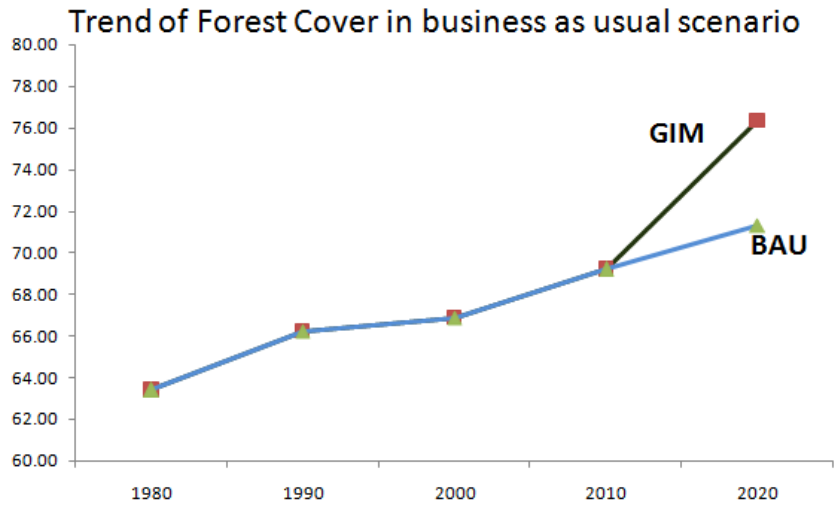


Figure 6.2. Trend of forest cover in business as usual scenario.

However, the Green India Mission has set the target of creating additional 5 mil ha plantations outside forests to be attained by 2020 as part of mitigation option in the context of climate change. This kind of additionality and the exponential growth of Indian economy and decreasing demand for forest products will reduce the recovery period for Indian forests. The milestone of 75 mil ha is likely to be reached in the near future (Figure 6.2). However the pressure on land resource for agricultural

production and other development activities will be the limiting factor in achieving the milestone of beyond 75 mil ha as forest cover. Since full recovery of forests in a country like India with high population density will not follow the transition of European countries, this barrier to the transition is bound to play its role beyond a certain point. The target of one-third of geographical area (110 M ha) under forests, as envisaged in the National Forest Policy (1952, 1988) thus was a long term vision, a goal which may require another 150 years to reach.

6.5 Possible Paradigm Shifts in Forest Management and Associated Policy Shifts and their Implementation

"Managing Environment, Forests, Wildlife and challenges due to Climate Change for faster and equitable growth, where ecological security for sustainability and inclusiveness is restored, equity in access to all environmental goods and ecosystem services is assured through institutionalization of people's participation; and a future in which the nation takes pride in the quality of its environment, forests, richness of its biodiversity, and efforts by the state and its people to protect, expand and enrich it, for intra and inter-generational equity and welfare of the local and global community".

It has been further opined that such forests cannot provide livelihoods, and at the most can fulfil the subsistence need of tribal population and other rural poor living in the vicinity of these forests. While catering to the needs of the people for goods from forests through managerial and technical innovative interventions, there is a need for balancing and convergence of existing programmes to provide livelihoods, so that sustainable development of the country's forests for uninterrupted flow of ecological services like carbon sequestration, hydrological services, etc are not affected.

Nations' Production Forests
The trees outside forests in various models of agro forestry, farm forestry, and social forestry are contributing a major portion of pulp and small timber, particularly subsequent to imposition of moratorium on green felling by honourable Supreme Court of India. The national annual requirement for fuel wood, timber, and fodder is 201 mil metric tonnes, 64 mil cu m, and 1337 mil metric tonnes respectively. Forest degradation due to expansion of agriculture, indiscriminate wood extraction, and other anthropogenic pressures has resulted in a net deficit of 21 mil cu m for timber, 365 and 86 mil tonnes of fodder and fuel wood respectively. The policy emphasis on restricted extraction from conservation forests and the moratorium on green felling from forests imposed by the Supreme Court of India have further aggravated this situation. Consequently, it has been opined that a special category of forests – 'production forests' – should be maintained and managed for focused production of timber, fuel wood, and leaf fodder. It has been emphasized that such forests have a higher MAI (Mean Annual Increment) than the national average of 0.7 cu m per ha. Trees of known genetic potential growing on soils of high fertility, moisture content, and rich nutrient status would be required to achieve this. Not more than 10% of the 78 mil ha of national forests will qualify as production forests.

Need for Adaptation of Adequate Policies
India's potential for wood production has not been realized fully; skills, suitable land, and investment resources from private sector are available but there are significant policy and regulatory bottlenecks to such investment in the forestry sector. The reasons for this have been pointed out as follows.

- There has been an over-interpretation of the 1988 National Forest Policy, which gave excess primacy to environmental services at the expense of economic benefits. Consequently, there have been focused efforts for creation of conservation areas, national parks, and sanctuaries. However, initiatives to address the problem of gaps between demand and supply of wood and wood products have taken a back seat. Further, there has been limited government investment in the forest sector — only an annual budget expenditure of $350million annually in the sector at the end of 2007-12.
- There has been significant investment by farmers (landholders) in plantations but relatively little investment from large corporate bodies. This can be attributed to pedantic interpretation of the forest laws by the courts, which has led to several legal interventions. This, in turn, has worked against the legal wood production by the corporate sector such as pulp and paper mills and the plywood sector in the country.
- Implementation and management of land in India is a state issue. Although, the federal government sets broad policies and strategies and allocates financial support, the success of

commercial plantations and TOF (Trees outside Forests) programmes have largely been influenced by the capacity of the state governments to offer an 'enabling environment'. The benefits of this are easy to see; Haryana, a state with very little natural forest resource now has a wood processing industry based upon plantation poplars and eucalypts and selected imported timbers. Similarly in Andhra Pradesh, declaring Eucalyptus, casuarinas and Leucaenea wood as agricultural produce and marketing through agricultural market committee have facilitated large scale private plantations increasing the forest cover by 0.0939 mil ha in 5 years. They generally cater to the needs of the pulp and paper mills as explained before in Sections 4.4.2 and 4.4.3.

- The requirement to obtain a permit from a government office (such as a transit permit) is regarded as a severe risk to investment. Many farmers and industries see this as an impediment to expansion of wood production on the farmers' lands under these new strategies. There are demands that incentives for tree planting should be same as those enjoyed for agriculture and horticulture.
- Farm forestry (eucalyptus and poplars) is expanding rapidly in northern India. The growers are free to sell to whomever they wish. However, if a tree grown on private land is designated as a 'forest species' (these do not include eucalypts or poplars), then a permit to harvest is required from the Divisional Forest Officer of the area, where plantations are located. This varies from state to state and has resulted in an absurd situation where farmers cannot grow native bamboos commercially on their own land.
- One of major barriers facing expansion of India's commercial plantation is availability of land. It is very difficult for the federal government to make definitive proposals as land tenure regulations vary between states and plantation programmes can be derailed through petitions to the supreme courts (the legal argument over discount rates is a good example). Furthermore, it is the responsibility of the state governments to create an enabling environment for commercial plantations. Many regulations end up having perverse effects upon plantation development.

Financing and Implementation Mechanism Including Partnership Arrangements

In an earlier study, Barin (2006) has estimated that 3 mil ha of high technology based plantations (with a balance mix of short rotation, long rotation and NWFP species is required to relieve the burden of wood import in India. The authors have also recommended covering 5 mil ha area under social forestry and another 2 mil ha under agro-forestry in their study. The financial implications of such a proposition are too large to be borne by government agencies. At the prevalent rates, a ha of such plantation would cost between Rs 30,000 – Rs 40,000. Furthermore, the infrastructure requirement for raising quality seedling and human resource are not available with the forest departments in the country. Therefore, it will be prudent to adopt different institutional mechanisms to implement these projected goals, which could be as follows.

- The role of forest corporations in raising quality production forest is also being considered by the MoEF (Ministry of Environment and Forests), Government of India. It has been proposed that the forest corporations will acquire (on lease) community lands and other wastelands outside the notified forest area for raising such a production forest. Once again, collaboration with industries and local population can enhance the success of such plantations.
- The role of financial institutes such as NABARD (National Bank for Agriculture and Rural Development) for providing micro-finance for plantation related activities to farmers, is also very important. An increased effort in these arrangements can result in higher interest amongst the tree growers for production forestry. Further, such an effort can reduce the burden on the government and complement the efforts of forest departments, which can be contributed in forms of subsidized seedlings.

Protection/Restoration Forests

A large area of national forests notified under IFA (Indian Forest Act) 1927 falls in this category. These are open and scrub forests, which have less than 0.4 canopy density and are least productive. Further, in terms of species diversity these forests are less diverse. Consequently, MoEF has supported many schemes, which aim at restoration of these forests to productive forests. Moreover, large tracts in arid parts, Aravalli hills, degraded slopes in Himalayas, waterlogged areas, and coastal-lands have been afforested by the respective forest departments, under externally aided projects, for restoration. It is emphasized that the main function of forest management in such forests is ecological restoration and neither production nor conservation can be the mainstay of forest management in these lands. The MoEF has envisaged restoration and protection of these forests through a

participatory JFM approach. Some issues and future directions for this programme are discussed in the succeeding section.

A collaborative arrangement between the forest department and local JFM communities, was envisaged as a bottom-up mechanism to regenerate and manage the forests of the country. Initiated with the circular of the MoEF on June 1990, JFM has been one of the most visible signs of institutional action to protect forests. The JFM programme has gradually evolved to cover 22.02 mil has in 28 states, constituting around 32% of the forest cover of the country. These areas are being managed by around 0.1 million JFM committees, representing around 22 million forest fringe communities. Various studies across the country indicate that JFM has had a positive impact on vegetation and incomes, and on the relationship between local communities and the forest department.

Yet the impressive spread and positive impacts of JFM are also accompanied by some serious concerns that hurt the programme's efficacy. A study conducted by TERI (The Energy and Resources Institute), in the states of Jharkhand and Assam, reported that many FPCs (Forest Protection Committees) were non-functional and existed only on paper. In regions where the FPCs are functional, they are dogged by issues pertaining to legal backing, tenurial security, gender and equity, decision-making powers, linkages with PRIs (Panchayati Raj Institutions), ownership of NTFPs (non-timber forest products) in scheduled areas, financial sustainability, and conflict resolution. Except in a few states like Jammu and Kashmir, Uttar Pradesh, and Uttaranchal, FPCs do not have any legal backing, which dilutes their powers vis-à-vis other socio-political institutions and seriously limits programme implementation. Also, communities have very limited rights and control over forests, which discourages them to make long-term investments. Likewise, there is a serious concern related to the participation of women and other marginalized groups in JFM. It has been reported that women constitute only 32% of FPC members. Another major concern is the financial sustainability of JFM. So far, it has been largely funded by international organizations and to a lesser extent by the government. Ravindranath *et al*., (2000) reported a difference in the rate of spread of JFM between states that received external funding and those that did not. In case of the former, almost 48% of the open forests, amounting to 17% of the total forest area, have been regenerated through JFM. On the other hand, states that did not receive international financial aid show regeneration in only 16% of the open forests, accounting for 7% of the total forest area.

Despite all these problems and pit falls, real and empowered involvement of local people in forest management can play a major role in preventing degradation of forests and improving their ecological condition. Strengthening JFM, therefore, would entail devolution of more management and decision-making powers to communities, with forest departments providing technical guidance rather than involving themselves in day-to-day decisions. Moreover, women and marginalized sections of the community need to be empowered through SHGs (self-help groups) so that they can participate in JFM. In states where no legal backing has been provided to FPCs, rules need to be framed urgently to strengthen them. Further, in the case of conflicting legal provisions such as the Panchayats (extension to the scheduled areas) Act i.e. PESA Act of 1996 and JFM guidelines in scheduled areas, rules should be amended to provide a clear direction to JFM.

Further, ensuring better livelihood opportunities for forest-dependent people is the key to sustain their participation, which also has potential to reduce the over-exploitation of forest resources. However, forestry-based interventions alone cannot fulfil the livelihood needs of the communities under consideration. Hence, initiatives to bolster their livelihood options need to be dovetailed with interventions in the agricultural sector and other income-generation activities. In the forestry sector, livelihoods can be improved significantly through NTFP-oriented forest management in areas where NTFPs are in abundance.

Various studies across India indicate that income from NTFPs constitutes a substantial amount of the annual income for forest-based communities. A study in a few villages of Jharkhand and Odisha indicated that NTFPs contributed, on average, 19% of total household annual income. Another study in forest fringe villages of Orissa reveals that income from NTFPs can be as high as 49% (Singh 1997). In such areas, forest management practices that facilitate multiple products from forests and better growth of NTFP species need to be promoted. Capacity building of the primary collectors in management of NTFPs, coupled with sustainable harvesting, is also essential to maintain a healthy stock of NTFP species. Likewise, NTFP collectors need to be organized in groups to increase their bargaining power and insulate themselves from exploitation. Improving their marketing and

management skills and developing a market information system, which gives them regular information about prevailing market stocks and prices, can strengthen these institutions.

6.6 Conclusion

It is estimated that the livelihood of 70 million tribal and 200 million non tribal rural people population is dependent on forests. The large scale dependence exerts pressure on forests, leading to their unsustainable exploitation and eventual degradation. In the past few years with the increasing concern on ecological importance of natural forests and loss of natural biodiversity, there will be a dramatic increase in the creation of plantation forests in the nation. Most of such plantations will be raised in agricultural lands and other areas located outside the traditional forestlands and will qualify as TOF (tree outside forests). India's potential for wood production has not been realized fully; skills, suitable land and investment resources from private/public sector are available but there are significant policy and regulatory bottlenecks to such investment in the forestry sector. Therefore, forest transition in India will follow the trend established in last three decades in the business as usual scenario. It has been seen that there are no socio-economic or social factors, which are reversing the trend. For estimation of future forest cover of the country, the linear regression model is developed to predict the forest cover in the business as usual scenario. National forest policy of the country rightly emphasises at attaining 33% of the geographical area under forests. Special plantation drives like Green India Mission at national level and state specific efforts such as Greening Punjab for Punjab and Hariyali Mission for Bihar are bound to change the present trend and improve the forest cover in India.

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Appendix

THE CASE STUDY OF HARYANA

Summary

The country report has clearly indicated the role of transition cluster in forest transition at national level. We argue that the various socio-economic, legal policy, technical and environmental factors have contributed towards the phenomenon of forest transition in different states and union territories of the Republic of India. However, the relative contribution of these factors varies from state to state. To corroborate these points we present a case study from Haryana, a small state located in the north central part of India. In the first part of case study, it is shown that in the period (1987–2007), there has been a net increase in the forest and tree cover in the State of Haryana. In the succeeding section detailed description of the journey of forest transition in the state of Haryana has been given.

It is important to note that the state of Haryana was carved out of the erstwhile state of Punjab in 1966, when it was trifurcated in to three states namely (a) Punjab (b) Himachal Pradesh and (c) Haryana. The new state Haryana had little forests as the majority of wooded area went in to hill state of Himachal Pradesh. Further, post independence i.e. in the period between (1947-1966) major landuse in geographic area, which become Haryana was primarily agriculture, and therefore, most development and infrastructure in the state was agriculture oriented i.e. creation of canal network. It is argued that in the period between 1966 to 1997 focused efforts were made by the state for development of industry and associated infrastructure, such as urban centers, roads, and power houses for electricity etc. A continuous improvement in per capita income further led to increased contribution of service sector and industry in the state GDP, thereby, resulting into reduced pressure on natural resources such as agriculture land. Furthermore, the development of industry and expansion of urban centres led to increase in opportunity cost of land, which further resulted in diversification of agriculture to forestry and horticulture. Moreover, availability of sustained supply of wood, simple and favourable policy regime and adequate infrastructure such as roads and energy lead to development of wood based industries. Thus, establishment of effective backward and forward linkages along the value chain of farm grown timber has resulted into significant employment generation, income to farmers, development of industry and income to government in form of taxes. This has further strengthened the forestry sector in an otherwise predominantly agriculture state and has attributed to stabilization and increase of tree cover both in the legal forests and outside forests in agro-forests and social forests.

Haryana State profile

Physiography

The State of Haryana is situated in the northern part of India and is bounded by Punjab and Himachal Pradesh to the north, and by Rajasthan to the west and south. The river Yamuna defines its eastern border with Uttarakhand and Uttar Pradesh. Haryana also surrounds Delhi on three sides, forming the northern, western and southern borders of Delhi.

Haryana is a landlocked state in northern India. It is located between 27^{o}37' to 30^{o}35' N latitude and between 74^{o}28' and 77^{o}36'E longitude. The altitude of Haryana varies between 200 m to 1200 m above sea level. The total geographical area of the state is 44,212 sq km, which is 1.4% of the geographical area of the country (Figure 1).

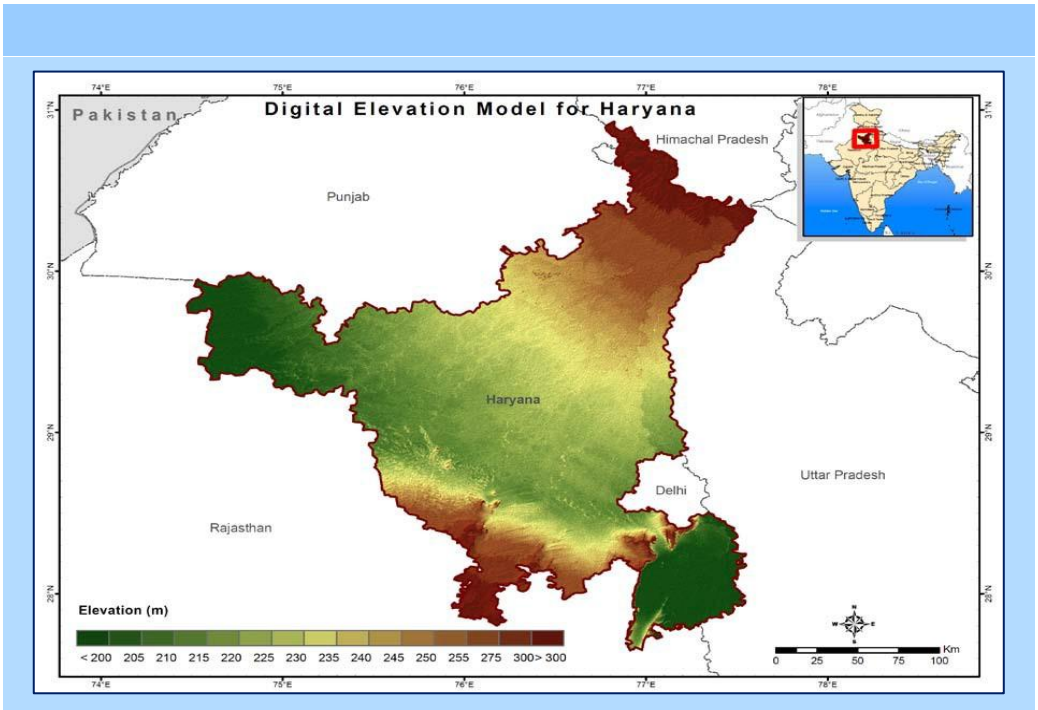

Figure 1. Geographical context of the study area.

Haryana has four main geographical features, namely the Shivalik Hills to the northeast, the Aravalli Range in the south, the Aravalli Range in the south, the Semi-desert sandy plain to the southwest and the Yamuna-Ghaggar plain forming the largest part of the state.

- Shivalik Hills: These hills are the source of the rivers like Saraswati, Ghaggar, Tangri and Markanda. Parts of Panchkula, Ambala and Yamunanagar districts.
- Aravali hills: This is a dry irregular hilly area.
- Semi-desert sandy plain: This area includes the districts of Sirsa and parts of Hissar, Mahendergarh, Fatehbad, Bhiwani and shares border with Rajasthan.
- Ghaggar Yamuna Plain: Divided in 2 parts - the higher one is called 'Bangar' and the lower 'Khadar'. This alluvium plain is made up of sand, clay, silt and hard calcareous balls like gravel known locally as kankar.

The main seasonal river of Haryana is Ghaggar. The Ghaggar rises in the outer Himalayas, between the Yamuna and the Sutlej and enters Haryana near Pinjore, Panchkula district and passes through Ambala and Hissar. The Markanda river originates from the lower Sivalik Hills and enters Haryana near Ambala. Another important tributary is the Tangri and The river Yamuna flows along its eastern boundary.

Climate

The climate of Haryana is very hot in summer and cold in winters. The hottest months are May and June and the coldest being December and January. Rainfall is varied, with the Shivalik Hills region being the wettest and the Aravali Hills region being the driest. About 80% of the rainfall occurs in the monsoon season during the months of July and September. Rainfall is varied with Shivalik Hills region being the wettest and the Aravali Hills region being the driest.

Haryana is very hot in summer and cold in winters. The temperature falls to the lowest in January and reaches upto 50^{o}C during the months of May and June. Winter months have average temperatures in the range 3^{o}C to 9^{o}C and the summer months temperatures are higher in the range of 48^{o}C to 35^{o}C.

Natural Resources

Water Resources

Haryana has limited rainfall ranging from 300 mm in the southwest to 1100 mm in the northeast in the state. The state lies in the basins of the Indus and the Yamuna Rivers and receives water from Sutlej and Yamuna Rivers and its share from the surplus water of rivers Ravi and Beas, as per various inter-state agreements.

There are no perennial rivers in Haryana, Ghaggar is the only seasonal river, which flows through the northern fringes of the state. The Ghaggar rises in the outer Himalayas, between the Yamuna and the Sutlej and enters Haryana near Pinjore, Panchkula district. Passing through Ambala and Hissar, it reaches Bikaner in Rajasthan and runs a course of 467 km before disappearing into the deserts of Rajasthan. The Markanda river which is a seasonal stream like the Ghaggar, originates from the lower Sivalik Hills and enters Haryana near Ambala. During monsoons, this stream swells into a raging torrent notorious for its devastating power. The surplus water is carried on to the Sanisa lake where the Markanda joins the Sarasvati.

The availability of water vis-à-vis demand is less, which has created an imbalance and sometimes leads to conflict. In view of the scarce availability of surface irrigation water, development of canal network assumed vital importance for the State. The share of water for Haryana is shown in Table 1.

Table 1. Share of water for Haryana in various rivers.

River	Share BCM	Availability in River BCM	Agreement
Yamuna	5.730	11.983	MOU between partner states i.e. Haryana, UP, HP, Rajasthan and Delhi (1994)
Sutlej	5.427	17.281	Bhakra Nangal Agreement (1959)
Ravi–Beas	4.724	26.409	As per the Ravi Beas Tribunal Report
Total	**15.881**	**56.173**	

Landuse

There are two agro climatic zones in the state. The north western part is suitable for Rice, Wheat, Vegetable and temperate fruits and the south western part is suitable for high quality agricultural produce, tropical fruits, exotic vegetables and herbal and medicinal plants. Figure 2 shows the agro-climatic zones of the state.

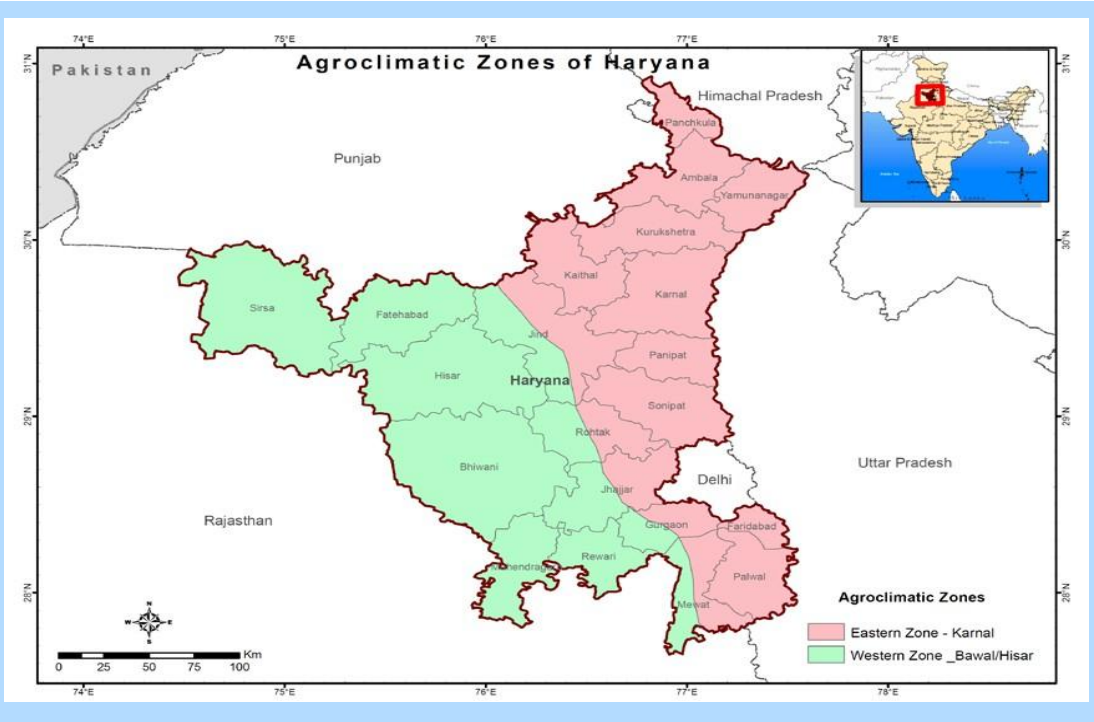

Figure 2. Agro climatic zones of Haryana.

Major land use in Haryana is agriculture (85%), Forest (2.4%), about 7.2% fallow and 5% waste land (Table 2). Figure 3 shows the land use pattern of Haryana.

Table 2. Land use land cover (LULC) statistics of Haryana (Mapping cycle wise) –Area in 100000 ha

LULC Class	2004-2005	2005-2006	2006-2007	2007-2008	2008-2009	2009-2010	2010-2011
Kharif (only)	6.76	8.48	2.62	1.15	5.91	1.22	2.6
Rabi (only)	9.23	4.22	4.43	1.86	0.96	6.34	0.02
Zaid (only)	2.49	0	0	0.1	0.15	0.71	0
Double	14.94	20.28	26.95	31.32	27.17	24.07	32.81
Plantation	0.53	0.41	0.41	0.41	0.41	0.41	0.41
Fallow	2.8	2.22	1.34	0.92	1.34	3.17	0.01
Evergreen / Semievergreen	0.01	0.01	0.01	0.01	0.01	0.01	0.01
Deciduous	0.81	0.78	0.78	0.78	0.78	0.78	0.78
Shrub / Degraded / Scrub	0.15	0.28	0.28	0.28	0.29	0.28	0.28
Littoral swamp / Mangrove/ Fresh water	0	0	0	0	0	0	0
Grassland and Grazing land	0.06	0	0	0	0	0	0
Other wasteland	2.68	2.55	2.55	2.55	2.54	2.53	2.53
Guilled / Ravines	0	0	0	0	0	0	0
Scrub land	1.97	2.19	2.19	0	2.18	2.18	2.18
Water bodies	0.53	0.49	0.35	0.35	0.19	0.19	0.27
Built up land (Urban / Rural)	1.25	2.3	2.3	2.3	2.3	2.31	2.31

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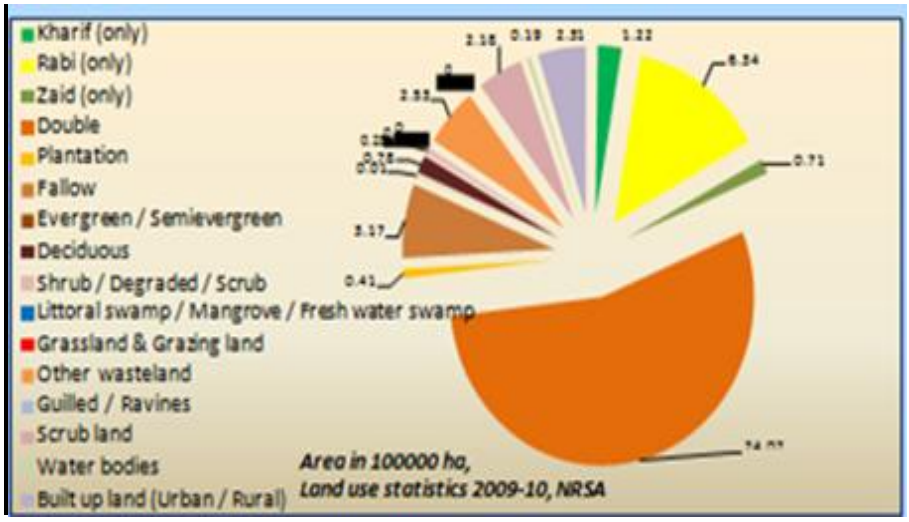
Figure 3. Land use of Haryana. (NRSA 2007-08)



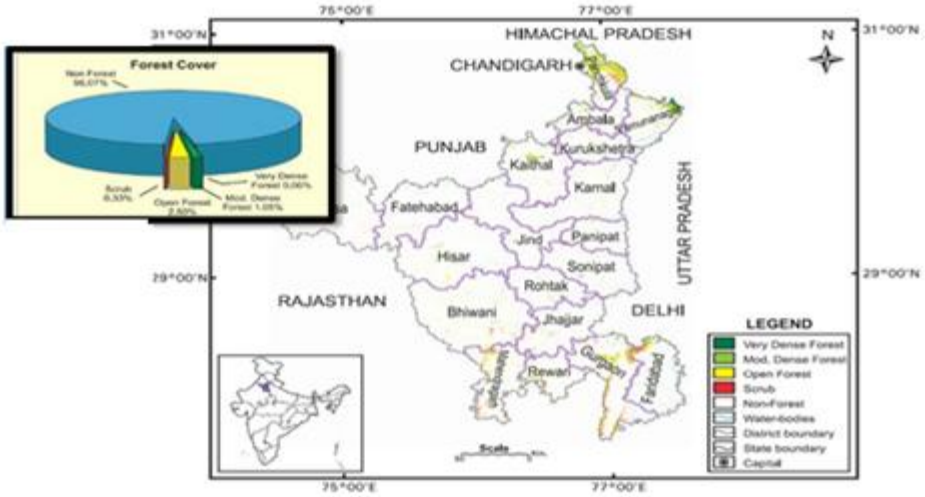


Figure 4. Forest cover map of Haryana.

Forest

The state of Haryana has a recorded forest area of 1,559 sq km which constitutes 3.53% of its geographic area. As per legal status Reserve Forest constitutes 15.97%, Protected Forests 74.28% and Unclassed Forests 9.75% (FSI 2009[6]). Most of the roadside plantations in the State have been notified as Protected Forests. The State has five different forest types as per Champion and Seth's classification system (1968), belonging to two type groups: Tropical Dry Deciduous and Subtropical Pine Forests. Forestry activities in the state are dispersed over rugged Shivalik Hills in north, Aravalli hills in south, sand dunes in west, wastelands, saline-alkaline lands and waterlogged sites in the central part of the state.

The distribution of forests along with crown densities in Haryana is given in Figure 4. Out of the total area under forests, open forests account for about 2.50% followed by moderately dense forests and very dense forests accounting for about 1.05% and 0.06%, respectively.

Forest cover dynamics in Haryana leading to Transition

Trends in change of forest and forest tree cover over time have been shown in Figure 5. Data clearly indicates that the tree and forest cover in Haryana stabilized around 500-520 km^2 between the period 1986–1998. However, a sudden increase was observed during the period 1998–2000. This is attributed to inclusion of Tree Outside Forests in the inventory by the Forest Survey of India. In the State of Forest Report of 2000, the Tree Outside Forests were inventorized for the first time. Such trees are those, which are grown by the government and or/private persons outside the notified forest areas e.g. agricultural fields, urban lands, institutional lands of government and private properties. This point is further corroborated in the discussion on the growing stock (Table 4), where it is shown that a significant volume of growing stock in Haryana is present in TOF, which is about times higher than the growing stock in the government forests. The trends in Figure 5. show that the area and Tree and Forest cover in the Haryana has stabilized around 1600 sq km between the period 2000–2012. The observed minor variations are due to higher felling of Eucalyptus and Poplar plantation in certain years due to increased demand of raw material by the wood based industries.

Thus, it can be argued that the forest transition initiated with advent of social forestry aided by ODA projects. It was further strengthened by adaptation of agroforestry, initially by the progressive/absentee farmers and subsequently by the small and marginal farmers presumably due to establishment of backward and forward linkages along the value chain of farm grown timber.

[6] FSI (2009) State of Forest Report 2009, Ministry of Environment and Forests, Government of India

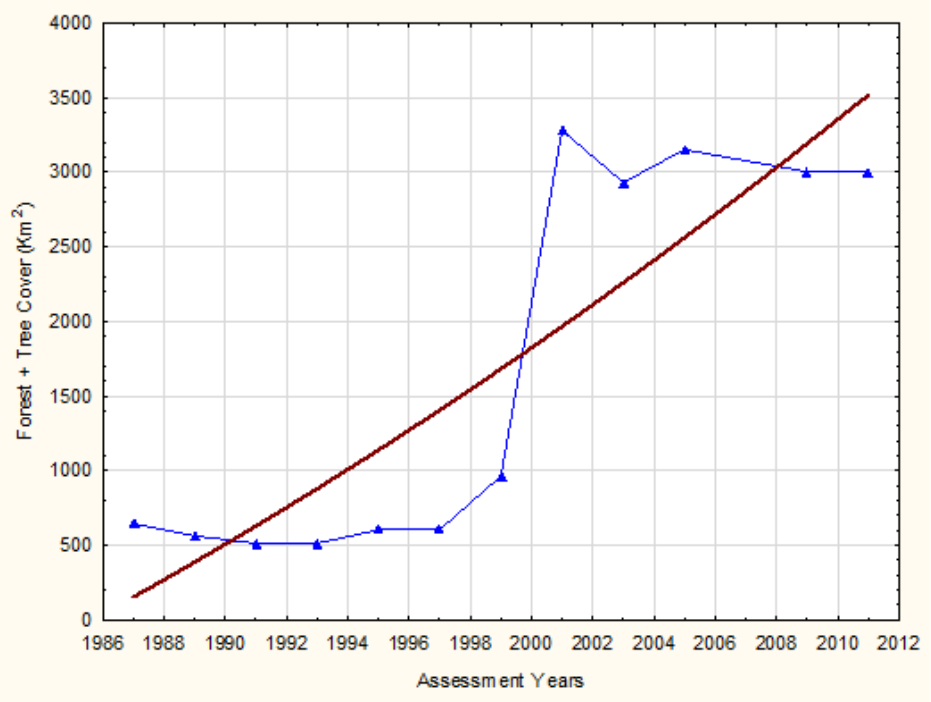


Figure 5. Trends of change in forest and tree cover in Haryana

Table 3 shows the district-wise distribution of forest cover in Haryana during 2007. Districts such as Bhiwani, Gurgaon and Panchkula have large areas under open forests.

Table 3. District-wise forest cover in 2007.

District	Geographical area	Very dense forest	Mod. dense forest	Open Forest	Total	% of G.A.	Change*	Scrub
Ambala	1,574	0	17	27	44	2.80	-2	1
Bhiwani	4,778	0	14	133	147	3.08	12	18
Faridabad	2,151	0	29	64	93	4.32	-3	20
Fatehabad	2,538	0	2	16	18	0.71	1	0
Gurgaon	2,766	0	52	177	229	8.28	-2	50
Hissar	3,983	0	13	29	42	1.05	6	1
Jhajjar	2,702	0	3	29	32	1.18	-3	2
Jind	1,834	0	5	15	20	1.09	0	0
Kaithal	2,520	0	36	36	72	2.86	-1	0
Karnal	2,317	0	6	31	37	1.60	-5	0
Kurukshetra	1,530	0	10	19	29	1.90	-5	1
Mahendragarh	1,859	0	16	54	70	3.77	1	23
Panchkula	1,268	6	151	243	400	31.55	-2	24
Panipat	898	0	4	14	18	2.00	-2	1
Rewari	1,745	0	8	43	51	2.92	0	4
Rohtak	1,582	0	3	20	23	1.45	3	0
Sirsa	4,277	0	3	53	56	1.31	2	0
Sonipat	2,122	0	4	16	20	0.94	-2	0
Yamunanagar	1,768	21	87	85	193	10.92	-8	0
Total	44,212	27	463	1,104	1,594	3.61	-10	145

Timber- Growing Tree Stock

The growing stock as reported in SFR-2009 was reported to be 4.89 mil cu m on recorded forest and 15.58 mil cu m on TOF (Table 4). The total growing stock (GS) was 20.47 mil cu m.

Table 4. Growing stock in 2010 (100000 cu m).

Forest	Growing Stock (GS) in 2007	MAI (=2*GS/30)	Growing stock (GS) in 2011
Recorded Forest	48.9	3.26	58.68
TOF	155.8	10.39	186.96
Total	204.7	13.65	245.64

Considering the average rotation age of 30 years, the mean annual increment (MAI) of Forests in Haryana comes to be 1.365 mil cu m/year. The mean annual increment of total recorded forest in Haryana comes to be 0.326 mil cu m/year. The MAI of tree outside forests (TOF) in Haryana comes to be 1.039 mil cu m/year. The period pertains to 2006-07. The growing stock of Haryana in 2010 will be 24.564 mil cu m. Total GS on Recorded Forest is 5.868 mil cu m and total GS on TOF is 18.696 mil cu m. The average tree outside the forest is13/ha.

Haryana Forest Department undertakes enumeration of Trees above 30 cm girth and the data is reported in the Annual Administrative Report. The total number of trees of various species on recorded government forests is 13.52 million with growing stock of 5.406 mil cu m which excludes trees below 30 cm girth.

Trees Outside Forests

Trees outside forests have been providing timber, fuelwood, fruit, fodder and other useful products to the rural population in Haryana, which have been deficient in natural forest resources. Though most of the revenue districts (21) in Haryana have some pockets of government forest resource, tree outside forests have been contributing in a big way in meeting the domestic timber and fuelwood needs of the people. Growing trees on farm and community land have been a common practice of the rural people since the formation of Haryana state in 1966. They have been grown in home gardens, farm boundaries, roads and canal side in the country for providing fruits, shade for keeping the cattle, as a source of fuelwood, timber and income during scarcity. Trees also provide protection to bunds of the sacred ponds. The pace of tree planting outside forest area gained momentum after launching of tree planting programmes especially under externally aided social forestry project in late 1980s. The objectives of most of these externally aided projects were to plant trees in vacant lands, private as well as public for meeting the domestic needs of the local people, soil and moisture conservation, wildlife preservation and recreation. A lot of trees have been planted in different districts outside the natural forests after the implementation of the social forestry projects. As a result of massive afforestation programme initiated by the Forest Department under different externally aided projects, central and state schemes the tree outside forest (TOF) grew to 18.696 mil cu m in 2010 (Table 5).

Table 5. Growing stock and MAI in Haryana (100000 cu m) in 2011.

Species	Forest	MAI	CNFA	MAI	Total GS	Total MAI	Rotation Age	Species wise %
Chir	1.02	0.03	0	0	1.02	0.03	60	0.4
Sal	1.7	0.03	0	0	1.7	0.03	120	0.7
Khair	4.34	0.22	0	0	4.34	0.22	40	1.8
Eucalyptus	16.62	4.16	67.91	16.98	84.54	21.13	8	34.4
Poplar	0	0	8.18	2.73	8.18	2.73	6	3.3
Kikar	8.63	1.08	3.28	0.41	11.91	1.49	16	4.8
Shisham	2.46	0.12	14.4	0.72	16.86	0.84	40	6.9
Misc	23.89	1.19	93.19	4.66	117.08	5.85	40	47.7
Total	58.68	6.83	186.96		245.64	32.33	30	100

As per the working plan and the demand for species in the market mostly Eucalyptus, Poplar, Shisham, Kikar and few miscellaneous species are harvested from forest strips and farm lands. Out of the total annual increment of 3.233 mil cu m, only 2.21 mil cu m is available as per the CEC estimate (Anonymous, 2006; 2007a, b, c, d; 2008a) report. The harvest from Government Forest land which is mainly from the production Forests (Forest Strips) was 0.151 mil cu m in 2010–11. The remaining were harvested from the Farm lands by private individuals due to ready market for Eucalyptus, Poplar Kikar, shisham and other local miscellaneous species.

Fuelwood, Fodder and Non-Timber Forest Products

Fuelwood: The household cooking energy requirement of the local communities is met from many sources. The Census of India 2001 has given detailed information regarding sources of energy in households Haryana as given in Table 6. It has been found that the 1.1 million households (31.3 %) of the total 3.53 million household use fuelwood as the source of cooking fuel. These fuelwood is collected from the local forest and farm land plantation. The fuelwood is collected by locals for sale and for self consumption.

Table 6. Sources of cooking fuel in Haryana.

	Total	%	Rural	%	Urban	%
Fuelwood	1105229	31.3	937270	38.2	167959	15.6
Crop residue	617927	17.5	583860	23.8	34067	3.2
Cow dung cake	579930	16.4	506121	20.6	73809	6.9
Coal, lignite, charcoal	3161	0.1	1548	0.1	1613	0.2
Kerosene	124558	3.5	28500	1.2	96058	8.9
LPG	1067110	30.2	376209	15.3	690901	64.3
Electricity	3372	0.1	2876	0.1	496	0
Biogas	18631	0.5	12858	0.5	5773	0.5
Any other	2436	0.1	1655	0.1	781	0.1
No cooking	7288	0.2	3566	0.1	3722	0.3
Total	3529642	100	2454463	100	1075179	100

Source: Census of India

The survey by NSSO (50 round) reveals that 80% of the rural population depends totally on fuelwood while 28% of the urban population uses wood and wood scraps for fuel. Out of the annual fuelwood consumed; 27.61 kg (32.8%) was home grown, while only 10.67 kg (12.5%) was from cash purchase, leaving 46.27 kg (54.7%) as from free collection. If we take the average annual fuelwood consumption of 1.0 tonnes per household then the fuelwood derived from the forest and trees in Haryana is approximately 1.1 million tonnes per year.

*Fodder***:** To estimate the fodder production and its value, it has been assumed that the average leaf fodder production in India is 4.9 tons of dry matter per hectare and grass production is 3 tons per hectare (Tewari 1994). Haripriya (2001) has assumed that only 2% of the leafy biomass is utilised as fodder. The estimation of fodder production from forest is estimated by estimating the total biomass produced by the woodland and forest. Though the HFD does not permit grazing in forest area, the incidence of illicit grazing is reported from all districts. It is assumed that since the Government forest and community forest lands are situated along roads, canals etc, and these are prone to illicit grazing. Thus keeping in view the large cattle population of 9.44 million in the state, about 20 % of the forest land is subject to grazing and the fodder consumed is not accounted for. The amount of land required to grow fodder grazed in the forests is computed as the ratio of total fodder grazed in forest and the average yield of fodder on agriculture land. The productivity of forest for fodder was estimated by Haripriya at 4.9 tonnes/ha. The total fodder produced in Haryana from Forest resource for these livestock is estimated to be: 152300 ha *0.2*4.9 t/ha = 0.15 million tonnes.

Non Timber Forest Product (NTFP): Trees on CNFA are traditionally grown for timber and as cash crops (Eucalyprus and Poplar, Shisham, Prosopis Cineraria and fruit plants). The block forests however produce NTFP such as bhabhar grass, fruits, bamboo, cane and rattans etc. The NTFP is collected by various JFM committees. The residents however are allowed to collect NTFP for their needs and this is not recorded. This makes the task of computing the value of NTFP in the state difficult. In order to take into account the unrecorded production of these MFP, the NSO consider the value of NTFP to be 10 times the value of recorded production. The value of NTFP recorded by HFD is tabulated. During 2009-10 NTFP worth Rs.1.44 million was recorded by HFD. There is no record of medicinal plant collection. The unrecorded MFP is taken to be 10 times at Rs 14.4 million.

Area under Wastelands in Haryana

Wastelands in India include degraded grasslands, forests and several other land types, and are classified into 28 categories by the National Remote Sensing Agency (NRSA). The total area under wastelands in Haryana is estimated to be about 3,266 sq. km. accounting for about 7% of the total geographic area. These land categories could be potentially considered for different sub-missions of the Greening India Mission. Table 7 presents the district-wise area under wastelands in Haryana.

Table 7. District-wise area under wastelands in Haryana.

Districts	Wastelands
Ambala	58.41
Bhiwani	287.42
Faridabad	318.35
Fatehabad	94.66
Gurgaon	414.5
Hissar	222.01
Jhajjar	130.9
Jind	119.82
Karnal	80.19
Kaithal	60.4
Kurukshetra	23.67
Mahendragarh	281.36
Panchkula	411.65
Panipat	76.95
Rewari	132.83
Rohtak	109.2
Sirsa	115.88
Sonepat	163.63
Yamunanagar	164.61
Total	**3266.45**

Biodiversity

The state has about 33000 ha under protected area network, which consists of 2 national parks, 8 wildlife sanctuaries and 2 conservation reserves. Over 500 bird species have been recorded in the State, which is almost 40% of total bird species in the country.

Thorny, dry, deciduous forest and thorny shrubs can be found all over the state. During the monsoon, a carpet of grass covers the hills. Mulberry, eucalyptus, pine, kikar, shisham and babul are some of the trees found here. The species of fauna found in the state of Haryana include black buck, nilgai, panther, fox, mongoose, jackal and wild dog.

Although Haryana is deficient in natural forests but it has vast climatic diversity, which makes it suitable for variety of wildlife particularly local and migratory bird species. Out of nearly 1250 bird species recorded in Indian subcontinent approximately 500 species of birds are found in Haryana. Various types of ducks and geese such as Graylag Goose, Bar-headed Goose, Brahminy Duck, Northern Pintail, Common Shelduck, Mallard, Gadwall, Eurasian Wigeon, Blue winged Teal, Shoveller, Common Pochard, Ferruginous Duck and Tufted Duck can be seen at the Ghaggar and tanks during winter.

There are three mini zoos in Haryana at Pipli (Kurukshetra), Rohtak and Bhiwani. There is also one Deer Park in Hisar district located on Dhansu road. All the above zoos and deer park have wild animals and birds to educate the public particularly school children and farmers about habits and habitat of wildlife Haryana forest department in collaboration with Bombay Natural History Society has established a Vulture Conservation Breeding Centre at Pinjore.

Agriculture and Horticulture

Haryana is primarily an agricultural state. Haryana is self-sufficient in food production and the second largest contributor to India's central pool of food grains. The main crops of Haryana are Wheat, Rice, Sugarcane, Cotton, Oilseeds, Gram, Barley, Pearl Millet, Green Gram etc. There are two main types of crops in Haryana: Rabi and Kharif. The major Kharif crops of Haryana are rice, jowar, bajra, maize, cotton, Green Gram and sugarcane. The major Rabi crops are wheat, gram, rapeseed and mustard. About 86% of the area of the State is arable, and of that 96% is cultivated and about 84% of the area is irrigated, through tube wells and an extensive system of canals.

Agriculture contributes 17% of the state's GDP and employs 65% of the total workforce. The net sown area is 85% of the total geographic area as compared to the national average of 46%, the gross cropped area is 6.5 mil ha with a cropping intensity of 180%. Small and marginal farmers account for 60% of the total land holding. The average landholding in the state is 2.13 ha. Irrigation covers 84% of the net sown area and the remaining 16% is rainfed.

Horticulture crops cover 4.9% of the gross cropped area, corresponding to 0.247 mil ha and with an annual production of horticulture crops in the state is 3.11 mil tonnes. The total area under fruits (mango, guava and citrus) was 24,071 ha with a total production of 0.247 mil MT during 2004- 05. The total area under vegetable (potatoes, cauliflower, cucurbits, carrots, tomatoes, radish and onions) was 2.08 mil ha with a total production of 2.767 million. Flower (marigold, rose, tuberose and gladiolus) cultivation is about 4,810 ha during 2004-05. Similarly, mushroom cultivation picked up during 1989-90 and by the end of 2004-05, production was to the extent of 6,163 MT and the state is now the highest producer of mushroom in the country. Cultivation of aromatic plants is also increasing due to higher returns and by the end of 2004-05 extended to 3,666 ha.

Government initiatives, which lead to Forest Transition in the state of Haryana

Plantation activity

In order to increase the forest and tree cover, the Haryana Forest Department (HFD) has undertaken a massive afforestation programme on Government lands, Institutional Lands, Panchayat lands, Common lands and wastelands. The area afforested annually under various programmes in Haryana is 21,000 ha. Saplings are also distributed to farmers, other government departments, institutions, schools, village panchayats etc. for planting in their lands. Due to large scale afforestation initiated by the Forest Department on non-forest land i.e community lands, panchayat lands, institutional lands, private wastelands etc. as well as adoption of tree farming by farmers on their holding, the tree cover of the state has increased to 7.13% as per the state of forest report published by the Forest Survey of India in 2005. The HFD had a target to achieve 10% of forest and tree cover by 2010.

Participatory forest management

The Government of Haryana had initiated Joint Forest Management in the state in the late seventies, much before it became a policy of the Ministry of Environment and Forests. The model developed in Sukhomajri village of Haryana, through participation of people in protecting forests, who were given rights over water and forest produce in return, is now world famous. Practice of participatory approach in forestry operations and forest management has continued in the state. Village level forest committees (VFC) have been constituted in over 817 villages under National Afforestation Programme (NAP). Besides this, 1135 VFCs have also been constituted under Japan International Cooperation Agency (JICA) funded Integrated Natural Resource Management Project and Haryana Community Forestry Project (HCFP). In all these programmes/projects, there is a special thrust to empower women by providing them assistance in forming self-help groups and training them to start some income generation activity to improve their economic well being. However, it has been increasingly felt that it will be virtually impossible to prevent degradation of forests in Haryana without the active involvement of the local people in their protection and maintenance. (See Box)

Formation of a state policy

The Haryana Government has adopted a State Forest Policy–2006 which targets at the following:

- Afforestation for maintenance of environmental stability and restoration of ecological balance affected by serious depletion of forests, woodlands and water.
- Conserving bio-diversity in natural forests of the State, containing genetic resource base of the rare species.
- Development and protection of habitat in protected areas and conservation and development of water resources in forests.
- Checking the denudation of forests.
- Increasing the productivity of forests to meet the essential needs of people on a sustainable basis by using genetically superior seedlings and better management practices.
- Checking soil erosion in the catchments of the rivers, rivulets and reservoirs for soil and water conservation.
- Checking the extension of sand dunes in the semi-arid areas of the State to save the infrastructure in that region.
- Reclamation of salt affected areas irrespective of the ownership by afforestation techniques.
- Increasing tree cover in the State through afforestation and social forestry programmes on wastelands.
- Production of industrial wood from non-forest lands by promoting agro-forestry.
- Encouraging efficient utilization of forest produce and also promoting wood substitutes.
- Creating a massive people's movement with the involvement of women and school children, for achieving these objectives and to minimize pressure on natural forests.
- Institution building at village level for Joint Forest Management and participation in forestry activities.
- Formation of self help groups, particularly of women for their empowerment through forestry based and other income generation activities.
- Conservation and development of medicinal plants and development of eco-tourism.
- Development of timber markets for stabilizing the prices of forest produce.

Sukhomajri Model Village

In the early 1980s, the people of Sukhomajri village in Shivalik range of the Himalaya in Haryana's Ambala district earned nation-wide acclaim for the way in which they had utilized their forests and water to their benefit. An estimated 5,000 khair trees had matured in the 400 ha Sukhomajri forest. At an average price of Rs 1,000 per quintal of heartwood, these trees could reap more than Rs 5 million in timber alone. One quintal of khair heartwood yields upto 6 kg of *katha* - an extract used in medicine, pan and natural dyes - that sells at Rs 500 per kg, adding upto Rs 10 million to the nation's kitty. About 5,000 trees would mature in the forest every year.

It was the result of a joint forest management programme introduced in 1976 that Sukhomajri prospered. For the rest of the country, Sukhomajri became a model of community participatory management. The project began in the mid-1970s out of concern for the silting-up Sukhna lake near Chandigarh, which had lost nearly 70% of its water storage. P.R. Mishra chose Sukhomajri, which is in the lake's catchment area, and constructed four check dams and planted trees.

Initially, Mishra's attempts at regenerating the local environment failed because the villagers had little regard for Chandigarh's water concerns. A change in attitude occurred after 1977 when four tanks built successively created an increased storage capacity and increased crop yield rates from 6.83 quintals per ha in 1977 to 14.32 in 1986. "Water acted as the catalyst in the transformation. In return for water, the villagers were ready to protect the watershed," says Mishra. The income that began to come from cutting *bhabbar* grass and harvesting mungri or forage grass started to change the face of the village.

Prosperity became a by-word. The 80 households in the village replaced their thatch-and-mud dwellings with brick-and-cement houses and about 40 of them owned television sets. With growing prosperity, Sukhomajri villagers were becoming increasingly conscious of economic self-reliance in the creation of community assets. They stopped auctioning *bhabbar* grass, which their Hill Resource Management Society (HRMS), set up in 1980, leased from the forest department, to contractors.

Just about five years after the setting up of the HRMS in 1980, the annual household income increased to Rs 3,000.

Sukhomajri was one of the few villages to be taxed on income from natural regeneration. A 1989 amendment in the Income Tax Act brought registered societies such as HRMS within its purview. HRMS was liable to pay 15 per cent income tax, but it took the initiative to have such societies exempted the same year. However, the society continued to pay 10 per cent sales tax on *bhabbar,* which was imposed in 1993 with retrospective effect from 1991. They also had to pay a toll on *bhabbar* taken to the paper mills in Himachal Pradesh at the rate of Rs 100 per carriage.

However, *bhabbar* turned out to be a point of conflict in later years. In 1995, the forest department arbitrarily divided the 400 ha hill tract between Sukhomajri and Dhamala, a neighbouring village, disrupting a unique resource management programme. Till the forest department intervened, the two villages used to share forest produce on the basis of social fencing (self-restraint in produce use). They shared grazing rights in the same forest area.

Thus, the two villages began to compete for fodder. The division of the forest also threatened social co-existence. Dhamala village, consisting of upper caste Jats, were given a portion more saturated with *bhabbar,* the division placing them in a position to reap most of the bhabbar bonanza. Sukhomajri villagers, consisting of lower caste Gujjars, were no longer allowed to collect fodder from the Dhamala section. This led to tensions and a worsening conflict.

Forestry and Wild Life preservation Programmes

Various Forestry schemes implemented in Haryana in 2009–10 by various wings are:

- Externally Aided Project: Integrated Natural Resource Management and Poverty Reduction Project
- State Schemes
  - ✓ Development of Agro-Forestry Clonal and Non-Clonal
  - ✓ Special Component Plan for Scheduled Caste
  - ✓ Forestry Activity in SC Villages
  - ✓ Social & Farm Forestry Scheme for SC
  - ✓ Green Belt in Urban Areas
  - ✓ Revitalization of Institutions in Arravali Hills
  - ✓ Rehabilitation of Degraded Forests
  - ✓ Strip Plantation on Govt. Land
  - ✓ Compensatory Afforestation
  - ✓ Desert Control

  - ✓ Schemes Without Plantation Targets
- Centrally Sponsored Schemes on Sharing Basis
  - ✓ Integrated Forest Protection
  - ✓ Development of National Parks & Sanctuaries
- Wild Life Preservation
  - ✓ Protection of Wild Life
  - ✓ Extension of Zoo and Deer Parks

Tree Improvement schemes (Plantation)

Plantation schemes have been formulated for different agro climate zones and plantation targets are allotted to different forest divisions.

- Development of Agro-Forestry Clonal and Non-Clonal
- Special Component Plan for Schedule Castes
- Forestry Activity in SC Villages
- Social & Farm Forestry Scheme for SC
- Green Belt in Urban Areas
- Revitalization of Institutions in Aravali Hills
- Rehabilitation of Degraded Forests
- Strip Plantation on Govt. Land
- Compensatory Afforestation
- Desert Control

Soil and Moisture Conservation

Soil conservation on watershed basis including cho-training are implemented in forest area. Check dams, water harvesting dams, percolation dams and village ponds are developed for soil and water conservation. Massive plantation is done on the catchment areas and around the pond and water harvesting structures.

Biodiversity Conservation

28 herbal parks have been developed after the names of medicinal plants in each districts of Haryana from 2005–06 to 2009–10. Main objectives of these gardens and parks are; conservation of medicinal plants for study and research; developing a gene-pool of indigenous and exotic plant species for conservation and propagation purposes; popularization of medicinal and aromatic plants cultivation and use in the area by local peoples; resource base establishment of sustainable medicinal plants.

Wild Life management

The wildlife is managed by separate wing headed by the Additional Principal Chief Conservator of Forests-cum-Chief Wild Life Warden Haryana at Van Bhawan Panchkula. At district level Divisional Wild Life officer is responsible for wild life protection and management of Wild Life Sanctuaries (WLS), National Parks (NP) and Conservation Reserves (CR) and report to Conservator of Forests(Wild life) Panchkula and Gurgaon (Table 20).

Table 20. National Parks in Haryana.

Name	Year of establishment	Area in Acre	District
Sultanpur National Park	1991	352.17	Gurgaon
Kalesar National Park	2003	11570	Y/Nagar
Wildlife sanctuaries			
Bhindawas Wildlife Sanctuary	1986	1016.94	Rohtak
Chilchhila Wildlife Sanctuary	1986	71.45	Kaithal
Nahar Wildlife Sanctuary	1987	522.25	Rewari
BirShikargah Wildlife Sanctuary	1987	1896	Ranchkula
Abubshehar Wildlife Sanctuary	1987	28492	Sirsa
Khaparwas Wildlife Sanctuary	1991	204.36	Jhajjar
Kalesar Wildlife Sanctuary	1992/1996	13431.65	Y/Nagar
Morni Hills KholHai Rattan	2004	12065.79	Panchkula
Total Area of Wildlife Sanctuaries		57700.44	
Conservation reserve			
Saraswati, Kaithal	2007	11003	Kaithal
Bir Bara Van, Jind	2007	1036	Jind
Total Area of Mini Zoos		12039	
Mini zoos			
Mini Zoo, Pipli	1085–86	8	Kurukshetra
Mini Zoo, Rohtak	1985–86	14	Rohtak
Mini Zoo, Bhiwani	1982–83	51	Bhiwani
Total Area of Mini Zoos		73	
Deer parks and breeding centres			
Deer Park, Hisar	1985	Hisar	
Black Buck Breeding Centre, Pipli	1985–86	Kurukshetra	
Chinkara Breeding Centre, Kairu	1985–86	Bhiwani	
Crocodile Breeding Centre, BhaurSaidan	1981–82	Kurukshetra	
Pheasant Breeding Centre, Morni	1992–93	Panchkula	
Pheasant Berwala, Panchkula	2006	Panchkula	

Based on these postulates of the state forest policies, following programmes have been initiated.

- Plantation and Farm Forestry
  - ✓ Plantation of 50 million seedlings in the state every year,
  - ✓ Massive plantation on Government Forest land
  - ✓ Revival and Strengthening of social and Community forestry activities by involving local community and various stakeholders.
  - ✓ Supply of quality seedlings of valuable species and grafted fruit plants free of cost to farmers to promote agro-forestry
- Soil and Moisture Conservation
- Soil and moisture conservation activities by constructing check dams, water harvesting dams and other suitable structures on watershed basis,
- Biodiversity conservation
  - ✓ Plantation of TRIVENI (three species of Bargad, Peepal and Neem etc.) in villages and preservation and development of SACRED TREE GROOVE in the village and Tree grooves of important and ecologically vulnerable species for biodiversity conservation,
  - ✓ Development and maintenance of Biodiversity Conservation Parks (Herbal Gardens) in each district to preserve and cultivate plants of medicinal value and impart education and create awareness among local community.
- Wild Life Preservation
  - ✓ Development of National Parks (NP), Wild Life Sanctuaries (WLS) and Conservation

Reserves, Mini Zoo, Wild Animal Breeding Centers, Wild Animal Rescue Centre and Elephant Habitat Development.

- Capacity Building
  - ✓ Formation of Village Forest Committee (VFC) and Hill Resource Management Committee (HRMS)
  - ✓ Formation of Self Help Group (SHG) and Federation of SHG of poor women and imparting training for self employment.
  - ✓ In house training of field staffs of Forest Department
- Clean Development mechanism (CDM) Project-Sirsa
- Based on the standardised mechanism, the PDD for 'Small Scale Cooperative Afforestation CDM Pilot Project Activity on private lands affected by shifting Sand Dunes in Sirsa, Haryana' was submitted to the National CDM Authority, MoEF. The national CDM Authority considered the PDD on 17th March 2007 and approved and communicated to the Society on 9th April 2008 has been approved as the first CDM project. The CDM project was funded by the Forest Department, Haryana.
  - ✓ Execution of CDM project started in April 2008 and seedling growing started. Plantation work started in June 2008. The CDM project is funded by the Forest Department, Haryana.

Social Forestry

Haryana state which was carved out of Punjab state in 1966, was deficient in forest resources at the time of its formation. There was a feeling in the state government that forest department should be merged with the agriculture department as there was not much scope for this department to function independently. To face this scenario, the visionary leadership of this department chalked out a strategy not only for the protection of natural forests but also for the expansion of forestry activities outside RFAs. Consequently, land along railway lines, roads, and canals, was declared as protected forests and massive afforestation was done on such land for meeting the demand of fuel, fodder, timber & raw material and for maintaining the ecological balance. As it was not possible to increase the forest areas in the state due to its high productive tract, so department made efforts to increase FTC on common lands, institution lands and farm lands.

Initially, the activities of the department were confined to selling plants to the farmers and advising them on management of the plantations. The advisory role did not yield result because the farmers did not have time to buy plants, transport and plant them. But the real breakthrough was achieved in early seventies, when a Crash Scheme for Rural Employment was implemented. Under this scheme, the department took over the entire responsibility and planted lands free of cost. Farm Forestry Programme was also undertaken under Integrated Rural Development Programme (IRDP) for planting the farmlands of small/marginal farmers only. Under Extension Forestry Scheme, the department planted compact farmlands which served as demonstration plots. To improve the returns from farmlands, the progressive farmers also developed many innovative agro-forestry models, which use fast growing species i.e. eucalyptus, poplar, etc. for production of timber and fiber. To consolidate social forestry, Haryana forest department successfully implemented certain externally aided projects, whose details have been elaborated in the next paragraph.

Implementation of Externally-aided Projects

Subsequently, World Bank-aided Social Forestry Project (1982–1991) boosted plantation activities on panchayat/community/institutional lands and farmlands in the state. During this period, plantations were raised on 103 692 hectare of government lands, common lands, institutional lands and farm lands. European Union-aided Aravalli Project was implemented in southern region of the state to rehabilitate the degraded Aravalli hills during 1992–1999 and 38 000 ha of common lands in 300 villages, were planted. The European Union-aided Haryana Community Forestry Project was

implemented in creating plantations on common land, institutional lands and farm lands in nine districts of the state during 1998–2008 and plantations on 27 380 ha land spread over 330 villages were created. The JICA aided Integrated Natural Resource Development and Poverty Reduction Project, which was implemented during 2004–11, created plantations on 48 850 ha which included forest lands, common lands, institutional lands and farmlands.

All projects helped in creating forest resources on non-forest lands and contributed significantly in increasing the wood production and FTC of the state. The impact of social forestry in this state has been expressed with the remarks "d*ue to increased focus on social forestry in Haryana, the standing volume of wood in non-forest areas is nearly 7 times that of the estimated volume in forest areas. It is hoped that this may be a harbinger of production of wood from non-forest areas in coming years"* (Anonymous 1998).

Present Status of Social Forestry

Presently, the plantations on non-forest lands in Haryana state, are generally carried out under state schemes, while a small portion of FDA scheme of MOEF Government of India is also implemented on non-forest lands. In the 12th Five year Plan, Green India Mission has been launched under which component of agro-forestry and urban forestry has also been kept for non-forest lands. The details of the scheme of non-forest lands of the Haryana state are as follows.

Table 21. Schemes for panting of non-forest lands.

Scheme	Norms (Rs)/Plant	Plants Planted in 2011–12	Remarks
Development of Agro-forestry clonal & non-clonal:	30.00	500 000	Planted and managed for three years.
Panchayat/Institution lands	28.50	650 000	
a) Village wood lot (1000/ha)	24.00	1 286 000	-------same----------
b) Sand dune fixation (1000/ha)	75.00	300 000	Free planting for small/marginal farmers
Farmlands			
c) Farm Forestry (1000/ha)			All farmers
d) Planting of clonal Eucalyptus in water-logged areas (200/ha)			
Social & Farm Forestry Plantation on farm lands (1000/ha)	22.00	2 100 000	Free planting for small/marginal farmers
Extension forestry on farm lands along state/National Highways to check pollution:	204.82	149 400	All farmers
	54.55	264 000	-----same-----
a) Tall plantation (166/Rkm)	64.00	315 000	----same----
b) Pit plantation (330/Rkm)			
c) Ridge plantation (500/Rkm)			
Distribution of Plants	3.00	27 000 000	All farmers
Sale of Plants			
a) Poplar	10.00	3 623 000	All farmers
b) Clonal Eucalypts	8.00	1 000 000	----same----
Total		**37 187 400**	

(Source: Haryana Forest Department)

The planting under farm forestry is carried free of cost for small and marginal farmers, while it is done free of cost for all category of the farmers in schemes like waterlogged areas and pollution control along highways. The entire income from harvesting of plantations goes to the owner of land. About 75% of the targets under non forest lands are achieved through free distribution of plants, while poplar and clonal Eucalyptus plants are sold to the farmers. The survival of plants under free planting is about 70%, clonal plants is about 80-90% and free distribution is about 25-30%. Hence efforts should be made to improve the survival of plants under free distribution of plants.

The details of plantations carried out in the state in last five years, are given in Table 22.

Table 22. Details of plantations.

Year	Forest Land	Common/Instt. Land	Farm/Private Land	Total
2006-07	14239492	469088	32196420	46905000
2007-08	14834629	2096659	28068712	45000000
2008-09	16556355	2887241	32758404	52202000
2009-10	13288849	2204674	35293477	50787000
2010-11	17004026	1056370	32609572	50669968
Total	7,59,23,351	87,14,032	16,09,26,585	24,55,63,968
Average (100000)	**152**	**17**	**322**	**491**
Percentage	*31*	*4*	*65*	*100*

(Source: Haryana Forest Department)

The average annual planting carried out in Haryana state during last 5 years is 49.1 million plants, out of which 69% of the planting has been carried out in non-forest lands (farm-lands – 65%, panchayat lands – 4%) and 31% of the planting in forest lands.

Contribution of Agro-Forestry

The agro-forestry makes substantial direct or indirect contribution to the development of forestry sector in several ways. These are enumerated and briefly described below:

1. Increase in Forest & Tree Cover

The estimated distribution of FTC of Haryana state in 2006, was as follows.

Table 23. Estimated Contribution in FTC of Haryana State.

Type	Contribution (%)	Remarks
Block Forests	1.7	Whole area
Strip Forests	0.7	40% of area
Farmland Plantations	3.2	0.72 NFL plantation
Community/Institutional Land Plantations	1.2	0.28 NFL plantation
Total	**6.8**	

NFL means non-forest land

From the above table, it is clear that the area under TOF (as defined by FSI) in Haryana state was about 5.1% of the geographical area, which includes strip forests also. As the strip forests are under the management of forest department in Haryana state, hence the actual TOF on non-forest lands in the state is 4.4% of its geographical, as compared to 2.4% contribution of forest lands. The estimated contribution of agro-forestry in FTC of the Haryana state is 3.2% of the geographical area.

2. Production of Timber

The main purpose of social forestry activities in Haryana state was to produce wood from non-forest lands. The wood production of the Haryana state has increased continuously due to the increasing social forestry activities. The estimated wood production from forests and non-forest lands in Haryana state in different years was as follows.

Table 24. Details of wood production in Haryana State.

S. No.	Year	Wood Production (100000 cu m)
1	1985–86	13.0
2	1993–94	16.0
3	2006–07	22.1

(Srivastava *et al*. 2009)

The average annual yield from forests is about 0.15 mil cu m, so the annual yield from non-forest lands is about 2.06 mil cu m (14 times of yield from forests) (Srivastava *et al*. 2009). The wood production from farm lands of Haryana state has been estimated in table 5.

Table 25. Production of timber (100000 cu m) from farmlands.

Timber Production	Euc.	Poplar	SRS	LRS	Total	Remarks
Total (R1)	9.6	3.8	6.5	2.2	22.1	Anonymous, 2007
State Forests (R2)	1.0	0.0	0.4	0.1	1.5	HFD
Panchayat/Community Lands (R3)	1.5	0.0	2.2	0.7	4.4	Anonymous, 2006
Farm Lands (R4=R1-R2-R3)	7.1	3.8	3.9	1.4	16.2	
Rate of wood (R5) Rs/cum	2851	3830	5222	5222		HFD (2009-10)
Value of Wood (Rs in 10 million) (R6=R4xR5)	202.4	145.5	203.7	73.1	624.7	

The average annual production of wood from farmlands is about 1.6 mil cu m worth of about Rs. 6250 million, which is about 75% of total wood production of the Haryana state. It clearly shows that agro-forestry is the main instrument, which is helping the state in meeting the demand of wood-based industries.

3. Development of wood -based industries

Easy and sustained availability of large quantities of farm grown wood played a major role in the development and expansion of wood-based industries in the Haryana state. Yamunanagar (Haryana) has developed as the biggest market for farm-grown wood in the country. Wood to this market comes from Haryana and the adjoining states of Uttarakhand, U.P. and Punjab etc. In this market, the total annual arrival of wood from Haryana is estimated to be about 0.932 mil tonnes while 1.6.89 mil tonnes comes from adjoining states (Srivastava *et al*. 2009).

The city now has a heavy concentration of wood-based industries, such as plywood, veneer and saw mills. Led by Yamunanagar, the growth of wood-based industries in Haryana is as follows.

Year	Plywood & Veneer	Sawmills & Others	Total
1990	55	1,109	1,164
1994	117	1,681	1,798
2006	679	4,407	5,086

(Srivastava *et al*. 2009)

The value of wood products manufactured from this wood is about Rs 18000 million which generates a lot of employment for labourers and tax revenue for the government. (Srivastava *et al*. 2009).

4. Income to Tree Growers

Under rain-fed conditions, the tree crops are safer as compared to agricultural crops, while under irrigated conditions the profitability of agro-forestry models is higher as compared to agricultural crops. The farmers are generally getting Rs. 30 000–40 000 per acre annually from agricultural crops while clonal eucalypts crops are generating annual income of Rs. 50 000 to 60 000 per acre and about Rs. 80 000/acre/year from poplar. The farmers have adopted agroforestry as a mean to earn safer and higher income as compared to agricultural crops.

5. Employment Generation

Agro-forestry creates employment opportunities for the labourers. The labourers get employment through raising nurseries, planting and maintaining plantations, harvesting operations, transportation and trading of forest produce. The employment generation also occurs in wood-based industries where this forest produce is used as raw material. A long chain of employment activities is created due to popularization of agro-forestry. The agroforestry sector through wood based industries and its supporting units is able to provide employment opportunities to over 100000 people; thus able to generate over 35 million mandays and multiplying it with the minimum wage rate of Rs. 104 per day show that this sector is able to generate wage income to the tune of Rs. 3000 million every year in and around Yamunanagar (Bisht *et al*. 2008).

6. Environment Conservation

Agro-forestry is playing a major role in environment conservation in the rural areas. Together with other tree plantations in non-forest lands in forest deficient states, these are contributing substantially towards pollution control and provide many other environmental benefits. The contribution of agro-forestry in carbon sequestration has been estimated as 29.568 mil tonnes of CO_2 or 8.0614 mil tonnes of C valued about Rs. 1000–3000 million in Haryana state (Anonymous 2011). Hence, agro-forestry can play a major role in carbon sequestration and has a large potential for getting carbon credits.

Perspective of Forest Transition in Haryana

Greening India Mission

The Government of India has formulated a large Greening India Mission aimed at mitigation and adaptation to climate change in the forest sector. Greening is meant to enhance ecosystem services such as carbon sequestration and storage, biodiversity conservation and provision of biomass and NTFPs. The Mission aims at responding to climate change by combination of adaptation and mitigation measures which would aim at;

- Enhancing carbon sinks in sustainably managed forests and other ecosystems
- Adaptation of vulnerable species/ecosystems to the changing climate and
- Adaptation of forest dependent communities.

Thus under the State Action Plan, both adaptation and mitigation projects could be proposed for addressing climate change impacts on forest ecosystems as well as to mitigate the climate change through enhancing the carbon sinks.

Adaptation programme under the Greening India Mission

It was shown earlier that forests in Haryana are vulnerable to climate change risks and any afforestation/reforestation programme to be implemented under the Greening India Mission could also be vulnerable to climate change impacts. Thus there is a need to incorporate adaptation measures. There are no scientific studies to recommend specific adaptation measures suitable for different vulnerable forest types and regions. There is a need for conducting preliminary studies to identify and prioritize landscapes for implementing the adaptation measures. Potential projects under the adaptation programme could be adoption of short rotation species, sustainable harvesting of timber and non-timber products, promoting agro-forestry and Social Forestry (increasing biomass and creating carbon sink) with multiple species and incorporation of anticipatory planting of species.

Mitigation projects under the Greening India Mission

Forest sector provides a large opportunity for mitigation of climate change, in particular through reducing CO2 emissions by reducing deforestation and forest degradation as well as increasing carbon sinks in the existing forests, and creating new sinks in degraded lands through afforestation. The consequences of climate change will need to be countered by various mitigation measures. Some of the potential climate change related measures considered by Haryana are as follows:

- Plantation and tree resource as carbon sink and biodiversity conservation and employment generation
    - Plantation of degraded forest land.
    - Plantation on the village community and panchayat lands.
    - Agro Forestry plantation on agricultural field, farm boundary and in block.
    - Plantation of clonal plants of suitable agro forestry species.
    - Bio drainage plantation in water logged areas.
    - Plantation in Urban and Peri-Urban areas on waste land, parks, industrial areas and urban housing colonies for enhancing the tree cover.
    - Tree grove plantation in schools, religious places, village ponds and bus queue shelters.
- Soil and Moisture Conservation
    - Check dams
    - Gully plugging
    - Small and big water harvesting structures
    - Water collection ditches in plane and staggered trenches on hill slopes
    - Rain water harvesting in urban areas and forests
    - Digging and renovation of village ponds
- Wild Life Management
    - Development and maintenance of NP, WLS, Mini Zoo and Breeding Centers.
- Research
    - Identification of new drought resistant, pest resistant and frost resistant species for farm forestry with high yield with less water.
    - Modern plantation techniques.
    - Modern logging techniques and tool
    - Establishment of modern nurseries and High tech Mist Chamber and laboratory.
- Capacity Building and awareness
    - Establishment and training of SHG, VFC and HRMS
    - Training of field staffs in modern forestry, forest and general management, Law, social science and humanity.
    - Publicity of Government schemes and extension activities by conducting field visits of various stake holders.
    - Publicity and extension by audio visual and print media.

The GIM has identified several sub-missions and several activities or interventions under these sub-missions. The proposed mitigation programmes and projects under the GIM are presented in Table 9, along with area proposed and the investment cost required.

Sub Mission 1: Enhancing quality of forest cover and improving ecosystem services

- 20 000 ha of moderately dense forests show increased cover and density
- 100 000 ha of degraded forests are regenerated/afforested and sustainably managed
- 20 000 ha of degraded scrub/grasslands are restored and put under sustainable multiple uses.

Sub-mission 3: Enhancing tree cover in Urban and Peri-urban areas

- 10 000 ha of urban forest lands and institutional lands are under tree cover

Sub-mission 4: Agro-forestry and Social Forestry (increasing biomass and creating carbon sink)

- 100 000 ha of Community and Panchayat land are under tree cover
- 1 000 000 ha of degraded agricultural lands and fallows are brought under agro-forestry
- 10 000 ha of corridor areas, critical to wildlife migration are secured

The area and investment costs as provided by the State Forest Department of Haryana are used to estimate the mitigation potential and investment required to implement the different missions (Table 30). Carbon sequestration rates as provided by the Greening India Mission document are used for estimating the mitigation potential.

Perspective Transition of Forests in Haryana

Thrust Area-1. Greening of Haryana by increasing Forest and Tree cover

The National Forest policy envisages having at least 33% of the total geographical area of the country under forest and tree cover. But, Haryana being an agriculture state, it may not be possible to achieve that mandate. In an endeavour to come closer to the National Forest Policy goal, the State Forest Department is making all out efforts. A State Forest Policy has been formulated in the year 2006. The policy aims at increasing the forest and tree cover in Haryana State from the present 6.80% (FSI Report 2009) to 20% in a phased manner. Haryana is one of the few States in the country which have formulated their own State Forest Policy.

Tree cover (mainly constituting trees growing outside forest lands) can be increased in the state by growing large number of trees on private farmlands, i.e., through agro-forestry and farm forestry. Our vision is to have at least 20% geographical area of the state under forest and tree cover eventually. In order to increase such green cover in the state, besides rehabilitating wastelands and improving density of government forestlands, massive agro-forestry work must be undertaken on farmlands in participation with the rural people. Special emphasis need to be given to green southern region of Haryana that is arid and semi-arid.

Strategy

- To bring forest and tree cover to 20% in a phased manner.
- To involve rural people, especially women, in raising forest nurseries so that agro-forestry could become people's movement.
- To encourage formation of tree-growers cooperative societies in rural areas.
- To establish organised timber markets (Mandis) in important districts of the state to facilitate trade in agro-forestry produce. Timber market at Yamunanagar is being established in the first phase. Another timber market can be established at Rohtak, being central place in the state.

- To establish agro-forestry demonstration and extension centres in all the districts of the state in phased manner.
- To develop high yielding and disease resistant clones of eucalyptus, poplar, teak, ailanthus, jand etc. for sale and distribution in agro-forestry.
- To promote research for developing new agro-forestry models.
- To improve tree density of forest areas and protect these from wild fires, disease, grazing and illicit fellings.
- To afforest all degraded and blank forestlands, strips, wastelands, community lands, panchayat lands and institutional lands.

Thrust Area-2. Developing Haryana into a Medicinal Plant State

India has a very old tradition of herbal system of medicine. The state of Haryana, especially the Shiwalik hills, is rich in flora of medicinal plants. However, due to unchecked exploitation, the availability of these plants in the wild is limited or nearly extinct. Cultivation of these medicinal plants outside forest has a great scope for bringing about economic development of the state and its farming community. Haryana is a state with agricultural traditions and its people are sturdy, innovative and keen on diversification of crops. The state is endowed with a wide range of climate and soil conditions where a variety of important medicinal plants can be grown. Villagers will be encouraged to take up cultivation of these medicinal plants, using participatory approach, by providing them with seeds, cultivation techniques and marketing support.

In order to encourage this activity, a State Medicinal Plants Board (SMPB) has been constituted to promote the cultivation of medicinal plants on farm lands with Horticulture department as the nodal department whereas Forest department has been made as the nodal department for promotion of cultivation of medicinal plants on forest lands. Linkages need to be developed with sister organizations, such as Agriculture, Rural Development and Horticulture, and an integrated approach is to be employed through SMPB to promote medicinal plant cultivation in the state. Two agro-climatic zones have been identified in the state, namely South-West (arid and semi-arid) and North-East (irrigated and high rainfall) for the purpose of cultivating suitable medicinal plants, such as Isabgol, Mulethi, Ashgandha, Sanai, Satawar, Gurmar, Aloe-vera, Aonla, Guggal, Safed Musli, Sarapgandha, Konch, Haldi, Amahaldi, Harar, Vach, Akarkara and Bahera.

Forest department established one Herbal Park at village Chuharpur in district Yamunanagar where over 300 species of medicinal plants are being cultivated. The State Govt. took initiative to set up Herbal Parks in every district to generate awareness about traditional Indian system of medicine and to encourage farmers for diversification of agriculture by promoting cultivation of medicinal plants. So far 28 Herbal Parks, one in each district, have already been set up and 4 Herbal Parks are under establishment. Cultivation of medicinal plants outside forest has a great scope for bringing about economic development of the state and its farming community.

Table 26. List of Herbal Parks already established by the department in Haryana.

District	Name of Herbal Park	Location
Ambala	Harar Vatika	Old Officers Colony
Ambala	Herbal Park	Ambala Cantt
Bhiwani	Ch. Surender Singh Memorial Park	Kairu R.F.
Bhiwani	Ch. Surender Singh Memorial Park	Tosham PF
Faridabad	Ratanjot Vatika	Gurgaon Canal, Faridabad
Fatehabad	Mulethi Vatika	Gilakhera
Gurgaon	Anwala Herbal Vatika	Sohna RF
Hissar	Shatavar Vatika	Bir Hissar
Jhajjar	Putranjiva Vatika	Kamalgarh
Jhajjar	Herbal Park Bhindawas	Bhindawas
Jind	Chandan Vatika	Gohana Road, Jind
Jind	Herbal Park	Kahsoon (under establishment)
Kaithal	Jamun Vatika	Siwan RF

Karnal	Ashok Vatika	Gharaunda
Karnal	Herbal Park	Indri (under establishment)
Kurukshetra	Arjun Vatika	Rawgarh
Mewat	Aloevera Vatika	Sonkh Panchayat Land
Mahendergarh	Guggal Vatika	Salimabad RF
Mahendergarh	Dhosi Vatika	Kultajpur
Panchkula	Kapur Vatika	DP-244, Mallah
Panchkula	Thapli Herbal Park	Village Thapli
Panchkula	Tikar- Tal Herbal Park	Tikar- Tal (under establishment)
Panipat	Bilva Vatika	Patti Kalyana
Rewari	Ashwaganda Vatika	Devlawas
Rewari	Khalilpuri Vatika	Khalilpuri
Rewari	Herbal Park	Kakodia (under establishment)
Rohtak	Neem Vatika	Samar Gopalpur
Sirsa	Bahera Vatika	Phoolkan
Sonepat	Amaltas Vatika	HAIC Murthal
Sonepat	Khanpur Kalan Herbal Park	Khanpur
Yamunanagar	Rudraksh Vatika	Chuharpur Village
Yamunanagar	Adibadri Vatika	Adibadri

Strategy

- To provide wide publicity and extension services to encourage farmers and others for taking up cultivation of such medicinal plants.
- To establish more Herbal Parks, Herbal Gyan Kendras and demonstration centres.
- To provide additional budgetary support to State Medicinal Plant Board to promote cultivation of medicinal plants.
- To provide training and organise seminars/workshops and field visits of villagers to study cultivation, processing and marketing of medicinal plants.
- To include more and more medicinal plant species in afforestation activities inside and outside forests.
- To strengthen market intelligence and information system for the benefit of farmers.
- To provide marketing support in collaboration with pharmaceutical companies and to involve Haryana Forest Development Corporation in purchase and storage of non-perishable produces wherever and whenever necessary.

Thrust Area–3. Making Haryana a Centre for Eco-tourism

Haryana by virtue of its location, vast network of roads and wide range of habitats for wildlife, especially birds, has vast potential to be developed as a centre for eco-tourism in the country. Haryana may not have big wild animals such as rhino, elephants, lions or tigers, but it is rich in birdlife, including migratory birds. Over 500 bird species have been recorded in the state that constitutes about 40% of total bird species recorded in the country. The state as a whole can be developed into a paradise for bird watchers, especially during winter months from October till February end. Bombay Natural History Society has identified five Important Bird Areas (IBA) in the state, namely Sultanpur NP, Basai wetland (Gurgaon), Bhindawas sanctuary (Jhajjar), Kalesar NP and Jamuna wetlands (Yamunanagar). Haryana has taken initiative to establish a Bird Safari (Berwala, Panchkula) for eco-tourism, Vulture Care Centre (Pinjore, Panchkula) for conservation, captive breeding and recovery of rapidly diminishing population of Gyps vulture and a breeding centre for Red Jungle Fowl (Morni, Panchkula) for ex-situ conservation of its pure gene-pool. By developing bird and wildlife habitats, promoting publicity and extension activities and improving infrastructure facilities for recreation and scientific studies, Haryana can become a centre for eco-tourism.

Two projects for development of eco-tourism in the state have been sanctioned by the Ministry of Tourism, Government of India. The Eco-tourism society of Haryana is also being constituted to

regulate the management of Eco-tourism activities in the state. Brief outlines of the two sanctioned projects are:

(i) **Development of Eco-tourism in Kalesar Protected Area:** This project has been sanctioned for Rs. 31.3 million. The activities include development of nature camp sites near Kalesar, nature trails, extension of forest rest houses at Kalesar and Darpur, development/extension of herbal park at Chuharpur, development/extension of facilities of Sarswati Udgam Sthal at Adi Badri and construction of adequate water bodies at appropriate locations.

(ii) **Development of Eco-tourism in Morni-Pinjore hills and Sultanpur National Park:** This project has been sanctioned for Rs. 32.9 million. The activities include development of tourist facilities at Morni Fort including its renovation, at Tikkar and Bara Tals in Morni, at Berwala Bird Safari near Panchkula, extension of forest rest house at Morni, development of herbal park at Mallah, nature care centre at Thapli, construction of watch towers and extension of facilities at Sultanpur National Park

Strategy

- To develop infrastructure for eco-tourism, such as camping areas, recreation and picnic spots, watch-towers, binoculars, guided tours, nature trails, etc. in forest, National Parks, Wildlife Sanctuaries and Important Bird Areas.
- To select, register and train guides for bird watching and eco-tourism.
- To increase publicity and extension activities to attract tourists to National Parks, Sanctuaries and important bird areas in the state.
- To conduct regular census of all important wildlife species.
- To systematically reduce the use of such chemicals and drugs that adversely affect birds and to promote development of ecologically safer alternatives.
- To develop database on flora and fauna in the state.
- To identify and develop additional sites for eco-tourism in the state.
- To identify and develop banks of Yamuna river and other additional sites for eco-tourism in the state.

Thrust Area–4. Modernisation of the Haryana Forest Department

The goals stated in the vision of the Forest Department can be realized only if its manpower is up to date with latest skills and knowledge. That makes development of Haryana Forest Department into an efficient and user-friendly organisation as an important thrust area. Although the Department is manned by trained personnel, it is imperative for them to modernize themselves by keeping abreast with the latest technologies, especially those related to Information & Communication Technology.

Management Information System (MIS) and Geographical Information System (GIS) are significant tools for scientific planning and management. These are being developed to improve efficiency in accounts, administration, forest and wildlife management and personnel management. Haryana Forest Department in collaboration with National Remote Sensing Centre, Hyderabad and Haryana Space Application Centre (HARSAC), Hisar is developing Geographical Information System (GIS) for the districts of Yamaunnagar and Panchkula. Mapping of forest boundaries, National Parks, Wildlife Sanctuaries and Eco-Sensitive Zones is being carried out with the help of Global Positioning Systems (GPS).

A Memorandum of Understanding (MoU) has been signed by the department with Madhya Pradesh Forest Department (MPFD) for development/strengthening of Forest Management Information System (FMIS). Decision Support Systems (DSSs) like Forest Land Management System (FLMS), Wildlife Management System (WLMS), Forest Plantation Management System(FPMS), Forest Enumeration Management System (FEMS) and Forest Offence Management System (FOMS) are being developed with the assistance with MPFD for implementation in the department.

The department has also developed its Website http://www.haryanaforest.gov.in.The information related to various activities of the department has been uploaded on this website.
There is need to have forestry personnel well trained in the use of these technologies and software.

Strategy

- To make use of Information and Communication Technology within the department by using computer facilities being provided upto range level.
- To develop Management Information System (MIS) for all subjects/themes handled by the department, such as personnel and general administration, forest areas, wildlife, stores and inventory, forest produce, plantations, forest fires, etc. to provide transparency and accountability in departmental functioning.
- To strengthen the MIS/GIS cell at the headquarters and to procure work stations, satellite data/imageries, GIS and Digital Image Processing software for efficient forest and wildlife management and monitoring.
- To make extensive use of Global Positioning System (GPS) for mapping and monitoring of forest boundaries, fire affected areas, plantations, watersheds and wastelands in the state.
- To generate all relevant databases and to update these on regular basis.
- To train forestry personnel in use of these technologies and software.